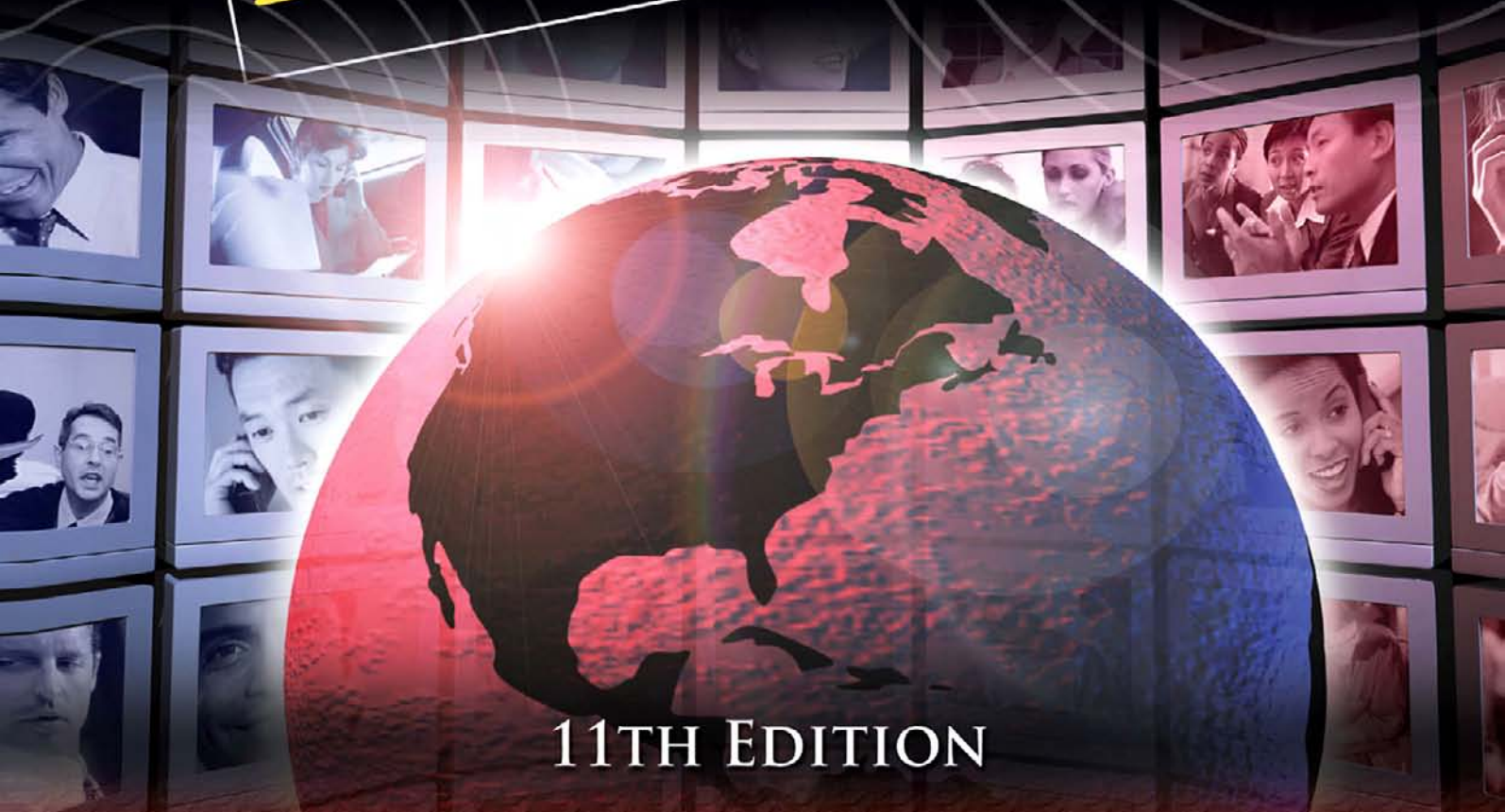


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COMMUNICATION TECHNOLOGY UPDATE AND FUNDAMENTALS



11TH EDITION

August E. Grant

Jennifer H. Meadows

In Association with Technology Futures Inc.



Communication Technology Update and Fundamentals

11th Edition

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Editors

August E. Grant

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Communication Technology Update and Fundamentals Home Page
<http://www.tfi.com/ctu/>

Preface

The book you are holding says “11th edition,” but it is significantly different from any of the previous 10 editions of the *Communication Technology Update*. In addition to the “Updates,” we have added a complete section on the “Fundamentals” of studying communication technology. This change is in keeping with the spirit of the *Communication Technology Update* series, which embraces constant change. In this case, we believe changing the scope of the book corresponds with the rapid pace of change in the field.

The one thing that all of these chapters has in common is that they are written by scholars who are passionate about the subject of each chapter. Individually, the chapters provide snapshots of the state of the field for individual technologies, but together they present a broad overview of the role that communication technologies play in our everyday lives. We are grateful to these scholars for their efforts to provide you with the latest information on tight deadlines: authors were asked to refrain from beginning work on their chapters until January 2008, most chapters were submitted in April, and final details were added in May 2008. The efforts of these authors have produced a remarkable compilation, and we thank them for all of their hard work in preparing this volume.

The impetus for expanding the scope of the book to include the *Fundamentals* came from a series of conversations with readers and users of the book, which led to a series of discussions with Focal Press’s Elinor Actipis, who, along with Michelle Cronin, provided encouragement and feedback to help guide the new structure. TFI’s Deb Robison again played the pivotal role in production, moving all 24 chapters from draft to camera-ready and creating an index in record time. Helen Mary Marek also provided on-demand graphics production, adding visual elements to help make the content more understandable.

Another important change we’ve made in this edition is moving some important information to the companion Web site for the *Communication Technology Update* (www.tfi.com/ctu) so that information will be more accessible and easier to use. The complete Glossary for the book is on the site, where it will be much easier to find individual entries than in the paper version of the book. We have also moved the vast quantity of statistical data on each of the communication technologies that were formerly printed in Chapter 2. Our long-term goal is to continue to add content and value to the Web site, allowing you to stay better informed about these technologies. As always, we will periodically update the Web site to supplement the text with new information and links to a wide variety of information available over the Internet.

Preface

As a reader of this book, you are also part of the *Communication Technology Update* community. Each edition of this book has been improved over previous editions with the help of input from readers like you. You are also invited to send us updates for the Web site, ideas for new topics, and other contributions that will inform all members of the community. You are invited to communicate directly with us via e-mail, snail mail, or voice.

Thank you for being part of the CTU community!

Augie Grant and Jennifer Meadows
May 15, 2008

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Introduction to Communication Technologies

August E. Grant, Ph.D.^{*}

We are surrounded by communication technologies. They are critical to commerce, essential to entertainment, and intertwined in our interpersonal relationships. In short, communication technology is the nervous system of contemporary society, transmitting and distributing sensory and control information and interconnecting a myriad of interdependent units. Because these technologies are vital to commerce, control, and maintaining interpersonal relationships, any change in communication technologies has the potential for profound impacts on virtually every area of society.

One of the hallmarks of the industrial revolution was the introduction of new communication technologies as mechanisms of control that played an important role in almost every area of the production and distribution of manufactured goods (Beniger, 1986). These communication technologies have evolved throughout the past two centuries at an increasingly rapid rate. This evolution shows no signs of slowing, so an understanding of this evolution is vital for any individual wishing to attain or retain a position in business, government, or education.

The economic and political challenges faced by the United States and other countries since the beginning of the new millennium clearly illustrate the central role these communication systems play in our society. Just as the prosperity of the 1990s was credited to advances in technology, the economic challenges that followed were linked as well to a major downturn in the technology sector. Today, communication technology is seen by many as a tool for reducing the need for, and making more efficient use of, energy sources, especially oil.

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Communication technologies play as big a part in our private lives as they do in commerce and control in society. Geographic distances are no longer barriers to relationships thanks to the bridging power of communication technologies. We can also be entertained and informed in ways that were unimaginable a century ago thanks to these technologies—and they continue to evolve and change before our eyes.

This text provides a snapshot of the process of technological evolution. The individual chapter authors have compiled facts and figures from hundreds of sources to provide the latest information on more than two dozen communication technologies. Each discussion explains the roots and evolution, recent developments, and current status of the technology as of mid-2008. In discussing each technology, we will address these technologies from a systematic perspective, looking at a range of factors beyond hardware.

The goal is to help you analyze technologies and be better able to predict which ones will succeed and which ones will fail. That task is harder to achieve than it sounds. Let's look at Google for an example of how unpredictable technology is.

The Google Tale

As this book goes to press in mid-2008, Google is the most valuable media company in the world in terms of market capitalization (the total value of all shares of stock held in the company). To understand how Google attained that lofty position, we have to go back to the late 1990s, when commercial applications of the Internet were taking off. There was no question in the minds of engineers and futurists that the Internet was going to revolutionize the delivery of information, entertainment, and commerce. The big question was how it was going to happen.

Those people who saw the Internet as a medium for distribution of information knew that advertiser support would be critical to its long-term financial success. They knew that they could always find a small group willing to pay for content, but the majority of people preferred free content. To become a mass medium similar to television, newspapers, and magazines, an Internet advertising industry was needed.

At that time, most Internet advertising was banner ads, horizontal display ads that stretched across most of the screen to attract attention, but took up very little space on the screen. The problem was that most people at that time accessed the Internet using slow dial-up connections, so advertisers were limited in what they could include in these banners to about a dozen words of text and simple graphics. The dream among advertisers was to be able to use rich media, including full-motion video, audio, animation, and every other trick that makes television advertising so successful.

When broadband Internet access started to spread, advertisers were quick to add rich media to their banners, as well as create other types of ads using graphics, video, and sound. These ads were a little more effective, but many Internet users did not like the intrusive nature of rich media messages.

At about the same time, two Stanford students, Sergey Brin and Larry Page, had developed a new type of search engine that ranked results on the basis of how often content was referred to or linked from other sites, allowing their computer algorithms to create more robust and relevant search results (in most cases) than having a staff of people indexing Web content. But they needed a way to pay for the costs of the servers and other technology.

According to Vise & Malseed (2006), the budget did not allow Google to create and distribute rich media ads. They could do text ads, but they decided to do them differently from other Internet advertising, using computer algorithms to place these small text ads on the search results that were most likely to give the advertisers results. With a credit card, anyone could use this “AdWords” service, specifying the search terms they thought should display their ads, writing the brief ads (less than 100 characters total—just over a dozen words), and even specifying how much they were willing to pay every time someone clicked on their ad. Even more revolutionary, the Google founders decided that no one should have to pay for an ad unless a user clicked on it.

For advertisers, it was as close to a no-lose proposition as they could find. Advertisers did not have to pay unless a person was interested enough to click on the ad. They could set a budget that Google computers could follow, and Google provided a control panel for advertisers that gave a set of measures that was a dream for anyone trying to make a campaign more effective. These measures indicated not only overall effectiveness of the ad, but also the effectiveness of each message, each keyword, and every part of every campaign.

The result was remarkable. Google’s share of the search market was not that much greater than the companies that had held the number one position earlier, but Google was making money—lots of money—from these little text ads. Wall Street investors noticed, and, once Google went public, investors continually bid up the stock price, spurred by increases in revenues and a very large profit margin. Today, Google is involved in a number of other ventures designed to aggregate and deliver content ranging from text to full-motion video, but its little text ads are still the primary revenue generator.

In retrospect, it was easy to see why Google was such a success. Their little text ads were effective because of context—they always appeared where they would be the most effective. They were not intrusive, so people did not mind the ads on Google pages, and later on other pages that Google served ads to through its “content network.” And advertisers had a degree of control, feedback, and accountability that no advertising medium had ever offered before (Grant & Wilkinson, 2007).

So what lessons should we learn from the Google story? Advertisers have their own set of lessons, but there are a separate set of lessons for those wishing to understand new media. First, no matter how insightful, no one is ever able to predict whether a technology will succeed or fail. Second, success can be due as much to luck as to careful, deliberate planning and investment. Third, simplicity matters—there are few advertising messages as simple as the little text ads you see when doing a Google search.

The Google tale provides an example of the utility of studying individual companies and industries, so the focus throughout this book is on individual technologies. These individual snapshots, however, comprise a larger mosaic representing the communication networks that bind individuals together and enable them to function as a society. No single technology can be understood without understanding the competing and complementary technologies and the larger social environment within which these technologies exist. As discussed in the following section, all of these factors (and others) have been considered in preparing each chapter through application of the “umbrella perspective.” Following this discussion, an overview of the remainder of the book is presented.

The “Umbrella Perspective” on Communication Technology

The most obvious aspect of communication technology is the hardware—the physical equipment related to the technology. The hardware is the most tangible part of a technology system, and new technologies typically spring from developments in hardware. However, understanding communication technology requires more than just studying the hardware. It is just as important to understand the messages communicated through the technology system. These messages will be referred to in this text as the “software.” It must be noted that this definition of “software” is much broader than the definition used in computer programming. For example, our definition of computer software would include information manipulated by the computer (such as this text, a spreadsheet, or any other stream of data manipulated or stored by the computer), as well as the instructions used by the computer to manipulate the data.

The hardware and software must also be studied within a larger context. Rogers’ (1986) definition of “communication technology” includes some of these contextual factors, defining it as “the hardware equipment, organizational structures, and social values by which individuals collect, process, and exchange information with other individuals” (p. 2). An even broader range of factors is suggested by Ball-Rokeach (1985) in her media system dependency theory, which suggests that communication media can be understood by analyzing dependency relations within and across levels of analysis, including the individual, organizational, and system levels. Within the system level, Ball-Rokeach (1985) identifies three systems for analysis: the media system, the political system, and the economic system.

These two approaches have been synthesized into the “Umbrella Perspective on Communication Technology” illustrated in Figure I.1. The bottom level of the umbrella consists of the hardware and software of the technology (as previously defined). The next level is the organizational infrastructure: the group of organizations involved in the production and distribution of the technology. The top level is the system level, including the political, economic, and media systems, as well as other groups of individuals or organizations serving a common set of functions in society. Finally, the “handle” for the umbrella is the individual user, implying that the relationship between the user and a technology must be examined in order to get a “handle” on the technology. The basic premise of the umbrella perspective is that all five areas of the umbrella must be examined in order to understand a technology.

(The use of an “umbrella” to illustrate these five factors is the result of the manner in which they were drawn on a chalkboard during a lecture in 1988. The arrangement of the five attributes resembled an umbrella, and the name stuck. Although other diagrams have since been used to illustrate these five factors, the umbrella remains the most memorable of the lot.)

It is also helpful to add another layer of complexity to each of the five areas of the umbrella. In order to identify the impact that each individual characteristic of a technology has, the factors within each level of the umbrella may be identified as “enabling,” “limiting,” “motivating,” and “inhibiting,” depending upon the role they play in the technology’s diffusion.

Enabling factors are those that make an application possible. For example, the fact that the coaxial cable used to deliver traditional cable television can carry dozens of channels is an enabling factor at the hardware level. Similarly, the decision of policy makers to allocate a portion of the spectrum for cellular telephony is an

enabling factor at the system level (political system). One starting point to use in examining any technology is to make a list of the underlying factors from each area of the umbrella that make the technology possible in the first place.

Figure 1.1

The Umbrella Perspective on Communication Technology



Source: A. E. Grant

Limiting factors are the opposite of enabling factors; they are those factors that create barriers to the adoption or impacts of a technology. A great example is related to the cable television example above. Although coaxial cable increased the number of television programs that could be delivered to a home, most analog coaxial networks cannot transmit more than 100 channels of programming. To the viewer, 100 channels might seem to be more than is needed, but to the programmer of a new cable television channel unable to get space on a filled-up cable system, this hardware factor represents a definite limitation. Similarly, the fact that the policy makers discussed above initially permitted only two companies to offer cellular telephone service in each market was a system-level limitation on that technology. Again, it is useful to apply the umbrella perspective to create a list of the factors that limit the adoption, use, or impacts of any specific communication technology.

Motivating factors are a little more complicated. They are those factors that provide a reason for the adoption of a technology. Technologies are not adopted just because they exist. Rather, individuals, organizations, and social systems must have a reason to take advantage of a technology. The desire of local telephone companies for increased profits, combined with the fact that growth in providing local telephone service is limited, is an organizational factor motivating the telcos to enter the markets for new communication technologies. Individual users desiring information more quickly can be motivated to adopt electronic information technologies. If a technology does not have sufficient motivating factors for its use, it cannot be a success.

Inhibiting factors are the opposite of motivating ones, providing a disincentive for adoption or use of a communication technology. An example of an inhibiting factor at the software level might be a new electronic information technology that has the capability to update information more quickly than existing technologies, but provides only "old" content that consumers have already received from other sources. One of the most im-

portant inhibiting factors for most new technologies is the cost to individual users. Each potential user must decide whether the cost is worth the service, considering his or her budget and the number of competing technologies. Competition from other technologies is one of the biggest barriers any new (or existing) technology faces. Any factor that works against the success of a technology can be considered an inhibiting factor. As you might guess, there are usually more inhibiting factors for most technologies than motivating ones. And if the motivating factors are more numerous and stronger than the inhibiting factors, it is an easy bet that a technology will be a success.

All four factors—enabling, limiting, motivating, and inhibiting—can be identified at the system, organizational, software, and individual user levels. However, hardware can only be enabling or limiting; by itself, hardware does not provide any motivating factors. The motivating factors must always come from the messages transmitted (software) or one of the other levels of the umbrella.

The final dimension of the umbrella perspective relates to the environment within which communication technologies are introduced and operate. These factors can be termed “external” factors, while ones relating to the technology itself are “internal” factors. In order to understand a communication technology or be able to predict the manner in which a technology will diffuse, both internal and external factors must be studied and compared.

Each communication technology discussed in this book has been analyzed using the umbrella perspective to ensure that all relevant factors have been included in the discussions. As you will see, in most cases, organizational and system-level factors (especially political factors) are more important in the development and adoption of communication technologies than the hardware itself. For example, political forces have, to date, prevented the establishment of a single world standard for high-definition television (HDTV) production and transmission. As individual standards are selected in countries and regions, the standard selected is as likely to be the product of political and economic factors as of technical attributes of the system.

Organizational factors can have similar powerful effects. For example, as discussed in Chapter 4, the entry of a single company, IBM, into the personal computer business in the early 1980s resulted in fundamental changes in the entire industry, dictating standards and anointing an operating system (MS-DOS) as a market leader. Finally, the individuals who adopt (or choose not to adopt) a technology, along with their motivations and the manner in which they use the technology, have profound impacts on the development and success of a technology following its initial introduction.

Perhaps the best indication of the relative importance of organizational and system-level factors is the number of changes individual authors made to the chapters in this book between the time of the initial chapter submission in March 2008 and production of the final, camera-ready text in May 2008. Very little new information was added regarding hardware, but numerous changes were made due to developments at the organizational and system levels.

To facilitate your understanding of all of the elements related to the technologies explored, each chapter in this book has been written from the umbrella perspective. The individual writers have endeavored to update developments in each area to the extent possible in the brief summaries provided. Obviously, not every technology experienced developments in each of the five areas, so each report is limited to areas in which relatively recent developments have taken place.

So Why Study New Technologies?

One constant in the study of media is that new technologies seem to get more attention than traditional, established technologies. There are many reasons for the attention. New technologies are more dynamic and evolve more quickly, with greater potential to cause change in other parts of the media system. Perhaps the reason for our attention is the natural attractions that humans have to motion, a characteristic inherited from our most distant ancestors.

There are a number of other reasons for studying new technologies. Perhaps you want to make a lot of money off a new technology—and there is a lot of money to be made (and lost!) on new technologies. If you are planning a career in the media, you might simply be interested in knowing how the media are changing and evolving, and how those changes will affect your career.

Or you might want to learn lessons from the failure of new communication technologies so you can avoid failure in your own career, investments, etc. It is a simple fact that the majority of new technologies introduced do not succeed in the market. Some fail because the technology itself was not attractive to consumers (such as the 1980's attempt to provide AM stereo radio). Some fail because they were far ahead of the market, such as Qube, the first interactive cable television system, introduced in the 1970s. Others failed because of bad timing or aggressive marketing from competitors that succeeded despite inferior technology.

The final reason we offer for studying new communication technologies is to identify patterns of adoption, effects, economic opportunity, and competition so that we can be prepared to understand, use, and/or compete with the next generation of new media. Virtually every new technology discussed in this book is going to be one of those “traditional, established technologies” in just a few short years, but there will always be another generation of new media to challenge the status quo.

Overview of Book

The key to getting the most out of this book is therefore to pay as much attention to the reasons that some technologies succeed and other fail. To that end, this book provides you with a number of tools you can apply to virtually any new technology that comes along. These tools are explored in the first five chapters, which we refer to as the *Communication Technology Fundamentals*. You might be tempted to skip over these to get to the “fun facts” about the individual technologies that are making an impact today, but you will be much better equipped to learn lessons from these technologies if you are armed with these tools.

The first of these is the “umbrella perspective” discussed above that broadens attention from the technology itself to the users, organizations, and system surrounding that technology. To that end, each of the technologies explored in this book provides details about all of the elements of the umbrella.

Of course, studying the history of each technology can help you find patterns and apply them to different technologies, times, and places. In addition to including a brief history of each technology, the following chapter, Historical Perspectives on Communication Technologies, provides a broad overview of most of the technologies discussed later in the book, allowing a comparison along a number of dimensions: the year each was first introduced, growth rate, number of current users, etc. This chapter anchors the book to highlight

commonalties in the evolution of individual technologies, as well as present the “big picture” before we delve into the details. By focusing on the number of users over time, this chapter also provides the most useful basis of comparison across technologies.

Another useful tool in identifying patterns across technologies is the application of theories related to new communication technologies. By definition, theories are general statements that identify the underlying mechanisms for adoption and effects of these new technologies. Chapter 3 provides an overview of a wide range of these theories and provides a set of analytic perspectives that you can apply to both the technologies in this book and to any new technology that will follow.

The structure of communication industries is then addressed in Chapter 4. The complexity of organizational relationships, along with the need to differentiate between the companies that make the technologies and those that sell the technologies, are explored in this chapter. The most important force at the highest level of the umbrella, regulation, is then introduced in Chapter 5.

These introductory chapters provide a structure and a set of analytic tools that define the study of communication technologies in all forms. Following this introduction, the book then addresses the individual technologies.

The technologies discussed in this book have been organized into three sections: electronic mass media, computers and consumer electronics, and networking technologies. These three are not necessarily exclusive; for example, Internet video technologies could be classified as either an electronic mass medium or a computer technology. The ultimate decision regarding where to put each technology was made by determining which set of current technologies most closely resembled the technology from the user’s perspective. Thus, Internet video was classified with electronic mass media. This process also locates the discussion of a cable television technology—cable modems—in the “Broadband and Home Networks” chapter in the Networking Technology section.

Each chapter is followed by a brief bibliography. These reference lists represent a broad overview of literally thousands of books and articles that provide details about these technologies. It is hoped that the reader will not only use these references, but will examine the list of source material to determine the best places to find newer information since the publication of this *Update*.

Most of the technologies discussed in this book are continually evolving. As this book was completed, many technological developments were announced but not released, corporate mergers were under discussion, and regulations had been proposed but not passed. Our goal is for the chapters in this book to establish a basic understanding of the structure, functions, and background for each technology, and for the supplementary Internet home page to provide brief synopses of the latest developments for each technology. (The address for the home page is <http://www.tfi.com/ctu..>)

The final two chapters return to the “big picture” presented in this book. The first of these two chapters discusses a set of developments that may revolutionize the entire field of communication technologies as much as the Internet has: the revolution in mobile communication technologies. The final chapter then attempts to place these discussions in a larger context, noting commonalties among the technologies and trends over time. It is impossible for any text such as this one to ever be fully comprehensive, but it is hoped that this text will provide you with a broad overview of the current developments in communication technology.

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Historical Perspectives on Communication Technology

Dan Brown, Ph.D.*

The history of communication technologies can be examined from many perspectives: telling stories about the creators, discussing the impacts of the technologies, or analyzing competition among these technologies. Each chapter in this book provides a brief history of the technology discussed in that chapter, but it is also important to provide a “big picture” discussion that allows you to compare technologies.

For that type of comparison, the most useful perspective is one that allows comparisons among technologies across time: numerical statistics of adoption and use of these technologies. To that end, this chapter follows patterns adopted in previous summaries of trends in U.S. communications media (Brown & Bryant, 1989; Brown, 2006). To aid in understanding rates of adoption and use, the premise for this chapter is that non-monetary measures such as the number of users or percentage of adoption are a more consistent evaluation of a technology’s impact than the dollar value of sales. More meaningful media consumption trends emerge from examining changes in non-monetary media units and penetration (i.e., percentage of marketplace use, such as households) rather than on dollar expenditures, although frequent mentions of dollar expenditures are offered. Box office receipts from motion pictures offers a notable exception; here, the dollar figure has emerged as the de facto standard of measuring movie acceptance in the market.

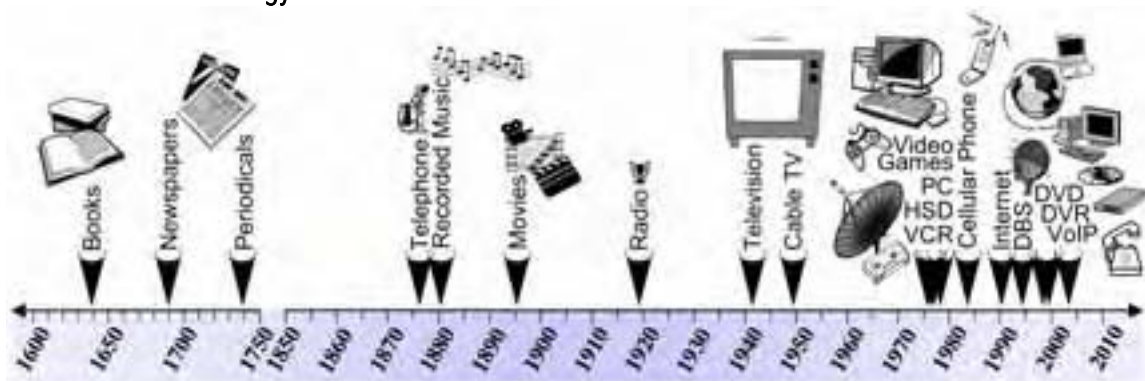
Another premise of this chapter is that government sources should provide as much of the data as possible. Researching the growth or sales figures of various media over time quickly reveals conflict in both dollar figures and units shipped or consumed. Government sources sometimes display the same variability seen in private sources, as the changes in the types of data used for reporting annual publishing of book titles will show. Government sources, although frequently based on private reports, provide some consistency to the reports, although many government reports in recent years offered inconsistent units of measurement and dis-

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continued annual market updates. Readers should use caution in interpreting data for individual years and instead emphasize the trends over several years. One limitation of this government data is the lag time before statistics are reported, with the most recent data being a year or more old. To compensate for the delay, the companion Web site for this book (www.tfi.com/ctu) reports more up-to-date statistics than could be printed in this chapter.

Figure 2.1 illustrates relative startups of various media types and the increase in the pace of introduction of new media technologies. This rapid increase in development is the logical consequence of the relative degree of permeation of technology in recent years versus the lack of technological sophistication of earlier eras. This figure and this chapter exclude several media that the marketplace abandoned, such as quadraphonic sound, 3D television, CB radios, 8-track audiotapes, and 8mm film cameras. Other media that receive mention have already and may yet suffer this fate. For example, long-playing vinyl audio recordings, audiocassettes, and compact discs seem doomed in the face of rapid adoption of newer forms of digital audio recordings. This chapter traces trends that reveal clues about what has happened and what may happen in the use of respective media forms.

Figure 2.1
Communication Technology Timeline



Source: Technology Futures, Inc.

To help illustrate the growth rates and specific statistics regarding each technology, a large set of tables and figures have been placed on the companion Web site for this book at www.tfi.com/ctu. Your understanding of each technology will be aided by referring to the Web site as you read each section. To help, each discussion makes specific reference to the tables and figures on the Web site.

Print Media

The U.S. printing industry is the largest such industry among the printing countries of the world (U.S. Department of Commerce/International Trade Association, 2000). The U.S. Bureau of the Census (2006) lists more than 80,000 publishing industry establishments involved in print media. These include publishers of newspapers, periodicals, books, databases, directories, greeting cards, and other print media.

Newspapers

Publick Occurrences, Both Foreign and Domestick was the first newspaper produced in North America, appearing in 1690 (Lee, 1917). As illustrated in Table 2.1 and Figure 2.2 from the companion Web site for this book (www.tfi.com/ctu), U.S. newspaper firms and newspaper circulation had extremely slow growth until the 1800s. Early growth suffered from relatively low literacy rates and the lack of discretionary cash among the bulk of the population. The progress of the industrial revolution brought money for workers and improved mechanized printing processes. Lower newspaper prices and the practice of deriving revenue from advertisers encouraged significant growth beginning in the 1830s. Newspapers made the transition from the realm of the educated and wealthy elite to a mass medium serving a wider range of people from this period through the Civil War era (Huntzicker, 1999).

The Mexican and Civil Wars stimulated public demand for news by the middle 1800s, and modern journalism practices, such as assigning reporters to cover specific stories and topics, began to emerge. Circulation wars among big city newspapers in the 1880s featured sensational writing about outrageous stories. Both the number of newspaper firms and newspaper circulation began to soar. Although the number of firms would level off in the 20th century, circulation continued to rise.

The number of morning newspapers more than doubled after 1950, despite a 16% drop in the number of daily newspapers over that period. Circulation remained higher at the start of the new millennium than in 1950, although it inched downward throughout the 1990s. Although circulation actually increased in many developing nations, both U.S. newspaper circulation and the number of U.S. newspaper firms remain lower than the respective figures posted in the early 1990s. The decline in 2003 reversed a string of five consecutive years of small increases in the number of American newspaper firms that began in 1998, but the figure increased again in the following year.

Newspaper circulation, however, enjoyed no increases in this period. In fact, the last increase in annual circulation occurred in 1987. The average hours spent with daily newspapers per person per year declined annually from 201 hours in 2000 to 184 hours in 2005 (U.S. Bureau of the Census, 2008).

More precipitous drops than usual in newspaper circulation occurred in the six-month period that ended in March 2005, spurred by a scandal revealing exaggerated circulation reports from newspapers owned by Hollinger International, Inc. The Securities and Exchange Commission subsequently asked for reports from many other prominent newspapers concerning their circulation figures, and many organizations tightened their reporting practices. Circulation checks are routinely performed by the Audit Bureau of Circulation, a nonprofit organization created by advertisers and publishers to verify claims made by publishers.

Newspaper operations in the United States are largely concentrated in a few companies. Among the 1,455 American daily newspapers operating in 2006, 24% of the total circulation was generated by top 20 newspapers. The largest 10 newspaper owners held more than 260 newspapers and accounted for about 44% of the industry circulation (Peters & Donald, 2007).

In the six-month period ending in March 2007, the daily circulation of all the newspapers audited by the Audit Bureau of Circulation fell by 2.1% from that of the same period in the previous year. Circulation of Sunday newspapers declined in the same period by 3.1%, and only six of the top 20 American newspapers experienced an increase in circulation (Peters & Donald, 2007). Factors that produced declining newspaper circulation included new federal rules restricting telemarketing, changing consumer patterns in the face of competi-

tion from other media (including increasing use of the Internet for news and entertainment), a shrinking pool of newspaper readers, and growing popularity of free newspapers supported only by advertising sales (Peters & Donald 2005; 2007).

Newspaper advertising revenues have been declining for about 50 years, going back to the growth of broadcast television, cable, and more recently the Internet. In the 10-year interval that ended in 2006, media advertising increased by 4.9%. During that period, newspaper advertising grew annually by an average of 3.3%, while national cable television advertising increased by 11.3% and Internet advertising grew by 45% (Peters & Donald, 2007). The slide in circulation continued in the six-month period ending on March 31, 2007, as data from the Audit Bureau of Circulation (as cited by Perez-Pena, 2007) revealed a 2.1% decline in weekday circulation and a 3.1% drop in Sunday circulation among 745 of the more than 1,400 daily American newspapers.

The Internet has been particularly damaging to newspaper advertising revenue because of the inherent advantages of Internet ads, which are more focused on targeted demographic groups. The Newspaper Advertising Association (as cited by Peters & Donald, 2007) reported that 59 million readers, 37.6% of Internet users, visited newspaper Web sites during the first quarter of 2007. That figure represented a 5.3% increase from the similar period in the previous year. Newspaper ads also suffer in comparison with the potentially larger Internet audiences and, therefore, cheaper rates. In the face of these factors, newspaper advertising revenue declines have persisted, falling by 4.8% in the first quarter of 2007.

Periodicals

"The first colonial magazines appeared in Philadelphia in 1741, about 50 years after the first newspapers" (Campbell, 2002, p. 310). Few Americans could read in that era, and periodicals were costly to produce and circulate. Magazines were often subsidized and distributed by special interest groups, such as churches (Huntzicker, 1999). *The Saturday Evening Post*, the longest running magazine in U.S. history, began in 1821 and became the first magazine to both target women as an audience and distribute to a national audience. By 1850, nearly 600 magazines were operating.

By early in the 20th century, national magazines became popular with advertisers who wanted to reach wide audiences. No other medium offered such opportunity. However, by the middle of the century, the many successful national magazines began dying in face of advertiser preferences for the new medium of television and the increasing costs of periodical distribution. Magazines turned to smaller niche audiences that were more effective at reaching these audiences. Table 2.2 and Figure 2.3 on the companion Web site for this book (www.tfi.com/ctu) show the number of American periodical titles by year, revealing that the number of new periodical titles nearly doubled from 1958 to 1960.

In the 10 years beginning in 1990, the average annual gain in the number of periodical titles was by only 20, despite the average of 788 new titles published annually in the 1990s. The difference occurred from the high mortality rate, as evidenced by a loss in total titles in six of the 10 years in the decade. The rebound in 2000 and 2001 did not continue in 2002. "Approximately two-thirds of all new titles fail to survive beyond four or five years" (U.S. Department of Commerce/International Trade Association, 2000, p. 25-9).

Issuance of periodical titles has a strong positive correlation to the general economic health of the country. Other important factors include personal income, literacy rates, leisure time, and attractiveness of other media forms to advertisers. With the decline in network television viewing throughout the 1990s, magazines became more popular with advertisers, particularly those seeking consumers under age 24 and over age 45. Both of

those groups seem likely to increase in numbers (U.S. Department of Commerce/International Trade Association, 2000).

By 2004, the U.S. periodicals industry included 7,602 firms that employed just more than 1.5 million people. The number of firms grew by 1,350, or 13.6%, since 2000, and the number of employees increased by 13.9%. In 2000, however, Americans averaged 135 hours per person per year reading consumer magazines and spent \$47.58 per person per year buying them. By 2004, time spent with periodicals decreased by 8.1% to 124 hours per person per year, and spending remained about level (U.S. Bureau of the Census, 2008).

Periodicals earn revenue through advertising and purchase prices for their circulated issues. Most magazine circulation, however, is generated by annual subscriptions, which have steadily increased by about 2% annually since the late 1980s (Peters & Donald, 2007). The Magazine Publishers of America (MPA), a trade group that audits more than 250 periodicals, in June 2005 (as cited in Peters & Donald, 2005), praised strong magazine advertising growth in 2004 and 2005, reflecting effectiveness of promoting growth through magazine advertising. The Publishers Information Bureau (as cited in Peters & Donald, 2007), which audits more than 200 periodicals, found that total magazine advertising increased during the first half of 2007 by 6.1% over the same period in 2006 to \$11.8 billion.

The MPA (as cited by Peters & Donald, 2007) reported that 18,267 consumer and business publications appeared in 2005, including 6,325 consumer magazines. The largest 10 of these publishers accounted for 26% of total magazine revenues in that year.

Advertising revenue grew by 13.5% in 2006 over the 2004 figure. During the same period, revenue from circulation declined by 4%, and average single copy prices increased by 6% and average annual subscription prices increased by 5.3% (Peters & Donald, 2007).

Books

Books obviously enjoy a history spanning many centuries. Stephen Daye printed the first book in colonial America, *The Bay Psalm Book*, in 1640 (Campbell, 2002). Books remained relatively expensive and rare until after the printing process benefited from the industrial revolution. Linotype machines developed in the 1880s allowed for mechanical typesetting. After World War II, the popularity of paperback books helped the industry expand. The current U.S. book publishing industry includes 87,000 publishers, most of which are small businesses. Many of these literally operate as “mom-and-pop desktop operations” (Peters & Donald, 2007, p. 11).

Table 2.3 from the companion Web site (www.tfi.com/ctu) shows new book titles published by year from the late 1800s through 2004. These data show a remarkable, but potentially deceptive, increase in the number of new book titles published annually, beginning in 1997. The U.S. Bureau of the Census reports that provided the data were based on material from R. R. Bowker, which changed its reporting methods beginning with the 1998 report. Ink and Grabois (2000) explained the increase as resulting from the change in the method of counting titles “that results in a more accurate portrayal of the current state of American book publishing” (p. 508). Data for previous years came from databases compiled, in part by hand, by the R. R. Bowker Company. The older counting process included only books included by the Library of Congress Cataloging in Publication program. This program included publishing by the largest American publishing companies, but omitted such books as “inexpensive editions, annuals, and much of the output of small presses and self publishers” (Ink & Grabois, 2000, p. 509). Ink and Grabois observed that the U.S. ISBN (International Standard Book Number) Agency assigns more than 10,000 new ISBN publisher prefixes annually.

The figure of 190,078 new titles for 2004 represented the fifth consecutive year of increases in titles. That 2004 figure represented an increase of 11.1% over the previous year, with more than half (59.2%) of the increase coming from adult fiction titles, a category that produced less a 2% gain in 2003 (Grabois, 2006). The three years following the September 11, 2001 terrorist attacks on the United States experienced a non-fiction boom period. In 2003, juvenile titles grew by nearly 10% and enjoyed an even greater increase in 2004. Preliminary 2005 figures foretold another expected increase.

Data reported by the Book Industry Study Group (as cited by Rich, 2007) indicated that 3.09 billion books were sold in the United States in 2005, and another 3.1 billion sold in 2006. Total revenues from book sales climbed from \$34.6 billion to \$35.7 billion in 2006, a gain of 3.2% that was attributed to higher book prices.

In 1999, more than 40% of U.S. adults (79,218,000) reported reading books at least once as a leisure activity during the previous 12 months, and more than 20% (43,919,000) reported such participation at least twice each week (U.S. Bureau of the Census, 2003). From 1999 to 2004, the number who reported reading books fell by 2.2% to 77,472,000. The number of adults who reported reading books at least twice weekly dropped from 1999 to 2004 by 2.4% to 42,861,000 (U.S. Bureau of the Census, 2006).

Americans spend more on books than on any other mass medium except cable television (Peters & Donald, 2007). Annual expenditures for books per American consumer in 1999 averaged \$87.34 (U.S. Bureau of the Census, 2005). The figure increased to \$95.62 per person in 2005 (U.S. Bureau of the Census, 2008). The same trend occurred in consumer time spent with books, with the number of hours per person per year growing by only one hour from 2000 through 2005 to 108 hours. Book publishers shipped nearly 3.1 billion books in 2006. Shipments were projected to increase annually each year through 2010.

Telephone

Alexander Graham Bell became the first to transmit speech electronically, that is, to use the telephone, in 1876. By June 30, 1877, 230 telephones were in use, and the number rose to 1,300 by the end of August, mostly to avoid the need for a skilled interpreter of telegraph messages. The first exchange connected three company offices in Boston beginning on May 17, 1877, reflecting a focus on business rather than residential use during the telephone's early decades. Hotels became early adopters of telephones as they sought to reduce the costs of employing human messengers, and New York's 100 largest hotels had 21,000 telephones by 1909. After 1894, non-business telephone use became ordinary, in part, because business use lowered the cost of telephone service. By 1902, 2,315,000 telephones were in service in the United States (Aronson, 1977). Table 2.4 and Figure 2.6 on the companion Web site (www.tfi.com/ctu) document the growth to near ubiquity of telephones in U.S. households and the expanding presence of wireless telephones.

Guglielmo Marconi sent the first wireless data messages in 1895. The growing popularity of telephony led many to experiment with Marconi's radio technology as another means for interpersonal communication. By the 1920s, Detroit police cars had mobile radiophones for voice communication (ITU, 1999). The Bell system offered radio telephone service in 1946 in St. Louis, the first of 25 cities to receive the service. Bell engineers divided reception areas into cells in 1947, but cellular telephones that switched effectively among cells as callers moved did not arrive until the 1970s. The first call on a portable, handheld cell phone occurred in 1973. However, by 1981, only 24 people in New York City could use their mobile phones at the same time, and only 700 customers could have active contracts. The Federal Communications Commission (FCC) began offering cellular telephone system licenses by lottery in June 1982 (Murray, 2001). Other countries, such as Japan in 1979 and Saudi Arabia in 1982, operated cellular systems earlier than the United States (ITU, 1999).

The U.S. Congress promoted a group of mobile communication services in 1993 by creating a classification of commercial mobile services that became known as Commercial Mobile Radio Service. This classification allowed for consistent regulatory oversight of these technologies and encouraged commercial competition among providers (FCC, 2005). By the end of 1996, about 44 million Americans subscribed to wireless telephone services (U.S. Bureau of the Census, 2008). Ten years later, the number of wireless subscribers exceeded 230 million in the United States. Subscriber growth rose by 11% between the end of 2005 and early 2007 (U.S. Bureau of the Census, 2008). Earlier predictions (e.g., Stellan, 2002) that the wireless telephone phenomenon was reaching the saturation point proved incorrect.

The sale of wireless handsets is the “world’s largest consumer electronic market” (Bensinger, 2007, p. 6) as measured in units sold. An estimated 990 million mobile telephone handsets were sold globally in 2006, up by more than 20% from the approximately 800 million sold in 2005. That figure represents more than four times the approximately 230 million computers sold around the world in 2006. About half of these handset sales went for upgrading phones, and the other half marked new wireless users. By April 2007, the number wireless subscribers around the world reached 2.9 billion, a penetration rate of approximately 44%.

Wireless subscribers in the United States numbered almost 242 million at the end of 2006, and the 28.8 million one-year increase from 213 million a year earlier marked the largest one-year subscriber growth in history. The physical coverage of wireless service reached 75% of the American land mass. Excluding federal land, that figure reaches 85%, and 80% of the approximately 300 million Americans used wireless phones (FCC, 2008c). Penetration by the end of 2007 reached 20%, and estimated growth in penetration was expected to rise significantly (Amobi & Kolb, 2007). A survey by MediaMark Research (as cited by Mindlin, 2007) of about 13,000 households in April 2007 found that, for the first time, the proportion of American households with at least one mobile phone (86.2%) exceeded the proportion of households with landline-only phone service (84.5%). The company has been conducting such surveys since the mid-1980s.

A Pew study of teenagers (Lenhart, et al., 2007) found that 35% talked on mobile phones every day. The average wireless subscriber used 472 minutes of wireless voice service per month in 2002. That figure increased annually to an average of 714 minutes per month in 2006, although the rate of increase began to slow by that time. This usage was more than four times that of Western Europe and Japan, where wireless service tended to be more expensive than in the United States. Users in those areas of the world have tended to use more text messages than Americans, but text messaging has gained popularity in America, too (FCC, 2008c).

In 2002, American wireless users sent an average of 1.02 billion text messages per month. Like voice messages, that figure increased annually to 18.71 billion monthly messages in 2006, but unlike voice messages, the rate of growth increased every year (FCC, 2008c). The Pew study (Lenhart, et al., 2007) of teen media use reported that 28% of teens sent text messages daily, and nearly half of the substantial group of teens who were classified as multichannel teens sent text messages every day.

The demographic group spending the most time on mobile phones falls within the ages of 18 to 24. The data came from a 2007 survey by Telephia, Inc. (as cited by Jennings, 2007). The members of this group averaged 290 calls per month. Users from ages 13 to 17 sent the most text messages, an average 435 per month. People aged 45 to 54 placed an average of 194 monthly calls, but they used text messaging only 57 times per month.

Other services used by wireless customers also showed increasing popularity. Multimedia messages, including photo messages, doubled from 2005 to 2006, growing from 1.1 billion messages to 2.7 billion (FCC,

2008c). By the end of 2005, about 44% of wireless subscribers owned cell phones that supported gaming. Jupiter Research (as cited by Leon & Kawaguchi, 2007) projected that 70% of American wireless phones would be gaming-capable by the end of 2006. Seven million Americans watched video via their wireless phones in 2007, and the number was expected to reach 24 million by 2010. Many more services will go wireless after the 2008 FCC auction of spectrum in the 700 MHz band that will support broadband wireless services (Kessler, 2007a).

Approximately 10.7% of American wireless users surfed the Internet during the first quarter of 2006, an increase of 9.9% over the comparable period in 2005. In 2005, 3.1 million wireless Internet capable devices were in use, and the figure grew to 21.9 million by the end of 2006. About 82% of Americans lived in census blocks served by at least one wireless Internet provider (FCC, 2008c).

Wireless telephone users paid about \$0.11 per minute in 2002 for their service. Unlike the increases in usage, the prices paid declined until 2005, when the cost per minute remained steady through 2006 at \$0.07 per minute. Prepaid phone plans increased from 13% of wireless customers in 2005 to 15% in 2006 (FCC, 2008c).

The average monthly bill for local wireless service in 2002 was \$48.40. The average local wireless bill of \$50.64 in December 2004 represented a roughly flat trend since 1995, when the figure was \$51, although monthly average prices in the interim fell as low as \$39.43 in December 1998. Average monthly bills increased over the previous yearly average every year from 1998 through 2004 (FCC, 2005) when the year-end average was \$50.64, nearly half of the 1987 average of \$96.83 (FCC, 2007). However, the decline to \$49.98 in 2005 reversed in 2006 to \$50.56 per month (FCC, 2008c).

How much Americans will pay for wireless phone services remains to be seen. By early 2006, only about two million subscribers enrolled in data and video packages for mobile phones. These packages typically cost from \$10 to \$25 per month and accounted for only about 5% of revenues for wireless companies in 2005. Such services include news updates, sports information, and other material that can mean additional monthly charges from \$39.95 to \$199.99 (Manly, 2006).

Between 2001 and 2006, the number of wired home telephone lines in the United States fell from 161 million to 124 million. In 2006, nearly 7% of wired lines were dropped by consumers, many to be replaced by wireless service as the only home telephone, and 11.8% of adults lived in households with wireless phones but no wired phones. This trend applied particularly often with young adults, with half of such consumers under 30 years of age using wireless service only. Among adults aged 18 to 24, 25.2% lived in households with wireless-only service. The figure for adults aged 25 to 29 was 30%. However, as the users' ages increased, the proportion of wireless-only households dropped: 12.4% of adults 30 to 44; 6.1% for ages 45 to 64; and 1.9% of adults over 65 had wireless-only in 2006 (FCC, 2008c).

Motion Pictures

In the 1890s, George Eastman improved on work by and patents purchased from Hannibal Goodwin in 1889 to produce workable motion picture film. The Lumière brothers projected moving pictures in a Paris café in 1895, hosting 2,500 people nightly at their movies. William Dickson, an assistant to Thomas Edison, developed the kinetograph, an early motion picture camera, and the kinetoscope, a motion picture viewing system. A

New York movie house opened in 1894, offering moviegoers several coin-fed kinetoscopes. Edison's Vitascope, which expanded the length of films over those shown via kinetoscopes and allowed larger audiences to simultaneously see the moving images, appeared in public for the first time in 1896. In France in that same year, Georges Méliès started the first motion picture theater. Short movies became part of public entertainment in a variety of American venues by 1900 (Campbell, 2002), and average weekly movie attendance reached 40 million people by 1922.

Average weekly motion picture theater attendance, as shown in Table 2.5 and Figure 2.7 on the companion Web site (www.tfi.com/ctu), increased annually from the earliest available census reports on the subject in 1922 until 1930. After falling dramatically during the Great Depression, attendance regained growth in 1934 and continued until 1937. Slight declines in the prewar years were followed by a period of strength and stability throughout the World War II years. After the end of the war, average weekly attendance reached its greatest heights: 90 million attendees weekly from 1946 through 1949. After the beginning of television, weekly attendance would never again reach these levels.

Although a brief period of leveling off occurred in the late 1950s and early 1960s, average weekly attendance continued to plummet until a small recovery began in 1972. This recovery signaled a period of relative stability that lasted into the 1990s. Through the last decade of the century, average weekly attendance enjoyed small but steady gains.

Box office revenues, which declined generally for 20 years after the beginning of television, began a recovery in the late 1960s. Box office revenues then began to skyrocket in the 1970s, and the explosion continued until after the turn of the new century. However, much of the increase in revenues came from increases in ticket prices and inflation, rather than from increased popularity of films with audiences, and total motion picture revenue from box office receipts declined during recent years, as studios realized revenues from television and videocassettes (U.S. Department of Commerce/International Trade Association, 2000).

Motion picture attendance in terms of tickets sold displayed a steady upward trend from 1991 through 2002, with minor dips in 1995, 1999, and 2000. After increases in two consecutive years, declines returned in ticket sales for 2003 and 2004 (National Association of Theater Owners, 2006a).

However, box office receipts experienced steady gains after 1991, with the exception of a slight drop in 2003 (National Association of Theater Owners, 2006b). Increasing receipts in a time of falling attendance seems to suggest inflation in ticket prices. Consumer spending per person per year increased from \$32.72 in 2000 to \$36.38 in 2005 (U.S. Bureau of the Census, 2008).

The total American box office receipts remained mostly steady from 2001 through 2006. In 2005, the most frequent purchasers of film tickets fell in the 12 to 20 year-old bracket. Members of that group purchased 27% of the tickets, although they accounted for only 15% of the population. The proportion of tickets purchased declined as ages grew higher, with people of ages 50 to 59 purchasing only 10% of the tickets, although they accounted for 15% of the population (Amobi & Donald, 2007).

Americans purchased about 1.45 billion movie theater tickets in 2006, paying about \$9.2 billion. That figure was slightly larger than the year before, aided by an 11% increase in the number of motion pictures exhibited and a 3.3% increase in the number of tickets sold. Average ticket prices increased from \$6.40 in 2005 to \$6.58 in 2006, a gain of 2.6% (Amobi & Donald, 2007). The overseas box office for American film studios reached \$9.52 billion in 2007, up about 10% from 2006 (McNary & McClintock, 2008).

Although American movie fans went out in fewer numbers in recent years, consumers spent an average of 12 hours per person per year from 1993 through 1997. As shown in Table 2.5 on the companion Web site (www.tfi.com/ctu), moviegoers increased their in-theater viewing to a steady average of 13 hours in the years from 1998 through 2004, with only minor fluctuation during this period. A slight decrease to 12 hours was projected in 2005 and 2006 and is expected to remain at that level (U.S. Bureau of the Census, 2008).

Audio Recording

Thomas Edison expanded on experiments from the 1850s by Leon Scott de Martinville to produce a talking machine or phonograph in 1877 that played back sound recordings from etchings in tin foil. Edison later replaced the foil with wax. In the 1880s, Emile Berliner created the first flat records from metal and shellac designed to play on his gramophone, providing mass production of recordings. The early standard recordings played at 78 revolutions per minute (rpm). After shellac became a scarce commodity because of World War II, records were manufactured from polyvinyl plastic. In 1948, CBS Records produced the long-playing record that turned at 33-1/3 rpm, extending the playing time from three to four minutes to 10 minutes. RCA countered in 1949 with 45 rpm records that were incompatible with machines that played other formats. After a five-year war of formats, record players were manufactured that would play recordings at all of the speeds (Campbell, 2002).

The Germans used plastic magnetic tape for sound recording during World War II. After the Americans confiscated some of the tapes, the technology became a boon for Western audio editing and multiple track recordings that played on bulky reel-to-reel machines. By the 1960s, the reels were encased in cassettes, which would prove to be deadly competition in the 1970s for single song records playing at 45 rpm and long-playing albums playing at 33-1/3 rpm. At first, the tape cassettes were popular in 8-track players. As technology improved, high sound quality was obtainable on tape of smaller width, and 8-tracks gave way to smaller audio-cassettes. Thomas Stockholm began recording sound digitally in the 1970s, and the introduction of compact disc (CD) recordings in 1983 decimated the sales performance of earlier analog media types (Campbell, 2002). Figure 2.8 and Table 2.6 on the companion Web site (www.tfi.com/ctu) trace the rise and fall of the sales of audio recordings of these respective types.

This table and figure appeared in previous communication technology updates in this series and remain available to show the history of respective forms of shipping recorded music. Because of the declining shipments in some music genres, reported categories have recently been combined. Table 2.6A and Figures 2.8 and 2.9 show new categories that emerged to explain and illustrate these trends.

Table 2.6 shows that total unit sales of recorded music generally increased from the early 1970s through 1999. The data show a brief recovery in 1995 through 1997, followed by steady declines except for a brief recovery in 2004 (Leeds, 2005) in total units sold. Music sales fell from a peak in 1999 by an average 3% annually before plummeting by 6.5% in 2006. CD sales account for about 80% of music sales, and CD sales averaged a 5% decline after 1999 through 2006, with the rate of decline occurring at an every increasing rate.

Graves and Donald (2005) reported an explosion of popularity of digital audio players, with about 40 million in use by 2005. Digital audio on demand changed the business requirements of music distributors. In 2003, almost no spending occurred for subscriptions and downloads of digital music, but market analysts predicted \$1 billion in such spending by 2007. By April 2005, music Web sites received 61.9 million visits, and more than 230 online music services took advantage of the more than one million songs digitized by music

publishers. In 2006, wireless phone subscribers spent more than \$500 million to download music to their phones (Leon & Kawaguchi, 2007). Table 2.6A and Figure 2.8A on the companion Web site (www.tfi.com/ctu) show trends in downloads of digital music types.

However, the huge annual sales increases in music sold via online services failed to overcome the declines in other music media by 2005. *Billboard* magazine used a strategy of bundling singles downloads into units of 10 and considering them as albums, calculating that 2005 sales declined by 5%. Leeds (2005) described the major music distributors as hampered by the usual methods of business and increased attention to illegal payments to broadcasters for favorable airing of music.

Through early 2007, hot selling digital singles still did not adequately replace the lost sales in albums. However, in 2004, Internet downloads accounted for only 1% of music revenues, but the figure rose to 16% in 2006 (Leon & Kawaguchi, 2007). Nielsen SoundScan (as cited by Kessler, 2007a) reported a 65% increase over the 2005 figure in online digital tracks sold in 2006, a total of 582 million tracks sold in the United States. Global revenues from online music sales totaled \$979 million in 2005 (Kessler, 2007a).

In 2007, 10 million Americans bought music from an online wireless phone carrier, and annual sales for the year were expected to exceed \$100 million and surpass \$800 million for mobile music by 2011 (Kessler, 2007a). Leon and Kawaguchi (2007) forecast that convenience of shopping, support for instant gratification, wider product selection, and reduced expense of distribution will all lead to digital sales soon becoming the dominant revenue source in music sales.

Leon and Kawaguchi (2007) wrote that the public has long complained about having to buy unwanted songs with albums and CDs to get the desired songs. Had downloadable singles been available sooner, they would have been popular sooner. Other obstacles to sales of recorded music include piracy, copyright concerns, the death of bricks-and-mortar music distributors, and the power of big box retailers (e.g., Wal-Mart and Best Buy) that squeeze the floor space devoted to CDs.

Radio

Guglielmo Marconi's wireless messages in 1895 on his father's estate led to his establishing a British company to profit from ship-to-ship and ship-to-shore messaging. He formed a U.S. subsidiary in 1899 that would become the American Marconi Company. Reginald A. Fessenden and Lee De Forest independently transmitted voice by means of wireless radio in 1906, and a radio broadcast from the stage of a performance by Enrico Caruso occurred in 1910. Various U.S. companies and Marconi's British company owned important patents that were necessary to the development of the infant industry, so the U.S. firms formed the Radio Corporation of America (RCA) to buy out the patent rights from Marconi.

The debate still rages over the question of who became the first broadcaster among KDKA in Pittsburgh, WHA in Madison (Wisconsin), WWJ in Detroit, and KQW in San Jose (California). In 1919, Dr. Frank Conrad of Westinghouse broadcast music from his phonograph in his garage in East Pittsburgh. Westinghouse's KDKA in Pittsburgh announced the presidential election returns over the airwaves on November 2, 1920. By January 1, 1922, the Secretary of Commerce had issued 30 broadcast licenses, and the number of licensees swelled to 556 by early 1923. By 1924, RCA owned a station in New York, and Westinghouse expanded to Chicago, Philadelphia, and Boston. In 1922, AT&T withdrew from RCA and started WEAJ in New York, the first radio station

supported by commercials. In 1923, AT&T linked WEAf with WNAC in Boston by the company's telephone lines for a simultaneous program. This began the first network, which grew to 26 stations by 1925. RCA linked its stations with telegraph lines, which failed to match the voice quality of the transmissions of AT&T. However, AT&T wanted out of the new business and sold WEAf in 1926 to the National Broadcasting Company, a subsidiary of RCA (White, 1971).

The 1930 penetration of radio sets in American households reached 40%, then approximately doubled over the next 10 years, passing 90% by 1947 (Brown, 2006). Table 2.7 and Figure 2.10 on the companion Web site (www.tfi.com/ctu) show the rapid rate of increase in the number of radio households from 1922 through the early 1980s, when the rate of increase declined. The increases resumed until 1993, when they began to level off.

By the end of 2006, the FCC reported that 11,020 commercial radio stations were broadcasting in the United States. In addition, 2,817 educational FM radio stations were on the air. Ownership of these stations is highly concentrated, with 20% of the total being owned by the largest 10 groups, accounting for about 45% of the radio broadcasting industry revenues (Amobi & Kolb, 2007).

Although thousands of radio stations were transmitting via the Internet by 2000, Channel1031.com became the first station to cease using FM and move exclusively to the Internet in September 2000 (Raphael, 2000). Many other stations were operating only on the Internet when questions about fees for commercial performers and royalties for music played on the Web arose. In 2002, the Librarian of Congress ruled by setting rates for such transmissions of sound recordings, a decision whose appeals by several organizations remained pending at the end of 2003 (U.S. Copyright Office, 2003). A federal court upheld the right of the Copyright Office to levy fees on streaming music over the Internet (*Bonneville v. Peters*, 2001).

In March 2001, the first two American digital audio satellites were launched, offering the promise of hundreds of satellite radio channels (Associated Press, 2001). Consumers were expected to pay about \$9.95 per month for access to commercial-free programming that would be targeted to automobile receivers. The system included amplification from about 1,300 ground antennas. By the end of 2003, 1.621 million satellite radio subscribers tuned to the two top providers, XM and Sirius, up 51% from the previous quarter (Schaeffler, 2004). A market research firm, eMarketer, reported in November 2005 that the two firms combined attracted 4.37 million subscribers in 2004 and 9.32 million in 2005 (Satellite radio, 2006). By the end of 2007, the combined audience for the two reached about 17.6 million subscribers, and the projected audience was estimated to reach 22 million by the end of 2008 (Amobi & Kolb, 2007). Most consumers paid about \$13 per month for satellite radio subscriptions by 2005 (Siklos, 2005).

A proposed merger of the two dominant satellite radio providers, XM and Sirius, had not yet been approved by federal officials as this publication goes to press. Monthly subscriptions for both companies were \$12.95 at the end of 2007 for 130 to 170 channels, but the two released projected plans in July 2007 for a la carte pricing systems ranging from \$6.99 to \$16.99 (Amobi & Kolb, 2007). Proposed pricing for the merged company would allow users to add channels for \$0.25 each, tiers would be available offering family-friendly, news and sports, and music tiers. Opponents of the merger contend that the deal would be anti-competitive, but the companies argued that the many competing media (e.g., portable digital audio players, the Internet, wireless phones) offer bountiful competition.

The estimated average number of hours of radio (broadcast and satellite combined) listening per person per year have been declining, according to recent publications by the U.S. Bureau of the Census (2008). The projected figure for 2008 back in 2006 was 1,120 hours per person per year, but the most current figure given

(U.S. Bureau of the Census, 2008) is only 785 hours per person per year, a decline of nearly 30%. Additionally, the projected radio listening averages from two previous years were increasing annually, suggesting that satellite radio is not reaching the growth that was anticipated.

In January 2006, Clear Channel Radio and CBS began broadcasting high-definition digital radio without advertising in 43 American markets. This technology permits broadcasters to transmit three different channels within the frequency allocation previously used to program a single channel. Outfitting costs about \$100,000 per station, and 622 stations offered HD radio, potentially reaching 80% of Americans. To hear the HD radio broadcasts, consumers need a capable receiver, which sold for about \$500 in early 2006. BMW car buyers in 2006 had the option to add digital receivers in two models as a \$500 item. Market analysts estimated that about 85,000 digital radio receivers had been sold by the end of 2004 (Taub, 2006).

Television

Paul Nipkow invented a scanning disk device in the 1880s that provided the basis from which other inventions would develop into television. In 1927, Philo Farnsworth became the first to electronically transmit a picture over the air. Fittingly, he transmitted the image of a dollar sign. In 1930, he received a patent for the first electronic television, one of many patents for which RCA would be forced, after court challenges, to negotiate. By 1932, Vladimir Zworykin discovered a means of converting light rays into electronic signals that could be transmitted and reconstructed at a receiving device. RCA offered the first public demonstration of television at the 1939 World's Fair.

The FCC designated 13 channels in 1941 for use in transmitting black-and-white television, and the commission issued almost 100 television station broadcasting licenses before placing a freeze on new licenses in 1948. The freeze offered time to settle technical issues, and it ran longer because of U.S. involvement in the Korean War (Campbell, 2002). As shown in Table 2.8 on the companion Web site (www.tfi.com/ctu), nearly 4,000 households had television sets by 1950, a 9% penetration rate that would escalate to 87% a decade later. Penetration has remained steady at about 98% since 1980. Figure 2.10 illustrates the meteoric rise in the number of households with television by year from 1946 through the turn of the century.

From 1993 through 2003, the total number of U.S. commercial and noncommercial broadcast television stations grew by 13.7% to 1,733 (FCC, 2004b). By June 2004, the number of noncommercial and commercial U.S. television stations reached 1,747 and remained unchanged through June 2005. More than 15 million households, or 14% of all American television households, were still receiving broadcast television over the airwaves, not subscribing to any multichannel service (FCC, 2006a). As of the end of 2006, the number of FCC licensed commercial television stations numbered 1,376.

Television's popularity rebounded from declines early in the new century to new heights. Total television households increased by just more than 1% from the previous year to 109.6 million by June 2005. The FCC (2006a) cited data from Nielsen Media Research showing that typical American households kept television on for eight hours and 11 minutes daily during the 2004-2005 programming season, an increase of 12% over comparable statistics from a decade before. The new figures reached the highest viewing levels since the early days of television in the 1950s. Personal viewing set an all-time record by averaging four hours and 32 minutes daily. Broadcast television programming drew a 47 share of all primetime viewing during the 2004-2005 season, compared with 48 the previous year. Although ratings were down for most major broadcast networks in 2007-

2008, audience data were difficult to interpret because of the writers' strike that derailed programming for the major networks.

As important as programming success was to the television industry, perhaps technical standards were even more critical. American television standards set in the 1940s provided for 525 lines of data composing the picture. By the 1980s, Japanese high-definition television (HDTV) increased the potential resolution to more than 1,100 lines of data in a television picture. This increase enabled a much higher-quality image to be transmitted with less electromagnetic spectrum space per signal. In 1996, the FCC approved a digital television transmission standard and authorized broadcast television stations a second channel for a 10-year period to allow the transition to HDTV. As discussed in Chapter 6, that transition will eventually make all older analog television sets obsolete because they cannot process HDTV signals (Campbell, 2002).

The FCC (2002) initially set May 2002 as the deadline by which all U.S. commercial television broadcasters were required to be broadcasting digital television signals. Progress toward digital television broadcasting fell short of FCC requirements that all affiliates of the top four networks in the top 10 markets transmit digital signals by May 1, 1999.

The FCC (2006a) revised the schedule of transition from analog to digital services on June 9, 2005 by requiring that new sets and other receiving equipment, such as videocassette recorders (VCRs) and digital video recorders (DVRs) be capable of receiving digital transmissions. March 1, 2006 was subsequently set as the deadline by which all receivers including screens of 25 inches through 36 inches must contain digital tuners. By March 1, 2007, all sets with screens of 13 inches to 24 inches were required to meet that standard, and the same rules now apply to smaller screens. By October 2005, at least 1,537 television stations in the United States were broadcasting digital signals, including all of the 119 stations affiliated with the top four broadcast networks in the 30 largest television markets (FCC, 2006a). Congress eventually mandated that February 17, 2009 would be the last date for legal analog television broadcasts by full-power stations (FCC, 2008a).

Within the 10 largest television markets, all except one network affiliate had begun HDTV broadcasts by August 1, 2001. By that date, 83% of American television stations had received construction permits for HDTV facilities or a license to broadcast HDTV signals (FCC, 2002). Despite broadcast HDTV signals and having cable systems carrying HDTV programming available to more than 60 million households (FCC, 2004a), only about 1.5 million households were watching high-definition television by early 2004 (In-Stat/MDR, 2004). By the end of 2004, HDTV service was available to about 92 million households or 87% of homes with access to cable television. Among the 210 television markets, 184 included at least one cable system offering HDTV, and all 100 of the largest markets had the service (FCC, 2006a). Nielsen Media Research (as cited in Amobi & Kolb, 2007) estimated in October 2007 that 14% of American households, or nearly 16 million, had HDTV capable televisions.

The transition from analog to digital television received resistance from consumers over the need to purchase equipment capable of receiving the new signals. The average 1998 price of a digital television set of \$3,147 fell to an estimated \$1,189 in 2005. The FCC (2006a) received reports estimating that some digital sets would soon sell for \$400. As the digital transition speeds up, converters making digital signals viewable on analog sets were planned at around \$60. Among the sources of educational information about DTV and HDTV, the FCC site at <http://www.dtv.gov> serves to inform consumers.

In fall 2007, major broadcast television networks began offering primetime program episodes for free, supported by advertising, over the Internet via their own Web sites, as well as on syndicated Web sites oper-

ated by other distributors. Such shows could also be downloaded for fees from a variety of online sites (Amobi & Kolb, 2007).

Cable Television

Cable television began as a means to overcome poor reception for broadcast television signals. John Watson claimed to have developed a master antenna system in 1948, but his records were lost in a fire. Robert J. Tarlton of Lansford (Pennsylvania) and Ed Parsons of Astoria (Oregon) set up working systems in 1949 that used a single antenna to receive programming over the air and distribute it via coaxial cable to multiple users (Baldwin & McVoy, 1983). At first, the FCC chose not to regulate cable, but after the new medium appeared to offer a threat to broadcasters, cable became the focus of heavy government regulation. Under the Reagan administration, attitudes swung toward deregulation, and cable began to flourish. Table 2.9 and Figure 2.11 on the companion Web site (www.tfi.com/ctu) show the growth of cable systems and subscribers, with penetration remaining below 25% until 1981, but passing the 50% mark before the 1980s ended.

The rate of growth in the number of cable subscribers slowed over the last half of the 1990s. Penetration, after consistently rising every year from cable's outset, declined every year after 1997. The FCC reports annually to Congress regarding the status of competition in the marketplace for video programming, and the agency reported that, by 2001, the franchise cable operator share of multichannel video programming distributors (MVPDs) slipped from 80% in 2000 to 78% a year later (FCC, 2001). Continuing the slide, that figure reached 69.4% of the approximately 94.2 million MVPD households by June 2005 (FCC, 2006a). MVPD households account for almost 86% of the 109.6 million television homes.

During the decade beginning in 1994, the number of U.S. households passed by cable increased from 91.6 million to about 103.5 million in 2003. Cable systems passed 108.2 million homes with television in 2004, about 99% of homes that had television. The number of homes subscribing to cable fell in 2005 by 700,000 to 65.4 million subscribers. Despite that decline in penetration, cable revenue continued to increase because of additional services such as high-speed Internet access, digital channels, and higher basic subscription rates (FCC, 2006a).

Although the most popular broadcast networks continued to draw more viewers than the most popular cable television networks, audience share of cable television networks in primetime increased to 53% for the 2004-2005 season. Non-broadcast channels attracted a 53 share of primetime attention in 2004-2005, up from 52 a year earlier. Similar trends occurred across the entire viewing schedule, with non-broadcast channels growing from a 56 share the previous year to a 59 share during 2004-2005, reflecting the strength of cable programming.

During the decade beginning in 1993, the cost of cable television subscriptions grew by 53.1%, more than double the 25.5% increase in the consumer price index. The National Cable Television Association (NCTA) claimed that, although prices for cable were up, cost per viewing hour declined, as the public spent more time watching cable programming. Cable programming expenses grew by 10.6% from the end of 2003 to the end of 2004 to \$12.68 billion. Average monthly cable revenue per subscriber increased from \$66.22 in 2003 to \$72.87 in 2004, and projected revenue per subscriber for 2005 was \$80.33 (FCC, 2006a).

During 2005, the average subscriber monthly prices for cable television increased by 5.2% over the average for the previous year. The total average monthly price in 1995 for basic and expanded basic cable television was \$22.35. By 2005, the figure rose to \$43.04 per month, an increase of 92.6% in a decade (FCC, 2006b).

At the end of 2000, 8.7 million households subscribed to digital cable. Within another six months, the estimated count reached 12 million (FCC, 2002). The total grew to 22.5 million at the end of 2003, and continued to 25.4 million in 2004, a 12.9% increase in a year. By June 2005, 26.3 million digital cable subscribers (FCC, 2006a) began receiving access on many cable systems to such options as digital video, video on demand, DVRs, HDTV, and telephone services.

The prevalence of digital services was an important factor in the FCC decision to eliminate analog broadcast television as of February 17, 2009. However, in September 2007, the FCC unanimously required cable television operators to continue to provide carriage of local television stations that demand it in both analog and digital formats for three years after the conversion date. This action was designed to provide uninterrupted local station service to all cable television subscribers, protecting the 40 million (35%) U.S. households that remain analog-only (Amobi & Kolb, 2007).

The FCC (2002) noted that video on demand (VOD) services showed signs of growing popularity by the end of 2001, when the services were estimated to have generated revenues exceeding \$65 million. The service provides alternatives for digital cable customers to video rentals and was enabled in 19.5 million households by the end of 2004. The FCC (2006a) projected a 22.6% increase by the end of 2005 to 23.9 million.

By the end of 2004, 93% of homes passed by cable were offered high-speed Internet service (FCC, 2006a), and 38% were offered telephone services. In addition to the advantage of producing new revenue opportunities for cable operators, these services offered valuable options in competition with a variety of competitors (FCC, 2006a).

For years, some cable television operators offered circuit-switched telephone service, attracting 3.6 million subscribers by the end of 2004. Also by that time, the industry offered telephone services via voice over Internet protocol (VoIP) to 38% of cable households, attracting 600,000 subscribers. That number grew to 1.2 million by July 2005. In 2006, a consortium of cable companies formed a 20-year agreement with Sprint Nextel to offer enhanced wireless services, including voice and entertainment available to consumers using a single device (Amobi, 2005).

Although cable penetration dropped after 2000, as illustrated in Figure 2.11 on the companion Web site (www.tfi.com/ctu), estimated use of a combination of cable and satellite television increased steadily over the same period (U.S. Bureau of the Census, 2008). The combination of cable and satellite television serves about 84% of American households (Amobi & Donald, 2007). Consumers devoted 690 hours per person per year to MVPD services in 2000, and that figure reached 980 hours in 2005. Projections of such use continue to rise through 2010 (U.S. Bureau of the Census, 2008), although the number of cable systems fell to 6,391 by the end of 2007 (FCC, 2008b).

Ownership of cable systems in the United States is concentrated in the hands of the four largest multiple system operators (MSOs). These companies combine to serve about 75% of American subscribers and account for about 80% of the total cable revenues (Amobi & Kolb, 2007).

MSOs have now upgraded their content delivery systems to enable them to concentrate less on expansion of infrastructure and more on new services, such as high-speed broadband Internet access to digital data and video transmissions. Telephone services provided by cable operators offer additional service opportunities, particularly with voice over Internet protocol (VoIP). MSOs offer bundles of telephone, cable television, and broadband Internet access services that help the companies reduce customer turnover or churn. VoIP offers several advantages over wired telephone systems. For example, VoIP enjoys low call routing costs that bypass regulatory toll charges, simplified maintenance, reduced operating costs from using a single network, and popular calling features, such as video voice conferencing, unified messaging, Web-based voicemail, file sharing, and voice-enabled chat (Bensinger, 2007). In the United States, nearly eight million VoIP subscribers were online by the end of 2006. Among these providers, the top three companies served nearly 70% of all the customers (Bensinger, 2007).

Direct Broadcast Satellite and Other Cable TV Competitors

Satellite technology began in the 1940s, but HBO became the first service to use it for distributing entertainment content in 1976 when the company sent programming to its cable affiliates (Amobi & Kolb, 2007). Other networks soon followed this lead, and individual broadcast stations (WTBS, WGN, WWOR, and WPIX) used satellites in the 1970s to expand their audiences beyond their local markets by distributing their signals to cable operators around the United States.

Competitors for the cable industry include a variety of technologies. Annual FCC reports distinguish between home satellite dish (HSD) and direct broadcast satellite (DBS) systems. Both are included as MVPDs, which include cable television, wireless cable systems called multichannel multipoint distribution services (MMDS), and private cable systems called satellite master antenna television (SMATV).

DBS attracted the second largest group of MVPD households after cable television, with a share of 27.7% of total MVPD subscribers by June 2005, up from 25.1% a year earlier. Total subscriptions to the combination of all other MVPD services declined from 2004 to 2005 to 2.9%, down from 3.3% in 2004 (FCC, 2006a). The three DBS providers attracted about 26.1 million American households in June 2005, representing growth in one year by 12.8% and approximately 27.7% of all American MVPD subscribers. Growth was stimulated in part by the increasing availability of local channels, with at least one local channel available to DBS subscribers in 167 of 210 television markets and 96% of all American homes. The *Satellite Home Viewer Improvement Act of 1999* granted permission to DBS providers to carry local broadcast stations in their local markets, and the December 2004 *Satellite Home Viewer Extension and Reauthorization Act of 2004* (SHVERA) extended for five more years many of the copyright and retransmission rights provisions of the original measure.

The two major providers of satellite television in 2001, DirecTV and EchoStar, attracted about 16 million subscribers, an 18% market share (FCC, 2008b). Near the end of 2006, wired cable connections declined to a six-year low at the same time that alternatives were accounting for 24.5% of viewing households. The largest proportion of these alternatives was satellite television, which accounted for 28.1% of all television households in 2006 (Kingsport Times News, 2006). By late 2007, the two companies served 30 million subscribers, a 30% market share. During the same period, cable television subscribers fell by 4%, as DirecTV was growing by 54% and EchoStar was growing by 92% (FCC, 2008b).

C-band home satellite dishes in the early 1980s spanned six feet or more in diameter. Sales of dishes topped 500,000 only twice (1984 and 1985) between 1980 and 1995 (Brown, 2006), when home satellite system ownership apparently peaked before a steady decline in numbers. In 2003, the number of larger dish owners was less than 25% of the 1995 total. Conversely, smaller dish DBS subscribers have increased explosively every year since their numbers were first reported by census data in 1993, with the increase from 2004 to 2005 reaching 12.8%. Conversely, use of the larger home satellite dishes continued to decline through 2005 to slightly more than 200,000 households, a loss of 38.5% from 2004. By late 2007, 68,781 households were authorized to receive HSD services, which included about 350 free channels and 150 subscription-only channels over the C-band satellite transmissions (FCC, 2008b). Such declines characterized other forms of non-cable MVPD sources, as well.

MMDS, or wireless cable systems, peaked in popularity in 1996 (1.2 million households). However, only 100,000 homes used the services by 2005, a 50% decline in a year (FCC, 2006a). Major wireless telephone services began offering video programming through wireless phones by February 2005.

SMATV, or private cable, operations sometimes use their own facilities and sometimes partner with DBS companies to deliver video to consumers. SMATV systems often serve 3,000 to 4,000 subscribers, and larger operators serve up to 55,000 subscribers (FCC, 2008b). Although these systems do not report their operations to the FCC, 76 different providers of SMATV belonged to a trade association for their membership in late 2007. The total number of subscribers generally increased after 1993 until a 1998 decline, followed by a brief resurgence through 2002 (FCC, 2006a). Subscriptions declined every year thereafter. Table 2.10 and Figure 2.12 on the companion Web site (www.tfi.com/ctu) track trends of these non-cable video delivery types.

The FCC also considers several types of services as potential MVPD operators. These services include home video sales and rentals, the Internet, electric and gas utilities, and local exchange carriers (LECs). The latter category includes telephone service providers that were allowed by the *Telecommunications Act of 1996* to provide video services to homes, at the same time that the act allowed cable operators to provide telephone services. LECs use high-speed lines, including DSL (digital subscriber line) and fiber optic technology, to deliver video services to communities in 46 states, connecting 322,700 households. Verizon began offering multichannel video services in Texas in September 2005, and quickly opened similar services in Virginia and Florida (FCC, 2006a). By late 2007, the company served nearly one million video subscribers (FCC, 2008b).

In 2001, the FCC began reporting on a new category of video program distributor that began in 1998: broadband service providers (BSPs). These providers offer video, voice, and telephone capability over a single network to their customers. In that first year, such services passed 7.2 million households, but, by 2003, they were authorized by franchises to serve 17.7 million homes, with 1.4 million of those households subscribing, despite the obstacle of availability in only a few areas of the country (FCC, 2004a). By June 2005, BSPs served approximately 1.4 million subscribers or 1.5% of all MVPD households. Electric and gas utilities also provide MVPD and other services. At that time, 616 public power entities (serving about 14% of American households) offered some kind of broadband services (FCC, 2006a).

Home Video

Although VCRs became available to the public in the late 1970s, competing technical standards slowed the adoption of the new devices. After the longer taping capacity of the VHS format won greater public acceptance

over the higher-quality images of the Betamax, the popularity of home recording and playback rapidly accelerated, as shown in Table 2.II and Figure 2.I3 on the companion Web site (www.tfi.com/ctu).

The annual FCC (2006a) report on competition in the video marketplace listed VCR penetration at about 90%, with multiple VCRs in nearly 46 million households. By 2004, approximately 100 million American households had VCRs, and about 80 million (about 72%) had DVD (digital videodisc) players. By the end of 2005, about 47,000 DVD titles were available, up from 30,000 in 2004. Rental spending for videotapes and DVDs reached \$24.5 billion in 2004, far surpassing the \$9.4 billion spent for tickets to motion pictures. DVD purchases accounted for \$15.5 billion, up by 33% from 2003, and DVD rentals grew by 26% to more than \$5.7 billion during the same period.

DVD sales rose in 2005 by 400% over the \$4 billion figure for 2000 to \$15.7 billion. The rate of growth, however, slowed by 2005 to 45%. By 2006, that rate continued declining by 2% to \$15.9 billion, and VHS sales amounted to less than \$300 million (Amobi & Donald, 2007).

In 2000, home video (VCR and DVD combined) accounted for an average of 43 hours per person per year. That figure rose through 2004 to 67 hours, but declined in 2005 to 63 (U.S. Bureau of the Census, 2008). Nielsen Media Research (as cited by Mindlin, 2006) reported that DVD penetration in American households surpassed VCRs by late 2006, but most homes still used both types of machines.

The DVD market suffered because of competing new formats for playing high-definition content. This battle was similar to the one waged in the early years of VCR development between Betamax and VHS formats. Similarly, in early DVD player development, companies touting competing standards settled a dispute by agreeing to share royalties with the creator of the winning format. Until early 2008, the competition between proponents of HD-DVD and Blu-Ray formats for playing high-definition DVD content remained unresolved, and some studios were planning to distribute motion pictures in both formats. Blu-Ray seemed to emerge the victor in 2008 when large companies (e.g., Time Warner, Wal-Mart, Netflix) declared allegiance to that format.

Digital video recorders (DVRs, also called personal video recorders, PVRs) debuted during 2000, and about 500,000 units were sold by the end of 2001 (FCC, 2002). The devices save video content on computer hard drives, allowing fast-forwarding, rewinding, and pausing of live television; retroactive recording of limited minutes of previously displayed live television; automatic recording of all first-run episodes; automatic recording logs; and superior quality to that of analog VCRs. Dual-tuner models allow viewers to watch one program, even on satellite television, while recording another simultaneously.

DVR providers generate additional revenues by charging households monthly fees, and satellite DVR households tend to be less likely to drop their satellite subscriptions. Perhaps the most fundamental importance of DVRs is the ability of consumers to make their own programming decisions about when and what they watch. This flexibility threatens the revenue base of network television in several ways, including empowering viewers to skip standard commercials. Amobi (2005) cited potential advertiser responses, such as sponsorships and product placements within programming.

At the outset, consumers purchased their own set-top DVRs for connection with their television sets, and the leading seller (TiVo) commanded 3.6 million customers by July 2005 (FCC, 2006a). Satellite television providers began offering the service by early 2002, and EchoStar and DirecTV had 1.5 million of the 2.1 million customers using DVRs by 2003, a penetration rate of 2% (FCC, 2004a). By the end of 2004, 79% of homes

were passed by cable television DVR services, and 1.8 million cable households purchased DVR service (FCC, 2004a). By July 2005, 8.3 million American households subscribed to DVR services.

Nielsen Research, Inc. added DVR households to the sample in late 2005 and began releasing reports in 2005 about shows viewed within 24 hours of recording. In 2006, the company planned reports about viewing within a week of recording on DVR, which Nielsen estimated to be in 7% of American households by early 2006, compared with 4% penetration during the previous year (Aspan, 2006).

Standard & Poor's (Amobi & Kolb, 2007) estimated DVR penetration by the end of 2007 at 20%. During the 2007-2008 television season, major television networks and advertisers agreed that viewing is defined as watching a first-time broadcast on television or watching it within three days via DVR.

The leading British pay-television provider, British Sky Broadcasting, began offering DVR service to its customers in 2001 as an expensive add-on at about \$770 (U.S.). Sales reached 700,000 annual units in 2006, and the company announced total sales of more than two million by early 2007. These figures indicated an approximate penetration of 20% of households, suggesting a comparable rate of DVR usage with that in the United States, and surveys of usage revealed that 12.2% of viewing in homes with British Sky DVRs involved recorded programming. Such homes averaged 2 hours and 26 minutes of daily television viewing, compared with only 2 hours and 7 minutes in homes without DVRs. Sales in other European countries remained slower, although Sky Italia in Italy reportedly showed more vigorous reception of DVR technology. Both British Sky Broadcasting and Sky Italia are owned by the Rupert Murdoch media empire (Pfanner, 2007).

Personal Computers

The history of computing traces its origins back thousands of years to such practices as using bones as counters (Hofstra University, 2000). Intel introduced the first microprocessor in 1971. The MITS Altair, with an 8080 processor and 256 bytes of RAM (random access memory), sold for \$498 in 1975, introducing the desktop computer to individuals. In 1977, Radio Shack offered the TRS80 home computer, and the Apple II set a new standard for personal computing, selling for \$1,298. Other companies began introducing personal computers, and, by 1978, 212,000 personal computers were shipped for sale.

Early business adoption of computers served primarily to assist practices like accounting. When computers became small enough to sit on office desktops in the 1980s, word processing became a popular business use and fueled interest in home computers. With the growth of networking and the Internet in the 1990s, both businesses and consumers began buying computers in large numbers. Computer shipments around the world grew annually by more than 20% between 1991 and 1995 (Kessler, 2007b).

By 1997, the majority of American households with annual incomes greater than \$50,000 owned a personal computer. At the time, those computers sold for about \$2,000, exceeding the reach of lower income groups. By the late 1990s, prices dropped below \$1,000 per system (Kessler, 2007b), and American households passed the 60% penetration mark in owning personal computers within a couple of years (U.S. Bureau of the Census, 2008). By 2006, prices dropped below \$500 for desktops, with laptops selling for an average of about \$700 (Kessler, 2007b), and 52% of adults with annual incomes under \$30,000 reported being computer users (U.S. Bureau of the Census, 2008).

Factors other than prices that fueled computer purchases include both software and hardware upgrades. For example, operating systems such as Windows Vista and Windows XP and major applications such as new word processors and video editors stimulated demand for systems with more processing power. Computer peripherals such as color monitors and compact disc drives that replaced floppy disc drives also motivated upgrades. The last major upgrade period occurred in 1999 when consumers feared the millennium bug. More recently, owners of hot-selling Apple iPods (digital music and video players introduced in 2001) and iPhones (introduced in 2007) often purchased new Apple computers to match their earlier purchases (Kessler, 2007b).

A decline in computer shipments occurred between 1995 and 1999 when worldwide shipments grew by 23% before slumping again (Kessler, 2007b). The first global decline in personal computer shipments since 1985 occurred in 2001, but growth returned in 2002 with a slight increase that jumped to 12% in 2003. During this period, lower prices and stronger computing power in laptop computers led to growth of more than 15% in both 2004 and 2005, although 2006 worldwide shipments grew by only 10%.

Table 2.12 and Figure 2.14 on the companion Web site (www.tfi.com/ctu) trace the rapid and steady rise in American computer shipments and home penetration. By 2003, 61.8% of American households owned personal computers, up from 42.1% in 1998 (U.S. Bureau of the Census, 2006). By 2006, an estimated 75 million computers were shipped annually in America, where about 29% of the more than 220 million worldwide computer shipments occurred. In that year, annual shipments of computers in the United States declined in the fourth quarter, but total worldwide shipments increased by 8.7%, thanks to growth in laptop computers that overcame the decline in desktops (Kessler, 2007b).

Internet

The Internet began in the 1960s with ARPANET, or the Advanced Research Projects Agency (ARPA) network project, under the auspices of the U.S. Defense Department. The project intended to serve the military and researchers with multiple paths of linking computers together for sharing data in a system that would remain operational even when traditional communications might become unavailable. Early users, mostly university and research lab personnel, took advantage of electronic mail and posting information on computer bulletin boards. Usage increased dramatically in 1982 after the National Science Foundation supported high-speed linkage of multiple locations around the United States. After the collapse of the Soviet Union in the late 1980s, military users abandoned ARPANET, but private users continued to use it, and multimedia transmissions of audio and video became available. More than 150,000 regional computer networks and 95 million computer servers hosted data for Internet users (Campbell, 2002).

As of 2004, 61.4% of U.S. adults connected to the Internet either at home or at work within 30 days of being surveyed, and more than 60% of American households had Internet access (U.S. Bureau of the Census, 2006). The combination of cable modems, DSL, and other wired and wireless Internet access technologies reached 35.3 million households by the end of 2004 (FCC, 2006a). By June 2005, 70.3 million American households had Internet access, and about 33.7 million of those homes enjoyed broadband access (FCC, 2006a). Internet penetration reached 71% of American households by 2006, and 57 million Americans enjoyed broadband access at home. Third Age, Inc. (as cited by Kessler, 2007a) reported that more than 72% of adults older than 40 years used broadband home connections to access the Internet in 2007. The most common explanation given by Americans for buying a home computer is connection to the Internet (Kessler, 2007a).

In 2003, the average monthly time spent at the home computer was 25.5 hours. Three years later, the average reached 30.5 hours, according to Nielsen/NetRatings (as cited by Herring, 2006). Much of the expanded use is attributable to growth in high-speed broadband access to the Internet.

The global popularity of the Internet is illustrated by the worldwide figure of 263 million broadband Internet subscribers in 2006. IDC (as cited by Bensinger, 2007) estimated that 400 million subscribers would be online by 2010. Internet World Stats reported (as cited by Kessler, 2007a) that global Internet use grew by 225% between 2000 and July 2007 to nearly 1.2 billion. About 90% of the 233 million North American Internet users resided in the United States. Penetration rates around the world often exceed that achieved in American households, as exemplified in South Korea (89%) and Hong Kong (83%) (Kessler, 2007a).

As late as 2004, 36 million households in the United States, more than half of those with Internet access, connected to the network by means of a dial-up telephone connection (Belson, 2005). America still lags behind other countries in high-speed access to the Internet. For example, high-speed Internet access in Japan and Germany achieved only about half of the American penetration in 2001. In France, the number reached only about 25% of that in the United States. By 2006, residents in all three of those countries were more likely to have broadband Internet access at home than were Americans, and the connections for Americans were slower and more expensive. Connections in France averaged three times faster than in America, and Japanese connections averaged 12 times faster than average American connections. In France, Internet connections include free voice calls, television, and Wi-Fi as well (Krugman, 2007).

At least eight countries other than the United States enjoyed broadband Internet penetration of equal or greater than 26% (OECD, 2007). This figure exceeded the rate (less than 20%) for the United States, which housed the greatest number of users of broadband home access. For data and reports about technology use in the United States and other countries, see <http://www.oecd.org>, the home page of the Organisation for Economic Co-operation and Development. Table 2.13 and Figures 2.15 and 2.16 on the companion Web site (www.tfi.com/ctu) show trends in Internet usage in the United States.

In 2006, about 15 million American households were in rural areas that lacked wired access to the Internet. Satellite access to the Internet filled that void, but at quite expensive rates (\$50 to \$130 per month) that often double the cost of wired service. The monthly rates exclude the installation costs of the satellite dish (about \$500, minus discounts) needed to deliver the connections. About 463,000 homes and businesses used these satellite connections in 2006, nearly 35% more than in 2005. One service reported that 80% of its customers are homes, not businesses (Belson, 2006).

Another example of foreign leadership in Internet use is wireless computer access. In 2004, nearly 85,000 public wireless hotspots operated worldwide. Annual growth of that number is projected to reach 25% (Kessler, 2007a). Wireless local area networks make the Internet accessible from locations away from the traditional desktop, usually with 150 to 250 feet of a wired connection. Wi-Fi technology usually fits IEEE 802.11 standards, with basic data transfer speeds of 11 Mb/s to 54 Mb/s. Newer routers take the transfer rate past 108 Mb/s. Many commercial and civic organizations, such as coffee shops, airports, and public areas, provide free Wi-Fi access to computers equipped with appropriate cards. The FCC (2005) cited Intel in estimating 25,877 such hotspots in the United States in 2005. Such access is promoted by the inclusion of wireless cards in 75% of all notebook computers shipped.

Internet access supports the formation of virtual communities or social networks on such services as MySpace and Facebook. Social networks do much more than support connections among member users by

offering music, file sharing, video sharing, games, and many other services. Negative consequences also emerge when Internet predators use social networks as a means to find victims. MySpace captured nearly 80% of the social network connections in the United States in April 2007, and reported 114 million unique visitors by June of that year. Facebook attracted 52 million unique visitors. Having opened its doors to all Internet users in September 2006, Facebook gathered an 11.5% share of American social networking traffic. By July 2007, Facebook attracted 30 million users who visited the site at least monthly and increased its market share in North America to 68%. MySpace attracted 42% (Kessler, 2007a).

A survey (Lenhart, et al., 2007) of nearly 1,000 teenagers found that 21% send daily messages by means of social networking sites. A subset of teens using the Internet, instant messaging, text messaging, and social networking sites made up 28% of the survey sample and was given the label of “multichannel teens” (p. 4). Members of this group were even more invested in social networking, with 47% of them using the sites daily to send messages to friends.

The leading social network site in Europe in June 2007 was Bebo.com, which attracted a 63% share in its market. Friendster.com was the market leader in Asia with a share of 88% of its market, and Orkut.com led the Latin American market with 40%. MySpace is also available to members in Europe, Japan, Australia, and Latin America, and the company licensed itself in 2007 for operations in China where many local social networking competitors were already thriving (Kessler, 2007a).

Social networking also operates without computers through a variety of online services that allow individuals to use mobile phones to send out reports of daily activities. Users obtain software for their phones from Web sites. This software allows sending messages and photographs to receivers who use phones or computers accessing Web sites for reception (Stone & Richtel, 2007).

The growing penetration of broadband technology makes possible new video services such as video on demand via the Internet. The FCC (2006a) reported that, in January 2005, 14% of Americans had seen streaming video within the previous month. By mid-2006, 107 million Americans viewed online video, and about 60% of American Internet users had downloaded video. By the end of 2007, YouTube, an Internet video-serving site, used more bandwidth than was used by the entire Internet in 2000 (FCC, 2008b).

As more video content, including motion pictures, becomes available via the Internet, demand should increase for high-speed service. Perhaps broadband might enjoy even wider adoption if the service were not so expensive. Stross (2006) observed that consumers in Europe and Japan pay far less in monthly fees to access broadband content at higher speeds than are available in the United States.

In the United States, cable modems offered the most commonly used (60.3%) means of broadband access, with 24.3 million American homes receiving access via cable modems by 2005. However, growing popularity of DSL high-speed connections (34.3% in 2003, up to 37.2% in 2004) deprived cable modems of market share, which fell from 63.2% in 2003. Although satellite broadband services exist, their installation and monthly charges tend to exceed those of other broadband technologies (FCC, 2006a).

Outside the United States, DSL has an edge over cable access because of the much greater penetration of wired telephone lines relative to cable infrastructure. DSL attracted nearly 150 million subscribers in 2005, compared with just more than 50 million for cable. In 2006, DSL accounted for about 65% of the worldwide broadband Internet subscriptions. IDC (as cited by Bensinger, 2007) projected that the DSL growth rate would increase for several years, while the growth rate for cable Internet access would remain mostly stable.

DSL Forum (as cited by Bensinger, 2007), an industry consortium, estimated a global presence of 200 million DSL subscribers in mid-2007. Nine countries had more than five million DSL connections, with China holding 20% of the worldwide subscribers and the United States 15% (Bensinger, 2007).

Video Games

Competition for the attention of home entertainment audiences has included commercial video games since the 1970s, and research into the form began in the 1950s, as discussed in Chapter 12. Early versions were quite sedate, compared with modern versions that incorporate complex story lines, computer animation, and/or motion picture footage. Table 2.14 and Figure 2.17 trace trends in video game popularity, as measured by units purchased, spending per person, and time spent per person. Classifying games by media category will become increasingly difficult because they are available for dedicated gaming consoles that qualify as specialized computers, and both game software and hardware allow players to compete via the Internet. Since 1996, the number of home devices that play video games has more than doubled, and the amount of spending per person per year has more than tripled.

In 2004, console-based video gaming surpassed computer-based gaming. Surveys of gamers revealed that nearly 25% reported reduced television viewing, and 18% anticipated watching even less television in 2005. Weekly television viewing among gamers fell from 18 hours in 2004 to 16 in 2005. The number of households with video game consoles reached an estimated 62.6 million in 2005, 15% more than a year before. Homes using computer-based gaming were estimated at 56.6 million, an 8.2% gain over 2004. In all, about 76.2 million Americans engaged in video gaming by 2005, nearly 13% more than a year earlier (Ziff-Davis Media, 2005).

Bloomberg News (Video game, 2006) cited a report by the NPD Group that found that, during 2005, revenues from video games increased by 6% over sales in 2004. Revenues in 2005 reached \$1.4 billion for portable game players alone, and the total sales increased to \$10.5 billion for both games and hardware for playing them. That figure exceeded the previous record of \$10.3 billion in 2002 and might have been even higher but for the late 2005 release of the Xbox 360 console, for which few games were available when the new player arrived. Long lines of consumers waited in pre-dawn darkness for stores to open to allow the purchase of the new Xbox 360.

Along with the Xbox 360, the Wii and Sony PlayStation 3 make up the triumvirate of game consoles, with all three featuring Internet interactivity. By mid-2007, 11.3 million Xbox 360 units, 9.3 million Wii players, and 5.5 million PlayStation 3 consoles were shipped. Sony had already shipped 118 million of the earlier iteration PlayStation 2 consoles. To measure online usage of these machines, Nielsen Media Research started Nielsen GamePlay Metrics in 2007. June 2007 data revealed average minutes played per online session of these consoles was 83 minutes for the PlayStation 3, 57 minutes for the Wii, and 61 minutes for Xbox 360 (Kessler, 2007a).

Video game players expanded from computers and consoles to the Internet through online gaming, a \$1.8 billion market in 2006. Online multiplayer role-playing games are the most popular segment of online games, and *World of Warcraft* is the most popular game of that type, with nine million players in mid-2007. Gaming moved to mobile phones through simple games, such as solitaire, *Brickbreaker*, and *Sudoku*. As mentioned earlier, nearly half of wireless phones included game playing by 2005. Worldwide revenues in 2006 for mobile games reached \$2.9 million and were expected to soar to nearly \$10 million by 2011 (Kessler, 2007a).

Synthesis

Horrigan (2005) noted that the rate of adoption of high-speed Internet use approximated that of other electronic technologies. He observed that 10% of the population used high-speed Internet access in just more than five years. Personal computers required four years, CD players needed 4.5 years, cell phones required eight years, VCRs took 10 years, and color televisions used 12 years to reach 10% penetration.

Early visions of the Internet (see Chapter 18) did not include the emphasis on entertainment and information to the general public that has emerged. The combination of this new medium with older media belongs to a phenomenon called “convergence,” referring to the merging of functions of old and new media. The FCC (2002) reported that the most important type of convergence related to video content is the joining of Internet services. The report also noted that companies from many business areas were providing a variety of video, data, and other communications services.

Just as media began converging nearly a century ago when radios and record players merged in the same appliance, media in recent years have been converging at a much more rapid pace. Wireless telephones enjoyed explosive growth, and cable and telephone companies began offering competing personal communications opportunities. Electronic media are enticing consumers to switch from print media. Increasing proportions of the population are using laptop computers, personal digital assistants (PDA), mobile telephones with multimedia capability, and digital audio and video players that resemble small computers, all resulting in greater portability and convenience of online content. Electronic media content often contains materials that are not included in print media versions of the same titles, and consumers enjoy the ability to edit electronic materials and move them around to various playback devices (Peters & Donald, 2007).

Popularity of print media forms generally declined throughout the 1990s, perhaps, in part, after newspapers, magazines, and books began appearing in electronic and audio forms. After 2000, business remained strong in providing a variety of titles in both periodicals and books, although newspaper circulation continued to decline. Recorded music sales, including CDs, declined, although the controversies over digital music indicated no loss in the popularity of music listening. After debuting in 2001, satellite radio increased its subscribers elevenfold from 2003 to 2007. Motion picture box office receipts remained steady, although theater attendance seems to be losing ground to home viewing. Television time shifting has become easier with the growing popularity of the DVR, a device that attracted such a strong following that advertisers changed their definition of television viewing to incorporate three days of recorded viewing. Video game competition for viewer attention strengthened over the period from 2002 to 2007. Game playing not only thrived at home on consoles that stand alone and interact over the Internet, but games expanded to mobile players and phones. The popularity of the Internet continued upward, particularly with the growth of high-speed broadband connections, for which adoption rates achieved comparability with previous new communications media. Consumer flexibility remains the dominant media consumption theme as we near the end of the first decade of the new century.

The Pew Internet and American Life Project investigated how young people communicate and called teenagers “super communicators” (Lenhart, et al., 2007, p. 5) because of the way they interact through media tools. Surprisingly, or not, their use of mobile telephones and social networking outweigh their face-to-face communication away from school. Among the most media-oriented teens, 70% talk on mobile phones every day, more than half send text messages every day, and more than half send instant messages every day. Although their seniors remain less likely to use these tools as often as do teens, the devices that support these activities are

likely to become *modus operandi* for Americans, as they have more rapidly been adopted by residents of other countries.

Convergence has arrived in a big way for both audio and video content. Music and video remain strong at home, but consumers now can also purchase packaged content “to go” from providers. Media fans can also record their own digital content and save it to such devices as computers, iPods, cell phones, DVD players, personal digital assistants, and other portable equipment for playback almost any time, anywhere. Understanding how people live requires knowing how they use media, and the remainder of this book explores the structure and use of these individual media.

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Understanding Communication Technologies

Jennifer H. Meadows, Ph.D.*

You can do dozens of things that your parents never dreamed of: surfing the Internet anytime and anywhere, watching movie-theater quality television programs on a high-definition television (HDTV) in your home, battling aliens on “distant worlds” alongside game players scattered around the globe, and “Googling” any subject you find interesting. This book was created to help you understand these technologies, but there are a special set of tools you can use that will not only help you understand them, but also understand the next generation of technologies, and every generation after that.

All of the communication technologies explored in this book have a number of characteristics in common, including how their adoption spreads from a small group of highly interested consumers to the general public, what the effects of these technologies are upon the people who use them (and on society in general), and how these technologies affect each other.

For more than a century, researchers have studied adoption, effects, and other aspects of new technologies, identifying patterns that are common across dissimilar technologies, and proposing theories of technology adoption and effects. These theories have proven to be valuable to entrepreneurs seeking to develop new technologies, regulators who want to control those technologies, and everyone else who just wants to understand them. The utility of these theories is that they allow you to apply lessons from one technology to another or from old technologies to new technologies. The easiest way to understand the role played by the technologies explored in this book is to have a set of theories you can apply to virtually any technology you discuss. The purpose of this chapter is to give you those tools by introducing you to the theories.

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The umbrella perspective discussed in Chapter I is a useful framework for studying communication technologies, but it is not a theory. This perspective is a good starting point to begin to understand communication technologies because it targets your attention at a number of different levels that might not be immediately obvious including hardware, software, organizational infrastructure, the social system, and, finally, the user. Understanding each of these levels is aided by knowing a number of theoretical perspectives that can help us understand the different levels of the umbrella for these technologies. Indeed, there are a plethora of theories that can be used to study these technologies. Theoretical approaches are useful in understanding the origins of the information-based economy in which we now live, why some technologies take off while others fail, the impacts and effects of technologies, and the economics of the communication technology marketplace.

The Information Society and the Control Revolution

Our economy used to be based on tangible products such as coal, lumber, and steel. That has changed. Now, information is the basis of our economy. Information industries include education, research and development, creating informational goods such as computer software, banking, insurance, and even entertainment and news (Beniger, 1986). Information is different from other commodities like coffee and pork bellies, which are known as “private goods.” Instead, information is a “public good” because it is intangible, lacks a physical presence, and can be sold as many times as demand allows without regard to consumption. For example, if 10 sweaters are sold, then 10 sweaters must be manufactured using raw materials. If 10 subscriptions to an online dating service are sold, there is no need to create new services: 10—or 10,000—subscriptions can be sold without additional raw materials.

This difference actually gets to the heart of a common misunderstanding about ownership of information that falls into a field known as “intellectual property rights.” For example, a person can purchase a music compact disc (CD). The information, the music, is printed on a physical medium, the CD. That person may believe that because he or she purchased the CD, that purchase allows the copy and distribution of the music on the CD. It is important to realize the difference between the information (music), which has value, and the physical media that contains the information (the CD).

Several theorists have studied the development of the information society, including its origin. Beniger (1986) argues that there was a control revolution: “A complex of rapid changes in the technological and economic arrangements by which information is collected, stored, processed, and communicated and through which formal or programmed decisions might affect social control” (p. 52). In other words, as society progressed, technologies were created to help control information. For example, information was centralized by mass media. In addition, as more and more information is created and distributed, new technologies must be developed to control that information. For example, with the explosion of information available over the Internet, search engines were developed to help users find it.

Another important point is that information is power, and there is power in giving information away. Power can also be gained by withholding information. For example, at different times in modern history, governments have blocked access to information or controlled information dissemination to maintain power. The first question you might ask about new technologies is whether the innovation is a “thing” (a private good such as a new

video game console) or a type of information (public good such as the software for the game that is played on that console).

Adoption

Why are some technologies adopted while others fail? This question is addressed by a number of theoretical approaches including the diffusion of innovations, social information processing theory, and critical mass theory.

Diffusion of Innovations

The diffusion of innovations, also referred to as diffusion theory, was developed by Everett Rogers (1962; 2003). This theory tries to explain how an innovation is communicated over time through different channels to members of a social system. There are four main aspects of this approach. First, there is the innovation. In the case of communication technologies, the innovation is some technology that is perceived as new. Rogers defines characteristics of innovations: relative advantage, compatibility, complexity, trialability, and observability. So if someone is deciding to purchase a new iPod, for example, characteristics would include the relative advantage over other digital audio players or even other ways to listen to music like CDs, whether or not the iPod is compatible with the existing needs of the user, how complex it is to use, whether or not the potential user can try it out, and whether or not the potential user can see others using the new iPod with successful results.

Information about an innovation is communicated through different channels. Mass media is good for awareness knowledge. For example, the new iPod has television commercials and print advertising announcing its existence and its features. Interpersonal channels are also an important means of communication about innovations. These interactions generally involve subjective evaluations of the innovation. For example, a person might ask some friends how they like their new iPods.

Rogers (2003) outlines the decision-making process a potential user goes through before adopting an innovation. This is a five-step process. The first step is knowledge. For example, you find out there is a new iPod available and learn about its new features. The next step is persuasion when you form a positive attitude about the innovation. Maybe you like the new iPod. The third step is when you decide to accept or reject the innovation. Yes, I will get the new iPod. Implementation is the fourth step. You use the innovation, in this case, the iPod. Finally, confirmation occurs when you decide that you made the correct decision. Yes, the iPod is what is thought it would be; my decision is reinforced.

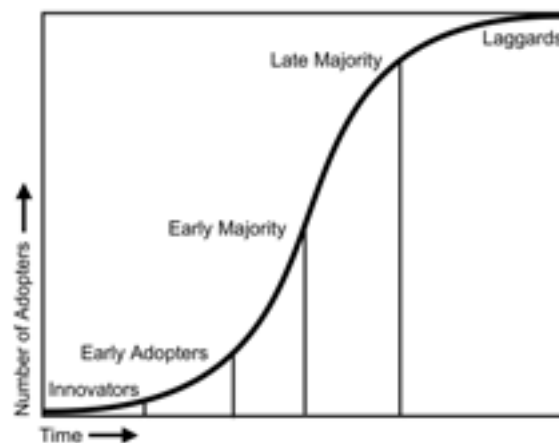
Another stage that is discussed by Rogers (2003) and others is “reinvention,” the process by which a person who adopts a technology begins to use it for purposes other than those intended by the original inventor. For example, iPods were initially designed for music and other sound recording, but users have found ways to use them for a wide variety of applications ranging from alarm clocks to personal calendars.

Have you ever noticed that some people are the first to have the new technology gadget, while others refuse to adopt a proven successful technology? Adopters can be categorized into different groups according to how soon or late they adopt an innovation. The first to adopt are the innovators. Innovators are special because they are willing to take a risk adopting something new that may fail. Next come the early adopters, the

early majority, and then the late majority, followed by the last category, the laggards. In terms of percentages, innovators make up the first 2.5% percent of adopters, early adopters are the next 13.5%, early majority follows with 34%, late majority are the next 34%, and laggards are the last 16%. Adopters can also be described in terms of ideal types. Innovators are venturesome. These are people who like to take risks and can deal with failure. Early adopters are respectable. They are valued opinion leaders in the community and role models for others. Early majority adopters are deliberate. They adopt just before the average person and are an important link between the innovators, early adopters, and everyone else. The late majority are skeptical. They are hesitant to adopt innovations and often adopt because they are pressured. Laggards are the last to adopt and often are isolated with no opinion leadership. They are suspicious and resistant to change. Other factors that affect adoption include education, social status, social mobility, finances, and willingness to use credit (Rogers, 2003).

Adoption of an innovation does not usually occur all at once; it happens over time. This is called the rate of adoption. The rate of adoption generally follows an S-shaped “diffusion curve” where the X-axis is time and the Y-axis is percent of adopters. You can note the different adopter categories along the diffusion curve. Figure 3.1 shows a diffusion curve. See how the innovators are at the very beginning of the curve, and the laggards are at the end. The steepness of the curve depends on how quickly an innovation is adopted. For example, DVD has a steeper curve than VCR because DVD players were adopted at a faster rate than VCRs. Also, different types of decision processes lead to faster adoption. Voluntary adoption is slower than collective decisions, which, in turn, are slower than authority decisions. For example, a company may let its workers decide whether to use a new software package, the employees may agree collectively to use that software, or finally, the management may decide that everyone at the company is going to use the software. In most cases, voluntary adoption would take the longest, and a management dictate would result in the swiftest adoption.

Figure 3.1
Innovation Adoption Rate



Source: Technology Futures, Inc.

Critical Mass Theory

Have you ever wondered who had the first e-mail address or the first telephone? Who did they communicate with? Interactive technologies such as telephony and e-mail become more and more useful as more people

adopt these technologies. There have to be some innovators and early adopters who are willing to take the risk to try a new interactive technology. These users are the “critical mass,” a small segment of the population that chooses to make big contributions to the public good (Markus, 1987). In general terms, any social process involving actions by individuals that benefit others is known as “collective action.” In this case, the technologies become more useful if everyone in the system is using the technology, a goal known as universal access. Ultimately universal access means that you can reach anyone through some communication technology. For example, in the United States, the landline phone system reaches almost everywhere, and everyone benefits from this technology although a small segment of the population initially chose to adopt the telephone to get the ball rolling. There is a stage in the diffusion process that an interactive medium has to reach in order for adoption to take off. This is the “critical mass.”

Another relatively new conceptualization of critical mass theory is the “tipping point” (Gladwell, 2002). Here is an example. The videophone never took off, in part, because it never reached critical mass. The videophone was not really any better than a regular phone unless the person you were calling also had a videophone. If there were not enough people you knew who had videophones, then you might not adopt it because it was not worth it. On the other hand, if most of your regular contacts had videophones, then that critical mass of users might drive you to adopt the videophone. Critical mass is an important aspect to consider for the adoption of any interactive technology.

A good example is facsimile or fax technology. The first method of sending images over wires was invented in the '40s—the 1840s—by Alexander Bain, who proposed using a system of electrical pendulums to send images over wires (Robinson, 1986). Within a few decades, the technology was adapted by the newspaper industry to send photos over wires, but the technology was limited to a small number of news organizations. The development of technical standards in the 1960s brought the fax machine to corporate America, which generally ignored the technology because few businesses knew of another business that had a fax machine.

Adoption of the fax took place two machines at a time, with those two usually being purchased to communicate with each other, but rarely used to communicate with additional receivers. By the 1980s, enough businesses had fax machines that could communicate with each other that many businesses started buying fax machines one at a time. As soon as the “critical mass” point was reached, fax machine adoption increased to the point that it became referred to as the first technology adopted out of fear of embarrassment that someone would ask, “What’s your fax number?” (Wathne & Leos, 1993). In less than two years, the fax machine became a business necessity.

Social Information Processing

Another way to look at how and why people choose to use or not use a technology is social information processing. This theory begins by critiquing rational choice models, which presume that people make adoption decisions and other evaluations of technologies based upon objective characteristics of the technology. In order to understand social information processing, you first have to look at a few rational choice models.

One model, social presence theory, categorizes communication media based on a continuum of how the medium “facilitates awareness of the other person and interpersonal relationships during the interaction (Fulk, et al., 1990, p. 118).” Communication is most efficient when the social presence level of the medium best matches the interpersonal relationship required for the task at hand. Another rational choice model is information richness theory. In this theory, media are also arranged on a continuum of richness in four areas: speed of feedback, types of channels employed, personalness of source, and richness of language carried (Fulk, et al.,

1990). Face-to-face communications is the highest in social presence and information richness. In information richness theory, the communication medium chosen is related to message ambiguity. If the message is ambiguous, then a richer medium is chosen.

Social information processing theory goes beyond the rational choice models because it states that perceptions of media are “in part, subjective and socially constructed.” Although people may use objective standards in choosing communication media, use is also determined by subjective factors such as the attitudes of coworkers about the media and vicarious learning, or watching others’ experiences. Social influence is strongest in ambiguous situations. For example, the less people know about a medium, then the more likely they are to rely on social information in deciding to use it (Fulk, et al., 1987).

As an example, think about whether you prefer a Macintosh or a Windows-based computer. Although you can probably list objective differences between the two, many of the important factors in your choice are based upon subjective factors such as which one is owned by friends and coworkers, the perceived usefulness of the computer, and advice you receive from people who can help you set up and maintain your computer. In the end, these social factors probably play a much more important role in your decision than “objective” factors such as processor speed, memory capacity, etc.

Impacts and Effects

Do video games make players violent? Do users seek out the World Wide Web for social interactions? These are some of the questions that theories of impacts or effects try to answer. To begin, Rogers (1986) provides a useful typology of impacts. Impacts can be grouped into three dichotomies: desirable and undesirable, direct and indirect, and anticipated and unanticipated. Desirable impacts are the functional impacts of a technology. For example a desirable impact of e-commerce is the ability to purchase goods and services from your home. An undesirable impact is one that is dysfunctional, such as credit card fraud. Direct impacts are changes that happen in immediate response to a technology. A direct impact of wireless telephony is the ability to make calls while driving. An indirect impact is an impact of the direct impact. For example, laws against driving and using a handheld wireless phone are an impact of the direct impact described above. Anticipated impacts are the intended impacts of a technology. An anticipated impact of text messaging is to communicate without audio. An unanticipated impact is an unintended impact, which is people sending text messages in a movie theater and annoying other patrons. Often, the desirable, direct, and anticipated impacts are the same and are considered first. Then, the undesirable, indirect, and unanticipated impacts are noted later.

A good example of this is e-mail. A desirable, anticipated, and direct impact of e-mail is to be able to quickly send a message to multiple people at the same time. An undesirable, indirect, and unanticipated impact of e-mail is spam—unwanted e-mail clogging the inboxes of millions of users.

Uses and Gratifications

Uses and gratifications research is a descriptive approach that gives insight into what people do with technology. This approach sees the users as actively seeking to use different media to fulfill different needs (Rubin, 2002). The perspective focuses on “(1) the social and psychological origins of (2) needs, which generate (3) expectations of (4) the mass media or other sources, which lead to (5) differential patterns of media exposure

(or engagement in other activities), resulting in (6) needs gratifications and (7) other consequences perhaps mostly unintended ones” (Katz, et al., 1974, p. 20).

Uses and gratification research surveys audiences about why they choose to use different types of media. For examples, uses and gratifications of television studies have found that people watch television for information, relaxation, to pass time, by habit, excitement, and for social utility (Rubin, 2002). This approach is also useful for comparing the uses and gratifications between media. For example, studies of the World Wide Web (WWW) and television gratifications find that, although there are some similarities such as entertainment and to pass time, they are also very different on other variables such as companionship where the Web was much lower than for television (Ferguson & Perse, 2000). Uses and gratifications studies have examined a multitude of communication technologies including mobile phones (Wei, 2006), digital media players (Keeler & Wilkison, in press), radio (Towers, 1987), and satellite television (Etefa, 2005).

Media System Dependency Theory

Often confused with uses and gratifications, media system dependency theory is “an ecological theory that attempts to explore and explain the role of media in society by examining dependency relations within and across levels of analysis” (Grant, et al., 1991, p. 774). The key to this theory is the focus it provides on the dependency relationships that result from the interplay between resources and goals. The theory suggests that, in order to understand the role of a medium, you have to look at relationships at multiple levels of analysis including the individual level—the audience, the organizational level, the media system level, and society in general. These dependency relationships can be symmetrical or asymmetrical. For example, the dependency relationship between audiences and network television is asymmetrical because an individual audience member may depend more on network television to reach his or her goal than the television networks depend on that one audience member to reach their goals.

A typology of individual media dependency relations was developed by Ball-Rokeach & DeFleur (1976) to help understand the range of goals that individuals have when they use the media. There are six dimensions: social understanding, self-understanding, action orientation, interaction orientation, solitary play, and social play. Social understanding is learning about the world around you, while self-understanding is learning about yourself. Action orientation is learning about specific behaviors, while interaction orientation is about learning about specific behaviors involving other people. Solitary play is entertaining yourself alone, while social play is using media as a focus for social interaction. Research on individual media system dependency relationships has demonstrated that people have different dependency relationships with different media. For example, Meadows (1997) found that women had stronger social understanding dependencies for television than magazines, but stronger self-understanding dependencies for magazines than television.

In the early days of television shopping (when it was considered “new technology”), Grant, et al. (1991) applied media system dependency theory to the phenomenon. Their analysis explored two dimensions: how TV shopping changed organizational dependency relations within the television industry and how and why individual users watched television shopping programs. By applying a theory that addressed multiple levels of analysis, a greater understanding of the new technology was obtained than if a theory that focused on only one level had been applied.

Social Learning Theory/Social Cognitive Theory

Social learning theory focuses on how people learn by modeling others (Bandura, 2001). This observational learning occurs when watching another person model the behavior. It also happens with symbolic modeling, modeling that happens by watching the behavior modeled on a television or computer screen. For example, a person can learn how to fry an egg by watching another person fry an egg in person or on a video.

Learning happens within a social context. People learn by watching others, but they may or may not perform the behavior. Learning happens, though, whether the behavior is imitated. Reinforcement and punishment play a role in whether or not the modeled behavior is performed. If the behavior is reinforced, then the learner is more likely to perform the behavior. For example, if a student is successful using online resources for a presentation, other students watching the presentation will be more likely to use online resources. On the other hand, if the action is punished, then the modeling is less likely to result in the behavior. For example, if a character drives drunk and gets arrested on a television program, then that modeled behavior is less likely to be performed by viewers of that program.

Reinforcement and punishment is not that simple though. This is where cognition comes in—learners think about the consequences of performing that behavior. This is why a person may play *Grand Theft Auto* and steal cars in the videogame, but will not then go out and steal a car in real life. Self-regulation is an important factor. Self-efficacy is another important dimension: learners must believe that they can perform the behavior.

Social learning/cognitive theory, then, is a useful framework for examining not only the effects of communication media, but also the adoption of communication technologies (Bandura, 2001). The content that is consumed through communication technologies contains symbolic models of behavior that are both functional and dysfunctional. If viewers model the behavior in the content, then some form of observational learning is occurring. A lot of advertising works this way. A movie star uses a new shampoo and then is admired by others. This message models a positive reinforcement of using the shampoo. Cognitively, the viewer then thinks about the consequences of using the shampoo. Modeling can happen with live models and symbolic models. For example, a person can watch another playing Wii bowling, a videogame where the player has to manipulate the controller to mimic rolling the ball. Their avatar in the game also models the bowling action. The other player considers the consequences of this modeling. In addition, if the other person had not played with this gaming system, watching the other person play with the Wii and enjoy the experience will make it more likely that he or she will adopt the system. Therefore, social learning/cognitive theory can be used to facilitate the adoption of new technologies and to understand why some technologies are adopted and why some are adopted faster than others (Bandura, 2001).

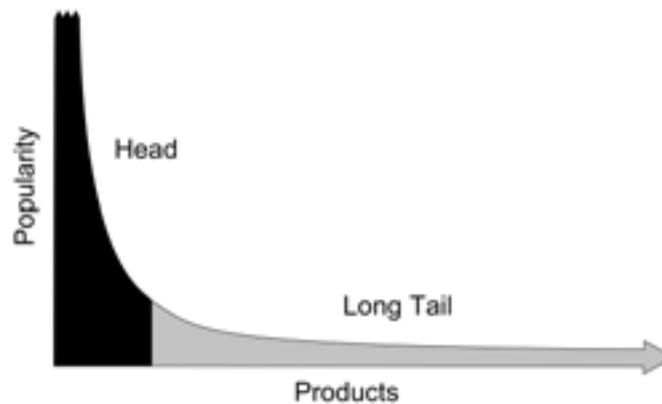
Economic

Thus far, the theories and perspectives discussed have dealt mainly with individual users and communication technologies. How do users decide to adopt a technology? What impacts will a technology have on a user? Theory, though, can also be applied to organizational infrastructure and the overall technology market. Here, two approaches will be addressed: the theory of the long tail that presents a new way of looking at digital content and how it is distributed and sold, and the principle of relative constancy that examines what happens to the marketplace when new media products are introduced.

The Theory of the Long Tail

Wired editor Chris Anderson developed the theory of the long tail. This theory begins with the realization that there are not any huge hit movies, television shows, and records like there used to be. What counts as a hit TV show today, for example, would be a failed show just 15 years ago. One of the reasons for this is choice: 40 years ago viewers had a choice of only a few television channels. Today, you could have hundreds of channels of video programming on cable or satellite and limitless amounts of video programming on the Internet. You have a lot more choice. New communication technologies are giving users access to niche content. There is more music, video, video games, news, etc. than ever before because the distribution is no longer limited to the traditional mass media of over-the-air broadcasting, newspapers, etc. The theory states that, “our culture and economy is increasingly shifting away from a focus on a relatively small number of ‘hits’ at the headend of the demand curve and toward a huge number of niches in the tail” (Anderson, n.d.). Figure 3.2 shows a traditional demand curve; most of the hits are at the head of the curve, but there is still demand as you go into the tail. There is a demand for niche content and there are opportunities for businesses that deliver content in the long tail.

Figure 3.2
The Long Tail



Source: Anderson (n.d.)

Physical media and traditional retail has limitations. For example, there is only so much shelf space in the store. Therefore, the store, in order to maximize profit, is only going to stock the products most likely to sell. Digital content and distribution changes this. For example, Amazon and Netflix can have huge inventories of hard-to-find titles, as opposed to a bricks-and-mortar video rental store, which has to have duplicate inventories at each location. All digital services, such as the iTunes store, eliminate all physical media. You purchase and download the content digitally, and there is no need for a warehouse to store DVDs and CDs. Because of these efficiencies, these businesses can better serve niche markets. Taken one at a time, these niche markets may not generate significant revenue but when they are aggregated, these markets are significant.

Anderson (2006) suggests rules for long tail businesses. Make everything available, lower the price, and help people find it. Traditional media are responding to these services. For example, Nintendo is making classic games available for download. Network television is putting up entire series of television programming

on the Internet. The audience is changing, and expectations for content selection and availability are changing. The audience today, Anderson argues, wants what they want, when they want it, and how they want it.

The Principle of Relative Constancy

So now that people have all of this choice of content, delivery mode, etc., what happens to older media? Do people just keep adding new entertainment media, or do they adjust by dropping one form in favor of another? This question is at the core of the principle of relative constancy, which says that people spend a constant fraction of their disposable income on mass media over time. People do, however, alter their spending on mass media categories when new services/products are introduced (McCombs & Nolan, 1992). What this means is that, if a new media technology is introduced in order for adoption to happen, the new technology has to be compelling enough for the adopter to give up something else. For example, a person who signs up for Netflix may spend less money on movie tickets. A satellite radio user will spend less money purchasing music downloads or CDs. So, when considering a new media technology, the relative advantage it has over existing service must be considered, along with other characteristics of the technology discussed earlier in this chapter. Remember, the money users spend on any new technology has to come from somewhere.

Conclusion

This chapter has provided a brief overview of several theoretical approaches to understanding communication technology. As you work through the book, consider theories of adoption, effects, and economics and how they can inform you about each technology and allow you to apply lessons from one technology to others. For more in-depth discussions of these theoretical approaches, check out the sources cited in the bibliography.

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The Structure of the Communication Industries

August E. Grant, Ph.D.^{*}

The field of communication technologies is one of the most dynamic areas of study. One factor that makes it so dynamic is the continual flux in the organizational structure of communication industries. “New” technologies that make a major impact come along only a few times a decade. New products that make a major impact come along once or twice a year. Organizational shifts are constantly happening, making it almost impossible to know all of the players at any given time.

Even though the players are changing, the organizational structure of communication industries is relatively stable. The best way to understand the industry, given the rapid pace of acquisitions, mergers, start-ups, and failures, is to understand their organizational functions. This chapter addresses the organizational structure, and explores the functions of those industries, which will help you to understand the individual technologies discussed throughout this book.

In the process of using organizational functions to analyze specific technologies, do not forget to consider that these functions cross national as well as technological boundaries. Most hardware is designed in one country, manufactured in another, and sold around the globe. Although there are cultural and regulatory differences that are addressed in the individual technology chapters later in the book, the organizational functions discussed in this chapter are common internationally.

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What's in a Name?

A good illustration of the importance of understanding organizational functions comes from analyzing the history of AT&T, one of the biggest names in communication of all time. When you hear the name, “AT&T,” what do you think of? Your answer probably depends on how old you are and where you live. If you live in Texas, you know AT&T as the new name of your local phone company. In New York, it is the name of one of the leading wireless telephone companies. If you are older than 55, you might think of the company's old nickname, “Ma Bell.”

The AT&T Story

In the study of communication technology over the last century, no name is as prominent as AT&T. The company known today as AT&T is an awkward descendent of the company that once held a monopoly on long-distance telephone service and a near monopoly on local telephone service through the first four decades of the 20th century. The AT&T story is a story of visionaries, mergers, divestiture, and rebirth.

Alexander Graham Bell invented his version of the telephone in 1876, although historians note that he barely beat his competitors to the patent office. His invention soon became an important force in business communication, but diffusion of the telephone was inhibited by the fact that, within 20 years, thousands of entrepreneurs established competing companies to provide telephone service in major metropolitan areas. Initially, these telephone systems were not interconnected, making the choice of telephone company a difficult one, with some businesses needing two or more local phone providers to connect with their clients.

The visionary who solved the problem was Theodore Vail, who realized that the most important function was the interconnection of these telephone companies. As discussed in the following chapter, Vail led American Telephone & Telegraph to provide the needed interconnection, negotiating with the U.S. government to provide “universal service” under heavy regulation in return for the right to operate as a monopoly. Vail brought as many local telephone companies as he could into AT&T, which evolved under the eye of the federal government as a behemoth with three divisions:

- ♦ AT&T Long Lines—the company that had a virtual monopoly on long distance telephony in the United States.
- ♦ The Bell System—Local telephone companies providing service to 90% of U.S. subscribers.
- ♦ Western Electric—A manufacturing company that made equipment needed by the other two divisions, from telephones to switches. (Bell Labs was a part of Western Electric.)

As a monopoly that was generally regulated on a rate-of-return basis (making a fixed profit percentage), AT&T had little incentive—other than that provided by regulators—to hold down costs. The more the company spent, the more it had to charge to make its profit, which grew in proportion with expenses. As a result, the U.S. telephone industry became the envy of the world, known for “five nines” of reliability; that is, the telephone network was available 99.999% of the time.

Divestiture

The monopoly suffered a series of challenges in the 1960s and 1970s that began to break AT&T's monopoly control. First, AT&T lost a suit brought by the "Hush-a-Phone" company, which made a plastic mouthpiece that fit over the AT&T mouthpiece to make it easier to hear a call made in a noisy area (*Hush-a-phone v. AT&T*, 1955; *Hush-a-phone v. U.S.*, 1956). (The idea of a company having to win a lawsuit in order to sell such an innocent item might seem frivolous today, but this suit was the first major crack in AT&T's monopoly armor.) Soon, MCI successfully sued for the right to provide long-distance service between St. Louis and Chicago, allowing businesses to bypass AT&T's long lines (*Microwave Communications, Inc.*, 1969).

Since the 1920s, the Department of Justice (DOJ) had challenged aspects of AT&T's monopoly control, earning a series of consent decrees to limit AT&T's market power and constrain corporate behavior. By the 1970s, it was clear to the antitrust attorneys that AT&T's ownership of Western Electric inhibited innovation, and the DOJ attempted to force AT&T to divest itself of its manufacturing arm. In a surprising move, AT&T proposed a different divestiture, spinning off all of its local telephone companies into seven new "Baby Bells," keeping the now-competitive long distance service and manufacturing arms. The DOJ agreed, and a new AT&T was born (Dizard, 1989).

Cycles of Expansion and Contraction

The history of the Baby Bells is traced in Chapter 17, so we will set those seven companies aside for a moment. After divestiture, AT&T attempted to compete in many markets with mixed success; AT&T long distance service remained a national leader, but few people bought the overpriced AT&T personal computers.

In the 1990s, AT&T entered a repeating cycle of growth and decline. It acquired NCR Computers in 1991 and McCaw Communications (the largest U.S. cellular telephone company) in 1993. Then, in 1995, it divested itself of its manufacturing arm (which became Lucent Technologies) and the computer company (which took the NCR name). It grew again in 1998 by acquiring TCI, the largest U.S. cable television company, renaming it AT&T Broadband, and then acquired another cable company, MediaOne. In 2001, it sold AT&T Broadband to Comcast, and it spun off its wireless interests into an independent company (AT&T Wireless), which was later acquired by Cingular (a wireless phone company co-owned by Baby Bells SBC and BellSouth) (AT&T, 2008).

The only parts of AT&T remaining were the long distance telephone network and the business services, resulting in a company that was a fraction the size of the AT&T behemoth that had a near monopoly on the telephone industry in the United States just two decades earlier. In the meantime, consolidation began among the Baby Bells, with Bell Atlantic and NYNEX merging to create Verizon.

Under the leadership of Edward Whitacre, Southwestern Bell became one of the most formidable players in the telecommunications industry. With a visionary style not seen in the telephone industry since the days of Theodore Vail, Whitacre led Southwestern Bell to acquire Baby Bells Pacific Telesis and Ameritech (and a handful of other, smaller telephone companies), renaming itself SBC. Ultimately, SBC merged with BellSouth and purchased what was left of AT&T, then renamed the company AT&T, an interesting case comparable to a child adopting its parent.

Today's AT&T is a dramatically different company with a dramatically different culture than its parent, but the company serves most of the same markets in a much more competitive environment. The lesson is that it is

not enough to know the technologies or the company names; you also have to know the history of both in order to understand the role that company plays in the marketplace.

Functions within the Industries

The AT&T story is an extreme example of the complexity of communication industries. These industries are easier to understand by breaking their functions into categories that are common across most of the segments of these industries. Let's start by picking up the heart of the "umbrella perspective" introduced in Chapter 1, the hardware and software. For this discussion, let's use the same definitions used in Chapter 1, with hardware referring to the physical equipment used and software referring to the content or the messages transmitted using these technologies. Some companies produce both equipment and content, but most companies specialize in one or the other.

The next distinction has to be made between "production" and "distribution" of both equipment and content. As these names imply, companies involved in "production" engage in the manufacture of equipment or content, and companies involved in "distribution" are the intermediaries between production and consumers. It is a common practice for some companies to be involved in both production and distribution, but, as discussed below, a large number of companies choose to focus on one or the other.

These two dimensions interact, resulting in separate functions of equipment production, equipment distribution, content production, and content distribution. As discussed below, distribution can be further broken down into national and local distribution. The following section introduces each of these dimensions, which are applied in the subsequent section to help identify the role played by specific companies in communication industries.

One other note: These functions are hierarchical, with production coming before distribution in all cases. Let's say you are interested in creating a new type of telephone, perhaps a "high-definition telephone." You know that there is a market, and you want to be the person who sells it to consumers. But you cannot do so until someone first makes the device. Production always comes before distribution, but you cannot have successful production unless you also have distribution—hence the hierarchy in the model. Figure 4.1 illustrates the general pattern, using the U.S. television industry as an example.

Hardware Path

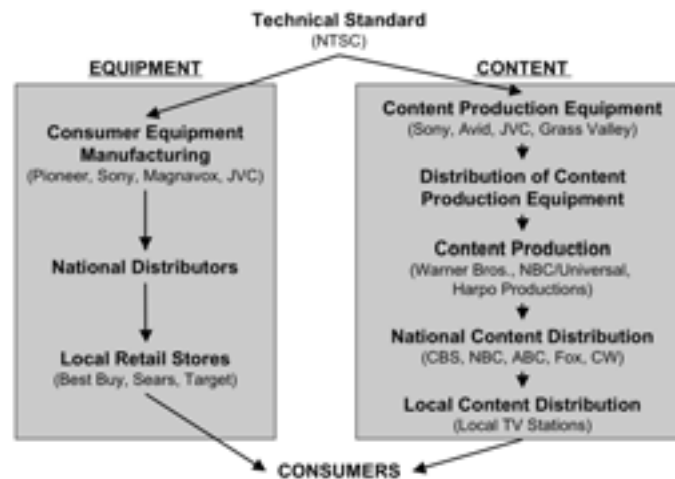
When you think of "hardware," you typically envision the equipment you handle to use a communication technology. But it is also important to note that there is a second type of hardware for most communication industries—the equipment used to make the messages. Although most consumers do not deal with this equipment, it plays a critical role in the system.

Production

Production hardware is usually more expensive and specialized than other types. Examples in the television industry include TV cameras, microphones, and editing equipment. A successful piece of production equip-

ment might sell only a few hundred or a few thousand units, compared with tens of thousands to millions of units for consumer equipment. The profit margin on each piece of production equipment is usually much higher than on consumer equipment, making it a lucrative market for electronics manufacturing companies.

Figure 4.1
Structure of the Broadcast TV Industry



Source: Grant (2008)

Consumer Hardware

Consumer hardware is the easiest to identify. It includes anything from a digital video recorder (DVR) to a mobile phone or DirecTV satellite dish. A common term used to identify consumer hardware in consumer electronics industries is “CPE,” which stands for “customer premises equipment.” An interesting side note is that many companies do not actually make their own products, but instead hire manufacturing facilities to make products they design, shipping them directly to distributors. For example, Microsoft does not manufacture the Xbox 360; Flextronics, Wistron, and Celestica do. As you consider communication technology hardware, consider the lesson from Chapter I—people are not usually motivated to buy equipment because of the equipment itself, but because of the content it enables, from the pictures recorded on a camera to the conversations (voice and text!) on a wireless phone to the information and entertainment provided by a high-definition television (HDTV) receiver.

Distribution

After a product is manufactured, it has to get to consumers. In the simplest case, the manufacturer sells directly to the consumer, perhaps through a company-owned store or a Web site. In most cases, however, a product will go through multiple organizations, most often with a wholesaler buying it from the manufacturer and selling it, with a mark-up, to a retail store, which also marks up the price before selling it to a consumer. The key point is that few manufacturers control their own distribution channels, instead relying on other companies to get their products to consumers.

Software Path: Production and Distribution

The process that media content goes through to get to consumers is a little more complicated than the process for hardware. The first step is the production of the content itself. Whether the product is movies, music, news, images, etc., some type of equipment must be manufactured and distributed to the individuals or companies who are going to create the content. (That hardware production and distribution goes through a similar process to the one discussed above.) The content must then be created, duplicated, and distributed to consumers or other end users.

The distribution process for media content/software follows the same pattern for hardware. Usually there will be multiple layers of distribution, a national wholesaler that sells the content to a local retailer, which in turn sells it to a consumer.

Disintermediation

Although many products go through multiple layers of distribution to get to consumers, information technologies have also been applied to reduce the complexity of distribution. The process of eliminating layers of distribution is called disintermediation (Kottler & Keller, 2005); examples abound of companies that use the Internet to get around traditional distribution systems to sell directly to consumers. Netflix is a great example. Traditionally, DVDs (digital videodiscs) of a movie would be sold by the studio to a national distributor, which would then deliver them to hundreds or thousands of individual movie rental stores, which would then rent or sell them to consumers. (Note: The largest video stores would buy directly from the studio, handling both national and local distribution.) Netflix cuts one step out of the distribution process, directly bridging the link from the movie studio and the consumer. (As discussed below, iTunes serves the same function for the music industry, simplifying music distribution.) The result of getting rid of one “middleman” is greater profit for the companies involved, lower costs to the consumer, or both.

Illustrations: HDTV and HD Radio

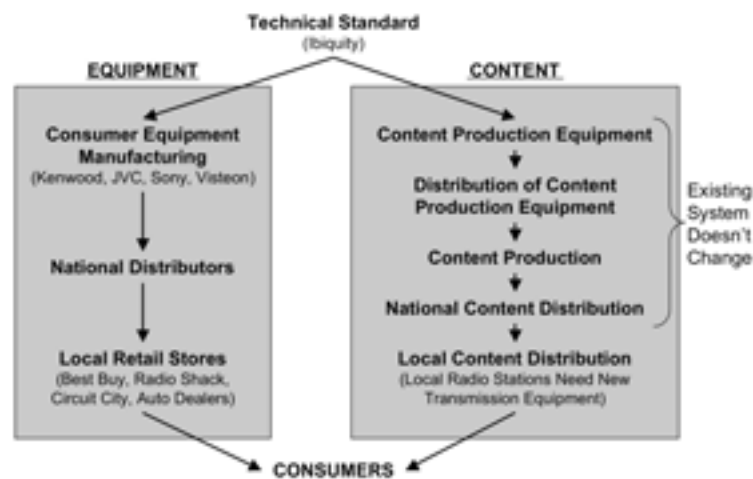
The emergence of digital broadcasting provides two excellent illustrations of the complexity of the organizational structure of media industries. HDTV and its distant cousin HD radio have had a difficult time penetrating the market because of the need for so many organizational functions to be served before consumers can adopt the technology.

Let's start with the simpler one: HD radio. As illustrated in Figure 4.2, this technology allows existing radio stations to broadcast their current programming (albeit with much higher fidelity), so no changes are needed in the software production area of the model. The only change needed in the software path is that radio stations simply need to add a digital transmitter.

The complexity is related to the consumer hardware needed to receive HD radio signals. One set of companies needs to make the radios, another has to distribute the radios to retail stores and other distribution channels, and stores and distributors have to agree to sell them. The radio industry is therefore taking an active

role in pushing diffusion of HD radios throughout the hardware path. In addition to airing thousands of radio commercials promoting HD radio, the industry is promoting distribution of HD radios in new cars (because so much radio listening is done in automobiles). As discussed in Chapter 10, adoption of HD radio has begun, but has been slow because listeners see little advantage in the new technology. However, as the number of receivers increases, broadcasters will have the incentive to begin broadcasting the additional channels available with HD. As with FM radio, programming and receiver sales have to both be in place before consumer adoption takes place. Also, as with FM, the technology may take decades to take off.

Figure 4.2
Structure of HD Radio



Source: Grant (2008)

The same structure is inherent in the adoption of HDTV, as illustrated in Figure 4.3. Before the first consumer adoption could take place, both programming and receivers (consumer hardware) had to be available. Because a high percentage of primetime television programming was recorded on 35mm film at the time HDTV receivers first went on sale in the United States, that programming could easily be transmitted in high-definition, providing a nucleus of available programming. (On the other hand, local news and network programs shot on video would require entirely new production and editing equipment before they could be distributed to consumers in high-definition. As of mid-2008, very little local or syndicated programming is produced in HD.)

As discussed in Chapter 6, the big force behind the diffusion of HDTV and digital TV was a set of regulations issued by the Federal Communications Commission (FCC) that first required stations in the largest markets to begin broadcasting digital signals, then required that all television receivers include the capability to receive digital signals, and finally required that all full-power analog television broadcasting cease on February 17, 2009. In short, the FCC implemented mandates ensuring production and distribution of digital television, easing the path toward both digital TV and HDTV.

Figure 4.3
Structure of HDTV Industry



Source: Grant (2008)

From Target to iTunes

One of the best examples of the importance of distribution comes from an analysis of the popular music industry. Traditionally, music was recorded on CDs and audiotapes and shipped to retail stores for sale directly to consumers. At one time, the top three U.S. retailers of music were Target, Wal-Mart, and Best Buy.

Once digital music formats that could be distributed over the Internet were introduced in the late 1990s, dozens of start-up companies created online stores to sell music directly to consumers. The problem was that few of these stores offered the top-selling music. Record companies were leery of the lack of control they had over digital distribution, leaving most of these companies to offer a marginal assortment of music. The situation changed in 2003 when Apple introduced the iTunes store to provide content for its iPods, which had sold slowly since appearing on the market in 2001. Apple obtained contracts with major record companies that allowed them to provide most of the music that was in high demand. Initially, record companies resisted the iTunes distribution model that allowed a consumer to buy a single song for \$0.99; they preferred that a person have to buy an entire album of music for \$13 to \$20 to get the one or two songs they wanted. Record company delays spurred consumers to create and use file-sharing services that allowed listeners to get the music for free—and the record companies ended up losing lots of money. Soon, the \$0.99 iTunes model began to look very attractive to the record companies, and they trusted Apple's digital rights management system to protect their music.

Today, as discussed in Chapter 15, iTunes is the number one music retailer in the United States. The music is similar, but the distribution of music today is dramatically different from what it was when this decade began. The change took years of experimentation, and the successful business model that emerged required cooperation from dozens of separate companies serving different roles in the production and distribution process.

Two more points should be made regarding distribution. First, there is typically more profit potential and less risk in being a distributor than a creator (of either hardware or software) because the investment is less

and distributors typically earn a percentage of the value of what they sell. Second, distribution channels can become very complicated when multiple layers of distribution are involved; the easiest way to unravel these layers is simply to “follow the money.”

Importance of Distribution

As the above discussion indicates, distributors are just as important to new communication technologies as manufacturers and service providers. When studying these technologies, and the reasons for success or failure, the distribution process (including the economics of distribution) must be examined as thoroughly as the product itself.

Diffusion Threshold

Analysis of the elements in Figure 4.1 reveals an interesting dimension—there cannot be any consumer adoption of a new technology until all of the production and distribution functions are served, along both the hardware and software paths. This observation adds a new dimension to Rogers (2003) diffusion theory. The point at which all functions are served has been identified as the “diffusion threshold,” the point at which diffusion of the technology can begin (Grant, 1990).

It is easier for a technology to “take off” and begin diffusing if a single company provides a number of different functions, perhaps combining production and distribution, or providing both national and local distribution. The technical term for owning multiple functions in an industry is “vertical integration,” and a vertically integrated company has a disproportionate degree of power and control in the marketplace. Vertical integration is easier said than done, however, because the “core competencies” needed for production and distribution are so different. A company that is great at manufacturing may not have the resources needed to sell the product to end consumers.

Let’s consider the newest innovation in radio, HD radio, again (also discussed in Chapter 10). A company such as JVC or Pioneer might handle the first level of distribution, from the manufacturing plant to the retail store, but they do not own and operate their own stores—that is a very different business. They are certainly not involved in owning the radio stations that broadcast HD radio music—that is another set of organizations.

Let’s look at the big picture—in order for HD radio to become popular, one organization (or set of organizations) has to make the radios, another has to get those radios into stores, a third has to operate the stores, a fourth has to make HD radio transmitters and technical equipment for radio stations, and a fifth has to operate the radio stations. (Fortunately, the content is already available in the form of existing music or talk radio, or even more organizations would have to be involved in order for the first user to be able to listen to HD radio or see any value in buying an HD radio receiver.)

Most companies that would like to grow are more interested in applying their core competencies by buying up competitors and commanding a greater market share, a process known as “horizontal integration.” For example, it makes sense for a company that makes radio receivers to grow by making other electronics than by buying radio stations. Similarly, a company that already owns radio stations will probably choose to grow by buying more radio stations than by starting to make and sell radios.

The complexity of the structure of most communication industries prevents any one company from serving every needed role. Because so many organizations have to be involved in providing a new technology, many new technologies end up failing. The lesson is that understanding how a new communication technology makes it to market requires comparatively little understanding of the technology itself compared with the understanding needed of the industry in general.

A “Blue” Lesson

One of the best examples of the need to understand (and perhaps exploit) all of the paths illustrated in Figure 4.1 comes from the earliest days of the personal computer. When the PC was invented in the 1970s, most manufacturers used their own operating systems, so that programs and content could not easily be transferred from one type of computer to other types. Many of these manufacturers realized that they needed to find a standard operating system that would allow the same programs on content to be used on computers from different manufacturers, and they agreed on an operating system called CP/M.

Before CP/M could become a standard, however, IBM, the largest U.S. computer manufacturer—mainframe computers, that is—decided to enter the personal computer market. “Big Blue,” as IBM was known (for its blue logo and its dominance in mainframe computers, typewriters, and other business equipment) determined that its core competency was making hardware, and they looked for a company to provide them an operating system that would work on their computers. They chose a then-little-known operating system known as MS-DOS, from a small start-up company called Microsoft.

IBM’s open architecture allowed other companies to make compatible computers, and dozens of companies entered the market to compete with Big Blue. For a time, IBM dominated the personal computer market, but, over time, competitors steadily made inroads on the market. (Ultimately, IBM sold its personal computer manufacturing business in 2006 to Lenovo, a Chinese company.) The one thing that most of these competitors had in common was that they used Microsoft’s operating systems. Microsoft grew...and grew...and grew. (It is also interesting to note that, although Microsoft has dominated the market for software with its operating systems and productivity software such as Office, it has been a consistent failure in most areas of hardware manufacturing. Notable failures include Microsoft’s routers and home networking hardware, keyboards and mice, and WebTV hardware. The only major success Microsoft has had in manufacturing hardware is with its Xbox video game system, discussed in Chapter 12.)

The lesson is that there is opportunity in all areas of production and distribution of communication technologies. All aspects of production and distribution must be studied in order to understand communication technologies. Companies have to know their own core competencies, but a company can often improve its ability to introduce a new technology by controlling more than one function in the adoption path.

What Are the Industries?

We need to begin our study of communication technologies by defining the industries involved in providing communication-related services in one form or another. Broadly speaking, these can be divided into:

- ♦ Mass media, including books, newspapers, periodicals, movies, radio, and television.

- ♦ Telecommunications, including networking and all kinds of telephony (landlines, long distance, wireless, and voice over Internet protocol).
- ♦ Computers, including hardware and software.
- ♦ Consumer electronics, including audio and video electronics, video games, and cameras.
- ♦ Internet, including enabling equipment, network providers, content providers, and services.

These industries are introduced in Chapter 2 and individual chapters. At one point, these industries were distinct, with companies focusing on one or two industries. The opportunity provided by digital media and convergence enables companies to operate in numerous industries, and many companies are looking for synergies across industries. Figure 4.4 lists examples of well-known companies in the communication industries, some of which work across many industries, and some of which are (as of this writing) focused on a single industry. Part of the fun in reading this chart is seeing how much has changed since the chart was created in mid-2008.

Figure 4.4
Examples of Major Communication Company Industries,
2008

	TV/Film/Video Production	TV/Film/Video Distribution	Print	Telephone	Wireless	Internet
AT&T		•		•••	•••	•
Disney	•••	•••				••
Gannett		•••	•••			
Google					•	•••
News Corp.	•••	•••	•••			••
Sony	•••	•				•
Time Warner	•••	•••				••
Verizon				•••	•••	••
Viacom	•••	•••	•			••
Yahoo!						•••

Source: Grant (2008)

There is a risk in discussing specific organizations in a book such as this one; in the time between when the book is written and when it is published, there are certain to be changes in the organizational structure of the industries. For example, as the first draft of this chapter was being written in early 2008, Microsoft had proposed a buyout of Yahoo. As the final edits were being completed in May 2008, Microsoft had just called off the buyout. By the time you read this, Yahoo might be acquired by another company, it might purchase another company itself, or it might remain independent.

Fortunately, mergers and takeovers of that magnitude do not happen that often—only a couple a year! The major players are more likely to acquire other companies than to be acquired, so it is fairly safe (but not completely safe) to identify the major players and then analyze the industries in which they are doing business. As in the AT&T story earlier in this chapter, the specific businesses a company is in can change dramatically over the course of a few years.

Future Trends

The focus of this book is on changing technologies. It should be clear that some of the most important changes to track are changes in the organizational structure of media industries. The remainder of this chapter projects organizational trends to watch to help you predict the trajectory of existing and future technologies.

Disappearing Newspapers

For decades, newspapers were the dominant mass medium, commanding revenues, consumer attention, and significant political and economic power. As the first decade of the 21st century is coming to an end, however, newspaper publishers are reconsidering their core business. Noted newspaper researcher Philip Meyer (2004) has even predicted the demise of the newspaper, projecting (with a smile) that the last printed newspaper reader will disappear in the first quarter of 2043.

Before starting the countdown clock, it is necessary to define what we mean by a “newspaper publisher.” If a newspaper publisher is defined as an organization that communicates and obtains revenue by smearing ink on dead trees, then Meyer’s general prediction is more likely than not. If, however, a newspaper publisher is defined as an organization that gathers news and advertising messages, distributing them via a wide range of available media, then newspaper publishers should be quite healthy through the century.

The current problem is that there is no comparable revenue model for delivery of news and advertising through new media that approaches the revenues available from smearing ink on dead trees. It is a bad news/good news situation. The bad news is that traditional newspaper readership and revenues are both declining. Readership is suffering because of competition from the Web and other new media, with younger cohorts increasingly ignoring print in favor of other news sources. Advertising revenues are suffering for two reasons. The decline in readership and competition from new media are impacting revenues from display advertising. More significant is the loss in revenues from classified advertising, which at one point comprised up to one-third of newspaper revenues.

The good news is that newspapers remain profitable, with margins of 10% to 25%. This profit margin is one that many industries would envy. Stockholders in newspaper publishers are used to much higher profit margins, and newspaper companies have been punished for the decline in profits.

Some companies such as Belo are reacting by divesting themselves of their newspapers in favor of TV and new media investments. Some newspaper publishers are using the opportunity to buy up other newspapers; consider McClatchy’s 2006 purchase of the majority of Knight-Ridder’s newspapers (McClatchy, 2008).

Gannett, on the hand, is taking the boldest, and potentially the riskiest, strategy by aggressively transforming both their newspaper and television newsrooms into “Information Centers,” where the goal is to be

platform agnostic, getting news out in any available medium as quickly as possible. According to Gannett CEO Craig Dubow, the goal is to deliver the news and content anywhere the consumer is, and then solve the revenue question later (Gahran, 2006). Gannett's approach is a risky one, but it follows the model that has worked for new media in the past—the revenue always follows the audience, and the companies that are first to reach an audience through a new medium are disproportionately likely to profit from their investments.

Advertiser-Supported Media

For advertiser-supported media organizations, the primary concern is the impact of the Internet and other new media on revenues. As discussed above, some of the loss in revenues is due to loss of advertising dollars (including classified advertising), but that loss is not experienced equally by all advertiser-supported media.

The Internet is especially attractive to advertisers because online advertising systems have the most comprehensive reporting of any advertising medium. For example, an advertiser using the Google AdWords system discussed in Chapter I gets comprehensive reports on the effectiveness of every message—but “effectiveness” is defined by these advertisers as an immediate response such as a click-through. As Grant and Wilkinson (2007) discuss, not all advertising is this type of “call-to-action” advertising. There is another type of advertising that is equally important—image advertising, which does not demand immediate results, but rather works over time to build brand identity and increase the likelihood of a future purchase.

Any medium can carry any type of advertising, but image advertising is more common on television (especially national television) and magazines, and call-to-action advertising is more common in newspapers. As a result, newspapers, at least in the short term, are more likely to be impacted by the increase in Internet advertising. Interestingly, local advertising is more likely to be call-to-action advertising, but local advertisers have been slower than national advertisers to move to the Internet, most likely because of the global reach of the Internet. This paradox could be seen as an opportunity for an entrepreneur wishing to earn a million or two by exploiting a new advertising market.

The “Mobile Revolution”

Another important trend that can help you analyze media organizations is the shift toward mobile communication technologies. This trend is significant enough that an entire chapter is devoted to it in the concluding section of this book (Chapter 23). Companies that are positioned to produce and distribute content and technology that further enable the “mobile revolution” are likely to have increased prospects for growth.

Consumers—Time Spent Using Media

Another piece of good news for media organizations in general is the fact that the amount of time consumers are spending with media is increasing, with much of that increase coming from simultaneous media use (Papper, et al., 2009). Advertiser-supported media thus have more “audience” to sell, and subscription-based media have more prospects for revenue. Furthermore, new technologies are increasingly targeting specific messages at specific consumers, increasing the efficiency of message delivery for advertisers and potentially reducing the clutter of irrelevant advertising for consumers. Already, advertising services such as Google's Double-Click and Google's AdWords provide ads that are targeted to a specific person or the specific content on a Web page, greatly increasing their effectiveness. Imagine a future where every commercial on TV that you see is targeted—and is interesting—to you! Technically, it is possible, but the lessons of previous technologies suggest that the road to customized advertising will be a meandering one.

Principle of Relative Constancy

On the other hand, the potential revenue from consumers is limited by the fact that consumers devote a limited proportion of their disposable income to media, the phenomenon discussed in Chapter 3 as the “Principle of Relative Constancy.” The implication is that emerging companies and technologies have to wrest market share and revenue from established companies. To do that, they cannot be just as good as the incumbents. Rather, they have to be faster, smaller, less expensive, more versatile, or in some way better so that consumers will have the motivation to shift spending from existing media.

Conclusions

The structure of the media system may be the most dynamic area in the study of new communication technologies, with new industries and organizations constantly emerging and merging. In the following chapter, organizational developments are therefore given a significant amount of attention. Be warned, however, between the time these chapters are written and published, there is likely to be some change in the organizational structure of each technology discussed in this book. To keep up with these developments, visit the *Communication Technology Update and Fundamentals* home page at www.tfi.com/ctu.

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Communication Policy and Technology

Lon Berquist, M.A.*

Throughout its history, U.S. communication policy has been shaped by evolving communication technologies. As a new communication technology is introduced into society, it is often preceded by an idealized vision, or Blue Sky perspective, of how the technology will positively impact economic opportunities, democratic participation, and social inclusion. Due, in part, to this perspective, government policymakers traditionally look for policies and regulation that will foster the wide diffusion of the emerging technology. At the same time, however, U.S. policy typically displays a light regulatory touch, promoting a free-market approach that attempts to balance the economic interests of media and communication industries, the First Amendment, and the rights of citizens.

Indeed, much of the recent impetus for media deregulation was directly related to communication technologies as “technological plenty is forcing a widespread reconsideration of the role competition can play in broadcast regulation” (Fowler & Brenner, 1982, p. 209). From a theoretical perspective, some see new communication technologies as technologies of freedom where “freedom is fostered when the means of communication are dispersed, decentralized, and easily available” (Pool, 1983, p. 5). Others fear technologies favor government and private interests and become technologies of control (Gandy, 1989). Still others argue that technologies are merely neutral in how they shape society. No matter the perspective, the purpose of policy and regulation is to allow society to shape the use of communication technologies to best serve the citizenry.

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Background

The First Amendment is a particularly important component of U.S. communication policy, balancing freedom of the press with the free speech rights of citizens. The First Amendment was created at a time when the most sophisticated communication technology was the printing press. Over time, the notion of “press” has evolved with the introduction of new communication technologies. The First Amendment has evolved as well, with varying degrees of protection for the traditional press, broadcasting, cable television, and the Internet.

Communication policy is essentially the balancing of national interests and the interests of the communications industry (van Cuilenburg & McQuail, 2003). In the United States, communication policy is often shaped in reaction to the development of a new technology. As a result, policies vary according to the particular communication policy regime: press, common carrier, broadcasting, cable TV, and the Internet. Napoli (2001) characterizes this policy tendency as a “technologically particularistic” approach leading to distinct policy and regulatory structures for each new technology. Thus, the result is differing First Amendment protections for the printed press, broadcasting, cable television, and the Internet (Pool, 1983).

In addition to distinct policy regimes based on technology, scholars have recognized differing types of regulation that impact programming, the industry market and economics, and the transmission and delivery of programming and information. These include content regulation, structural regulation, and technical regulation. Content regulation refers to the degree to which a particular industry enjoys First Amendment protection. For example, in the United States, the press is recognized as having the most First Amendment protection, and there certainly is no regulatory agency to oversee printing. Cable television has limited First Amendment protection, while broadcasting has the most limitations on First Amendment rights. This regulation is apparent in the type of programming rules and regulations imposed by the Federal Communication Commission (FCC) on broadcast programming that is not imposed on cable television programming.

Structural regulation addresses market power within (horizontal integration) and across (vertical integration) media industries. Federal media policy has long established the need to promote diversity of programming by promoting diversity of ownership. The *Telecommunications Act of 1996* changed media ownership limits for the national and local market power of radio, television, and cable television industries; however, the FCC is given the authority to review and revise these rules. Structural regulation includes limitations or permissions to enter communication markets. For example, the *Telecommunications Act of 1996* opened up the video distribution and telephony markets by allowing telephone companies to provide cable television service, and for cable television systems to offer telephone service (Parsons & Frieden, 1998).

Technical regulation needs prompted the initial development of U.S. communication regulation in the 1920s, as the fledgling radio industry suffered from signal interference while numerous stations transmitted without any government referee (Starr, 2004). Under FCC regulation, broadcast licensees are allowed to transmit at a certain power, or wattage, on a precise frequency within a particular market. Cable television systems and satellite transmission also follow some technical regulation to prevent signal interference.

Finally, in addition to technology-based policy regimes and regulation types, communication policy is guided by varying jurisdictional regulatory bodies. Given the global nature of satellites, both international (International Telecommunications Union) and national (FCC) regulatory commissions have a vested interest in satellite transmission. Regulation of U.S. broadcasting is exclusively the domain of the federal government through the FCC. The telephone industry is regulated primarily at the federal level through the FCC, but also

with regulations imposed by state public utility commissions. Cable television, initially regulated through local municipal franchises, is regulated both at the federal level and the local municipal level (Parsons & Frieden, 1998). Increasingly, however, state governments are developing statewide cable television franchises, preempting local franchises (Eleff, 2006).

The Evolution of Communication Technologies

Telegraph

Although the evolution of technologies has influenced the policymaking process in the United States, many of the fundamental characteristics of U.S. communication policy were established early in the history of communication technology deployment, starting with the telegraph. There was much debate on how best to develop the telegraph. For many congressmen and industry observers, the telegraph was viewed as a natural extension of the Post Office, while others favored government ownership based on the successful European model as the only way to counter the power of a private monopoly (DuBoff, 1984). In a prelude to the implementation of universal service for the telephone (and the current discussion of a “digital divide”), Congress decreed that, “Where the rates are high and facilities poor, as in this country, the number of persons who use the telegraph freely, is limited. Where the rates are low and the facilities are great, as in Europe, the telegraph is extensively used by all classes for all kinds of business” (Lubrano, 1997, p. 102).

Despite the initial dominance of Western Union, there were over 50 separate telegraph companies operating in the United States in 1851. Interconnecting telegraph lines throughout the nation became a significant policy goal of federal, state, and local governments. No geographic area wanted to be disconnected from the telegraph network and its promise of enhanced communication and commerce. Eventually, in 1887, the *Interstate Commerce Act* was enacted, and the policy model of a regulated privately-owned communication system was initiated and formal federal regulation began. Early in the development of communication policy, the tradition of creating communications infrastructure through government aid to private profit-making entities was established (Winston, 1998).

Telephone

Similar to the development of the telegraph, the diffusion of the telephone was slowed by competing, unconnected companies serving their own interests. Although AT&T dominated most urban markets, many independent telephone operators and rural cooperatives provided service in smaller towns and rural areas. Since there was no interconnection among the various networks, some households and businesses were forced to have dual service in order to communicate (Starr, 2004). As telephone use spread in the early 1900s, states and municipalities began regulating and licensing operators as public utilities, although Congress authorized the Interstate Commerce Commission (ICC) to regulate interstate telephone service in 1910. Primarily an agency devoted to transportation issues, the ICC never became a major historical player in communication policy. However, two important phrases originated with the commission and the related *Transportation Act of 1920*. The term, common carrier, originally used to describe railroad transportation, was used to classify the telegraph and eventually the telephone (Pool, 1983). Common carriage law required carriers to serve their customers without discrimination. The other notable phrase utilized in transportation regulation was a re-

quirement to serve the “public interest, convenience, or necessity” (Napoli, 2001). This nebulous term was adopted in subsequent broadcast legislation, and continues to guide the FCC even today.

As telephone use increased, it became apparent that there was a need for greater interconnection among competing operators, or the development of some national unifying force. In 1907, AT&T President Theodore Vail promoted a policy with the slogan, “One system, one policy, universal service” (Starr, 2004, p. 207). There are conflicting accounts of Vail’s motivations: whether it was a sincere call for a national network available to all, or merely a ploy to protect AT&T’s growing power in the telephone industry (Napoli, 2001). Eventually, the national network envisioned by Vail became a reality, as AT&T was given the monopoly power, under strict regulatory control, to build and maintain local and long distance telephone service throughout the nation. Of course, this regulated monopoly was ended decades ago, but the concept of universal service as a significant component of communication policy remains today.

Broadcasting

While U.S. policymakers pursued an efficient national network for telephone operations, they developed radio broadcasting to primarily serve local markets. Before the federal government imposed regulatory control over radio broadcasting in 1927, the industry suffered from signal interference and an uncertain financial future. The *Federal Radio Act* imposed technical regulation on use of spectrum and power, allowing stations to develop a stable local presence. Despite First Amendment concerns about government regulation of radio, the scarcity of spectrum was considered an adequate rationale for licensing stations. In response to concerns about freedom of the press, the *Radio Act* prohibited censorship by the Radio Commission, but the stations understood the power of the commission to license implied inherent censorship (Pool, 1983). In 1934, Congress passed the *Communication Act of 1934*, combining regulation of telecommunications and broadcasting by instituting a new Federal Communications Commission.

The *Communication Act* essentially reiterated the regulatory thrust of the 1927 *Radio Act*, maintaining that broadcasters serve the public interest. This broad concept of “public interest” has stood as the guiding force in developing communication policy principles of competition, diversity, and localism (Napoli, 2001; Alexander & Brown, 2007). Rules and regulations established to serve the public interest for radio transferred to television when it entered the scene. Structural regulation limited ownership of stations, technical regulation required tight control of broadcast transmission, and indirect content regulation led to limitations on station broadcast of network programming and even fines for broadcast of indecent material (Pool, 1983). One of the most controversial content regulations was the vague Fairness Doctrine, established in 1949, that required broadcasters to present varying viewpoints on issues of public importance (Napoli, 2001). Despite broadcasters’ challenges to FCC content regulation on First Amendment grounds, the courts defended the commission’s ability to limit network control over programming (*NBC v. United States*, 1943) and the Fairness Doctrine (*Red Lion Broadcasting v. FCC*, 1969). In 1985, the FCC argued the Fairness Doctrine was no longer necessary given the increased media market competition, due in part to the emergence of new communication technologies (Napoli, 2001).

Historically, as technology advanced, the FCC sought ways to increase competition and diversity in broadcasting with AM radio, UHF television, low-power TV, low-power FM, and more recently, HDTV.

Cable Television and Direct Broadcast Satellite

Since cable television began simply as a technology to retransmit distant broadcast signals to rural or remote locations, early systems sought permission or franchises from the local authorities to lay cable to reach homes. As cable grew, broadcasters became alarmed with companies making revenue off their programming, and they lobbied against the new technology. Early on, copyrights became the major issue, as broadcasters complained that retransmission of their signals violated their copyrights. The courts sided with cable operators, but Congress passed compulsory license legislation that forced cable operators to pay royalty fees to broadcasters (Pool, 1983). Because cable television did not utilize the public airwaves, courts rebuffed the FCC's attempt to regulate cable.

In the 1980s, the number of cable systems exploded and the practice of franchising cable systems increasingly was criticized by the cable industry as cities demanded more concessions in return for granting rights-of-way access and exclusive multi-year franchises. The *Cable Communications Act of 1984* was passed to formalize the municipal franchising process while limiting some of their rate regulation authority. The act also authorized the FCC to evaluate cable competition within markets (Parsons & Frieden, 1998).

After that, cable rates increased dramatically. Congress reacted with the *Cable Television Consumer Protection and Competition Act of 1992*. With the 1992 Cable Act, rate regulation returned with the FCC given authority to regulate basic cable rates. To protect broadcasters and localism principles, the act included "must carry" and "retransmission consent" rules that allowed broadcasters to negotiate with cable systems for carriage (discussed in more detail in Chapter 7). Although challenged on First Amendment grounds, the courts eventually found that the FCC had a legitimate interest in protecting local broadcasters (*Turner Broadcasting v. FCC*, 1997).

To support the development of direct broadcast satellites (DBS), the 1992 act prohibited cable television programmers from withholding channels from DBS and other prospective competitors. As with cable television, DBS operators have been subject to must-carry and retransmission consent rules. The *1999 Satellite Home Viewers Improvement Act* (SHIVA) required and, more recently, the *Satellite Home Viewer Extension and Reauthorization Act* (SHVER) reconfirmed that DBS operators must carry all local broadcast signals within a local market if they choose to carry one (FCC, 2005). DBS operators challenged this in court, but as in *Turner Broadcasting v. FCC*, the courts upheld the FCC rule (Frieden, 2005).

Policies to promote the development of cable television and direct broadcast satellites have become important components of the desire to enhance media competition and video program diversity, while, at the same time, preserving localism principles within media markets.

Convergence and the Internet

The *Telecommunications Act of 1996* was a significant recognition of the impact of technological innovation and convergence occurring within the media and telecommunications industries. Because of that recognition, Congress discontinued many of the cross-ownership and service restrictions that had prevented telephone operators from offering video service and cable systems from providing telephone service (Parsons & Frieden, 1998). The primary purpose of the 1996 Act was to "promote competition and reduce regulation in order to secure lower prices and higher-quality service for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies" (*Telecommunications Act of 1996*). Competition was expected by opening up local markets to facilities-based competition and deregulating rates for cable tele-

vision and telephone service to let the market work its magic. The 1996 Act also opened up competition in the local exchange telephone markets and loosened a range of media ownership restrictions.

In 1996, the Internet was a growing phenomenon, and some in Congress were concerned with the adult content available online. In response, along with passing the act, Congress passed the *Communication Decency Act* (CDA) to make it a felony to transmit obscene or indecent material to minors. The Supreme Court struck down the CDA on First Amendment grounds in *Reno v. ACLU* (Napoli, 2001). Congress continued to pursue a law protecting children from harmful material on the Internet with the *Child Online Protection Act* (COPA), passed in 1998; however, federal courts have found it, too, unconstitutional due to First Amendment concerns (McCullagh, 2007). It is noteworthy that the courts consider the Internet's First Amendment protection more similar to the press, rather than broadcasting or telecommunications (Warner, 2008).

Similarly, from a regulatory perspective, the Internet does not fall under any traditional regulatory regime such as telecommunications, broadcasting, or cable television. Instead, the Internet is considered an "information service" and therefore not subject to regulation (Oxman, 1999). There are, however, policies in place that indirectly impact the Internet. For example, section 706 of the *Telecommunications Act of 1996* requires the FCC to "encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans;" with advanced telecommunications essentially referring to broadband Internet connectivity (Grant & Berquist, 2000).

Recent Developments

Network Neutrality

In 2005, AT&T CEO Edward Whitacre, Jr. created a stir when he suggested Google and Vonage should not expect to use his pipes for free (Yang, 2005). Internet purists insist the Internet should remain open and unfettered, as originally designed, and decried the notion that broadband providers might discriminate by the type and amount of data content streaming through their pipes. Users of Internet service are concerned that, as more services become available via the Web such as video streaming and voice over IP (VoIP), Internet service providers (ISPs) will become gatekeepers limiting open access to information (Gilroy, 2007).

More recently, the FCC received a complaint accusing Comcast of delaying Web traffic on its network for the popular file sharing site BitTorrent (Kang, 2008a). Because of the uproar among consumer groups, the FCC has held hearings on the issue, and Congress has begun to debate whether there should be regulations ensuring network neutrality (Dunbar, 2008). Net neutrality is not simply an issue for Internet users. As Stanford Law Professor and Internet advocate Lawrence Lessig suggests, technology investors have expectations for the future of the Web, and an unsettled issue concerning net neutrality may have economic implications (Kang, 2008b).

Media and Communication Ownership

The *Telecommunications Act of 1996* requires the FCC to periodically review broadcast ownership rules under Section 202, and determine if the rules continue to serve the public interest and are necessary as a result of competition. In 2003, the FCC completed its *2002 Biennial Review Order* after completing a series of studies on broadcast ownership and program diversity (FCC, 2003). The order loosened ownership rules in such a

significant way that a single entity could own a newspaper, a cable television system, three television stations, and eight radio stations within a single market (Watson & Chang, 2008). Media activists and civic groups criticized the report for lacking public input, while scholars questioned the methodology of the studies supporting the report conducted primarily by FCC staff (Rice, 2008).

Many of the groups objecting to the FCC order formed a coalition, the Prometheus Radio Project, to challenge the FCC in court. The result was a rejection of the FCC order by the Third Circuit Court of Appeals in June 2004 (*Prometheus v. FCC*, 2004). The court opinion was critical of the FCC's empirical basis for the ownership changes, and the FCC has responded with revised research of media ownership issues, although Congress has changed the Section 202 review period from two to four years.

As part of its 2006 Quadrennial Review of media ownership, the FCC revisited the longstanding ban on newspapers owning a broadcast station within the same market and reviewed national cable system ownership. Responding to the growth of cable giant Comcast Communication, they reconfirmed the rule that no one entity can control more than 30% of cable systems nationwide. The other determination, which proved more controversial, relaxed newspaper/broadcast cross-ownership within the top 20 markets, allowing a company to operate both a newspaper and a television or radio station in the same market (Labaton, 2007).

While the courts have often reversed FCC rulemaking, Congress, too, has exerted its power by revisiting broadcast ownership statutes. In 2003, when the FCC raised the national television ownership limit to 45% of the national market, Congress responded by initially restoring it to the previous 35% limit. However, in final form, the statute set the limit at 39% of the national market. As critics of the new cap pointed out, the 39% level protected the existing market share for Viacom (38.8%) and News Corporation (37.7%), thereby shielding incumbent media corporations from violating the rule (Watson & Chang, 2008).

Localism

Recognizing that localism, as a policy and regulatory concept, had been neglected for some time, the FCC in August 2003 initiated a review of localism efforts by broadcasters. To gather information, the FCC held hearings in six locations across the country from 2003 to 2007. In addition to the field hearings, 83,000 written comments from members of the public, broadcasters, public interest groups, and industry groups were reviewed. Specifically, the FCC staff examined nine key components of broadcast station operations (FCC, 2008b):

- 1) Communication between licensees and their community.
- 2) Nature and amount of community-responsive programming.
- 3) Political programming.
- 4) Underserved audience.
- 5) Disaster warnings.
- 6) Network affiliation rules.
- 7) Payola/sponsorship identification.

- 8) License renewal procedures.
- 9) Additional spectrum allocation.

The resulting *Report on Broadcast Localism and Notice of Proposed Rulemaking* made recommendations for increasing local and diverse programming throughout the nation. The FCC recommended that some low-power TV stations be enhanced with hopes of promoting local programming; that stations should establish community advisory boards within their communities; that license renewal guidelines should include local programming provisions; and that potential FM frequencies in communities be identified in order to develop additional stations. The report also sought ways to educate the public so more public input might be leveraged to encourage local programming.

Predictably, the National Association of Broadcasters (NAB) is opposed to the proposal and has lobbied against it. A number of minority groups and public interest organizations, including the American Farm Bureau Federation, are supporting the recommendations with hopes broadcasters will better serve the interests of their communities (Skrzycki, 2008).

Broadband

In January 2008, the Department of Commerce's National Telecommunications and Information Administration (NTIA) released *Networked Nation: Broadband in America, 2007* touting the growth of broadband connectivity throughout the United States. Using FCC data, NTIA reported that broadband lines had increased by 1,100% from December 2000 to December 2006, praising the Bush Administration for promoting free-market policies leading to broadband availability in 99% of ZIP codes (NTIA, 2008).

Critics countered that the FCC data was not reliable because it overstated broadband penetration by counting a ZIP code as "broadband available" if there was a single user within the area, and, more significantly, defined "broadband" as merely 200 Kb/s (Turner, 2006). In response to criticism, the FCC announced a new data collection method, defining broadband as having a bandwidth of at least 768 Kb/s and requiring ISPs to report subscriber counts at the census block level (Broache, 2008).

Despite the impressive broadband growth reported by the NTIA, in an international comparison, the United States ranked 15th among developed nations for broadband penetration (see Table 5.1). More alarming, the United States ranked a lowly 19th for average advertised download speed (8.9 Mb/s), with many countries offering significantly greater broadband speeds: Japan (93.7 Mb/s), France (44.1 Mb/s), Korea (43.3 Mb/s), and Sweden (21.4 Mb/s) (OECD, 2007). In terms of price, the U.S. average cost of \$53/month for broadband ranked 22nd in the OECD report. From an international perspective, U.S. broadband is not quite as impressive as presented in the NTIA report.

Privacy

Recent research shows that most Americans who use the Internet are unaware of how their personal information is collected and disseminated by sites they visit on the World Wide Web (Turow, 2003). As technology becomes more sophisticated, the easier it becomes to inexpensively and virtually monitor the behavior of Internet users (Lessig, 2007). The Internet, however, is not the only communication technology with the means to gather personal, individual information. With digital cable television (Canalis, 2008) and digital video recorders such as TiVo (Carlson, 2006), the means are available to monitor viewing habits of users.

Table 5.1

International Broadband Penetration

Country	Broadband Penetration*
Denmark	34.3
Netherlands	33.5
Switzerland	30.7
Korea	29.9
Norway	29.8
Iceland	29.8
Finland	28.8
Sweden	28.6
Canada	25.0
Belgium	23.8
United Kingdom	23.7
Australia	22.7
France	22.5
Luxembourg	22.2
United States	22.1

* Broadband access per 100 inhabitants

Source: OECD (2007)

Factors to Watch

As technology continues to converge, it is apparent that the traditional policy regimes may no longer be so easily distinguished, leading to a convergence of policy (van Cuilenburg & McQuail, 2003). The *Telecommunications Act of 1996* was a first attempt at rearranging policy and regulation around new communication technologies, more than 60 years after the initial *Communication Act of 1934*. Over 10 years have passed since enactment of the 1996 law, and technologies are significantly more advanced while policies and regulation have remained stagnant. It is unlikely that Congress will wait another 60 years to revisit the *Communications Act*, and some legislators have already considered major revisions to the 1996 legislation (Watson & Chang, 2008).

As an unregulated Internet increasingly becomes a means of distribution for video and audio content, pressure will grow for greater relaxation of the remaining regulation for television and radio broadcasting. Ensuring competition among media and communication firms, along with limiting media concentration, will become a challenge as the corporate lines blur among telecommunications, media, and Internet companies.

Despite the recent growth of broadband adoption, the United States will need to explore initiatives to promote broadband deployment, increased bandwidth, and Internet use in order to compete economically in a global market. As more Americans access the Internet, issues of privacy and open access to a variety of information may require legislation to ensure users have the freedom to access information and the ability to protect their personal information (Lessig, 2007).

As communication policy is reshaped to accommodate new technologies, policymakers must continue to explore ways to serve the public interest. Despite the limitations of communication policy and regulation in

promoting communication technologies, the successful diffusion of technologies is evident in the wide range of technologies presented in this book.

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Electronic Mass Media

Digital Television

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The end of analog television broadcasting is imminent. In the United States, midnight on February 17, 2009 will mark the end of analog transmissions by full-power television stations and the end of the 12-year-long digital television (DTV) transition period defined by Congress and the Federal Communications Commission (FCC) (*Deficit Reduction Act*, 2005). Over 1,700 full-power U.S. television stations will turn off their analog transmitters that night and broadcast solely in DTV (see FCC, 2007b). The final stages of the transition to DTV in the United States are dependent upon viewers being aware of its implications for households that do not subscribe to either cable or satellite services. Viewers with over-the-air television service will need to purchase digital-to-analog converter boxes to continue watching television after the analog shut-off. Details on the DTV conversion program in the United States are provided later in this chapter. Japan and Europe are experiencing the same transition challenges as the United States, although European broadcasters have chosen to focus their digital migration efforts on standard-definition television (SDTV) instead of high-definition television (HDTV).

This expensive global conversion from analog to digital television technology is the most significant change in television broadcast standards since color images were added in the 1960s. Digital television combines higher-resolution image quality with improved multichannel audio, and the ability to seamlessly integrate Internet-delivered “television” programming into these displays. The transition to digital television will facilitate the merger of computing technology with that of television in ways that will transform traditional concepts of broadcasting. A picket sign carried by a member of the Writers Guild of America in their strike against Hollywood studios in spring 2008 summed up this trend, “The revolution will not be televised, it will be downloaded” (Dovarganes, 2008).

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As discussed in this chapter, digital television in the United States refers primarily to native digital (ATSC) programming produced by terrestrial broadcasters, even though it may be retransmitted into a majority of homes by cable or satellite operators. The FCC (1998) defines DTV as “any technology that uses digital techniques to provide advanced television services such as high-definition TV, multiple standard-definition TV, and other advanced features and services” (p. 7,420). Therefore, digital cable and standard direct broadcast satellite (DBS) services that deliver digitized and compressed NTSC signals in MPEG-2 format are not covered in this chapter (see Chapter 7).

One key attribute of digital technology is “scalability”—the ability to produce audio/visual quality as good (or as bad) as the viewer desires (or will tolerate). This does not refer to program content quality; that factor will still depend on the creative ability of the writers and producers. Within the constraints of available transmission bandwidth, digital television facilitates the dynamic assignment of sound and image fidelity in a given transmission channel. The two common digital production/transmission options are:

- ♦ HDTV (high-definition television).
- ♦ SDTV (standard-definition television).

High-definition television represents the highest image and sound quality that can be transmitted through the air. It is defined by the FCC in the United States as a system that provides image quality approaching that of 35mm motion picture film, has an image resolution of approximately twice (1,080i or 720p) that of analog television, and has a picture aspect ratio of 16:9 (FCC, 1990) (see Table 6.1). At this aspect ratio of 1.78:1 (16 divided by 9), the television screen is wider in relation to its height than the 1.33:1 (four divided by three) of NTSC. Figure 6.1 compares a 16:9 HDTV aspect ratio with that of a 4:3 NTSC display—note that the wider screen of an HDTV display more closely matches that of a motion picture than the conventional television screen. Computer displays are also expanding their aspect ratios in a similar manner to accommodate wide-screen content—another example of the merger between television and computing.

Table 6.1

U.S. Advanced Television Systems Committee (ATSC) DTV Formats

Format	Active Lines	Horizontal Pixels	Aspect Ratio	Picture Rate*
HDTV	1,080 lines	1,920 pixels/line	16:9	60i, 30p, 24p
HDTV	720 lines	1,280 pixels/line	16:9	60p, 30p, 24p
SDTV	480 lines	704 pixels/line	16:9 or 4:3	60i, 60p, 30p, 24p
SDTV	480 lines	640 pixels/line	4:3	60i, 60p, 30p, 24p

* In the picture rate column, “i” indicates interlaced scan in television *fields*/second with two fields required per frame and “p” is progressive scan in *frames*/second.

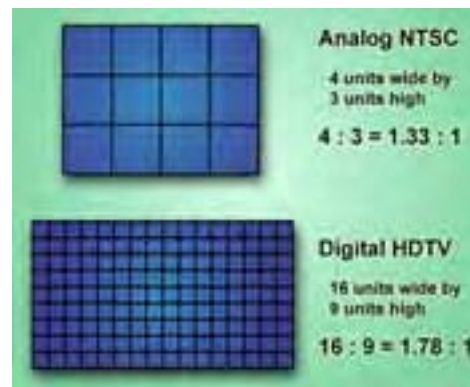
Source: ATSC

SDTV, or standard-definition television, is another type of digital television technology that can be transmitted *along with*, or *instead of*, HDTV. Digital SDTV transmissions offer lower resolution (480p or 480i—see Table 6.1) than HDTV, and they are available in both narrow screen and widescreen formats. Using digital video compression technology, it is feasible for U.S. broadcasters to transmit up to five SDTV signals instead

of one HDTV signal within the allocated 6 MHz digital channel. The development of multichannel SDTV broadcasting, called “multicasting,” is an approach that broadcasters at national and local levels are studying. A local television station could transmit a network daytime soap opera while simultaneously broadcasting children’s programming and three additional dedicated news, sports, and weather channels in SDTV. Most stations will reserve true HDTV programming for evening primetime hours.

Figure 6.1

From Narrow Screen to Widescreen—Change in Television Aspect Ratio



Source: P. B. Seel

Background

In the 1970s and 1980s, Japanese researchers at NHK developed two related analog HDTV systems: an analog “Hi-Vision” *production* standard with 1,125 scanning lines and 60 fields (30 frames) per second; and an analog “MUSE” *transmission* system with an original bandwidth of 9 MHz designed for satellite distribution throughout Japan. Japanese HDTV transmissions began in 1989 and steadily increased to a full schedule of 17 hours a day by October 1997 (Nippon Hoso Kyokai, 1998).

The decade between 1986 and 1996 was a significant era in the diffusion of HDTV technology in Japan, Europe, and the United States. There were a number of key events during this period that shaped advanced television technology and related industrial policies:

- ♦ In 1986, the Japanese Hi-Vision system was rejected as a world HDTV production standard by the CCIR, a subgroup of the International Telecommunications Union (ITU), at a Plenary Assembly in Dubrovnik, Yugoslavia. European delegates successfully lobbied for a postponement of this initiative that effectively resulted in a de facto rejection of the Japanese technology (Dupagne & Seel, 1998).
- ♦ By 1988, a European research and development consortium, EUREKA EU-95, had created a system known as HD-MAC that featured 1,250 widescreen scanning lines and 50 fields (25 frames)

displayed per second. This analog 1,250/50 system was used to transmit many European cultural and sporting events, such as the 1992 summer and winter Olympics in Barcelona and Albertville (France).

- ♦ In 1987, the FCC in the United States began a series of policy initiatives that led to the creation of the Advisory Committee on Advanced Television Service (ACATS). This committee was charged with investigating the policies, standards, and regulations that would facilitate the introduction of advanced television (ATV) services in the United States (FCC, 1987).
- ♦ U.S. testing of analog ATV systems by ACATS was about to begin in 1990 when the General Instrument Corporation announced that it had perfected a method of digitally transmitting a high-definition signal. This announcement had a bombshell impact since many broadcast engineers were convinced that digital television transmission would be a technical impossibility until well into the 21st century (Brinkley, 1997). The other participants in the ACATS competition soon developed digital systems that were submitted for testing. Ultimately, the three competitors in the testing process with digital systems (AT&T/Zenith, General Instrument/MIT, and Philips/Thomson/Sarnoff) decided to merge into a common consortium known as the Grand Alliance. With the active encouragement of the Advisory Committee, in 1993, they combined elements of each of their ATV proponent systems into a single digital Grand Alliance system for ACATS evaluation.

The FCC adopted a number of key decisions during the ATV testing process that defined a national transition process from NTSC to an advanced broadcast television system:

- ♦ In August 1990, the commission outlined a *simulcast* strategy for the transition to an ATV standard (FCC, 1990). This strategy required that U.S. broadcasters transmit *both* the new ATV signal and the existing NTSC signal concurrently for a period of time, at the end of which all NTSC transmitters would be turned off. Rather than try and deal with the inherent flaws of NTSC, the FCC decided to create an entirely new television system that would be incompatible with the existing one. This was a decision with multibillion dollar implications for broadcasters and consumers since it meant that all existing production, transmission, and reception hardware would have to be replaced with new equipment capable of processing the ATV signal.
- ♦ In summer 1995, the Grand Alliance system was successfully tested, and a digital television standard based on that technology was recommended to the FCC by the Advisory Committee on November 28, 1995 (ACATS, 1995).
- ♦ In May 1996, the FCC proposed the adoption of the *ATSC Digital Television Standard* based upon the work accomplished by the Advanced Television Systems Committee in documenting the technology developed by the Grand Alliance consortium (FCC, 1996a). The ATSC DTV standard specified 18 digital transmission variations as outlined in Table 6.1. Stations would be able to choose whether to transmit one channel of HDTV programming, four to six channels of SDTV programs during various dayparts, or a mixture of HDTV and SDTV programs.

Note that the DTV standard allows for *both* interlaced and progressive scanning. Interlaced scanning is a form of signal compression that first scans the odd lines of a television image onto the screen, and then fills in the even lines to create a full video frame every 1/30th of a second. Although interlaced scanning is spectrum-efficient, it creates unwanted visual artifacts that can degrade image quality. Progressive scanning—where each

complete frame is scanned on the screen in only one pass—is utilized in computer displays because it produces fewer image artifacts than interlaced scanning.

In December 1996, the FCC finally approved a DTV standard that deleted *any* requirement to transmit any of the 18 transmission video formats listed in Table 6.1 (FCC, 1996b). The commission resolved a potential controversy over the image aspect ratio and scanning structure by leaving these decisions up to broadcasters. The commission also declined to mandate any requirement that broadcasters must transmit true HDTV on their digital channels. However, over the past 11 years (1997 through 2008), U.S. broadcasters have decided to produce and transmit HDTV in the 16:9 aspect ratio with either 720p or 1,080i picture rates.

The ATSC standard specified the adoption of the Dolby AC-3 (Dolby Digital) multichannel audio system. The AC-3 specifications call for a surround-sound, six-channel system that will approximate a motion picture theatrical configuration. These powerful multiple-speaker audio systems are enhancing the diffusion of home theater television systems (often placed in a dedicated room in the home) with front-projection screens, rear-projection DLP screens, or flat-panel displays that can be mounted on the wall.

In April 1997, the FCC defined how the United States would make the transition to DTV broadcasting and set December 31, 2006 as the target date for the phase-out of NTSC broadcasting (FCC, 1997). However, in 1997, the U.S. Congress passed a bill that would allow television stations to continue operating their NTSC transmitters as long as more than 15% of the television households in a market cannot receive digital broadcasts through cable or DBS *and* do not own a DTV set or a digital-to-analog converter box capable of displaying digital broadcasts on their older analog television sets (*Balanced Budget Act*, 1997). This law has been superseded by the establishment of the revised February 17, 2009 deadline for the cessation of analog full-power television broadcasting (*Deficit Reduction Act*, 2005).

Recent Developments

The February 17, 2009 deadline for the DTV transition as specified by the *Digital Television Transition and Public Safety Act of 2005* was set by the federal government to provide a “date certain” for the end of analog full-power television broadcasting (*Deficit Reduction Act*, 2005). The act also defined the new DTV spectrum to include only channels 2 through 51. The spectrum in the 700 MHz range outside these allocations was auctioned off early in 2008 (mainly to wireless communication providers), and these auctions have raised \$19.6 billion for the U.S. Treasury (Dickson, 2008b; Hansell, 2008). The U.S. government has a significant vested economic interest in these auctions and is a primary stakeholder in speeding the national transition to digital broadcasting.

The act also included a provision to allocate a total of \$990 million from the U.S. Treasury for the issuance of two coupons per household for the purchase of digital-to-analog converter boxes for households with older analog television sets (*Deficit Reduction Act*, 2005). An additional \$500 million will be available to subsidize the coupon program if warranted by consumer demand. These boxes will down-convert DTV signals so that homes with analog sets can still watch broadcast television after the analog shut-off date. The converter boxes sell for \$50 to \$60 at electronics retailers, so each \$40 coupon would defray most of the retail cost. Any U.S. resident can apply for two coupons between January 1, 2008 and March 31, 2009. The coupons cannot be combined, have no cash value, and will expire three months after issuance (see the coupon site at <https://www.dtv2009.gov>).

According to the National Telecommunications and Information Administration (NTIA) that manages the converter box coupon program, there were 1.78 million applications for 3.3 million coupons in the first two weeks of 2008, so most households are requesting the maximum two coupons. A total of 22.25 million coupons will be available to any U.S. television household that requests them (even if they have cable or satellite service), and another 11.25 million coupons will be available only to applicants with analog-only over-the-air television service. Thus, households with only over-the-air TV reception will be assured of access to the coupons in the second round of distribution. It is estimated that there are 70 million television sets in the United States that rely on over-the-air transmissions, and there will only be 33.5 million coupons issued, so quite a few analog sets will need converters purchased at full price (National Association of Broadcasters, 2008).

Current Status

United States

Receiver sales. In 1998, the first HDTV receivers went on sale in the United States at prices ranging from \$5,000 to \$10,000 or more (Brinkley, 1998). Since then, the average price of a DTV set has declined by 73% to \$850 in 2007 (see Table 6.2). Table 6.3 also shows that the average retail prices of LCD (liquid crystal display) and plasma TV sets have dropped steadily from 2005 to 2007 for a variety of screen sizes. A total of 83.4 million DTV sets and displays have been sold to dealers between 1998 and 2007. Unit sales figures in Table 6.2 indicate that DTV consumer adoption in the United States finally took off in 2006 and 2007 beyond innovators and early adopters. In October 2007, the consumer electronics retailer Best Buy announced that it would stop selling analog television receivers in its stores. The Consumer Electronics Association (CEA) has forecast that digital TV shipments will reach about 34 million units in 2008. These statistics do not mean that the household penetration of DTV is actually 74% (83.4 million units divided by an estimated 113 million U.S. households) because not all DTV buyers are consumers and some buyers may own more than one DTV set.

LCD and plasma HDTV displays have become a commodity market as prices decline and set sizes increase. Manufacturers have responded to this marketing challenge by showcasing new display technologies with ever-larger screens and resolutions that exceed conventional HDTV. At the 2008 Consumer Electronics Show in Las Vegas, Panasonic brands (made by Matsushita Electric Industrial Company) exhibited an enormous 150-inch (diagonal) plasma display with a screen six feet high by 10 feet wide (Albanesius, 2008). At the other extreme are very thin "OLED" 11-inch televisions exhibited by Sony that provide a remarkably bright and sharp (1,080p) image with a display depth that is similar to a piece of corrugated cardboard. The OLED displays point to the future of high-definition television with very thin, bright, and sharp screens, but large-screen OLED displays are not expected in stores for a few years. The 11-inch display (Sony XEL-1 OLED) was available in April 2008 for \$2,500 (Baig, 2008).

Table 6.2

Sales of Digital TV Sets and Displays to Dealers, 1998-2008*

Year	Units Sales in Thousands	Dollar Sales in Millions	Average Unit Price in Dollars
1998	14	\$43	\$3,147
1999	121	\$295	\$2,433
2000	625	\$1,422	\$2,275
2001	1,460	\$2,648	\$1,812
2002	2,535	\$4,280	\$1,688
2003	4,102	\$6,521	\$1,590
2004	8,287	\$10,420	\$1,257
2005	12,333	\$17,388	\$1,410
2006	23,504	\$23,380	\$995
2007e	30,462	\$25,907	\$850
2008p	33,637	\$26,596	\$791

*This category includes (1) DTV-capable sets (direct view, rear projection, DLP), (2) integrated DTV sets (direct view, rear projection, DLP), and (3) LCD and plasma TV sets (EDTV and HDTV). e = estimated. p = predicted.

Source: Consumer Electronics Association

Table 6.3

Average Prices of LCD and Plasma TV Sets for Different Screen Sizes, 2005-2007

Top Selling Flat-Panel Screen Sizes Based on Unit Volume	Average Retail Price in 2005	Average Retail Price in 2006	Average Retail Price in 2007
32-inch LCD TV	\$1,354	\$796	\$745
37-inch LCD TV	\$2,096	\$1,113	\$963
40-inch LCD TV	\$3,014	\$1,606	\$1,200 (720p)
46-inch LCD TV	n/a	\$2,601	\$2,300 (720p)
52-inch LCD TV	n/a	n/a	\$3,000 (720p)
42-inch Plasma TV	\$2,034	\$1,265	\$900
50-inch Plasma TV	\$3,574	\$2,052	\$1,555

Sources: Personal retail survey for 2007 data and NDP Group for 2005 and 2006 data

HDTV penetration. Finding an accurate household penetration rate of HDTV sets is a difficult task because different sources consider different universes for their calculations. In addition, sampling error can explain percentage variations from one consumer survey to another. In November 2007, Nielsen reported that 13.7% (15.5 million) of all U.S. television households own an HDTV set and tuner *capable* of receiving HDTV signals, and 11.3% (12.7 million) own an HDTV set and tuner and *receive* HDTV programming (Dickson, 2007a). Nielsen's penetration rate jumps to 21% (24 million) for HD displays *whether* households are equipped with a tuner or not (Dickson, 2007c). Also in November 2007, the Leichtman Research Group estimated that about 25% (28 million) of U.S. households have a set capable of displaying HDTV pictures (Dickson, 2007c).

In July 2007, the CEA put the HDTV household penetration at a higher 32% (36 million) of homes (Dickson, 2007a).

Estimates of the number of homes that actually watch HDTV programming run the gamut from 13 million (Nielsen), to 15 million (Leichtman Research), to 16 million (CEA) (Dickson, 2007c; Kurz, 2007). Leichtman Research attributes the disparity between the HDTV viewing universe and the HDTV set penetration to consumer confusion and lack of accurate information from retailers. According to this research company, “20% of HDTV set-owners think they’re watching HDTV programming when they’re not, and only 41% of HDTV set-owners were told how to get HD programming when they purchased the set” (Dickson, 2007c, p. 24). One study seems to validate this argument. According to a “secret shopper” survey of 132 electronics retailer stores, 81% of the sales staff provided incorrect information about converter boxes to customers and 78% misinformed them about the government’s TV converter box coupon program (Eggerton, 2008c).

Figure 6.2

LCD Sets on Display at a Retail Store



These 52-inch LCD sets are all 1,080p models.

Photo: P. B. Seel

Display types. Consumers have many technological options available for digital television displays. The Consumer Electronics Association (2008) stated that 27.1 million DTV units of all types were sold in 2007. Of these sets, LCD models were the most popular display technology with sales of 16.7 million sets. This is more than four times the number of plasma sets sold (3.5 million). Rear projection models equaled 1.9 million sets, and 1.1 million home theater front projection systems were sold (CEA, 2008). LCD and plasma flat panel displays far outsold other technologies.

- ♦ *Direct-view CRTs*—These sets feature traditional cathode ray tubes (CRTs) that have been the standard display technology since the invention of television. As display dimensions grew with the advent of HDTV, the CRT became very heavy as the volume of glass in the tube also increased. These sets are disappearing from retail outlets as manufacturers focus on flat-panel and rear-projection technologies.

- ♦ *Liquid crystal display (LCD) models*—LCDs work by rapidly switching color crystals off and on. Early LCD displays needed to be viewed head on, but newer technology has eliminated this problem, and they can be viewed from a wider angle. LCD displays use less electrical power than plasma displays when comparing similar screen sizes. Most laptop and flat-panel computer displays also utilize LCD technology, another example of the merger of television and computer technology with DTV.
- ♦ *Plasma displays*—Plasma gas is used in these sets as the medium in which tiny color elements are switched off and on in milliseconds. Compared with early LCD displays, plasma sets offered wider viewing angles, better color fidelity and brightness, and larger screen sizes, but these advantages have diminished over the past five years. The high power demand of plasma displays, especially for the largest set sizes, is a factor for consumers to consider.
- ♦ *Digital light processing (DLP) projectors*—Developed by Texas Instruments, DLP technology utilizes hundreds of thousands of tiny micro-mirrors mounted on a one-inch chip that can project a very bright and sharp color image. This technology is used in a three-chip system to project digital versions of “films” in movie theaters. For under \$3,000, a consumer can create a digital home theater with a DLP projector, a movie screen, and a multichannel surround-sound system.
- ♦ *Organic light emitting diode (OLED)*—The Sony Corporation displayed bright and sharp “OLED” televisions at the 2008 Consumer Electronics Show with a display depth of 3mm—about the thickness of three credit cards. The OLED displays are small and comparatively expensive (the 11-inch model costs \$1,700), but they illustrate how thin these displays can be made and still have a remarkably sharp 1,080p display.

Consumer awareness. Several 2008 surveys have indicated that consumers are becoming more aware of the DTV transition—awareness percentages range from 59% to 79% (Dickson, 2008c; Eggerton, 2008b; Association of Public TV Stations, 2008), suggesting that recent educational efforts of retailers and broadcasters may produce results. On the other hand, there is also evidence that many consumers are still confused about the basic aspects of the digital transition. For instance, only 27% of surveyed consumers know that the DTV transition will be completed in 2009 (Cable & Telecommunications Association for Marketing, 2007). Other typical misconceptions about the conversion include: 73% of consumers report not being aware of the NTIA coupon program to buy digital-to-analog converter boxes; 48% believe that they will need a DTV set to watch television; and 24% believe that they will need to discard their analog TV sets (Consumer Reports, 2008). A greater concern, however, is the substantial percentage of consumers (42%) who plan to take no action, even though they will have no functioning TV set by the transition deadline.

Consumer education. The NTIA was allocated \$5 million in the DTV transition bill for consumer education (*Deficit Reduction Act*, 2005). This meager amount for a national campaign was acknowledged as “a drop in the bucket” by NTIA Administrator John Kneuer (Kneuer interview, 2007). He added that this campaign would require significant in-kind contributions by the broadcasting and consumer electronics industries. In 2007, these entities announced a major DTV public education campaign promoted by a “DTV Transition Coalition” comprised of broadcast and retail organizations (The DTV transition, 2008). The coalition uses “marketing and public education strategies including paid and earned media placements to distribute consistent, unified, and accurate information on the transition” (Helping consumers, 2008). Consumers walking into any consumer retailer in the United States will see messages displayed on placards and DTV sets. Broadcasters and cable companies are running public service announcements about the transition on their respective networks.

Despite these efforts, the lack of consumer knowledge about the DTV transition prompted the FCC to demand more forceful educational efforts. In 2008, the commission issued a *DTV Consumer Education Initiative* requiring broadcasters, telecommunications carriers, retailers, and manufacturers to promote awareness of the transition (FCC, 2008). The order mandates the previously voluntary education efforts of the entities involved:

- ♦ Broadcasters must provide on-air information to viewers about the DTV transition.
- ♦ Cable and satellite television services must provide monthly notices about the transition in customer billing statements.
- ♦ Television manufacturers must provide notices to consumers of the transition's impact on displays and related hardware.
- ♦ The FCC would assist the NTIA in ensuring that retailers are fulfilling their commitment to the DTV converter box program.

The bottom line is that no federal official, elected or otherwise, wants to be accused that they were responsible for consumer television sets going dark on the transition date in February 2009. As a result, consumers and television viewers in the United States will be bombarded with these messages in 2008 and early 2009.

Programming. With the analog shut-off date looming, a race is underway between program providers and broadcasters to convert all programming to widescreen HDTV content. The major broadcast networks are simulcasting HD programs throughout the day and night. Multichannel video programming distributors (MVPDs), such as cable operators, DBS (direct broadcast satellite) providers, and telephone companies, are competing to see who can deliver 100 HD channels to customers first—and are using television advertising to tout their progress. Ads by satellite provider DirecTV claimed that they will reach this milestone first, only to be countered by cable operators, such as Comcast. However, the real winners in this competition are consumers with HDTV sets (Hemingway, 2007). As of November 2007, 68 networks offered HD programming to MVPDs and their customers (Wider world of HD, 2007). Purchasers of new DTV sets now have a wealth of HDTV programming options to watch on cable or satellite providers, even if they must pay more to access the HD channels.

In a September 2007 decision, the FCC required that U.S. cable television operators either provide a set-top converter box that will down-convert digital programming for display on older analog televisions, or continue to distribute the analog signals of all channels carried (in addition to the digital versions) for a three-year period starting February 18, 2009 (FCC, 2007a). For many cable systems, converting digital programming to analog at the subscriber's set is preferable to simulcasting all programs in both analog and digital versions, a major demand on available cable bandwidth. Analog televisions in cable and satellite households will continue to function after February 17, 2009—representing about 85% of the nation's TV households.

An incentive for broadcasters and MVPDs to produce programming in DTV involves the demographics of the HDTV viewer market. These viewers have the discretionary income to purchase DTV displays and pay the premium required to see HDTV programming, making them a desirable market for advertisers. For local broadcasters, HDTV homes represent a key demographic group for advertisers, and local stations are taking steps to convert their news operations to widescreen HDTV. Local news is the most profitable programming for affiliate

stations, many of which are busy upgrading ENG (electronic news gathering) cameras, editing suites, and studio equipment to produce local news, weather, and sports in HDTV. Once the DTV conversion is complete, some local television stations may turn off their analog transmitters in advance of the 2009 deadline (with viewer and FCC approval) to save on the large power bills involved in operating two transmitters.

Japan

It is ironic that, despite its longstanding leadership position in HDTV development, Japan has fallen somewhat behind the United States in deployment of digital terrestrial television (DTT) service. Not only has Japan had to adapt its primarily analog HDTV program to the digital realities of the 1990s (see Dupagne & Seel, 1998), but it also could no longer ignore the importance of over-the-air television to its digital future. As stated above, Japan's original strategy was to deliver HDTV programming via satellite. Today, Japan offers digital television on both satellite and terrestrial platforms. Both high-power and low-power satellites are transmitting digital HDTV and SDTV programs (A. Sugimoto, personal communication, April 2, 2008). In September 2007, NHK ceased broadcasting its analog HDTV programming. Between 2000 and 2007, Japanese consumers purchased more than 30 million television sets capable of receiving digital BS programs (Suzuki, 2007). Analog satellite transmissions are still available in 2008, but they will stop by the end of 2011.

Using the Integrated Services Digital Broadcasting-Terrestrial (ISDB-T) standard (see Table 6.4), Japanese terrestrial broadcasters began DTT service in three major cities by December 2003 and rolled it out nationwide by the end of 2006. The Japan Electronics and Information Technology Association reported that domestic shipments of DTT sets increased from 11 million in 2006 to 19 million in 2007 (Japan Electronics and Information Technology Association, personal communication, April 3, 2008). Japanese analog NTSC broadcasting is scheduled to end on July 24, 2011.

Japan remains a key innovator in HDTV technology. For several years, NHK has demonstrated its progress on the next-generation HDTV system called Super Hi-Vision (SHV). With a video format of $4,320 \times 7,680$ pixels, SHV produces a resolution 16 times higher than that of conventional HDTV (e.g., $1,080 \times 1,920$ pixels). It also offers 22.2 audio channels (24 speakers) to enhance the presence and realism of HD images, a 16:9 aspect ratio, and an optimal viewing distance of 0.75H (three quarters of the height of the screen) instead of the standard 3H for HDTV (Nakasu, et al., 2006). While experimental SHV broadcasting could start in 2015 via satellite for niche applications (e.g., projections in theaters and museums), SHV technology might not be available to average consumers for another 25 years.

Table 6.4

International Terrestrial DTV Standards

System	ISDB-T	DVB-T	ATSC DTV
Region	Japan	Europe	North America
Modulation	OFDM	COFDM	8-VSB
Aspect Ratio	1.33:1, 1.78:1	1.33:1, 1.78:1, 2.21:1	1.33:1, 1.78:1
Active Lines	480, 720, 1080	480, 576, 720, 1080, 1152	480, 720, 1080*
Pixels/Line	720, 1280, 1920	varies	640, 704, 1280, 1920*
Scanning	1:1 progressive, 2:1 interlace	1:1 progressive, 2:1 interlace	1:1 progressive, 2:1 interlace*
Bandwidth	6-8 MHz	6-8 MHz	6 MHz
Frame Rate	30, 60 fps	24, 25, 30 fps	24, 30, 60 fps*
Field Rate	60 Hz	30, 50 Hz	60 Hz
Audio Encoding	MPEG-2 AAC	MUSICAM/Dolby AC-3	Dolby AC-3

* As adopted by the FCC (1996b) on December 24, 1996, the ATSC DTV image parameters, scanning options, and aspect ratios were not mandated, but were left to the discretion of display manufacturers and television broadcasters.

Source: P. B. Seel & M. Dupagne

Europe

Using the Digital Video Broadcasting-Terrestrial (DVB-T) standard (see Table 6.4), European terrestrial broadcasters continue to follow their SDTV strategy by offering multiple digital channels instead of a single HDTV source. For example, in the United Kingdom, the household penetration of DTT rose to 37% from 1998 to 2007. When digital cable (13%), digital satellite (37%), and ADSL (less than 1%) are factored into the equation, 87% of U.K. households receive digital, primarily SDTV, television programs (Ofcom, 2008). Unlike the United States, European countries frequently count digital cable and satellite subscribers in their DTV universe. As shown in Table 6.5, some European countries have already shut down their analog terrestrial transmitters. The Commission of the European Communities (2005) "expects that by the beginning of 2010, the switchover process should be well advanced in the EU as a whole, and proposes that a deadline of the beginning of 2012 be set for completing analogue switch-off in all EU Member States" (p. 9).

In recent years, the prospect of an upgrade from SDTV to HDTV on European terrestrial and satellite platforms has become almost inevitable. Although such a transformation will take many years to implement in Europe, HD DTT trials have already been conducted, and some HDTV services have been launched.

- ♦ In 2004, Belgium-based Euro1080 introduced the first European satellite HDTV channel, HD1. In 2008, it offers four channels to satellite subscribers: HD1 (sports and lifestyles), HD2 (special events), HD5 (demonstrations), and EXQI (culture).
- ♦ In April 2006, U.K. BSkyB launched a satellite HDTV tier, which attracted 292,000 subscribers by mid-2007 (Ofcom, 2007).
- ♦ In June 2006, the BBC, ITV, Channel 4, and Five tested HD DTT in 450 London homes.

- ♦ Spanish TV3 and Swedish SVT have provided limited HD DTT services as well (Mouyal, 2007).

Table 6.5

**Switch-Off Dates of Analog Terrestrial Television in
Selected European Countries (2007)**

Country	Official or Estimated Date
Netherlands	2006
Finland	2007
Sweden	2007
Germany	2008
Denmark	2009
Norway	2009
Switzerland	2009
Austria	2010
Spain	2010
Czech Republic	2010
France	2011
Italy	2012
United Kingdom	2012
Hungary	2012
Poland	2014

Source: DigiTAG (2007)

France has become the most proactive European country with regard to HDTV programming and plans to launch eight public and private HD DTT channels by the end of 2008. French viewers will need an HDTV set with an integrated or external MPEG-4 decoder to receive HDTV broadcasts. In addition, French lawmakers have required that all HDTV sets sold in France be equipped with a built-in MPEG-4 decoder by December 2008, an obligation not unlike the FCC ATSC tuner mandate in the United States (Conseil Supérieur de l'Audiovisuel, 2008). Two new technological advances—the MPEG-4 AVC compression standard and the forthcoming second-generation DVB-T2—will improve the spectrum efficiency of the HD DTT transmissions (DigiTAG, 2007). European broadcasters have always expressed concern that HDTV broadcasts demand much greater spectrum capacity than its SDTV counterparts.

In the London HD DTT trial, 71% of the participants felt that “HDTV will become the standard norm for all television in the future” and 98% stated that “it is important for HD content to be available on the DTT platform” (Mouyal, 2007). Four main factors could drive the consumer adoption of HDTV sets and demand for HDTV services in Europe:

- 1) The growing household penetration of flat-panel displays, which reached nearly 50% in Europe by 2008.

- 2) The accelerating diffusion of Blu-ray disc players due to anticipated price drops in 2008 and 2009.
- 3) The perceived lower image quality of SDTV programs on large-screen receivers.
- 4) The broadcast of sporting events, such as the Olympic Games and soccer championships (DigiTAG, 2007; Mouyal, 2007).

The European household penetration rate of HD ready sets is expected to increase from 1% in 2005 to 26% in 2008 (DigiTAG, 2007). On the broadcaster side, the European Broadcasting Union estimates that HDTV production will cost 10% to 30% more than SDTV production, but this expenditure differential should dissipate over time (DigiTAG, 2007).

Factors to Watch

The global diffusion of DTV technology will evolve over the first decade of the 21st century. Led by the United States, Japan, and the nations of the European Union, digital television will gradually replace analog transmission in technologically-advanced nations. It is reasonable to expect that many of these countries will have converted their cable, satellite, and terrestrial facilities to digital television technology by 2010. In the process, DTV will influence what people watch, especially as it will offer easy access to the Internet and other forms of entertainment that are more interactive than traditional television.

The global development of digital television broadcasting is entering a vital stage in the coming decade as terrestrial and satellite DTV transmitters are turned on, and consumers get their first look at HDTV and SDTV programs. The following issues are likely to emerge in 2008 and 2009 in the United States:

- ♦ *Receiver prices*—This factor continues to be a critical component of a successful consumer DTV diffusion. Sales of DTV sets have increased dramatically in the United States since 2006, and falling retail prices have been a prime contributor to this trend. In 2008, the average price of a DTV set in the United States will fall below the \$800 mark (Table 6.3). Some HDTV receivers have already reached price parity with previous analog models (e.g., a 19-inch LCD HDTV for less than \$300, a 32-inch LCD HDTV for less than \$600), but flat-panel displays with 43-inch screen size and larger still cost more than \$1,000. As a reality check, we must remember that the 2007 household penetration of HDTV sets hovered between 21% and 32% in the United States, a far cry from universal adoption.
- ♦ *Deadline date*—Some policymakers publicly or privately worry that a significant number of U.S. viewers might be deprived of their local broadcast signals on February 18, 2009. For instance, FCC Commissioner Michael Copps stated in early 2008 that “My greatest concern is for over-the-air viewers who are unprepared for the DTV transition and wake up to no TV service at all on February 18, 2009” (Eggerton, 2008a, p. 26). Developing effective outreach programs for senior citizens and low-income households will go a long way to ensuring a smooth DTV transition. The American Association of Retired Persons (AARP) points out that about 40% of households relying exclusively on terrestrial broadcast signals include 50-year-old and older people (Merli, 2008). While some disruptions are likely to occur on February 18, 2009, the FCC made it clear that this

deadline is “a hard date” and that analog broadcast transmissions on full-power television stations after February 17 would be penalized (Eggerton, 2008a; Robichaux, 2008).

- ♦ *DTV reception*—Although indoor reception of over-the-air DTV signals has always been a concern in the DTV transition, we had optimistically surmised that future generations of ATSC DTV tuners would increase the signal-to-noise ratio and improve the signal coverage for viewers (see Dupagne, 2003). Unfortunately, a recent 2008 study reminds us that the issue of DTV reception has not gone away. Centris, a marketing research firm, reported significant gaps in DTV coverage throughout the country that could prevent as many as 5.9 million TV households from receiving all the over-the-air signals they did prior to February 18, 2009. To avoid this reception problem, many viewers who now use rabbit-ear antennas would have to purchase outdoor antennas (Furchgott, 2008).
- ♦ *Multicasting*—The use of multiple SDTV channels will remain on the economic agenda of many local broadcast stations in the next two years. According to one study, “57% of broadcasters say they see multicasting as the most visible new business opportunity for the industry, ahead of station Web sites, interactive TV, and local mobile video” (Romano, 2008, p. 17). Despite the failure of such datacasting ventures as USDTV and MovieBeam, about 25% of full-power local TV stations have launched one or more secondary digital channels. To address this demand, some companies are offering DTV turnkey-type programming services, allowing local broadcasters to insert their own commercials and sharing a percentage of advertising revenues with them. For instance, local stations that affiliate with the 24/7 DTV movie channel .2Network will be able to add local content, receive barter spots, and earn 30% of national ad revenues the first year, 40% the second year, and 50% the third year (Freed, 2007). Apart from financial considerations, the main obstacle to the implementation of multicasting remains the FCC’s decision to grant digital must-carry obligations *only* on the primary video signals of local broadcasters, not on the secondary multicast signals (FCC, 2005).
- ♦ *Mobile video*—This emerging technology would allow local TV stations to transmit signals using their digital spectrum to cell phones and other handheld devices. Designing mobile DTV technology is challenging because “[i]t requires the transmission of robust signals to small, portable devices within the existing 6 MHz DTV channel, without interfering with the core programming services stations are already providing with their 19.4 megabits of digital throughput” (Dickson, 2007b, p. 13). The ATSC issued a call for technical proposals in April 2007 and received 10 submissions for a mobile/handheld (M/H) DTV standard in June 2007 (Dickson, 2007b). The committee expects to make a decision by the first quarter of 2009. As of this writing, two main mobile DTV systems, A-VSB (Advanced-Vestigial Side Band) developed by Samsung, Rohde & Schwarz, and Nokia and MPH (mobile pedestrian handheld) supported by LG Electronics and Harris, are vying for broadcaster interest (Dickson, 2008a). Based on the high penetration rate of cell phones in the United States (83%) and economic scenarios, local TV stations could earn \$2.2 billion from M/H DTV advertising by 2012 (Ducey, et al., 2008). With a start-up cost of \$100,000 per station, the collective investment for inserting M/H DTV capability into the transmitters of 1,700 TV stations would amount to about \$170 million (Ducey, et al., 2008).
- ♦ *Digital low-power television*—In 2004, the FCC established a separate regulatory framework to govern the digital transition for the nearly 2,300 low-power television (LPTV) and more than 4,300 TV translator stations. In spite of their secondary status, the commission emphasized that

"These stations are a valuable component of the nation's television system, delivering free over-the-air TV service, including locally produced programming, to millions of viewers in rural and discrete urban communities" (FCC, 2004, p. 19,332). In this *Report and Order*, the FCC (2004) concluded that LPTV stations, like their full-power counterparts, must convert to digital and allowed them to either convert their analog operations to digital on their existing analog channel (a practice called "flash-cut") or apply for a digital channel. It declined to specify a transition deadline, leaving the future of the LPTV industry in limbo. The predicament of LPTV stations reached a new level in early 2008 when Ron Bruno, President of the Community Broadcasters Association (CBA), declared that "the DTV-to-analog converter boxes were not allowed to contain analog tuners, and that only four of 37 NTIA-certified boxes even pass through an analog signal" and alluded to the "bankruptcy" of the industry if this situation was not promptly reversed (Eggerton, 2008d, p. 17). In a February 2008 letter to the industry, FCC Chairman Kevin Martin (2008) proposed that LPTV stations complete the digital transition by 2012 and urged manufacturers to incorporate analog pass-through functionality in their converter boxes. In March 2008, the CBA filed a lawsuit in federal court to force the FCC to halt the distribution of converter boxes that block analog LPTV signals. Such action could well slow down or even derail the NTIA converter box program.

In the United States, the national conversion to the new digital television standard was almost complete in early 2008. One of the most massive technological conversions in modern history will take place at midnight on February 17, 2009. Most broadcasters, program producers, cable, satellite, and telephone companies have made their conversions to DTV and are offering a wealth of HDTV programming to viewers. With the market stimulation provided by this high-definition programming, consumers are purchasing new HDTV sets at a record pace. The converter box program for over-the-air viewers is in place to hand out 33.3 million coupons for the box needed to down-convert DTV programs for older analog sets. Television viewers are watching DTV programs on their widescreen displays that have remarkable image clarity, color accuracy, and audio fidelity. It represents a new era in television broadcasting, and as ESPN Vice President Bryan Burns noted, "Television is not going to be a 4 × 3 world anymore" (Becker, 2007, p. 11).

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Multichannel Television Services

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Just several decades ago, people would sit down for an evening of television and have a choice of two to five channels. Nowadays, most people have so many channels to choose from that they have to use interactive program guides to help them choose which program to watch. Who would think there would be channels devoted to food, auto racing, and jewelry shopping? Multichannel television services deliver this programming and more.

Multichannel television services include cable television, direct broadcast satellite (DBS) services, and pay television services. (Internet protocol television services are also considered multichannel television services, but they will be discussed in Chapter 8.) With cable television services, television programming is delivered to the home via a coaxial cable or a hybrid system combining fiber optics and coaxial cable. The subscriber either uses a set-top box or connects the cable directly into the television. DBS customers receive programming using a small, pizza-sized satellite dish and a set-top receiver connected to a television set.

Pay television services are available on both cable and DBS systems and include premium channels, pay-per-view (PPV), near video on demand (NVOD), and video on demand (VOD). Premium channels are programming channels for which subscribers pay a monthly fee above the regular cable or DBS subscription fee. These channels usually contain a mix of movies, events, and original programming without commercials. HBO and Starz are examples of premium channels. Pay-per-view is a program such as a movie, a concert, or a boxing match that is ordered and then played at a specific time. Near video on demand is like pay-per-view except that there are many available starting times. Video on demand is programming that is available at any time. Users also have control over the program so the program can be paused, rewind, and fast-forwarded. VOD can be available for a one-time charge. For example, a movie can be ordered for a set fee. VOD can also be offered for a monthly fee. For example, subscription video on demand (SVOD) is a slate of programming offered on demand for a monthly charge. Many premium channels offer SVOD included in their monthly sub-

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scription rate. Finally, free VOD is available; its programming is varied, and offerings range from children's shows to fitness videos to broadcast network programming.

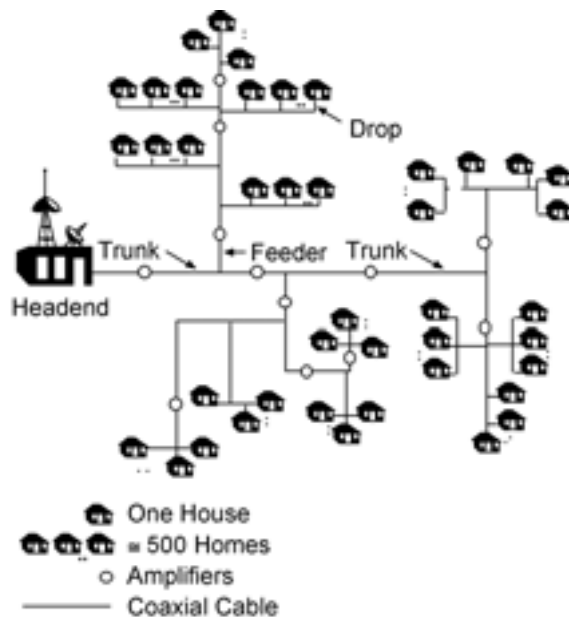
This chapter will discuss the origins of multichannel television services as well as recent developments such as high-definition programming services, DVRs (digital video recorders), and the changing regulatory landscape.

Background

The Early Years

Many people do not realize that cable television has been around since the beginning of television in the United States. Cable television grew out of a need to sell television sets. People were not going to purchase television sets if they had nothing to watch on it. It has not been established who was first, but communities in Oregon, Pennsylvania, and Arkansas have claimed to be the first to establish Community Antenna Television (CATV). These communities could not get over-the-air programming with regular television antennas because of geographical limitations. Antennas were erected on top of hills and mountains to receive signals from nearby cities, and then homes in the community were connected via coaxial cable. Appliance stores could sell televisions, and people who bought them had programming to watch (NCTA, n.d.).

Figure 7.1
Traditional Cable TV Network Tree and Branch
Architecture



Source: Technology Futures, Inc.

Soon CATV operators began to offer customers distant channels since their antennas could pick up other stations besides those in the local market. These new channels threatened local broadcast stations, and the FCC responded by limiting the importation of distant channels. Continuing into the early 1970s the FCC responded to concerns of broadcasters and the film industry by limiting cable's ability to offer any programming other than that offered by local broadcast channels (for example, sports and movies). There was not much growth in cable during this time.

The situation changed in 1972 when the FCC began to deregulate cable, and previous restrictions on cable programming were loosened. Also in the early 1970s, "the Open Skies" policy was established that allowed private companies into satellite communications (NCTA, n.d.). In 1972, HBO, the first premium channel, began as a local microwave premium service in Pennsylvania, and was offered to cable companies around the country via satellite. A few years later, Ted Turner put his small independent television station from Atlanta on the same satellite carrying the HBO service, giving cable companies another "free channel" and establishing the first "Superstation," WTBS. Use of satellites to deliver programming soon facilitated the creation of many cable networks that are still popular today including ESPN, A&E, CNN, and MTV.

This use of satellites was also key to the development of DBS services. Chances are, if you lived in a rural area in the 1970s, your community was not wired for cable television. With a television receive only satellite dish (TVRO), people could receive television programming delivered via satellite. In 1977, Taylor Howard, a professor at Stanford University who worked with satellite technology, may have been the first to build a satellite dish to receive HBO programming at his home. This marked the beginning of TVRO satellites. The technology has limitations, though. First, it used the low-power C-band (3.7 GHz to 4.2 GHz) frequencies, which meant the dishes were large and unattractive. Some communities even banned the dishes because of their appearance. They were also expensive to install and complicated to operate. Finally, programming networks began to scramble their signals so TVRO users had to purchase decoding boxes and pay to unscramble the signals (Museum of Broadcast Communication, n.d.).

The Growth Years

Deregulation continued into the 1980s, allowing cable systems to accelerate their growth. The *Cable Communications Act of 1984* amended the *Communications Act of 1934* with regulations specific to cable. The most important change made by this act was that it removed the rights of a local franchising authority to regulate cable TV rates unless the area was served by fewer than three broadcast signals. When a cable company operates in a community, it has to have a franchising agreement with the community. This agreement covers issues such as public access requirements, subscriber service and renewal standards, and a franchise fee; it is negotiated between the franchising agency and the cable company. With the passage of the 1984 act, cable companies were allowed to increase rates without government approval, and rates grew—and grew. At the same time, deregulation and rising rates allowed cable companies to raise capital to expand their services and upgrade their technology. However, cable customers found their cable rates rising significantly, with the average rate more than doubling from 1984 to 1992 as service standards dropped.

At the same time, new satellite television services and wireless cable companies were struggling to be established. Direct-to-home satellite service in the 1980s used the medium-power Ku-band (11.7 GHz to 12.2 GHz) and offered customers a limited amount of "cable" programming. The service was not successful, though, for a number of reasons. First, the service only offered a limited number of channels. Second, the operators were unable to obtain the programming that customers wanted—popular cable programming networks. In addition, the service was expensive and performed poorly in bad weather (Carlin, 2006).

Another attempt at satellite television was made in 1983 when the International Telecommunications Union and the World Administrative Radio Conference established that the high power Ku-band (12.2 GHz to 12.7 GHz) would be used for direct broadcast satellite service and assigned orbital positions and frequencies for each country. In the United States, the FCC established eight orbital positions and accepted eight applications for the slots. The applicants had to prove due diligence, which meant they had to begin constructing a satellite within a year and have the service operational within six years. All of those applicants failed. The FCC collected a new group of applicants in 1989, and those companies also failed to begin service by 1992. The services could not take off for two reasons. First, they could not transmit enough channels because there was no acceptable digital video compression standard. Without digital video compression, these satellite services could only broadcast a very limited amount of channels, nowhere close to what cable systems were offering at the time. Digital video compression would allow several channels worth of programming to be squeezed into the space of one analog channel. Second, there needed to be a way for satellite services to get access to popular cable programming channels. Cable companies, at the time, were using their power to prevent any programming deals with the competition (DBS), leaving satellite providers with a small number of channels that few people wanted to watch.

These problems were solved in the early 1990s. First, the MPEG-I digital video compression standard was approved in 1993, followed by the broadcast-quality MPEG-2 format in 1995. This standard allowed eight channels to be compressed into the space of one analog channel. Second, the *Cable Television Consumer Protection and Competition Act* (a.k.a. The Cable Act of 1992) forced cable programming companies to sell to other video distribution outlets for terms comparable to cable. Now, DBS had the channel capacity and the programming to adequately compete with cable. DirecTV (Hughes) and USSB (Hubbard) were the first to launch service in 1994. EchoStar launched their DISH service in 1996. Other DBS applicants failed to launch their services, and some of their channels were obtained by DirecTV and EchoStar. Rainbow DBS launched in 2003 and was used for the short-lived VOOM HD service.

Not to be outdone, the cable industry entered the satellite television service market with Primestar. This medium-power KU-band service offered only a limited number of channels, so as to not compete with local cable systems. The consortium of cable systems involved in Primestar included Cox, Comcast, Newhouse, TCI, and Time Warner. Primestar eventually adopted digital video compression to offer more channels and directly compete with DirecTV. They highlighted the fact that subscribers did not have to buy the equipment; rather, they rented it just like a cable set-top box.

Primestar was eventually purchased, along with USSB, by DirecTV, making it the largest DBS service in the United States. EchoStar eventually took over the VOOM channels from Rainbow DBS and took over the orbital positions of DBS applicant MCI. Finally, one last DBS service was launched in 1999: Sky Angel, which offers religious programming.

Consolidation within the satellite television market sparked a price war between DirecTV and DISH and between the DBS companies and cable. Subscribers no longer had to pay for equipment as the DBS services began to offer free installation and hardware and even multiple room receivers. Cable still had a major advantage over DBS, because DBS subscribers could not get local broadcast stations through their satellite service. This was due to the *Satellite Broadcasting Act of 1988*, which prohibited the distribution of local broadcast stations over satellite to subscribers who lived in the coverage area of the station. This meant that DBS subscribers had to set up an antenna or subscribe to basic cable to get local channels. This problem was solved with the *Satellite Home Viewer Improvement Act of 1999*, which allowed DBS companies to offer those local channels to their customers. The issue now was for DBS companies to have enough space on their satellites

available to offer local channels in all markets in the United States. The *Satellite Home Viewer Extension and Reauthorization Act* (SHVERA) extended SHVIA in 2004 (FCC, n.d.).

Cable television at this time was reacting to its first real competition. After the boom years brought about, in part, by the deregulation of the *Cable Act of 1984*, the cable industry was perhaps a little complacent, raising prices and disregarding service. These complaints eventually led to the *1992 Cable Act* discussed earlier, which re-regulated basic cable rates. One of the most important provisions of the Act gave broadcasters negotiating power over cable companies. Broadcasters had for years been complaining about how cable operators were retransmitting their signals and collecting money for them, with none of the money coming back to broadcasters. The “must carry” and “retransmission consent” provision of the 1992 act let broadcasters decide if the cable system must carry their signal or an agreement had to be reached between the cable company and the broadcaster for retransmission consent. This consent could “cost” anything from money to time.

The concept of “must carry” would come back to haunt both cable operators and broadcasters as the digital television transition nears. As discussed in Chapter 6, broadcasters can transmit one HDTV and up to six SDTV channels. Broadcasters argue that cable operators under must carry should be forced to carry all of those channels. Cable operators, on the other hand, say they should only have to carry the stations’ primary signal. The Federal Communications Commission (FCC), thus far, has sided with the cable operators saying that multichannel must carry appears to be a burden to cable operators under the dual must-carry ruling. The cable system also must carry both the local broadcaster’s primary analog and digital signals for three years starting on February 18, 2009. They must also carry the broadcaster’s HD signal in HD. Finally, the cable system can drop the analog signal, carrying just the digital signal only if all subscribers have the necessary equipment to receive the signal (Hearn, 2007a).

While cable and DBS services were growing and developing quickly at this time, the same was not true for pay television services. Premium channels were popular, especially HBO and its main competitor Showtime, but pay-per-view had failed to gain major success. The limitations of PPV are numerous and mostly outweigh the advantages. First, PPV programs had a very limited number of available start times. The programs could not be paused, rewind, or fast-forwarded. There was only a limited amount of programming available. Users needed to call the cable company to order the program and had to have a cable box to get them. By the time a movie was available in PPV, it had already been available for sale and rental at home video stores. Often times, as well, the price was higher for PPV than rental. The only real advantages of PPV were no late fees, you did not have to leave your house, and sometimes that was the only way to get certain special events such as championship boxing.

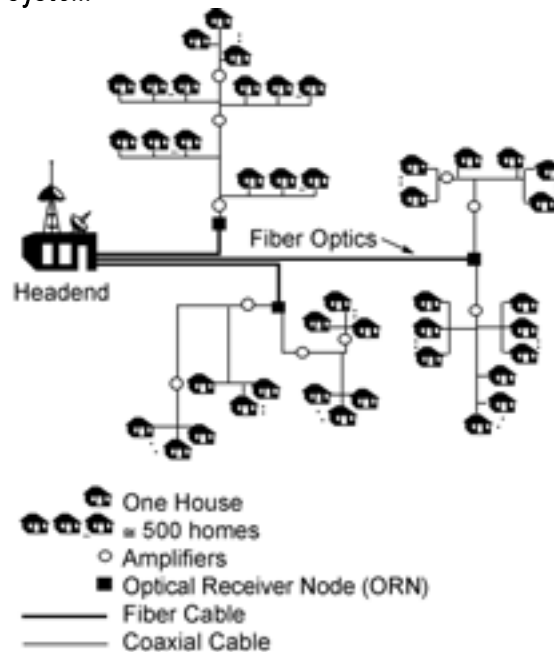
DBS solved some of these problems with near video on demand. Instead of having only a few channels devoted to PPV, DBS providers could have 50 channels of PPV and could offer programs at staggered start times so the viewer had more choice. The buy rates for movies on NVOD were higher than PPV (Adams, 2005).

Digital Upgrades

As cable television systems upgraded their networks from analog to digital, new services and features began to roll out. For example, cable systems began to upgrade their networks from coax to hybrid fiber/coax (see Figure 7.2). This upgrade allowed cable systems to offer new services such as high-definition programming, DVR services, VOD, SVOD, broadband Internet access, and telephony. Video programming, broadband Internet access, and telephony makes up the cable “triple play,” which is one feature that the cable industry

uses to differentiate its service from DBS. Cable also offers VOD and SVOD, not available as of spring 2008 on DBS. (For more on DVRs, see Chapter 14, and for more on cable Internet, see Chapter 8.)

Figure 7.2
Hybrid Fiber/Coax Cable TV System



Source: Technology Futures, Inc.

DVR services have been solid source of revenue for both cable and DBS. The cost of including the technology in the set-top box and providing the service is less than the yearly subscription fees (usually around \$5 a month). DVRs are also seen as a potential revenue loss when people skip commercials. Cable operators are trying several avenues to mitigate this problem. Time Warner, for example, has the Start Over service. Digital cable customers in selected markets can go back to the beginning of a program by activating the Start Over function when watching a show. Users can then pause, rewind, and resume (within five minutes). Unlike with a DVR, though, you cannot fast forward (Time Warner, n.d.).

The digital upgrades helped advance pay television services. First, the upgraded digital networks allowed cable systems to carry more channels of programming. Premium channels took advantage of this additional bandwidth by offering multiplexed versions of their services. So, for example, instead of just getting one HBO channel, a subscriber also gets different versions or “multiplexes” of HBO including HBO2, HBO Signature, HBO family, etc. Most premium channels now offer a package of multiplexed channels to subscribers including Starz, Showtime, and Cinemax. Even “regular” cable programming channels are multiplexing. For instance, sports fans can now watch ESPN, ESPN2, ESPN Classic, ESPN U, and ESPN News. More advanced pay television services were also introduced, including subscription VOD. HBO was the first to offer HBO on Demand in 2001 that allows HBO subscribers with digital cable to access a selection of HBO programs on demand. These programs include original series, movies, and events. HBO even experimented with the service by making episodes of *The Wire* available first on On Demand before airing on HBO (Kaufman, 2007).

Video on demand was the next service to be rolled out by cable companies. VOD has been tested for the last three decades, with the largest test being Time Warner's Full Service Network in Orlando (Florida) from 1994 to 1997. The Full Service Network eventually failed because of numerous factors including cost and technological limitations. The VOD feature of the service was popular with customers, though.

Video on demand is now offered to digital cable subscribers by the major cable multiple system operators (MSOs) including Comcast, Cox, Time Warner, and Cablevision. Subscribers have access to a variety of programming including new movies for a one-time charge. The fee usually entitles the viewer 24-hour access to the program. Free older movies are available as well as a selected number of television shows from broadcast and cable networks. Finally, special VOD only channels and programs have developed and are available by choosing from a menu of "channels" such as Comcast's Life and Home, News and Kids, and the Cutting Edge (On demand menu, n.d.).

Recent Developments

The multichannel television market is changing quickly due to a number of important developments including high-definition programming and regulatory changes.

High-Definition Programming

When it comes to high-definition programming, DBS services have been the most aggressive in developing and marketing the service. DirecTV started the battle when it announced that it would be offering 100 channels of HD content by 2008 (Berger, 2007). As of April 2008, the service offers 95 HD channels, compared to 73 on DISH (DirecTV, n.d.). DISH has also been adding HD channels at a fast pace. Both services use MPEG-4 AVC video compression for HD programming. The new compression allows the companies to squeeze two channels of HD into the space formerly used by one. The biggest problem with the move to MPEG-4 AVC is that customers with older DirecTV and DISH MPEG-2 boxes have to upgrade to a new box to get the new HD channels (Patterson & Katzmaier, 2008).

In order to offer more HD channels, both services have launched and plan to launch new satellites. DISH had a setback in March 2008 when its AMC-14 satellite launch failed (Dickson, 2008a). DISH CEO Charlie Ergen claims that DISH will have 100 HD networks and local HD channels in 100 markets by the end of 2008, but the satellite failure may impact that goal. DISH Network plans to launch two other satellites in 2008 (Moss, 2008a). DirecTV also had some satellite setbacks when it had to postpone a launch of DirecTV II, but the satellite was launched successfully just a few days later on March 19, 2008 (Moss, 2008). DirecTV is also focused on offering local HD channels and, as of March 2008, offered HD locals in 77 markets although not all locals in a market were offered by the service.

With the transition to digital terrestrial television on February 17, 2009, both DBS providers are working to ensure a smooth switch although they received a break from the FCC in March 2008. Both companies now have until 2013 to carry all local channels in HD "within any market where they have elected to carry any station's signal in HD format" (Hearn, 2008e). The FCC did require the DBS companies meet benchmarks of 15% by 2010, 30% by 2011, 60% by 2012, and 100% by 2013. The FCC did not specify particular markets, so DBS providers can choose which markets to serve with HD locals, probably leaving rural and smaller markets with down-converted signals.

Cable television companies are also bulking up their HD offerings, especially in response to competition from DBS. Not only do cable MSOs offer HD channels, but they are also able to offer HD VOD and HD SVOD. The local HD channels are a different issue. As discussed earlier, under the must carry and retransmission consent rules of the *Cable Act of 1992*, broadcasters can decide if the cable company must carry their channel. With the digital transition, broadcasters can offer their primary signal in HD and several other digital multicast channels. Broadcasters want must carry to apply to all of their digital channels, not just the primary channel. FCC chairman Kevin Martin is a supporter of multicast must carry, but the commission as a whole is not. Martin had to pull a vote on the subject in June 2006 (Hearn, 2007a). The FCC did vote that cable operators must carry the local broadcaster's signals in digital and analog form for three years after the 2009 digital transition date. A number of major cable networks including Discovery and the Weather Channel sued the FCC over this rule claiming the rule unfairly removes available space for their services and violates their First Amendment rights (Hearn, 2008a). No decision on multicast must carry had been made as of April 2008.

The FCC also issued a ruling on "plug-and-play" in 2003. The ruling requires that digital television sets be able to receive digital cable without a set-top box. A "CableCARD" can be inserted into an equipped digital television, and then the customer can receive digital cable services without the set-top box. With CableCARD, though, users can only get one-way information, so using advanced services such as VOD is impossible with a CableCARD (FCC, n.d.-b). To get around this, subscribers can also insert CableCARDs into set-top boxes and DVRs like TiVo. This development is interesting, since the CableCARD was supposed to help eliminate the set-top box.

Another advantage of the CableCARD is that the technology allows people to purchase set-top boxes independent of retailers and then get a CableCARD from the cable provider. An FCC rule went into effect on July 1, 2007 that required cable operators to take out the security technology from set-top boxes to allow for the use of outside boxes. Comcast sued the FCC over this rule in April 2008 saying they were singled out by the FCC, that other cable companies were granted waivers, and that they wanted to continue offering their low-cost set-top boxes without CableCARD to ease the digital transition (Kaplan, 2008). As of March 25, 2008, 4.18 million CableCARD enabled set-top boxes had been deployed by the 10 largest cable MSOs (Spangler, 2008).

Regulation

No industry has been under such regulatory pressure by the current (as of 2008) FCC and its chairman Kevin Martin as cable. These issues include a la carte, Class A must carry, franchising deadlines, Multiple dwelling unit (MDU) contracts, and the 70/70 rule. Representative Joe Barton (R-TX) even told Martin at a subcommittee meeting, "I've had a number of cable operators in to see me in the last couple of months and they are of the opinion, Chairman Martin, that you are picking on them, that you are treating them unfairly, and that the commission is treating them unfairly on a whole series of issues" (Hearn, 2007c).

A la carte. Arguing that cable customers are charged too much for channels they do not even watch, Chairman Martin has been pushing for "a la carte." With a la carte, customers would choose what channels they wanted instead of purchasing programming in tiers. Martin has also argued that parents like a la carte because they could avoid channels that are not family friendly. Cable responded to that concern with the establishment of family tiers. Spanish-speaking viewers, argues Martin, would also benefit but not having to pay for English language programming. The cable industry is vehemently against a la carte. They argue that a la carte would raise prices, limit diversity, and lower revenue for the development and expansion of new services. The FCC cannot force the cable companies to break up their programming tiers, so Martin is considering another ave-

nue—allowing cable companies to drop any cable programming network from the expanded basic tier that asked for a fee over a set price ceiling (\$0.75 has been suggested). This would hurt popular but pricey networks such as ESPN (Hearn, 2008c). Indeed, cable companies have been under pressure because of increasing programming costs.

Class A must carry. There are 567 Class A low-power local television stations in the United States. Class A stations are not covered by the must carry regulations, except in rural areas. Chairman Martin proposed that Class A television stations have must carry status in all areas. Class A stations are not required to transition to digital by the 2009 cut off date, but Martin is proposing a 2012 deadline. The cable industry is opposed to the must carry policy because they claim that they have a limited amount of channel capacity, especially in light of the requirement that they carry an analog and digital signal of full power local stations (Hearn, 2008b).

Video franchising order. One of cable's new competitors is the telephone companies, which are rolling out IPTV (Internet protocol television) services using advanced fiber optic network technology. One of the difficulties of starting a new video service is the negotiation of franchising agreements, those agreements between the community and the video service provider. AT&T and Verizon argued that franchising agreements were hampering their efforts to roll out these new services and lobbied for national and statewide franchising agreements. Many states passed these. (For more on this, see Chapter 8.) The FCC became involved when it ruled that local governments only have 90 days to negotiate a franchising agreement, and, if no agreement is reached, then the franchise would be granted. This would allow the telephone company to avoid good faith negotiations and just wait until the deadline passed. Then, these companies could build out their systems as they please, perhaps avoiding lower income neighborhoods or rural areas (Bangeman, 2007). The same franchising rules are not applicable to cable.

MDU exclusive contracts. MDUs are multiple dwelling units such as apartment buildings, condos, and co-ops. Often, MDUs have exclusive contracts with multichannel television providers. On October, 31, 2007, the FCC ruled to prohibit these exclusive contacts between building owners and cable companies. The ruling even voided existing contracts. The National Cable and Telecommunications Association requested a stay on the ruling pending an appeal, and it was rejected (Hearn, 2008d). The result should be additional choice in multichannel television providers for residents of MDUs.

30% cable cap and the "70/70" test. Citing concerns for customers, FCC Chairman Martin has pushed for a 30% cable cap, meaning that no cable company can serve more than 30% of multichannel television subscribers nationally. Comcast, the nation's largest cable MSO, as of 2008 serves about 27% of the nation's multichannel television customers. The cap would greatly hinder Comcast's expansion plans including hampering their efforts to sell their "triple play" of bundled services and their ability to purchase other cable operators (Hearn, 2007b). Comcast has appealed this ruling. The FCC's ability to regulate cable became an issue in 2007 after the *13th Annual Report on Video Competition* was released indicating that the "70/70" test from Section 612(g) of the *1984 Communications Act* has been met thus allowing cable regulation. The "70/70" test says that the FCC can regulate cable to ensure the diversity of information sources if "cable systems with 36 or more activated channels are available to 70% of households in the United States and are subscribed by 70% of households to which such systems are available" (*Cable Communications Act of 1984*, 1984). The cable industry, members of Congress, and even other FCC commission members argued that the statistics used in the report were faulty, noting that the 12th report cited cable's penetration as 68.7%, Nielsen Media Research estimated 61%, and SNL Kagan reported an even lower penetration of 58.1% (McSlarrow, 2007).

DBS services have had it a little easier on the regulation front. The biggest recent development is that News Corp. sold its 41% interest in DirecTV to Liberty Media in 2008. Liberty now has 48% of DirecTV. The Justice Department cleared the deal in February 2008 (Hearn, 2008c).

Other Recent Developments

DISH Network and DirecTV are looking for ways to add customers and compete with the cable “triple play.” They have made deals with satellite and DSL (digital subscriber line) broadband suppliers and landline and mobile telephone companies.

DirecTV and DISH are also looking for other revenue streams such as mobile delivery. In the 2008 auction of the soon-to-be-vacated television spectrum, DISH Network successfully bid on 168 700-MHz licenses in the E block. Then, the company announced they were working with Alcatel-Lucent to test DVB-SH (digital video broadcasting-satellite services to handhelds) mobile-TV technology (Dickson, 2008b).

DirecTV announced in March 2008 that they are getting into the VOD business. They have been testing the new service, called DirecTV On Demand. The service uses a set-top box combined with a broadband Internet connection. The programming is sent to the set-top box, which has a DVR. The obvious limitations of the service will be that the content will take up space on the user's DVR and the amount of time it takes to download the content (Kumar, 2008).

There was little change in the field of premium channels since they introduced multiplexing. That all changed in April 2008 when Paramount, Lionsgate, and MGM announced plans to roll out a new premium channel in 2009. In addition to offering new competition, the biggest impact is that Showtime will lose its supply of Paramount movies, but Showtime indicated that it was not planning to renew its contract with the studio because of high licensing fees. The new channel will also have a VOD channel associated with it (Reynolds, 2008).

Cable, and in particular, premium channels continue to produce high-quality programming. For example, in 1990 cable networks took home 10 Emmys and 1 Peabody Award. In 2007, cable networks were awarded 43 Emmys and 11 Peabody Awards (NCTA, 2008).

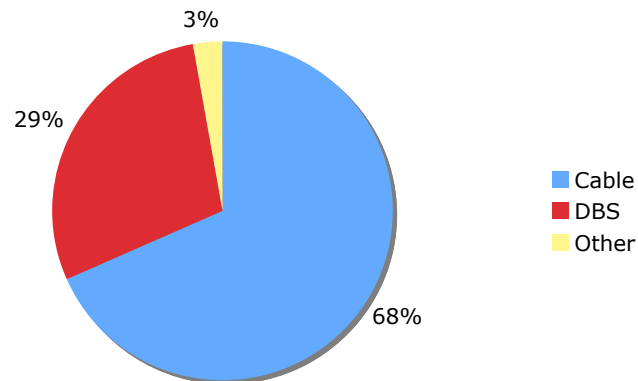
Much of this award winning programming and many shows on cable and satellite are decidedly adult in nature (e.g., *Sopranos*, *Weeds*, *Nip/Tuck*, and *SouthPark*). Although the broadcast television and radio stations have to comply with the FCC's indecency and obscenity rules, cable and satellite services do not. There are many individuals and groups, though, that would like to change this. Both Senator Stevens (R-AK) and Representative Barton (R-TX) have attempted to push through legislation to apply the indecency and obscenity rules to multichannel television services. The industry has responded by saying that they have technologies available to block offensive content and that parents can control what their children are watching (Ahrens, 2005). Thus far, this legislation has not made it out of committee.

Current Status

As discussed throughout this chapter, the FCC issues an *Annual Video Competition Report*. The 13th report, released in 2007, found that, as of June 2006, there were 110.2 million television households, and

95.8% of those households subscribed to a multichannel television service. The report found that, as of June 2006, 68.2% of those households subscribed to cable and 29% subscribed to DBS. Other services include those operated by broadband service providers, incumbent local exchange carriers (telephone companies), electric and gas utilities, satellite master antenna services, and wireless cable (FCC, 2007).

Figure 7.3
Multichannel TV Market Share



Source: FCC (2007)

Worldwide, the division between cable and satellite television is different than in the United States. While 95.8% of U.S. households subscribe to a multichannel television service, that percentage varies worldwide (see Table 7.1). The data in this table are a little old (2002), but they provide some useful comparisons.

U.S. Cable

According to the NCTA, cable penetration as of September 2007 is 58% of total television households. That adds up to 64.8 million subscribers. As of December 2007, there were 37.1 million digital cable customers, 35.6 million cable Internet customers, and 15.1 million cable voice/phone customers. The average expanded basic programming package in 2007 cost \$42.76 (NCTA, 2008).

Comcast is the largest cable MSO in the United States with 24.1 million subscribers as of December 2007. Time Warner is second with 13.3 million subscribers, followed by Cox Communications with 5.4 million, and Charter Communications with 5.3 million subscribers (NCTA, 2008). Table 7.2 lists the top 10 Cable MSOs as of September 2007.

Table 7.1

Worldwide Multichannel Television Penetration

Area	Country	Penetration (% of HHs)	Cable	Satellite
Asia/Oceania	Australia	22.2	12.1	10.0
	China	29.3	29.3	0
	Hong Kong	65	35	30
	India	60.2	54.2	6
	Malaysia	30.5	3.1	27.6
	New Zealand	32	3	29
	Philippines	11.3	10.5	.8
	Singapore	33	33	0
	South Korea	31	27.7	3.3
	Taiwan	83.6	81	2.6
	Thailand	2.8	.9	1.9
Europe	Austria	78.6	33.4	45.2
	Belgium	99.3	95	4.3
	Czech Republic	46.8	27.8	19
	Denmark	78	60	18
	Finland	56.1	45.4	10.7
	France	30.4	15.1	15.3
	Germany	89	56	33
	Greece	5	0	5
	Hungary	69.5	52	17.5
	Ireland	70	49	21
	Italy	11	1	10
	Netherlands	99	94.5	4.5
	Norway	74	49	25
	Poland	54	34	20
	Portugal	51.4	36.2	15.1
	Romania	63.4	58	5.4
	Russia	10.1	9.7	.4
	Spain	24	4	20
	Sweden	80	63	17
	Switzerland	99	84	15
	Turkey	13.2	6.2	7
	United Kingdom	39.6	14.5	25.2
Latin America	Argentina	55.2	52	3.2
	Brazil	12.8	8.6	4.2
	Chile	28.4	26	2.4
	Colombia	3.8	2.9	1
	Mexico	18.2	13.7	4.5
	Venezuela	25.5	20	5.5
Middle East/Africa	Israel	84	79	5
	South Africa	15		
North America	Canada	91	66	25
	United States	86.3	72	14.3

Source: WorldScreen.com

Table 7.2

Top 10 Cable MSO as of September 2007

MSO	Subscribers
Comcast Cable Communications	24,156,000
Time Warner Cable	13,308,000
Cox Communications	5,414,000
Charter Communications	5,347,800
Cablevision Systems	3,122,000
Bright House Networks LLC	2,239,400
Mediacom LLC	1,331,000
Suddenlink Communications	1,129,000
Insight Communications	722,000
CableOne	701,900

Source: NCTA (2008)

Discovery and TNT are the U.S. cable channels with the greatest number of subscribers, counting an estimated 98 million subscribers each. ESPN is next with 97.8 million subscribers, closely followed by CNN, USA, Lifetime, Nickelodeon, TBS, The Weather Channel, and The Learning Channel (NCTA, 2008).

U.S. DBS

As of the end of 2007, DISH Network had 13.78 million subscribers in the United States (Moss, 2008b.). DirecTV had 16.58 million subscribers as of September 30, 2007 (Moss, 2007). DirecTV reported strong growth especially in subscriptions to HD service. Both services offer programming and service packages that start at \$29.99 per month and go up depending on the number of channels, HD programming, premium channels, special sports packages, and DVR services you want.

U.S. Pay Television Services

HBO and Cinemax have the most premium channel subscribers with a total of 40 million in the United States. HBO on Demand is the leading SVOD service (Time Warner, n.d.). Starz is second with 16.1 million subscribers. Starz differentiates itself from HBO and Showtime by focusing on movies rather than original series (Umstead, 2007a). Showtime is in third place with 15 million subscribers (Becker, 2007), and is now aggressively pursuing HBO's core audience with original programming such as *Weeds* and *The Tudors* and making their content available online to non-subscribers.

PPV had done surprisingly well lately with events, particularly sports, but not with movies. PPV boxing events earned HBO about \$200 million in 2007. Mixed martial arts (MMA) events continue to be popular, and UFC (Ultimate Fighting Championship) earned \$200 million in 2006. Finally, professional wrestling continues to earn solid income, with \$160 million in revenues worldwide for the first nine months of 2007 (Umstead, 2007b).

VOD keeps growing in popularity. A Horowitz Associates survey found that 30% of 18 to 34 year olds and 28.7% of 35 to 49 years olds watch free VOD at least once a week (Winslow, 2007). VOD revenue is expected to top \$10 billion worldwide by 2012, with North America and Europe accounting for 83%. A report by Informa Telecoms & Media forecasts that 909 million homes worldwide will have access to VOD or near-VOD by 2012. VOD revenues in 2007 totaled \$4.8 billion worldwide, with North America accounting for 56% (Schreiber, 2008).

Factors to Watch

Multichannel television services are going to grow. Changes will most likely occur in the way people get their services. Other things to look for include the fallout of the digital television transition and the changes that will happen under the new administration in 2009, when Chairman Martin's tenure at the FCC ends.

Digital television transition. What will happen once the analog signal is cut off? Cable and satellite customers are being told that they will not even notice a change in their service. This depends on the result of the lawsuit brought about by the dual carriage ruling. Also, DISH and DirecTV have only been slowly meeting with local broadcasters to prepare for the switch. Will subscribers in smaller markets have to wait for carriage of their local HD channels? Will the FCC require carriage like cable?

Broadband distribution. Increasingly we have choices in how we get our television programming. Not only can people use cable and DBS as discussed in this chapter, but also the Internet and mobile devices. These services are discussed in more detail in Chapters 8 and 9. The most formidable new competitors are likely to be telephone companies that have developed a complete package of services using IP delivery. These include Verizon's FiOS service and AT&T's U-verse, both of which are discussed in Chapter 8. Look for cable programming providers and multichannel television providers to use the combination of the Internet and television delivery to create new types of content and interactive services (discussed in detail in Chapter 9).

Changes in the FCC. FCC Chair Kevin Martin has been critical of the cable industry since taking the reins of the commission. If the FCC comes under new leadership, look for changes in cable regulation. Indecency and obscenity regulation may be pushed more aggressively.

DirecTV and DISH Network merger. These two companies attempted to merge without success in 2002. The regulatory environment might now favor the merger, especially since the Justice Department approved the merger of satellite radio companies XM Radio and Sirius Satellite Radio. While the FCC has not made a decision on the radio merger as of May 2008, the Justice Department agreed with the companies' reasoning that their main competition was not each other, but rather the other audio services available to the consumer. This same argument could be made for satellite television. They could argue that consumers have much more choice in multichannel television programming with cable, satellite, IPTV, and online video.

Cross-platform multichannel television services. Multichannel television service subscribers and television viewers in general have shown that they like to control their media. They timeshift with DVRs and video-cassette recorders, and they watch content on computer screens, television screens, and mobile device screens. Look for all of the major multichannel television services to offer cross platform access to their content. As a Comcast customer, for example, subscribers may not be limited to watching television at home on the television, but may also be able to access that content on laptops, desktop computers, and cell phones.

Multichannel television services are bringing the consumer more choice. Sometimes, that choice can be overwhelming. Most people only watch a few of the channels available to them, but people still want a wide variety of choices. Digital technologies are enabling multichannel television providers to offer more programming choice and more control over that programming every day. New delivery options including broadband Internet and mobile networks are creating even more competition in the multichannel television service market. This competition is good for the customer, and it will be exciting to see the new choices and services the future will bring.

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IPTV: Streaming Media

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A little over a decade ago, the term “streaming” was coined to describe moving audio and video files across the Internet and playing them back on a computer. The arguments then were whether you should use Real, Windows, or some other brand-name player. Now, that kind of discussion seems quaint and even romantic, harkening back to the days when the information superhighway was fresh, new, and unexplored. More important, much (if not all) of the content was free.

Streaming has changed, just as the economics of the Internet have changed. We have now entered the new commercial world where Internet video and television have merged to give us IPTV—Internet protocol television—that delivers content to televisions as well as computers.

Broadly speaking, IPTV stands for Internet protocol television and refers to television that is delivered using Internet protocol over a broadband network (Open IPTV Forum, 2007, p. 5). Internet protocol, of course, is the ubiquitous “IP address” assigned to every computer/online device. The advantages of IPTV over traditional broadcast TV is that it can provide a more personalized and interactive environment. The types of services are only limited by the imagination. All forms of content can be provided on demand. IPTV operators often refer to “triple play” services that combine high-speed Internet access, TV service, and telephony services over a broadband connection, and “quadruple play” that adds a mobile wireless service to the bundle (Open IPTV Forum, 2007, p. 6).

It is more complicated than it seems because all the services and content involving video, the PC, and the television use the term “IPTV.” So, depending on who you read or talk with, IPTV can involve streaming (or not), satellite delivery of audio and video (or not), wireline delivery of audio and video (or not), and wireless delivery of audio and video (or not). IPTV can also involve only television (or not) or the computer (or not). It is difficult to find marketing material that does *not* use the term.

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Regardless of what it is, there is a vicious battle going on for the so-called “triple play”—involving television, broadband Internet, and voice telephony—to bring an array of digital services into the home. There is a lot of money at stake as the nation and the world increasingly look for video on demand. Whether it is through a dish or fiber optic cable, a myriad of companies all claim to provide it through IPTV. In the United States, satellite companies such as DirecTV and DISH, cable companies such as Comcast, and telcos such as AT&T are all initiating rollouts and distributing information as to why they are so much better than all the others. What is a customer to do? They want their MTV, and this new round of “TV wars” seems to be all about delivery and distribution. This chapter hopes to sort out the good, the bad, and the ugly side of IPTV.

Background

Back in 1995, Progressive Networks launched RealAudio, and a new distribution platform was born. Throughout the 1990s, streaming audio and video became an interesting add-on to computers (along with gaming, e-mail, word processing, and simple surfing). After a brief partnership with Progressive Networks, Microsoft launched Windows Media Player, and not long after that, Apple launched Quicktime, an MPEG-based architecture/codec. In 1999, Apple introduced QuickTime TV, using Akamai Technologies’ streaming media delivery service. A few years later came Flash, DIVX, MPEG players, and others. As the technology improved and bandwidth increased, new applications sprang up. Sports highlights, news, and music clips became increasingly popular. Napster made (illegal) file-sharing a household phrase, and YouTube heralded the beginning of a new age, redefining forever what media professionals and audiences considered to be “content.”

Types of Streaming

The most common distinctions on streaming are “live” versus “on demand,” and “true streaming” versus “progressive download.” Among media companies and professional business applications, on-demand streamed video content is more common than live streamed content (delivering live video via videoconferencing and webcams constitutes a different type of technology; see Chapter 22). To offer on-demand streaming, you must use a streaming server with enough capacity to hold your content that can be configured to enable a sufficient number of simultaneous users (unlike broadcasting, the number of simultaneous users is limited to server capacity). To do professional *live* streaming, you need all of the above and the addition of a dedicated computer (called a “broadcaster” or “encoder”) to create the streams from the live inputs (such as a microphone or camera) by digitizing, compressing, and sending out the content to the streaming server as an RTP (real-time transport protocol) stream. Most of the commercial Web video services offer content that is on-demand.

From the perspective of the consumer, true streaming occurs when the content takes a few seconds to buffer before playing, while a progressive download actually stores the file on your hard drive before playback. True streaming demands that the provider employ a special streaming server (such as Real’s Helix server, Apple’s Xserve, Microsoft’s Silverlight Streaming, or Adobe’s Flash Media Rights Management Server). The streaming server uses the appropriate protocols (such as RTSP [real-time streaming protocol] and RTP) so that the content simply plays and is not stored. This method differs from what is called “progressive streaming” that uses a regular HTTP Web server. Since video files are still quite large, progressive download is normally not the first choice for users. However, it is the easiest way around firewalls.

The main advantages of true streaming are speed, (host) control, and flexibility. Streamed material is played back quickly—almost instantaneously. Control is maximized for the host, because the original content remains on the server, and access can be controlled using password, digital rights management (DRM), registration, or some other security feature. Finally, since streamed segments are placed individually on a host server and can be updated or changed as needed, there is tremendous flexibility. The major advantages for progressive download are that playback quality may be higher (because the media file is downloaded onto the user's computer) and the user has a digital copy of the material (user control).

Streaming Platforms

A player is needed to play streamed material, and there are several established platforms for providing and playing streaming video. For a decade, the general streaming players were from Real, Windows, and Apple. The ubiquitous Flash plug-in used by YouTube is technically a browser plug-in, not a streaming player, because consumers cannot operate the player independently of the browser, save and manipulate files, or create playlists.

According to Weboptimization.com, the four most widely adopted players are Windows Media Player (Microsoft), Real (RealNetworks), QuickTime (Apple), and iTunes (Apple). Each has some technical differences, each has its merits, and all are regularly upgraded. Table 8.1 shows the number of unique users of the popular streaming players from 2003 to 2008. While Windows media player continues to be the most popular player, the growth in iTunes users has been nothing short of phenomenal.

Table 8.1.

Streaming Media Player Growth (in Thousands)

Month	iTunes	Apple QuickTime	RealPlayer	Windows Media Player
Dec-03	669	13,627	28,652	49,023
Dec-04	4,735	12,720	28,808	60,292
Dec-05	17,905	13,638	30,313	72,409
Dec-06	28,134	13,987	33,408	75,923
Dec-07	35,664	12,787	27,565	75,865

Source: Nielsen Online

RealNetworks/RealPlayerII. The early dominance of RealNetworks has been attributed to it having been the first on the scene and having the foresight to give away players rather than sell them. Since 1995, several generations of improvements have been made in its products. The overall pricing structure for Real services has remained stable, and the basic player is a free download (new models with tech support are offered for a price).

For those wishing to deliver video and audio, Real offers a wide variety of servers and other products, as streaming applications/needs expand. Real has allowed developers a free “starter” streaming server capable of allowing 25 concurrent Internet viewers. In 2008, RealNetworks offered RealProducer and the Helix Mobile Producer for encoding content.

In recent years, Real has diversified to offer content such as music, movies, and gaming services. For example, in February 2008, Real announced a partnership with Beliefnet, the leading online community for spirituality and inspiration to provide over 500 downloadable “family friendly and safe” games and puzzles (Real.com, 2008a).

Microsoft/Silverlight (formerly Windows Media Player). Shortly after RealNetworks began streaming audio, Microsoft became interested and, for a time in the late 1990s, the two enjoyed a technology-sharing relationship. After the partnership dissolved, Windows Media Player was offered as a free plug-in to users. Since then, improved versions of Windows Media Player have been regularly released, and WMP is by far the most-installed player in the world (see Table 8.1). The most recent version has been the much-ballyhooed Silverlight player, advertised as a cross-platform multi-purpose player.

Because streaming is just one of the many things Microsoft does, it is easy for it to get lost in the vast array of products and services. There is no extra cost for the streaming server because it is just one part of the larger whole. As you buy into the full range of services Microsoft provides, costs begin to accumulate. Once you have purchased a package, you can efficiently control content and Web transactions, including pay-per-view (e.g., pay-per-download or pay-per-stream), registration, subscription, and digital rights management.

Apple/QuickTime/iTunes. In 1999, Apple began offering a streaming application with the QuickTime 4 platform. QuickTime has been popular because it plays on both PC and Macintosh computers and delivers virtually any kind of file from your Web server. The QuickTime file format is an open standard and was adopted as part of the MPEG family of standards. Apple has a few types of servers (such as Xserve and Mac OSX server). To produce live events, Apple provides QuickTime Broadcaster. Most recently, Apple has been marketing and providing content and services to take advantage of the combined applications of iPhone, iTunes, iPod, and Apple TV.

Adobe/Adobe Media Player/Flash. In December 2005, Adobe acquired Macromedia and has since enjoyed great success with the Flash platform. In May 2008, Adobe announced the Open Screen Project. Supported by companies such as Cisco, Intel, Marvell, Motorola, Nokia, Samsung, Sony Ericsson, Toshiba, and Verizon Wireless, the project seeks to provide “rich Internet experiences across televisions, personal computers, mobile devices, and consumer electronics” (Adobe, 2008). Content providers such as BBC, MTV Networks, and NBC Universal are also involved. The Open Screen project employs the Adobe Flash Player (and in the future, Adobe AIR) to allow developers and designers to publish content and applications across desktops.

Proprietary Platforms

The streaming platforms mentioned above are qualitatively different from the other direction of the so-called “traditional media” companies. As we are witnessing in the convergence of computers, television, and digital applications, traditional content providers also seek to find their place in the new media environment. To stay relevant (and profitable), the race is on for distribution, what cable companies used to call “the last mile.” Now it is about *the* connection and what companies will be able to use IPTV to supply all a person's information, entertainment, and communication needs. Information now means not only news, but also banking, security, weather, and politics. Entertainment includes a variety of live and recorded experiences involving music, sports, and dramatic, comedic, and theatrical performances. Communication through technology can now involve all one-way or two-way interactions with family, friends, classmates, colleagues, and strangers.

The fight for who is chosen to deliver the triple-play is ongoing between telephone companies, cable companies, and satellite companies. Fresh from a decade of dominance (having surpassed traditional TV networks as the primary means of bringing information into the home), cable companies remain number one. Telephone companies are pushing more advanced technology to provide services that cable cannot provide as of mid-2008. As of spring 2008, telephone company Verizon made the biggest headlines with its FiOS digital TV service, using a high-capacity, fiber optic network. FiOS set the bar high by offering up to 50 Mb/s downstream (Spangler, 2008a) and 20 Mb/s upstream connectivity (Henson & Marchand, 2007).

Two basic and distinct forms of IPTV have emerged (Light & Lancefield, 2007). One is centered around distribution via the PC (Web television) and the other one through a set-top box (STB). The term “streaming” is still used to describe the former, while those who market the latter use a closed network broadband connection (commonly advertised as IPTV). Bringing video through an STB harkens to traditional pay-TV models while video to the PC uses a vastly different approach. Compare Verizon’s FiOS with YouTube in terms of content and cost.

Podcasting

A relative of video streaming, podcasting, remains an important aspect of IPTV. Podcasting refers to producing various types of online audio and video on demand programs (Webster, 2007). Podcasts are common on the Web, and are typically programs such as a talk show, hosted music program, or commentary. They are commonly pulled by the user as an automatic download via RSS (really simple syndication) through a service such as iTunes. According to Edison Media Research, overall numbers of people listening to audio podcasts increased from 11% to 13% of Americans 12 years old or older from 2006 to 2007 (Webster, 2007). The most popular types of podcasts were about technology news/commentary, national news, and local news/public affairs. Sports and music news followed. While IPTV use and adoption is spreading rapidly, podcasting, by comparison, appears to be settling into a rather small, specialized niche (for more on podcasting, see Chapter 15).

IPTV via STB

Gartner (2008) defines IPTV as “the delivery of video programming (either broadcast or on-demand) over a carrier’s managed broadband network to a customer’s TV set. It does not include streaming media over the Internet to a PC” (p. 5). According to Gartner, the importance of IPTV is that it is not a single service; it is a new carrier distribution platform over which several communication and entertainment services can be offered.

Many believe that, for now, the appeal of IPTV is more about the TV than the IP (Reedy, 2008). Since most television watching is still relatively passive, it is the viewer experience that matters most. Added services sound good to consumers, but there is enough confusion and fear associated with surveillance and security (home, video, and banking). While it is important to bundle myriad services, the foot in the door is still the TV experience. Most customers do not care whether the provider is a telephone, cable, or satellite company, and, at present, bundling HD content may still be the best means of differentiating services (Reedy, 2008).

For example, AT&T is introducing a new tier for U-verse customers that will provide up to 10 Mb/s downstream and up to 1.5 Mb/s upstream over digital subscriber lines (Spangler, 2008a). The AT&T Yahoo high-speed Internet max service will be available for \$55/month when bundled with U-verse TV. A number of cable providers advertise peak download speeds of up to 30 Mb/s.

A variety of added services help make the STB-IPTV attractive. In particular, Reedy (2008) noted that AT&T's U-verse offered the following:

- ♦ The "U-bar" which offers customizable on-screen stock quotes, sports highlights, and local traffic and weather information.
- ♦ Whole-home DVR (digital video recorder) service, allowing set-top boxes to access video content from a DVR STB in another room.
- ♦ Photo sharing on a TV through Flickr or another embedded middleware application.
- ♦ Voice over IP service enabling viewers to access call histories on their TVs.
- ♦ The capability to display, screen, and forward calls.
- ♦ Enabling "do not disturb" and international call-blocking options.
- ♦ Purchasing movies online from Amazon.
- ♦ Eventually, there will be a Webcam feature that will let viewers in different locations watch live events via switched digital video.

IPTV via P2P

While cable, telephony, and satellite are working to deliver the highest quality (and most expensive) programs and services into the home, the "other" delivery form of IPTV is also making inroads. So-called "P2P" or peer-to-peer networking became famous through Napster and associated with illegal file-sharing, so some prefer to call it "distributed streaming media" (Miller, 2007, p. 34). Either way, P2P is far cheaper than the STB approach. Some believe that delivery of high-definition video may need to use P2P in order to be cost-effective.

Well-known providers of content via P2P include BitTorrent and Azureus, and content owners such as Fox, Viacom, and Turner use P2P to publish and distribute content. The basic concept is that P2P moves digital content through several paths before reaching the user's (destination) computer. While STB systems need to purchase several servers to dedicate bandwidth and deliver programs, P2P becomes more efficient (and cheaper) as more clients join the distributed network. This is because the content can be drawn in pieces from multiple sources. This type of network tends to be less concerned with copyright and more about sharing popular files. Obscure or less common content will take longer to pull together because there will be fewer sources to draw from. As of early 2008, BitTorrent had 130 million clients to send content to users (Miller, 2008).

The result is that an examination of the 25 most popular BitTorrent sites in March 2008 found that 21 improved noticeably in a listing of the most popular Internet sites. Web sites such as mininova.org (#53), ThePirateBay.org (#130), isohunt.com (#147), and Torrentz.com (#192) were also listed in the top 200 by the Web information company, Alexa (Torrentfreak, 2008).

One of the factors influencing the STB-P2P debate is digital rights management. Controlling access to the content is a key element for STB providers, and they argue it is the only/best way to maintain appropriate (monetized) use. P2P providers such as BitTorrent and Abacast suggest that a more passive approach to DRM will win the heart and wallet of the consumer. In other words, they suggest marking the file so everyone knows where it came from, but then let it go (Miller, 2008)

Recent Developments

Interoperable Players

For a decade, there was a struggle among Real, Microsoft, Apple, Adobe, and others to try to be the primary viewing platform for online video. In those early days, compatibility was a factor, and consumers needed to install all the players. All of these platforms have since upped the ante by expanding the types and formats of video content to be played. In April 2007, Microsoft introduced Silverlight as a cross-platform/ cross-browser media and application delivery plug-in. At the same time, Adobe announced its Adobe Media Player would provide DRM features for the first time. Both launches were marked by an impressive array of content publishers who agreed to collaborate and use the respective platform. Adobe Media Player said it was working with companies such as blip.tv, Brightcove, Feedburner, Maven Networks, Motionbox, and thePlatform; Silverlight would play content from providers such as Brightcove, CBS, Major League Baseball, and Netflix (Schumacher-Rasmussen, 2007). In April 2008, Real announced its new RealPlayer for MIDs (mobile Internet devices) would also be able to decode and play most of the standard media formats (Real.com, 2008). Now, it seems the long-expressed goal of interoperability has been pretty much achieved. Each company is finding other ways to differentiate themselves and find their own niches.

Cable Versus Telcos

In January 2008, Verizon's FiOS TV passed one million subscribers (Spangler, 2008b). Some analysts said the growth was less than expected, even though they were adding more than 90,000 new subscribers every month. Meanwhile, AT&T U-verse service was up to more than 230,000 subscribers by the end of 2007 and was on track to reach one million by the end of 2008 (Spangler, 2008s). The telco said its U-verse TV service was being installed in approximately 12,000 homes per week. Following its merger with BellSouth, AT&T announced it would rollout U-verse throughout the southeast.

STB-IPTV Joins with P2P-IPTV

In March 2008, Comcast cable was investigated for interfering with and hampering online file-sharing of subscribers. Comcast announced it would treat all types of Internet traffic equally, a practice known as "net neutrality" (discussed further in Chapter 18). An Associated Press investigation in October 2007 revealed that Comcast was undermining net neutrality in its practices. Comcast was secretly blocking some connections between file-sharing computers, and they were accused of stifling delivery of Internet video, an emerging competitor to the cable company's core business. The investigation indicated that Comcast had been hampering the BitTorrent file-sharing protocol that, together with the eDonkey protocol, accounts for about one-third of all Internet traffic according to Arbor Networks (CNN, 2008). Most of the file sharing was illegal sharing of copyright protected files, but file-sharing has also emerged as a low-cost way of distributing legal content—especially video.

Afterward, Comcast began working with BitTorrent to come up with a way to transport large files over the Internet. BitTorrent also acknowledged that managing content could become an issue during peak usage times.

In mid-March 2008, Verizon announced that a successful collaboration with Pando Networks enabled them to speed up file-sharing downloads for its subscribers while, at the same time, reducing network strain. AT&T is also looking into similar collaborations.

According to a report by CNN (2008), Time Warner is experimenting with managing traffic by placing caps on monthly downloads for new customers in Beaumont (Texas). According to CNN, “subscribers who go over their allotment will pay extra, much like a cell phone subscriber who uses too many minutes in a month.”

Universities Produce Content

Many schools are developing digital media strategies. For example, students at Stanford get podcasts from the university on their iPods (Riismandel, 2007). Some may be concerned that students would have to purchase an iPod, but podcasts can play on a variety of devices, including digital media players and personal computers. Platform-specific content will become less of an issue over time. As Riismandel (2008) notes, “from professors’ podcasts to students’ video assignments and video press releases from communications officers, there is plenty of media out there” (p. 42).

Current Status

To read the market surveys, it is fast becoming an IPTV world. In contrast to podcasts, online video is rapidly becoming more popular. In 2007, research indicated 57% of Internet users have watched videos online, and most of them share what they find with others (Madden, 2007). Young adults are especially avid online video viewers—roughly three-out-of-four watch on a typical day.

Globally, IPTV—providing video services over managed IP networks to consumers’ televisions—has been doubling each year since its commercial introduction in 2002 (Casey, 2008). In 2007, the number of Internet TV subscribers more than doubled to somewhere between 10 million and 13 million (Prodhan & Elliott, 2008; Casey, 2008; Spangler, 2008c). France, Italy, and Hong Kong are notable markets where IPTV has been widely adopted. China has about one million IPTV subscribers, and Hong Kong reports more than 60% of DSL (digital subscriber line) broadband customers subscribing to TV over the Web according to Informa Telecoms & Media (Prodhan & Elliott, 2008). The United States also added more than one million IPTV subscribers in 2007, thanks to rollouts by Verizon and AT&T (Prodhan & Elliott, 2008).

The type of content people watch online continues to grow, and new content categories emerge (see Table 8.2). News is still the top category, but comedy has grown to a solid number two. Clips from movies and TV shows, music, and educational content round out the highest-viewed categories.

Another feature of online viewing is the social networking aspect. According to the same Pew study, two-thirds of younger adults (ages 18 to 29) send links of online videos to their friends. Older viewers also do this, but the percentage drops to 50%. In addition, when they watch, they watch with others.

Table 8.2

Video: What They're Watching

Content Type	Yesterday	Ever
News	10%	37%
Comedy	7%	31%
Movies or TV	3%	16%
Music	4%	22%
Sports	3%	14%
Commercials	2%	13%
Political	2%	15%
Animation	3%	19%
Educational	3%	22%
Adult	1%	6%
Other	2%	6%
Yes to any of the above	19%	57%

Source: Madden (2007)

A final intriguing aspect of viewing online relates to the quality of the production itself. The research by Pew found that most online video viewers preferred professionally produced programs except for one particular group. A substantial proportion—34%—of young adult men (ages 18 to 29) indicated they preferred “amateur content” to professionally produced content. This group—highly sought by advertisers—was larger than any other age or gender group (Madden, 2007, p. 9).

Content Online

Full-length movies and TV shows are consistently among the most viewed content on the major video sharing sites (Madden, 2007). One in six Internet users (16%) say they watch or download this type of content. Whether this entails watching excerpts or the entire episode is not known. Many movies and television shows are also widely available on peer-to-peer networks and BitTorrent sites. Pew researchers estimate that video files account for 10% of file-sharing activity on peer-to-peer networks.

For example, major television networks now provide more full-length episodes of primetime television shows for free online. ABC's *Lost* and *Desperate Housewives* were among the first free offerings, and many other shows from all the networks soon followed (Madden, 2007). There are a number of ways to find and watch favorite programs online. As seen in Table 8.3, the most popular source by far is still YouTube.

But there are countless other video Web sites including FreeTVOnline and Veoh. Professional or amateur, long-form or clips, high-definition or low-grade and grainy—consumers can find what they want, the way they want it. Veoh, for example, provides several channels and programs but few network shows. Another video online site, FreeTVOnline, does not actually host programs on its servers, but instead simply mirrors freely and publicly available video links from other sites.

Table 8.3

Top 10 Online Video Sources (Thousands)

Brand	Total Streams	Unique Viewers
YouTube	2,570,182	66,167
Fox Interactive Network	376,859	18,955
Yahoo!	299,044	22,119
Nickleodeon	172,567	7,014
MSN/Windows Live	132,769	7,659
Disney Online	102,914	8,977
Turner Entertainment	98,162	5,056
ESPN	90,212	4,709
Google	79,395	12,949
Veoh	72,832	2,385

Source: Nielsen Online (2008)

One of the earliest online TV distribution platforms is Joost. Launched in early 2006 by founders Janus Friis and Niklas Zennström, Joost proclaims itself the first online, global TV distribution platform. Joost strives to create an interactive environment and viewing community. Offering hundreds of channels and thousands of programs, Joost offers content from every genre (comedy, action, drama) across several countries. In November 2007, Coca-Cola announced they created a commercial widget to allow Joost users to comment on specific scenes with their friends. Joost strives to make the service as interactive as possible in order to build community (Joost, 2008).

Another noteworthy online TV site is called Hulu, which is an online video joint venture between NBC Universal and News Corporation that was launched in March 2007. Hulu is free (ad-supported) with selections from more than 50 content providers including NBC, Fox, MGM, Sony Pictures Television, Warner Brothers, and Lionsgate. The site offers both clips and full-length features. Some network TV shows are offered the day after being broadcast (*The Simpsons*, *The Office*). The site also offers older "classics" such as *Miami Vice* and *Buffy the Vampire Slayer*. Hulu is headquartered in Los Angeles.

IPTV Audiences

The trend with consuming video content online correlates nearly perfectly with age—but it is a negative correlation. Right now, the largest audience group for online movies and television content is young adults. According to research by Pew, nearly one-third of users ages 18 to 29 watch or download movies and TV shows, while half as many among those ages 30 to 49 do so (30% versus 16%). That figure continues to drop with age, and just 7% of users age 50 and older say they get movies online (Madden, 2007).

Movie viewing is not only popular with young adults. There are significant numbers of children who also watch online. According to Nielsen Online, children are at ease with viewing videos online and have their own favorite sites as well (see Table 8.4).

Table 8.4

Top 10 Video Sites Visited by Kids Ages 2 to 11

Brand/Channel	% of Streams Watched by Viewers Ages 2-11	Total Streams (thousands)	Unique Viewers (thousands)
Barbie	51.47	666	219
EverythingGirl.com	47.94	1,151	504
Hit Entertainment Network	47.4	1,027	108
MyePets	47.22	497	300
AOL KOL	47.05	245	107
JETIX	46.47	835	163
LEGO	42.9	3,270	306
DisneyChannel.com	37.12	20,945	1,910
Nick	35.13	32,382	1,571
Nick Jr.	34.64	19,278	889

Source: Nielsen Online (2008)

Factors to Watch

File sizes of films. Video file sizes have always been extremely large, but engineers have been hard at work to reduce file size, and this is not the barrier it once was. Originally, content providers were compressing video files for dial-up (56K) lines. Many still remember small windows, low resolution, and constant re-buffering from these dial-up connections.

The stream of content is now a river, and files are still getting smaller even as bandwidth continues to expand. Each of the most popular streaming platforms (Real, Adobe, Microsoft, and Apple) offers HD video clips on their Web sites. In general, broadband users need at least 6 Mb/s to 10 Mb/s service in order to enjoy HD video (Gubbins, 2008). Both Verizon and AT&T's fiber-based services are sufficient to provide full-length films in HD as are a number of cable broadband services. Broadcasters in Europe are also experimenting with transporting HD video over a single 3 Gb/s fiber link (Network Electronics demonstrates, 2008 April 29). ABC.com has been offering streams of selected shows like *Lost* and *Ugly Betty* in HD since 2007.

Trans Border Content Flow

Globally, it is less a question of whether HD can be delivered than what the regulatory restrictions are. Since the Web is global, we are fast approaching a time when European or Asian content providers can compete with domestic companies for market share. In the United States, there are a number of ways for consumers to purchase services from content providers in other countries. The current does not always run both ways, and protectionism manifests itself in many forms.

IPTV Projected Number of Users

Projections for the future vary, but all are upbeat about IPTV. According to Spangler (2008c), IMS research projects hybrid IP STBs (combining IP features with traditional TV delivery technologies) to grow from five million in 2006 to 39 million by 2012. Gartner (2008) predicts that, by 2010, there will be around 48.8 million U.S. households subscribing to IPTV, while the Open IPTV Forum predicts 55 million that year (Open IPTV, 2007). Another research group (TMG) predicts 60 million by 2010 (Casey, 2008), while IMS predicts that, by 2012, there will be roughly 65 million U.S. households subscribing to IPTV (Spangler, 2008c).

The rosiest forecast of all comes from Technology Marketing Corporation, which predicts the numbers will balloon to 489 million IPTV subscribers worldwide by 2016 (Viscusi, 2007). The combination of telco and cable operators offering IPTV services is said to be unstoppable because of the flexibility that IPTV enables.

Regions of Growth

In terms of region, North America is predicted to be the largest growth market over the next five years (Gartner, 2008). This is attributed to the major players all launching new TV services. Leading the way are Verizon's FiOS and AT&T's U-verse TV services, which are being aggressively marketed in selected markets across the United States.

According to Telecommunications Management Group (TMG), at the end of 2007, France Telecom was the largest IPTV operator in the world, followed by Verizon in the United States. TMG rated Hong Kong's PCCW as the most successful operator, with over 50% of its broadband subscribers using its "now" broadband TV service (Casey, 2008). IPTV is not limited to high-income economies. China and India have launched IPTV, as have several countries in Africa. TMG forecasts that China and the United States will be the world's largest IPTV markets by 2010 (Casey, 2008).

Consumer-Generated Content

The joker in the deck regarding IPTV is the effect or influence of consumer-generated content. YouTube has changed the video landscape forever. From now on, Viacom and the BBC must compete with piano playing pets and dancing ninjas for audience share. Human beings are resourceful, and we have not exhausted the possible genres or types of video content. How new forms of expression and creativity will influence future generations cannot be known, but media companies and providers of "professional" (paid-for) content will remain vigilant to adopt "the next big thing" in entertainment, information, or communication.

IPTV reflects the cacophony of the digital marketplace. With hundreds of channels, thousands of programs, and millions of clips and excerpts, it is easier than ever for individuals to create their own unique and personal media experiences.

From the user's perspective, the search is on for the "most perfect" IPTV-computer-television-Internet experience. According to Ezra Davidson, the Holy Grail of IPTV is "HDTV that connects to the Internet and services all DVRs" (2008, p. 86). There are a variety of products approaching this standard (Panasonic's Viera TV, Sony's Bravia, HP's MediaSmart TVs), and consumers should find something available either in 2008 or 2009. This may sound like "video paradise" to the consumer, but it is limited to the home environment. Video providers are planning for ways to offer even more to the consumer.

The next stage is undoubtedly mobile broadband high-definition video. No one really knows when or how it will pay for itself. Consumers may find it too inconvenient on a crowded bus or a noisy bar to warrant the cost. Or they may find it too dangerous in wind, rain, or snow to even sample the experience.

When the time is right, we will be able to watch whatever we want, wherever we want, whenever we want. And when we can find more than 24 hours worth of our “video fantasy come true,” life will only be the spare moments we allow to happen between watching and being entertained.

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Interactive Television

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Television as an idea and experience is facing obsolescence due to the proliferation of mobile and personal media delivery platforms. Replacing TV is a plethora of programming available either on-demand or at a scheduled time, allowing the viewer to interact with it by requesting more information, making a purchase, expressing an opinion, or contributing other content. The types of response permitted will vary depending on the input device: available inputs on a cell phone will likely be different than those available on a large-screen home theater system complete with elaborate remotes and keyboards. Interactive inputs include handsets, touch screens, keyboards, mice, gesture recognition, and other feedback technologies. Nearly every news day reveals an innovative, new input option, as well as a new usage envisioned for interactive media. One can imagine interactive television (ITV) as a continuum where any content delivered “on demand” constitutes one end of the spectrum, and runs all the way through applications that allow the viewer to fully shape the content to be delivered, as in interactive storytelling. Shopping applications, where the user responds to embedded tags or content to permit browsing and purchasing, falls somewhere in the middle of this continuum.

Interactive television is a term used to describe the “convergence of television with digital media technologies such as computers, personal video recorders, game consoles, and mobile devices, enabling user interactivity. Increasingly, viewers are moving away from a ‘lean back’ model of viewing to a more active, ‘lean forward’ one” (Lu, 2005.). Interactive television is increasingly dependent on an Internet delivery system for advanced digital services (and in this case, also referred to as Internet protocol TV or IPTV). Another frequently used technical definition of a delivery system describes the process as slicing a signal into packets, “sending the packets out over a secure network...” and reassembling them at the endpoint (Pyle, 2007). This process, discussed in the previous chapter, sounds similar to what is used to send e-mail across the network, but requires a highly layered and complex architecture to achieve it.

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The potential of ITV has long been discussed and continues to enjoy its share of hyperbole: "It will seem strange someday that I cannot chat with a friend on a show we're both watching..." or "that I can't get to my sports team with a few clicks of a button to see how the game is going currently" (Reedy, 2008). Current-day uses are more prosaic: Users of video delivered over mobile handsets observed in an eight-week study in Göttingen (Germany) reportedly viewed news most often, followed by music videos and weather reports (Hanekop & Shrader, 2007).

"Imagine a television viewing experience so intuitive and interactive that a set-top box recognizes which viewer is watching and adapts to meet his or her entertainment needs" (Reedy, 2008). Many viewers are beginning to understand what video delivered over the Internet might provide, and their imaginations have already broken free of their living rooms. Multi-platform initiatives and mobile ITV have been added to the strategic planning of many key players in the ITV industry (Porges, 2007).

The past few years have been a proving ground in Europe, Asia, and North America in terms of whether or not audiences will accept and demand ITV in the long run, once the novelty effect has worn off, and whether currently-understood ITV business models would be feasible (Porges, 2007; Burrows, 2007; Dickson, 2007; Harris, 1997). Notably, Microsoft shifted its IPTV strategy both in the United States and overseas. In the United States, even small, rural "Tier III" telcos with a few thousand customers are using IP-based networks and advanced MPEG-4 compression to launch ITV services by teaming with satellite service providers and providing a range of services similar to those of much larger players such as AT&T (Dickson, 2007). Some question whether advertising-supported programming in the ITV era can survive. "Unbundled" and "on demand" programming is predicted to bring about the demise of the television business models as we have known them in the United States. Recent proposals have included a call for an "unbundled" advertising market, but these ideas have yet to be tested or accepted.

For nearly 70 years, the notion of "watching television" has emphasized the centrality of the "television set" in the home as an important source of ad-supported news, information, and entertainment. Our ideas of what constitutes an "audience" and how to measure viewership have stuck rather closely to the iconographic status of that centralized, home-based television set. Many of those assumptions have been challenged as multi-set households, out-of-home viewing, and portable video/TV delivery devices have proliferated. Already, programming can be watched anywhere and on a multitude of devices such as PDAs (personal digital assistants), cell phones, iPods, seatback screens on an airplane, or mesmerizing big-screen monitors in home "entertainment centers." It has been widely reported that media delivery is likely to become more portable (untethered from a specific location) and personalized. Portability threatens the ability to adequately measure media exposure, at the same time as it opens new opportunities for targeting. Personalization and customizability are perhaps more of a concern to the media industry because of the propensity for audiences who can customize media delivery to choose to strip out advertising messages and to shift programming out of the carefully constructed "programming schedules" so cherished by network executives.

Television broadcasting is in the latter stages of its transition to digital broadcasting. The move to digital television is taking place at the same time as the number of subscribers to broadband Internet access has reached 66.4 million U.S. households (Macklin, 2008), with broadband available to 91% of the U.S. population (Martin, 2006). Widespread availability of broadband service, coupled with digital program delivery, has long been considered a key condition in promoting interactive television in the United States. It should be noted, however, that U.S. broadband access is still considered to be costlier, less available, and offered at slower speeds than in several Asian countries, especially Japan (Berman, et al., 2006; McChesney & Podesta, 2006). At least in theory, search services and Internet browsing have put audiences in the habit of seeking interactiv-

ity, something the ITV platform can build on (Stump, 2005). Google, for example, may well prove to be a leader in combining its search, profiling, and advertising delivery services to provide highly customized ITV offerings.

Some have said that a “critical mass” of consumer interest to pave the way for ITV in the United States was required, and that stage has now been reached. Examples cited include the observation that popular TV shows such as *American Idol* are explicitly interactive and involve millions of voting viewers (Mahmud, 2008; Loizides, 2005). The number of users of on-demand video has steadily increased since 2004, and experiments by interactive agencies such as Ensequence and the company Visible World have proven that dynamic, addressable advertising is viable (Mahmud, 2008).

It must be noted, however, that despite the forward momentum of interactive content and advertising services, there are still questions about whether personalized content is inherently more appealing or persuasive for viewers than content that is not customized. At least one study that examined this assumption reported “mixed results” and also found that too much choice diminished impact (Varan, 2004). Audience research has not yet definitively proven that we understand either the nature of interactivity or the perceived value of personalization. However, work is being done in developing a conceptual framework for how ITV (and any advertising associated with ITV) might be processed cognitively and emotionally, and how this might differ (if it does) from patterns associated with conventional television viewing or from other forms of video delivery (Bellman, et al., 2005).

Despite this uncertainty, various types of content are under development for the forthcoming two-way digital delivery system, including interactive games, video on demand, and enhancements to programming that provide “t-commerce” (the ability to learn more about products or even purchase a product directly). Some of these enhancements take the form of product placement (that, on mouseover, for example, could be purchased) or even other types of interactive and embedded advertising within programs to encourage longer “dwell-time” in the interactive advertising environment (Lee, 2005).

There are several capabilities that are considered to be critical components of a native ITV application (Reedy, 2008; Damásio & Ferreira, 2004). These include:

- ♦ Multichannel delivery.
- ♦ Time-shifting capabilities.
- ♦ Content personalization (intelligent agent/dynamic delivery).
- ♦ Content enhancements.
- ♦ User interaction (including user-to-user and user-to-content).
- ♦ Content on demand (content alerts, search, and converged services).

There are still a number of other, unpredictable factors. Mike Ramsay, the cofounder of DVR (digital video recorder) and interactive programming guide company TiVo, speculates that connecting the Internet to video delivery could turn the 500-channel cable TV universe into “50 million channels” via Internet protocol television (Levy, 2005). Since programming is likely to be delivered primarily upon demand, there is also the prob-

lem of learning what is available and being able to efficiently select programs. To do so, a wealth of collaborative filtering agents (or bots) and other personalization software tools that go beyond the traditional interactive program guide (IPG, sometimes called the EPG) are likely to be needed by audiences and offered by inventive entrepreneurs. Such tools could study a user's preferences, behaviors (such as what has been watched in the past), and other information to customize a "microchannel" to the user. It is also worth noting that many experts believe that viewers will be more interested in interacting with *content* than with *advertising* in this new ITV environment, which presents a challenge to the traditional model of ad-supported video delivery (Meskauskas, 2005).

Background

The history of interactive television in the United States, to date, has been one of experimentation and, often, commercial failure. Conspicuous investments in various forms of interactive television ranged from the 1977 Qube TV service offered by Warner Amex in Columbus (Ohio), Dallas, and Pittsburgh to Time Warner's much-publicized FSN (Full Service Network) in Orlando in 1994-1997. An earlier, 1960s era effort called "Subscription TV (STV)," which debuted in Los Angeles and San Francisco and offered cultural events, sports, and even an interactive movie channel, fizzled out (Schwalb, 2003). Microsoft joined the fray with its purchase of WebTV in 1997, which, after three years, "topped out at about a million users before descending into marketing oblivion" (Kelly, 2002). Although MSN spent hundreds of millions of dollars to finance speculative programming (such as \$100 million on the Web show *474 Madison*), it did not find an audience to support its programming. Meanwhile, throughout 2006, a small, (then) anonymous crew using a cramped, makeshift room made to look like a teenager's bedroom, and an unknown volunteer actress, posted a series of videos on YouTube under the pseudonym "LonelyGirl15" and drew millions of obsessive viewers who posted streams of commentary, speculation, and blog postings throughout the Internet. Is this non-professional, user-generated content the future of the 500-million channel ITV universe (McNamara, 2006)?

Not surprisingly, the success of ventures such as YouTube, coupled with the apparent willingness of audiences to interact and contribute to these venues, have resulted in considerable investor interest. In 2006, \$266.9 million was invested in online-video related ventures; in 2007, that figure rose to \$460.5 million (Learmonth, 2008).

While ITV efforts in the United States were having difficulty finding audiences in the last decade, European and U.K. ITV initiatives continued to be developed and, in some cases, flourish. As a result, American hardware and content providers have had the rare opportunity to watch and learn from several well-funded ITV applications abroad, such as BSkyB. Interactive commercials are already commonplace in the United Kingdom. In the European ITV model, operators have found that gambling and gaming (not advertising) comprise a large part of their revenue (Shepherd & Vinton, 2005)

Recent Developments

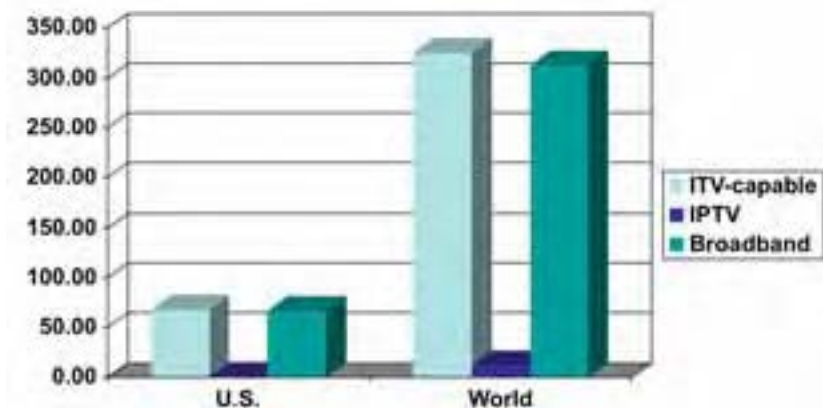
By 2005, EchoStar Communications' DISH Network and DirecTV had already rolled out ITV platforms in the United States, with a combined audience of about 25 million viewers (Morrissey, 2005). A majority of cable TV companies are currently offering video on demand (VOD) services or will in the near future. Microsoft has

made a large commitment to IPTV services, but with a multi-platform strategy involving converged services focusing on the “MediaRoom” environment (Porges, 2007). Bill Gates announced that the next generation of “interactive television services completely blows open any of the limitations that channels used to create” and has abolished the previous video platform in favor of IPTV (InformITV, 2006a). Gates described the forthcoming Microsoft product as providing “interactivity, choice, and personalization.” Microsoft already has agreements to provide IPTV services with major corporations in Europe, Asia, and the United States; companies include Deutsche Telekom, Swisscom, Telecom Italia, BellSouth, Bell Canada, and Reliance Infocomm, among others (Burrows, 2007; Jones, 2008; InformITV, 2006a; InformITV, 2006b)

The research firm eMarketer reported current demand for ITV-capable services to be 77.6 million in the United States in 2007, compared with 325 million users worldwide. Demand is expected to increase by nearly 50% in both cases within five years (Macklin, 2008). Compared with the overall population of available viewers, this certainly represents a slice of the early adopter universe. Kagan Research, more conservatively, believes that as many as 69 million households will be ITV-enabled subscribers by 2009 (Business Wire, 2005, 2006).

Figure 9.1

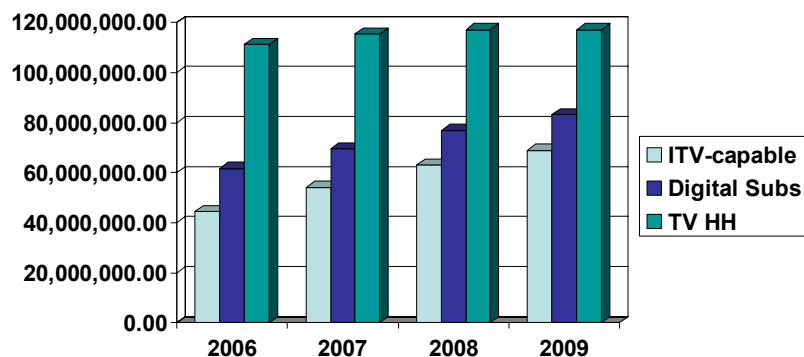
Worldwide Service Availability, 2007 (Millions)



Source: Macklin (2008)

Figure 9.2

ITV Penetration Estimates



Source: Business Wire (2005, 2006)

What could hold up ITV's progress? The technology underlying ITV delivery is complex, and several key problems have yet to be solved, particularly those related to packet processing and security. The transport network supporting Internet services such as voice over IP (VoIP), video, and all the regular Internet traffic is described as "limited" in its ability to provide an adequate "quality of experience" from a user-perspective. Adding the heavy burden of almost unlimited video on demand to this infrastructure is proving worrisome to the engineers developing the means of managing all of these signal streams (Tomar, 2007).

A positive development is the announcement in January 2008 by the International Telecommunications Union of the first set of global standards for IPTV, built with technical contributions from service providers and technology manufacturers as well as other stakeholders. This group has committed to regular ongoing meetings so that these standards will continue to evolve (Standards for Internet Protocol TV, 2008).

Current Status

Media Buying/Planning

Confusion about how to buy or sell advertising on IPTV and ITV is rampant, even years after its introduction. Traditional television networks circulate content proposals to media buyers a year or more in advance, while newer video forms provide little lead time for buyers to make decisions. Viewers claim to be interested in interacting with advertising targeted to their interests: a surprising 66% said they were looking for an opportunity to do so. Apparently, the interest crosses content genres and is not limited to reality shows, at least according to the data released to date (Mahmud, 2008; Krihak, 2006). Agencies and advertisers will need to come to an agreement concerning how to treat the market for ITV product, both during the transitional period and when ITV is fully implemented. There is also concern that consumer-generated content (CGC)—content that individuals provide that include blogs (with/without RSS [really simple syndication]), podcasts, vblogs (blogs with video content), animations, newsletters, content "traces," and other information—will continue to be a rising trend. These media offerings may compete for the same advertiser dollars as affiliated networks, but outside of the traditional media planning framework.

Media Measurement

An upheaval in media measurement practices and accepted standards is currently underway, fueled in part by advertiser demand to better account for new technologies such as DVR, VOD, and portable media devices. Nielsen Media Research continues to adhere to client demand to "follow the video" (Story, 2007; Whiting, 2006). Other media measurement players such as Integrated Media Measurement, Inc. (IMMI) propose using cell phones adapted to measure consumer media exposure by sampling nearby sounds. The sound samples are then compared, and the database matches them to media content. This approach could potentially track exposure to compact discs, DVDs (digital videodiscs), video, movies seen in a theater, and videogames, among other types of media. Clear Channel Communications was also reported to be testing a cell phone-based system offered by Media Audit and Ipsos SA (Clark, 2006). No clear winner in the race to provide satisfactory media measurement has emerged. Other players such as Omniture have entered the field (Omniture, 2008; Dorrell, 2008). Established online ratings providers ComScore and NetRatings will also be positioned to deliver ratings or measurement services to ITV.

However, there will be considerable pressure to produce an acceptable and highly accountable system for measuring media exposure and for determining ad effectiveness in the converged media environment. Some experts believe that the field of Web analytics, already relatively sophisticated after more than 10 years of development, may offer some solutions. In a converged media environment with Internet-delivered content as the primary focus, all exposure from all users could conceivably be tracked, without reliance on panel-based measurement schemes. Data mining models could then be used to profile and extract program and ad exposure information, as well as what audience members then did in response to exposure.

Lessons learned from this kind of data could eventually allow advertisers and content providers to apply powerful behavioral targeting techniques that would further customize media delivery.

Factors to Watch

Business Models

All the content delivery options now in play and expected to be available in the future create a number of questions for new business and revenue models that may support the content infrastructure. In competition for both viewers and advertising dollars will be contenders such as the download services (iTunes, Google, Yahoo), TV networks and producers, Web sites containing video offerings, and specialty programming targeted to devices such as cell phones. There is also the continuing threat from peer-to-peer or file-sharing networks that swap content, much of it illegally obtained, and without anyone getting paid. Some believe that content providers, including television networks and movie studios, should put ads in their programming and give them away for free. Others believe the best value proposition is to emphasize the value of content over advertising and sell episodes or films directly, advertising-free, at a higher price than ad-supported media products.

Consultants are piling up with theories about how to win in the emerging marketplace. IBM recently released an influential report revealing their thinking about how ITV will stack up. First, analysts predict a “generational chasm” between baby boomers in early retirement or nearing retirement age who are accustomed to decades of passive media usage and the younger generation X and millennials. Described as in the “lean back” category, baby boomers may have splurged on a flat screen TV and DVR, but have not greatly modified their TV viewing habits in many years. Their children are likely to be much more media-evolved and more likely to be “multi-platform” media users, looking to smart phones, P2P (peer-to-peer) services, VOD—whatever improves convenience and access.

At a further remove, teenagers have been exposed to (immersed in) high-bandwidth networks and services from very early ages and experiment unflinchingly with media and platforms. Mobile devices and multitasking behaviors are central to their lives. It is second nature for them to rip and share content and have different definitions of both privacy and piracy, ones perhaps unrecognizable to their parents. They expect—and have many of the tools to obtain—total control of media content (Berman, et al., 2006).

In the same report, the pronouncement that “the mass market will stop always, trumping the niche market” is made to stunning effect (Berman, et al., 2006). The point is that the so-called “long-tail theory” popularized by Chris Anderson of *Wired* fame suggests that a convergent marketplace is one that ITV is perfectly positioned to take advantage of (Anderson, 2006).

When programming tied to a schedule is no longer supported, pre-release content may command a premium price. It is not clear, however, what happens to any of the former television pricing models when the idea of a “fixed schedule” of programming is truly out the window. Some question remains as to whether or not *any* content needs to be offered live or “real-time” in the future. Sporting events, news, and even election results may have more value to viewers if under their control. These issues have yet to be put to the test. Interestingly, although Apple’s business venture of offering individual recordings at an average of \$.99 through its iTunes Store has been a huge success in its first few years (and has reportedly brought the traditional music business “to its knees”), its related video business over iTunes has languished, and its future is uncertain (Barnes, 2007).

New forms of content are also emerging, including efforts by companies interested in porting existing content to various alternative devices, and even those solely dedicated to developing new content for devices such as mobile phones. Ad formats that are in consideration for the support of content delivery include on demand ads delivered to match stated interests:

- ♦ *Vertical ads* that link the viewer to topical information and related products.
- ♦ *Opt-in ads* accepted in exchange for free or discounted programming.
- ♦ *Hypertargeted ads* delivered with localization or profiled matching criteria.
- ♦ *Embedded advertising*, the digital equivalent of product placement.
- ♦ *Sponsored content*, longer-form programming sponsored by an advertiser, similar to the early sponsorship models of 1950s-era television (Kiley & Lowrey, 2005; Brightman, 2005).

Consumer-Generated Content

There is little doubt that the Internet has provided a powerful means of disintermediation (the process of businesses communicating or dealing directly with end users rather than through intermediaries). More than one observer has noted that the “blog” or Weblog has afforded everybody a printing press at little or no cost. Similarly, video programming can be created, distributed, and sold online without the assistance of the traditional media gatekeepers. Consumer-generated content is endemic online, ranging in quality from the primitive to the highly polished. Even seasoned television and film producers as well as news correspondents are said to be producing their own shows for online distribution and sale outside of the network and studio system (Hansell, 2006).

Few people are asking, however, whether or not there will really be an audience for all the available content in a future ITV environment. In the “50 million channel universe,” how many of those channels will be able to survive and endure?

According to Nielsen Media Research—and this finding is consistent over time—households receiving more than 60 channels tend to watch only about 15 of them on a regular basis (Webster, 2005). Will we see a similar concentration of interest once the novelty of ITV wears off?

Piracy and Digital Rights

Consumer-generated content, which is generally free of charge to those who wish to view it, is certainly a threat to established television business models, although a relatively small problem. However, the threat from file-sharing sites such as BitTorrent or YouTube, which may facilitate the distribution of copyright-restricted content, is much greater. Such sites account for half the daily volume of data sent via the Internet by some estimates (Wray, 2008; Kiley & Lowrey, 2005). Industry analysts assume that billions of dollars are already lost each year to copyright theft and outright piracy (Brightman, 2005). In an all-digital content world, sharing content becomes much easier, and many file-sharing consumers do not see their actions as theft or piracy. Adding insult to injury, few encryption schemes hold up to the concerted, and sometimes well-coordinated, efforts of crackers (Tomar, 2007).

Media Delivery Options Proliferate

Devices through which media might be delivered are likely to proliferate in the coming months and years, assuming consumer demand for increased portability and personalized media delivery continues. Some of these devices might be entirely new in form, and others might be examples of converging functions in single devices. The extent to which personalization might be taken as a result of consumer interest in customizing media experiences is still unclear. Early experiments in alternative interactive media suggest that there may be many ways of determining consumer interest and preferences, such as bioreactive devices, and consequently, our ideas of what constitutes interactive television or media, today, might not bear much resemblance to what might be considered “interactive” in a decade or less.

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Radio Broadcasting

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Our research shows that 92% of Americans believe radio is important in their daily lives. But while it is valued, radio is also taken for granted. Because it is so pervasive, radio is sometimes overlooked, just like water or electricity (National Association of Broadcasters, n.d.).

The industry once believed its future would be secure simply by switching to digital technology, but the popularity of satellite radio, MP3 players, and Internet radio has changed the game plan (Taub, 2006).

Radio technology spent its first 80 years in sedate existence. Its most exotic innovation—beyond improvements in the tuner itself—was the arrival of FM stereo broadcasting in 1961. The latest radio technological sizzle comes from digital over-the-air radio broadcasting (called HD radio, HD2, and HD3), an effort by the radio industry to promote new technological competition but not create new competitors to the radio industry. HD (high-definition) radio allows existing radio stations to stream digital content simultaneously with their analog FM and AM signals.

Today, satellite-delivered audio services from XM and Sirius, streaming audio options, and audio downloads (both music and full-length programming) are allowing consumers to think anew about the meaning of the word *radio*. Radio has come to mean personal audio media—to encompass the multiple selections and formats of audio content provided by a variety of sources—beyond FM and AM radio. Radio is becoming a generic term for audio entertainment supplied by terrestrial broadcast frequency, satellite, Internet streaming, cell phones, and portable digital audio players—via podcasts, some of which come from traditional radio companies and still others that are the product of technology innovators (Green, et al., 2005).

Radio remains an important part of the daily lives of millions of people. Personality and promotion driven radio formats thrust themselves into the daily routines of listeners. Radio station ownership consolidation has

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led to greater emphasis on formats, format branding, and promotional efforts designed to appeal to listener groups and, at the same time, yield steady returns on investments for owners and shareholders through the sale of advertising time.

Deregulation has increased the number of radio stations a company or individual may own, pushing operators to own clusters of stations in individual cities, or to own hundreds or even a thousand stations around the United States. Critics are quick to point to the malaise brought upon the radio industry by consolidation and cost-cutting, but the previous ownership fragmentation may never have allowed today's radio to reach the point of offering HD radio as a competitor to satellite and streaming technologies. Through consolidation, the largest owner groups have focused their attention on new product development to position radio to respond to new technological competition. There have been technology stumbles in the past:

- ♦ FM broadcasting, which almost died because of lack of support from AM station owners and ultimately took more than 35 years to achieve 50% of all radio listening in 1978.
- ♦ Quad-FM (quadraphonic sound).
- ♦ AM stereo, touted in the early 1980s as a savior in AM's competitive battle with FM.

These technologies did not fail exclusively for want of station owner support, but it was an important part of their failure. Large ownership groups have an economic incentive to pursue new technology. HD radio best exemplifies the economy of scale needed to introduce a new radio technology. Whether consumers will view HD radio as a technological offering worthy of adoption when they can subscribe to satellite services or download digital music to various portable music players is not yet clear.

This chapter examines the factors that have redirected the technological path of radio broadcasting. The most important technological improvement for AM and FM radio is the implementation of digital terrestrial audio broadcasting capable of delivering near-CD-quality audio and a variety of new data services from song/artist identification, to local traffic and weather, to subscription services yet to be imagined.

Background

The history of radio is rooted in the earliest wired communications—the telegraph and the telephone—although no single person can be credited with inventing radio. Most of radio's "inventors" refined an idea put forth by someone else (Lewis, 1991). Although the technology may seem mundane today, until radio was invented, it was impossible to simultaneously transmit entertainment or information to millions of people. The radio experimenters of 1900 or 1910 were as enthused about their technology as are the employees of the latest tech startup. Today, the Internet allows us to travel around the world without leaving our seats. For the listener in the 1920s, 1930s, or 1940s, radio was the only way to hear live reports from around the world.

Probably the most widely known radio inventor/innovator was Italian Guglielmo Marconi, who recognized its commercial value and improved the operation of early wireless equipment. The one person who made the most lasting contributions to radio and electronics technology was Edwin Howard Armstrong. He discovered regeneration, the principle behind signal amplification, and invented the superheterodyne tuner that led to a high-performance receiver that could be sold at a moderate price, thus increasing home penetration of radios.

In 1933, Armstrong was awarded five patents for frequency modulation (FM) technology (Albarran & Pitts, 2000). The two traditional radio transmission technologies are amplitude modulation and frequency modulation. AM varies (modulates) signal strength (amplitude), and FM varies the frequency of the signal.

The oldest commercial radio station began broadcasting in AM in 1920. Although AM technology had the advantage of being able to broadcast over a wide coverage area (an important factor when the number of licensed stations was just a few dozen), the AM signal was of low fidelity and subject to electrical interference. FM, which provides superior sound, is of limited range. Commercial FM took nearly 20 years from the first Armstrong patents in the 1930s to begin significant service and did not reach listener parity with AM until 1978 when FM listenership finally exceeded AM listenership.

FM radio's technological add-on of stereo broadcasting, authorized by the Federal Communications Commission (FCC) in 1961, along with an end to program simulcasting (airing the same program on both AM and FM stations) in 1964, expanded FM listenership (Sterling & Kittross, 1990). Other attempts, such as Quad-FM (quadraphonic sound), ended with disappointing results. AM stereo, touted in the early 1980s as the savior in AM's competitive battle with FM, languished for lack of a technical standard because of the inability of station owners and the FCC to adopt an AM stereo system (FCC, n.d.-a; Huff, 1992). Ultimately, consumers expressed minimal interest in AM stereo.

Why have technological improvements in radio been slow in coming? One obvious answer is that the marketplace did not want the improvements. Station owners invested in modest technological changes; they shifted music programming from the AM to the FM band. AM attracted listeners by becoming the home of low-cost talk programming. Another barrier was the question of what would happen to AM and FM stations if a new radio service were created? Would existing stations automatically be given the first opportunity to occupy new digital space, as an automatic grant, eliminating the possibility that new competition would be created? What portion of the spectrum would a new digital service occupy? Were listeners ready to migrate to a new part of the spectrum? New radio services would mean more competitors for the limited pool of advertising revenue.

Listeners, the radio industry believed, were satisfied with commercially supported and noncommercial radio programming offered by AM and FM stations. Consumers, either wanting something new or tiring of so many radio commercials, first bought tape players, then CD players, and today, portable digital audio players (DAPs) to provide improved audio quality and music choice. The consumer electronics industry focused on other technological opportunities, including video recording and computer technology, rather than new forms of radio.

The change in thinking for the radio industry came when iBiquity Digital was formed in August 2000 by the merger of USA Digital Radio and Lucent Digital Radio (iBiquity, n.d.). Clear Channel, Viacom/Infinity Radio, Disney/ABC, Susquehanna Radio, Cox Radio, and Hispanic Broadcasting—some of the largest radio groups at that time—were investors in the company. Two of them—Disney and Susquehanna—have since been purchased by competing groups as further steps in consolidation. These companies supported the creation of a new digital radio service that would allow the use of existing FM and AM frequencies, thus lessening the potential for the creation of new competitors and likely ensuring existing broadcasters with first claims to the new service. The new digital service came to be called in-band, on-channel (IBOC).

The Changing Radio Marketplace

The FCC elimination of ownership caps mandated by the *Telecommunications Act of 1996* set the stage for many of the changes that have taken place in radio broadcasting in the last decade. Before the ownership limits were eliminated, there were few incentives for broadcasters, equipment manufacturers, or consumer electronics manufacturers to upgrade the technology. Outside of the largest markets, radio stations were individual small businesses. (At one time, station owners were limited to seven stations of each service. Later, the limit was increased to 18 stations of each service, before deregulation eventually removed ownership limits.) Analog radio, within the technical limits of a system developed nearly 90 years ago, worked just fine. Station owners did not have the market force to push technological initiatives. The fractured station ownership system ensured station owner opposition to FCC initiatives and manufacturer efforts to pursue technological innovation.

Ownership consolidation, along with station automation and networking, reflect new management and operational philosophies that have enabled radio owners to establish station groups consisting of 100 or more stations. The behemoth of the radio industry is Clear Channel Communications. The San Antonio-based company owns 1,005 U.S. radio stations that reach 100 million listeners or 45% of all U.S. residents, ages 18 to 49, on a daily basis (Clear Channel, n.d.-a). As substantial as the company is, Clear Channel has recently been a seller of stations, rather than a buyer. The company has sold about 200 stations in smaller markets, and its remaining stations total only about 9% of all U.S. stations (Clear Channel, n.d.-b). As of mid-2008, Clear Channel is in the process of being acquired by private-equity buyers Thomas H. Lee Partners and Bain Capital, (Clear Channel sale, 2008). The fall of Clear Channel demonstrates that, in the long run, huge station groups may not work. Cumulus Media, the second largest station owner, owns or operates a comparatively small 336 stations in 64 mid-sized markets (Cumulus Media, 2008).

The compelling question today is whether anyone cares about the technological changes in terrestrial radio broadcasting. Or, are the newest changes in radio coming at a time when public attention has turned to other sources and forms of audio entertainment? The personal audio medium concept suggests that *local*/personality radio may not be relevant when listeners can access both mega-talent personalities and local stars through satellite services, online, and with podcasting.

Recent Developments

There are four areas where technology is affecting radio broadcasting:

- 1) New digital audio broadcasting transmission modes that are compatible with existing FM and AM radio.
- 2) Delivery competition from satellite digital audio radio services (SDARS).
- 3) New voices for communities: low-power FM service.
- 4) New technologies that offer substitutes for radio.

New Digital Audio Broadcasting Transmission Modes

Most free, over-the-air AM and FM radio stations may still be broadcasting in analog, but their on-air and production capabilities and the audio chain, from music and commercials to the final program signal delivered to the station's transmitter, is digitally processed and travels to a digital exciter in the station's transmitter where the audio is added to the carrier wave. The only part of the process that remains analog is the final transmission of the over-the-air FM or AM signal.

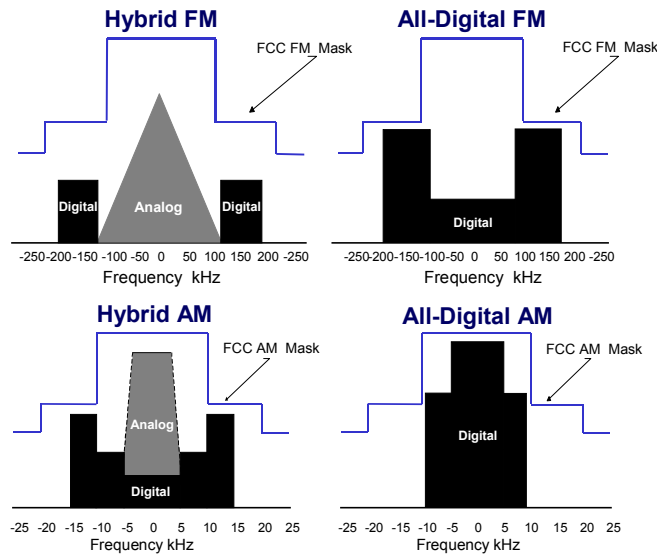
AM and FM radio made the critical step toward digital transmission in 2002, when the FCC approved the digital broadcasting system proposed by iBiquity Digital (marketed as HD radio). The first HD radio receiver was sold about two years later in January 2004 in Cedar Rapids (Iowa). By then, nearly 300 stations were broadcasting the HD radio signal. Stations providing the new digital service are called hybrid broadcasters by the FCC because they continue their analog broadcasts (FCC, 2004a). The FCC is committed to "... foster the development of a vibrant terrestrial digital radio service..." and thus encourage stations to convert to IBOC while, at the same time, ensuring that some measure of free over-the-air broadcasting continues (FCC, 2004a).

The HD radio digital signal eliminates many of the external environmental factors that often degrade a conventional FM or AM station's signal. IBOC technology consists of an audio compression technology called perceptual audio coder (PAC) that allows the analog and digital content to be combined on existing radio bands, and digital broadcast technology that allows transmission of music and text while reducing the noise and static associated with current reception. The system does not require any new spectrum space, as stations continue to broadcast on the existing analog channel and use the new digital system to broadcast on the same frequency. As illustrated in Figure 10.1, this digital audio broadcasting (DAB) system uses a hybrid in-band, on-channel system that allows simultaneous broadcast of analog and digital signals by existing FM stations through the use of compression technology, without disrupting the existing analog coverage. The FM IBOC system is capable of delivering near-CD-quality audio and new data services including song titles, and traffic and weather bulletins. A similar system for AM stations has also been approved for daytime use, although concerns about IBOC's impact on nighttime AM signals have prevented its approval for nighttime operation. The AM IBOC will provide FM stereo quality signals from daytime AM station broadcasts. The so-called killer application to attract consumers to HD radio is the ability to offer a second or third audio channel. For example, KITS in San Francisco has HD 105.3 with an alternative format and HD2 at 105.3-2 with the classic alternative format (Stations on the air, n.d.).

The establishment of terrestrial digital audio broadcasting involves not only regulatory procedures, but also marketing the technology to radio station owners, broadcast equipment manufacturers, consumer and automotive electronics manufacturers and retailers, and most important, the public. iBiquity Digital markets the new technology to consumers as HD radio, a static-free service without hiss, fading, or pops and available without a monthly subscription fee. According to iBiquity, the cost for a station to implement hybrid IBOC broadcasts is about \$75,000 (FCC, 2004a). As with satellite radio's earliest efforts to attract subscribers, receiver availability is a significant consumer barrier. Receiver choices are limited, and models are expensive; automotive HD radio tuners built by Kenwood, JVC, and Sanyo cost from \$99 to \$400, and home/office unit from JVC, Sangean, and Sony retail from \$180 to more than \$1,000 (Crutchfield.com, n.d.).

Unlike satellite radio (and direct broadcast satellite), where hardware (receivers) is given away or price-discounted to encourage subscriber growth, HD digital radio lacks subscriber revenue to offset receiver discounts.

Figure 10.1

Hybrid and All-Digital AM & FM IBOC Modes*Source: iBiquity*

Unlike digital television that will require television stations to cease their analog broadcasts, there is no current plan to eliminate analog FM and AM broadcasts, and the HD radio transmissions will not return any spectrum to the FCC for new uses. Thus, there are questions as to whether consumers will want the new service, given the potential expense of new receivers, the abundance of existing receivers, and the availability of other technologies including subscriber-based satellite-delivered audio services, digital audio players with audio transfer and playback, and competition from digital television. As was true with satellite radio, gaining the interest of the automotive industry to offer HD radio as an optional or standard audio feature is crucial. Unlike satellite radio, no automotive manufacturers are investors in iBiquity Digital, although car manufacturers such as BMW, Ford, and Hyundai are beginning to add the service.

For broadcasters, digital audio broadcasting is more than just a new broadcast technology—it is a new means of delivering a variety of forms of broadcast content and requires a new set of programming standards to accompany the new technology. HD radio will allow wireless data transmission similar to the radio broadcast data system (RBDS or RDS) technology that allows analog FM stations to send traffic and weather information, programming, and promotional material from the station for delivery to smart receivers, telephones, or personal digital assistants (PDAs). HD radio utilizes multichannel broadcasting by scaling the digital portion of the hybrid FM broadcast. IBOC provides for a 96 Kb/s (kilobits per second) digital data rate, but this can be scaled to 84 Kb/s or 64 Kb/s to allow 12 Kb/s or 32 Kb/s for other services, including non-broadcast services such as subscription services.

iBiquity Digital, in a marketing document for radio stations, described a future where listeners will be able to pause, store, fast forward, and index radio programming (iBiquity, 2003). Part of that future was unveiled at the 2008 Consumer Electronics Show. iBiquity demonstrated a generation of receivers incorporating Apple iTunes tagging technology that would allow consumers to download songs heard on HD radio stations (iBiquity, 2008b).

iBiquity Digital's HD radio also gives listeners, who are used to instant access, one odd technology quirk to get used to. Whenever an HD radio signal is detected, it takes the receiver approximately 8.5 seconds to lock onto the signal. The first four seconds are needed for the receiver to process the digitally compressed information; the next 4.5 seconds ensure robustness of the signal (iBiquity, 2003). The hybrid (analog and HD) operation allows receivers to switch between digital and analog signals, if the digital signal is lost. Receivers compensate for part of the lost signal by incorporating audio buffering technology into their electronics that can fill in the missing signal with analog audio. For this approach to be effective, iBiquity Digital recommends that analog station signals operate with a delay, rather than as a live signal. Effectively, the signal of an analog FM receiver, airing the same programming as an HD receiver, would be delayed at least 8.5 seconds. As a practical matter, iBiquity Digital notes, "Processing and buffer delay will produce off-air cueing challenges for remote broadcasts..." (iBiquity, 2003, p. 55).

A different form of DAB service is already in operation in a number of countries. The Eureka 147 system broadcasts digital signals on the L-band (1452-1492 MHz) or a part of the spectrum known as Band III (around 221 MHz) and is in operation or experimental testing in Canada, the United Kingdom, Sweden, Germany, France, and about 40 other countries. Because of differences in the Eureka system's technological approach, it is not designed to work with existing AM and FM frequencies. Broadcasters in the United States rejected the Eureka 147 system in favor of the "backward and forward" compatible digital technology of iBiquity Digital's IBOC that allows listeners to receive analog signals without having to purchase a new receiver for the DAB system (FCC, 2004a).

The World DAB Forum, an international, non-government organization to promote the Eureka 147 DAB system, reports that more than 500 million people around the world can receive the 1,000 different DAB services (World DAB, n.d.). As with digital broadcasting in the United States, proponents of Eureka 147 cite the service's ability to deliver data as well as audio. Examples of data applications include weather maps or directional information that might be helpful to drivers or emergency personnel. As with the iBiquity Digital projections, the Eureka numbers seem impressive until put into perspective: 500 million people can potentially receive the signal, but only if they have purchased one of the required receivers. Eureka 147 receivers have been on the market since the summer 1998; about 930 models of commercial receivers are currently available and range in price from around \$75 to more than \$1,000 (World DAB, n.d.).

Two new services, DAB+ and digital multimedia broadcasting (DMB), offer the potential for DAB to leap beyond ordinary radio applications. DAB+ is based on the original DAB standard, but uses a more efficient audio codec. It provides the same functionality as the original DAB radio services including services following traffic announcements and PAD multimedia data (dynamic labels such as title artist information or news headlines, complementary graphics, and images) (World DAB, n.d.-b).

Interactive DMB is a video and multimedia technology based on DAB. It offers services such as mobile TV, traffic and safety information, interactive programs, data information and the potential for other applications. DMB is currently the world's most successful mobile TV standard, with over eight million devices sold with users in Europe and Asia (World DAB, n.d.-b).

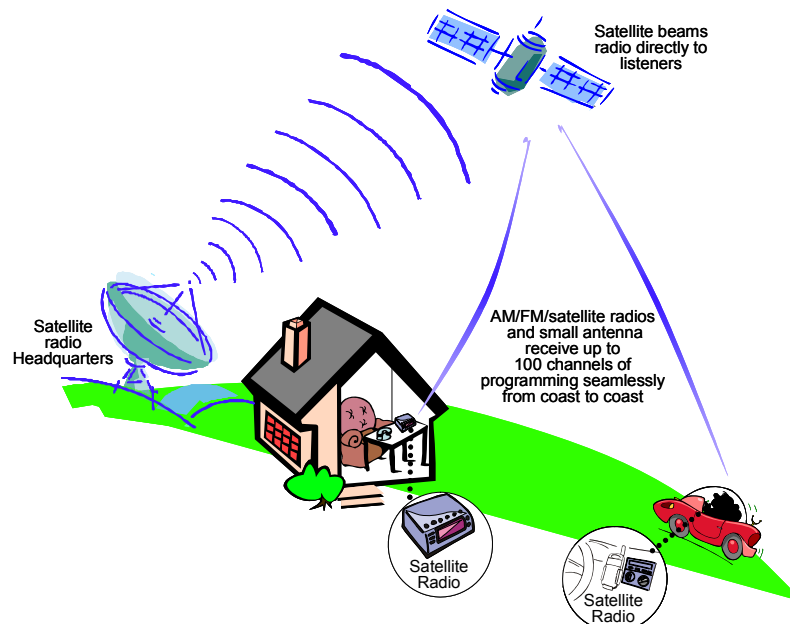
As with HD radio technology, both DAB+ and DMB require new receivers if consumers are to use the content. For consumers to adopt the technology, there must be sufficient rollout of the services to create enough consumer interest in the products. DMB, with eight million devices sold, is reaching less than 2% of the 500 million potential users.

One particularly astute move by iBiquity Digital and its broadcast equipment manufacturing partners has been the introduction of HD radio to other countries, particularly in Europe. Switzerland was the first country where tests were announced, but other countries, including France, Thailand, Brazil, New Zealand, and the Philippines, have begun tests. These countries give iBiquity additional influence with equipment and receiver manufacturers. For international broadcasters, HD radio offers the advantage of adding digital while maintaining their analog broadcasts—the sole reason U.S. broadcasters would not support Eureka 147.

Competition from SDARS

The single biggest competitive challenge for free, over-the-air radio broadcasting in the United States has been the introduction of competing subscriber-based satellite radio service, a form of out-of-band digital “radio,” launched in the United States in 2001 and 2002 by XM Satellite Radio and Sirius Satellite Radio, respectively. The service was authorized by the FCC in 1995 and, strictly speaking, is not a radio service. Rather than delivering programming primarily through terrestrial (land-based) transmission systems, each service uses geosynchronous satellites to deliver its programming (see Figure 10.2). (Both services use terrestrial signals to enhance reception in some reception fringe areas, such as tunnels.) Although listener reception is over-the-air and electromagnetic spectrum is utilized, the service is national instead of local. It requires users to pay a monthly subscription fee of between \$10 and \$14, and it requires a proprietary receiver to decode the transmissions (Sirius, 2008; XM, 2008). The companies have proposed a merger to enable their continued operation in what has become a consumer choice technology marketplace. As the chapter is being submitted for publication, only the U.S. Department of Justice has approved the merger, citing digital audio players and HD radio as audio technology competitors. The FCC has not indicated when it may act on the proposal (Shenon, 2008).

Figure 10.2
Satellite Radio



Source: J. Meadows & Technology Futures, Inc.

The initial question, of course, was whether consumers would pay for an audio product they have traditionally received for free. Two practices have enticed consumers to try the services. First, receiver hardware has been sold at reduced prices to gain subscribers. Second, both companies' programming buying sprees have allowed content to drive subscription demand. Most notable was Sirius Satellite's recruitment of Howard Stern, who began his satellite broadcasts in January 2006 (Sirius, 2006).

While both companies continue to lose money, subscriber growth has been strong. XM, by the end of the end of 2007, had more than nine million subscribers; Sirius had more than eight million subscribers (XM, 2008; Sirius, 2008). Past projections called for each service to be profitable, with between 3.5 million and 4.3 million subscribers (Elstein, 2002; Stimson, 2002; O'Dell, 2004). Both companies continue to lose money, thus their business motive to merge. Given the development and programming costs of each service, satellite radio technology continues to face an uncertain future. The cost to attract and add each new subscriber remains high; XM calculates its cost per gross addition (including subscriber acquisition costs, advertising, and marketing expenses) at \$121 per subscriber for 2007, with an adjusted operating loss per subscriber of \$29. This essentially means that the company generates almost no positive revenue from a subscriber's first-year customer subscription fees. If the subscriber discontinues the service after one year (referred to as listener churn), the company makes no money (XM, 2008).

Helping the growth of both companies has been an array of savvy partnerships and investments. Both companies have alliances with various automobile manufacturers. General Motors and Clear Channel are investors in XM Satellite Radio. Sirius and XM have a technology-sharing agreement that allows for production of receivers that work with either service. Both receiver manufacturers and major electronics retailers offer automobile, home, and portable receivers. Programming rights, such as exclusive sports deals with the NFL, MLB, and NHL, provide branded content and marketing opportunities. Both services also offer market-specific traffic and weather information to further enhance the appeal and compete head-to-head with local radio stations. Blunders by radio station group owners have encouraged a curious public to investigate the services, as public concern increases regarding radio station playlists that restrict music diversity (O'Dell, 2004).

New Voices for Communities: Low-Power FM Service

The FCC approved the creation of a controversial new classification of noncommercial FM station on January 20, 2000 (Chen, 2000). LPFM, or low-power FM, service limits stations to a power level of either 100 watts or 10 watts (FCC, n.d.-c). Although the service range of a 100-watt LPFM station is about a 3.5-mile radius, full-power commercial and noncommercial stations feared interference. A little more than a year after approving the service, and before any stations were licensed, the commission acquiesced to congressional pressure on behalf of the broadcast industry and revised the LPFM order. To prevent encroachment on existing stations' signals, Congress slipped the *Radio Broadcasting Preservation Act of 2000* into a broad spending bill, which was reluctantly signed by President Clinton (McConnell, 2001; Stavitsky, et al., 2001).

The congressionally-mandated revision required LPFM stations to provide a third adjacent channel separation/protection for existing stations. Practically speaking, this meant that a currently licensed station, operating on 95.5 MHz, would not have an LPFM competitor on a frequency any closer than 94.7 MHz or 96.3 MHz. The FCC has not approved third adjacent channel spacing, but the commission has taken some minor steps to promote LPFM licensing. These include allowing LPFM stations to seek a second-adjacent channel short spacing waivers and to be afforded some protection from interference or remedy from interference caused by full-service stations. Further, the FCC has added an online "channel finder" utility to its Web site to enable applicants to search for available LPFM frequencies (FCC, 2007).

New Competition—Internet Radio, Digital Audio Files, and Podcasts

Listening online and downloading music have become mainstream practices. High-speed Internet connectivity—wired or wireless—is one more technological challenger for terrestrial radio. (For more information on digital audio and Internet connectivity, see Chapters 15 and 19.) In the United States, Apple's iPod line sold 50 million players in 2007 (XM, 2008), and it remains the favorite player for many consumers. The opportunity to control music listening options and to catalog those options in digital form presents not just a technological threat to radio listening, but also a lifestyle threat of greater magnitude than listening to tapes or CDs. Listeners have thousands of songs that can be programmed for playback according to listener mood, and the playback will always be commercial-free and in high fidelity. As digital audio file playback technology migrates from portable players to automotive units, the threat to radio will increase.

Cellular telephones are seen as the leading delivery vehicle for mobile entertainment in the future (Borzo, 2002). Consumers in Europe, Japan, the United States, and Australia already use cell phones to receive music files, video clips, and video games. As discussed in Chapter 17, the latest cell network improvements, such as Verizon's V CAST service, promises to convert a mobile phone into a portable music player with ready access and ease-of-use to a downloadable music service (Verizon, n.d.). Whether cell phones are used for audio playback, mobile video applications, or personal television viewing, they are a competitor to radio stations. They occupy listener time and consume financial resources that are not committed to radio or the purchase of HD radio receivers. As noted in Table 10.1, *other media* now occupy 17% of consumer time, and radio consumption is only slightly ahead at 22%.

Current Status

Broadcast radio or terrestrial radio remains a big part of the lives of most people. Each week, the nearly 13,997 FM and AM radio stations in the United States are heard by more than 233 million people, and advertisers spent \$19.6 *billion* on radio advertising in 2005 (FCC, 2008; RAB, 2007; Bachman, 2008; U.S. Bureau of the Census, 2006). These are impressive statistics but a closer examination shows persistent radio industry declines, ranging from a 2.5% drop in ad revenue in 2007 to a daily drop in listeners, from a 12+ listener reach of 75% in 2005 to a 72.4% reach in 2007 (Bachman, 2008; RAB, 2007).

HD radio is yet to be widely available. While radio stations are quick to promote free, over-the-air signals, listeners find a limited number of stations even in the largest markets. In Chicago, 44 FM and 10 AM stations were broadcasting with HD radio by early 2008; another seven stations are planning to launch HD services. As of mid-2008, 1,258 FM stations and 251 AM stations were broadcasting at least one HD radio channel (FCC, n.d.-b). These numbers seem impressive until put into perspective: 90% of people in the United States can potentially receive the signal, but only if they have purchased one of the required receivers. Receiver penetration is still too small to measure.

The FCC estimates there are nearly 800 million radios in use in U.S. households, private and commercial vehicles, and commercial establishments (FCC, 2004a). All of these radios will continue to receive analog signals from radio stations even after the stations convert to HD radio broadcasts. An obvious marketing challenge for HD radio will be to inform listeners about the new service, while not creating the false impression that listeners receiving a simulcast signal from an analog FM station mistakenly think they are listening to an HD radio broadcast. An HD Digital Radio Alliance funded survey optimistically found that 77% of radio listen-

ers were aware of HD radio and that 31% were interested in the service (iBiquity, 2007). Satellite radio has had strong subscriber growth. XM Satellite Radio reported over nine million subscribers, and Sirius has 8.3 million subscribers as of the end of 2007 (XM, 2008; Sirius, 2008).

Table 10.1

Radio in the United States at a Glance

Households with radios	99%
Average number of radios per household	8
Number of radios in U.S. homes, autos, commercial vehicles and commercial establishments	800 million
<i>Source:</i> U.S. Bureau of the Census (2006) and FCC (2006)	
Radio Station Totals	
AM Stations	4,776
FM Commercial Stations	6,309
FM Educational Stations	2,892
Total	13,997
FM Translators and Boosters	5,904
LPFM Stations	831
<i>Source:</i> FCC (2008)	
Radio Audiences	
<i>Persons Age 12 and Older Reached by Radio:</i>	
Each week:	92.9% (About 233 million people)
Each day:	72.4% (About 182 million people)
<i>Persons Age 12 and Older Time Spent Listening to the Radio:</i>	
Each week:	19 hours
Each weekday:	2:48 hours
Each weekend:	5 hours
<i>Where Persons Age 12 and Older Listen to the Radio:</i>	
At home:	35.9% of their listening time
In car:	45.2% of their listening time
At work or other places:	18.9% of their listening time
<i>Radio reaches 72% of all consumers every day.</i>	
<i>Daily Share of Time Spent With Various Media:</i>	
Radio	22%
TV/Cable	38%
Newspapers	5%
Internet	5%
Other Media	17%
<i>Source:</i> Radio Advertising Bureau (2007)	
Satellite Subscribers	
XM Satellite Radio	9,100,000
Sirius Satellite Radio	8,321,725
<i>Source:</i> XM Satellite Radio (2008) and Sirius Satellite Radio (2008)	

LPFM has been limited by regulation. As of December 31, 2007, 831 LPFM stations were licensed by the FCC; additional construction permits have been issued for nearly 1,000 stations that have not yet been built.

Factors to Watch

Radio stations have been in the business of delivering music and information to listeners for nearly a century. Public acceptance of radio, measured through listenership more than any particular technological aspect, has enabled radio to succeed. Stations have been able to sell advertising time based on the number and perceived value of their audience to advertising clients. Technology, when utilized by radio stations, focused on improving the sound of the existing AM or FM signal or reducing operating costs.

Digital radio technology has perhaps modest potential to return the radio industry to its interest status among consumers. The plethora of alternative delivery means suggests that radio may be entering the competitive arena too late to attract the attention of consumers. Chris Andersen (2006), writing in *Wired*, promotes the notion of *The Long Tail*, where consumers, bored with mainstream media offerings, regularly pursue the digital music road less traveled. As *Business Week* noted, “Listeners, increasingly bored by the homogeneous programming and ever-more-intrusive advertising on commercial airwaves, are simply tuning out and finding alternatives” (Green, et al., 2005). Where digital broadcasting might achieve its greatest success is through streaming data content to wireless devices—although even this option will be dependent on the introduction and adoption of new receivers. Satellite audio holds the promise to create multiple revenue streams: the sale of the audio content, sale of commercial content on some programming channels, and possible delivery of other forms of data. Regulatory barriers to these new technologies are not the issue. Appropriate timing for the introduction of new delivery technologies, consumer interest in the technologies, perfecting the technology so that it is as easy to use as traditional radio broadcasting has always been, marketing receivers at affordable prices, and delivering content that offers value will determine the success of HD radio.

Consumer ability to easily store and transfer digital audio files to and from a variety of small personal players that have a pricing advantage over HD radio receivers will be another determining factor in the success of HD radio. Listeners desiring only entertainment will find little compelling advantage to purchasing a digital receiver. Eclectic or narrowly programmed formats might be attractive in the short term to encourage audiences to consider purchasing an HD receiver, but the desire by radio companies to attract the largest possible audience will result in a contraction of format offerings. The iBiquity station consortium, for the time being, is working to facilitate the introduction of new formats to market HD, HD2, and HD3 stations. The competitive nature of radio suggests that the battle for listeners will lead to fewer format options and more mass appeal formats, as stations attempt to pursue an ever-shrinking radio advertising stream.

Localism—the ability of stations to market not only near-CD-quality audio content but also valuable local news, weather, and sports information—has been cited as the touchstone for the terrestrial radio industry. In his farewell address in 2005, retiring NAB President Eddie Fritts presented this challenge: “Our future is in combining the domestic with the digital. Localism and public service are our franchises, and ours alone” (Fritts farewell, 2005, p. 44). New NAB CEO David Rehr, more in-step with the digital universe, noted, “We also learned from consumers that being local, in and of itself, is not what defines radio’s value. It’s the accessibility and the connection with radio personalities. And it’s being everywhere and available to everyone” (Rehr, 2008). New technologies from cell phones to wireless networking will enable listeners to access local content—as text or audio—whenever they want, without waiting for delivery by a radio announcer. But ease of

access from radio technology that requires only a receiver and no downloading or monthly fees may keep radio relevant as listeners face higher costs for new services and new technologies.

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Computers & Consumer Electronics

Personal Computers

Chris Roberts, Ph.D.^{*}

Sometime in late 2006, someone, somewhere in the world, plugged in a box that represented the one billionth personal computer in use (Computer Industry Almanac, 2007). Still-thriving and long-gone companies have sold hundreds of millions of units since the first “personal computer” debuted in 1975, and it seems superfluous to recount the impact computers have on nearly every aspect of modern society. The current college-age generation is among the first wave of “digital natives,” whose lives, cultures, and identities are tied with computers and computer-mediated communication. Even people born before computers became common have seen their lives changed—usually for the better—because of the machines. Consider that:

- ◆ People are spending more time in front of their computer screens than their television screens. The average person with an Internet connection spent nearly 33 hours a week online, more than the time spent in front of a TV set and nearly half the 71 hours a week a typical person spends consuming all media (IDG, 2008). Not all Internet use involves a personal computer, of course, but PCs remain the key device for delivery of online content.
- ◆ Computer sales keep rising. Worldwide sales in 2007 surpassed 271 million units, up 13% from 2006 (Gartner, 2008b). Sales have jumped nearly 10,000% since 1983, the year the industry shipped 2.8 million PCs and *Time* magazine named the computer its “Machine of the Year” (Friedrich, 1983).
- ◆ The “digital divide” is narrowing worldwide. In 2006, about one-quarter of all the world’s PCs were in America. A decade earlier, it was more than one-third (Computer Industry Almanac, 1997). While nearly three-fourths of all computers are in use in just 15 countries—a figure that has not changed in the past decade—the world’s number of PCs has tripled during the same time period. Although the gap between the digital haves and have-nots remains wide, PCs are common in many more places. See Table II.1 for details.

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Table 11.1

Personal Computers in Use By Country, 1996 and 2006

	1996		2006	
	No.*	Share*	No.	Share
1. U.S.	108.2	35.5%	240.5	24.2%
2. Japan	23.3	7.6%	77.95	7.8%
3. China	4.34	1.4%	74.11	7.4%
4. Germany	16.2	5.3%	54.48	5.5%
5. UK	14.5	4.8%	41.53	4.2%
6. France	11.7	3.9%	35.99	3.6%
7. South Korea	4.57	1.5%	30.62	3.1%
8. Italy	7.86	2.6%	29.31	2.9%
9. Russia	3.64	1.2%	26.97	2.7%
10. Brazil	3.15	1.0%	25.99	2.6%
11. Canada	8.85	2.9%	25.1	2.5%
12. India	2.12	0.7%	21.17	2.1%
13. Australia	5.67	1.9%	15.47	1.6%
14. Mexico	3.23	1.1%	14.77	1.5%
15. Spain	4.16	1.4%	13.42	1.4%
Top 15 Total	223	73.0%	727.4	73.0%
Worldwide Total	305	100%	996.1	100%

* No. is millions of PCs in use. Share is percentage of all computers in use worldwide.

Source: Computer Industry Almanac, Inc.

- ♦ More people use computers. It took seven decades before telephones reached 60% of U.S. households in the 1940s, but personal computers needed about three decades to top the 60% rate (Day, et al., 2005). Nearly three-quarters of American adults used a computer “at least on an occasional basis” in 2006, up from 54% in 1995 (U.S. Bureau of the Census, 2008).
- ♦ The “digital divide” is narrowing in the United States, at least for women: 73% of men and women used computers in 2006; men held a seven percentage point advantage a decade earlier. But while 74% of whites used computers in 2006, the rate was 63% for blacks—wider than the gap of five percentage points in 1995 (U.S. Bureau of the Census, 2008).
- ♦ Computer chip capacity and speeds continue to grow, even as chips become smaller. In 1983, the fastest processing chip made by industry giant Intel ran at 12 million cycles per second (Old-computers.com, n.d.). The newest Intel chip designed for desktop computing in early 2008 had four independent processors, each running at nearly three *billion* cycles per second (Intel, 2008).
- ♦ Few commodities in the history of manufacturing have seen such increases in quality and declines in prices. Take, for example, IBM’s 5150, the “personal computer” that sold 200,000 units within a year of its August 1981 introduction and had much to do with jump-starting the computer revolution. The original business-focused machine ran at a mere 4.77 megahertz and had a monochrome, text-only display. Its built-in memory held 64,000 bytes—not quite enough to hold all the characters in this chapter. There were no hard drives; the business version shipped with a single floppy disc drive. The cost: about \$3,000, or \$7,500 after adjusting for inflation (IBM, n.d.).

Today, a PC that runs thousands of times faster and holds millions of more pieces of data sells for a few hundred dollars.

♦ Nearly every other technology in this book is tied to a computer.

This chapter provides a brief history of computers, describes the current state of technology, and offers some insight into what may be coming next.

Background

A Brief History of Computers

As America's size and population grew during the late 1800s, the U.S. Bureau of the Census was overwhelmed by the constitutional mandate to conduct a decennial headcount. It took seven years to complete work on the 1880 census; data was delivered too late for useful decision making. The answer was technology. The Census Bureau turned to employee Herman Hollerith, who built a mechanical counting device based on how railroad conductors punched tickets of travelers. The technology helped the agency compile its 1890 results in about three months (Campbell-Kelly & Aspray, 1996). This exercise marked the first practical use of a computer.

Hollerith, who laid the foundation for International Business Machines Corporation, owed a debt to 1800s British inventor Charles Babbage. While his "difference engine" was never built, Babbage's idea for a computer remains a constant regardless of the technology: Data is input into a computer's "memory," processed in a central unit, and the results output in a specified format.

Early computers were first called "calculators," because "computers" were people who solved math equations. The early machines were built to tackle a specific task—counting people, calculating artillery firing coordinates, or forecasting weather. The first general-purpose computers emerged at the end of World War II in the form of ENIAC, the "electronic numerical integrator and computer" (Brown & Maxfield, 1997). Sperry-Rand's UNIVAC first reached the market in 1950, but Rand and six other computer companies soon became known as the "Seven Dwarfs" compared with the giant that was IBM. The combination of IBM's powerful marketing efforts and its understanding of business needs grew its market share to more than two-thirds in 1976.

The original massive machines ultimately gave way to personal computers as components were miniaturized. The 1975 introduction of MITS Altair 8800, which used an Intel chip and later software designed by a new company called Microsoft, put the first practical PC on the market (Freiberger & Swaine, 2000). An assembled box started at \$600, or \$2,600 in current dollars. A year later in California, Apple demonstrated its Apple I computer—which, unlike the Altair, came with a keyboard. The company's Apple II machine hit the market in 1977, and the company owned half of the personal computer market by 1980. The early 1980s were marked by a Babel of personal computing formats, but a standard emerged after the August 1981 arrival of the IBM PC, powered by an Intel chip and the MS-DOS operating system from Microsoft (Campbell-Kelly & Aspray, 1996).

IBM's influence as a maker of PCs faded as competitors delivered machines with better prices and performance. The corporation controlled less than one-fourth of the computer market share in 1985, and two dec-

ades later, sold its PC business to concentrate on its server-based systems (Lohr, 2004). Microsoft, however, built a still-growing market share for its operating systems, the programs that manage all other programs in a computer. The company eventually controlled the market for text-based operating systems, and it managed to hold off competitors while creating its “Windows” operating systems. Windows employs a graphical user interface (GUI) that harnesses the computer’s graphics capability to make the machine simpler and more intuitive. Apple’s 1984 debut of the Macintosh (and its 1983 predecessor, the Lisa) were built upon a GUI, giving them an ease-of-use advantage over IBM-based systems. Microsoft’s first version of Windows shipped in late 1985, but the software did not reach widespread use until its third version, which shipped in mid-1990. The mass acceptance of Windows gave Microsoft further dominance in the business of selling operating systems, and the company leveraged that power by selling applications based on the Windows platform. A Microsoft operating system ran on somewhere between 90% (Net Applications, 2008) and 95% (XiTiMonitor, 2008) of all PCs that accessed the Internet as of January 2008.

How Computers Work

The elements that make up a computer can be divided into two parts—hardware and software. Hardware describes the physical parts of a computer, such as the central processing unit, power controllers, memory, storage devices, input devices such as keyboards, and output devices such as printers and video monitors. Computer software is the term used to describe the instructions regarding how hardware manipulates the information (data) (Spencer, 1992). This definition of software differs from the Umbrella Perspective on Communication Technology discussed in Chapter I, which defines software as the “messages communicated through a technology system.” Under the Umbrella Perspective, the content of a word-processing document would be considered “software,” while the word-processing program would be defined as part of the hardware.

Key to understanding hardware is the central processing unit (CPU), also known as the microprocessor. The CPU is the brain of the computer, and it performs math and logic tasks according to given information. To do its work, the CPU requires memory to hold the data and instructions to process that information. The memory is based upon a series of switches that, like a light switch in a house, are flipped on or off.

The original memory devices required vacuum tubes, which were expensive, prone to breakage, generated a great deal of heat, and required a great deal of space. The miniaturization of computers began in earnest after December 23, 1947, when scientists perfected the first “transfer resistor,” better known as a “transistor.” Nearly a decade later, in September 1958, Texas Instruments engineers built the first “integrated circuit”—a collection of transistors and electrical circuits built on a single “crystal” or “chip.” These semiconductors sharply reduced CPU sizes from buildings to wafers. Today, circuit boards hold the CPU and the electronic equipment needed to connect the CPU with other computer components. The “motherboard” is the main circuit board that holds the CPU, sockets for random access memory, expansion slots, and other devices. “Daughterboards” attach to the motherboard to provide additional components, such as extra memory or cards to accelerate graphics.

The CPU needs two types of memory: random access memory (RAM) and storage memory. RAM is the silicon chip (or collection of chips) that holds the data and instruction set to be dealt with by the CPU. Before a CPU can do its job, the data are quickly loaded into RAM—and that data are eventually wiped away when the work is done. RAM is measured in “megabytes” (the equivalent of typing a single letter of the alphabet one million times) or, increasingly, in “gigabytes” (roughly one billion letters). Microsoft’s Vista Home Basic operating system claims to function with as little as 512 megabytes of RAM (Microsoft, n.d.). Only the cheapest PCs sold in 2008 ship with less than 1 gigabyte of RAM.

Think of RAM as “brain” memory, a quick but volatile memory that clears when a computer’s power goes off or when a computer crashes. Think of storage memory as “book” memory—information that takes longer to access but stays in place even after a computer’s power is turned off. Storage memory devices use magnetic or optical media to hold information. Major types of storage memory devices include:

- ♦ *Hard drives*, which are rigid platters that hold vast amounts of information. The platters spin at speeds of 5,400 to 15,000 revolutions per minute, and “read/write” heads scurry across the platters to move information into RAM or to put new data on the hard drive. The drives, which can move dozens of megabytes of information each second, are permanently sealed in metal cases to protect the sensitive platters. A drive’s capacity is measured in gigabytes, and only the most basic desktop computers today ship with less than 250 gigabytes of hard-drive capacity. Laptops tend to have drives that are smaller in size and capacity. The drives almost always hold the operating system for a computer, as well as key software programs (PC World, 2007). Although nearly every computer has a built-in hard drive, external drives that plug into computers using universal serial bus (USB) or Firewire ports are increasingly common. Newer external drives can be powered through the USB port, meaning the drive does not need to be plugged into a traditional power socket.
- ♦ *Keydrives (also called flashdrives and thumbdrives)* are tiny storage devices that earned the name because they are small enough to attach to a keychain. They use flash memory—a solid-state storage device with no moving parts also known as NAND—and plug into a computer using the USB port, which also powers the device. Some of the larger-capacity keydrives hold 32 gigabytes or more of data, and capacity improvements are continual. Prices have plunged, with one GB devices selling for less than \$10.
- ♦ *Other flash memory devices* can be connected to a computer. Most personal computers ship with devices that can read small memory cards used in digital cameras, music players, and other devices. Storage capacities are also increasing, driven by rising sales of iPods and similar devices.
- ♦ *Compact discs*. Introduced more than two decades ago, these 12-centimeter wide, one-millimeter thick discs hold nearly 700 megabytes of data or more than an hour of music. They ship in three formats: CD-ROM (read-only memory) discs that come filled with data and can be read from but not copied to; CD-R discs that can be written to once; and CD-RW discs that, like a floppy diskette, can be written to multiple times. Most computers ship with CD drives capable of recording (“burning”) CDs.
- ♦ *DVDs*, known as “digital versatile” or “digital video” discs, are increasingly replacing CDs as the storage medium of choice. They look like CDs but hold much more information—typically 4.7 gigabytes of computer data, which is more than six times the capacity of a conventional CD. DVD players and burners are becoming standard equipment with new computers, because DVD video has reached critical mass acceptance and because DVD players and burners are backward-compatible with CDs. As illustrated in Table 11.2, DVD technology includes multiple formats, not all of which are compatible with each other. In early 2008, the industry appears to have settled upon Blu-ray as the next-generation DVD format, ending a years-long battle after Toshiba suspended production of its competing HD DVD format (Fackler, 2008).

Table 11.2
DVD Formats

Format	Storage Size*	Pros	Cons
DVD-ROM	4.7 to 9.4 GB	Works in set-top DVD players and computers	Read-only
DVD-R	4.7 to 9.4 GB	Works in most set-top DVD players and computers	Can be written to only once; may not work in DVD+R drives
DVD-RAM	2.6 to 9.4GB	Is rewritable many times	Works only in a DVD-RAM drive
DVD-RW	4.7 to 9.4 GB	Can be written to up to 1,000 times; used in most DVD players/computers	DVD-RW discs may not play back on some older systems
DVD+R	4.7 to 9.4 GB	Works in most set-top DVD players and computers equipped with DVD-ROM drives	Can be written to once; may not work in DVD-R drives.
DVD+RW	4.7 to 9.4 GB	Works in most set-top DVD players and computers equipped with DVD-ROM drives	DVD+RW discs may not play back on some older or entry-level DVD systems
Blu-ray	23.3 to 27 GB	Original backers include Sony and Dell	Won the battle with HD DVD for acceptance

* Assumes single-side storage only.

Source: Roberts (2008)

Another key category of hardware is known as input and output devices. Input devices—named because they deliver information to the computer—include keyboards, mice, microphones, and scanners. Output devices that deliver information from the computer to users include monitors and printers. Other devices that let computers communicate with the outside world are modems (modulator/demodulators that translate the digital data of a computer into analog sound that can travel over telephone lines) and network cards that let computers send and receive high-speed digital data signals through computer networks. Most computers ship with modems, but the devices are much less likely to be used than a decade ago as broadband or network-accessed data connections have become more common.

Software

Computers need software—the written commands and programs that load in the computer's random access memory and are performed in its central processing unit. The most important software is the operating system, which coordinates with hardware and manages other software applications. The operating system controls a computer's "look-and-feel," stores and finds files, takes input data and formats output data, and interacts with RAM, the CPU, peripherals, and networks. Microsoft's Vista operating systems reign supreme in sales against competing operating systems such as Apple's OS X, UNIX, and various versions of GNU/Linux. For smaller computer devices known as personal digital assistants, Palm OS and Microsoft's Windows Mobile are the two main competitors. Operating systems provide the platform for applications—programs designed for a specific purpose for users. Programmers have created tens of thousands of applications that let users write, make calculations, browse the Web, create Web pages, send and receive e-mail, play games, edit images, download audio and video, and program other applications.

Programs designed to improve computer performance are known as utilities. The best-known utility programs improve how data is stored on hard drives and stop malicious computer code (such as viruses, worms,

or Trojan horses) designed to destroy files, slow computer performance, or let outsiders surreptitiously take control of a computer. Software that identifies and sorts unsolicited commercial “spam” e-mail messages is also popular, as is software that removes “pop-up” advertising from Web sites.

Recent Developments

Hardware

A few years ago, Intel and Advanced Micro Devices, Inc. (AMD) were just moving into efforts to pack two CPU chips on a single die. Today, it is four—and counting. These multi-core processors use the principle of “parallelism,” in which computing tasks are divided among the multiple CPUs on the chip. The chips may not have clock speeds as fast as single-core CPUs, but they make up for it by generating less heat and sharing the processing load (Gain, 2005). While IBM’s PowerPC line had dual-core chips as early as 2001, industry powerhouses Intel and AMD both released dual-core chips in 2005 as they placed more focus on multi-core chips. Intel released its first quad-core chip in 2007 as part of its efforts “in reclaiming its technological leadership from AMD” (Flynn, 2007, p. C8). AMD took an early lead in multicore design and held nearly one-quarter of the PC market in 2006 (Reimer, 2006). AMD’s market share fell to about 13% in late 2007, however, caused by manufacturing problems at AMD and Intel’s aggressive price-cutting and new chip designs (Kessler, 2007a). AMD’s struggles contributed to its \$3.8 billion loss during 2007, but it hopes that new chip designs—plus a \$600 million investment by the government of Abu Dhabi—will keep AMD afloat and cut its \$5 billion debt load (Quinn, 2007).

Chip transistors are becoming tinier every day. Chips are now shipping with 45-nanometer transistors, allowing chipmakers to pack more transistors onto chips than the previous mass-market PC chips with 65-nanometer transistors. (One inch equals 25.4 million nanometers.) In 2007, Intel introduced chips based on the smaller design; AMD expects to ship similar chips in 2008. The new design will continue to boost chip performance (Flynn, 2008).

As chips acquire more cores with smaller transistors, they are also being built to address more information at once. Many new processors can manipulate binary numbers that are 64 zeroes and ones long, and they can work with up to 16 quintillion (that is, 16 billion billion) bytes of RAM—far more than the four billion bytes of RAM that were all a 32-bit processor could handle (Markoff, 2003). Major chipmakers introduced 64-bit chips in 2003. Microsoft’s Vista operating system included a 64-bit version with its 2007 debut, but “the software needed to take advantage of those chips is harder to find than a Beatles song on iTunes” (Krazit, 2007). While the Fab Four’s catalog may wind up online during 2008 (Graham & Baig, 2007), the “Wintel” industry still has been slow to fully take advantage of 64-bit technology. Apple (2008) operating systems also ship with the ability to handle 64-bit operations.

The introduction of multi-core chips with ever-more transistors means Moore’s Law remains operative. The 1965 prediction by Intel engineer Gordon E. Moore states that the number of transistors on a computer chip would double every two years, meaning computing power roughly doubles along with it (Intel, n.d.). Moore’s statement remains prescient after more than four decades (see Table II.3), but Moore now says the law is within 10 or 15 years of ending because “we’ll hit something fairly fundamental”—such as the physical size of atoms (Martell, 2007). The greater issue continues to be ways to dissipate the heat generated by CPU chips

(Kanellos, 2003). (Heat is the chief enemy of a CPU; most chips come with “heat sinks” and small fans designed to draw heat away from the chip.)

Table 11.3

Moore's Law

Microprocessor	Year of Introduction	Transistors
4004	1971	2,300
8008	1972	2,500
8080	1974	4,500
8086	1978	29,000
Intel286	1982	134,000
Intel386 processor	1985	275,000
Intel486 processor	1989	1,200,000
Intel Pentium processor	1993	3,100,000
Intel Pentium II processor	1997	7,500,000
Intel Pentium III processor	1999	9,500,000
Intel Pentium 4 processor	2000	42,000,000
Intel Itanium processor	2001	25,000,000
Intel Itanium 2 processor	2003	220,000,000
Intel Itanium 2 processor (9 MB cache)	2004	592,000,000
Intel Dual Core (Two processors)	2006	1,720,000,000
Intel Xenon processor (Four processors)	2007	820,000,000
Intel Tukwila (30 GB cache)	Late 2008	More than 2 billion

Source: Intel

You'll find those Intel-produced multi-core chips in computers made by Apple, which, in 2005, dropped the IBM/Motorola-made Power PC line of processors and, by summer 2006, had completed its transition to Intel processors (Hafner, 2006). The move made it easier for users to run both Mac and PC software on their Apple-made computers using programs such as Parallels Corporation's "Parallels Desktop for Mac" or Apple's "Boot Camp," which allows users to run Windows on an Apple machine. Boot Camp is a part of Apple's latest operating system, Mac OS X version 10.5 (dubbed "Leopard"), but it can run only one operating system (OS) at a time. Parallels, an add-on product, can run more than one OS simultaneously—and not just Windows.

The big news in hard drives is that the leading-edge storage devices do not use spinning disks anymore. "Solid-state" drives are essentially NAND-based flash drives that have enough capacity to hold an operating system, applications, and data. Intel, one of the many makers of flash-based memory, said it will ship drives in 2008 with at least 160 gigabytes of capacity (Fonseca, 2008). Flash costs are falling but remain comparatively high, which means solid-states drives are included only in higher-end laptop computers. The flash drives use much less power than conventional spinning disk drives, which can ease demand for battery power on laptops. They also are quieter, smaller and generate less heat, which are more advantages for laptops. They also can load software faster and move the industry closer to the goal of instant-on computers (Kanellos, 2006).

A downside of the solid-state drive is that it cannot hold nearly as much data as conventional disk-driven drives, whose prices continue to fall as capacity continues to grow. In spring 2007, Hitachi began selling a 3.5-

inch hard drive designed for personal computers with a capacity of one terabyte—the rough equivalent of 1,000 gigabytes, or one million megabytes. The original 2007 price was \$400 (Meritt, 2007); a year later, prices were nearing the \$200 mark. As of mid-2008, the one terabyte capacity threshold has not yet been reached for 2.5-inch drives used in laptops, but 500-gigabyte drives were already available.

The additional hard drive capacity, combined with falling prices, greater processing power, and ease of portability mean that laptop sales may outstrip desktop sales in the next few years. The industry sold 31.6 million laptops in the United States during 2007, up 21% (Quinn, 2008). Desktop sales, meanwhile, fell 4%, to 35 million. NPD Group (2008) said computer makers sold nearly \$20 billion in laptops during 2007, up 23% from the previous year. Consumers bought about \$9 billion in desktop computers, up just 2%. While laptop prices are down roughly 20% compared with a few years ago, they generally still cost more than desktops.

Not every laptop is expensive, however. The One Laptop Per Child initiative, created by the MIT Media Lab to provide low-cost laptops to children in developing nations, produced its first machines in November 2006 (Gardner, 2006). At least 10 nations, plus Birmingham (Alabama), are expected to receive the machines (Reeves, 2008). More than 600,000 were ordered worldwide during 2007, but the cost has been nearly double the original goal of \$100. The project has been criticized for political, technological, and environmental reasons, and the project has battled Intel and Microsoft because the machine may compete in nations against those two companies. The One Laptop machine uses an AMD chip and open-source software (Markoff, 2008).

One thing that laptops and desktops have in common is flat-panel monitors. Those monitors are built into laptops, and, starting in 2005, for desktops, the thinner flat-panel monitors outsold the heavier, larger cathode-ray tube monitors. One major English chain stopped selling CRT-based monitors in late 2007 (Mirror, 2007); others will likely follow as prices continue to fall because of rising consumer demand for flat-panel computer monitors and televisions.

Just as sales have declined for bulky monitors, so have sales of standalone scanners. Computer owners who want scanners are more likely to buy all-in-one units that combine a printer, scanner, fax, and copier. Prices for some all-in-one units have dipped below \$100, and the units come with either ink-jet or laser printers. IDC says multifunction printers account for more than two-thirds of all inkjet sales (Taylor, 2008). Also rising are sales of color laser printers, which have fallen in price as vendors make up for falling hardware prices through cartridge sales.

A final major development in computer hardware comes with Blu-ray's win in its battle for supremacy in the next generation of DVDs. Toshiba's HD DVD format, originally supported by Microsoft, failed to reach acceptance from the movie industry and was discontinued in spring 2008 (Fackler, 2008). Most computers currently ship with "dual-layer" DVD devices that can read and write to discs that hold 8.5 gigabytes of information. Next up should be computers that can handle the Blu-ray format.

Computer Software

Microsoft sold 100 million copies of Vista and earned billions of dollars in its first year on the market, but many consider the operating system to be a flop. Microsoft's successor to its 2001 Windows XP operating system shipped with much fanfare in January 2007, and was designed to look better than previous versions and to better fight viruses and other malware. It was installed on one in eight PCs worldwide by the end of its first year on the market, trailing only Windows XP, which was on one-third of desktops within the first year (Taylor, 2008). Many businesses delayed upgrading to Vista for reasons of cost and compatibility. Moreover, the sys-

tem received ho-hum reviews—and was even panned by some of its executives for requiring too much computing horsepower and shipping without the drivers needed to operate existing printers and other accessories (Stross, 2008). Microsoft has since cut prices on boxed versions of Vista (Fried, 2008) and postponed until mid-2009 its plans to discontinue selling or upgrading XP, because computer makers still want it to be available for customers unwilling to make the switch.

While Microsoft software powers most PC systems, it is not without competitors with new operating systems. Apple holds a growing but single-digit portion of the market, and its new operating system shipped in October 2007. The “Leopard” system, the latest Macintosh OS based on UNIX, was aimed at drawing more business-related interest, and it shipped with the Boot Camp software that made it compatible with Windows-based systems (McDougall, 2007a).

Also holding ground are various flavors of Linux-based operating systems, which also hold single-digit shares of the personal computer market but are more common on servers. Linux-based systems require users to be more technically proficient, and Linux has less available software, but the various versions can be found for free or at little cost. Wal-Mart, the nation’s largest retailer, briefly sold a Linux-based computer in 2007, but it drew little attention in stores (Associated Press, 2008). See Table 11.4 for a look at how market share is divided among operating systems.

Table 11.4
Operating System Market Share

Operating System	Market Share
Windows XP	74.5%
Windows Vista	12.9%
Linux	6.5%
Windows NT	6.4%
Windows 98	6.0%
MacIntel	4.4%
Windows ME	3.3%
Mac OS	3.1%
Windows 2000	2.5%

Source: Net Applications (March 2008)

Just as Windows dominates its category despite free competitors, Microsoft’s Office also holds a wide lead in the market for business application suites. The company released a new Windows version of Office in January 2007, and sales in the first six months were nearly double the sales of Office 2003 during its first six months (Fried, 2007). It also released a new Macintosh version in 2008. In all, Microsoft claims 97 cents of every \$1 in sales of business application suites (Gonsalves, 2007). Not every user buys a suite; OpenOffice, funded by Sun Microsystems, is a free suite that released an update to its second edition in 2007 (McDougall, 2007b) and plans a third version to be released in late 2008 (Openoffice.org, 2008). OpenOffice is an example of open-source software, in which the code is freely available to the public to use and improve. Some government entities have moved to OpenOffice to save money (or make a statement against Microsoft) and sought “open document” formats that will let word processing files, spreadsheets, and presentation files work regardless of the program used to create them.

The OpenOffice suite can generally handle Office documents with little loss of formatting, and can save its files in native Office formats. (Office applications are not quite as friendly with files in native OpenOffice formats.) Still, after much debate, the International Organization for Standardization/International Electrotechnical Commission accepted Microsoft's "Open XML" format as a world standard (Letzing, 2008). Others continue to back the OpenOffice "OpenDocument" format, which was accepted as an ISO standard in 2006 (LaMonica, 2008).

Microsoft also faces competition from Google, which provides the world's best-known and most-used Web search engine. Google moved onto Microsoft's prime space—the PC desktop—with its free "Google Desktop" software that, among other things, catalogs a user's hard drive and makes it easy to find words inside of documents. Apple's OS already offers this feature, and Microsoft installed similar software with Vista. Google is also going after Microsoft by offering "Google Docs," a series of online applications for word processing, spreadsheets, presentations, e-mail, and calendars (Graham, 2008). Microsoft's "Office Live" application is its online response.

Current Status

America's information-communication-technology industries accounted for nearly 12% of the U.S. gross domestic product in 2006, the highest level in three years, according to the U.S. Bureau of Economic Analysis (2008). Businesses spent more than \$250 billion on technology hardware and software during 2006, up 6% from the previous year (Edwards, 2008).

Intel continues to hold the lead in market share for processors, with a market share that has hovered around 80% for the past few years (Hesseldahl, 2006; Krazit, 2008). Intel reported \$38 billion in sales during 2007, and its profit margin was 18%. AMD reported about \$6 billion in 2005 sales and a 3% profit margin.

After a virtual tie in 2006, in 2007, Hewlett-Packard replaced Dell as the world's largest seller of personal computers. HP sold nearly one in 5.5 computers worldwide during 2007, and its 30% sales jump came through higher sales of laptops and home desktops (Gartner, 2008b). HP reported \$104 billion in sales and a \$7.2 billion profit for the year ending October 2007. (See Table 11.5 for total sales and market share of the world's major computer companies.) Microsoft remains the world's largest seller of software. It reported sales of \$58 billion and profits of \$17 billion for the year ending December 2007, and its profit margin was nearly 29%.

Factors to Watch

How will Microsoft follow up Vista? The next installment to the Windows operating system is expected to be known as "Windows 7" and arrive in 2009 or 2010. The company has said little publicly about the new release, but it "seems to be accelerating the timetable" of its new operating system (Wildstrom, 2008).

Will Microsoft's pledge to be more transparent pay off? Under heavy criticism from others in the computer industry and facing fines from world regulators, in February 2008, Microsoft vowed to release more information to make its products work better with competitors and to support new standards (Woodie, 2008).

The result could be open-source software that uses Microsoft file formats and interfaces, giving computer users more choices and quicker updates to software they use.

Table 11.5

The World's Top 5 PC Makers, 2006-2007

	Millions Shipped		Market Share in 2007
	2006	2007	
HP	38,037	49,434	18.2%
Dell Inc.	38,050	38,709	14.3%
Acer	18,252	24,257	8.9%
Lenovo	16,652	20,131	7.4%
Toshiba	9,198	10,932	4.0%
Others	119,022	127,717	47.1%
Total	239,211	271,180	100

Note: Data includes both desktops and laptops.

Source: Gartner (2008b)

What will happen to PC sales? Some PC makers are struggling to continue making the profits they have made in the past, but PC sales continue to boom and will keep growing at double-digit rates. Gartner estimated that PC sales grew by 13.4% to 271 million units during 2007, and will grow by 11.6% during 2008, although concerns about the global economy have tempered predictions (Shiffler, et al., 2008).

Will Apple crack the world's Top 5 PC vendors? Gartner (2008) predicts that Apple's market share in the United States and Western Europe will double by 2011, which is a function of Apple's abilities and struggles by other PC makers. Apple cracked the top three in PC sales in America during 2007, to a little more than 8% of the market. Even if Gartner's prediction is right, it would still hold around 7% of the worldwide PC market (Offner, 2008).

Will more users "rent" their software instead of buying it? More software companies are offering service subscriptions, in which users (mostly businesses) pay for a subscription to the software. Users pay for "software as a service" (SaaS) based on their size and the extent to which they use the software and technical support. Gartner (2008a) predicts that one-third of the spending on business-related software will be subscription-based by 2012. Players such as Microsoft, Google, Oracle, and others are already providing software to handle accounting, e-mail, and video teleconferencing applications. What is unknown is the extent to which typical home PC users will migrate to the services.

How "green" can hardware become? The ingredients needed to build a personal computer include minerals that must be extracted from the earth and are not easily recycled. PCs also contribute to the rising demand for electricity. The result has been calls for both hardware and software companies to find ways to trim power demands. HP, for example, has vowed to trim one-quarter of the power demands for its PCs and laptops by 2010 (Volynets, 2008), and Microsoft CEO Steve Ballmer said his company is looking for more energy-efficient PCs (Mueller, 2008).

Will Blu-ray be accepted? The demise of its competitor has given a green light to the Blu-ray format of high-definition DVDs, but that does not mean the format will be adopted by the masses anytime soon. There is

also a new potential competitor—HD VDM, or versatile multilayer disc—whose English backers say they can undercut Blu-ray's higher costs by using cheaper red-ray laser technology (Taub, 2008).

Will tiny laptops take off? As laptops are poised to outsell desktops in the coming years, the industry hopes to boost sales of “sublaptops,” the smallest personal computers. Some vendors sell higher-priced devices with 11.1-inch screens aimed at the traveling businessperson, but others are aiming even tinier, cheaper computers at what computer company president calls “nonsophisticated users” (Eihorn, 2008). Intel has said it is working on new chips to power the smaller devices and expects the world's computer makers to ship 47 million of these units by 2011 (Smith, 2008).

How will AMD survive? With millions in losses and fierce competition from Intel, AMD is pinning its hopes on the quad-core chips it will release in 2008 and on an antitrust lawsuit it filed against Intel (Kessler, 2007b). Intel, meanwhile, plans to open a chipmaking factory in China in 2010 (Krazit, 2007) that at first will focus on lower-level chipsets.

What can be done to kill viruses? A chief selling point of Microsoft's Vista was its ability to thwart viruses, Trojan horses, and worms. The evil people who write malware are still aiming at Microsoft-designed software, meaning computer users must remain on the watch. While most virus writers aim at Microsoft-designed systems because they dominate the desktop, Apple software has also become a target as it gains wider acceptance.

Will piracy ebb? More than one-third of the business software used in the world during 2006 was pirated, representing a loss of \$40 billion for software companies (Business Software Alliance, 2007). The industry trade group notes that while one-third of all computers are shipped to developing nations, those nations buy just 10% of all software. Companies continue to find a sweet spot between making piracy easy and making registration and copy-protection schemes too onerous for users.

Fewer wires. More computers and peripherals, such as mice and keyboards, are using the Bluetooth standard of wireless connectivity. A faster technology—Wireless USB, which can transmit up to 110 megabits of data per second with signal strength up to 30 feet—became a standard in 2006 (Shankland, 2006). But devices have been few in coming. While Apple has had the technology for several years, some non-Apple laptop computer companies said they will include the technology on machines in 2008, which will let PCs send data to a printer wirelessly (Kessler, 2007c).

Will TVs and PCs merge? Computer companies for years have sought to move the PC out of the home study and into the entertainment room. Early efforts failed, but PC companies are encouraged by better hardware, digital video recorders, wireless home networks, flat-panel monitors that double as TV sets, and the movement of entertainment software onto digital formats. New versions of operating systems—not to mention the burgeoning number of online services that deliver TV-like content to computers—are putting more faces in front of computer screens than ever. Researchers note that the fundamental differences between computers and televisions make it difficult for one technology to be used as the other (one example: computer users sit much closer to the screen than television users) (Morrison & Krugman, 2001).

Will multifunction wireless phones, or other mobile devices, replace some laptops? Nearly half of business travelers will keep their laptops at home by 2012, according to a Gartner (2008a) prediction. Powerful phones running on Palm, Windows Mobile, and other software platforms already make redundant some laptop

uses. Gartner notes that tiny, Web-driven devices that cost less than \$400—as well as Web services that let you access your data and software from anywhere—will help workers sometimes ditch their laptops.

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Video Games

Brant Guillory*

Video gaming has expanded from a small university time-waster to a multibillion dollar industry that includes a variety of hardware and software, as well as multiple delivery and distribution models. Video games have inspired movie franchises, novels, and television shows. The opening day sales of *Halo 3* for Microsoft's Xbox 360 of \$170 million outpaced the opening day sales of the largest-ever weekend movie gross (*SpiderMan 3*) and the first-day sales of the final Harry Potter book (Zabek, 2008; Nystedt, 2007).

"Video games" as a catch-all term includes games with a visual (and usually audio) stimulus, played through a digitally-mediated system. Video games are available as software for other digital systems (home computers, cell phones), standalone systems (arcade cabinets), or software for gaming-specific systems (platforms). There have been tentative forays into games delivered through set-top boxes and digital integration with offline games.

A video game system will have some form of display, a microprocessor, the game software, and some form of input device. The microprocessor may be shared with other functions in the device. Input devices have also evolved in sophistication from simple one-button joysticks or computer keyboards to replicas of aircraft cockpits and race cars, as well as new controllers integrating haptic feedback (enabling users to "feel" aspects of a game).

Background

Video gaming has advanced hand-in-hand with the increases in computing power over the past 50 years. Some might even argue that video games have pushed the boundaries of computer processors in their quest for ever-sharper graphics and increased speed in gameplay. From their early creation on large mainframe com-

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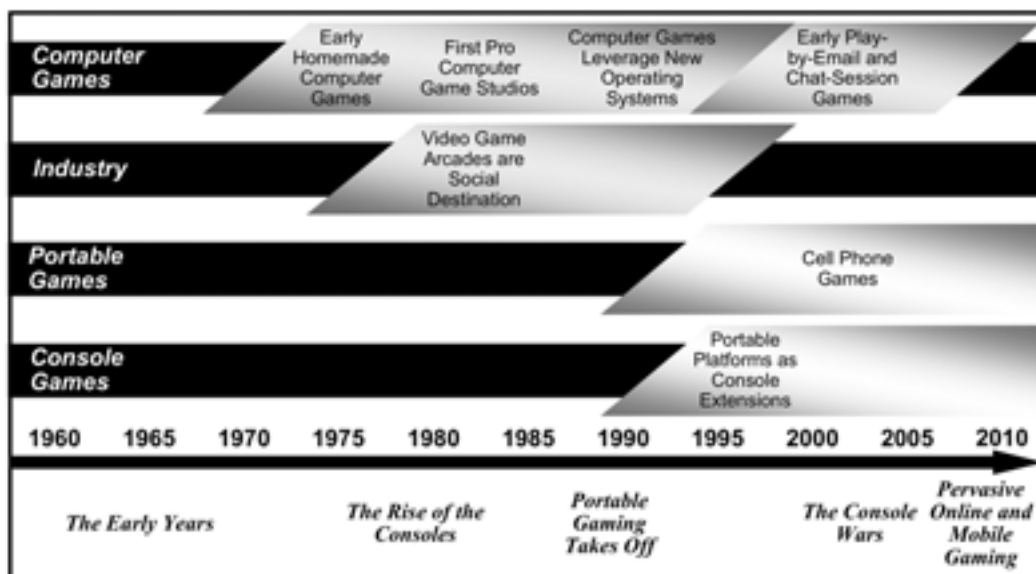
puters, video games evolved through a variety of platforms, including standalone arcade-style machines, personal computers, and dedicated home gaming platforms.

As media properties, video games have shared characters, settings, and worlds with movies, novels, comic books, non-digital games, and television shows. In addition to a standalone form of entertainment, video games are often an expected and planned facet of a marketing campaign for new major movie releases. The media licensing has become a two-way street, with video game characters and stories branching out into books and movies as well.

As video gaming has spread throughout the world, the culture of video gaming has spawned over two dozen magazines and countless Web sites, as well as several major industry conventions, professional competitions, and a cottage industry in online “farming” of in-game items in massive multiplayer online role-playing games (MMORPGs).

Although some observers have divided the history of video games into seven, nine, or even 14 different phases, many of these can be collapsed into just a few broader eras, as illustrated in Figure 12.1, each containing a variety of significant milestones. Most histories of video games focus on the hardware requirements for the games, which frequently drove where and how the games were played. However, it is equally possible to divide the history of games by the advances in software (and changes in the style of gameplay), the diffusion of games among the population (and the changes in the playing audience), or the increases in economic power wielded by video games, measured by the other industries overtaken through the years. Regardless of the chosen path, as the history of video games developed, however, it became increasingly fragmented into specialty niches.

Figure 12.1
Video Game Chronology



Source: Guillory (2008)

Most industry observers describe the current generation of home gaming consoles as the seventh generation since the release of the first-generation Magnavox Odyssey. Handheld consoles are often said to be on their fourth generation. No one has yet attempted to assign “generations” to computer gaming software, in large part, because console “generations” are hardware-based and released in specific waves, while computer hardware is continually evolving, and major computer milestones are the releases of new operating systems (Windows Vista, Mac OS X, etc).

The early years of video gaming were marked by small hobby programs, many developed on large university and corporate mainframes. Willy Higenbotham, a nuclear physicist with the Department of Energy, had experimented with a simple tennis game for which he had developed a rudimentary analog computer (Anderson, 1983). A team of designers under Ralph Baer developed a variety of video game projects for the Department of Defense in the mid-1960s, eventually resulting in a hockey game, which left their military sponsors nonplussed (Hart, 1996). Baer also led another team that developed *Chase*, the first video game credited with the ability to display on a standard television set. In the early 1960s, *SpaceWar* was also popular among the graduate students at MIT and inspired other work at the Pentagon. Although many different treatises have been written arguing over the invention of the video game, it is still unclear how much, if at all, any of the early video game pioneers even knew of each others' work; it is completely unknown if they drew any inspiration from each other.

In the early 1970s, dedicated gaming consoles began to appear, starting with the Magnavox Odyssey in 1972. Built on switches, rather than a microprocessor, the Odyssey included a variety of “analog” components to be used in playing the video portions of the game, such as dice, play money, and plastic overlays for a common touchpad. The first home video game product built on a microprocessor was a home version of the popular coin-operated *Pong* game from Nolan Bushnell's Atari. Although it contained only one game, *Pong*, hard-coded into the set, it would be a popular product until the introduction of a console that could play multiple games by swapping out software (Hart, 1996).

The second generation of video gaming began approximately in 1977 with the rise of consoles. The Atari 2600 led the market for home video game sales, in which consumers would purchase a standard console and swap insert cartridges to play different games. While Colecovision and Intellivision (two other consoles) were popular in the market, nothing could compare with the market power wielded by Atari (which was purchased by Warner Communications) from 1977 to 1982, during which an estimated \$4 billion of Atari products were sold (Kent, 2001). During this time, Atari also pioneered the media license tie-in with other Warner Communications products, such as the popular movie licenses for *E.T. The Extra-Terrestrial*, and *Raiders of the Lost Ark*. Atari's success also led to the formation of Activision, a software company founded by disgruntled Atari game programmers. Activision became the first major game studio that designed their games exclusively for other companies' consoles, thus separating the games and consoles for the first time.

After a brief downturn in the market from 1981 to 1984, mostly as a result of business blunders by Atari, home video game consoles began a resurgence. Triggered by the launch of the Sega Master System in the mid-1980s, and the Nintendo Entertainment System (NES) shortly thereafter, home video game sales continued to climb for both the games and the hardware needed to play them. The inclusion of 8-bit processors closed the gap between the performance of large standalone arcade machines and the smaller home consoles with multiple games and signaled the start of the decline of the video game arcade as a game-playing destination. By 1987, the NES was the best-selling toy in the United States (Smith, 1999).

During this time, video games also began to appear in popular culture not as mere accessories to the characters, but as central plots around which the stories were built. *Tron* (1982), *War Games* (1983), and *The Last Starfighter* (1984) all brought video gaming into a central role in their respective movie plots.

Computer games were also developing alongside video game consoles. Catering to a smaller market, computer games were seen as an add-on to hardware already in the home, rather than the primary reason for purchasing a home computer system. However, the ability to write programs for home computers enabled consumers to also become game designers and share their creations with other computer users. Thus, a generation of schoolkids grew up learning to program games on Commodore PET, Atari 800, and Apple II home computers.

The commercial success of the Commodore 64 in the mid-1980s gave game publishers a color system for their games, and the Apple Macintosh's point-and-click interface allowed designers to incorporate the standard system hardware into their game designs, without requiring add-on joysticks or other special controllers. Where console games were almost exclusively graphics-oriented, early computer games included a significant number of text-based adventure games, such as *Zork* and *Bard's Tale*, and a large number of military-themed board games converted for play on the computer by companies such as SSI (Falk, 2004). In 1988, the first of several TSR-licensed games for *Dungeons & Dragons* appeared, and SSI's profile continued to grow. Other prominent early computer game publishers included Sierra, Broderbund, and Infocom, among others. Nevertheless, home computer game sales continued to lag behind console game sales, in large part, because of the comparatively high cost and limited penetration of the hardware.

With video games ensconced in U.S. and Japanese households and expanding worldwide, it was only a matter of time before portable consoles began to rival the home siblings in quality and sophistication, and thus began the third phase in the history of video games.

Portable video games proliferated in the consumer marketplace beginning in the early 1980s. However, early handhelds were characterized by very rudimentary graphics used for one game in each handheld. In fact, "rudimentary" may even be generous in describing the graphics—the early Mattel handheld *Electronic Football* game starred several small red "blips" on a one-inch-by-three-inch screen in which the game player's avatar on the screen was distinguished only by the brightness of the blip.

Atari released the Lynx handheld game system in 1987. Despite its color graphics and relatively high-speed processor, tepid support from Atari and third-party developers resulted in its eventual disappearance from the marketplace. In 1989, Nintendo released Game Boy, a portable system whose controls mimicked the NES. With its low cost and stable of well-known titles ported from the main NES, the Game Boy became a major force in video game sales (Stahl, 2003). Although technically inferior to the Lynx—black-and-white graphics, dull display, and a slower processor—the vast number of Nintendo titles for the Game Boy provided a major leg up on other handheld systems, as audiences were already familiar and comfortable with Nintendo as a game company. Sega's Gamegear followed within a year. Like the Lynx before it, superior graphics were not enough to overcome Nintendo's catalog of software titles or the head start in the market the Game Boy already had. By the mid-1990s, most families that owned a home game console also owned a handheld, often from the same company.

Although the portable revolution did not (yet) migrate to computer gaming, it was hardware limitations, rather than game design, that prevented the integration of computer games into portable systems. The release of the Palm series of handheld computers (Hormby, 2007) gave game designers a new platform on which they

could develop that was not tied to any particular company. This early step toward handheld computing would include early steps toward handheld computer gaming.

The third and fourth generations of video game history begin to overlap as the console wars included the handheld products of various console manufacturers, coinciding with the release of Windows 95 for Intel-powered PC computers, which gave game designers a variety of stable platforms on which to program their games. The console wars of the late 1990s have continued to today, with independent game design studios developing their products across a variety of platforms.

As Nintendo began to force Sega out of the platform market in the mid-1990s, another consumer electronics giant—Sony—was preparing to enter the market. With the launch of the Playstation in 1995, Sony plunged into the video game platform market. Nintendo maintained a close hold on the titles it would approve for development on its system, attempting to position itself primarily as a “family” entertainment system. Sony developers, however, had the ability to pursue more mature content, and their stable of titles included several whose graphics, stories, and themes were clearly intended for the 30-year-old adults who began playing video games in 1980, rather than 13-year-old kids (Stahl, 2003). Sony and Nintendo (and to a lesser extent, Sega) continued their game of one-upmanship with their improvements in hardware over the next several years. By early 2001, Sega admitted defeat in the hardware arena and focused instead on software. The next salvo in the platform wars was about to be launched by Microsoft, who debuted the Xbox in late 2001.

With built-in networking and a large hard drive, Microsoft’s Xbox began to blur the lines between computer video gaming and platform-based video gaming. Additionally, building their console on an Intel processor eased the transition for games from PC to Xbox, and many popular computer titles were easily moved onto the Xbox. Around the same time, Sony entered the handheld arena to challenge Nintendo’s Game Boy dominance with the PSP: PlayStation Portable. Capable of playing games as well as watching movies and (with an adapter) having online access, the PSP was intended to show the limitations of the Game Boy series with its greater number of features. Although the platform wars continue today, every one of them supports networked gaming, the cusp of the fifth generation of video gaming.

With high-speed data networks proliferating throughout North America, Japan, Korea, Western Europe, and (to a lesser extent) China and Southeast Asia, online gameplay has become a major attraction to many video gamers. MMORPGs offer pervasive worlds to players, and dedicated servers host shared versions of a variety of different games, including sports, military, and sci-fi and fantasy games. Wireless networking has also extended the ability to participate in online-based games to handhelds, both dedicated to gaming (Nintendo DS) and consumer-oriented (personal digital assistants and cell phones). Moreover, many software-specific companies have designed their online game servers such that the players’ platforms are irrelevant, and thus gamers playing on an Xbox might compete against other gamers online who are using PCs.

The 2006 release of Nintendo’s Wii game console has drawn in a new video game audience by attracting large numbers of older users to the motion-based games enabled by the Wii’s motion-sensitive remote. Not long after its release, the Wii began to appear on the evening network news as a new activity in senior citizens homes and in stories about children and grandparents sharing the game (Potter, 2008). Although graphically inferior to the Xbox or PS3, the Wii has developed an audience of players who had never tried video gaming before.

While computer-based video gaming continues to expand, many titles are released on multiple platforms, and computer-only games tend to be those with a high number of input requirements, as a keyboard and mouse offer players greater input options than the limited buttons on console controllers.

Recent Developments

By some estimates, video games may be in their seventh, tenth, or twelfth generation. Those generations have been collapsed into five for this chapter: the early years, the rise of the consoles and computer games, portable gaming, the console wars, and pervasive online gaming. Computer gaming roughly followed this same trajectory, although the introduction of portable computer gaming lags behind for hardware reasons. While the fourth generation described above is still ongoing, it seems as though the market has stabilized in that the three current major players in the console market (Nintendo, Microsoft, and Sony) appear likely to remain in the market for the long term. Similarly, with three major computer platforms (Windows, Macintosh, and UNIX/Linux), computer gamers are expected to have a variety of choices for the foreseeable future as well.

The wide availability of broadband connections has resulted in many software companies selling games online directly to the consumer (especially for computer gaming), with manuals and other play aids available as printable files for those players who wish to do so. Matrix Games (a major publisher of digital strategy games) sells virtually every title as a download directly to their customers, and many other software makers sell their software either directly or through online stores. These sales are *not* simply mail-orders of physical copies, but actual direct-to-PC downloads. This direct-to-consumer sales route has reduced the dependence on the local computer software store for computer games; these stores have reacted by stocking more console games.

Regulatory Environment—First Amendment Meets Outraged Parents

For a variety of reasons, legislation continues to be introduced that seeks to restrict or limit the sales of certain video games, either in all forms, or to particular audiences (usually children). At least eight states have had laws targeting video games overturned or blocked (Walters, 2008a). For example, a 2006 law in Oklahoma sought to restrict the sale of games that contained “inappropriate violence.” This law was overturned in federal court as violating the First Amendment (Price, 2007).

As of mid-2008, there are at least three other federal statutes in the legislative process that could in some way restrict or inhibit the sales of video games. In addition, there are several currently under consideration at the state level (Walters, 2008b).

The phenomenon is not limited to the United States. A judge in Brazil banned the video game *Bully* because of its violent content (Azonni, 2008). Singapore banned the science fiction game *Mass Effect* because of a lesbian scene (Associated Press, 2007b), although the ban was later lifted (Wai-Leng, 2007). As of 2008, the European Union is considering a variety of legislation to limit the exposure of young children to a variety of video games (Cendrowicz, 2008).

Game System as Entertainment Hub

With the release of the latest generation of consoles, all three major manufacturers have included a variety of functionality intended to extend the usefulness of their consoles beyond mere gameplay. Microsoft's Xbox

includes the ability to connect to Windows Media Center PCs and the Xbox Live Marketplace to download or stream content through the Xbox 360 (Microsoft, 2008). Sony's PlayStation 3 includes a Blu-ray DVD player for high-definition movies in the Blu-ray format (Sony, 2008). Some retailers actually complained during the 2007 holiday shopping season that Sony's discounts on their PS3 systems were undercutting the sales of stand-alone Blu-ray DVD players, as customers were buying a PS3 as a DVD player and treating the game-playing capabilities as a secondary feature. Nintendo's Wii console includes the ability to play games online and browse Internet Webpages through the same connection (Nintendo, 2008).

Pervasive Mobile Gaming

With the increase in computing power available in handsets, mobile gaming has split along two lines. First, Nintendo and Sony both have handheld game platforms with wireless capability built in, allowing for head-to-head gameplay with other nearby systems, as well as shared gameplay through an Internet connection, where available. In addition, mobile phone handsets have sufficient computing power to allow for a variety of gaming. Nokia's N-Gage phone, while critically panned, showed that handheld multipurpose systems—such as a mobile smart phone—possessed sufficient memory and processor speed for true gaming (Carnoy, 2006). Most important, the portability of gaming, whether on a cell phone, a PDA, or a dedicated handheld platform, ensures that gamers have the ability to play regardless of their locations.

The Rise of the MMORPG

Although MMORPGs have been available since networked computing began in the 1980s, wide diffusion of games did not begin until the widespread diffusion of home Internet access. Originally offering fantasy worlds such as *Ultima Online* and *EverQuest*, MMORPGs are now available for science-fiction, comic-book, and military themes, as well as everyday life, such as *The Sims*. MMORPGs are most commonly accessed through computer platforms rather than game consoles. Since its launch in 2004, *World of Warcraft* has grown to exceed 10 million simultaneous subscribers at any one time, though their rate of subscriber turnover continues to be high. Of the 10 most popular computer software products in sales in 2007, the top two were both for *World of Warcraft*, and five of the remaining eight were expansions for *The Sims* (Linde, 2008).

MMORPGs have highly-developed in-game economies, and those economies have begun to spill over into the "real world." Web sites and online classified listings offer game-world items, money, and characters for sale to players seeking an edge in the game but are reluctant to sacrifice the time to earn the rewards themselves. Fans' reactions have not been universally positive to these developments, and some have started petitions to ban such behavior from the games (Burstein, 2008).

Current Status

No new platforms have been released since late 2006, although the three major platforms have all received upgrades to their current configurations. Because consoles are primarily dependent on their software to maintain customer interest, constant hardware upgrades may not be as necessary, and in fact might be considered detrimental to sales if the consoles are not backward-compatible with older games in the same product family.

In 2007, sales of games and game consoles totaled nearly \$18 billion; games for both consoles and computers totaled \$9.5 billion of that (Zabek, 2008). One reason for the tremendous growth in sales (almost 40%

above the previous year) was the diffusion of several new consoles after the 2006 holiday season, including the Wii and PlayStation 3, as well as long-anticipated games such as *Halo 3*.

As of mid-2008, the total number of consoles in the U.S. user base was 7.4 million for the Nintendo Wii and 9.2 million for the Xbox 360. Sony's user base for the PlayStation 3 was approximately 3.3 million, but the PS3 continued to be outsold by the less expensive PS2 (Hillis, 2008).

Following the success of *America's Army* as a game and a recruiting tool for the U.S. Army, the U.S. Air Force and Navy soon followed suit (Peck, 2005), and other organizations, such as police departments, the U.S. Border Patrol, U.K. Ministry of Defense, and the Canadian Land Forces have all launched similar projects. An extension of in-game advertising, these video games (dubbed "advergams" by some) have proven to be controversial for a variety of reasons, such as the supposed targeting of impressionable youth and glorification of violence. They have also been adopted by a variety of questionable organizations, such as the game *Special Force*, which is used as a recruiting tool by Hezbollah in Lebanon. These games have also become the subject of interest for several researchers, who have sought to understand and describe the potential effects on game players (Moon, et al., 2006).

"Gamer parents" have recently become a phenomenon of interest. Often used as a buttress against the argument that "video games are for kids," gamer parents are those game players that grew up with a game console in their houses and are now raising their own children with consoles in the house. The average game player is 33 years old, and 36% of American parents claim to play video games, with 80% of them playing with their children (ESA, 2008). Although legislative action has often been touted as a remedy for inhibiting access to video games that legislators feel is inappropriate, gamer parents have repeatedly noted that they are intimately familiar with video games and capable of making informed choices about their children's access to video games. In addition, gamer parents tend to take the lead in game purchases for their households, thus making them a valuable target for the corporate marketing machines.

As noted above, legislative action against video games continues in multiple venues. Not every legislative action is opposed by industry trade groups, however. The Entertainment Software Association has consistently supported measures designed to prohibit access to sexually explicit games by minors, as well as supporting legislation that increases access to ratings information for consumers (Walters, 2008b). However, no serious law intended to severely limit the access of games to any large segment of the population has yet stood up to judicial scrutiny.

Independent game design firms continue to work with all three console manufacturers and, in some cases, with computer software companies, as well. Often, the console companies acquired game design studios to create uniquely-licensed games, such as Bungie's *Halo* series for the Xbox (Associated Press, 2007a). Other games, such as Electronic Arts' popular licensed sports games tied into the major American sports leagues (NFL, NBA, etc.) are available for any of the consoles, as well as some computer systems. In general, Nintendo is seen as very protective of its brand name, and it enforces strict controls on the games developed for their console, while Sony and Microsoft both allow developers to create more mature themed games with more explicit graphics than does Nintendo.

Factors to Watch

Industry-watchers have looked to Microsoft for several years in anticipation of an expected foray into mobile, handheld gaming to compete with platforms from Nintendo (Game Boy series) and Sony (PSP). An expected handheld product from 2006 turned out to be the Zune music player and, as of mid-2008, Microsoft has not yet announced a mobile gaming device. Microsoft has also not made any moves to leverage the wide user base for its Windows Mobile software currently running on several million PDAs and smart phones. Possible reasons for the delay include issues of compatibility with Vista (which also plagued the Zune), licensing agreements for software titles, or the possibility that Microsoft really does not have a product, which seems least likely.

While the industry was watching Microsoft in anticipation of a yet-to-appear handheld device, Apple's iPhone has excited a variety of developers with its motion sensors, multi-touch screen, microphone, and haptic feedback (Schramm, 2008). Apple has come under some criticism for its strict licensing of software development kits to developers and their tight controls on software to consumers. Developers, however, seem willing to work within Apple's constraints to create software. It remains to be seen when, or if, developers begin to release games designed to leverage the iPhone's unique characteristics.

The growth in the numbers of women playing video games is expected to continue to accelerate. Currently 38% of the game-playing public, women over 18 actually represent a greater share of the market (31%) than young males under 17 (20%). While there is anecdotal evidence that women prefer computer games over console games, this difference may be driven by the availability of certain titles such as *The Sims* rather than any hardware preferences (ESA, 2008). The online titles favored by women are dependent not only on the continued diffusion of the software, but also on the continued diffusion of the high-speed Internet access needed to enable the online environment.

Government funding of new projects with video game developers will also continue as sponsors search for projects applicable to their specific fields. The U.S. Army established an office specifically designed to leverage video game technology for training purposes (Peck, 2007) and is expanding the use of commercial off-the-shelf (COTS) games for a variety of teaching purposes. The U.S. Marine Corps continues to lead the services in the adoption and integration of various COTS games for training purposes. With VBS-2 already in use, the USMC integrated a language module for it that allows for voice-recognition interaction with computer-controlled characters within the game. They have also committed to a long-term, multimillion dollar project to attempt to create a "holodeck" for soldier training, not unlike the simulation environment from the popular *Star Trek: The Next Generation* television series (P. Nichols, personal communication, March 6, 2008).

Legislators will continue to react to media coverage of parental concern about video game content. Despite the overwhelming proliferation of demographics describing adult video game players and the usage of video games in training for the military and public safety sectors, many news outlets and legislators continue to view video games as toys for kids, and make no distinction in subject matter between mature-themed games and games clearly targeted at children. As a result, legislators will continue to refine their legal approaches in an attempt to craft laws that restrict video game sales to minors or through certain outlets, without running afoul of federal court rulings based on the First Amendment. Similar actions should be expected overseas, as well, where First Amendment protections do not apply. However, given the international nature of the digital communications used by many video game players (especially computer game players with desktop broadband

Internet access), these actions are likely to result only in restricting open, commercial sales of such games, not their overall diffusion in the marketplace.

All three major consoles and many computer games allow for collaborative online play. Expect to see two developments in this area. First, as game titles proliferate across platforms, expect to see more games capable of sharing an online game across those platforms, allowing a player on the Xbox to match up against an opponent on a PC system, as both players communicate through a common back-end server. Second, many of these online systems, such as the Xbox Live, already allow voice conversations during the game through a voice over Internet protocol system. As more digital cameras are incorporated into consoles, either as an integrated component or an aftermarket peripheral, expect these services to start offering some form of videoconferencing, especially for players involved in games such as chess, poker, or other “tabletop” games being played on a digital system.

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Virtual & Augmented Reality

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After more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. Rapidly, we approach the final phase of the extensions of man—the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society (McLuhan, 1994).

Virtual reality (VR) and augmented reality (AR) are complex combinations of computer technology, virtual reality hardware, and artistic vision. Augmented reality (also called mixed reality) is the popular term for using computers to overlay virtual information onto the real world. If you look at virtual reality and true reality as two ends of a spectrum, AR would fall somewhere between the two. By contrast, true virtual reality allows for all human sensory systems to be stimulated in such a way as to allow for complete immersion into a computer-generated realm (Lentz, et al., 2006). In other words, AR simply enhances the real environment, whereas VR replaces it (Tang, et al., 2003; Barfield & Caudell, 2001). Although VR receives much media attention, AR may prove to be more useful, especially with the added range of information supplied from sources such as the Internet (Augmented reality, n.d.).

In its most basic form, VR represents “the forward edge of multimedia” computing (Biocca & Meyer, 1994, p. 185). Imagine being able to walk on, see, and touch the moon; fly an F-14 fighter plane; enter a human aorta; overcome your fear of public speaking; or perform a delicate surgical procedure without fear of error. All of these experiences can be achieved through the realm of virtual reality.

Virtual reality systems are comprised of three basic components: high levels of user interactivity; high-quality, three-dimensional (3D), computer-generated images; and varying levels of user immersion. The last of these is dependent upon the complexity of the VR interface (Pimental & Teixeira, 1995).

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Biocca and Meyer (1994) say that a prototypical VR system consists of:

- 1) A computer that generates and keeps track of virtual objects and renders new images as the user navigates through the virtual environment.
- 2) Output devices such as a head-mounted display with earphones (see Figure 13.1).
- 3) Input devices or sensors, such as datagloves, that detect the actions of the user.

A piece of data sent or received by any of the three components causes a change in the other components.

Figure 13.1
Head-Mounted Display



Source: Biocca, M.I.N.D.labs

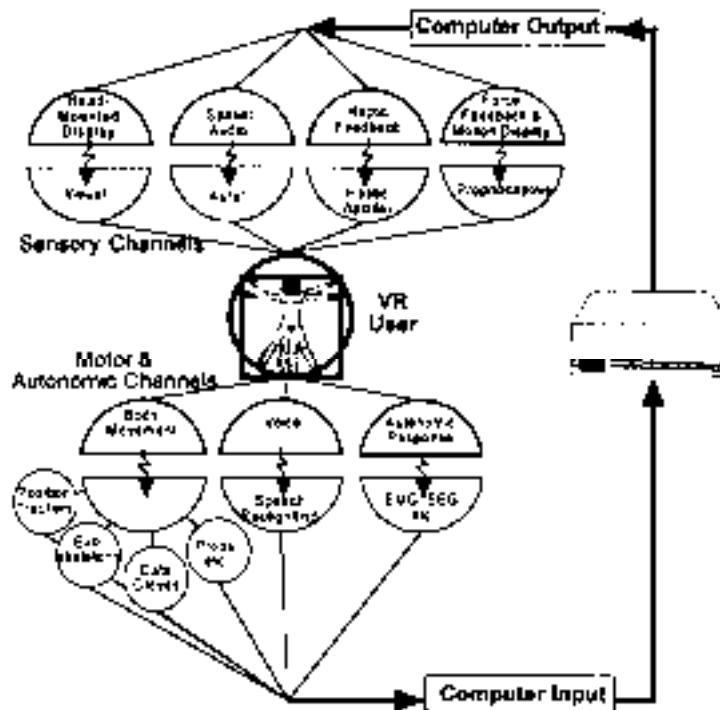
The virtual reality experience begins with the creation of a virtual environment (VE). This is done by using computer technology to create realistic 3D graphics. Someone wishing to enter a VE will utilize both output devices (to see and hear) and input devices (to touch and move). At this point, information has been sent only from the computer to the output device. Once the user sees the environment, he or she can make decisions as to how to navigate through the environment. As the user “moves” through the VE, information is sent from the input device back to the computer. Once the computer receives this information, it renders a new VE image, and the process begins again. Figure 13.2 illustrates this process.

Background

The term “virtual reality” was first coined by Jaron Lanier founder of VPL Research in 1989 (Heudin, 1999). However, there is some argument as to when the concept of virtual reality first began. Some believe the concept began with vehicle simulators in the 1920s (Hillis, 1999). Others believe that Morton Heilig’s invention of “Sensorama” in the mid-1950s was the starting point for VR (Welter, 1990). The Sensorama was an arcade-style attraction that allowed users to put their eyes to two stereo mounted lenses. Users would grasp motorcycle

handlebars and watch a “movie” of Manhattan traffic. The seat and handlebars would vibrate while the movie gave users the illusion of riding through the city streets (Welter, 1990). Horn (1991) points to Tom Furness’ work at Wright-Patterson Air Force Base in 1966 as the launching point of VR. Furness experimented with new methods of displaying visual information for the purposes of flight simulation.

Figure 13.2
Virtual Reality Experience



Source: Biocca, M.I.N.D.labs

Despite the argument surrounding the origins of VR, it is clear that sufficient expertise existed by the 1960s to move the concept of VR to the next level. Douglass Engelbart, a scientist exploring the idea of interfacing humans and computers, developed the idea of using computer screens as input and output devices (Pimental & Teixeira, 1995). Engelbart’s work led to Ivan Sutherland’s work on the “ultimate display.” Also called a “kinesthetic display,” it allowed the user to interact with the computer (Sutherland, 1965). Such a display, as Sutherland envisioned, would be a room where objects could be completely controlled by a computer (Sutherland, 1965).

Sutherland’s idea of the kinesthetic display led him to propose a system described as a “head-mounted three-dimensional display” (Sutherland, 1968). This display showed a slightly different, two-dimensional image to each eye. The brain would fuse the two images together to form a realistic 3D image. As the user’s head moved, the images changed. In addition to creating one of the first head-mounted displays (HMDs), Sutherland worked on VR developments in flight simulation (Hillis, 1999).

In the early 1970s, the entertainment industry began shaping this technology into what it is today. Movie-makers began using computers to generate thrilling special effects. The increased ability of computers to generate graphics led to various forms of data being displayed as dynamic images. For example, instead of looking at such things as DNA in the form of a pie chart, it was now possible to see a three-dimensional representation of an entire strand of DNA. Despite these advancements, one key component of virtual reality was still missing—interactivity (Mitchell, 1996).

By the late 1970s, the military had developed HMDs capable of real-time visual feedback, and computers were producing more and more sophisticated graphics (Pimental & Teixeira, 1995). When the two sides meshed in the early 1980s, the first primitive versions of virtual reality, complete with three-dimensional graphics and interactivity, emerged (Mitchell, 1996).

In the years that followed, there were no changes in the actual tenets of virtual reality technology. Instead, changes came in the level of sophistication available in virtual reality systems and with an increase in the applications of this technology.

Recent Developments

Virtual reality, as a technology, continues to become more pervasive in today's society. Specifically, VR has made its way into home video game consoles (see Nintendo's Wii, discussed in Chapter 12). However, as innovative as the Wii is, it is important to understand that it is not nearly as sophisticated as a "true" VR system. Uses of VR and AR technology continue to grow, and technological improvements have continued to make this technology more powerful, more precise, and more flexible. However, despite decreasing prices, costs of true VR and AR technology remain high. As a result, the main users of and investors in VR and AR technology continue to be large organizations such as the military and the aerospace industry. The most significant changes in VR and AR technology have come in the following areas: video games, image generation, displays, tracking, haptics and tactile devices, and augmented reality.

Video Games

Although VR technology has been around for some time, it has typically been available only to large companies or organizations. Cost has been a limiting factor. However, as with most technologies, over time, prices drop. While consumer applications of VR technology are not at the same level as high-end VR systems, this technology is, nonetheless, available for the home. The Nintendo Wii is a home video game console that incorporates elements of virtual reality. Instead of using controllers with buttons and joysticks, the Wii uses a wireless motion activated controller. This controller allows users to "throw" a ball, "swing" a tennis racket, or "punch" an opponent while boxing. While not as sensitive or accurate as a more sophisticated VR system, it does give users a sense of realism not present in other games. According to Romero (2006), these controllers utilize small accelerometers. Within these chips is a small silicone wafer anchored by tiny silicone springs. As the controller is waved about, the wafer presses against the springs. The faster the controller is moved, the faster the wafer moves. A small accelerator is also housed within the controller that monitors the motion of the wafer. It does so by measuring capacitance in different directions. "Using capacitance to measure how far and in what direction the wafer moves, the system translates your real-life movements into the perfect jab to your opponent's face" (Romero, 2006)—virtually speaking, of course.

If punching an opponent in the face is not for you, how about creating an entirely new identity? Second Life is a 3D virtual reality where participants can create their own "identity" (or character) called an avatar. As a Second Life resident, you can explore all types of virtual environments. You can purchase "virtual land" (with not so virtual money) to open a business or create your own virtual paradise. Second Life is not a game. It truly is a real experience using virtual environments, and it is not the only game in town.

Shields (2007) says that other virtual worlds such as Gaia Online, Club Penguin, and There.com are growing in popularity. These Web-based virtual worlds include, in addition to social networking options, sales of virtual goods and real-world e-commerce. Hampp (2007) says that "...the consumer appetite for putting a real-life spin on everyday digital activities has never been higher" (p. 10). Marketers are trying to cash in. He says "... marketers were tripping over themselves to get their brands into the video-esque virtual world, where users can create real-life versions of themselves to live out their virtual fantasies, all the while interacting with real-life brands" (p. 10).

Image Generation

At the heart of any VR or AR system is a high-speed computer capable of generating ultra-realistic graphics. These systems must be powerful enough to allow the computer to make changes to the virtual environment at a speed that appears to be realistic to the user. Silicon Graphics, Inc. has been a leader in visualization solutions. In April 2008, SGI launched its latest visualization solution, the Virtu VN200. They claim that their new arrival is "designed to power the performance visualization needs of today's HPC (high-performance computing) and commercial business users" (Silicon Graphics, n.d.).

Because of the complexity of the data that needs to be processed and the speed at which it needs to be processed, these supercomputer systems must be extremely powerful. It is, therefore, not uncommon for this type of system to cost more than \$100,000. However, the processor is just one part of the overall system. The end user, much like an ordinary computer user, still needs a monitor. In the case of VR systems, "monitors" (or displays as they are most often called) must also be highly unique.

Displays

Virtual reality displays vary depending upon their level of immersion. Displays such as head-mounted displays (HMDs), head-mounted projection displays (HMPDs), and computer automated virtual environments (CAVEs) have been in existence for some time and have a relatively high level of immersion. Others, such as workbenches and traditional computer monitors, have a relatively low level of immersion.

HMDs continue to be the most popular form of VR display. These units are worn on the head and have small liquid crystal displays (LCDs) covering each eye. They also have stereo headphones covering each ear (NVIS, n.d.-a).

CAVEs were developed by the Electronic Visualization Laboratory (n.d.) at the University of Illinois, Chicago in 1992. A CAVE is a type of stereovision system using multiple displays. Instead of wearing an HMD, the user is surrounded by images presented on three to six large screens.

A newer type of display is the head-mounted projection display. NVIS unveiled the P50 HMPD at the 2005 Interservice/Industry Training, Simulation and Education Conference. This display is similar to standard HMDs, but instead of projecting images into the user's eyes, it projects images onto a retro-reflective screen

that is placed in front of the user's eyes. Figure 13.3 shows a second-generation prototype of the HMPD. The images are then reflected toward the user, independent of the user's viewing angle (NVIS, n.d.-b). As with most VR components, HMPDs are not cheap. The P50 lists for just under \$35,000.

Two primary applications for the HMPD have currently been identified. The primary function is to allow for out-the-window simulation. According to Marc Foglia of NVIS, "the use of screens for virtual image isolation provides out-the-window images in precisely the correct locations without 'leakage' into the cockpit environment" (Foglia, personal communication, April 13, 2006). Multiple users wearing these devices will each have a unique perspective when viewing the virtual environment.

Perhaps the most exciting display, however, is newer still. Engineers at the University of Washington have created a VR/AR display in the form of contact lenses. While still being tested, early results are encouraging. Uses for this type of display abound. The lenses could allow video gamers to become completely immersed in a virtual environment without suffering a restriction in their range of motion. Internet users could use the display to surf the Internet while walking about (Contact lenses, 2008).

Figure 13.3
Head-Mounted Projection Display



Source: NVIS, Inc.

Tracking

The principal component for virtual reality eye tracking research is an HMD-fitted binocular eye tracker, built jointly by Virtual Research and ISCAN. Unlike typical monocular ("single-eye") devices, the binocular eye tracker allows the measurement of vergence eye movements, which, in turn, provides the capability for calculating the three-dimensional world coordinates of the user's gaze (Virtual Reality Eye Tracking Laboratory, n.d.). Vergence eye movement is used to calibrate the action an HMD wearer sees. Think about the contraption your optometrist uses when checking your eyes. When he or she closes off one eye, the object you are looking at appears to be in a certain place. When he or she closes off the other eye, the same object appears to be in a different place. When both eyes are unblocked, the object appears to be in yet a third location. Measuring ver-

gence eye movement provides an accurate read on exactly where both eyes are looking. This measurement helps to more accurately track the eye movement and yields, at least in theory, a more accurate VR image.

Haptics and Tactile Devices

Haptic and tactile devices enable users to experience artificially created tactile sensations in response to movement. A haptic display can recreate the experience caused by contact between a tool and an object. This capability is useful in a variety of applications, such as surgical simulators, because when haptic simulation is combined with a graphic simulation, an enhanced sense of realism is created (Mahvash & Hayward, 2004). Doing this requires significant computer power. To put it into perspective, consider that television signals are created using 30 frames per second. Relatively clear VR images can be created using 20 frames per second. Tactile functions, however, require more than 1,000 frames per second. Nonetheless, haptic devices have evolved from primitive units with as little as two degrees of freedom (directions the device can move) to the Freedom 7S from MPB Communications (n.d.) that provides high-fidelity force feedback in seven degrees of freedom, giving the user an increasingly realistic sense of touch.

Improved haptic technology coupled with improved software has allowed for highly advanced tactile functions. Researchers in Europe have created an interface that allows users to "touch, stretch and pull virtual fabrics that feel like the real thing" (Haptics, 2008). Researchers at Carnegie Mellon University have created a haptic device that uses magnetic levitation to allow users to perceive textures (Magnetic, 2008).

While VR is still being used to conduct flight simulations and other types of military and work-related training, this technology is being used in more and more settings. Here are some examples:

- ♦ Scientists in Switzerland have managed to induce an "out-of-body-experience" with the help of virtual reality technology. "When people gaze at an illusory image of themselves through the goggles and are prodded in just the right way with the stick, they feel as if they have left their bodies" (Blakeslee, 2007, p. 1).
- ♦ Researchers at the University of Haifa are using virtual reality technology to teach autistic children road safety. This and other research is designed to help children with autism develop skills that allow them to become more independent (Virtual reality teaches, 2008).
- ♦ Scientists at the University of Reading (U.K.) are using virtual reality technology to help treat post-traumatic stress disorder in troops returning from Iraq. Using VR technology gives soldiers the chance to confront situations that may have contributed to their trauma (Virtual Iraq, 2007).
- ♦ The Foundation of the Hellenic World, a nonprofit cultural institution in Athens, is using VR to create realistic tours of such historic places as the Ancient Agora, the birthplace of democracy (Hellenic Cosmos, n.d.). Visitors can stroll through the Temple of Hephaistos where "the vibrant memory of ancient Athenian life will be inseparable from the now empty monuments and square."
- ♦ Virtual reality is also finding its way into medical training. In this capacity, VR is used to create a "virtual cadaver" that allows students and established surgeons to practice various procedures, and it allows for new procedures to be developed (Cosman, et al., 2002). One example of such technology is the VRmagic Surgical Simulator used to train ophthalmic surgeons. The cost of training surgeons in this area is expensive, time consuming, and potentially dangerous to the

patient. "Without the use of simulation, beginning surgeons can gain surgical experience only on actual patients, thus increasing rates of complications" (eMagine supplies, 2003).

- ♦ Virtual reality technology has been used in various entertainment applications as well. Back in 1975, Walt Disney World with cooperation from NASA unveiled its Mission to Mars attraction. Guests would sit inside one of two cabins. These cabins would move giving the sensation of lift-off. At the same time, guests would look "out" display screens located on the floor and ceiling where they could see the progress of their "flight." The combined movement and visual stimulation gave guests a sense of actual space travel (Mission to Mars, n.d.). Today, virtual reality rides and games are becoming more commonplace. Amusitronix, a company with offices in Bardonia (New York) and St. Louis sell and rent virtual reality games and simulators. The self-described "VR Guys" have everything from sports simulators to whole body interaction systems.
- ♦ Another area for VR technology is virtual prototyping. Combining VR technology with CAD (computer aided-design) allows manufacturers to forego the actual construction of prototypes relying instead on CAD systems coupled with haptic technology. This allows "designers and engineers to carry out assembly processes. The use of touch in CAD systems allows operators to feel forces and local stimuli similar to those in real situations" (Using computerized, 2007). Doing this provides more intuitive manipulation and saves money.

Augmented Reality

Kooper and MacIntyre (2003) describe a prototype AR system that combines a three-dimensional display with the World Wide Web. The authors refer to this as the "Real-World Wide Web" (RWWW). This system merges the Web with the physical world to help users more fully comprehend the subject they are studying.

Another practical use of AR is the mobile augmented reality system (MARS), which attempts to superimpose graphics over a real environment in real time and change those graphics to accommodate a user's head and eye movements. This way, the graphics always fit the user's perspective even while the user is moving. This is achieved using a transparent head-mounted display (with orientation tracker), a tracking system, a differential global positioning satellite (GPS) system, and a mobile computer all incorporated into one wireless unit housed in a belt-worn device that relays information to an HMD. This allows the user to move freely (Augmented reality, n.d.).

Current Status

Unfortunately, because of changes in the global marketplace, up-to-date financial data is difficult to find. Since the printing of the 6th edition of the *Market for Visual Simulation/Virtual Reality System Report*, which indicated revenues of \$43 billion in 2003, VR/AR technology has become almost completely absorbed into the global marketplace. As such, VR/AR technology is no longer a standalone industry, and a new method for tracking its market value must be developed. The *Market for Visual Simulation/Virtual Reality System Report* is no longer published. Prior to its last edition, VizSim/VR industry revenue had regularly grown since the late 1990s. The primary growth in the VR/AR industry resulted from a more than 75% increase in antiterrorism spending including disaster recovery training, hazardous materials handling, counterterrorism training, and a

variety of military training applications. The medical/biotech sector also helped spur the overall increase in revenue (CyberEdge, n.d.).

While VR/AR technology is no longer a standalone industry, financial data is circulating regarding some sub-groupings of the field. As an example, MedMarket Diligence forecasts an increase in spending of surgical training simulators of more than \$26 million in 2009. This increase correlates to a roughly 25% per year increase until that time (MedMarket Diligence, 2005).

Mark Long believes VR/AR technology has "failed to live up to the promise that it would transform our lives in areas ranging from entertainment to education to sports" (Long, 2006, p. 1). The VR/AR industry, he contends, is victim to the high costs of equipment and development. A full virtual reality lab can cost more than \$30 million. A standalone display can easily exceed \$50,000. Therefore, it is unlikely that anyone other than large corporations or government agencies will utilize this technology.

Factors to Watch

In the future, costs of VR systems and software will continue to drop, and quality will continue to increase. Computer processors are at the heart of any VR/AR system. Because processing power is increasing so rapidly, it is easy to understand how quickly improvements can be made to such systems.

Interestingly, the ongoing war on terrorism continues to be the impetus for major gains in the visual simulation/VR industry. This is because two of the fastest-growing applications for VR technology continue to include military training and gas and oil exploration. A third area, not directly related to the war on terrorism, is virtual prototyping (Virtual reality industry, 2003).

The military uses VR/AR technology to train personnel in vehicle operations and maintenance. The military also uses it to train personnel for dangerous missions. The oil industry is using the advanced visualization components of VR/AR technology to help search for petroleum; it also saves money on drilling and allows for more efficient management of refineries and pipelines. Virtual prototyping is used by all types of manufacturers. This type of VR/AR technology allows companies to create virtual products at a fraction of the cost of the real thing. Virtual prototypes can be sophisticated and detailed enough to allow for actual product testing without having to create the actual product (Virtual reality industry, 2003).

The National Research Council has made a set of recommendations to facilitate development of VR applications:

- ♦ A comprehensive national information service should be developed to provide information regarding research activities involving virtual environments.
- ♦ A number of national research and development teams should be created to study specific virtual and augmented reality applications.
- ♦ Federal agencies should begin experimenting with VR technologies in their workplaces.

- ♦ The federal government should explore ways to promote the acceptance of universal standards involving hardware, software, and networking technologies (Franchi, n.d.).

In the 1990s, VR was something seen only in movies. Today, it is used worldwide in a variety of settings. Tomorrow, it may be as common as television. Quoting Jaron Lanier (1989), credited with coining the term virtual reality, "VR is a medium whose only limiting factor is the imagination of the user" (p. 108).

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Home Video

Steven J. Dick, Ph.D.*

Not so long ago, home video technology meant watching live, over-the-air programs. The evolution of home video from simple reception devices to the media centers of today marks a tremendous investment for consumers and media companies alike. Each change in home video has given audiences more power, yet at a cost: frequently, old equipment has been abandoned in favor of a new generation of devices.

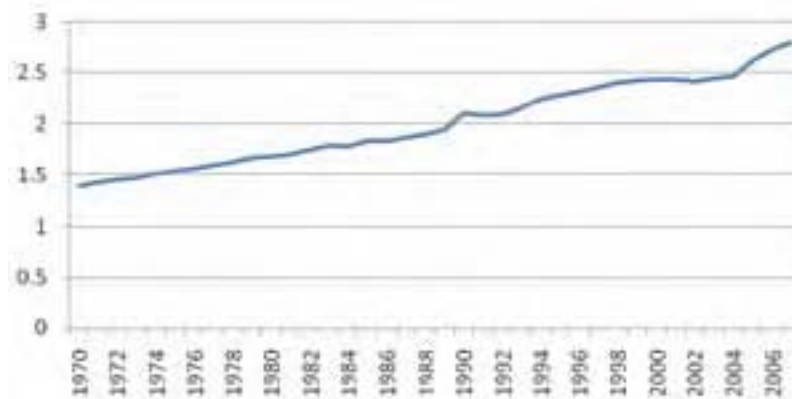
Background

As technology has improved, it is not enough to simply *receive* video. Increasingly, we have begun to *manipulate* video through storage and editing systems. Finally, *displays* have grown dramatically in quality and picture size. Consumers have aggressively adopted television. Since the 1970s, 97% to 98% of U.S. households have owned a television. In addition, the number of televisions per household continues to increase (see Figure 14.1), with an average of 2.8 televisions per household in 2007 (eBrain Market Research, 2007).

The most visible part of the home video industry has been reception. Media companies have made billions in either direct costs of reception (subscriptions or sales) or indirect costs (advertising). The way the consumer receives the media has a great deal to do with business models and media options. There are three basic ways for a home to receive an electronic signal: by air, by wire, and by hand.

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Figure 14.1

Televisions per Household

Compiled from eBrain Market Research (2007)

Reception by Air

U.S. commercial television began in 1941 when the Federal Communications Commission (FCC) established a broadcasting standard. Over-the-air television stations were assigned 6 megahertz (MHz) of bandwidth in the very-high-frequency (VHF) band of the electromagnetic spectrum. Video is encoded using amplitude modulation (same as AM radio), but sound is transmitted the same as it is for FM (frequency modulation). Initially, television was broadcast in black-and-white. In 1953, color was added to the signal by adding color information to the existing (luminance) signal. This meant that color television transmissions were still compatible with black-and-white televisions.

Television got off to a slow start for reasons that were more political than technical or audience driven. Television development virtually stopped during World War II, with only six stations continuing to broadcast. Post-war confusion led to more delays, culminating in 1948 when an inundated FCC stopped processing license applications (Whitehouse, 1986), starting the infamous FCC television freeze. Four years later, the FCC formally accepted a plan to add ultra-high-frequency (UHF) television. UHF television transmissions were encoded the same way as VHF, but on a higher frequency. Existing television sets needed a second tuner to receive the new band of frequencies, and new antennas were often needed. This put UHF stations in a second-class status that was almost impossible to overcome. It was not until 1965 that the FCC issued a *final* all-channel receiver law, forcing set manufacturers to include a second tuner for UHF channels.

Today, only 14.5% of U.S. households still receive television from traditional terrestrial broadcasting alone. At the same time, traditional broadcast networks are still an essential part of the media landscape. When the Solutions Research Group asked viewers what seven channels they would want to keep, ABC, CBS, NBC, and Fox were the top four mentioned. In two 2007 surveys, Discovery, ESPN, History, and HBO rounded out the top seven. PBS ranked 10 and nine in the two surveys (Solutions Research Group, 2007).

Reception by Conduit

A combination of factors, including the public's interest in television, the FCC freeze on new stations, and the introduction of UHF television, created a market for a new method of television delivery. As discussed in

Chapter 7, cable television's introduction in 1949 brought video into homes by wire. At first, cable simply relayed over-the-air broadcast stations. In the 1970s, however, cable introduced a variety of new channels and expanded home video capability.

Cable television companies are not locked into the same channel allocations as broadcasting since the coaxial cable is a closed communication system. For example, there is a large gap between VHF channels six and seven. Over-the-air, the gap is used for FM radio stations, aircraft communication, and other purposes. Cable TV companies use the same frequencies for channels 14 through 22 (Baldwin & McVoy, 1986). Other cable channels are generally placed immediately above the over-the-air VHF channels. Cable companies did not have to use the VHF band, but it made the transition easier. The cable box (at first) simply supplied an outside tuner to receive the extra channels. The industry then promoted the creation of "cable-ready" television sets that allowed reception of cable channels.

Reception by Hand

After Ampex developed videotape for the broadcast industry in 1956, the next logical step was to develop a version of the same device for the home. Sony introduced an open videotape recorder for the home in 1966. Open reel tape players were difficult to use and expensive, so they did not have much effect on the market. Sony went on to develop the videocassette recorder (VCR). Videocassettes eliminated the need to touch the tape since they allowed the machine to thread it, creating a consumer-friendly, easy-to-handle box for the tape.

After demonstrating a VCR in 1969, Sony debuted their most powerful machine in 1977, the Betamax, which could record up to two hours. This meant that most movies could be played back on a single tape. However, Sony's Betamax was already falling behind as another group of companies developed a competing standard called VHS. In 1977, JVC introduced a VCR with four hours of recording time, enough to record an evening's television programming. By 1982, a full-blown price and technology war existed between the two formats, and, by 1986, 40% of U.S. homes had VCRs. Eventually, the VHS format became the standard, and Betamax owners were left with incompatible machines.

VCRs combined two functions into one use. Rented and purchased videotapes were essentially a video distribution technology. At the same time, VCRs, as the name implies, allowed home viewers to record (or manipulate) video. This record capability became the subject of a lawsuit (*Sony v. Universal Studios*, 1984, commonly known as the "Betamax" case), as a wary film industry attempted to protect its rights to control content. However, the U.S. Supreme Court determined that the record and playback capability (time-shifting) was a justifiable use of the VCR. This decision legalized the VCR and helped force the eventual legitimization of the video sales and rental industry. VCR penetration quickly grew from 10% in 1984 to 79% 10 years later. In 2006, the FCC estimated that 90% of television households had at least one VCR (FCC, 2006).

In the 1980s, VCRs received a major challenge from two incompatible videodisc formats. RCA's "Selectavision" videodisc player used vinyl records with much smaller grooves than those for audio recording to store the massive amount of information in a video signal. After selling a record-breaking half-million players in its first 18 months on the market, RCA ceded the market to the VCR and stopped making the player and discs (Klopfenstein, 1989).

MCA and Philips introduced a more sophisticated "Discovision" format in 1984 that used a laser to read an optical disc. Lack of marketplace interest led MCA and Philips to sell the format to Pioneer, which renamed it "Laserdisc" and marketed the format as a high-end video solution. Although Laserdiscs never enjoyed massive

popularity, well over one million players were sold by Pioneer before the format was abandoned in the late 1990s in the face of the emerging DVD (digital videodisc) format.

Video Manipulation

The first manipulation technology was the home video camera. If you track home video back to film, home cameras are much older than television itself. The practical home camera was introduced in 1923 in the 16-millimeter “Cine Kodak” camera and the “Kodascope Projector” (Eastman Kodak, n.d.). Video manipulation became practical with VCRs. The growth of home videotape cameras meant that users did not have to set up a separate system to view home videos. The big impediment to home video cameras was the image sensor. Professional quality cameras used an expensive vacuum pick-up tube as the image sensor. This meant the camera had to have at least one glass bulb a few inches long in it. Replacing the pickup tube with a photosensitive chip reduced camera size and fragility and increased reliability. JVC introduced two such cameras in 1976. The cameras weighed three pounds, but were attached to an outside VCR (at least 16 pounds). In 1982, JVC and Sony introduced the combination “Camcorder,” and the true home video industry was born (CEA, n.d.).

Display

As a fixture in American homes, the history of the television set itself deserves some discussion. The television “set” is appropriately named because it includes *tuner(s)* to interpret the incoming signals and a *monitor* to display the picture. Tuners have changed over the years to accommodate the needs of consumers (e.g., UHF, VHF, cable-ready). Subprocessors were later added to the tuners to interpret signals for closed captioning, automatic color correction, and the V-chip. Consumers have adopted the television, with most homes becoming multiset households (see Figure 14.1).

In 1953, the National Television Standards Committee (NTSC) established the standard for analog color TV reception. The NTSC standard called for 525 lines of video resolution with interlaced scanning. Interlacing means that the odd numbered video lines are transmitted first, and then the display transmits the even numbered lines. The whole process takes one-thirtieth of a second (30 frames of video per second). Interlaced lines ensured even brightness of the screen and a better feeling of motion (Hartwig, 2000).

The first and still most popular monitor is the cathode ray tube (CRT). The rectangular screen area is covered with lines of phosphors that correspond to the picture elements (pixels) in the image. The phosphors glow when struck by a stream of electrons sent from the back of the set. The greater the stream, the brighter the phosphor glows. Color monitors use three streams of electrons, one for each color channel (red, blue, and green).

The *Telecommunications Act of 1996* formalized the next major change in home video—the transition to digital broadcasting (discussed in Chapter 6). The act established a 10-year period during which all broadcasters would first simulcast analog and digital television signals and then only digital. At the same time, consumers were to retire their analog television receivers. While the target date in 2006 was allowed to slip to February 2009, the transition has spurred many consumers to reconsider their home video equipment.

Recent Developments

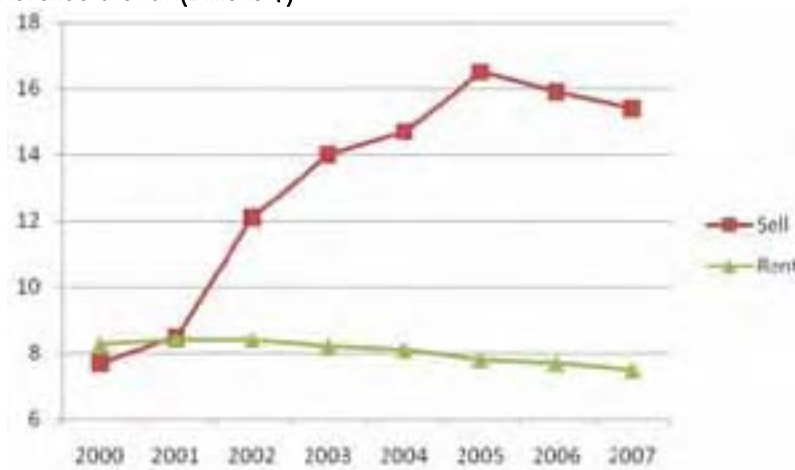
As consumers have been faced with new equipment choices, competing parts of the industry have attempted to earn a place in their homes. From 1996 to 2005, the number of satellite delivered programming networks increased from 145 to 565 (NCTA, 2007). At the same time, the competition to deliver those channels to the home has increased dramatically. Consumer satisfaction has been high. According to Solutions Research Group, the top nine cable and satellite video providers range from 79% to 92% of customers at least “somewhat satisfied.” Only 14.5% of the 110 American households do not subscribe to one of these services (compiled from Solutions Research Group, 2007).

In the late 1990s, a new by-hand distribution system was introduced. The DVD (digital videodisc or digital versatile disc) was developed to be the new mass storage device for all digital content. The DVD is based on the same technology as the compact disc. Bits are recorded in optical format within the plastic disc. Unlike earlier attempts to record video on CDs (called VCDs), the DVD has more than enough capacity to store an entire motion picture in television quality. The first DVDs were disadvantaged by the lack of a record capability. However, they were lighter and more durable than VHS tapes. The great nonlinear capacity allowed motion picture companies to include extra content on the discs such as better quality video, multiple language tracks, trailers, and even computer programs.

DVD players and discs were introduced in 1997. Penetration grew from 6.7% in 1999 to 81.2% by the third quarter of 2006, eclipsing VCR penetration (79.2%) (Gyimesi, 2006). The Consumer Electronics Association notes that factory shipments of DVD players grew by 22.5% to 19.8 million in 2006 (CEA, 2007b). DVD player prices are dropping, with high definition on the way.

Figure 14.2

Home Video Store Revenue Growth (Billions \$)



Source: Ault (2008)

While DVD players have become more common, DVD rental revenues have dropped slowly from a high of just over \$8 billion in 2001. Blockbuster Video Analyst Day Webcast (2007) blamed the decrease on alternative delivery systems (e.g., direct sales, vending, and subscription services). In addition, although VHS tapes

were obtained through a profit sharing arrangement with major studios, DVDs are distributed under a direct sale model. The change made it more costly to have sufficient inventory in rental stores—especially in the high-demand first few weeks after release. The change gave an advantage to video sales outlets such as Wal-Mart and companies such as Netflix that can hold large centralized inventories.

The transition to DVDs also created a new means of distribution: by mail subscription services. DVDs are lighter and less fragile than VHS tapes. Netflix capitalized on the change when they started business in 2000. By using up to 44 shipping centers, Netflix estimated one-day delivery to 95% of its subscribers. Customers were allowed to enjoy videos without the fear of late fees. When a video was returned, another was sent from a predetermined list. Six years later, Netflix projected 2006 subscribership at 8.8 million, bringing in \$1.2 billion in total annual revenue (Netflix, 2008). The result was so successful that Blockbuster followed with a similar service in 2004. The by-mail segment of the DVD market increased from 5.3% to 19.1% from 2004 to 2007 (Blockbuster, 2007).

If consumers are not happy with video entertainment from the outside, a growing number are choosing to produce content at home. Home quality video cameras were improved with the replacement of analog formats with digital videocassette formats (DVC or DV). Panasonic and Sony introduced the Mini DV camcorder in 1995. The combination of smaller tapes, flat LCD screens, and chips rather than tubes for optical pickup resulted in smaller, sturdier cameras. These cameras also offer easy digital video transfer to personal computers for editing and DVD authoring.

Advances made in home video cameras and multimedia computers have been matched by software developments. Both Microsoft (MovieMaker) and Apple (iMovie) have joined a growing field of companies distributing software designed for home video editing. Amateur content has become more important with online video distribution systems. A growing *prosumer* market, gathering talent between traditional media professionals and amateurs, has had a market impact. For example, JibJab.com has created effective politically oriented animation. Plus, Quarterlife.com has content shared between NBC and online distribution.

One new entrant has generated more excitement than sales. Digital video recorders (DVRs) have generated a fairly small but extremely loyal following. Initial units were marketed under the names ReplayTV and TiVo. The heart of a DVR is a high-capacity hard drive capable of recording 40 or more hours of video. However, the real power of the DVR is the computer brain that controls it. The DVR is able to search out and automatically record favorite programs. Since it is a nonlinear medium, the DVR is able to record and playback at the same time. This ability gives the system the apparent ability to pause (even rewind) live television. Since users can watch programming even as it is being recorded, they have the option move start times from minutes to days.

However, the DVR's built-in computer power allows the system to do some more controversial things. First, the system could be designed to identify and skip commercials. Users are becoming more aggressive about skipping commercials. In 2007, 65% of DVR users said they always skip commercials compared with 52% percent in 2006 (Solutions Research Group, 2007). Second, since the system must download program schedules, it can also be used to upload consumer use data. Use data, such as which shows have been watched and where users have manipulated the programs (e.g., paused or rewound a program), have already been collected by TiVo.

DVRs were being used by about 17.3% of U.S. households in late 2007 (Solutions Research Group, 2007). A study by the Carmel Group predicted that the number will rise to 50% by 2010 (Schaeffler, 2006). More important, overall revenue (for hardware, software, and service fees) will increase from about \$1.1 billion to

\$5.5 billion. The study indicates that the devices provide an excellent opportunity to reach out to Hispanic and other ethnic groups that together only account for 10% of current recorder use. At the same time, most households with a DVR currently have only one. Multiple installations in each household should increase their use even further (Pasztor, 2006). In July 2007, Solutions Research Group noted that 35% of DVR households use VOD (video on demand) weekly.

Current Status

The transition to a high-definition DVD player resulted in an all-out format battle reminiscent of the Beta/VHS competition in consumer videocassettes. Two standards were introduced in 2001. The first, called Blu-ray, was supported by Sony, Hitachi, Pioneer, and six others. It is compatible with current DVDs, but requires a more expensive production process and extensive copy protection. The second, called HD-DVD, was supported by Toshiba, NEC, and Microsoft (HDDVD.org, 2003). While current DVDs hold only about 9 GB of content, Blu-ray disks hold 50 GB of data, and HD-DVD only about 30 GB. The initial cost for the players was around \$500, but fell dramatically into the \$250 range as the format war continued (Ault, 2008). Still, player sales remained flat in 2007 as consumers waited for a winner. Both groups created exclusive deals with major film studios. Warner Brothers delivered a surprising blow at the 2008 Consumer Electronics Show by switching from HD DVD to Sony's Blu-ray. While Toshiba initially vowed to continue to fight, the company gave up within a month. Unlike with Betamax VCRs, Sony won the format war in Blu-ray.

Even though the transition to digital broadcasting was mandated by Congress in 1996, consumer interest in digital TVs did not dramatically grow until 2005, jumping from 11.4 to 23.8 million. The new televisions were expensive, and initially there was little content. Even today, it is not necessary to buy a new television unless you want high definition or are part of the 14.5% of U.S. households that do not have cable or satellite service. Still, set sales have increased dramatically since the transition to digital became real in the mind of the consumer (see Figure 14.3). Although the original deadline for the transition was 2006, in 2005, Congress set an absolute deadline of February 2009 (U.S. Congress, 2005).

In 2006, the International Telecommunications Union set 2015 as a global target for conversion to digital television (ITU, 2006). International manufacturers are working to meet the world's needs. The top manufactures are from Korea and Japan. In 2007, Samsung earned the top position with a 17.7 share in value and 13.3 share of units sold. Second and third place went to Japan's Sony Corporation and Korea's LG Electronics, with market shares of 10.8% and 9.6%, respectively (Lee, 2007).

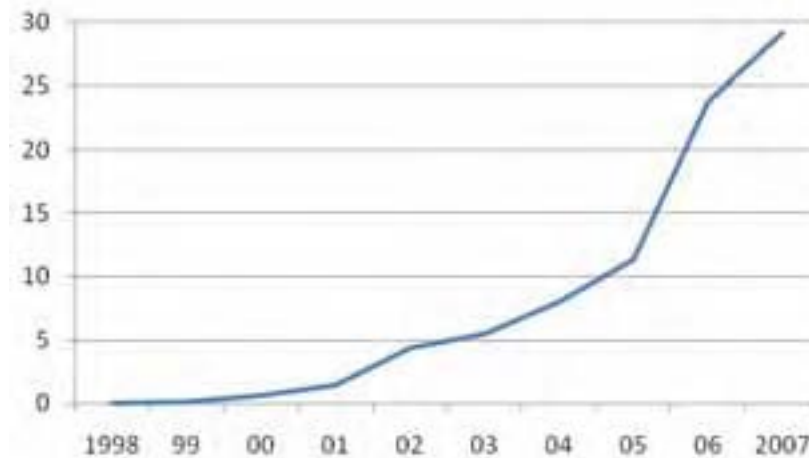
As the digital set market has grown, consumers have more choices than ever when they select a new television. While most digital sets will at least attempt to produce a picture for all incoming signals, some will be better able than others. The Consumer Electronics Association suggests five steps in the decision process (CEA, 2007a):

- 1) Select the right size.
- 2) Choose an aspect ratio.
- 3) Select your image quality.

- 4) Pick a display style.
- 5) Get the right connection.

Figure 14.3

Digital Set Sales (Millions)

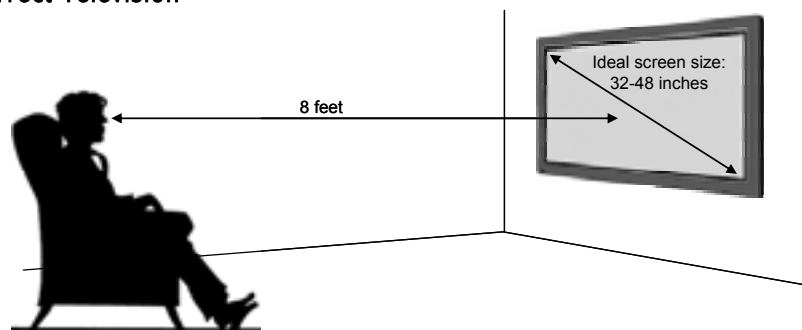


Source: eBrain market Research (2007)

New sets are larger than ever, and it is easy to buy too large or small. Even with a high-definition set, if you sit too close, you see too much grain. If you sit too far away, you lose the quality of the picture. The rule of thumb is to measure the distance from the picture to the seating. Divide that distance by three. The product is the smallest set for the room. Divide the distance by two and the product is the largest set for the room (see Figure 14.4).

Figure 14.4

Choosing the Correct Television



Selecting the right size set for your room is easy using this simple calculation: 1. Measure distance from TV to sitting position. 2. Divide by 2 and then by 3 to get ideal screen size range. The resulting numbers will be your ideal screen sizes. **Example:** Distance = 8 feet (or 96 inches), $96 / 2 = 48''$ set, $96 / 3 = 32''$ set, and Ideal set is 32" to 48".

Source: Technology Futures, Inc.

The aspect ratio is changing for high-definition content. Standard definition sets have an aspect ratio of 4:3 or four inches wide for every three inches tall. The new widescreen format is 16:9. Most televisions will attempt to fill the screen with the picture, but the wrong image for the screen distorts or produces a “letterbox” effect. In addition, picture size is a measure of the diagonal distance, and wider screens have proportionally longer diagonals. For example, a 55-inch diagonal set with a 4:3 aspect ratio has 1,452 square inches of picture space. The same 55-inch set with a 16:9 aspect ratio has only 1,296 square inches of picture space. Thus, it is misleading to compare the diagonal picture size on sets with different aspect ratios.

Image quality may be one of the most important choices. People spending more money on the television are expecting a better image. This assumes, however, that content is available in the image quality selected. As digital television content becomes available, there is an ever-increasing variety of resolutions. It is not always easy for a set to display a lower-quality image. The Consumer Electronics Association has established three quality levels:

- ♦ *Standard definition* uses 480 lines interlaced. It is most like analog television, but contains the circuitry to convert higher-quality images down to the lower-resolution screen.
- ♦ *Enhanced definition* sets use 480p or higher. The image more smoothly presents high-definition content because of the progressive scan; it meets the quality of standard DVDs.
- ♦ *High-definition* pictures are at resolutions of 720p or better. They can display HD content and HD DVDs at full resolution.

While the natural temptation is to assume that 1,080 lines of resolution is better than 720, that may not be the case. There are additional considerations. Signals come in from broadcasters, cablecasters, and others each encoded to various broadcast/production “standards.” (See Chapter 6 for more on digital broadcast standards.) The modern video monitor must be able to quickly interpret and display several incoming formats. The monitor is designed to display certain signals best. These are called “native resolutions.” All other signals are converted. If a monitor has only 720 lines of resolution, it cannot display 1,080 lines native, and the signal must be converted. Furthermore, due to differences in technologies, even native resolutions can be displayed with unequal clarity. Non-native resolutions can be even worse. *Consumer Reports* indicates some monitors with 720 lines of resolution are better than 1,080 (Consumer Reports, 2008). The key is to choose a set based on the kind of content watched in your home or business. Fast-moving, highly-detailed content (e.g., sports) looks better on some screens, while others are more attuned to movies with brilliant pictures and high contrast.

The major display styles are CRT, plasma, LCD, and rear projection. The CRT (cathode ray tube) is similar to current sets. While the screen tends to be smaller, it remains the most affordable choice for a bright picture and a wide viewing angle. LCD (liquid crystal display) and plasma are the new flat screen technologies. They take up less floor space and can be mounted like a picture on the wall. LCD displays tend to have a brighter image but a narrower viewing angle. Plasmas have a wider viewing angle but the shiny screens more easily reflect images from the room. Front or rear projection systems offer the best value for very wide images but use an expensive light bulb that must be replaced periodically. Projection systems are best in home theater installations.

Finally, the right connections are essential to transmitting the highest quality image into the set. Analog video connectors will move an image to the monitor, but can severely limit quality. Depending on your video

accessories, sets should ideally come with an HDMI input, or IEEE-1394 (Firewire) and/or component jacks. Given the growth of Internet video, a connection to your computer may be desirable.

New digital cable networks required a new cable ready television. Manufacturers developed a new generation of CableCARDs in 2005. CableCARD (formerly the point of deployment or POD card) is a PCMCIA card that consumers would obtain from their cable company. The card would slide into slots on the new cable ready sets and allow access to subscribed services without a set-top box. In 2007 a new generation of cards was introduced, allowing receivers to display, manipulate, or record up to six channels of programming.

In addition, video on demand and other content services are becoming more popular with about 14.5% of U.S. households using the service (Solutions Research Group, 2007). By the end of 2005, all major multiple system operators (MSOs) were offering VOD services. VOD was offered to digital cable subscribers with some to most of the content free of charge (FCC, 2006). In the 2006 National Show for the National Cable & Telecommunications Association, Time Warner COO Jeffrey Bewkes challenged cable operators to make all networks available on free, ad-supported VOD in the following year. Bewkes maintained, "I think that the record is clear for 20 years on pay-per-view that that is not the way to maximize usage. It's not really what consumers want" (Farrell, 2006). For more on VOD, see Chapter 7.

Factors to Watch

Telephone companies are starting to make serious inroads into home video delivery with IPTV (Internet protocol television) (discussed in more detail in Chapter 8). As of early 2006, IPTV serves only about 240,000 customers (Brown, 2006), with projections of one-half million by the end of the year according to ABI Research. This is a minuscule market compared with the 27.6 million claimed by cable television. However, ABI expects to see subscribers grow to eight million by 2011, with much stronger projections abroad.

Perhaps the most advanced market for IPTV is Europe with about 2.3 million paid subscribers, about half of which are in France. In August 2007, several European phone companies announced a major expansion into IPTV. Deutsche Telekom leads the effort after already wiring nearly 40% of German households for IPTV. Globally, phone companies are expected to spend about \$9 billion annually on IPTV and triple play services (New York Times Media Group, 2007). In addition, Japanese vendor NEC announced the launch of its IPTV business in early 2008. In April 2007, the company released a VOD server that will be its core IPTV product (Reedy, 2008)

New delivery options include new paths to the home and new twists on old program models. As broadband Internet penetrates the U.S. market, there is a growing ability to offer full-motion movies via online delivery. Multiple vendors are now offering online distribution and sale; Movielink (owned by Blockbuster), iTunes (Apple), Vongo (Starz Entertainment), Hulu (NBC Universal and News Corp.), and CinemaNow are among the leaders. In addition, all major broadcast networks have started streaming programs with limited commercial interruption through their own Web services. In the summer 2007, when CBS canceled the program *Pirate Master*, the run was completed on its Web page. In fall of the same year, NBC broadcast the program *Quarter-life*, which started and ended its run online. In February 2008, Solutions Research Group estimated that 43% of the online population watched one program online. This was up from 25% just one year earlier (CEA, 2007a).

The problem with online delivery is that it may be cutting into the longstanding DVD market. Despite Sony's victory with Blu-ray that ended the high-definition DVD war, DVDs are in trouble. For the first time, 2007 saw an overall decline in domestic DVD sales of 3.2%, with similar declines predicted for 2008 and 2009 (Barnes, 2008). The Internet's success, small as it is, has watered down the DVD market. DVDs sold for an average price of \$21.95 in 2000, falling to \$15.01 in 2007. In addition, studios earn much more from the sale of a DVD than they do from a rental. South Korea, with some of the biggest broadband pipes in the world, has almost no DVD market. Pirate DVDs are not only sold on street corners, they can be easily downloaded (Paquet, 2006).

DVD marketers are working hard to continue to revive the DVD market. France-based Carrefour, the world's second largest retailer, is taking a cue from its major competition, Wal-Mart. Major DVD releases are sold at extra low prices as a loss leader for higher-priced items as both stores expand into Latin America and China (Geoffroy, 2007). In another move, movies are heading to DVD faster. Quicker DVD releases have led to spikes in sales, but steeper declines later. Finally, 20th Century Fox is planning to pack an extra copy of the movie with each DVD. The extra copy can be quickly loaded—much faster than an Internet download—on a computer or iPod. The anticipated result is an increase in sales for a few major releases, but not for the entire DVD market.

While Blu-ray won the format war, HD-DVD is not completely finished. Technical updates, long a part of the HD DVD platform, are still in the works. Firmware improvements coming out in 2008 include picture-in-picture (Profile 1.1) and online special features (Profile 2.0). In addition, temporary price increases are expected until competition re-enters the market and movie titles, currently on HD-DVD, migrate to Blu-ray (Falcone, 2008).

Display

The original mandate for the transition to digital broadcasting (*Telecommunications Act of 1996*) set a 2006 target for the transition. It also required 85% penetration of digital television equipment. There is reason to believe that the 85% threshold has been achieved, depending on how you define the market. However, there is fear that certain groups are still disenfranchised. Nielsen Media Research estimates that 13 million U.S. households are not yet ready for the digital transition, especially the less affluent (Elliot, 2008).

Table 14.1

Percentage of Households Completely or Partially Unready for Digital Conversion

	Completely Unready (%)	One or More Unready Sets (%)
White	8.8	15.2
Black	12.4	19.5
Asian	11.7	18.8
Hispanic	17.3	26.2
Under age 35	12.3	17.3
Age 35-54	9.6	16.7
Age 55+	9.4	16.4

Source: Elliot (2008)

The transition to digital television has caused many to worry about the “media disenfranchised,” those who cannot afford to convert. The act that created the hard deadline for the U.S. transition also created a coupon program administered by the National Telecommunication and Information Administration. The coupon gives consumers a discount on a converter box to allow older analog sets to receive digital broadcasts.

The International Telecommunications Union set the international transition date for digital television at 2015. More than 1,000 delegates representing 104 countries adopted the new treaty in Geneva. The agreement establishes a single standard in an area covering Europe, Africa, Middle East, Iran, and former Soviet Union. While there is excitement now, countries with earlier targets such as Korea (2012) and Kenya (2012) have begun to worry about continuing to provide service throughout their rural and poor areas.

Conclusion

The next few years are going to bring some dynamic changes to the home video marketplace. With the conversion to digital and new technologies becoming more important, consumers will have more choices than ever. It seems that consumers are on the cusp of a spending spree in home video. Options are just too enticing as a new generation of home video technologies comes of age.

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Digital Audio

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Record companies continued their transition into a digital business in 2008. Music sales via online and mobile channels have risen from zero to an estimated \$2.9 billion—15% of industry sales—since 2003, making music more digitally advanced than any entertainment sector except games (IFPI, 2008). Audio hardware sales continued to surge ahead in 2006 and 2007 after sluggish results in the early part of the decade. According to the Consumer Electronics Association (CEA), the audio category continues to benefit from rapid consumer adoption of digital audio products and related accessories, as more and more consumers buy into the concept of plug-and-play, portable, personal audio and video (CEA, 2008).

For example, digital audio players once again surpassed previous CEA estimates of units sold to establish record-setting years in 2006 and 2007, with 38.1 million units sold in 2006 and 41.5 units sold in 2007. This growth was fueled primarily by a continued drop in unit prices (Gerson, 2007). The interest in and launch of Microsoft's Zune player, as well as new digital players with video capabilities, also contributed to increased unit sales. Dollar revenues of digital audio players for 2006 increased to \$5.56 billion, a 31% increase over 2005, but are forecast to drop by 2009 to \$5.2 billion as unit prices continue to fall (CEA, 2008).

Compact stereo systems, which have also replaced those "ancient" audio component towers, are themselves evolving to encompass the digital audio lifestyle of today's consumer. These systems have morphed into "MP3 hi-fi stations," creating a whole new category of consumer electronics (CEA, 2008). These integrated playback systems connect to a specific brand of digital audio player, and often play compact discs (CDs) and DVDs (digital videodiscs), amplify PC-music audio, and connect to satellite-radio tuners.

While sound quality has improved with digital audio technology, the prevalence of the portable digital media player (e.g., iPod) has also led to lower quality audio as producers now are recording music specifically for listening on portable media devices with lower-quality ear-buds. The quality of the digitally compressed audio signal is lower, and the music tends to be mixed louder and flatter (Gomes, 2007).

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Advances in compact stereos and digital audio technology are not the only developments pointing to vigorous audio industry growth. The last few years have included technological developments that have given consumers compelling reasons to buy products that will rekindle their passion for listening to music—the passion that launched the hi-fi industry in the 1950s. From digital media player/wireless phone convergence to solid-state disk (SSD) devices, audio innovation is creating a new breed of audio consumer. Today, most audio digitizers listen to music as background in the home while engaged in other activities, and serious music listening is more likely to be done in the car or on-the-go outside the car and home. In addition, thousands of theatrical DVDs and hundreds of electronic games exist in surround- and high-quality sound (Dolby Labs, 2008).

As a result, convenience, portability, and sound quality have re-energized the audio industry for the 21st century. Competition, regulation, innovation, and marketing will continue to shape and define this exciting area of communication technology.

Background

Analog Versus Digital

Analog means “similar” or “a copy.” An analog audio signal is an electronic copy of an original audio signal as found in nature, with a continually varying signal. Analog copies of any original sound suffer some degree of signal degradation, called generational loss, and signal strength lessens and noise increases for each successive copy. However, in the digital domain, this noise and signal degradation can be eliminated (Watkinson, 1988).

This digitalization process, then, creates an important advantage for digital versus analog audio:

A digital recording is no more than a series of numbers, and hence can be copied through an indefinite number of generations without degradation. This implies that the life of a digital recording can be truly indefinite, because even if the medium (CD, DAT, etc.) begins to decay physically, the sample values can be copied to a new medium with no loss of information (Watkinson, 1988, p. 4).

Encoding. In a digital audio system, the original sound is encoded in binary form as a series of 0 and 1 “words” called bits. The process of encoding different portions of the original sound wave by digital words of a given number of bits is called “pulse code modulation” (PCM). This means that the original sound wave (the modulating signal, i.e., the music) is represented by a set of discrete values. In the case of music CDs using 16-bit words, there are 2^{16} word possibilities (65,536). The PCM tracks in CDs are represented by 2^{16} values, and hence, are digital. First, 16 bits are read for one channel, and then 16 bits are read for the other channel. The rest are used for data management. The order of the bits in terms of whether each bit is on (1) or off (0) is a code for one tiny spot on the musical sound wave (Watkinson, 1988). For example, a word might be represented by the sequence 1001101000101001. In a way, it is like Morse code, where each unique series of dots and dashes is a code for a letter of the alphabet (see Figure 15.1).

Sampling and quantizing. Digital audio systems do not create exact bit word copies of the entire original continuous sound wave. Instead, depending on the equipment used to make the digital copy, various samples

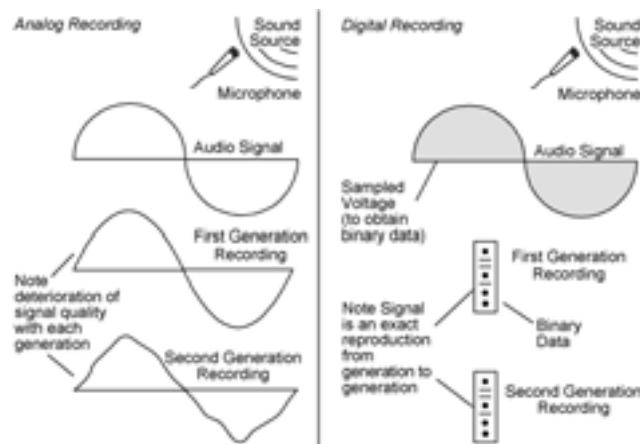
of the original sound wave are taken at given intervals using a specified sampling rate to create a discrete digital wave (Alten, 2007). The established sampling rates for digital audio are:

- ♦ 32 kHz for broadcast digital audio.
- ♦ 44.1 kHz for CDs.
- ♦ 48 kHz for digital audiotape (DAT) and digital videotape (mini-DV and DV).
- ♦ 96 kHz or 192.4 kHz for DVD-audio and BD-ROM (Blu-ray disc) audio.
- ♦ 2.8224 MHz for SACD (Super Audio CD) and DSD (Direct Stream Digital).

These samples are then quantized at a specific bit level (16-bit, 32-bit, etc.); the higher the bit level, the higher the quality of the digital reproduction.

Figure 15.1

Analog Versus Digital Recording



Source: Focal Press

File formats and codecs. Once the signal is digitized, sampled, and quantized, the digital signal can be subjected to further processing—in the form of audio data compression—to reduce the size of the digitized audio file even further. This is similar to “zipping” a text file to more easily send it as an attachment to an e-mail. However, there are file formats that do not require reduction and remain uncompressed. These include audio files stored on CDs and DV tape, as well as audio files stored as .AIFF or .WAV. Some file formats, including QuickTime and DVD-Audio, can be compressed or uncompressed.

Any time a file is compressed, there is a potential loss of quality as information is “squeezed” from the file (Alten, 2007). Audio compression is typically used for three reasons:

- ♦ To reduce file size so that more audio may be stored on a given media format (digital audio players, DVD-video discs, MiniDiscs, etc.).

- ♦ To reduce file size so that files will download from a Web site faster.
- ♦ To reduce the data rate so that files will stream (broadcast) over a network such as the Internet.

Audio compression techniques are typically referred to as *audio codecs*. As with other specific forms of digital data compression, there exist many “lossless” and “lossy” formulas to achieve the compression effect (Alten, 2007). Lossless compression works by encoding repetitive pieces of information with symbols and equations that take up less space, but provide all the information needed to reconstruct an exact copy of the original. As file storage and communications bandwidth have become less expensive and more available, the popularity of lossless formats has increased, as people are choosing to maintain a permanent archive of their audio files. The primary users of lossless compression are audio engineers, audiophiles, and those consumers who want to preserve the full quality of their audio files, in contrast to the quality loss from lossy compression techniques such as MP3.

Lossy compression works by discarding unnecessary and redundant information (sounds that most people cannot hear) and then applying lossless compression techniques for further size reduction. With lossy compression, there is always some loss of fidelity that becomes more noticeable as the compression ratio is increased. (That is why the audio quality of MP3s and other file formats are compared to the lossless audio quality of CDs.) The goal then becomes producing sound where the losses are not noticeable, or noticeable but not annoying. Unfortunately for consumers, there is no one standard audio codec. As is discussed later in this chapter, several companies are battling it out in the marketplace. Table 15.1 provides a list of the major codecs in use in 2008.

Copyright Legislation, Cases, and Actions

With this ever-increasing ability to create and distribute an indefinite number of exact copies of an original sound wave through digital reproduction comes the incumbent responsibility to prevent unauthorized copies of copyrighted audio productions and safeguard the earnings of performers and producers. Before taking a closer look at the various digital audio technologies in use, a brief examination of important legislative efforts and resulting industry initiatives involving this issue of digital audio reproduction is warranted.

Audio Home Recording Act of 1992

The *Audio Home Recording Act (AHRA) of 1992* exempts consumers from lawsuits for copyright violations when they record music for private, noncommercial use and eases access to advanced digital audio recording technologies. The law also provides for the payment of modest royalties to music creators and copyright owners, and mandates the inclusion of the Serial Copying Management Systems (SCMS) in all consumer digital audio recorders to limit multigenerational audio copying (i.e., making copies of copies). This legislation also applies to all future digital recording technologies, so Congress is not forced to revisit the issue as each new product becomes available (HRRRC, 2000).

Multipurpose devices, such as personal computers, CD-ROM drives, or other computer peripherals, are not covered by the AHRA. This means that the manufacturers of these devices are not required to pay royalties or incorporate SCMS protections into the equipment. It also means, however, that neither the manufacturers of

the devices, nor the consumers who use them, receive immunity from copyright infringement lawsuits (RIAA, 2006a).

Table 15.1

Popular Audio Codecs

Codec	Developer	Date	Compression Type
AAC	MPEG	2002	lossy
AACplus or HE-ACC	MPEG	2003	lossy
AIFF	Electronic Arts/Apple	1985	uncompressed
ALAC	Apple	2004	lossless
AU	Sun	1992	uncompressed
FLAC	Xiph.org	2003	lossless
LAME	Cheng/Taylor	1998	Lossy
Monkey's Audio	M. Ashland	2002	lossless
MP3	Thomson/Fraunhofer	1992	lossy
MP3 Pro	Thomson/Fraunhofer	2001	lossy
MP3 Surround	Thomson/Fraunhofer	2004	lossy
Musepak	Buschmann/Klemm	1997	lossy
SDII (Sound Designer II)	Digidesign	1997	lossless
SHN (Shorten)	T.Robinson/W. Stielau	1993	lossless
Speex	Xiph.org	2003	lossy
Vorbis (Ogg Vorbis)	C. Montgomery/Xiph.org	2002	lossy
WavPack	D. Bryant	1998	lossless
WMA (Windows Media Audio)	Microsoft	2000	lossy
WMA Lossless	Microsoft	2003	lossless

Source: T. Carlin

The Digital Performance Right in Sound Recordings Act of 1995

This law allows copyright owners of sound recordings to authorize certain digital transmissions of their works, including interactive digital audio transmissions, and to be compensated for others. This right covers, for example, interactive services, digital cable audio services, satellite music services, commercial online music providers, and future forms of electronic delivery. Most non-interactive transmissions are subject to statutory licensing at rates to be negotiated or, if necessary, arbitrated.

Exempt from this law are traditional radio and television broadcasts and subscription transmissions to businesses. The bill also confirms that existing mechanical rights apply to digital transmissions that result in a specifically identifiable reproduction by or for the transmission recipient, much as they apply to record sales.

No Electronic Theft Law (NET Act) of 1997

The *No Electronic Theft Law* (the NET Act) states that sound recording infringements (including by digital means) can be criminally prosecuted even where no monetary profit or commercial gain is derived from the infringing activity. Punishment in such instances includes up to three years in prison and/or \$250,000 in fines. The NET Act also extends the criminal statute of limitations for copyright infringement from three to five years.

Additionally, the NET Act amended the definition of “commercial advantage or private financial gain” to include the receipt (or expectation of receipt) of anything of value, including receipt of other copyrighted works (as in MP3 trading). Punishment in such instances includes up to five years in prison and/or \$250,000 in fines. Individuals may also be civilly liable, regardless of whether the activity is for profit, for actual damages or lost profits, or for statutory damages up to \$150,000 per work infringed (U.S. Copyright Office, 2002a).

Digital Millennium Copyright Act of 1998

On October 28, 1998, the *Digital Millennium Copyright Act* (DMCA) became law. The main goal of the DMCA was to make the necessary changes in U.S. copyright law to allow the United States to join two new World Intellectual Property Organization (WIPO) treaties that update international copyright standards for the Internet era.

The DMCA amends copyright law to provide for the efficient licensing of sound recordings for Webcasters and digital subscription audio services via cable and satellite. In this regard, the DMCA:

- ♦ Makes it a crime to circumvent anti-piracy measures (i.e., digital rights management technology) built into most commercial software.
- ♦ Outlaws the manufacture, sale, or distribution of code-cracking devices used to illegally copy software.
- ♦ Permits the cracking of copyright protection devices, however, to conduct encryption research, assess product interoperability, and test computer security systems.
- ♦ Provides exemptions from anti-circumvention provisions for nonprofit libraries, archives, and educational institutions under certain circumstances.
- ♦ In general, limits Internet service providers from copyright infringement liability for simply transmitting information over the Internet. Service providers, however, are expected to remove material from users' Web sites that appear to constitute copyright infringement.
- ♦ Limits liability of nonprofit institutions of higher education—when they serve as online service providers and under certain circumstances—for copyright infringement by faculty members or students.
- ♦ Calls for the U.S. Copyright Office to determine the appropriate performance royalty, retroactive to October 1998.

- ♦ Requires that the Register of Copyrights, after consultation with relevant parties, submit to Congress recommendations regarding how to promote distance education through digital technologies while maintaining an appropriate balance between the rights of copyright owners and the needs of users (U.S. Copyright Office, 2002b).

The DMCA contains the key agreement reached between the Recording Industry Association of America (RIAA) and this coalition of non-interactive Webcasters (radio stations broadcasting on the Web), cablecasters (DMX, MusicChoice, Muzak), and satellite radio services (XM, Sirius). It provides for a simplified licensing system for digital performances of sound recordings on the Internet, cable, and satellite. This part of the DMCA provides a compulsory license for non-interactive and subscription digital audio services with the primary purpose of entertainment. Such a compulsory licensing scheme guarantees these services access to music without obtaining permission from each and every sound recording copyright owner individually, and assures record companies an efficient means to receive compensation for sound recordings. This is similar to ASCAP and BMI compulsory licensing for music used on radio and television stations.

The U.S. Copyright Office designated a nonprofit organization, SoundExchange, to administer the performance right royalties arising from digital distribution via subscription services. Once rates and terms are set, SoundExchange collects, administers, and distributes the performance right royalties due from the licensees to the record companies (SoundExchange.com, 2008). Of the performance royalties allocated to the record companies, the DMCA states that half of the royalties are distributed to the copyright holder of the song. The other half must be distributed to the artists performing the song. SoundExchange only covers performance rights, not music downloads or interactive, on-demand Internet services. These are governed by the reproduction rights in sound recordings of the Copyright Act, are not subject to the DMCA compulsory license, and must be licensed directly from the copyright owner, usually the record company or artist.

All of this now leaves an artist with three types of copyright protection to consider for one piece of music, depending on how it is used:

- ♦ Traditional compulsory license via ASCAP, BMI, or SESAC for music broadcast on AM and FM radio stations.
- ♦ DMCA compulsory license via SoundExchange for music digitally distributed on Webcasts and cable or satellite subscription services.
- ♦ Voluntary (or direct) license via an individually-negotiated agreement for music to be downloaded on the Internet from a Web site or an Internet jukebox; used in a movie, TV program, video, or commercial; or used in a compilation CD.

Digital Rights Management

Digital rights management (DRM), as mentioned in the *Digital Millennium Copyright Act*, is the umbrella term referring to any of several technologies used to enforce predefined policies controlling access to software, music, movies, or other digital data. In more technical terms, DRM handles the description, layering, analysis, valuation, trading, and monitoring of the rights held over a digital work (Planet eBook, 2006). Some digital media content publishers claim DRM technologies are necessary to prevent revenue loss due to illegal duplication of their copyrighted works. However, others argue that transferring control of the use of media from con-

sumers to a consolidated media industry will lead to loss of existing user rights and stifle innovation in software and cultural productions.

The two most prominent digital audio DRM technologies are Apple's Fairplay and Microsoft's Windows Media DRM (WMDRM). Some of the other popular DRM technologies in use today include Advanced Access Content System (AACs) used by Blu-ray discs, Content Protection for Prerecorded Media (CPPM) used in DVD-Audio, High-Bandwidth Digital Content Protection (HDCP), and OpenMobile Alliance (OMA) for mobile phones.

MGM v. Grokster

Although there has been a constant debate in all three of these copyright areas, it is the copyright protection pertaining to Internet music downloading that has led to the most contentious arguments. On June 27, 2005, the U.S. Supreme Court ruled unanimously against peer-to-peer (P2P) file-sharing service providers Grokster and Streamcast Networks (developers of Morpheus). The landmark decision in *MGM Studios, Inc. v. Grokster, Ltd.* (545 U. S. 125 S. Ct. 2764, 2005) was a victory for the media industry and a blow to P2P companies. At the same time, the decision let stand the main substance of the Supreme Court's landmark "Betamax" ruling (*Sony Corp. of America v. Universal City Studios*, 1984), which preserved a technologist's ability to innovate without fear of legal action for copyright infringement, and which the media industry sought to overturn.

The Supreme Court found that technology providers should be held liable for infringement if they *actively promote* their wares as infringement tools. Writing for the court, Justice David Souter stated, "We hold that one who distributes a device with the object of promoting its use to infringe copyright, as shown by clear expression or other affirmative steps taken to foster infringement, is liable for the resulting acts of infringement by third parties" (*MGM Studios, Inc. v. Grokster, Ltd.*, 2005, p. 1).

The decision creates a new theory of secondary infringement liability based on "intent to induce" infringement, which now extends the existing theory of contributory liability (knowingly aiding and abetting infringement). This inducement concept is derived from an analogous and established theory in patent law (Kalinsky & Sebal, 2005). Again, technology inventors must promote the illegal use of the product to be found liable:

...mere knowledge of infringing potential or of actual infringing uses would not be enough here to subject a [technology] distributor to liability.... The inducement rule, instead, premises liability on purposeful, culpable expression and conduct, and thus does nothing to compromise legitimate commerce or discourage innovation having a lawful promise (*MGM v. Grokster*, 2005, p. 19).

The effect of this decision on illegal P2P downloading has been mixed. The decision remanded the case back to the Ninth Circuit Court of Appeals and cleared the way for a trial that could have lasted years. However, both Grokster and StreamCast reached out-of-court settlements with the record companies. Grokster agreed to end operations and pay a \$50 million settlement, while StreamCast agreed to a \$100 million settlement and to the installation of filters that prevent music file sharing by Morpheus users (Mark, 2006).

Overall, this decision does not mean that P2P services have shut down altogether—as of mid-2008, Morpheus is still active, and many P2P services without previous marketing efforts are flourishing on the Internet, including LimeWire, BearShare, and eDonkey.

U.S. Department of Justice Operations & RIAA Lawsuits

The DOJ's Computer Crimes and Intellectual Property Section (CCIPS) is responsible for coordinating and investigating violations of the *U.S. Copyright Act*, the *Digital Millennium Copyright Act*, and other cyber laws discussed earlier in this chapter. The CCIPS, along with the Federal Bureau of Investigation's (FBI's) Cyber Division and numerous state Attorneys General, have been actively monitoring and investigating illegal operations associated with digital audio and copyright violations since 2004, namely through *Operation Buccaneer* ("warez" group copyright piracy), *Operation Fastlink* (international intellectual property piracy), *Operation Digital Gridlock* (P2P copyright piracy), and *Operation Site Down* (international intellectual property and organized crime).

The RIAA and several of its member record companies provide assistance to the DOJ and FBI in their investigations. The legal issues surrounding digital audio are not limited to file sharing networks. The RIAA assists authorities in identifying music pirates and shutting down their operations. In piracy cases involving the Internet, the RIAA's team of Internet specialists, with the assistance of a 24-hour automated Webcrawler called MediaSentry, helps stop Internet sites that make illegal recordings available.

Based on the *Digital Millennium Copyright Act's* expedited subpoena provision, the RIAA sends out information subpoenas as part of an effort to track and shut down repeat offenders and to deter those hiding behind the perceived anonymity of the Internet. Information subpoenas require the Internet service provider (ISP) providing access to or hosting a particular site to provide contact information for the site operator. Once the site operator is identified, the RIAA takes steps to prevent repeat infringement. Such steps range from a warning e-mail to litigation against the site operator. The RIAA then uses that information to send notice to the operator that the site must be removed. Finally, the RIAA requires the individual to pay an amount designated to help defray the costs of the subpoena process (RIAA, 2008).

Digital Audio Technologies

Digital Audiotape

Digital audiotape is a recording medium that spans the technology gulf between analog and digital. On one hand, it uses tape as the recording medium; on the other, it stores the signal as digital data in the form of numbers to represent the audio signals. DAT has not been very popular outside of professional and semi-professional audio and music recording, although the prospect of perfect digital copies of copyrighted material was sufficient for the music industry in the United States to force the passage of the *Audio Home Recording Act of 1992*, creating the "DAT tax" (Alten, 2007).

Compact Disc

In the audio industry, nothing has revolutionized the way we listen to recorded music like the compact disc. Originally, engineers developed the CD solely for its improvement in sound quality over LPs and analog cassettes. After the introduction of the CD player, consumers became aware of the quick random-access characteristic of the optical disc system. In addition, the size of the 12-cm (about five-inch) disc was easy to handle compared with the LP. The longer lifetime of both the medium and the player strongly supported the acceptance of the CD format. The next target of development was the rewritable CD. Sony and Philips jointly

developed this system and made it a technical reality in 1989. Two different recordable CD systems were established. One is the write-once CD named CD-R, and the other is the re-writable CD named CD-RW (Alten, 2007).

High-density compatible digital (HDCD), developed by Pacific Microsonics and now owned by Microsoft, is a recording process that enhances the quality of audio from compact discs, giving an end result more acceptable to audiophiles than standard CD audio. HDCD discs use the least significant bit of the 16 bits per channel to encode additional information to enhance the audio signal in a way that does not affect the playback of HDCD discs on normal CD audio players. The result is a 20-bit per channel encoding system that provides more dynamic range and a very natural sound. Over 5,000 HDCD titles are available and can be recognized by the presence of the HDCD logo (Microsoft, 2008a). Microsoft has also included the HDCD playback technology in its Windows Media Series 9, 10, and 11 Players.

Super Audio CD (SACD). When the CD was developed by Philips and Sony in the 1980s, the PCM format was the best technology available for recording. Nearly three decades later, huge strides in professional recording capabilities have outgrown the limitations inherent in PCM's 16-bit quantization and 44.1 kHz sampling rate. Philips and Sony have produced an alternative specification called Super Audio CD that uses a different audio coding method, Direct Stream Digital, and a two-layer hybrid disc format. Like PCM digital audio, DSD is inherently resistant to the distortion, noise, wow, and flutter of analog recording media and transmission channels. DSD samples music at 64 times the rate of a compact disc (64×44.1 kHz) for a 2.8224 MHz sampling rate. As a result, music companies can use DSD for both archiving and mastering (Geutskens, 2008).

The result is that a single hybrid SACD contains two layers of music—one layer of high-quality DSD-coded material for SACD playback and one layer of conventional CD encoded material for regular CD playback. The SACD makes better use of the full 16 bits of resolution that the CD format can deliver, and is backward-compatible with existing CD formats (SonyMusic.com, 2006). In addition to the hybrid SACD, there are two other SADC variations—the Single Layer SADC (which contains one high-density layer) and the Dual Layer SADC (with two high-density layers for extra recording time).

As of mid-2008, there are more than 5,100 SACDs available in a variety of music genres from a wide range of recording labels (Geutskens, 2008). A quick scan of Internet retailers found close to 100 different SACD players, many of which are DVD units that can playback multiple audio formats including SACD. Prices for the individual SACD players from brands such as Pioneer, Sony, and TEAC range from \$200 to \$3,000.

DVD-Audio

The main competitor to SACD, the initial version of DVD-Audio was released in April 1999, with discs and players appearing in the second half of 1999. DVD-Audio can provide higher-quality stereo than CDs, with a sampling rate of up to 192 kHz (compared with 44.1 kHz for CD). A typical DVD-Audio disc contains up to seven times the data capacity of a CD. There are about 750 DVD-Audio titles available.

MP3

Before MP3 came onto the digital audio scene, computer users were recording, downloading, and playing high-quality sound files using an uncompressed codec called .WAV. The trouble with .WAV files, however, is their enormous size. A two-minute song recorded in CD-quality sound would eat up about 20 MB of a hard drive in the .WAV format. That means a 10-song CD would take more than 200 MB of disk space.

The file-size problem for music downloads has changed, thanks to the efforts of the Moving Picture Experts Group (MPEG), a consortium that develops open standards for digital audio and video compression. Its most popular standard, MPEG, produces high-quality audio (and full-motion video) files in far smaller packages than those produced by .WAV. MPEG filters out superfluous information from the original audio source, resulting in smaller audio files with no perceptible loss in quality. On the other hand, .WAV spends just as much data on superfluous noise as it does on the far more critical dynamic sounds, resulting in huge files (MPEG, 1999).

Since the development of MPEG, engineers have been refining the standard to squeeze high-quality audio into ever-smaller packages. MP3—short for MPEG I Audio Layer 3—is the most popular of three progressively more advanced codecs, and it adds a number of advanced features to the original MPEG process. Among other features, Layer 3 uses entropy encoding to reduce to a minimum the number of redundant sounds in an audio signal. The MP3 codec can take music from a CD and shrink it by a factor of 12, with no perceptible loss of quality (Digigram, 2006).

To play MP3s, a computer-based or portable digital audio player is needed. Hundreds of portable digital audio players are available, from those with 512 MB flash drives to massive 160 GB hard drive-based models. They are sold by manufacturers such as Apple, Creative, Microsoft, Philips, and Samsung. The amount of available disc space is most relative to the way a person uses the portable player, either as a song selector or song shuffler. Song selectors tend to store all of their music on players with larger drives and select individual songs or playlists as desired, whereas song shufflers are more likely to load a group of songs on a smaller drive and let the player shuffle through selections at random.

Dozens of computer-based digital audio players are available for download. Winamp, still the most popular, sports a simple, compact user interface that contains such items as a digital readout for track information and a sound level display. This user interface can be customized by using “skins,” small computer files that let the user change the appearance of the digital audio player’s user interface.

Another intriguing part of the MP3 world is the CD ripper. This is a program that extracts—or rips—music tracks from a CD and saves them onto a computer’s hard drive as .WAV files. This is legal as long as the MP3s created are solely for personal use, *and* the CDs are owned by the user. Once the CD tracks have been ripped to the hard drive, the next step is to convert them to the MP3 format. An MP3 encoder is used to turn .WAV files into MP3s.

All the copyright laws that apply to vinyl records, tapes, and CDs also apply to MP3s. Just because a person is downloading an MP3 of a song on a computer rather than copying it from someone else’s CD does not mean he or she is not breaking the law. Prosecution of violators, through the efforts of the RIAA, is the recording industry’s main effort to prevent unauthorized duplication of digital audio using MP3 technology.

The first era in Internet audio has undeniably belonged to the MP3 codec, the audio standard codified by MPEG 14 years ago. France’s Thomson and Germany’s Fraunhofer Institute for Integrated Circuits IIS, the companies that hold the patents for the MP3 technology, have long been licensing and collecting royalties from software and hardware companies that use the codec (Thomson, 2008).

Competing with MP3, Microsoft, with its own digital audio codec, Windows Media Audio (WMA), has been a beneficiary of a similar type of interoperability. WMA is being used in hundreds of different devices and by AOL MusicNow, Musicmatch, Napster, PassAlong, Wal-Mart, and other distributors (Microsoft, 2008b).

In April 2004, Apple Computer incorporated MPEG-4 Advanced Audio Coding (AAC) into QuickTime, iTunes, and iPod portable music players. AAC was developed by the MPEG group that includes Dolby, Fraunhofer, AT&T, Sony, and Nokia. The AAC codec builds upon signal processing technology from Dolby Laboratories and brings true variable bit rate (VBR) audio encoding to QuickTime and the iPod, which will now support AAC, MP3, MP3 VBR, Audible, AIFF, and WAV codecs.

This created a struggle—or opportunity for collaboration—among the primary players in the digital download arena. However, rather than develop a universal standard under the SDMI banner, companies have been taking their technology to the marketplace to let consumers decide (Hydrogenaudio, 2008). The big winner, without a doubt, has been Apple. For example, with sales of its iPod music players continuing to grow at an astonishing pace—sales were up 17% in the first fiscal quarter of 2008 versus the same quarter in 2007—Apple reported the highest revenue and earnings results (\$9.6 billion) in the company's history. Apple shipped more than 22 million iPods during this period (Crum, 2008). Much of the credit has been given to the diversity of iPod models introduced since 2005, including the iPod touch, video iPods, and lower priced iPod shuffles.

Wireless MP3. Another interesting MP3 development is the launch of the wireless MP3 player. The first use for a wireless MP3 player is fairly obvious: transferring music without physically connecting the player to a computer. This change is certainly convenient, but if wireless connections become common for MP3 players, the sky is (literally) the limit in terms of where your music can come from.

Mobile phone companies, looking to extend their reach even further, are taking the wireless MP3 concept to the next level. In January 2006, Europe's largest mobile phone operator, Vodafone, joined forces with Sony Europe's NetServices, to launch the Vodafone Radio DJ service, which offers personalized music channels streamed to customers' mobile phone handsets and computers. A key feature of the Vodafone service is a personalization system that enables customers to set preprogrammed channels to their own personal tastes by simply pressing a button to indicate "like" or "dislike" while listening to a song (Blau, 2006). In 2007, Vodafone added a 3G phone service, Vodafone live!, to serve the multimedia needs of these phone customers. As of mid-2008, just under 16 million Vodafone live! devices were in use across 28 countries (Vodafone, 2008). Around 750,000 music tracks are currently available for download through agreements with Sony BMG Music Entertainment, EMI, Universal Music, Warner Music, and independent music labels.

In the United States, Verizon continues to make news with its V CAST Music Service, an online music store where customers can download WMA songs (but not MP3s) directly to their V CAST-enabled phones or to Microsoft Windows XP computers. Customers are able to download music to their computers for \$0.99 per song or buy them over-the-air on their phones for \$1.99 per song. Users can, however, synchronize existing MP3s from their PC to their phone via USB (Verizon Wireless, 2008).

Hard-disk jukebox MP3 players. With computer hard drive prices steadily falling since 2002, and with computer technology becoming more crash-resistant and portable, manufacturers are rapidly producing portable digital recorders that use expansive hard drives (1.5 GB to 160 GB) as their recording media. The number of companies offering these multimedia jukeboxes rose from 30 in 2004 to over 60 in 2008, with the leaders being the Apple iPod, the Microsoft Zune 80GB, and the Creative Nomad Zen (Hard drive MP3, 2008). Storing music in MP3, AAC, or WMA, these devices archive both video and audio, accessible by album title, song title, artist name, or music genre.

Some of the recorders feature built-in modems to download music from Web sites without the assistance of a PC. Some deliver streaming audio content from the Web to connected AV systems. For superior sound quality, the devices can be connected to cable modems or DSL (digital subscriber line) modems. Some hard-drive recorders also come with a built-in CD player, making it possible to rip songs from discs for transfer to the hard drive. Next-generation jukeboxes from Archos and Cowon are marketed as portable media players (PMPs) capable of displaying MPEG and MPEG-4 video, streamed video content, JPEG pictures, MP3, MP3Pro, and WMA audio files (MP3.com, 2008).

Podcasting

Podcasting is the distribution of audio or video files, such as radio programs or music videos, over the Internet using RSS (really simple syndication) for listening on mobile devices and personal computers (Podcast Alley, 2008). A podcast is basically a Web feed of audio or video files placed on the Internet for anyone to download or subscribe to. Podcasters' Web sites may also offer direct download of their files, but the subscription feed of automatically delivered new content is what distinguishes a podcast from a simple download or real-time streaming. A quick search of the Internet will uncover a myriad of content that is available—and accumulating daily.

Recent Developments

Copyright Legislation, Cases, and Actions

Congress has continued to be a player in the digital audio arena, without much recent success. The *Copyright Modernization Act of 2006* (GovTrack.us, 2006b), proposed by Rep. Lamar Smith (R-TX), never made it out of the House Judiciary Committee. The bill was an attempt to allow music companies to blanket license all computer network, cache, or buffer copies of music from source to consumer device. The bill would have required consumers to seek permission from the music companies at every step to copy any piece of music, including fair use copies.

The *Audio Broadcast Flag Licensing Act of 2006* (GovTrack.us, 2006a), proposed by Rep. Michael Ferguson (R-NJ), also never made it out of the House Energy and Commerce Committee. This bill would have authorized the Federal Communications Commission (FCC) to implement “broadcast flag” technologies within consumer devices to prohibit unlawful transmission and copying from satellite and HD radio (Taylor, 2006).

The latest Congressional attempt to standardize digital music copyright law, the *Platform Equality & Remedies for Rights Holders in Music Act of 2007* (GovTrack.us, 2007), more commonly referred to as the *Perform Act of 2007*, was proposed by Rep. Dianne Feinstein (D-CA). It attempts to equalize rate setting standards for music copyright licenses. To accomplish this, the bill would encompass both satellite radio broadcasting and online Webcasting of music by requiring Copyright Royalty Judges to establish rates for *one, new* statutory license based on a set of newly devised criteria.

In addition, and of more importance to the consumer, the *Perform Act of 2007* would obliterate the *Audio Home Recording Act of 1992*, where consumers have the right to make noncommercial analog *and* digital copies of broadcasts. In essence, the *Perform Act of 2007* would require satcasters and Webcasters to use new DRM that restricts the recording of their transmissions. If the *Perform Act of 2007* becomes law, satcasters

and Webcasters who already use SoundExchange licenses to play music would have to give up current streaming technology (that allows consumers the choice to purchase devices that record and play) in favor of DRM-restricted, proprietary streaming formats that impose restrictions on any recordings made by the consumer.

Not waiting for Congress to act, several record companies, with the support of the RIAA, filed a related lawsuit, *Atlantic Recording Corporation et al. v. XM Satellite Radio, Inc.* (2007), in U.S. District Court of Southern New York. The lawsuit claims that XM Radio is operating as both a broadcaster and a digital download subscription service by allowing devices such as the Pioneer Inno to record blocks of XM Radio programming, which then can be sorted through, reorganized, and listened to by users at a later time. It argues that XM Radio is not authorized to "distribute" music in this "disaggregation" method under its current license agreement, and that XM Radio is actually competing unfairly with the music companies in the sale of digital music downloads. The suit contends that XM's "librarying function...does not have substantial or commercially significant *non-infringing uses*" that might protect it under *AHRA* and *MGM v. Grokster* (*Atlantic Recording*, 2007, p. 18).

After a failed attempt to have the lawsuit dismissed, XM Radio initiated discussions with the record companies to settle the dispute. By mid-2008, three of the four major record labels (Sony BMG Music, Universal Music Group, Warner Brothers Records) participating in the lawsuit had reached multi-year settlement agreements, while EMI and several smaller companies had not (Reuters, 2008a). It is expected that, by the end of 2008, XM will be able to secure agreements with all of the plaintiffs and have the lawsuit dismissed.

While making progress in this broadcast area, the record companies and the RIAA are still actively pursuing illegal P2P downloaders. As has been the case since 2006, the RIAA continues to pursue college students in record numbers. With these "John Doe" lawsuits, the RIAA must work through the courts to find out the identities of the defendants, which, at the outset, are identified only by the numeric Internet protocol addresses assigned to computers online, and are more easily detected when part of campus networks (RIAA, 2008). The RIAA claims that:

...the piracy habits of college students remain especially and disproportionately problematic—despite real progress by the music industry on other fronts. According to some recent surveys, more than half of the nation's college students frequently download music and movies illegally from unlicensed P2P networks. That's a statistic we just cannot ignore. As a result, we have stepped up our efforts to address college piracy across the board by significantly expanding our deterrence and education programs, continuing our push for legal music offerings on campuses, and advocating technological measures that block or curb piracy on college networks (RIAA, 2008).

A recent wave of copyright pre-litigation letters brought by the RIAA in February 2008 targeted 410 individuals for illegally distributing copyrighted music on the Internet via unauthorized P2P services such as LimeWire and eDonkey. In addition to these new "John Doe" litigations, the RIAA has filed 2,465 lawsuits since February 2007 against named college students across the nation.

Digital Audio Technologies

DRM-Free Music

Although buying practices are rapidly changing, much of the music sold in the world is still sold on compact discs. CDs have no encryption. They are DRM-free and can play on any CD player, including computer drives. CDs also provide high-quality digital content that can easily be ripped to a digital file, copied, or shared (legal issues notwithstanding) at the discretion of the buyer.

Digital downloads, in contrast, are accessible online at any time, making their purchase convenient. Often sold as singles and not full albums, they are economical as well. That convenience comes at the cost of quality and, especially, portability. Smaller digital files appropriate for downloads mean that the purchaser gets the music with lesser sound quality. Because the major labels insisted (until 2007) that downloadable music be encrypted with DRM, and there is no universal, open-standard for that encryption, the music could only play on devices capable of decrypting the specific DRM encryption the music was encoded with (as opposed to universally on any MP3 player).

One of the biggest developments in digital audio technologies is the announcement by the Big Four record companies, Amazon.com, Apple, and others to offer DRM-free music tracks over the Internet (Holahan, 2008). For years, DRM was simply a way to protect the rights of the artists whose music was being illegally distributed. Most in the music industry believed that the technology was a necessary evil that needed to be put in place for content creators to make sure that they were being fairly compensated for their work. However, as mentioned earlier in the chapter, DRM wraps music tracks in a copy-protection code that is not only restrictive but also confusing for many potential users. Very few consumers want to purchase music on one service using a specific DRM, only to find out later that they cannot play it on this MP3 player, that computer, or this operating system.

The good news is that the negative attitude toward DRM has kept nearly every independent label from utilizing the technology, and it has pressured the Big Four labels into backing out of the restriction-laden model in 2007 and 2008. One reason could be the increasing popularity of iTunes, as music labels have made no secret of wanting to wrest power away from Apple in the wake of their success in the music download market. Three of the Big Four labels are surely making Apple uneasy by selling DRM-free music through Amazon while keeping it off of the iTunes Store. While not all DRM-free music can be played back on every single device, taking DRM out of the equation makes things considerably easier for the consumer (Holahan, 2008). This means there are now ever-increasing options for legally acquiring DRM-free music (for an updated list of DRM-free services, see the CTU Web site: www.tfi.com/ctu).

Wireless MP3

Blackberry and Puretracks. Toronto-based Puretracks, the leading Canadian digital music provider has developed a new DRM-free mobile music store and service for BlackBerry smart phones. The Puretracks Mobile Edition music store for BlackBerry is a digital music service developed exclusively for wireless handsets using DRM-free AAC/AAC+ file formats. The files will be in the same AAC format used by iTunes, which offers higher quality at smaller file sizes than MP3. Unlike many of the songs on iTunes, none of the songs will be encumbered by DRM, allowing users to transfer the tracks to other devices (Troaca, 2008). This digital format is only half the size of MP3 files, significantly reducing the download time and storage capacity required

while maintaining CD quality sound—both important qualities for time-based wireless services. Puretracks Mobile Edition will have over two million available tracks from all of the Big Four music companies and several indie labels.

AT&T Wireless and Napster/e-music. AT&T Wireless has also joined the music download business in a partnership with Napster and e-music (AT&T Wireless, 2008). Selecting from over seven million available music tracks, AT&T Wireless customers can purchase five song Track Packs for \$7.49 or individual tracks for \$1.99. A unique artist and title searching feature, MusicID, is included for an additional \$3.99/month. It is interesting to note that the e-music per track cost is almost five times that of e-music's most expensive \$0.33 rate for non-wireless customers who subscribe to its regular download service. It appears that AT&T Wireless, like most other U.S. wireless providers, will continue to charge more for impulse, on-the-go purchases.

On the international side, Napster has also been a leader in wireless MP3 subscription service overseas in 2008. Partnering with Chilean provider Entel PCS and Ericsson phones, Napster established the first mobile music service in Latin America. Partnering again with Ericsson, Napster teamed up with Telecom Italia, Italy's largest telecommunications group, to create Napster Mobile for TIM. In Japan, Napster expanded its music subscription service to NTT DoCoMo wireless phone customers through partnerships with nine different phone manufacturers (Napster, 2008a).

Sprint Power Vision. The first music service to utilize wireless phones to download music over the air, Sprint's Music Store, reached 15 million song downloads by 2008 (MobileTracker, 2007). Originally priced at \$2.49 per track, but recently reduced to \$0.99, customers receive two copies of the song—one for their phone and another for their PC. Customers can also burn their music to a CD using Windows Media Player. To use the Sprint Music Store, a Sprint phone enabled for the Sprint Power Vision network is required. A monthly Power Vision access plan costing \$20, in addition to the customer's existing wireless calling plan, is required (Sprint, 2008).

Subscription-based Services

With the evolution of track-based DRM-free Internet and wireless downloading, only three subscription-based online music services remain as of mid-2008: Napster, Rhapsody, and Zune Pass (Reuters, 2008b).

Napster. With over five million songs encoded with Windows Media DRM, Napster is available for \$12.95 a month. Subscribers can access their account and copy their library of downloaded songs on up to three computers. If a subscriber decides to terminate a subscription, downloaded music will no longer be playable at the end of final billing period. Subscribers can choose to pay additional per track fees to permanently purchase music. Only these purchased tracks can be burned to CD or transferred to WMA-compatible devices (Napster, 2008b).

Rhapsody. Rhapsody, which is jointly owned by MTV and RealNetworks, offers two types of subscription services: Rhapsody to Go and Rhapsody Unlimited. Rhapsody to Go, available on Windows PCs only for \$14.99 per month, allows subscribers to listen to all available music (over five million tracks) and transfer this music to supported MP3 players, such as the Sansa e200R Rhapsody. Rhapsody Unlimited, available on Windows, Mac, and Linux computers for \$12.99 per month permits subscribers to listen to unlimited music just on the download computer. Like Napster, the downloaded music is unavailable after subscription termination, and tracks must be purchased separately to permit CD burning. Two unique features are the ability of subscribers

to add downloaded music to their Facebook site and for any non-member consumer to listen to 25 free tracks per month (Rhapsody, 2008).

Zune. From Microsoft, Zune includes digital audio players, client software, and the Zune Marketplace online music store. The Zune devices come in three styles, all of which play music and videos, display pictures, and receive FM radio broadcasts. They can share files wirelessly only with other Zunes and via USB (universal serial bus) with Microsoft's Xbox 360, and can sync wirelessly with Windows PCs. The Zune software, which runs on Windows XP and Vista, allows users to manage files on the player, rip audio CDs, and buy songs at the online store. The Zune Pass subscription is similar to the other two subscription services and allows subscribers to download as many songs as they like from Zune Marketplace and listen to them while their subscription is current, on up to three PCs. Like Napster, songs downloaded via a Zune Pass do not include burn rights, which only be obtained through the purchase of Microsoft Points (Zune, 2008).

P2P Music File Sharing

The music industry's anti-piracy efforts appear more and more futile as CD sales continue to decline and illegal P2P file sharing networks continue to proliferate. Digital rights management, long touted as a solution, has been all but abandoned by the Big Four music companies and most legal music download services. Although the RIAA is said to have threatened or taken action against some 20,000 suspected file sharers, the market-research firm NPD Group reports that nearly 20% of U.S. Internet users downloaded music illegally in 2007 (NPD Group, 2008).

Having failed to stop piracy by suing Internet users, the music industry is, for the first time, seriously considering a file sharing surcharge that Internet service providers would collect from users and place into a pool that would be used to compensate songwriters, performers, publishers, and music labels. A collecting agency would divide the money according to artists' popularity on P2P sites, just as ASCAP and BMI pay songwriters for broadcasts and live performances of their work (Rose, 2008).

Current Status

CEA Sales Figures

In 2007, one of the fastest growing segments of the audio consumer electronics segment was the MP3-player dock/speaker system. According to the CEA, factory-level sales of these systems have risen so rapidly in the past few years that their 2007 dollar volume (\$867 million) was almost one-third of the size of the traditional home audio market of \$3 billion, which was down 7% from 2006 (Palenchar, 2008). In fact, the overall portable audio share of the entire audio sales market has gone from 52% in 2005 to 61% in 2007 (CEA, 2008).

The primary reason stated for these developments was the penetration of digital audio players, now estimated by the CEA to be in 45% of U.S. households. Measured in units, digital audio player 2007 sales rose an estimated 23.5% to 47.1 million units, but the percentage gain was less than half that of 2006's 53.7% gain. In 2007, dollar sales flattened despite the unit sales increase, as consumers were able to purchase less expensive flash-memory models, and Apple lowered the cost of the iPod Shuffle 1 GB and 2 GB devices to \$49 and \$69. The average wholesale price of a digital audio player in 2007 was \$118, which was down from \$146 in 2006 (Palenchar, 2008).

The CEA expects the video-ready portable media player (PMP) to be the next big seller in consumer electronics. PMP demand has been low to date, primarily because of a lack of affordable video-capable devices and a limited amount of downloadable content. Sales of PMPs jumped from 415,000 units in 2005 to 4.39 million units in 2006, and are expected to take off in 2008 and 2009 to over 33 million units, as prices recede and available video content increases (CEA, 2008).

NPD Group Research Statistics

According to February 2008 NPD Group research, data corroborates the CEA statistics and supports the continued consumer movement away from traditional audio technology to the more interactive, user-driven technologies of digital audio:

- ♦ The amount of music that U.S. consumers acquired in 2007 increased by 6%.
- ♦ A sharp increase in legal digital download revenues could not offset declines in CD sales, which resulted in a net 10% decline in music spending (from \$44 to \$40 per capita among Internet users).
- ♦ As a result, the overall portion of music acquisition consumers actually paid for fell to 42% in 2007 from 48% in 2006.
- ♦ One million consumers, primarily younger consumers, dropped out of the CD buyer market in 2007.
- ♦ 48% of U.S. teens did not purchase a single CD in 2007, compared with 38% in 2006.
- ♦ The percentage of the Internet population in the United States who engaged in P2P file sharing reached a plateau of 19% last year; however, the number of files each user downloaded increased, and P2P music sharing continued to grow aggressively among teens.
- ♦ Legal music downloads now account for 10% of the music acquired in the United States.
- ♦ Reflecting the growth in that sector of the market, Apple's iTunes Music Store became the number one music retailer in the United States beating out Wal-Mart with 19% of the market (Apple iTunes, 2008).
- ♦ Twenty-nine million consumers acquired digital music legally via pay-to-download sites last year, which is an increase of five million over the previous year.
- ♦ Sales growth was largely driven by consumers age 36 to 50, a segment that was aggressively acquiring digital music-players in 2007 (NPD Group, 2008).

IFPI Digital Music Report

The International Federation of the Phonographic Industry (IFPI) is the organization that represents the interests of the recording industry worldwide. IFPI is based in London and represents more than 1,450 record

companies, large and small, in 75 different countries. IFPI produces an annual report on the state of international digital music, and the *Digital Music Report 2008* provided some interesting statistics:

- ♦ Consumers are downloading more than ever from authorized music-download sites, even if illegal file-sharing remains rampant.
- ♦ 1.7 billion music tracks were downloaded worldwide in 2007, up 53% from the previous year. That number includes tracks from full-album downloads, but excludes full-track downloads over the cellular airwaves directly to MP3-playing cell phones.
- ♦ Global digital music sales are estimated at approximately \$2.9 billion (U.S.) in 2007, a roughly 40% increase over 2006 (\$2.1 billion).
- ♦ Single track downloads, the most popular digital music format, grew by 53% to 1.7 billion (including those on digital albums).
- ♦ Digital sales now account for an estimated 15% of the global music market, up from 11% in 2006 and zero in 2003. In the world's biggest digital music market, the United States, online and mobile sales now account for 30% of all revenues.
- ♦ The music industry is more advanced in terms of digital revenues than any other creative or entertainment industry except games. Its digital share is more than twice that of newspapers (7%), films (3%), and books (2%).
- ♦ There are more than 500 legitimate digital music services worldwide, offering over six million tracks—over four times the stock of a music megastore.
- ♦ Tens of billions of illegal files were swapped in 2007. The ratio of unlicensed tracks downloaded to legal tracks sold is about 20 to 1.
- ♦ Progress in the digital music market is being hampered by lack of interoperability between services and devices, and lack of investment in marketing of new services.
- ♦ The growth rate of around 40% in digital sales did not offset the sharp fall in CD sales globally, meaning that the overall market for the year will be down over 2006.
- ♦ Research by IFPI debunks a myth about illegal P2P services: in fact, fans get better choice on legal sites. IFPI conducted research with a sample of 70 acts on the legal site iTunes and on the copyright infringing service LimeWire. In 95% of searches, the artists requested had more songs available on iTunes than on the leading P2P service (IFPI, 2008).

Factors to Watch

By the end of 2008, the factors to watch in digital audio will be:

Apple. How will the industry leader react to the emerging DRM-free services of Amazon, Rhapsody, and others? Will the iPhone and Apple iPod Touch help to extend Apple's device dominance? Will Apple's efforts overseas with EMI and other partners bolster its efforts? Will Apple continue to price competitively now that it has real competition for digital music download supremacy? Now that the iTunes Store is the top music seller in the United States, that question should be answered soon. Also, rumors have it that Apple may be considering an "all you can eat" subscription-based service.

TotalMusic. Speaking of competition, this potential new music service, which is aimed squarely at iTunes, is from Universal Music and Sony BMG (and possibly Warner Music Group as well). The plan is for the major labels to offer their music through a subscription program that would be subsidized by companies offering the service on their devices (for example, mobile carriers could build the estimated \$5 per month cost into their service plans) and ultimately be "free" to the user (Universal Music, 2007). However, the DOJ is already investigating the service for non-competitive behavior, just as they did in 2000 and 2001, when complaints surfaced concerning the labels' involvement with the PressPlay and MusicNet services (Cheng, 2008).

File sharing. The Big Four record labels and the RIAA have sued thousands of P2P users, and file sharing is up. The labels beat Grokster and other P2P networks in court, and file sharing is up. The labels proposed dozens of laws to thwart it, and file sharing is up. The labels successfully closed P2P applications and sites, and file sharing is up. The labels have formed several successful DRM-free pay services to make legal downloading easier and more portable for all. What happened? File sharing is up. This trend is certain to continue (IFPI, 2008). The two factors to watch here are:

- 1) The efforts of Congress to pass the *Perform Act of 2007*, or some other similar piece of legislation.
- 2) The ISP tax proposal that appears to be gaining momentum. Although the ISP tax would signal a definite change in the way the music industry deals with piracy, it would not necessarily be a sign of failure for its past approaches. Instead, it would be a fundamental shift toward achieving accountability at a different point in the puzzle, the ISP level.

Expect to see continued innovation, marketing, and debate in the next few years. Which technologies and companies survive will largely depend on the evolving choices made by consumers, the courts, and the continued growth and experimentation with the Internet and digital technology. Consumers seem to be very willing to move forward with the convenience and enjoyment being afforded by the new technologies of digital audio.

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Digital Imaging and Photography

Michael Scott Sheerin, M.S.*

*I got a Nikon camera
I love to take a photograph
so mama don't take my Kodachrome away.*

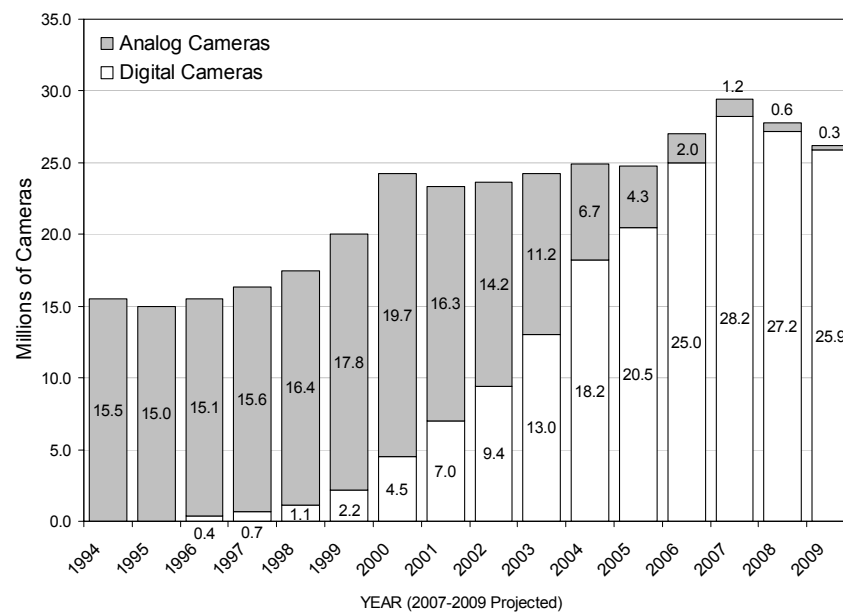
—Paul Simon (1973)

Sales of digital still cameras (DSCs) are forecast to reach 27.2 million in 2008, with a slight fall off to 25.9 million expected in 2009 (PMA, 2007). Meanwhile traditional still camera sales continue to plummet: less than half a million projected for 2009, the lowest total in more than 20 years (see Figure 16.1) (PMA, 2007). In fact, since 2003, DSCs have increasingly outsold traditional still cameras, prompting industry giant Eastman Kodak, in 2004, to stop selling their traditional 35mm still cameras and their Advanced Photo Systems (APS) cameras in the U.S. market. It looks like Paul Simon's concern about his mama was misplaced, as Kodak has discontinued all of their Kodachrome films (Super 8mm, 16mm, 25, and 200 ISO), save Kodachrome 64. With the shutdown of the Renens, Switzerland lab in late 2006 (Pytlak, 2006), only one processing house in the world (Dwayne's of Parsons, Kansas) is still developing that film stock (Eastman Kodak, 2008a).

Looking at the industry from the point of what happens after you take a picture, we find that an estimated 17.9 billion digital prints will be made in 2009, versus four billion prints processed from film (PMA, 2007). Our old way of using images, i.e., the print, is not the only factor to look at here, as an estimated 20.2 billion digital images will be saved, but not printed. We will view, transfer, manipulate, and post these images on high-definition television (HDTV) and computer screens, on Web pages and in e-mails, in collaborative virtual worlds, and on phones and other handheld devices. Looking at these factors, it is clear that the photo industry is fully converged with the computer industry. Unlike the discovery of photography, which happened when no one alive today was around, we are all eyewitnesses to this major sea change. What will be the implications for our society as digital images leave the old boundaries of camera and photographic paper, jump to the screen, and enter seamlessly into all our media?

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Figure 16.1

U.S. Camera Sales (Millions)

Source: PMA Marketing Research (2006)

Background

With digital imaging, images of any sort, from family photographs to medical X-rays, are now treated as data. This ability to take, scan, manipulate, disseminate, or store images in a digital format has spawned major changes in the communication technology industry. From the photojournalist in the newsroom to the magazine layout artist to the vacationing tourist, digital imaging has changed media and how we view the image. The ability to manipulate digital images has grown exponentially with the addition of imaging software, but photo-manipulation dates back to the film period. As far back as 1910, the Martin Postcard Company published an image of a man riding a giant fish (Pictures that lie, 2006). More humorous than deceitful, the same cannot be said of the 1984 *National Geographic* cover photo of the Great Pyramids of Giza, in which the two pyramids were moved closer together to fit the vertical layout of the magazine (Ritchin, 2008). In fact, repercussions stemming from the ease with which digital photographs can be manipulated caused the National Press Photographers Association (NPPA), in 1991, to update their code of ethics to encompass digital imaging factors (NPPA, 2008). Here is a brief look at how the captured image got to this point.

The first photograph ever taken is credited to Joseph Niepce, and it turned out to be quite pedestrian in scope. Using a process he derived from experimenting with the newly-invented lithograph process, Niepce was able to capture the view from outside his Saint-Loup-de-Varennes country house in 1826 in a camera obscura (Harry Ransom, 2008). The capture of this image involved an eight-hour exposure of sunlight onto bitumen of Judea, a type of asphalt (Lester, 2006). Niepce named this process heliography, which is Greek for sun writing.

Ironically, this was the only photograph of record that Niepce ever shot, and it still exists as part of the Gernsheim collection at the University of Texas at Austin (Lester, 2006).

The next 150 years included significant innovation in photography. Outdated image capture processes kept giving way to better ones, from the daguerreotype (sometimes considered the first photographic process) developed by Niepce's business associate Louis Daguerre, to the calotype (William Talbot), wet-collodion (Frederick Archer), gelatin-bromide dry plate (Dr. Richard Maddox), and the now slowly disappearing continuous-tone panchromatic black-and-white and autochromatic color negative films of today. Additionally, exposure time has gone from Niepce's eight-hour exposure to 1/500th of a second or less.

Cameras themselves did not change that much after the early 1900s until digital photography came along. Today's 35mm single lens reflex (SLR) camera works in principle like an original Leica, the first 35mm SLR camera introduced in 1924. Based on a relationship between film's sensitivity to light, the lens aperture (the size of the opening that lets light in, also known as the "f-stop"), and the shutter speed (time of exposure), the SLR camera allows photographers, both professional and amateur, to capture images using available light.

All images captured on these traditional SLR cameras had to be processed after the film's original exposure to light in order to see the image. Instant photography changed all that. Edwin Land invented the first instant photographic process in 1947. It produced a sepia colored print in about 60 seconds (Polaroid, 2008a). This first Polaroid camera, called Model 95, was sold in November 1948 at Jordan Marsh in Boston for \$89.75 (Polaroid, 2008a). Polaroid's innovations in instant photography peaked in 1972, when the SX-70 camera was introduced. Using Time-Zero film, this SLR camera was "fully automated and motorized, ejecting self-developing, self-timing color prints" (Polaroid, 2008a). On a sad note, having personally owned and enjoyed the product, the SX-70 is officially obsolete. Polaroid stopped making Time-Zero film, as well as many other instant films prior to 2008 and has plans to discontinue "almost all of its instant analog hardware products" in 2009 (Polaroid, 2008b). Digital image capture is the new instant photography and the company now sells many digital imaging products, including the Polaroid Digital Instant Photo Printer which uses a "revolutionary, inkless printing process" that "unlocks photos trapped on cell phones and digital cameras" (Polaroid, 2008c).

The first non-film camera produced analog, not digital, images. In 1981, Sony announced a still video camera called the MAVICA, which stands for magnetic video camera (Carter, 2008a). It was not until nine years later, in 1990, that the first DSC was introduced. Called the Dycam (and manufactured by a company called Dycam), it captured images in monochromatic grayscale only and had a resolution that was lower than most video cameras of the time. It sold for a little less than \$1,000 and had the ability to hold 32 images in its internal memory chip (Aaland, 1992).

In 1994, Apple released the Quick Take 100, the first mass-market color DSC. The Quick Take had a resolution of 640×480 , equivalent to a NTSC TV image, and sold for \$749 (McClelland, 1999). Complete with an internal flash and a fixed focus 50mm lens, the camera could store eight 640×480 color images on an internal memory chip and could transfer images to a computer via a serial cable. Other mass-market DSCs released around this time were the Kodak DC-40 in 1995 for \$995 (Carter, 2008b) and the Sony Cyber-Shot DSC-F1 in 1996 for \$500 (Carter, 2008c).

A DSC works in much the same way as a traditional still camera. The lens and the shutter allow light into the camera based on the aperture and exposure time, respectively. The difference is that the light reacts with an image sensor, usually a charge-coupled device (CCD) sensor, a complementary metal oxide semiconductor (CMOS) sensor, or the newer, live MOS sensor. When light hits the sensor, it causes an electrical charge. The

size of this sensor and the number of picture elements (pixels) found on it determine the resolution, or quality, of the captured image. The number of thousands of pixels on any given sensor is referred to as the megapixels. The sensors themselves can be different sizes. A common size for a sensor is $18 \times 13.5\text{mm}$ (a 4:3 ratio), now referred to as the Four Thirds System (Four Thirds, 2008). In this system, the sensor area is approximately 25% of the area of exposure found in a traditional 35mm camera.

The pixel, also known in digital photography as a photosite, can only record light in shades of gray, not color. In order to produce color images, each photosite is covered with a series of red, green, and blue filters, a technology derived from the broadcast industry. Each filter lets specific wavelengths of light pass through, according to the color of the filter, blocking the rest. Based on a process of mathematical interpolations, each pixel is then assigned a color. Because this is done for millions of pixels at one time, it requires a great deal of computer processing. The image processor in a DSC must “interpolate, preview, capture, compress, filter, store, transfer, and display the image” in a very short period of time (Curtin, 2008).

This processing issue, often referred to as shutter lag, has been one of the major drawbacks in digital photography, although it has been mostly eliminated in some of the newer, high-end digital single lens reflex (DSLR) cameras. In traditional photography, when the photographer pushes the button to take a picture, the film is immediately exposed, based on the shutter speed setting. In digital photography, there is a latent computer processing time that delays the actual exposure from happening when the user pushes the capture button, especially if the camera uses auto focus and/or a built-in flash. With many compact DSCs, what you think you are shooting, especially moving subjects, may be slightly different than what you actually capture.

Recent Developments

Innovations to the DSC, though still important, are no longer the lead story when discussing digital images. In keeping with Saffo's 30-year rule, we are quickly approaching the third decade, or the “so what? It's just a standard technology and everyone has it” phase (Fidler, 1997). In fact, in a statement that has further reaching implications than just the digital imaging industry, Saffo states, “the electronics revolution is over” (Saffo, 2008). If that is so, DSCs made great strides during the revolution, going from low-resolution black-and-white images to high-resolution lifelike images in a quarter of a century. It has been written, “Unlike the evolution of other types of media, the history of photography is one of declining quality” (Pavlik & McIntosh, 2004). Images shot with large format cameras in the 1880s were, in many ways, superior to the digital images of only a couple years ago. This perception is changing, as many of us now enjoy capturing digital images of similar, if not superior, quality to that of 35mm film (Ritchin, 2008). Roger N. Clark (2002) concludes in his study of digital still versus film resolution that the resolution obtained from an image sensor of 10 megapixels or more is equal to or greater than the resolution of 35mm film. Most all mid-range DSLRs on today's market are 10 megapixels or greater, with the extreme high-end Hasselblad H3DII-39, released in January 2008, offering 39 megapixels on a $48 \times 36\text{mm}$ CCD sensor (Blass, 2007).

Professional photographer Brad Tuckman thinks that the biggest change in the industry is what occurs after the image capture. Tuckman states that the workflow and the post-production process are just as critical to producing quality digital images as the capture process itself (Tuckman, personal communication, February 29, 2008). Interestingly enough, with the Wi-Fi ability of some new DSCs, professional photographers are more apt to be tethered to a computer when conducting a studio or field shoot. In addition to the photographer, a designer often works with the client, retouching photos “on-the-fly” on software platforms such as

Capture One (Tuckman, personal communication, February 29, 2008). This RAW workflow software promises “image quality, speed, and efficiency” and “measures image quality in over 20 parameters” (Phase One, 2007). RAW is an increasingly popular format for professionals because it is the minimally processed data from the digital camera or imaging device unlike the more popular JPEG format, which is compressed.

Tuckman’s observations allude to a point made earlier in the chapter: that of the digital image leaving the boundaries of the camera and photographic paper. Although this chapter has dealt mainly with DSCs, more images are captured worldwide on camera phones than on DSCs and film cameras combined (CEA, 2008b). This trend does not look like it will slow down, as the number of images taken with camera phones is estimated to reach 228 billion by 2010 (CEA, 2008a). As the market for compact DSCs slows, all these images create new markets in storage and dissemination methods. Revenue streams for wireless carriers and those in the photo finishing business are expected to increase. According to the Consumer Electronics Association, photo-messaging revenue is expected to double between 2005 and 2009 (CEA, 2008b), proving that the photograph has indeed “jumped to the screen.” With the ubiquitous nature of the camera phone, “the world has become like a stage, transformed into a photo-opportunity—a parallel universe owing its existence largely to the shutter’s release” (Ritchin, 2008).

This “jump to the screen” trend in digital imaging is obviously a result of convergence of the camera and the computer. This point can be illustrated by some new hardware and software products recently released or still under development. Let’s start with the hardware. Sony has introduced the Alpha Series a700, which is a DSLR with a 12.24-megapixel CMOS sensor and a built in HDMI (high-definition multimedia interface) terminal for direct connection to an HDTV set. It is interesting to note Sony’s tagline for the product: “Breathtaking quality from capture to playback” (Sony, 2008b). Sony also announced a 24.6-megapixel DSLR that will become the flagship camera of their Alpha series. Two other products from this line, the 14.5-megapixel DSLR-350 and 10.2-megapixel DSLR-300, come equipped with the newest must-have feature in DSLRs: the Quick AF (auto-focus) Live View that has two sensors, one for image capture and one to feed the viewing screen (Duiser, 2008). This eliminates the issue of the earlier Live View equipped cameras that would lose auto-focus capabilities, as well as the screen view, when pushing the shutter release. The reason for this is that the light entering the camera from the lens is split by a semi-transparent mirror, with some of the light reflected to the AF sensor and the rest to the viewfinder. When the image is captured, this mirror flips, letting all the light through to the main image sensor to record the image, thus cutting off the light to the viewfinder and AF sensor (Pogue, 2008). The added Live View sensor receives its light from an “innovative new pentamirror tilt mechanism,” and thus AF and viewfinder capabilities remain operational at all times (Sony, 2008b).

Fred Ritchin, in his essay “Of Other Times and Places” in *Aperture* magazine, identifies three software projects that, through photo-manipulation, can significantly change an image’s initial form. These programs are “taking advantage of this malleability and the pervasiveness of the photographic image on the Internet in powerful and potentially very exciting ways” (Ritchin, 2008). One of the software products is called Photosynth from Microsoft Live Labs. Photosynth starts by analyzing a large collection of digital photographs of a place or subject for similarities. It then reconstructs these images into a three-dimensional space (Photosynth, 2007). You can navigate this 3D space and zoom into any part of the image, whether it is a megapixel or gigapixel in size, using Microsoft’s newly acquired software called Seadragon. Seadragon’s “aim is nothing less than to change the way we use screens, from wall-sized displays to mobile devices, so that visual information can be smoothly browsed regardless of the amount of data involved or the bandwidth of the network” (Seadragon, 2008). Microsoft promises that future versions of Photosynth will start to change “the way you think of taking—and viewing—photos” (Photosynth, 2007). One of the architects of the project, Blaise Aguera y Arcas, explains how you can use a digital image that you might have taken of, say, the Eiffel Tower. Based on the col-

lective contributions of all other Eiffel Tower images that have been uploaded and tagged on the Web, you can “dive into this space, or metaverse, using everybody else’s photos and have a cross-modal, cross-user, social experience.” The end result is an “immensely rich virtual model” stitched together by Photosynth, “from the collective memory” of all digital image contributors (Arcas, 2007). Other similar projects that attempt the same type of digital image integration are EveryScape, “where together the real world is being created, *online*” (EveryScape, 2008) and Fotowoosh that will “forever change the way you think of your pictures” (Fotowoosh, 2007).

The second software product that Ritchin identifies is actually two systems created at Carnegie Mellon University. The first is called Photo Clip Art (PCA) and the second is named Scene Completion (Carnegie-Mellon, 2007). PCA works by using a library of digital images from a Web site named LabelMe. These images can be used as clip art to add visuals to a scene. The software looks at the orientation of the image to be modified (the user must first identify the horizon line of the image) and identifies which images would translate to the scene, based on light, camera angle, etc. “Matching an object with the original photo and placing that object within the 3D landscape of the photo is a complex problem,” said Jean-François Lalonde, who led the development of the system. “But with our approach, and a lot of clip art data, we can hide the complexity from the user and make the process simple and intuitive” (Carnegie-Mellon, 2007). The second system, Scene Completion, draws from the digital images found on the Flickr Web site. Its purpose is to fill in “holes” in digital images. The “holes” come about when something, such as a car or telephone pole, partially blocks a desired view. Other times the “hole” occurs when an image has previously been cropped. The software usually “gives the user 20 different choices for filling in the hole” and its success depends on the number of digital images available to the system (Carnegie-Mellon, 2007). “Why Photoshop if you can ‘photoswap’ instead?” said Alexei Efros, assistant professor at the Carnegie Mellon School of Computer Science (Carnegie-Mellon, 2007) (see Figure 16.2).

Figure 16.2

Carnegie-Mellon Scene Completion Software



Source: Carnegie Mellon (2007)

The last of the three software projects identified by Ritchin is called Spellbinder, developed at the University of Edinburgh in Scotland. It is defined as “a medium for social interaction in a branded city space” (Spellbinder, 2007). By using a camera phone to capture a digital image and then photo-messaging that image to the Spellbinder server, the software can use its “powerful image-matching algorithms” to match the image to previously captured images, even if “taken under different lighting conditions or orientations” (Ward, 2007). Spellbinder then sends a digital image back to the camera phone, complete with the branded extras. In one case, the

city was adorned with virtual artwork, which could only be found by snapping images with a camera phone and then seeing if the returned image contained virtual artwork. “Visible reality is augmented; the virtual and historical are made to be both potentially overlapping and alive” (Ritchin, 2008).

Another project similar to Spellbinder is Comera, a subgroup of Branded Tribes (a project studying the brand in places where people gather and interact). Comera users participate by first capturing a digital image of their surroundings with a camera phone. The image is then photo-messed to a specific phone number that relays the image to the Comera server. The server’s software categorizes and matches the image with other uploaded images and then updates the user’s location into a social networking site such as Facebook. If other members of the network are found to be at the same location, this information is text-messed back to the user’s phone (Comera, 2007). The goal of this project is to explore how technology influences social interactions, and the use of the digital image, far removed from its traditional use of recording memories, is vital to this effort and to the others noted above. Similar projects to Comera that deal with user location and social networking are GypSii and Bliin (both started in Amsterdam), MyGamma (from Singapore), and Itsmy.com (from Munich). Dan Harple, founder and chief executive of GypSii, predicts his network “could have more users in one year than Facebook had in three” (Shannon, 2008).

The camera phone plays a critical part in many of the noted projects. This is due, in part, to a social norm, as people usually do not leave the house without their phones, while the DSC only comes out when the main purpose is to take pictures. It is this ubiquitous nature of the camera phone that is causing this change in the way we perceive and use images. With only slightly less than 30% of all Internet users owning a camera phone, these image-driven social experiences will only grow in scope (CEA, 2007). The quality of the camera phone’s image resolution has also increased, though 80% of the available phones on the market come with less than two megapixels (Delis, 2007). With camera phones from Samsung becoming available in 2008 with eight-megapixel resolution, complete with auto-focus, the ability to take quality images with a cell phone will become a reality (Kim, 2007). With this increased image quality available on a phone (and other companies are sure to follow Samsung’s lead if sales are brisk), will this mark the beginning of the end of the “phone-less” DSC, especially for the average person?

With all the excitement surrounding these Web 2.0 digital image applications, there are still some recent developments on the DSC side of things that might not be found on a camera phone for some time. The plenoptic camera has found a home with a Silicon Valley start up called Refocus Imaging. Ren Ng is the Founder and Chief Executive of the company (Shankland, 2008). By using special microlenses on the camera’s sensor and running the RAW data through proprietary software, the camera allows the user to make a decision on the focal point of an image after the shot is taken. The distinct advantage for the photographer is the ability to obtain images in low-light situations that have greater depth-of-field options despite using large aperture exposures (normally, large apertures, such as f2.8, are needed for low-light conditions, resulting in an image with a shallow depth-of-field; in brighter lighting conditions, the ability to use a smaller aperture such as f16 yields an image with a greater depth-of-field). The microlenses also allow for shorter exposure times. The drawback is that final image resolution is dependent upon the number of microlenses. Ng says that “You can get gorgeous 4×6 prints or (larger), and take those much more dependably” (Shankland, 2008).

With our digital image collections growing exponentially, organizational software is very important if one is to manage all this data. A new version of Apple’s creative suite-in-a-box software package, iLife '08, was introduced in fall 2007 as “the most significant upgrade ever to Apple’s award-winning suite of digital lifestyle applications” (Apple, 2008a). The package, which ships with any new Mac, includes the reworked iPhoto '08. According to Apple, iPhoto '08 automatically organizes your images into “Events” and works seamlessly with

the Mac Web Gallery (Apple, 2008b). Simple retouching tools come with the program, so you do not have to open other programs, such as Photoshop, in order to quickly fix your images. The new unified search control allows you to “search by name, keyword, rating, or date and see your results in an instant—neatly organized by event” (Apple, 2008b). “Theme-Based Home Printing” is an added feature, taking advantage of the growth in this segment of the industry (Apple, 2008b). Apple also offers iPhoto print products such as books, calendars, postcards and of course, prints (up to 20 × 30-inch poster size). It also provides support for up to 250,000 digital images.

Getting these images from your DSC to the computer keeps getting easier, as storage and transfer devices are adding more space and functionality at a cheaper price. The introduction of the new Eye-Fi SD card with 2 GB of memory and Wi-Fi connectivity (802.11g) allows any camera with an SD slot to transfer digital images to blogs or image sharing Web sites such as Flickr without ever having to connect to a computer (Eye-Fi, 2008). In fact, with the new feature called Smart Boost, even “when your computer is off, the Eye-Fi Card will automatically send photos from the camera through your home Wi-Fi network to the Web-based Eye-Fi Service” and will later download from the service to your computer when it is turned on (Eye-Fi, 2008).

One new product that actually treats digital images somewhat traditionally (though the “jump to the screen” principle still applies) is the digital picture frame. Sales of these frames increased significantly in 2007, with unit sales up 361% and revenue up 314% (Bogaty, 2008). According to a November 2007 study by the NPD Group, DSLR users are more apt to use a digital picture frame to view their digital images than point-and-shoot users (Bogaty, 2008). However, most users come about their digital picture frames as gifts. In the second week of May 2007, over 112,000 units were sold, with a gross of almost \$12 million. These figures “made Mother's Day digital picture frame sales just as strong in units as frame sales during the week before Christmas and beat the revenue brought in by digital picture frame sales during the week of Black Friday” (Bogaty, 2007).

Current Status

In order to better understand how we capture the majority of our images, a distinction must be made between the types of DSCs used. Sales of point-and-shoot compact DSCs made up 94% of the total number of DSC units sold and 76% of the revenue, down 1% from 2006, marking the first ever drop. However, revenue of the DSLR cameras increased 25%, with unit shipment growth up 33% (Bogaty, 2008). One reason for the growth is that the average price of DSLR cameras dropped \$125 in the first half of 2007 (Graham, 2007a). The growth of DSLR cameras in Europe is even greater, as shipments grew 46% (Watson, 2007). These consumers are no longer early adopters, as today's profile of the compact DSC user is typically a woman or families with children. The DSLR user is increasingly from the same demographics, as lower-end (less than \$600) purchases of these cameras increased 23%, changing the perception that only professionals and avid enthusiasts are the ones using DSLRs. Overall, the Consumer Electronics Association reported that DSCs are found in more than 62% of all U.S. households (CEA, 2007).

Combined DSC sales increased 20% in the U.S. market in 2007, up 9.5% in dollars (Graham, 2007a). Repeat buyers spurred the growth, as 54% of all buyers were buying a second camera (or more), a figure that rose 46% from 2006 (Graham, 2007a). The cameras being bought were increasingly equipped with seven megapixels or more. November figures from 2007 show that 78% of cameras bought were this size, with the demand for eight megapixel cameras up an amazing 977% (Clairmont, 2007). During the same year, the pur-

chase of digital camera accessories, defined as “lenses, batteries, external flashes, filters, and tripods,” rose more than 50% (Graham, 2007b). In a study targeting the United States and Western Europe, accessory revenue is predicted to peak in 2008 at \$1 billion in the United States, and in 2009 at \$1.3 billion in Western Europe. The report predicts that 90% of all revenue for accessories in 2010 will be for DSLR accessories, with lenses making up nearly 60% of that total (Watson, 2007).

The growth of digital imaging has had an interesting effect on usage (defined as the number of prints made). The high water mark for the number of photographic prints made in a year (29.9 billion) occurred in 2000, with the vast majority of those prints developed from film (PMA, 2007). Since then, the number of prints made has declined every year (PMA, 2007). From 2000 to 2008, there was a 28% decline in prints made from film and digital cameras combined. This decline is most likely due to the fact that digital images can be viewed on a variety of sources (computer screens, TVs, camera phones, iPods), and can be shown to family and friends without prints being made. Accordingly, while the number of prints made has declined, the number of images saved has increased every year since 2000, with the majority coming from the digital format since 2005 (PMA, 2006). Because this non-printing trend will likely continue as usage of portable devices capable of displaying digital images grows, it should be noted that the total value of the photo printing market is expected to decrease for the first time since digital images surpassed “analog” images in 2005 (PMA, 2008). Note from the dark side of technology: unless properly backed-up, digital images stored solely on a PC are just a hard drive failure away from being lost. According to a Photo Marketing Association (PMA) report, only 39% of households backup all their images after storing them on a hard drive. Almost just as many households (35%) do not back-up any files after transferring from camera to hard drive, while the remaining 25% back up some of the images. Age demographics play a role in this action, as 43% of 35 to 44 year olds back up all their images, as compared with only 21% of those under 25 and 28% of those over 65 (Clairmont, 2007).

Perhaps the biggest growing trend is the number of households owning camera phones. From only 2.5% of all households owning one camera phone in 2003, this number has jumped to 41% in 2007 (Wong, 2007), with 50% of those households owning two devices (Clairmont, 2007). This growth is not expected to slow, as the installed base of approximately 850 million units in 2006 is projected to reach 1.5 billion units by 2010 (CEA, 2008b). Camera phone owners, as stated earlier, are projected to take 228 billion images in 2010, and as camera phone resolution continues to increase, usage of these images should also rise. It has been reported that users of camera phones with two megapixels or higher are more apt to share the images they capture (as screen savers, e-mail to friends, print outs, etc.) than those using cameras with lower resolutions. Image sharing of digital images has declined every year since the high water mark of 2003-2004, perhaps due to the novelty of the camera phone wearing off (Delis, 2007). It is possible that increased resolution, and perhaps added usage opportunities as presented by the social networking projects described earlier, will change this downward trend.

Two other things are predicted to occur due to the increased proliferation of camera phones. One is that the mobile camera phone market will become the “single largest market for image sensors, surpassing the entire consumer electronics segment, including DSCs worldwide” (Research and Markets, 2007). Leading the way could be Kodak, which introduced the KAC-05020 Image Sensor that “enables a new level of resolution in small optical formats, using significantly smaller pixels” (Eastman Kodak, 2008b). Second, it is predicted the United States will follow the Japanese, where ownership of camera phones surpassed ownership of DSCs in 2005 (CEA, 2008a).

Those who do own a DSC have seen vast improvements and options, as well as falling prices. DSLR prices dropped more than 30% with the average price expected to be around \$737 in 2010 (CEA, 2008b). Options,

such as better image stabilizers, Live View screens with increased screen sizes, and Wi-Fi capabilities are examples of this. HP has added a feature that will make all your dieting friends happy, as many of the HP Photosmart R series cameras have a slimming function that can “instantly trim off pounds from the subjects in your photos,” and provides a before and after version, allowing for comparison before deciding which image to save. Other features seen on many new camera releases are the smile detection and eye blink warning features. These cameras can automatically trigger the shutter release (some capture more than one image) when the subject smiles, and display a warning message when the subject blinks during the exposure time. Sony’s Cyber-shot DSC-T300 can detect multiple smiles and can be set for “adult priority” or “child priority” (Yeager, 2008). Photographers no longer need to make their portrait subjects say “cheese.” Instead, they frame the subject with their Live View screen, all the while keeping eye contact with the subject. They then tell the subject that the captured image will make them look 10 pounds lighter. This elicits a smile from the subject that is automatically captured by the DSLR. The captured image is then automatically sent, via Eye-Fi with Smart Boost to either an online server or the photographer’s computer, where image color, focus, and cropping corrections can instantaneously be made. At the same time the image can be viewed by the subject on an HDTV monitor in the studio as a copy of the image is uploaded to online photo services such as Flickr, Ofoto, or Snapfish and printed into a photo book; this is a 43% growth industry in 2008 (Long, 2008a). Alternately, the image is embedded into a Web page in Facebook, MySpace, or GypSii. From there, Photosynth runs it through an algorithm and weaves the digital image into a collective virtual world where it begins a life of its own!

Factors to Watch

- ♦ *The introduction of new products*, such as the Smartpants 32-inch digital picture frame that can store 1,500 images. It comes with a graphical user interface that lets you locate, resize, and transfer images without touching the originals on the computer. Their new SyncPix digital picture frame bypasses the computer altogether, as images are transferred right from the camera’s memory card. You can also straighten, resize, and rotate the transferred images. These photo frames will eventually morph into HDTV entertainment centers, as some new products can already display video and play audio over integrated speakers (Gretzner, 2008).
- ♦ *More standard options will appear on DSCs*, such as better face recognition software and Wi-Fi capabilities. DSCs with Wi-Fi are expected to increase 12% in Western Europe and the United States by 2011 (Wells, 2008). These Wi-Fi-enabled cameras will add to the “jump to screen” phenomenon already underway.
- ♦ *Moore’s Law remains in play*, as 32-gigabyte SDHC (secure digital high capacity) memory cards with a transfer rate of 15 Mb/s will be released by a number of companies in 2008 (Long, 2008b). Newer cards will continue to offer more storage in years to come, as they have increased in capacity from 8 Gb to 32 Gb since 2006.
- ♦ *Kodak’s new camera phone sensor, the KAC-05020*. The DSC sensor wars may not be over (Pogue, 2006); it is possible they just switched battlegrounds. Look for new sensors with better image quality and other options found on higher-end DSCs to migrate to camera phones.
- ♦ *Increased use of camera phones and the images derived from these phones*. Camera phones with higher resolution capabilities will capture more images that will then jump to many screens.

According to the Van House and Davis (2005) study, *The Social Life of Cameraphone Images*, camera phones will be used as “memory devices, communication devices, and expressive devices.” Because the camera phone is automatically networked, image creation and usage will take on a more collaborative nature. As third-generation wireless networks propagate, dissemination of captured images to devices other than camera phones will increase. Add software programs such as Spellbinder, Photosynth, and Comera to this collaboration, and we will see images used less in one-to-one modes and more in one-to-many instances, thus changing the social impact of the singular image.

- ♦ *New, powerful hardware and software will take the digital image away from its role of recording the past.* Advances to screen technology (Seadragon) will change the way we view and use the screen, and thus the images displayed on it. Meta “beehive” algorithms will alter the single image into a collective virtual footprint of our world. Manipulation software will alter captured images, sometimes before they even leave the camera. Combined, this technology will change the digital image collection found on the Web into a virtual representation of our world, far different than the quaint “faithful recording of the visible” (Ritchin, 2008).
- ♦ *Other sociological implications triggered by ubiquitous digital photography and the malleability of the digital image.* Sociologist Pierre Bourdieu, studying French families in the 1950s, called the camera a “festive technology,” referring to the posed snapshots of extended family members (Lagesse, 2003). In Susan Sontag’s book *On Photography*, she further illuminates the camera’s role in disguising “the actual disappearance of the extended family as a functioning social unit: the portraits that include grandparents and relations are in fact the only moments at which such gatherings occur” (Murray, 1993). It has been suggested that, by capturing more images, the posed, perfect family portraits will give way to more candid snapshots, thus altering our perception of family life. As increased image capture and sharing abilities become standard, photographic subjects may become less about the image and more about the use of the image in social interaction. Add to this factor another layer of change. DSCs that automatically capture a smile with slimming software on-board, coupled with powerful image manipulation programs, have combined to add a virtual layer to our portraits. Perhaps Bourdieu would call this “festive post-photographic technology.”
- ♦ *Privacy issues will remain, as the dissemination of digital photos over the Internet increases.* As the use of digital cameras by security and law enforcement agencies increases, the balance between “Big Brother” and personal rights will be tested even more. The rise of the social networking site also adds to this mix. Witness the recent controversies behind Facebook’s NewsFeed and Beacon features, where the public easily accessed information (including digital images) deemed private by users, via RSS feeds.

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Networking Technologies

Telephony

Ran Wei, Ph.D. & Yang-Hwan Lee, M.A.*

Since the 20th century, the telecommunications industry has grown rapidly thanks to the emergence of new technology, services, and the expansion of the telecommunications market. New technologies including wireless telephony and VoIP (voice over Internet protocol) have been eroding the market share of traditional wired telephones. However, the telephone still plays an important role in the telecommunications market, with billions of customers enjoying reliable and high-quality voice services. As of 2006, the number of wired telephone subscribers in the world was approximately four billion, averaging 61 subscribers per 100 inhabitants (ITU, 2008a).

Meanwhile, the U.S. telecommunications market has also changed dramatically. Before the breakup of the Bell System in 1980s, local telephone companies of American Telephone & Telegraph (AT&T) provided service to most of the United States. In the early 1980s, AT&T provided about 75% of the U.S. local and long distance telephone service (FCC, 2007b). In 1984, an antitrust suit filed by the U.S. government resulted in the divestiture of AT&T's local operating companies, which were divided into seven independent local telephone companies (Baby Bells). Mergers and acquisitions in the 1990s and 2000s, sanctioned by the *Telecommunications Act of 1996*, led to the survival of only three of the original seven Baby Bells.

In the meantime, wireless telephony has begun to offer formidable competition. Wireless telephone technologies are undergoing a technical evolution from 2G to 3G networks. The wireless telecommunications business continues its growth, marketing an increasing number of cutting-edge 3G services and applications for communication, data transactions, and commerce. The global popularity of the cell phone seems to be unabated. There were 2.7 billion mobile handsets in use worldwide in 2007 (ITU, 2008b), which is three times the number of computers in use. Over 200,000 iPhones were sold when they debuted on June 29, 2007. More than two million Americans now own an iPhone. A milestone was reached in 2007 when the total number of cell phones only American households (14.0%) outnumbered the total of fixed-line-only households (12.3%)

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(Mindlin, 2007). More importantly, a study by the Mobile Marketing Association (2007) reported that 79% of surveyed users indicated they were moderately or highly dependent on the cell phone.

The most significant mark of the growth of the wireless telephone in the past few years is the notion of the cell phone as a “third screen” after television and the PC. This means the cell phone has transformed itself from a voice-only personal communications device into a convergent medium platform. A concurrent sign of the transformation of the cell phone as a bona fide medium is the growth of advertising on cell phone screens. Increasingly attractive to advertisers who are willing to tap into the huge cell phone user market, the cell phone is following in the footsteps of broadcast TV and the Internet on the way to being commercialized.

Another fast-growing technology is voice over Internet protocol. Most telephone service providers in the United States have launched a version of VoIP on their networks. VoIP or IP telephony refers to a technology that allows users “to make telephone calls using a broadband Internet connection instead of a regular (or analog) phone line” (FCC, 2004). Using VoIP technology, individual users connected to the Internet via a broadband connection can get digital phone services delivered through that connection instead of through traditional local phone services.

Background

Traditional Wired Telephony in the United States

The word “telephone” originates from a combination of the Greek words “tele” meaning “afar, far off,” and “phone” meaning “sound, voice” (RSI, 2008). Since the first telephone was introduced by Alexander Graham Bell in 1876, the U.S. telephone industry’s growth was closely associated with AT&T, which became the parent company of the Bell System, and, with the *Communications Act of 1934*, AT&T was authorized as the American telephone monopoly (FCC, 1939).

Over the years, AT&T provided its telephone services exclusively and solidified its monopoly position until the 1970s. In 1948, AT&T opened its first microwave relay system between Boston and New York. In 1962, AT&T placed the first commercial communication satellite, Telstar I, in orbit. The percentage of U.S. households with telephone service also increased during this period from 50% in 1945, 70% in 1955, to 90% in 1969 (AT&T, n.d.).

AT&T’s dominance in the U.S. market, however, began to decline in the 1970s. First, the government had been burdened with the mammoth AT&T, and finally realized that it was time to launch an antitrust suit against AT&T to bring it under government control. The Department of Justice filed an antitrust suit against AT&T in 1974, which was settled in 1982. Second, as telephony technologies evolved, the level of technological barriers to entry became lower. Competitors such as MCI and Sprint began to offer long distance services (FCC, 2007; AT&T, n.d.). The competition caused basic telephone rates to drop, usage surged, and AT&T’s decline began (FCC, 2007b). In 1982, AT&T agreed to divest itself of its regional telephone companies to settle the suit, agreeing with the Department of Justice on the Modification of Final Judgment (MFJ), which became complete in 1984 (*U.S. v. AT&T, D.D.C.*, 1982).

After the breakup of the Bell System in the 1980s, there were seven independent regional Bell operating companies known as “Baby Bells”: Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern

Bell, and U S WEST. In 1995, Southwestern Bell was renamed SBC Communications, Inc.; it acquired Pacific Telesis in 1997 and Ameritech in 1998. In 2005, SBC acquired AT&T and retained the AT&T name. In 2006, the new AT&T merged with BellSouth, gaining full control of two original joint ventures between SBC and BellSouth, Cingular Wireless, and Yellowpages.com (AT&T, 2006). After SBC acquired AT&T, the new AT&T became the largest phone company in the United States, served 13 states (mostly throughout the western and southwestern regions of the country), and, through the acquisition of BellSouth, AT&T obtained more than nine states in the southeast (Reardon, 2006). Meanwhile, Bell Atlantic and NYNEX agreed to a merger valued at \$23 billion in 1996, and the company changed its name to Verizon after Bell Atlantic acquired GTE in 2000 (Verizon, n.d.). Finally, U S WEST was acquired by Qwest in 2000 (Edward, 2000). Currently, only three of the original seven AT&T descendants remain: AT&T (formerly SBC), Verizon (formerly Bell Atlantic), and Qwest (which acquired U S WEST).

The Evolution of Wireless Telephony Technologies

Wireless telephones are handheld portable phones with a built-in antenna. Basically, a cell phone is a two-way communication technology over radio dating back to the 1920s. AT&T developed the concept of cellular technology in 1947. The network architecture of wireless telephony divides a geographic area into multiple areas with limited size (a few miles in diameter) called “cells.” A cluster of cells covers a larger area, such as a city. Hence, the wireless telephone became known as the cellular telephone, a generic term to refer to all types of wireless telephones in the United States.

A cellular network consists of cellular base stations, mobile telephone switching offices (MTSOs), and mobile calling devices. When a user makes a call, the data is routed through the nearest cell phone tower to the MTSO. If the call is going to another wireless subscriber in the same area, it is routed to the closest tower to the recipient and then to the phone. If the call is going to a wireless subscriber on another service or to someone with a landline phone, the call is routed to the public switched telephone network (PSTN). Architecturally, cells resemble a honeycomb and provide local, regional, or national cellular coverage (Raciti, 1995). Figure 17.1 illustrates the architecture of cellular telephone networks.

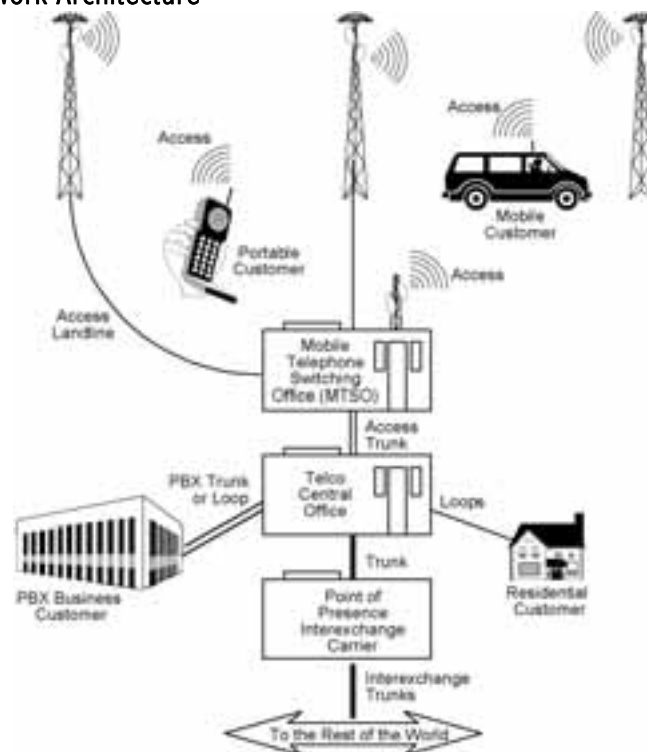
It took decades for cellular technology to become practical. The first U.S. cellular system for commercial use was built in 1983, 37 years after conception of the technology (the first commercial wireless telephone network debuted in Tokyo in 1979). Known as 1G, the first and uniform standardized cellular services—AMPS (Advanced Mobile Phone Service)—was launched on an experimental basis in Chicago. Using the 800 MHz to 900 MHz frequency band, 1G was an analog technology for voice communications only. In the same year, Motorola introduced the first commercial cellular phone, the DynaTAC 8000X. Anyone with phone service, including landlines, was able to receive calls from a wireless phone. This compatibility with the existing telephone network was a major reason why the wireless phone was so quickly adopted.

1G analog networks were phased out starting in the early 1990s when the 2 GHz band was allocated for digital telecommunications and the FCC allocated spectrum for PCS (personal communication services). The digital cellular era arrived. Digital means voice and data such as text messages or e-mails are converted into 0s and 1s, which are transmitted securely over wireless networks. Compared to 1G, 2G was capable of delivering wireless voice and data with 14.4 Kb/s data bandwidth.

However, the United States and Europe took different approaches to managing the spectrum for 2G services. Through the European Telecommunications Standards Institute (ETSI), Europe mandated a single standard technology, GSM (global system for mobile communications), in the 2G bands. In contrast, the United

States allowed the market to decide the winning technology. Wireless operators were free to choose among the four recognized but incompatible 2G digital wireless standards: CDMA/IS-95, GSM, TDMA, and iDEN. In 1996, the first commercial CDMA wireless network was launched (CTIA, 2008).

Figure 17.1
Cellular Telephone Network Architecture



Source: Technology Futures, Inc.

Accordingly, three incompatible standards dominated 2G: CDMA (code division multiple access), TDMA (time division multiple access), and GSM. U.S. wireless carriers operated on CDMA (first launched by Bell Atlantic Mobile) and TDMA. European wireless telephone companies relied on GSM. Globally, the popularity of GSM networks was unrivaled. GSM systems attracted 100 million users in 120 countries between 1991 and 1998. There were 300 GSM system operators worldwide in 1998, with 60% of all-digital networks using GSM (Future Horizons, 1998).

Although 2G networks were digital and capable of expanding services beyond voice calls to carrying data services such as text messaging, photos, and Internet connections, data transmission speed was a bottleneck. In addition, the standard was unable to carry mobile multimedia services. Hence, the next generation of wireless technology, 3G, was ushered in. 3G networks such as CDMA 2004 or W-CDMA (wideband CDMA) are able to support broadband voice and data, making it possible for carriers to offer broadband multimedia service (384 Kb/s of net bandwidth outdoors and 2 Megabits/second indoors) for music, video, Web surfing, and two-way videoconferencing. 3G networks also provide high-speed, cost effective access to the Internet and intranets via Wi-Fi technologies.

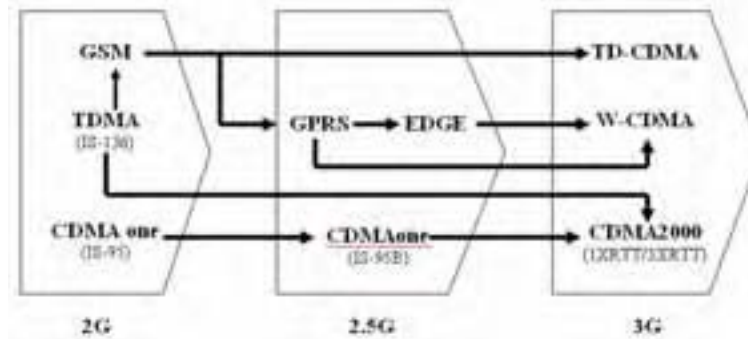
3G is a set of wireless technological requirements for bandwidth, network architecture, and service quality, not a standard itself. There is no single 3G standard. To facilitate the development of a global standard for 3G wireless technology, the International Telecommunications Union (ITU) provided a framework known as IMT-2000 (International Mobile Telecommunications 2000) in 1999. The framework featured an IP-based packet-switched access network for 3G and aimed to achieve global roaming (fully compatible local and national standards).

However, the 2G multi-standard situation persisted in 3G standards. Under the umbrella of IMT, there are currently three 3G standards: W-CDMA, CDMA2000, and TD-SCDMA. GSM operators favored WCDMA, which turned out to be the 3G standard in Europe and Japan. The competing standard to WCDMA is CDMA2000, the 3G standard developed in the United States. The advantage of CDMA2000 is that 2G networks that deployed CDMAOne can upgrade to CDMA2000 fast and inexpensively. The third 3G standard is TD-SCDMA (the “S” stands for synchronization) developed by the China Academy of Telecommunications Technology (CATT). TD-SCDMA 3G networks were officially launched for trial use in eight Chinese cities on April 1, 2008.

Europe and Asia led in the deployment of 3G networks. Finland issued the first 3G mobile technology licenses in the world in 1999. The rest of Europe issued 3G spectrum licenses in 2001. SK Telecom of Korea launched the first commercial CDMA2000 network the next year. In 2001, NTT DoCoMo launched a trial 3G service. However, the evolution from 2G to 3G turned out to be bumpy (see Figure 17.2). As a result, 2G and 3G technologies co-exist. It is estimated that 18 months are needed to deploy a full-fledged 3G network. In the interim, 2.5G, an intermediate generation emerged. GPRS (General Packet Radio Service) technology with 384 Kb/s data bandwidth offers download speeds up to 144 Kb/s. The most successful 2.5G service was i-Mode launched by Japan’s NTT DoCoMo in 1999. The service included e-mail, Internet connection, and m-commerce (NTT, 2006).

Figure 17.2

The Evolution from 2G to 3G Mobile Technologies



Source: ITU (2000)

Diffusion Patterns of the Cell Phone

The diffusion pattern of the cell phone mirrors that of the household telephone. Originally, both were marketed as a business tool, and early adopters were typically professionals. Only two million people used cell phones in 1986. The general public was priced out of the market. The first MicroTAC cell phone made by

Motorola carried a price tag of \$3,000. Cell phone users totaled slightly more than 10 million in the United States in 1992.

However, when the general population adopted it, the cell phone quickly became a household technology. The threshold was crossed after 1996 when the Telecommunications Act became law. The act opened up the wireless communications market to competition. The wireless industry expanded dramatically with revenues increasing from \$176 million in 1985 to \$8.7 billion in 1995 (CTIA, 2005). With more choices from wireless carriers, prices dropped: between 1978 and 1996, prices dropped 64% according to the Federal Communications Commission (FCC). When the average monthly rate declined below \$50 in 1996, the cell phone reached the mass market, spreading to all demographics. The total number of users went from 50 million 1997 to 100 million in 2000.

Internet Telephony: VoIP

Until recently, people relied on the public switched telephone network, which is based on a circuit-switched architecture, for their telephone calls. The PSTN is designed for voice-only traffic. Under its design, during a call, the connection between two users is closed, and no other information can travel over the line. That is, users use the circuit exclusively until the connection is freed up (Multi-Tech Systems, 2002). Thus, in a circuit-switched network, it costs a lot for long distance calls, and due to the limited number of available channels, the number of calls simultaneously handled by the system is limited. In addition, it is difficult to add new non-voice services such as data services to the network.

Given the limitations of the PSTN, the market has sought new communication technologies that allow the transmission of both voice and data, and enable simultaneous connections with the efficient use of bandwidth. Since the mid-1990s, with the rapid adoption of the Internet, Internet protocol (IP) has become the center of market attention because of its advantages (RAD Data Communications, 2001). For example, using IP, no circuit is closed between two users, and no bandwidth is spent when the call contains silent periods. Also, an IP-based network is easily upgraded, and new services can be added to the network without affecting existing services.

With these advantages, the first VoIP software was released in 1995 when the Israeli company, VocalTec, introduced the first IP phone software that was designed to run on a home PC with sound cards, microphones, and speakers (voiproxysox.com, 2004). VocalTec's IP phone software was a significant breakthrough, but it failed because of the poor quality and the lack of broadband availability. However, when hardware manufacturers such as Cisco, Nortel, and Lucent began to develop VoIP equipment capable of routing and switching, the era of VoIP arrived. In 2000, 3% of all voice traffic in the United States was made using VoIP technology (Bibens, 2007).

To make a call via the Internet, some basic equipment such as a PC, analog telephone, broadband modem, Wi-Fi router, or VoIP phone is required. In addition, a special technology is required to convert analog telephone signals to digital signals that can be sent over the Internet. This function can either be included in the phone itself or in a special converter such as an ATA (analog terminal adapter or analog telephone adapter). Depending on the type of VoIP service, users can make a VoIP call using their PC, analog phone, or VoIP phone with or without an ATA. When a user makes a phone call via an analog telephone, an ATA and broadband modem are essential. The ATA converts the analog signal to digital; this converted signal is sent upstream via broadband modem and then over the Internet (Bibens, 2007). If a user makes a phone call via a cell phone, Internet-capable 3G phones and Wi-Fi routers or Femtocell devices (explained later) are needed.

Benefits of VoIP

An increasing number of telephone service providers around the world have introduced VoIP into their broadband networks because of the benefits it has over traditional telephone services.

- ♦ *Lower costs.* VoIP can provide economic benefits over traditional telephone services. For example, many VoIP service providers offer their services with low monthly fees that include free long distance calling within the United States and neighboring countries (Bibens, 2007). Toll charges are eliminated by bypassing the PSTN. Companies can also save money though integrating their communications infrastructure by merging voice with data (Kaufman, 2007). Integrated service allows customers to input their personal information into a company Web site and be connected simultaneously with a sales agent.
- ♦ *Efficiency.* In traditional circuit-switched technology, no other traffic can pass over the line while a call takes place. However, on VoIP networks, multiple conversations and other data can be sent over the same channel.
- ♦ *Innovative applications.* VoIP includes numerous popular and innovative applications, such as voice mail, conference calling, call forwarding, caller ID, four- or five-digit dialing across locations, workgroup capabilities, and call center capabilities (ShoreTel, 2007).
- ♦ *Mobility.* Mobility is another driving force behind VoIP. The tendency toward mobile communications now holds sway in the world. With VoIP, users become highly mobile and are able to connect to others anywhere, anytime (ShoreTel, 2007).

Recent Developments

The most important event that has affected the traditional wired telephone industry is the enactment of the *Telecommunications Act of 1996*. Here, Congress directed the FCC and states to encourage reasonable and timely deployment of advanced telecommunications in the United States. The act supports open competition between local telephone companies, long distance providers, and cable companies (NTIA, 1999). This development means that entry barriers are lowered. Since 1996, the U.S. telecommunications industry has become a highly competitive system, involving players such as telephone companies, cable operators, satellite companies, and multinational telecommunications companies. These players have developed new technologies and services for telephone services competitively, but the developments and adoption of these resulted in a decline in traditional wired telephone use.

Until 2000, telephone line growth rate reflected the growth in population and the economy. However, the number of lines provided by wired telephone companies has declined, mainly because of the substitution of wireless service for wired telephone service (FCC, 2007b).

In addition, relatively expensive long distance call rates made customers bypass the PSTN (FCC, 2007b). Figure 17.3 shows the end-user revenue for local, wireless, and toll service from 1997 to 2006. The revenues from long distance service have decreased since 1999, while the revenues from wireless services have increased

since 1997. The trend is that the core business area of traditional wired telephone companies has shifted from wired to wireless and new services, such as VoIP.

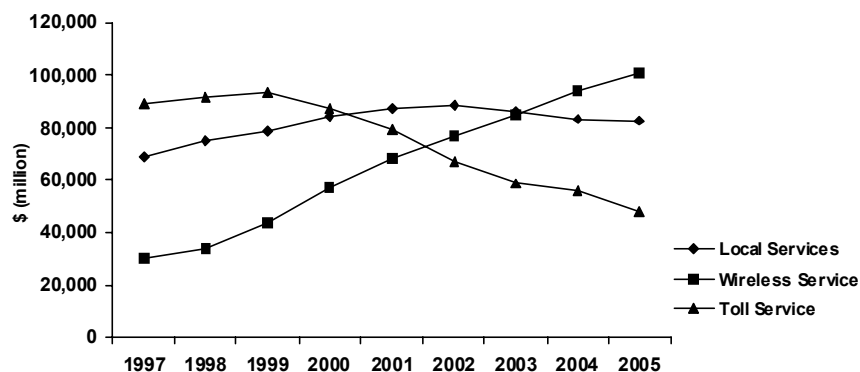
Table 17.1

U.S. Wired Telephone Lines, 2000-2005

Year	CLEC and ILEC Lines	Annual Growth (%)	ILEC Local Loops	Annual Growth (%)	ILEC Access Lines	Annual Growth (%)
2000	192,432,431	1.6	188,499,586	1.9	187,581,092	0.5
2001	191,570,800	-0.5	185,587,160	-1.5	179,811,283	-4.1
2002	189,250,143	-1.2	180,095,333	-3.0	172,265,210	-4.2
2003	182,933,281	-3.3	173,140,710	-3.9	161,376,638	-6.3
2004	177,690,711	-2.8	165,978,892	-4.1	154,590,517	-4.2
2005	175,160,940	-1.4	157,041,487	-5.4	147,661,287	-4.5

Source: FCC (2007b)

Figure 17.3

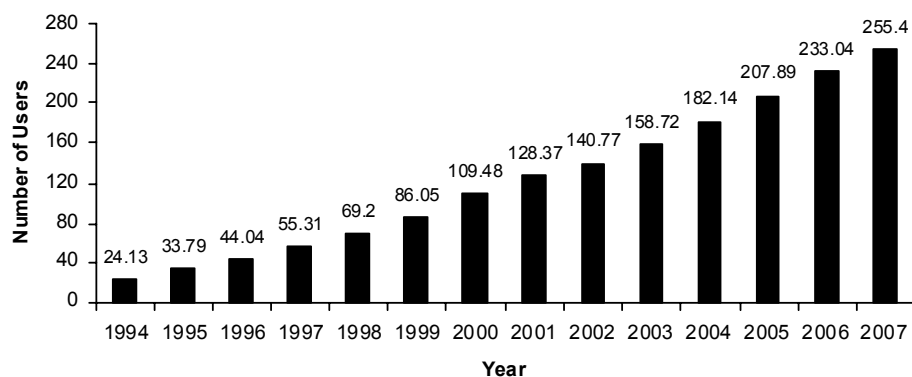
End-User Revenue for Local, Wireless, and Toll Service in the United States

Source: FCC (2007b)

Wireless Telephony

Based on data from the wireless industry group CTIA (2005), the growth rate in the number of users between 2000 and 2005 averaged 11.14%. This means an average gain of 18 million users per year. In 2004, the total number of U.S. cell phone users reached 184.7 million, increasing the nationwide penetration rate to 62% (FCC, 2005). On May 24, 2004, wireless number portability, allowing subscribers to keep their phone numbers when switching providers, became effective, boosting the total to 207.89 million in 2005. As of 2007, there were 255.4 million users in the United States (CTIA, 2008). Figure 17.4 traces user growth in the United States from 1994 to 2007.

Figure 17.4
Growth in Cell Phone Users in the United States, 1994-2007 (Millions)



Source: CTIA (2008)

The iPhone Phenomenon

Apple boosted the growth of smart phones with the wildly successful iPhone, introduced in the U.S. market on June 29, 2007. As an Internet-enabled multimedia device, the iPhone included a widescreen (3.5-inch) display (320 × 480 at 160 ppi) with touch controls. It also features a rich HTML e-mail client and Apple's Safari Web browser that enables customers to use desktop-like e-mail, Web browsing, maps, and searching in addition to calling.

In partnership with AT&T, which is the exclusive U.S. operator selling and supporting the iPhone, Apple expected to sell 10 million iPhones in its first 18 months (Reardon, 2007b). However, only few months after the launch of iPhone, it became the most popular and fastest-growing gadget in the world. As of December 2007, a total of 2.3 million iPhones had been sold (iPhone World, 2008). As of mid-2008, Apple has a 6.5% global and 28% U.S. market share of smart phones (Koman, 2008a). The biggest complaint about the iPhone in the United States is that the iPhone uses AT&T's slower 2.5G EDGE service. Analysts estimated that Apple will sell 45 million iPhone units by 2009 (iPhone World, 2008). AT&T CEO Randall Stephenson announced that AT&T plans to roll out 3G in 350 U.S. markets in 2008 and then expand to overseas markets (Koman, 2008b). Apple plans to offer a 3G iPhone in 2008.

Compared to other phones, iPhone facilitates the use of mobile content. An industry research group reported that 85% of iPhone users browsed news and information in January 2008 (M:Metrics, 2008). According to the report, 30.9% of iPhone owners watched mobile TV or video (4.6% market average), and 49.7% accessed a social networking Web site. As Table 17.2 shows, users of 3G and the iPhone used mobile content, surfed the Internet, and listened to music much more than the average user.

Table 17.2

Mobile Content Consumption of Cell Phone Users (January 2008)

Activity	iPhone	Smart Phone	Market Average
Any news or information via browser	84.6%	58.2%	13.1%
Accessed Web search	58.6%	37.0%	6.1%
Watched mobile TV and/or video	30.9%	14.2%	4.6%
Watched on demand video or TV programming	20.9%	7.0%	1.4%
Accessed social networking site or blog	49.7%	19.4%	4.2%
Listened to music on cell phone	74.1%	27.9%	6.7%

*Source: M:Metrics (2008)***Google and the Open Handset Alliance**

Google, the search engine giant, began its move into the wireless business in 2007. It was anticipated that Google would launch its own mobile phone, dubbed GPhone (Telegraph, 2007). However, instead of entering the wireless market as a phone maker, Google focused on developing new mobile operating software that can provide mobile users with the same Web experience as on a PC. On November 5, 2007, Google announced new Linux-based mobile operating software “Android” with its wireless alliance, the Open Handset Alliance (OHA). The OHA, a multinational alliance of 34 companies including chipmakers, handset manufacturers, and wireless service providers, advocates open software for mobile software. Its goal is to break the monopoly of wireless carriers over what phone, applications, and features can be used on their wireless network (The Google Phone, 2007). According to Google’s CEO Eric Schmidt, the first Android handsets will be rolled out in the second half of 2008 (Reardon, 2007c).

Because Google will distribute Android free and allow anyone who wants to modify the software to suit their needs, users including software developers, phone makers, and wireless carriers can choose phones, functions, and software (Reardon, 2007c). So far, KDDI and NTT DoCoMo in Japan; European carriers Telecom Italia, Telefinia, and T-mobile; and Sprint Nextel and T-Mobile in the United States have joined in the OHA. Phone makers such as Motorola, Samsung, and LG have also participated in the OHA (Graham, 2007).

The Android-based phone will compete with Apple’s iPhone, which has already adopted an easy-to-use Internet browser. Furthermore, Google has to compete with a variety of mobile operating systems such as Symbian, Microsoft’s Windows Mobile, and Palm’s OS Treos. Symbian is the biggest maker of mobile software (Telegraph, 2007). According to Gartner, Europe-based Symbian has about 74% of the market share of smart phone operating systems, followed by the collective implementations of Linux and Microsoft’s Windows Mobile (Reardon, 2007c).

The Cell Phone as a Bridge Medium

Thanks to 3G wireless technologies, which gave rise to packet-based networks, the wireless telephone has transformed from a person-to-person communication device into a convergent communication and entertainment platform. Technically, a 3G wireless phone is a portable computer connected to a radio and converged

with the Internet. One of the cutting-edge applications of 3G technologies added on for CDMA networks is EVDO (evolution data only). Using the 450 MHz band (CDMA450) to accelerate the transition from 1G to 3G networks and the 2.1 GHz band to provide high-speed packet data services, EVDO promises a download speed up to 2.4 Mb/s, making data-intensive video services such as live TV possible.

Wireless carriers sought to leverage the mass popularity of the cell phone and the converged functionality it offers to expand services and generate new revenues. In the United States, Verizon's EVDO-based broadband access service, V CAST, was launched in 181 markets (Verizon Wireless, 2005). With a fee of \$15 a month, subscribers can watch programs from providers such as CNN and MTV. MobiTV, in partnership with Sprint, provided subscribers a package of 28 channels of live TV for \$9.90 a month. In May 2008, AT&T introduced its own video service using Qualcomm's MediaFLO technology, charging \$15 a month for 10 channels (Svensson, 2008). Most programs on mobile television are short, ranging from three to six minutes. Industry research shows that there are seven million mobile phone users who view videos on their phones; the total is expected to grow to 24 million by 2010 (The Economist, 2007). No wonder the mobile phone is touted as the third screen after the television and PC!

A study (Wei & Huang, 2008) on using the cell phone to view TV suggested that mobile TV has not crossed the threshold of adoption with a lack of critical mass in the target population. Results show that the adoption of mobile TV in China was extremely low, less than 2% among the 856 surveyed cell phone users. Such findings are not unique to China. In other countries where mobile TV was launched, similar problems existed (Looms, 2007). Without a critical mass as an accelerator of adoption, how soon the cell phone will become established as the third screen remains to be seen.

On the other hand, the Wei and Huang (2008) study reported that mobile TV is viewed the most at certain times of the day and under circumstances in which the user was physically in a mobile environment such as in bus or taxi. Users tended to use the first two screens (e.g., TV and PC) in fixed locations, no matter whether it was the workplace or home. A report confirmed that mobile phone users categorically prefer to watch full-length shows on television at home (Red Bee Media, 2006). This report suggested that, instead of rivaling television and the PC, the cell phone supplements the first two established screens. As a broadcast platform, the cell phone would fill the gap between fixed localities that people traverse routinely. Accordingly, Wei and Huang characterized the cell phone as a bridging medium.

The Mobile Phone as an Advertising Medium

From a historical point of view, a communication technology that evolves fully into a media platform for disseminating information and entertainment goes through a commercialization process. The history of radio, TV, and the Internet shows that the introduction of the commercial model of third-party (e.g., advertisers) financial support was critical to their growth. Since the first mobile advertising in the form of text messaging appeared in Finland in 1997, text-based mobile advertising has become nearly ubiquitous in Europe and Asia. Industry reports showed that nearly three out of four cell phone users in Europe had received SMS (short message service) ads.

The deployment of 3G networks that offer voice communication, text messaging, Web browsing, interactive gaming, music, and on-demand video hastened the emergence of the cell phone as an advertising medium (Korzeniowski, 2005) beyond SMS ads. Fox Mobile Entertainment launched a global phone-content company Mobizzo that offered advertising and premium content for \$5.99. Even search engine giant Google rolled out Google Mobile for mobile search ads in 2007. Yahoo runs mobile display ads in 19 countries (Lev-Ram, 2007).

In addition to advances in wireless technologies, the push for commercializing the cell phone comes from two fronts: wireless carriers and advertisers. To offset the drop in revenues from voice and data services, wireless carriers sought new revenue streams. In 2007, Verizon and AT&T, the two dominant wireless service providers in the United States, announced that they would allow limited banner ads to hit their subscribers. The services planned to incorporate banner ads, text message marketing, and short video commercials (Reardon, 2007a). In partnership with Yahoo, T-Mobile introduced the first graphical advertising on its mobile Internet service—web'n'walk—in 2008. Advertisers were also eager to explore the personal, interactive, and ubiquitous features of the cell phone to increase the effectiveness of their ad campaigns beyond the use of traditional media channels (Cuneo, 2006). Big-name advertisers such as Procter & Gamble, Coca-Cola, Microsoft, and McDonalds were the pioneers in integrating the cell phone into their marketing campaigns.

The commercialization of the cell phone has been set in motion. In the United States, one in three users have seen or heard advertising on their cell phones within last three months (Carew, 2008). The spending on mobile advertising reached \$871 million in 2006 (O'Shea, 2006). A survey of major U.S. brands reported that 89% of them would do marketing via the cell phone in 2008. More than half of them would spend up to 25% of their marketing budget on the cell phone (Kotler & Armstrong, 2007). In the United States, the size of the mobile phone advertising market was \$45 million in 2005, but it is expected to grow to \$1.26 billion by 2009 (Richtel, 2006). Industry reports estimated that advertisers will spend more than \$11.3 billion by 2011 on mobile marketing (Reardon, 2007a).

The question is not whether to commercialize the cell phone as an advertising medium, but how. The history of Internet advertising offers some lessons. In the early 1990s, there was a debate on whether the Internet, built with public funds, should be commercialized. Realities took over; advertising swept the Internet quickly, and users were flooded with spam. There is a window of opportunity in mobile advertising to get it right, and not offer another type of spam on cell phones.

Academic research suggests that to be established as a viable advertising medium in the long run, advertising on the screens of the cell phone needs to be different from the interrupt-and-repeat broadcast model and the spam-model of Internet advertising. The insights (Tsang, et al., 2004; Wei & Lee, 2008) are that ads on cell phones should be selective, not indiscriminate, informative and entertaining, brand-driven, two-way interactive, permission-based, and mutually beneficial. For example, without permission, 79% of American consumers said they would be irritated by ads appearing on their phones (Forrester Research, 2007). With incentives such as free minutes and mobile content, 35% of U.S. cell phone users would willingly accept ads on their phone (Harris Interactive, 2007).

VoIP Developments

Since 2000, VoIP usage has grown dramatically. In 2005, VoIP revenues in the United States totaled \$1 billion. As of mid-2008, 50% of global business calls were handled over IP (Kretkowski, 2008), and the Gartner Group predicted that VoIP-enabled systems will account for some 97% of all systems sold in 2008 (Hotchmuth, 2007).

In the case of VoIP adoption by businesses, global IP PBX (private branch exchange) markets are expected to reach \$26.9 billion in 2009, according to WinterGreen Research, Inc. (VoIP-News, 2008a). Sales of business VoIP systems in 2008 were roughly 20 times higher than a year earlier (Kretkowski, 2008). In-Stat, a technology research firm, estimated that business IP phone sales will increase from 9.9 million units to 45.8 million units by 2010 (Edwards, 2007). IP PBX systems for businesses have taken the place of traditional PBX

systems (VoIP News, 2008b), and, in 2007, hybrid IP PBX made up two-thirds of all lines shipped, while pure IP systems alone accounted for 18% (Kretkowski, 2008).

Meanwhile, VoIP services have been extended to residential users. Infonetics reported approximately 80 million VoIP subscribers worldwide in 2007. The total is expected to reach 135 million in 2011 (Kretkowski, 2008). In the United States, the big four VoIP providers captured more than 12 million subscribers (Burton, 2008). Comcast is the biggest VoIP service provider with more than four million customers as of February 2008, followed by Time Warner Cable (three million), Vonage (2.6 million), and Cox Communications (2.4 million). Table 17.3 shows the top six public VoIP companies' U.S. VoIP revenues and subscribers in 2007.

Table 17.3
Six U.S. VoIP Company Revenues and Subscribers in 2007

	Revenue 4Q (millions)	Revenue Share (4Q)	2007 Total Subs.	4Q 2007 Subs. Growth	4Q 2006 Subs. Growth	2007 Subs. Share
Comcast	\$523	36%	4,377,000	604,000	509,000	32%
Time Warner	\$336	23%	2,900,000	285,000	211,000	22%
Vonage	\$216	15%	2,580,227	56,000	166,000	19%
CableVision	\$147	10%	1,592,000	102,000	109,000	12%
Skype	\$115	8%	1,073,763	118,918	137,288	8%
Charter	\$107	7%	959,300	115,300	106,200	7%
Total	\$1,444	100%	13,482,290	1,321,218	1,238,755	100%

Source: Elliott (2008a)

Cable operators have nearly 10 million phone users: Comcast leads the U.S. VoIP market, and four of six top VoIP service providers are cable companies. Compared with 4Q 2006, subscribers of the two "over-the-top" VoIP service providers, Vonage and Skype, have decreased while cable companies have shown improved growth rates. Cable operators led the U.S. VoIP market, and their dominance will hold in 2008 (Elliott, 2008a).

However, overall revenue growth in 2007 shows a slight decline of 4.6% from 1Q to 4Q. Figure 17.5 illustrates quarter over quarter revenue growth in 2007. The figure shows the strongest revenue growth for most of the year, while Skype's revenue shows a declining tendency from 1Q to 3Q and rebounding in 4Q.

Current Status

As of November 2007, 94.9% of the households in the United States had telephone service, an increase of 1.5% over a year earlier (FCC, 2008b). The penetration rate ranged from 88.6% in Indiana to 98.5% in North Dakota. Household income had an impact on telephone subscription: the rate for households with income below \$20,000 was at or below 92.2%, while the rate for households with income over \$60,000 was at least 98.6%.

Figure 17.5

Growth of Quarterly Revenues in U.S. VoIP in 2007

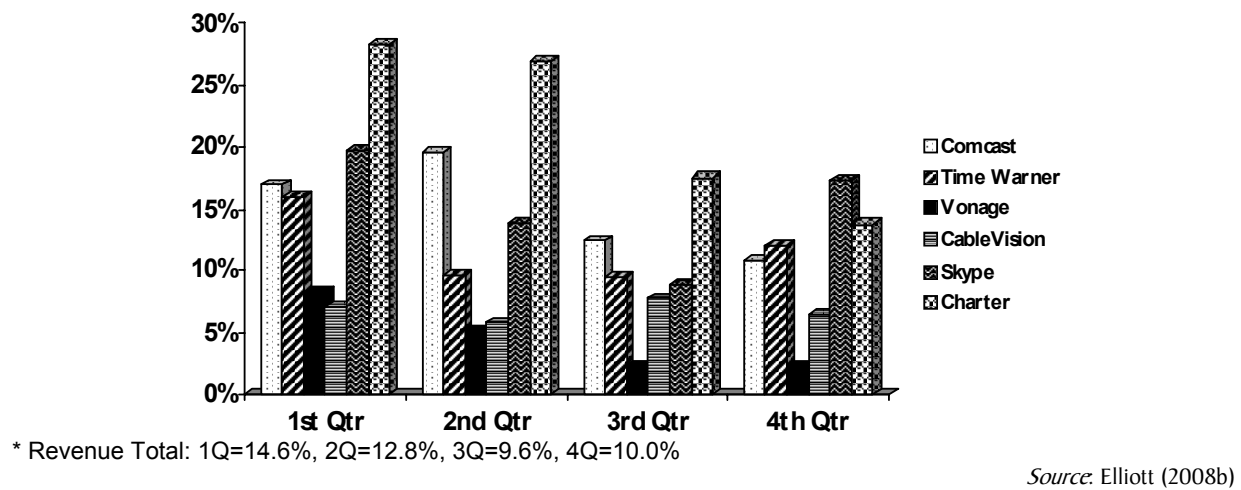
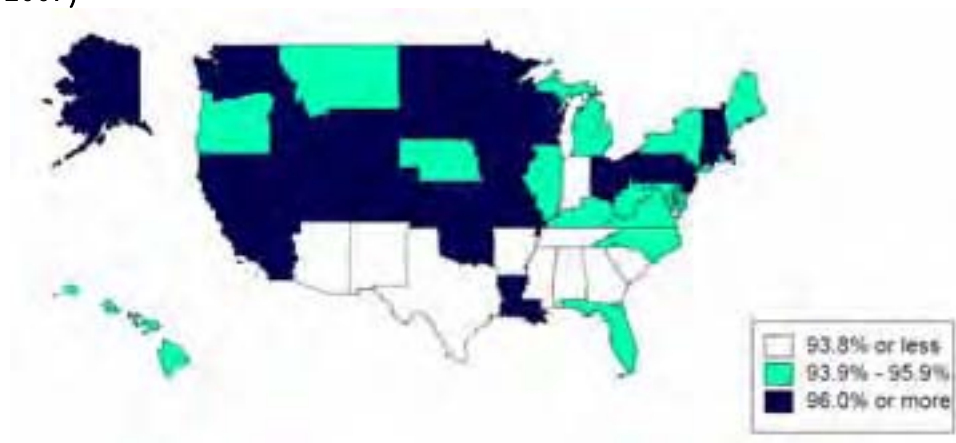


Figure 17.6

Telephone Penetration in the United States (as of November 2007)



In June 2007, end-user customers obtained local telephone service by utilizing approximately 134.5 million incumbent local exchange carrier (ILEC) switched access lines, and 28.7 million competitive local exchange carrier (CLEC) switched lines (FCC, 2008a). In addition, more than 1,200 companies now offer wireline long distance services (FCC, 2007b). In 2004, carriers providing toll service generated \$70.1 billion in toll revenues. These include toll revenues from long distance carriers, wireless toll from wireless carriers, and toll revenues from local exchange carriers.

The traditional wired telephone industry is now in transition from analog voice services to digital voice and data services (Bates, et al., 2002). A wireless, IP, or fiber optic-based platform is essential to provide advanced telecommunications services.

Following its merger with BellSouth in 2006, AT&T owned Cingular Wireless and has more than 65 million subscribers in 2008 (AT&T Wireless, n.d.). In 2007, AT&T introduced its U-verse VoIP service (U-verse Voice) to several regions in the United States, including Detroit and Austin. U-verse Voice customers get unlimited local and long distance calling within the United States and Canada for of \$40 per month (Telecommunications Industry News, 2008).

In 2007, Verizon served about 66 million wireless customers, more than 41 million wired access lines, and 8.2 million broadband connections nationwide. The company has been building all-digital fiber optic networks for its FiOS Internet and TV services. By 2010, Verizon plans to invest \$22.9 billion to deploy Verizon's fiber optic network in the United States (Verizon, n.d.).

Qwest now provides Internet, wireless, and VoIP services as well as local and long distance calling services. Qwest has also concentrated on building a nationwide fiber optic network to deliver its voice and data services. In 2008, Qwest launched "fiber to the neighborhood" service in 23 U.S. markets, offering both 20 Mb/s and 12 Mb/s broadband services (Hachman, 2008).

Wireless Industry Growth Indicators Since 2005

Facing the pressure to upgrade networks and be open to competition, the U.S. wireless industry had a new wave of mergers and acquisitions. SBC purchased AT&T Wireless, merged with BellSouth, then purchased AT&T, renaming the new company AT&T. With 65.7 million customers, AT&T Mobility is the largest wireless carrier in the United States. Verizon Wireless (co-owned by Verizon Communications and Vodafone, a British wireless giant) was a close second. It had 63.7 million subscribers in 2007. Together, subscribers to the two largest carriers (AT&T and Verizon) accounted for 54% of total subscribers. In 2007, AT&T Mobility acquired the number nine wireless carrier Dobson Communications for \$2.8 billion.

The third largest carrier was Sprint Nextel with 54 million subscribers, and T-Mobile was fourth. It bought out SunCom Wireless (Number 10) for \$2.4 billion in 2007 (Hill, 2007). Still, its customer base was half the size of Sprint Nextel at 27.7 million. Table 17.4 shows the ranking of the top 10 wireless carriers.

The global cell phone handset market was still dominated by Nokia. Nokia enjoyed a 26.5% growth rate in 2007 and captured 38% of the handset market (Malykhina, 2008). Samsung came in second with 14% market share, followed by Motorola (13.8%), Sony Ericsson (9%), and LG (8%). In the United States, however, the picture was different. Motorola was number one. According to the NPD Group, U.S. cell phone sales totaled 146 million units or \$11.5 billion during 2007 (Gilroy, 2008). Motorola's U.S. market share in 2007 was 32%, followed by Samsung (17%), LG (16%), Nokia (10%), and Sanyo (4%). Figure 17.7 shows the market share of the top five cell phone makers in the United States in 2007.

Table 17.4

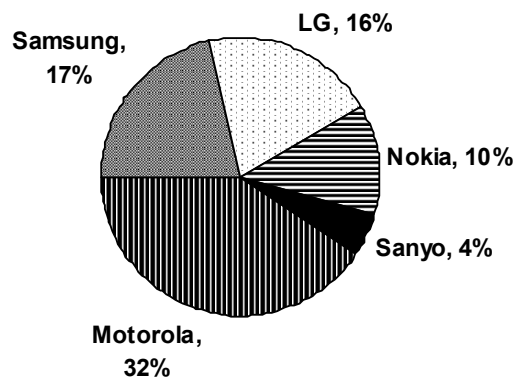
Top 10 U.S. Wireless Carriers by Subscribers (as of 3Q 2007)

Operators	Subscribers	Revenues
AT&T Mobility	65.7 million	\$10.9 billion
Verizon Wireless	63.7 million	\$11.3 billion
Sprint Nextel Corp.	54 million	\$8.7 billion
T-Mobile USA Inc.	27.7 million	\$4.9 billion
Alltel Corp.	12 million	\$2.3 billion
U.S. Cellular	6.1 million	\$1 billion
MetroPCS Communications Corp.	3.7 million	\$557 million
Leap Wireless International Inc.*	2.7 million**	\$393 million**
Dobson Communications Corp.	1.5 million	\$392 million
SunCom Holdings	1.14 million	240 million
Total	238.24 million	\$40.7 billion

* Estimates; ** 2Q 2007 results

Source: Hill (2007)

Figure 17.7

Top Five Handset Makers' Market Share of Units Sold in the United States, 2007*Source: Gilroy (2007)***Developments in M-Commerce**

Based on the growth in cell phone subscribers worldwide and the convergence of Internet and mobile telecommunications technologies, mobile commerce (m-commerce) has emerged as a new form of e-commerce. It is expected that U.S. m-commerce users will reach 10 million to 20 million by 2010 (Burger, 2007c). Juniper Research estimated that global m-commerce revenue will exceed \$88 billion by 2009, a \$69 billion increase from year-end 2005 (Burger, 2007b). M-commerce has two characteristics: a transaction with monetary value

(e.g., online banking) and purchasing actual goods and services. Hence, m-commerce is defined as "...the buying and selling of goods and services, using wireless handheld devices such as mobile telephones or PDAs" (Tiwari, et al., 2006). Although similarities between e-commerce and m-commerce exist, m-commerce has different characteristics such as ubiquity, accessibility, personalization, localization, and dissemination (Mèliane, 2005).

The development of m-commerce is led by Asian countries such as Japan, South Korea, China, and India. Some countries in South America also emerged as hotspots for m-commerce (Burger, 2007b). In Japan, NTT DoCoMo's i-mode is the most successful mobile Internet access model in the world. It has offered Internet content download services via its 3G network since 2001. NTT DoCoMo also launched its i-mode FeliCa service in July 2004 through which users can pay for goods and services using their cell phones (GSM Association, 2005; Burger, 2007b).

M-commerce has two broad categories: non-transactional and transactional services (BCG, 2000). Non-transactional services include e-mail and SMS data services (news, weather, sports, stock updates), ring tone and screen saver downloads, regional information, Internet surfing and Web browsing, travel information, chats and news groups, price comparisons, location-based services, and games. Transactional services include banking and the purchase of goods or services such as books and CDs, travel products, brokerage services, auctions, computer hardware and software, electronics, food and groceries, drugstore items, and home furnishings. Mobile banking enables customers to use their mobile phones to receive alerts, manage their accounts, pay bills, and transfer funds. In reality, the ability for consumers to access bank accounts to pay for products and services using a mobile device is already available. Customers in Japan, South Korea, Australia, and Norway have readily embraced these capabilities (VeriSign, 2007). Juniper Research (2007) predicts that worldwide mobile payment revenue will reach over \$22 billion by 2011.

Mobile ticketing allows users to purchase tickets for events, buy bus or train fares, and pay for parking. Juniper Research predicts that the market for mobile event ticketing will reach \$44.3 billion by 2010 (VeriSign, 2007). Mobile entertainment service is an application that provides entertainment services to users on a per event or subscription basis (Varshney & Vetter, 2002). It also includes content services such as music downloads, videos, gaming, and ring tones, as well as text-based messaging services such as audience voting. According to Juniper Research, the global market for mobile entertainment products and services totaled \$17.3 billion in 2006; it will reach \$47 billion in 2009 and \$77 billion in 2011 (Burger, 2007a).

Mobile VoIP

With 3G mobile technology development, Disruptive Analysis, Ltd. (2007) predicted a mobile VoIP market that will rise from today's zero users to 250 million users by 2012. According to the company, wireless carriers will be favorably disposed toward mobile VoIP for three reasons:

- 1) Using mobile VoIP will enable carriers to fit more phone calls into their scarce spectrum allocations.
- 2) Mobile VoIP can reduce operating expenses.
- 3) It can help to launch new services.

For example, T-Mobile's hybrid calling system, Hotspot@Home, provides "one-stop wireless VoIP service" through a Wi-Fi network combining cell phone and wireless VoIP services into a single phone and calling plan (Higdon, 2007). However, users need to purchase new expensive handsets for mobile VoIP that can operate over both wireless and Wi-Fi networks.

Factors to Watch

Wireless telephony technology will continue to evolve toward full-fledged 3G networks and beyond. Services will be more diverse and converge with online applications. The cell phone will complete its makeover from a personal communications device connected to a wireless telecommunications network into a bridging media platform. The following are future trends worth watching closely: 4G technologies, 2008 new spectrum auction, cellular technology at home, and the challenges of VoIP.

4G Technologies on the Horizon

The future of wireless telecommunications technology is 4G, which will boost the data rate to 20 Mb/s. With such high-speed, high-quality, live video transmission and fast downloads of large music files will be a reality. Considering the mess and complexity in updating from 2G to 3G networks, 4G does not appear to be a priority. In the transitional stage, technologies beyond 3G have already appeared. HSPA (high-speed packet access), which promises speeds up to 14.4 Mb/s (versus 3G at 384 Kb/s), offers a technology to upgrade 3G to 3.5G. Over 130 mobile network operators in 61 countries offer HSPA services, accounting for one-fifth of all GSM operators worldwide (Lunden, 2007).

Recent developments suggest that 4G will not likely be a single universal standard. AT&T and Verizon chose the LTE (long-term evolution) standard as their common access platform for their next-generation 4G networks in late 2007. This means that Verizon subscribers will be able to use their phones to roam around the world. This move also put Verizon in the same GSM-family as other U.S. carriers such as AT&T, T-Mobile, and Vodafone. Other carriers, including Sprint, eyed WiMAX as the technology for 4G networks. WiMAX is a rival, ad hoc networking technology that provides wireless connection solutions for the Internet. It is being deployed in several Asian countries such as South Korea, Japan, and Taiwan. These countries aim to set the trend in 4G technology by deploying WiMAX systems for wireless telephone services.

Long- and Short-Term Impacts of the 2008 New Spectrum Auction

As discussed in Chapter 6, the conversion from analog to digital broadcast is set to be complete in February 2009. The FCC auctioned off the spectrum used by the freed-up UHF TV spectrum in the 700 MHz band to 101 companies. The March 2008 auction raised more than \$19 billion. Verizon won 108 licenses for \$9.6 billion, and AT&T acquired 227 licenses for \$6.6 billion (Hansell, 2008). Google's highly publicized \$4.7 billion bid for the C-Block that can be used for nationwide voice and data services, however, failed. Thus, in the long-term, the two giant wireless service providers will strengthen their networks with stronger signals and wider coverage. The U.S. wireless telecommunications market is not going to be more competitive. On the other hand, both Verizon and AT&T claimed to be receptive to all kinds of devices and applications from phone makers and third-party software developers to be used on their networks. It remains to be seen if more choices in calling devices and services will come true in the short-term.

Cellular Technologies Penetrate the Walls at Home

The cell phone was invented for use while on the move. Ironically, an increasing number of people now have only a cell phone at the expense of landlines at home (14% in 2007). They used the cell phone at home as much as on the road. Weak signals from a nearby cellular tower, however, are unable to penetrate buildings, resulting in a bad-reception-at-home problem. Two signal amplifying technologies have emerged to improve cellular coverage in the home: femtocells and WiMAX.

Femtocells (also known as access point base stations) promise good reception at home. Technically, a femtocell is a personal cellular access point that covers up to 5,000 square feet (O'Shea, 2006). Similar to Wi-Fi access points, having a femtocell is like having a mini cellular tower in the house (Cheng, 2007). A cell phone connects wirelessly to the femtocell first, which routes the call through the Internet. There could be as many as 19 million femtocells shipped worldwide by 2011 (O'Shea, 2006). With a program called "Sprint AIRAVE," Sprint is doing trials with customers in selected markets including Indianapolis and Denver (Hruska, 2007). Using Wi-Fi network technologies, T-Mobile has a similar service called "HotSpot@Home" that allows subscribers to make calls through the Internet.

Challenges of VoIP

Similar to other innovative technologies, VoIP also has disadvantages, which are related to reliability, security, and 911 emergency calling services.

- ♦ *Reliability.* Although the adoption of VoIP has increased in recent years, VoIP services generally do not offer the reliability that consumers have come to expect from their traditional phones. For example, since VoIP is based on the broadband network, if this network is shut down, VoIP services will stop. Similarly, VoIP networks can be easily damaged by disasters and heavy call traffic in emergencies (Waxer, 2008). Furthermore, VoIP is still a supplementary means of traditional telephone services because VoIP cannot operate without power (Bibens, 2007).
- ♦ *Security.* VoIP is vulnerable to the same internal and external threats as in other data networks: viruses, worms, spam, and other malicious threats. VoIP users should consider the following security risks (Higdon, 2008; ShoreTel, 2007): DoS (denial of service) attacks on VoIP networks, phone service theft, eavesdropping, and vishing (voice fishing). In particular, the IC3 (Internet Crime Complaint Center) has reported that "vishing" attacks are on the rise.
- ♦ *Limitation of enhanced 911 (E911) emergency calling service.* Initially, the FCC required that interconnected VoIP service providers supply 911 emergency calling capabilities to their customers as a mandatory feature of the service by November 28, 2005 (FCC, 2007a). However, some VoIP providers do not offer E911 calling because of some technical problems. For example, VoIP 911 calls may not be connected to a Public Safety Answering Point (PSAP). When it is connected, the callers' phone numbers and their addresses will not be sent because, when VoIP service providers assign phone numbers, they do not consider customers' fixed physical addresses (Mayor, 2007). In addition, if the VoIP network is shut down, VoIP 911 calling service will fail.

If the history of the telephone industry is any indication, these challenges will be overcome, with adoption and use led by business customers, and spreading to residential users once prices fall. The stakes are high—in the United States, combined local, long distance, and wireless telephone revenues are greater than the reve-

nues of all advertising media combined. Considering the relatively small number of companies vying for this revenue, the pace of innovation should continue unabated.

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The Internet & the World Wide Web

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The Internet may be the most important communication technology in the world, primarily because it has such a strong impact on almost every other technology. The amazing thing is that the Internet itself is only a few decades old, and few of the most common Internet applications discussed in this book are more than a decade old. In that short time, the Internet has evolved from a technical curiosity to a major influence on nearly every aspect of life in developed countries. The Internet has become a social force, influencing how, when, and why people communicate; it has become an economic force, changing the way corporations operate and the way they interact with their customers; it has become a legal force, compelling re-examination and reinterpretation of the law.

On a typical day, notes a study by the Pew Internet and American Life Project, about 70 million Americans use the Internet to “e-mail, get news, access government information, check out health and medical information, participate in auctions, book travel reservations, research their genealogy, gamble, seek out romantic partners, and engage in countless other activities.” Indeed, the same study notes the Internet “has become the ‘new normal’ in the American way of life; those who don’t go online constitute an ever-shrinking minority” (Rainie & Horrigan, 2005).

Although the terms “Internet” and “World Wide Web” are often used interchangeably, they have distinct—and different—meanings. The Internet refers to the worldwide connection of computer networks that allows a user to access information located anywhere else on the network. The World Wide Web refers to the set of technologies that places a graphical interface on the Internet, allowing users to interact with their computers

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using a mouse, icons, and other intuitive elements rather than typing obscure computer commands. The two technologies can be combined to make possible a variety of types of communications, discussed in more detail in the next section.

This chapter addresses the basic structure and operation of the Internet and World Wide Web, including economic and social implications. The World Wide Web has, of course, become the foundation for a host of other technological developments that bring their own legal, economic, and social effects. Technologies such as Internet commerce, online games, and broadband access are discussed separately. In this chapter, the focus is on the Internet itself.

Background

In the 1950s, the U.S. Department of Defense started researching ways to create a decentralized communications system that would allow researchers and government officials to communicate with one another in the aftermath of a nuclear attack. A computer network seemed to be the most logical way to accomplish this, so the military formed the Advanced Research Projects Agency (ARPA) to study ways to connect networks. At the time, there was no reliable way to combine local area networks (LANs), which connected computers in a single location, and wide area networks (WANs), which connected computers across wide geographic areas. ARPA sought to create a combination of LANs and WANs that would be called an “internetwork”; ARPA engineers later shortened the term to Internet (Comer, 1995).

By 1969, ARPA had successfully interconnected four computers in California and Utah, creating what came to be called ARPANET. A key innovation in the development of ARPANET was the use of TCP/IP (transmission control protocol/Internet protocol), a method of data transmission in which information is broken into “packets” that are “addressed” to reach a given destination. Once the data reaches its destination, the packets are reassembled to recreate the original message. TCP/IP allows many different messages to flow through a given network connection at the same time, and also facilitates standardization of data transfer among networks. Interest in ARPANET from academia, government agencies, and research organizations fueled rapid growth of the network during the 1970s. By 1975, there were about 100 computers connected to ARPANET, and the number grew to 1,000 by 1984 (Clemente, 1998). In 1983, ARPANET became formally known as the Internet, and the number of computers connected to it continued to grow at a phenomenal rate (see Table 18.1).

The Domain Name System

Each computer on the Internet has a unique IP address that allows other computers on the Internet to locate it. The IP address is a series of numbers separated by periods, such as 129.1.2.169 for the computer at Bowling Green State University that contains faculty and student Web pages. However, since these number strings are difficult to remember and have no relation to the kind of information contained on the computers they identify, an alternate addressing method called the domain name system (DNS) is used; this assigns text-based names to the numerical IP addresses. For example, `personal.bgsu.edu` is the domain name assigned to the computer at Bowling Green State University referred to above. Domain names are organized in a hierarchical fashion from right to left, with the rightmost portion of the address called the top-level domain (TLD). For computers in the United States, the TLD identifies the type of information that the computer contains. Thus, `personal.bgsu.edu` is said to be part of the “.edu” domain, which includes other universities and education-related entities. To the immediate left of the TLD is the organizational identifier; in the example above, this is `bgsu`.

The organizational identifier can be a domain as well; the computer called “personal” is thus part of the “bgsu” domain. Table 18.2 lists TLDs approved for use as of mid-2008.

Table 18.1
Number of Host Computers Connected to the Internet by Year

Year	# of Host Computers	Year	# of Host Computers
1981	213	1995	4,852,000
1982	235	1996	9,472,000
1983	562	1997	16,146,000
1984	1,024	1998	29,670,000
1985	1,961	1999	43,230,000
1986	2,308	2000	72,398,092
1987	5,089	2001	109,574,429
1988	28,174	2002	162,128,493
1989	80,000	2003	171,638,297
1990	313,000	2004	233,101,481
1991	535,000	2005	317,646,084
1992	727,000	2006	394,991,609
1993	1,313,000	2007	433,193,199
1994	2,217,000	2008	541,677,360

Source: Internet Software Consortium

Table 18.2
Top Level Domain Names

Extension	Definition	Extension	Definition
.aero	Air-transport industry sites	.jobs	Companies advertising jobs
.arpa	Internet infrastructure sites	.mil	Military sites
.biz	Business sites	.mobi	Mobile devices
.cat	Catalan language and culture sites	.museum	Museum sites
.com	Commercial sites	.name	Individuals' sites
.coop	Cooperative organization sites	.net	Networking and internet-related sites
.edu	Educational institution sites	.org	Sites for organizations
.gov	Government sites	.pro	Sites for professions
.info	General usage sites	.travel	Travel-related sites
.int	International sites		

Source: J. Foust

Domain names are administered by a global, nonprofit corporation called the Internet Corporation for Assigned Names and Numbers (ICANN), and the only officially authorized TLDs are those administered by ICANN. A series of computers called root servers, also known as DNS servers, contain the cross-referencing information between the textual domain names and the numerical IP addresses. The information on these root servers is also copied to many other computers. Thus, when a user types in `personal.bgsu.edu`, he or she is connected to the computer at `129.1.2.169`.

Outside the United States, computers are identified by country code top-level domains (ccTLD). In these cases, the last part of the domain name identifies the country, not the type of information. For example, computers in Japan use the .jp ccTLD, while those in Canada use .ca.

Text-Based Internet Applications

Several communications applications developed before the rise of the graphical-based World Wide Web. Some of these applications have been largely replaced by graphical-based applications, while others merely have been enhanced by the availability of graphical components. All of these applications, however, rely chiefly on text to communicate among computers.

Electronic mail, or e-mail, allows a user to send a text-based “letter” to another person or computer. E-mail uses the domain name system in conjunction with user names to route mail to the proper location. The convention for doing so is attaching the user’s name (which is sometimes shortened to eight or fewer characters) to the domain name with an “at” (@) character. For example, the author’s e-mail address is `jfoust@bgsu.edu`. E-mail can be sent to one or many recipients at the same time, either by entering multiple addresses or by using a list processor (listproc), which is an automated list of multiple e-mail addresses. E-mail can also contain computer files, which are called attachments. The rise of graphical-based e-mail programs has also made possible sophisticated text formatting, such as the use of different font styles, colors, and sizes in e-mail communication.

Newsgroups are an outgrowth of early computer-based bulletin board systems (BBSs) that allow users to “post” e-mail messages where others can read them. Literally thousands of newsgroups are available on the Internet, organized according to subject matter. For example, the “alt.video.dvd” newsgroup caters to DVD (digital videodisc) enthusiasts, while “alt.sports.hockey” caters to hockey fans. One of the advantages of newsgroups is that they allow users to look back through archives of previous postings.

Chat allows real-time text communication between two or more users. One user types information on his or her keyboard, and other users can read it in real time. Chat can be used in either private situations or in open forums where many people can participate at the same time. To use chat, users normally enter a virtual “chat room” where they are then able to send and receive messages. A related technology, instant messaging (IM), allows users to exchange real-time text-based messages, video, and audio without having to be logged in to a chat room.

Telnet allows a user to log onto and control a remote computer, while file transfer protocol (FTP) allows a user to exchange files with remote computers. However, since both telnet and FTP are exclusively text-based, both have been, in most cases, supplanted by Web-based applications.

The World Wide Web

By the early 1990s, the physical and virtual structure of the Internet was in place. However, it was still rather difficult to use, requiring knowledge of arcane technical commands and programs such as telnet and FTP. All of that changed with the advent of the World Wide Web, which brought an easy way to link from place to place on the Internet and an easier-to-use graphic interface.

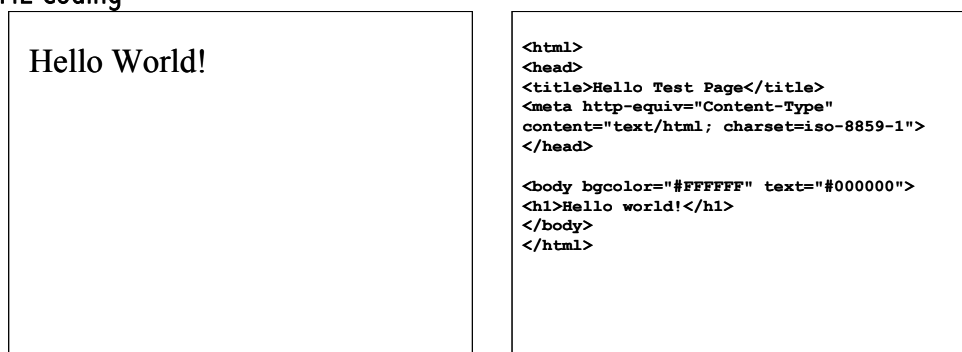
The WWW was the brainchild of Tim Berners-Lee, a researcher at the European Organization for Nuclear Research. He devised a computer language, HTML (hypertext markup language), that allows users with little or

no computer skills to explore information on the Internet. The primary innovations of HTML are its graphical-based interface and seamless linking capability. The graphical interface allows text to intermingle with graphics, video, sound clips, and other multimedia elements, while the seamless linking capability allows users to jump from computer to computer on the Internet by simply clicking their mouse on the screen (Conner-Sax & Krol, 1999). WWW documents are accessed using a browser, a computer program that interprets the HTML coding and displays the appropriate information on the user's computer. To use the Internet, a user simply tells the browser the address of the computer he or she wants to access using a uniform resource locator (URL). URLs are based on domain names; for example, the author's Webpage URL is `personal.bgsu.edu/~jfoust`.

The advent of the World Wide Web was nothing less than a revolution. As illustrated in Table 18.1, the impressive growth rate of the 1970s and 1980s paled in comparison with what has happened since, as users discovered they did not have to have a degree in computer science to use the Internet. Internet service providers such as America Online (AOL) brought telephone line-based Internet access into homes, and businesses increasingly connected employees to the Internet as well. Since HTML is a text-based language, it is also relatively easy to create HTML documents using a word processing program (Figure 18.1). However, more complex HTML documents are usually created using WYSIWYG (what you see is what you get) programs such as Microsoft *Frontpage* or Macromedia *Dreamweaver*. These programs allow users to create Web pages by placing various elements on the screen; the program then creates the HTML coding to display the page on a browser (see Figure 18.2).

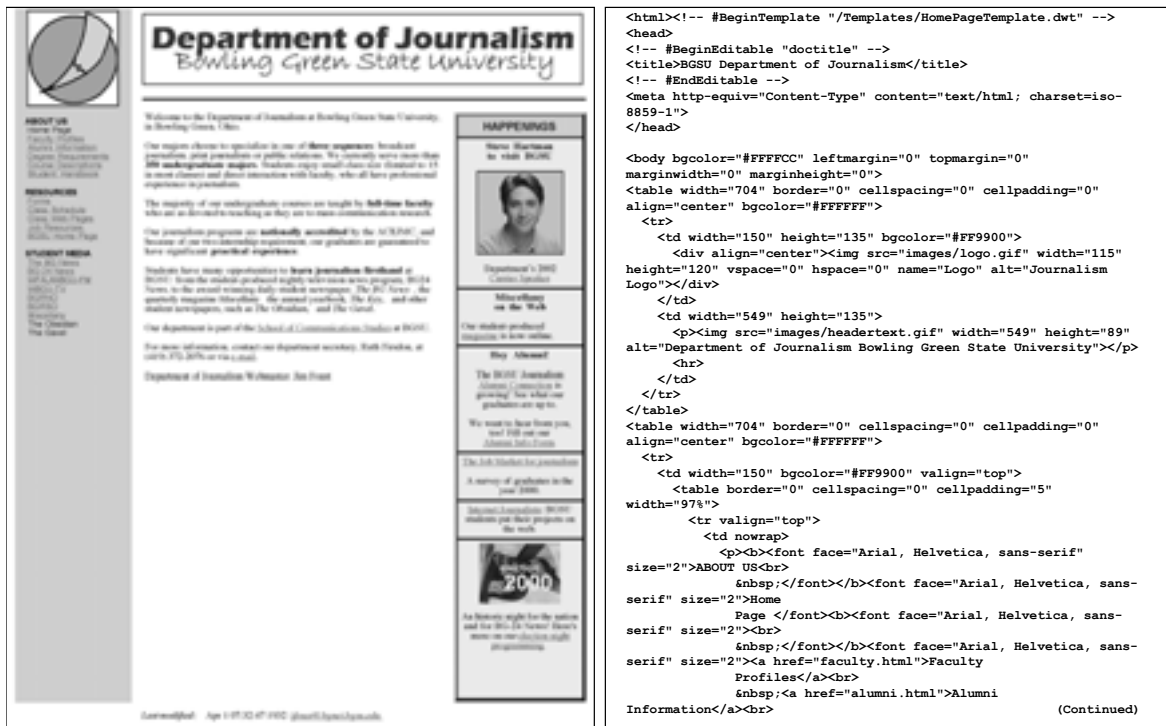
Extensible markup language (XML) is rapidly gaining acceptance as a protocol for sharing information over computer networks. XML is unique because it defines parts of documents according to the type of data, not the appearance of the data. Thus, rather than defining a color or size of a font as you would in HTML, you simply tag the *function* of the data, such as "headline" or "unit cost." Then, data can be more seamlessly shared across different computers and networks. For example, the simple objects access protocol (SOAP), based on XML, allows various programs to share bits of data, regardless of operating system or computer platform. HTML, in fact, is being replaced by XHTML, another form of XML, although there is very little actual difference between the way HTML and XHTML are used.

Figure 18.1
Simple HTML Coding



Source: J. Foust

Figure 18.2
Complex HTML Coding



The image displays a side-by-side comparison of a web page and its HTML source code. On the left is a screenshot of the Bowling Green State University Department of Journalism website. It has a header with the department name and logo, a left sidebar with navigation links, and a main content area with sections like 'ABOUT US', 'HAPPENINGS', and 'STUDENT MEDIA'. On the right is a snippet of the HTML code that generates this page. The code uses tables for layout, with various attributes for table and cell dimensions, background colors, and text formatting. It includes tags for images, links, and text, demonstrating the complexity of early web design.

A small part of the HTML code used to create the Web page on the left is illustrated on the right. Because the Web page is so complex, the actual code is quite extensive; printing it would take many pages.

Source: J. Foust

Recent Developments

As noted at the beginning of this chapter, the Internet has become an integral part of existing economic and social structures. In business, what started out as merely an alternate marketing channel has now become a critical part of the overall economy. Similar conclusions could be reached when considering the Internet's effects on legal and social issues. Still, its relative newness and uniqueness as a communications medium often raise issues that have not been dealt with before. Principles, precedents, and even ethical guidelines often need to be reconsidered when applied to an inherently unique medium that has become so ubiquitous so quickly. That very ubiquity has changed the nature of the Internet, making it much less a novelty and much more a tool.

Because the Internet is a critical part of so many of the technologies in this book, many important recent developments are discussed in other chapters. Among the most important ones are net neutrality (Chapter 21), Internet television (IPTV, Chapter 8), Internet telephony (VoIP, Chapter 17), mobile computing (Chapter 19), distribution of music over the Internet (Chapter 15), and e-commerce (Chapter 20). Each of these topics was deemed important enough to comprise a chapter or a substantial portion of a chapter. The fact that the Internet

is part of so many different technologies makes it one of the most difficult technologies to understand and keep up with.

On a day-to-day-basis, the Internet is an integral part of nearly all aspects of life for a significant slice of the world's population. "For the most part, the online world mirrors the offline world," notes one Internet study. "People bring to the Internet the activities, interests, and behaviors that preoccupied them before the Web existed" (Rainie & Horrigan, 2005). For example, enthusiasts of Ford Mustangs now supplement their enthusiasm behind the wheel and under the hood with newsgroups, discussion boards, and Web sites catering to their interest.

Within the past few years, the blog (short for "Web log") has emerged as one of the most popular Web site forms. At its most basic, a blog is a Web page where information—in the form of brief entries—is posted on a regular basis, and normally appears in reverse chronological order. Thus, a blog can be almost like a virtual diary, with the most recent entry appearing first. Blogs can be supplemented, however, with links to other Web sites, multimedia, and longer content (Conniff, 2005). The relative simplicity of the blog form and the availability of free software and Web sites to facilitate the easy creation and maintenance of blogs have helped to fuel their phenomenal growth.

Blogs have had perhaps the greatest impact in the field of journalism, where they are facilitating the availability of alternate voices and allowing mainstream media to supplement their traditional forms of journalism. Bloggers have been instrumental in uncovering and driving a number of important political stories, including accusations that documents used by Dan Rather in 2004 for a *60 Minutes II* story that called George W. Bush's National Guard service into question were forgeries, and the 2006 uproar over the government's decision to allow a company based in the United Arab Emirates to operate several U.S. seaports. Bloggers have provided alternative perspectives on the wars in Afghanistan and Iraq, and following Hurricane Katrina in 2005, the New Orleans *Times-Picayune's* Web log was one of the most referenced sources for news of the damage and recovery (Glaser, 2005).

The proliferation of RSS (Really Simple Syndication) technology is also changing the way many people use the Web. RSS is a form of XML that allows users to subscribe to services and then automatically receive information from those services. For example, a user could subscribe to a news site's RSS service that would automatically send him or her headlines, video clips, or podcasts. To use RSS, a user normally has to download and install special newsreader software, which is available from a variety of sources.

Economic Developments

The details of the growth of Internet commerce are addressed in Chapter 20, but a general sense of the importance of the Internet can be illustrated by the rise of Google. Started by two graduate students at Stanford University in 1998, the company began by offering a fast, no-frills search engine to help people find information on the Internet. Soon, the company began supplementing its search functions with targeted online advertising. For example, if someone searches for "exercise bikes," he or she will not only get Internet sites that mention that phrase, but links to advertisers hoping to sell exercise bikes or accessories. Today, in the words of one observer, Google has "cornered" online advertising, making it "precision targeted and dirt cheap" (Taylor, 2006). The company is now the most valuable media company in the world, with market capitalization (the total value of all stock in the company) hovering around \$200 billion through the first half of 2008.

Although more than 90% of its income is from online advertising, it is spending massive amounts of money on research and development to be well positioned for future technological innovations. “Name any long-term technology bet you can think of—genome-tailored drugs, artificial intelligence, the space elevator—and chances are, there’s a team in the Googleplex working on an application,” noted one observer (Taylor, 2006).

Social Networking

The most prominent development in the Internet since 2006 is the emergence of the social networking phenomenon. From its beginning, the Internet has facilitated one-on-one interpersonal communication, first through e-mail and later through online chat, voice conversations, and Web cams. Social networking takes interpersonal communication a step further, allowing an individual to connect with everyone in their network who chooses to be connected, sharing as much or as little of their lives through text, pictures, videos, links, etc. As of mid-2008, the most prominent social networking sites in the United States were Facebook and MySpace, while Bebo dominated in Europe, Orkut was number one in Latin America, and Friendster was tops in Asia. Asia not only has more social networking users than any other region, but it also has the highest growth rate. Latin American residents use social networking the most, averaging 349 minutes per month per user, with North American users a distant second with 249 minutes per month per user (Fulgoni, 2007.).

The explosion in the popularity of social networking has been noticed by companies seeking to take advantage of the phenomenon. Software is now available allowing anyone to create a social networking Web site or add a social networking component to an existing Web site. As discussed in Chapter 3, however, these sites cannot succeed without a “critical mass” of users who connect with each other frequently enough to maintain interest in the site. The social networking phenomenon is too new to know whether it is a fad or a permanent part of the Internet landscape, but the sheer volume of users suggests that it will have a continuing presence on the Internet.

Research on the Internet

The Internet is one of the most-researched new communication technologies ever. As a “new” technology that is still growing, many statistics are reported as “trends,” allowing you to make projections about specific statistics months or years after the trend is reported.

Any type of library or Web search will yield hundreds of articles, white papers, reports, and books containing Internet research. One source has proven especially valuable to the authors of chapters in this book, The Pew Center for Internet and American Life, which conducts research on every imaginable dimension of Internet use. Recent research topics include social networking, mobile access to data and information, privacy implications of mobile Internet user, the Internet’s use in politics, and use of video-sharing sites. (See a list of the latest reports at www.pewinternet.org/reports.asp.)

The “Dark Side” of the Internet

For nearly as long as there have been computers, there have been software programs designed with malicious intent. The rise of the Internet, however, has made these “malware” programs more prevalent and their effects potentially more devastating. The main types of malware include:

- ♦ *Viruses and worms*—Software that infects a computer and either slows down its operation, erases or damages files, or otherwise changes the way the computer operates.

- ♦ *Spyware*—Software that runs on a computer without the knowledge of its operator, logging information about keystrokes, Web sites visited, or other information about the user and sending it to another computer.
- ♦ *Spam*—Junk e-mails designed to lure the user into spending money on an often nonexistent product. One common type of spam is phishing—e-mails that try to trick users into revealing personal information or account passwords by posing as a bank or Web site with which the user has an account.

One study showed a 48% increase in malware threats in 2005, and estimated that one in 44 e-mails carried over the Internet was malware (Sophos, 2005). Perhaps the most remarkable change in malware over the past few years has been its intent. For many years, the people who created the vast majority of malware did so for purely narcissistic reasons—to impress their peers or make themselves feel important. Now, however, most malware is written in hopes of achieving direct financial gain at the expense of individuals or corporations (Sophos, 2005).

The increasing prevalence of viruses and other malware threats has obviously not deterred people from using the Internet. Instead, studies show that Internet users are increasingly savvy about *how* they use the Internet—for example, not opening e-mail attachments from people they do not know and not downloading information from sites they are not familiar with (Fear of, 2005).

Current Status

According to the Pew Center for Internet and American Life, as of December 2007, 75% of adult Americans are online, with almost no difference in use between women and men. Young adults 18 to 29 were most likely to be online, with 92% online, but only 37% of senior citizens (65+) were online. Ethnicity was still a factor, with 79% of English-speaking Hispanics online versus 76% of whites and 56% of African Americans. Income and education were positive predictors—the more education or income a person has, the more likely he or she is to be online (Pew Research Center, 2008).

It is estimated that about half a billion people worldwide have access to the Internet from their homes, and it is a safe assumption that many more who do not have home access have it at work or school. Forty percent of Internet users are in the United States, but the highest rates of growth are in Asia and Europe. As illustrated in Table 18.3, Internet use is strongly correlated with computer ownership, especially in countries with the highest level of use. (This table reports data from only 20 countries; Pew Research Center (2007) reports data on 50 countries.).

As of May 2008, more than 102 million active domains were registered in the six most common top level domains, up from about 63 million domain names as of early 2006 and half that number in 2003 (Domain Tools, 2008; Domain names, 2006). The sheer volume of change in domain names is staggering—in a single day, about half a million new domains are registered, and more than 300 million domain names have been deleted since record keeping began (Domain Tools, 2008).

Table 18.3
Internet and Computer Use in Selected Countries

Selected Counties	% Use Internet	% Own Computers
United States	78	76
Canada	75	77
Brazil	42	34
Mexico	31	22
Britain	72	73
France	71	73
Germany	66	70
Russia	25	30
Ukraine	19	21
Kuwait	71	84
Israel	69	77
Egypt	20	18
South Korea	80	93
Japan	62	68
China	34	37
India	22	14
Indonesia	7	6
Nigeria	40	16
South Africa	25	27
Uganda	9	2

Source: Pew Research Center, 2007.

Factors to Watch

The Internet has clearly become as much an integral part of communication technologies as computers and microprocessors did two decades ago. The rapid growth of applications and use is evidence of the need for people and society to be electronically connected. As we learned from the history of other emerging technologies, attempts to control the Internet are likely to increase over time.

The most important area to watch is therefore the regulation of the Internet. Although most attempts by the U.S. Congress to regulate Internet content have been struck down by the courts, there is a continuing interest in protecting minors from inappropriate content. Internationally, some countries such as North Korea simply do not allow their citizens to have Internet access.

China represents an interesting case. Once known for its “Great Firewall,” the Chinese government began opening up Internet access in 2007 and 2008, allowing Chinese citizens unprecedented access to the information, data, and entertainment available over the Internet (Agence France Presse, 2008). One reason for the new openness may be the 2008 Summer Olympics in Beijing; if that is the case, it will be interesting to see whether the openness continues into 2009 and beyond.

As discussed in Chapter 23, the Internet will also provide the basis for a new generation of mobile technologies that have the potential to revolutionize everyday life. Potential areas of impact discussed in that chapter include law enforcement, education, health care, and research, but those may be just a sample. The impacts of ubiquitous mobile networking will be limited only by the imagination of the entrepreneurs who are seeking to develop and exploit new technology systems.

It is also possible that the Internet is maturing as a technology, and the speed of development and the magnitude of impacts may be moderating. If that is the case, keeping up with developments in new communication technology will be significantly easier; unless, of course, something new comes along.

Meanwhile, a consortium of nearly 200 universities and 60 corporations is working on the so-called “Internet 2” project. Although it is not, as the name might imply, a replacement for the existing Internet, it seeks to fundamentally change online communication by increasing and then exploiting the speed of the existing Web. Participating universities are investing \$80 million per year in the project, and corporations have pledged an additional \$30 million over the life of the venture. The major goal of Internet 2 is “to ensure the transfer of new network technology and applications to the broader education and networking communities” (FAQs, n.d.). The project is simultaneously developing technologies that will make the Internet faster, and applications such as digital libraries, virtual laboratories, and tele-immersion that will take advantage of that increased speed. Internet 2 seeks to do this by “recreat[ing] the partnership of academia, industry, and government that helped foster today’s Internet in its infancy” (FAQs, n.d.). Once again, the Internet may be coming full circle.

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Mobile Computing

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In the larger sense, anything that contains a microprocessor and is portable or battery-operated falls under the spectrum of “mobile computing.” Examples of mobile computing devices include cell phones and “smart” phones, portable video games, satellite global positioning devices, personal digital assistants (PDAs), laptop and tablet computers with or without wireless capability, advanced walkie-talkies, so-called wearable computers, and the full range of evolving wireless networks. Mobile computing devices also enable an endless array of specialized applications, ranging from handheld inventory record-and-control devices to students on campus using wireless access to research journals to United Parcel Service (UPS) tracking of shipments to a growing use in hospitals for sharing information and access to patient and process databases to the portable computers used by car rental agencies to process a car return on the spot. This chapter focuses on the use of mobile computing through wireless technologies.

Mobile computing is fast becoming one of the largest links to the end-user in the vast panoply of data connectivity. While it takes enormous processing and storage capacity to perform the functions of wired networks (e.g., Internet, corporate mainframes, telephone or cable systems), the *wireless* end of that linkage, though still too often sluggish and sporadic in its accessibility, is rapidly overcoming many of the obstacles. Wireless networks are expanding on a global scale. Bandwidth has grown larger, even for mobile links. End-user devices have enjoyed an increase in function, mobility, capacity, and speed, as well as an increase in their multifunctional features. The whole landscape of connectivity is becoming more seamless at a rapid pace.

Not only is connectivity becoming more seamless, it is also becoming more automated or invisible. “End users” may not only be people, but other machines as well, leading to what some call the “Internet of things,” where machines communicate with machines (M2M) in an “always on” capacity in such things as radio-frequency identification (RFID) for tracking and inventorying products, or “smart computing” in a “world of networked devices” (ITU, 2005, p. 1; Dye, 2008).

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This chapter gives a short description of the background and history of mobile computing, recent and upcoming developments with some data on the current status of mobile computing, and a discussion of factors and issues to watch as this phenomenon continues to evolve.

Background

As with most technology-laden areas, the mobile computing area has its share of acronyms and jargon: 2G, 3G, Super 3G, CDMA, TDMA, UWB, Wi-Fi, WiMAX, Bluetooth, RFID, WPAN, EVDO, GSM, GPRS-EDGE, and so on. Unraveling the myriad of developments produces only a snapshot in time, since the technologies and their corresponding acronyms persistently continue to emerge.

Mobile wireless communication has existed for many years, and, in its early stages, included pagers, clunky bandwidth-hogging pre-cellular mobile telephones, and some limited-use radio communications such as amateur radio and citizen's band. Practical business and professional applications were very limited, and service costs were high. Although the range, penetration, and application of mobile computing and communication are extensive today, there is also a sense that the proliferation is only just beginning, especially for the convergence of functions mobile communication provides.

Development of mobile services has had bursts of progress, along with some fits and starts. There is the ever-present need to balance standardization of technology and systems against the need for change and progress to better levels. Today's mobile computing services show increased adoption of wideband and speed capability, as well as penetration of upgraded services, while research and development of the next generation of wideband digital goes on. Some of the prevalent problems include lack of total security, incompatibility of competing systems, lack of total service coverage areas, and the "digital divide" between the technology "haves" and "have-nots." It seems wireless services are on the verge of a growth spurt, particularly in the convergence of a wide range of functions, and especially as additional bandwidth becomes available when over-the-air television stations relinquish their traditional channel spectrum in 2009.

Recent Developments

The underlying transmission systems of mobile computing have been categorized in "generations" to reflect major system developments. They actually began as cell phone services (discussed in greater detail in Chapter 22). Essentially, cell phone technology incorporates a large number of low-power telephones that share the same frequencies because their transmission area is limited to geographic cells. When a user moves from cell to cell, as in a moving vehicle, the transmission is handed off to an available frequency in the new cell, thus freeing the frequency used in the former cell for another user.

The third generation, 3G, is the most recently rolled-out generation, although so-called 4G and enhancements to 3G are underway. It is useful to briefly look at the basic features of each generation, and to show how each of the technologies fits into the generations.

1G

The first generation began in the 1960s and was essentially the first cell phone service based on an analog system. First, the system was labeled Improved Mobile Telephone Service (IMTS). In the 1970s, the system added microprocessors and digitized control over the links among the cells. Then, it was called the Advanced Mobile Phone System (AMPS). Both were developed and first used in the United States. Use in other countries included the Nordic Mobile Telephone (NMT) and Total Access Communication System (TACS). The service grew rapidly in the 1980s, reaching 20 million subscribers by 1990 (Take, 2004; Galaxyphones, 2006).

2G

The second generation appeared at the end of the 1980s, and the system included digitization of the voice signal, but, being digital, could accommodate other basic kinds of digitized messages. The industry also applied standards that allowed worldwide compatibility using Global System for Mobile (GSM) communication. Concurrent with the second generation was the development of much smaller handheld devices with more efficient batteries. The generation was plagued with varying systems and standards and included a range of acronyms reflective of that variation: IS-136 based on TDMA, IS-95 based on CDMA, digital AMPS, and a whole family of GSM, including GSM900, GSM-Railway, GSM-1800, GSM 1900, and GSM 400. Many of the systems served only one country or region. There was a basic European standard set with GSM900 in 1990, but it became obvious that a new generation was needed. Another worldwide standard was proposed, known as IMT-2000, which led to 3G and was to take effect in the year 2000 (Galaxyphones, 2006; Phifer, 2006).

2.5G

As the IMT-2000 (3G system) was being developed, several improvements to 2G networks emerged that came to be known as 2.5G. Some of the 2.5G names include CDMA2000 1x, EDGE, and GPRS. They were really improvements leading up to meeting the 3G standards, but not quite reaching the data speeds and capabilities of that standard (Galaxyphones, 2006; Phifer, 2006).

3G

The IMT-2000 standards were set by the International Telecommunications Union (ITU) and incorporated the 2000 MHz frequency range. The standards prescribed the ability to accommodate worldwide use for all mobile applications, a high transmission rate up to 2 Mb/s, efficient use of radio spectrum, backward-compatibility to 2G, and support for both packet-switched and circuit-switched methods of transmission (Galaxyphones, 2006). In effect, the standard would accommodate the fast communication of voice, Internet, multimedia, games, location-based services, and high-speed mobility in a seamless, global standard. The first 3G network was in Japan in 2001, with other systems rolling out soon thereafter. By 2008, there were an estimated 190 3G networks in 40 countries with over 200 million subscribers, representing some 7% of mobile phone subscribers worldwide. In the early adopting countries of Japan and South Korea, more than half of mobile subscribers have 3G service (Global Mobile Suppliers Association, 2008).

Beyond 3G and 4G

Even as 3G began to take hold, several improvements were being made. Names of these improvements include Super 3G, Ultra 3G, and 3.5G (Smith, 2008b). Essentially, all of them involve higher speeds and the

ability to transmit more and more data through mobile devices, and incorporate such technologies as FOMA, TD-SCDMA, and GAN/UM .

The fourth generation, 4G, is predicted to be announced around 2010, and it will extend 3G capacity, and work with entirely packet-switched digital networks with speeds up to 100 megabytes per second (Mb/s). However, no standard for 4G has yet been developed, even as technologies and systems evolve. Some experimentation is already ongoing, including research by Motorola, Qualcomm, and several other companies that look for multimedia and video opportunities not available in 3G. Among 3G's shortcomings:

- ♦ Insufficiency for high-performance video and multimedia and wireless teleconferencing.
- ♦ Multiple standards for 3G making interoperability difficult.
- ♦ The need for wider bandwidth.
- ♦ Perhaps most important, the need for an all-digital packet network that uses an Internet protocol (IP) common standard (What is 4G, 2008).

Even as some “pre-4G” technologies are being considered and include long-term evolution (LTE), WiMAX, and ultra mobile broadband, the common denominator for this generation seems to be “having an open platform where the new innovations and evolutions can fit” (Lu & Hu, 2006). For example, the Open Handset Alliance is a consortium of over 30 technology companies advocating the adoption of a standard platform called Android that will make it possible for mobile handset makers to develop and enhance their products without being confined by the proprietary “closed” standards that systems have today (Open Handset Alliance, 2007).

Some of the systems described below are ready to move into the 4G realm, including WiMAX and WCDMA. ABI Research predicts that the number of 4G subscribers will reach over 90 million by 2012 (More than, 2008).

Acronym-proliferation aside, what all this means for the consumer is the capability for the mobile handheld handset, laptop, or notebook computer to process more and more information at faster rates and with greater mobility than ever before.

Consumer Systems

Currently, there are several technologies that provide wireless computer communication for the consumer, from the very short-range to the long distance. There are also varied applications for these systems, and these are discussed briefly here.

Bluetooth has a short range and a limited capacity of about 2 Mb/s and uses the frequency band of 2.5 GHz without requiring licensing. The technology is often used to interconnect devices at ranges of 33 feet or less. Bluetooth often interconnects devices within an office, such as a mouse, keyboard, printer, etc., without wires. Its use has been worldwide and is growing rapidly. Growth has been attributed to use with cell phones for hands-free operation, but it is also increasing in gaming and stereo headphone applications, and some more innovative uses such as personal area network (PAN) sensors that can detect and transmit information for sports, exercise, and health (Bluetooth, 2008; ABI Research, 2007c).

Zigbee is similar to Bluetooth insofar as it has a short range. ZigBee technology coordinates communication among devices using sensors such as thermostats, lighting controls, smoke detectors, medical monitoring, and remote set-top box control. One of its premier applications is helping with energy management in homes and commercial buildings through home automation (Zigbee Alliance, 2008).

Wi-Fi uses the IEEE 802.11 formats (802.11a, 802.11b, 802.11g, and 802.11n) for use as wireless local area networks (WLANs) and has a varying range of up to 350 feet, depending on which format is used, and a current capacity of up to 54 Mb/s with 802.11g. 802.11n has not been formally approved by the IEEE, but it is currently used, and there are 802.11n compliant devices available in retail stores. 802.11n has speeds up to 100 Mb/s and uses multiple-input/multiple-output (MIMO) signal processing. Most of the 802.11 protocols use the 2.4 GHz operating frequency, although future expansion will use 5 GHz or 3.7 GHz.

The number of users of Wi-Fi is hard to determine, but the technology is considered to be pervasive as most new computers and smart phones sold are Wi-Fi equipped. There has been a very large proliferation of “hotspots,” or places where a mobile computer has Wi-Fi access. JiWire’s Wi-Fi directory estimates more than 242,000 locations in 136 countries as of March 2008, with the United States and Europe having the most (JiWire, 2008). Hotspot locations include hotels, restaurants, coffee shops, businesses and educational institutions, homes, airports, libraries, and countless other public and private places. Some Wi-Fi sites are free, others require a fee or subscription, and many others are private and not available for public use.

Ultrawideband is designed to move huge files at high speeds over short distances. It uses a wide spectrum and transmits information over several frequencies simultaneously (Ultrawide Planet.com, 2008). The technology has a short range of only about 33 feet, but it can channel as much as 480 Mb/s, almost 10 times that of Wi-Fi. According to Intel, “UWB is ideal for exchanging data between consumer electronics, PCs, PC peripherals, and mobile devices at very high speeds over short distances. For instance, it could transfer all the pictures on a digital camera’s memory card to a computer in a few seconds (Intel, 2007).

WiMAX is similar to Wi-Fi technology. While Wi-Fi can service computers within a range of several hundred feet, WiMAX, by comparison, has a range of 25 to 30 miles, and is an alternative to wired broadband services provided by cable and DSL (digital subscriber line). Equipped portable computers can access the Internet over relatively long distances and in very mobile situations such as automobiles and other forms of transportation. After five years of testing and anticipation of this technology, 2008 is the year of its debut, with the expectation that 150 million people will have WiMAX coverage, growing to 1.3 billion by 2012 (Gardiner, 2007b). WiMAX uses the 2.5 GHz and 3.5 GHz bands and is called a “head start” on the 4G service. One WiMAX service to appear is called Xohm and is a joint effort of Sprint and Clearwire. At the time of this writing, it is described as costing \$1.5 billion and will be launched by summer 2008. Xohm will be an open network, meaning that many devices can be adapted for use on the network (ABI Research, 2008a; XohmUser.Com, 2008; Smith, 2008a).

Consumer Applications

Smart phones. Because all these systems bring more speed, versatility, and bandwidth, there are corresponding expansions in applications. The cell phone has long been a device for more than voice, with photography and text messaging already expected on many phones. With 3G and its many additional improvements rolling out worldwide, and 4G on the near horizon, expanded capabilities follow. Today’s applications are dominated by smart phones, followed by laptops. The smart phone is an all-encompassing technology that can include not only the functions above, but also word processing; global positioning; live gaming; Wi-Fi integra-

tion allowing viewing of movies, videos, and even teleconferencing; and a host of newer applications not yet developed or incorporated. All these capabilities are provided in a compact, all-in-one pocket wireless computer and communicator. The rollout of 3G led to the proliferation of these functions, but the move toward 4G will increase the number of applications even more.

Of the many functions these new devices have, the most prominent newer ones are live video gaming, global positioning system (GPS) access, music downloading and playing, and mobile TV. Both games and mobile TV give the greatest challenge for the need for advanced signal compression, high-resolution screen capability, speed and bandwidth, efficient processors, and long battery life.

Mobile television. It is possible today to watch movies and television on a mobile phone. CTIA reports that there are over 2,000 video titles available for download to mobile devices, although in the age of large-screen high-definition, watching a movie on a small smart phone screen leaves much to be desired (CTIA, 2008).

As for television, although picture size and quality are still a concern for many, the reality of mobile video capability is well in place. Two approaches to mobile TV are under development. The first follows the broadcast model of efficiently sending scheduled programs simultaneously to a large number of viewers, and seems the most prevalent, at least for the near future. The second, “unicasting,” follows the video on demand process, where consumers choose what and when to watch. This approach requires more and specifically dedicated use of bandwidth for the individual user, and it is therefore less efficient in bandwidth use. In the not-so-distant past, watching mobile television was limited to very short video clips, but ABI Research reports that people are often watching longer programs, and hour-long shows are in the planning (ABI Research, 2007d).

In the United States, each of the major cellular services offers some video transmission. MobileTV is one program provider offered by several services. Cingular launched its on-demand mobile TV service in March 2006 for short three- to five-minute clips from 18 channels. This came right after the launch of Verizon’s V CAST service and Sprint Nextel’s on-demand services, both still very limited (Reardon, 2006). After a year of Verizon’s offering of Qualcomm’s live television service called MediaFlo, AT&T-Cingular announced it was also offering the service’s two channels to its mobile subscribers using Samsung’s Access. This brought MediaFlo into 55 markets and about 130 million potential subscribers. However, subscriber acceptance was slow and the potential success of mobile television was hampered by weak consumer demand. Qualcomm predicted that growth would increase in February 2009 with the change from analog to all-digital over-the-air television services and the availability of more spectrum space (Carew, 2008).

Mobile television has competing standards. In parts of Europe and other countries, mobile TV uses the digital video broadcasting (DVB) standard. DVB-H brings broadcast service to handheld devices, and DVB-SH uses satellite and terrestrial networks. Many trials and some actual service launches have already begun in some 35 countries, and a projected 170 million receivers are already in use. The project is a consortium of over 270 members working for standards and open access to mobile television systems (DVB Project, 2008; DVB-H, 2008).

Another development enables the user to view live or recorded television via a broadband connection. By connecting the device to a home video live or recorded source, the signal can be live streamed via broadband to the user’s mobile or wired device. The Slingbox, HAVA, or SonyLocationFree are three such devices that offer this service (HAVA, 2008).

Current Status

Subscriber statistics. In early 2008, in the United States, there were an estimated 255.4 million subscribers to cell phone and other mobile services, and 13.6% of U.S. households were wireless only. Worldwide, there were an estimated 2.3 billion wireless subscribers (CTIA, 2008). It is difficult to separate cell phone usage data from other wireless usage, especially as multiple function devices proliferate.

In an October 2007 report, the Nielsen Mobile rating service determined that “among the 237 million wireless subscribers in the United States, 70% use their phones to text message, more than 32 million accessed the Internet on their phones last month, and 41% use their phones to send picture messages” (Nielsen Mobile, 2007). According to *3G Today*, there are over 939.1 million 3G subscribers worldwide, 254 3G operators in 99 countries, and over 1,950 different 3G devices for consumers (CDMA Development Group, 2008).

Smart phone features. Apple’s introduction of the iPhone in July 2007 signaled a ramping up of smart phone use in the United States, growing 48% in 2007 (Solomon, 2008). The iPhone outsold all smart phones in its debut month and spurred a growth in smart phone purchases. American cell phone users have long been accustomed to getting cell phones for little or no cost, but the iPhone’s revolutionary package of features such as the large touch screen, movie/video/music functions, and unique graphic interface showed that consumers will pay more for a smart phone. It became not only a truly multi-function device, but also a status symbol. Given the growing number of mobile phone users who have no landline phone service, it follows that users will want and pay for more functions on their portable phones. The third generation iPhone, with a planned launch in mid-2008, utilizes the full capability of 3G for a high-speed wireless Internet (Gardiner, 2007a; Reuters, 2008).

Following iPhone’s lead, other manufacturers brought forth a proliferation of similar models, shown at the 2008 Mobile World Congress, that include features such as touch screens, GPS and voice-assisted navigation, Bluetooth, Wi-Fi, 3.2- and 5-megapixel cameras with zoom features, MP3 players, FM radio, slots for flash memory, increased memory, and even more refined features, such as GPS location identification for photos taken (Shannon, 2008). As smart phone sales increase and the number and kind of features they have proliferate, there will likely be a decrease in sales of devices that perform those functions separately. For several years, sales of PDAs have decreased, and, in 2007, their sales dropped over 40% in the second quarter compared to the previous year’s sales for that quarter (Anderson, 2007). One might expect similar declines in sales of GPS devices and MP3 players, as smart phones increasingly incorporate their functions. The emergence of flash memory MP3 players may retain a strong segment because of the convenience of their very small size.

Municipal Wi-Fi. One area that is growing—although in fits and starts—is the development of city-sponsored, citywide Wi-Fi coverage, making it available to all residents for a low cost. ABI Research (2007a) estimated that, at the end of 2007, there were about 400 cities with planned municipal Wi-Fi networks, but that after the promise of a big start in 2004, growth and implementation have been hampered. Growth is predicted to cover more than 30,000 square miles by 2012, but this growth is not without its setbacks. Existing telecommunications service providers have lobbied for states to prohibit cities from deploying Wi-Fi nets, citing unfair competition from governments. Having Wi-Fi signals reach into peoples’ homes and buildings is technologically difficult, and, in many cases, may require thousands of Wi-Fi access points to be adequate. A slowing economy plus reluctance by private providers to pay for systems slowed the growth of municipal Wi-Fi in the last half of 2007. Finally, municipal Wi-Fi may be superseded by a technologically superior WiMAX service, requiring many fewer access points (Opsahl, 2008). *Wired Magazine* (The united, 2008) points out that, while

municipal Wi-Fi plans have been cut back in cities such as San Francisco, Chicago, and Atlanta, it is working well in Philadelphia and in dozens of smaller locales around the country.

Converged telephone services. Businesses, always on the lookout for cost savings, find that “converged telephone” services can save money. In such systems, a business cell phone, when within range of the company’s Wi-Fi network, automatically switches to the local PBX (private branch exchange). That PBX, in turn, is connected to the Internet and uses voice over Internet protocol (VoIP) as a free or low-cost telephone service, saving more costs for telephone as well. The whole system is seamless to the user. However, converged systems have been very slow to emerge, despite a great deal of hype in the past three years. Duffy (2007) believes that the slowdown is due to the reluctance of telephone service providers to implement a system that reduces its revenues.

M2M and GPS. Machine-to-machine communication, sometimes called the “Internet of things,” is a growing function where mobile wired or wireless communication devices communicate with each other, sometimes completely automatically but also often with end-user direction. Examples include truck fleet location tracking and management for businesses, automated toll collection on highways, telemetry systems, building automation systems, General Motors’ OnStar system, security systems, and a large number of manufacturing and service functions. A 2007 online survey by Manufacturing Insights “included M2M practitioners from the manufacturing, oil and gas, utilities, retail, government, health care, banking and insurance sectors, as well as M2M solutions providers.” The study “revealed that machine-to-machine adoption is widespread across multiple industries” (Manufacturing Insights, 2007). While it is not certain how widespread M2M technologies are, one estimate suggests that more than 38 billion devices are in operation. The wireless options for M2M can include satellite, cellular networks, and any of the other transmission systems discussed in this chapter (M2M Communications, 2003).

Two of the most commonly known application technologies for M2M are radio frequency identification and global positioning satellites. RFID technology uses a small, low cost “tag” containing a miniature integrated circuit that can be used to identify objects from a short distance. RFID is used in toll collecting systems such as EZ Pass, animal implant ID chips, access control and inventory monitoring, and emerging methods for retail check-outs, among an untapped array of applications. At Slippery Rock University, student IDs are fitted with RFID chips, allowing purchases both on and off campus from their campus accounts. Research estimates predict RFID will grow from \$3.8 billion revenues in 2007 to over \$8.4 in 2012 (ABI Research, 2007b).

GPS navigation devices in vehicles is still a high-end factory installation, although these systems are predicted to filter down to 30% of medium-priced vehicles by 2012, and the decreasing prices of aftermarket devices has become a popular addition among car owners. Moreover, the sale of GPS handsets is estimated to reach annual sales of 96 million by 2012 (ABI Research, 2008b). As mentioned above, GPS is available in many smart phone configurations. One interesting application being tested by CBS Mobile would allow family and friends to track one another via their mobile phones, and to send them advertising appropriate to their locations (Holson, 2008).

Factors to Watch

If the goal of mobile computing is “anytime, anywhere communications,” there has been progress toward that goal on many fronts. The primary technology of this movement was, of course, the cellular telephone.

Soon, personal communications service (PCS) technologies began to fill in following cellular designs, and, in recent years, the availability of wideband digital services promised to further revolutionize the mobile computing landscape.

The most significant development for the future of mobile computing and communication is the opening of the “700 MHz band,” part of the UHF spectrum (470-862 MHz) being vacated as television moves completely to digital on February 18, 2009. The March 2008 auction held by the FCC brought \$19.5 billion for the spectrum, which will be used essentially for 4G and LTE services. The biggest winner was Verizon Wireless, followed by AT&T. In making the spectrum available, the FCC has required open-access, which will likely allow consumers to download any content with any device, and would probably accommodate an array of Internet protocol operating systems (Verizon & AT&T, 2008; Duryee, 2008b). Meanwhile, Google presented plans for using unused “white space,” low-power use of unused spectrum between television channels 2 and 51, for “a new generation of wireless.” The FCC was asked by broadcasters to deny this use for fear it would interfere with their television transmissions (Duryee, 2008a; Kaplan & Auchard, 2008).

As mobile communication and its frequency allocation expand, and its ever-growing efficiency in the use of available spectrum continues, there is some concern that it will threaten the existence of traditional services, such as landline, cable, and broadcast. This is not likely in the near term, but as trends show that a decreasing percentage of people are subscribing to landline telephone service, wireless will surely command a stronger portion of computing and communication usage. As mobile computing advances, there are several factors that need to be considered:

- ♦ *Standardization and open interoperability*—The newly opened spectrum will bring increased open-access, but there remains uncertainty as to what form it will take. Although each of the generations—2G, 3G, 4G, etc.—has brought landmark standards, even before those standards are established and operating, newer developments have pushed the capabilities of the technology, its systems, and its markets, making several elements of standardization elusive or quickly obsolete. This will likely continue to be the case.
- ♦ *Legal and regulatory opportunities*—If a worldwide mobile broadband service is to be accessible to everyone, then great care must be taken in allocating adequate and proper portions of the electromagnetic spectrum. This care must involve significant testing for the most efficient use of spectrum, international agreements on spectrum use, and a careful balance between commercial, government, and public uses of the spectrum (National Telecommunications and Information Administration, 2006). Likewise, there needs to be better clarification and enforcement of patents and copyrights of the myriad developers using both the channels and the end-user devices for these technologies, especially in the international arena.
- ♦ *Security protections*—As more and more users participate in mobile wireless technologies, secure encryption becomes an even greater priority to protect the privacy and security of communications. There are concerns that total encryption security could be a threat to public and national security. The need for security increases with the proliferation of technologies that use airwaves, for obvious reasons. In Wi-Fi networks, anyone can hitchhike through a company’s hotspots, which do not usually honor the boundaries of walls or property. Encryption and firewalls become all the more important as one’s signals lie bare to intrusion, sabotage, and spying. Although there are ways for companies and individuals to protect the security of their Wi-Fi networks, many users find those methods daunting and leave their networks unsecured. Moreover, with the increased

use of flash cards that can be easily misplaced, and smart phones that are lost, stolen, or traded in, protecting the increased amount of information these devices hold becomes even more difficult.

- ♦ *Ease of use*—Like the stereotype of the photographer with the multi-pocketed vest, one's "personal area network" might just be the interconnection of devices through the inter-wiring among the 52 pockets in one manufacturer's garment (Wayner, 2007). As smart phones encompass more and more functions, the complexity of their use increases. While graphic interfaces make them more intuitive and easier to use through touch screens, the multiplication of functions adds to the difficulty of use. Computer chip and battery improvements provide greater speed and longer battery life, but the user is still saddled with the need for frequent recharging. Despite the wonders of device and function convergence, most users will still want at least two to carry, because the smart phone's tiny keyboards make writing much harder than on a laptop. Perhaps future developments will eliminate the need for a keyboard, but that is not likely for some time to come (Mathias, 2007).

In-building wireless networks will likewise expand, using the various technologies described. As network capability increases, so also do many of the problems associated with that increase: increased costs for hardware and network systems, increased complexity and the need for associated training, and increased vulnerability to security threats.

All these things will increase the power and "seamlessness" of mobile computing, as well as the invisibility of automatic mobile devices through M2M. Along with these growing conveniences will also be growing aggravation. Cell phones connected to the Internet are plagued by pop-up ads, spam, unwanted e-mail, viruses, pornography, and a host of other things.

An important concern with any and all new technological developments is the balance between the benefits to be derived and the costs in both money and time to implement the new technologies. For example, a recent conversation with a medical specialist revealed that many practicing physicians have an aversion to employing mobile computing as part of their routine daily practice. This physician, reflecting her views and those of colleagues, essentially feels that the computer technology is simply too complex and not worth the time to learn and master. Further, there appears to be a fundamental mistrust with respect to reliability, cost, privacy, and quickly outdated technologies. In the past few years, privacy has also become a substantive legal issue, with the implementation of the Health Insurance Portability and Accountability Act that protects people from misuse and unwarranted access to information.

Mobile digital connectivity via computing is the key to telecommuting and is rapidly becoming a mainstay of professional work life. Many white collar jobs can essentially be performed through access to a telephone, computer, e-mail, and an Internet connection. Teleconferences are inexpensive means of conducting business meetings, and they can substitute for traditional on-site meetings. However, there are many organizational, social, and psychological reasons why many organizations resist adopting or increasing telecommuting. Close traditional supervision of staff certainly is often a preferred management approach. From the worker's perspective, face-to-face interaction may provide more effective interpersonal communication and the means to reach problem resolution. Psychologists point out that people prefer a clear physical and psychological distinction between home and work, which telecommuting may eliminate. Personal interaction also provides a sense of importance and priority that electronic communication may deemphasize. (For more on teleconferencing, see Chapter 22.)

Organizations have become concerned about the costs and lack of standardization related to mobile devices. The strategy to employ mobile devices has essentially migrated into organizations via the backdoor as employees acquire and utilize devices. There has been a lack of focus and control. This is further complicated by the multiplicity of technologies and devices that are constantly emerging in the wireless market. Another problem that has been noted is the distraction that mobile devices cause in the workplace. Meetings are often disrupted by inbound cell phone calls, with users constantly accessing their mobile devices for messages.

Another issue that has emerged is the recreational usage of company-provided mobile devices, ranging from Web access, custom ringtones, and camera cell phones. Organizations that provide mobile devices require policies and controls relative to personal use of this equipment. With the ever-increasing volume of work-related information passing through mobile devices, privacy and security emerge as significant problems. Mobile devices are easily mislaid and lost, providing potential leaks of confidential information.

All told, there is non-stop progress in both technological and system development toward the “anytime, anywhere” utopia, and this affects not only the worker and workplace, but is pervasive in the personal and social life as well. While the “last mile” used to refer to the slowness of the last link in the wired telephone system, the term is more appropriately applied now to that last link in the wireless connection to the end user. That last mile is fast becoming a fast and vast link as well.

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Electronic Commerce

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The Internet and other communication technology certainly offer us many avenues to learn more about our world, as well as to express and entertain ourselves. Those technologies have also changed the way we think of business, as well as how business impacts our daily lives. It is obvious that we have the ability to purchase things online—a recent Pew Internet and American Life report shows that two-thirds of Americans who are on the Internet have purchased something online (Horrigan, 2008). Doing business through communication technology affects our economy in other ways, sometimes just by having a better product to offer or because of changes in the way that product is offered: say, a digital download of a movie rather than hard copy DVD (digital videodisc).

The fact that Google was the 13th largest company on the New York Stock Exchange in terms of market capitalization in mid-2008, but only one of seven media and communication companies in the top 20, should point to the power of those communication and media companies in the economy. This chapter examines how business happens through communication technology, whether it is over the Internet, through mobile devices, or good old fashioned television. We begin by looking at the background of e-business.

Background

Definitions

While they may seem synonymous, e-commerce and e-business are actually somewhat different. Mesenbourg (1999) defines e-business as any procedure that a business organization conducts over a computer mediated network (p. 3). E-business thus includes processes such as ordering new materials to aid in the production of goods, marketing to customers or processing their orders, or automated employee services, such as training

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information housed on a company Intranet. E-commerce, on the other hand, is defined as any *transaction* over a computer mediated network that involves the transfer of ownership or rights to use goods or services. For example, when you purchase a song from iTunes or any other electronic music store on the Internet, you are engaging in e-commerce.

These definitions also point out the similarities between e-business and e-commerce. Certainly some of the processes involved in e-business could be classified as commerce—that is, the exchange of ownership rights. If a pharmacy electronically orders its drugs from pharmaceutical companies, that is an exchange of ownership rights of a good. Using the definitions above, such a transaction would be considered e-commerce, not e-business. However, the above scenario also involves the order of new materials to aid in the production of goods (e.g., filling prescriptions), which would fall under the definition of e-business. So, is there any real difference between the two?

Perhaps an easier way to define the difference might be to examine the *recipient* of the transaction. In the above example, one business is ordering goods from another business; that is, *business to business* or B2B. The pharmacy needs to purchase the raw materials (large quantities of medicine) in order to provide a finished product (filled prescriptions, packages of cold medicine) to the consumer. Therefore, the transaction between the two businesses (from one to the other) seems best to fall under the **e-business** category. However, the purchase of a song from iTunes is the transaction between the business (record company) and you (consumer), or *business to consumer* (B2C). Because so many transactions between businesses and consumers are retail based (a business selling a finished product to a consumer), it is perhaps best to view transactions to consumers as **e-commerce**.

Even with the clarification above, one can see that e-commerce can very easily be classified as a subset of e-business. The U.S. federal government defines both that way, and its figures offer support for those definitions. Revised figures from 2007 show that e-commerce accounted for 3.4% of all commerce in that year; that is up from 2.9% from 2006 (Scheleur *et al.*, 2008). In larger numbers, e-commerce transactions in 2007 grew by 19% over the previous year, while total retail in the United States (both e-commerce and face-to-face) grew by only 4%. Basically, that means that electronic commerce growth is outpacing traditional commerce, although it is still a minor part of the economic equation.

Those figures do not include the third set of e-business transactions: those conducted from *consumer to consumer*, or C2C. One glance at online auction site eBay's 2008 revenue report shows the popularity of people selling to one another. eBay reported revenue of more than \$2.1 billion in 2007, a 29% jump in revenue from the year before (eBay, 2008). Sites such as eBay and Craigslist, as well as more complete and searchable online classified sections of newspapers and magazines, are becoming more and more popular. It is estimated that two-thirds of online Americans have purchased something on the Internet, and that on any given day, 2% of online users are trying to sell something online (Horrigan, 2008; Lenhart, 2005). So, now that we have some idea of what e-commerce is, it is worthwhile at this point to discuss the factors involved in its growth and development, and how e-commerce is set up to have a powerful impact on society.

Recent Developments

Many of the developments in communication technology commerce have centered around providing more *content* and *services* to the consumer, rather than just products, and making it more *convenient* for the con-

sumer to access content, services, and products. The following sections will outline some of the ways that these three areas have grown in recent months. First, an overview.

Online Purchasing

General purchasing online in the United States grew from 2006 to 2007, with clothing, computers, and automobiles leading the way (Brennan, 2008). While some of the main stalwarts continued to succeed (i.e., Amazon.com, eBay, Apple iTunes), the landscape became more and more crowded by other online services. In early 2008, MySpace reached agreements with some of the largest music producing companies to start selling music to its members (Reuters, 2008; Snider, 2008).

While eBay did report growth during both 2006 and 2007 (eBay, 2008), the auction giant did face its share of challenges, both from competitors and from users. Amazon.com, which has traditionally focused on selling retail goods, more than doubled its income from 2006 to 2007 (Amazon.com, 2008). Its auction site has been growing each year and has recently seen some defections from loyal eBay sellers who were upset about an increase in listing fees (Swartz, 2008). Online classified site Craigslist also challenged the auction giant, even though eBay owns one-fourth of the Craigslist stock through a 2004 purchase (Craigslist, 2007). The challenge came from Craigslist's more personal feel and connection among users (Swartz, 2008).

Content

The recent popularity of user generated videos and music has been part of an overall growth in the purchase of content online. In 2007, legal downloading of music accounted for almost 10% of the music sold in the United States; in addition, Apple's iTunes store became the largest seller of music in the United States, passing Best Buy in late 2007 and Wal-Mart in early 2008 (NPD Group, 2008). Apple, however, faces competition from Amazon.com, which launched its own music store in late 2007 (Sandoval, 2008). However, even though Amazon has attracted customers to its store (and slipped past Wal-Mart to become the second largest digital store), its sales are less than 10% of Apple's (NPD Group, 2008; Sandoval, 2008).

Rentals of videos online have recently increased as well, and not just through cable and satellite companies and their "on demand" services. Netflix—the mail order movie company—saw continued growth from 2003 through early 2008 (Netflix, 2008); its chief competitor, Blockbuster, bounced between profits and losses during the same time period (Blockbuster, 2008).

Table 20.1
Blockbuster/Netflix Revenues

Year	Blockbuster		Netflix	
	Revenue	Income	Revenue	Income
2007	5.54 Billion	-85.1 M	1.2 B	67 M
2006	5.52 Billion	39.2 M	996 M	49 M
2005	5.86 Billion	-588.1 M	682 M	42 M
2004	6.05 Billion	-1.25 B	272 M	20.8 M

Source: Blockbuster Investor Relations, Netflix Investor Relations

The overall growth of commerce on the Internet continued despite, or because of, competition. eBay's PayPal service generated close to \$2 billion in revenue for the company, helping to offset some lower profits. PayPal began asserting itself as the dominant online payment method (eBay, 2008; Swartz, 2008). However, it began to face growing competition from Google. The search engine giant continued to expand into other areas, pushing its own payment service, Google Checkout. While not as popular as PayPal, Checkout offered discounts on its popular AdWords service as an enticement for merchants to use the service (Munoz, 2007).

While these are not the only payment options on the Web, they are examples of how the larger companies started to branch out and look for opportunities to work with other brands. It also provides a segue into the next large growth area in e-commerce over the past few years: the growth in services.

Services

While eBay relied heavily on PayPal, it also branched out into other areas, purchasing the ticket site StubHub and the Internet phone provider, Skype. eBay touted the acquisitions as allowing the company to extend its foundational services even further, perhaps even sending payments using Skype in some cases. At the very minimum, it allows eBay users to communicate with one another (Swartz, 2008).

The purchase of StubHub.com, a clearinghouse for ticket sales, provided more integration opportunities for eBay. StubHub serves as an “eBay” for tickets to concerts, sporting events, and other large events. The idea is to centralize that portion of the C2C market—if it is really C2C. In late 2007 and early 2008, StubHub became the center of what some would call the “Hannah Montana effect.” Tween star Miley Cyrus stars in Disney Channel's Hannah Montana television show, about a middle school girl who is a major rock star at night. The show has become “life imitates art,” as Hannah Montana became one of the largest concert draws of 2007, depending on the data source. *Billboard* magazine, which charts the music industry, did not even have Hannah Montana in the top 10 for 2007 (Waddell, 2007). However, StubHub had the concert tour as its highest grossing ever (Reuters, 2007). So, what explains the difference?

StubHub tabulated the secondary ticket sales market, which calculates things differently: prices for secondary market sales are not likely to be at the same prices as regular outlets. StubHub sales of the tickets came from companies that used automated systems to purchase the tickets as soon as they went on sale. In the case of Hannah Montana/Miley Cyrus, parents were forced to shell out more money than face value to make sure their children had the chance to see their favorite star.

For its part, Amazon grew its business services, launching data-housing services for small European businesses and providing software assistance, much as the company has done for businesses in the United States (Amazon.com, 2008). By helping businesses grow on the main Amazon.com site, the company expects to diversify its services, providing for future revenue growth.

Convenience

In most cases, convenience in e-commerce relates to the *delivery* of the product. In the case of content and services, the delivery can take place over different devices and different channels. Netflix and Blockbuster's online services allow for users to order movies over the Internet and receive hard copy DVDs at home. However, Netflix and other services started offering online “rentals” of movies; essentially, the movie is streamed to your computer and is available only for a limited time, “self-destructing” after the time for the rental has

passed. Apple moved quickly into the picture, promising 1,000 movie titles by the end of February 2008. By early April 2008, Apple had secured rights to rent about half that number (Morphy, 2008).

There are other devices beside computers. Smart phone sales in the United States rose dramatically in 2007; the introduction of Apple's iPhone was just one of the bright spots for the smart phone industry (Reardon, 2007). Because smart phone users also usually spend money on data plans to access information on the Web, they are also likely to download content on the mobile Web as well. Nokia entered into agreements with both Universal and Sony BMG to offer music free to purchasers of certain Nokia phones. The lure was that people would buy the phones and plans from the carriers to get the free music (Pfanner, 2007).

Other Issues

Mobile commerce growth. As noted above, the convenience of delivery to a handset is one that has become more of a factor in e-commerce. Mobile communication companies are offering more services to their customers such as GPS (global positioning system) mapping services and local information. Apple combined its hugely popular iPhone and new iPod touch models and its iTunes store, along with partnerships with Starbucks, to allow owners of those handsets to download songs from the Wi-Fi iTunes store (TidBITS, 2008). However, the m-commerce market in the United States has been slow to take off compared with other countries. Most believe the slow start centers around competing standards from U.S. companies as well as a reluctance on the part of U.S. consumers to transmit personal information over their cell phone lines (Burger, 2007a, 2007b) (see Chapter 17). As an example, banking through mobile handsets got off to a slow start in the United States in 2006/2007, but has been gaining in popularity since (AiteGroup, 2008; Associated Press, 2008).

While mobile commerce is slow to pick up in the United States, it is flourishing in other parts of the world. Asian markets such as Japan and South Korea, along with other countries in Europe, have been using their handsets as "mobile wallets" for some time (Verisign, 2007). Commuters in the United Kingdom have been using their phones as rail tickets, thanks to an SMS bar code they purchased through their handsets (Chiltern Railways, 2007); and some McDonald's stores in Japan have been taking payments through mobile handsets (Burgers paid, 2007). In the United States, Major League Baseball and Mobiqua are working together on a barcode ticketing service. Teams participating include the Oakland Athletics and the Pittsburgh Pirates (Mobiqua, n.d.).

Banking online overall has continued to grow, but a recent Pew report notes that online security continues to be a concern among online bankers; that concern has helped slow the adoption of mobile handset banking in the United States (Horrigan, 2008). Advertising has taken on newer forms, such as shorter ads in front of videos on Web sites, as well as more advertising *around* content, such as user generated videos on YouTube (owned by Google) and others.

The tax man cometh—or does he? Whether the money is "changing hands" over traditional Internet or mobile connections, it is likely that taxes are not being paid, at least in the United States. With the exception of airline tickets, there is very little mandate for tax collection through Internet sales (Hansell, 2008). Two bills had been working their way through the U.S. Congress, but as of mid 2008, neither had been addressed by its full house membership. The concern comes from the increasing amount of goods and services being sold over the Internet and other electronic means, but with little of the standard sales tax going to the states (Broache, 2008a). States have not been collecting taxes because of a 1992 Supreme Court ruling in *Quill v. North Dakota*. The Court ruled that businesses that do not have a "nexus"—meaning a storefront, office, or even a

sales person—in the state where they are selling cannot be forced to collect and pay sales tax on the goods they sell. So, if you are in North Carolina and purchase something from “Levenger.com,” which does not have an office in North Carolina, technically Levenger is not obligated to collect the North Carolina tax from you and pay it to the state of North Carolina. Two things have led to changes on the taxation front:

- 1) The obvious increase in sales of products and services through electronic commerce.
- 2) The economic downturn in the United States in 2007 and early 2008.

States are not getting as much revenue as they had been from sales and property taxes; as a result, they are looking for more revenue streams (Broache, 2008b). While *Quill v. North Dakota* still governs much of the law on that front, states have been working “within the system.” In late 2007, the state of New York passed a measure that would require any online retailer with “affiliates” located in its state to collect sales tax on purchases by New York residents. Should other states follow suit, it could lead to major changes in how taxes are collected through e-commerce. For example, Amazon.com has thousands of “affiliates” to whom it pays a commission for linking to products for sale on Amazon’s Web site. If any of those “affiliates” are in New York state, that means that Amazon would have to collect sales tax on any purchases from New York residents (Broache, 2008b). Critics say that any taxation plan, either New York’s or the voluntary Steamlined Sales Tax and Use Agreement (designed to simplify tax codes and make them uniform; 22 states have signed on as of mid-2008) would cripple commerce over the Internet. Supporters of change point to the travel industry, which continues to thrive online (Broache, 2008a; Hansell, 2008).

Current Status

The current status of electronic commerce is one of stability and continued growth, as well as prominence in the general economy. The box below shows the top 20 U.S. companies in terms of market capitalization that are traded on the New York Stock Exchange as of April 25, 2008. Naturally, those numbers will change with any given day of trading, but it is important to note the companies that are in the top 20 as a way of understanding how much we use communication technology and how it is valued by investors. Notice that, in 2008, Microsoft and Google were in the top 10—two software giants that are looking to diversify. Google continues to make inroads into other forms of communication (cell phones with Android, location based services with Google Mobile, and Google maps). Microsoft, for its part, courted fellow online giant Yahoo with a takeover in 2007 and 2008, presumably to shore up its position to challenge Google in the search engine (and likely advertising) arena (Fried, 2008).

What impact could that have on the overall e-commerce picture? Take a look at Table 20.2, which shows the previously mentioned increase in e-commerce retail sales in the United States. Other studies have shown that online users often research products on the Internet before they purchase them, and this research usually involves using a search engine (Horrigan, 2008).

As previously mentioned, MySpace has partnered with other music producers to create an online environment for its users to enjoy music through its site. There is more broadband penetration in the United States and more outlets of content offering products to consumers in more places, more quickly. Blockbuster and Netflix, the two top movie rental services, have been considering set-top boxes so that customers can download their content directly to their televisions (Chen, 2008). The idea is that they would then compete

directly with Apple TV, the set-top box directly tied to Apple's successful iTunes store, as well as on-demand services from cable and satellite companies.

1. Exxon Mobil	11. Bank of America
2. General Electric	12. International Business Machines
3. Microsoft	13. JPMorgan Chase
4. AT&T	14. Cisco Systems
5. Wal-Mart Stores	15. Apple Inc.
6. Proctor and Gamble	16. Citigroup Inc.
7. Berkshire Hathaway	17. Pfizer Inc.
8. Chevron	18. Coca-Cola
9. Johnson and Johnson	19. ConocoPhillips
10. Google, Inc.	20. Intel Corporation

* Companies in bold are primarily media/communication hardware/software companies.

Table 20.2
Growth of E-Commerce, 2007 by Quarter

Quarter	Percent of Total Retail	Percent Change from Previous Quarter		Percent Change from One year Ago	
		Total	E-commerce	Total	E-Commerce
4th 2007	3.5	0.9	4.6	4.7	18.0
3rd 2007	3.4	0.9	3.6	3.9	19.2
2nd 2007	3.3	1.1	5.9	3.7	20.2
1st 2007	3.2	1.6	2.9	3.4	18.8
4th 2006	3.1	0.2	5.6	4.9	24.1

Source: U.S. Census Bureau; Department of Commerce

Factors to Watch

Because of the rapid changes in communication technology hardware, much of what is to come for e-commerce may hinge on how we communicate, as changes are coming quickly. Because of that, many of the factors to watch are similar to the issues that face e-commerce today. For the purposes of our discussion, we will break them down into three specific areas: m-commerce, users, and advertising.

M-Commerce

Because mobile telephones are really becoming mobile computing handsets (music/video players, organizers, Web browsers), m-commerce should continue to grow throughout the world. Mobile banking is expected to attract more users who are comfortable with security in a mobile world. Both eBay's PayPal and Google's Checkout, which are battling it out in the "desktop" e-commerce world, have mobile applications that allow consumers to make payments via mobile devices (Laptevsky, 2008). How that battle plays out could determine the viability of m-commerce with U.S. consumers. Recall that Google has already entered the mobile market

with its open source “Android” system. As more “smart phone” handsets are bought by consumers, their features will become more integrated into users’ lives.

In order for m-commerce to become more integrated and accepted in the U.S. economic culture, it is likely that m-commerce companies will have to rely on branding. Amazon’s entry into the SMS (short message service) sales arena is a good example of a company relying on its reputation to start something new (Regan, 2008). Other companies may either be purchased by the larger ones (as eBay did with Skype), or partner with them in order to gain a foothold. News Over Wireless, a company that sends local news and weather video to mobile handsets, signed a deal in 2008 with Verizon Wireless to be part of its V CAST service (Dickson, 2008). The deal allows News Over Wireless to grow its customer exposure, while, at the same time, making money through its agreement with Verizon to supply content (it was already supplying video to Sprint). MySpace.com and its music channel, as well as eBay and its various holdings (StubHub, Skype, PayPal, and PayPal Mobile), are other examples of how companies are reaching out to capitalize on their reputations for new ventures, many of them in the m-commerce arena.

Advertising

Whether it is mobile or “traditional” e-commerce, sales will continue to be driven by advertising. Marketers have recognized the popularity of Web video and are likely to focus larger portions of their budgets to producing videos that resonate with the consumer (Liebermann, 2008). Those videos are likely to be part of, or associated with, Web sites from third parties. Google’s AdSense and AdWords programs will allow businesses to find those consumers who are likely to purchase their product and target them specifically. Just how targeted should those ads be? The National Advertising Initiative published new guidelines in 2008, hoping to offer help to its subscribers (McCarthy, 2008). Questions centered around whether ethnicity was too sensitive of a topic to use for targeted advertising; yet the Hispanic market is rapidly growing in the United States, and advertisers of all kinds want to reach those consumers.

The day is coming when ads will not only be sent to your computer when you browse the Internet, but sent to your phone when you browse the store. New GPS chips in phones are making it possible for stores to track specific shopper profiles through their “bricks-and-mortar” stores. Imagine walking through the mall, approaching your favorite store, when a text or video message comes to your handset telling you of a sale at that store (Medford, 2008). New technology already allows you to find out information on your favorite DVD or DVR (digital video recorder) program; soon, it will be very common to click on an item in a scene, find information about it, and purchase it on the spot, right on your television (Gopaluni, et al., 2006).

Users

Ultimately, it is up to you, the user, to determine just how much e-commerce you will actually be willing to accept. Users are starting to get frustrated. A recent Pew Internet study noted that users are getting concerned about the connectivity in their lives. Almost 50% of those who responded noted that they use communication technology sparingly, and only because they have to (Horrikan, 2007). Only about 10% said that they enjoyed using communication technology and all its features. That means that the more we have at our fingertips, the more troubling and cumbersome it can become—we are always “on.”

From a global perspective, new segments of the world’s populations are coming online. In early 2008, China became the top country in the world in terms of the number of Internet users, beating out the United States (MacLeod, 2008). While the United States still has a higher percentage of its population online, it is

clear that, in 2008, China is ready to join the world e-economy on a grand scale. Citizens in previously connected countries are finding that they are facing many of the same frustrations as those in the United States (D'Haenens, et al., 2007; Daliot-Bul, 2007; Fox & Livingston, 2007).

In summary, the economic aspect of communication technology—the business conducted *over* interactive communication technology—continues to grow and change just as the hardware and software does. While the above issues may indeed become part of the future landscape of e-commerce, perhaps the most telling day will be when there is no “e” in front of the term; rather, it is just the way we do business.

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Broadband & Home Networks

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Think of all the things people enjoy doing on the Internet: playing games, watching videos, trading photographs, talking on the phone, and surfing the Web. Think of how we use the Internet everyday: work, commerce, entertainment, etc. A speedy Internet connection allows these activities to operate smoothly, have more complexity and features, and just be more enjoyable. A broadband network allows Internet users to access services and content over the Internet at fast speeds. What does it mean to have "broadband?" The Federal Communications Commission (FCC) defined broadband as a network with speeds over 200 Kb/s (kilobits per second) until March 2008, when they finally changed the definition to speeds above 768 Kb/s (FCC, n.d.; Broache, 2008). In reality, today's broadband Internet users enjoy speeds ranging from 1.5 Mb/s (Megabits per second) to over 100 Mb/s. Having a broadband Internet connection opens users up to a variety of advanced services such as VoIP (voice over Internet protocol) and IPTV (Internet protocol television). In addition, the broadband Internet connection is an always-on, fast information access and sharing tool. Many of the new activities discussed in this book would not be possible without a broadband network. For example, the explosion of user generated content and online gaming would not be what it is now without broadband.

Once you have broadband Internet access, then the question becomes how to best use that resource. Home networking technologies allow users to take advantage of that broadband connection, with several computers using the same broadband connection at the same time. The home network allows for resource sharing such as sharing a printer. It also allows users to move digital content throughout the home. For example, with a home network, you can move video from your PC to your television or move music files from a digital audio player to a home receiver.

One of the primary drivers behind home networking is the increase in broadband access to the home. As of 2007, over half of U.S. homes have broadband with an average speed of 4.8 Mb/s (OCED, 2008). Other groups put that number higher, even up to 81.8% (OECD broadband, 2007)! Measuring broadband in the United States is difficult in part because the official U.S. government definition is only 768 Kb/s, while the

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International Telecommunications Union defines broadband at 1.5 Mb/s to 2.0 Mb/s (ITU, 2003). Nonetheless, broadband Internet access has grown tremendously, reaching the 50% penetration level in only 10 years (Horri-gan & Smith, 2007). Ironically, the key attribute for home networking of these broadband services is not the speed, but the fact that the connection is always on. Once a broadband user becomes accustomed to instant access, without spending any time to dial up or connect, the utility of having this access available to all com-puters in the home becomes even more salient.

The key device in most home networks is a residential gateway, sometimes known as a router. These are devices that interconnect all of the computers and other devices that use IP (Internet protocol) data streams to create the home network, in turn connecting the network to the outside broadband connection and allowing different streams of information to be routed intelligently throughout the home. The capability of routing any type of data stream to set-top boxes, telephones, and other devices will eventually allow audio, video, and tele-phone signals to be distributed throughout the home in the same manner as computer data streams are routed.

This chapter briefly reviews the development of broadband and home networks and residential gateways, discusses the types and uses of these technologies, and examines the current status and future developments of these exciting technologies.

Background

Broadband networks can use a number of different technologies to deliver service. These technologies in-clude digital subscriber line (DSL), cable, satellite, fiber-to-the-node (FTTN) or fiber-to-the-home (FTTH), fixed and mobile wireless, and broadband power line (BPL). Providers include telephone companies, cable operators, public utilities, and private corporations.

DSL

DSL stands for digital subscriber line. This technology supplies broadband Internet access over regular telephone lines, and service is provided by local exchange carriers such as Verizon, Qwest, and AT&T. There are several types of DSL available, but asymmetrical DSL (ADSL) is the most widely used for broadband Inter-net access. “Asymmetrical” refers to the fact that download speeds are faster than upload speeds. This is a common feature in most broadband Internet network technologies because the assumption is that people download more frequently than upload, and they download larger amounts of data. With DSL, the customer has a modem that connects to a phone jack. Data moves over the telephone network to the central office. At the central office, the telephone line is connected to a DSL access multiplexer (DSLAM). The DSLAM aggregates all of the data coming in from multiple lines and connects them to a high-bandwidth Internet connection.

One big advantage of DSL is that the connection to the central office is not shared, so the connection speed is not affected by other users. On the other hand, distance from the central office has an impact on the connection speed, because DSL is distance sensitive. The technology only works within 18,000 feet of the cen-tral office, and, the farther away from the central office, the slower the connection speed, although DSL extenders can increase the distance. ASDL typically offers download speeds up to 1.5 Mb/s and upload speeds from 64 Kb/s to 640 Kb/s. ADSL2 and ADSL2+ offer higher bandwidth, up to 12 Mb/s with ADSL2 and 24 Mb/s with ADSL2+. Prices vary from a low of \$19.95 per month for 768 Kb/s download to \$35 per month for up to 6 Mb/s with AT&T’s Yahoo DSL service (AT&T, n.d.).

FTTN

Very high bit-rate DSL (VDSL) is another form of DSL being employed by telephone companies to offer speeds up to 52 Mb/s downstream and 16 Mb/s upstream. VDSL is being used by Verizon's FiOS and AT&T's U-verse services, and the technology employs fiber-to-the-node. The fiber optic cable runs from the central office to a node in a neighborhood. The cable goes to a junction box in the neighborhood that contains a VDSL gateway that converts the digital signal on the fiber optic network to a signal that is carried on ordinary copper wires to the residence. Verizon's FiOS service offers speeds from 5 Mb/s downstream and 2 Mb/s upstream for 42.99 a month to 30 Mb/s downstream and 15 Mb/s upstream for \$139.95 per month (Verizon, 2008). AT&T's U-verse begins with the express service with 1.5 Mb/s down and 1 Mb/s up to the maximum service of 10 Mb/s down and 1.5 Mb/s up (U-verse, n.d.). Prices for DSL services are usually lower when bundled with other services.

FTTH

Fiber-to-the-home employs fiber optic networks all the way to the home. Fiber optic cables have the advantage of being extremely fast and are the backbone of both cable and telecommunications networks. Extending these networks to the home is rare, as costs are incredibly high—connection costs per home run about \$1,000. Recently, though, discussions of FTTH have come to include FTTN services such as FiOS. As of mid-2008, FTTH/FTTN connections were deployed in over 2.91 million homes according to the Fiber to the Home Council (Fiber-to, n.d.) with up to 100 Mb/s speeds.

Cable Television

With the upgrade to hybrid fiber/coaxial cable networks, cable television operators began offering broadband Internet access over cable. They can do this because it is possible to fit the download data into the 6 MHz space of a channel and the upload data into about 2 MHz. The home user connects to the Internet with a cable modem that is attached to the coaxial cable in the home. This cable, then, is connected to the cable node in the neighborhood. Then the data travels to the cable headend to the cable modem termination system (CMTS), which works like the DSLAM: it aggregates all the data flowing in and out and connects it to a high-capacity connection to the Internet.

Cable modems use a standard called DOCSIS, which were used with first-generation hybrid fiber/coax networks, and DOCSIS 2.0 raised that bandwidth to up to 30 Mb/s (Berquist, 2006). DOCSIS 3.0 brings that number up to 160 Mb/s (CableLabs, n.d.). The disadvantage of cable broadband is that, unlike DSL, the user shares the bandwidth with other cable Internet users in the neighborhood so, depending on who is using the Internet and what they are doing, the speed could be affected. For example, my neighbors on one side only use e-mail, but my neighbor on the other side downloads movies and another one plays role-playing video games. My movie and video game loving neighbors slow the connection down.

Cable Internet services range from about \$43 per month for a service with 6 Mb/s download to up to \$150 for Comcast's new 50 Mb/s service (Comcast moves, 2008). Prices for cable broadband service are usually lower when bundled with other services. Comcast is the number one cable broadband provider with 14.1 million customers as of the first quarter of 2008 (Comcast moves, 2008).

Satellite

For those people who live out of DSL's reach and in rural areas without cable, satellite broadband Internet access is an option. With this service, a modem is connected to a small satellite dish which then communicates with the service providers' satellite. That satellite, in turn, directs the data to a provider center that has a high-capacity connection to the Internet. Satellite Internet service cannot deliver the bandwidth of cable or DSL, but speeds are a great improvement over dial-up. For example, HughesNet offers home service with 700 Kb/s download and 128 Kb/s upload for \$59.99 a month. Its highest speed service for the residential market, Pro-Plus, offers 1.5 Mb/s download and 200 Kb/s upload for \$79.99 a month. These numbers do not include the cost of installation and equipment, which runs around \$500 (HughesNet, 2008).

The two most popular satellite services are HughesNet and Wild Blue. HughesNet uses three DBS satellites on the high-power Ku band, while Wild Blue uses the Ka-band and 31 spot beams connecting to five gateways in the United States and Canada (Wild Blue, n.d.). Both services offer download speeds up to 1.5 Mb/s. Starband is another high-power Ku band service. The service is expensive, with services starting at \$89.99 a month and equipment costs of \$600, not including installation (Starband, n.d.).

Wireless

There are two different types of wireless broadband networks: mobile and fixed. Mobile broadband networks are offered by wireless telephony companies and employ 3G networks. Examples of these services include Verizon's Broadband Access and Sprint's Mobile Broadband Service which both use the EVDO standard and AT&T's BroadbandConnect which uses the slower EDGE standard (although the network is being upgraded to HSPA). Users can access these networks using a laptop card. For more on these networks, see Chapter 17.

Fixed broadband wireless networks use either Wi-Fi or WiMAX. Wi-Fi uses a group of standards in the IEEE 802.11 group to provide wireless Internet access to a range of mobile and fixed devices such as laptops, cell phones, and PDAs (personal data assistants). Wi-Fi hotspots are available for free and fee throughout the United States in public and private spaces ranging from coffee shops to city parks. In 2005, some big announcements about municipal Wi-Fi were made, as cities like Philadelphia and San Francisco announced plans to offer citywide free Wi-Fi. By 2008, most cities had dropped plans for these networks, and technology companies pulled out citing lack of potential revenue (Urbina, 2007).

WiMAX, which stands for worldwide interoperability for wireless access, is also known as IEEE 802.16. There are two versions: a fixed point-to-multipoint version and a mobile version. Unlike Wi-Fi which has a range of 120 to 300 feet, one WiMAX tower can cover up to 30 miles, although realistically the coverage is more around four to six miles (WiMAX.org, n.d.). Clearwire provides WiMAX service in selected locations throughout the United States including the home of this author, Chico (California). Clearwire customers get a WiMAX PC card that can be used at home and on the road as long as they are within range of a tower. Residential service is \$49.99 a month for speeds up to 1.5 Mb/s download (Clearwire, n.d.). For more on Wi-Fi and WiMAX, see Chapter 19.

BPL

Broadband over power line uses the medium voltage (MV) and low voltage (LV) portions of the electrical grid to deliver broadband services. The modem is actually plugged into an electrical outlet. Manassas (Vir-

ginia) was the first city to deploy a BPL network in October 2005. The service offered speeds of 300 Kb/s to 800 Kb/s for \$28 a month (First large, 2005). DirecTV and Current Communications teamed up to offer BPL service in Cincinnati with a 519 Kb/s symmetrical for \$19.99 a month. 3 Mb/s costs \$39.95 (Bangeman, 2007b). PowerGrid Communications started a pilot BPL network in Baton Rouge and Austin in 2007 (PowerGrid, 2007). There were only an estimated 75,000 BPL subscribers in the United States as of the beginning of 2007 although forecasts predict (optimistically) 2.5 million by 2011 (Bangeman, 2008).

One issue with BPL is interference with certain radio frequencies. Ham radio operators say BPL causes buzzing interference, and the National Association of Broadcasters even had concerns about interference with television channels two through five (Bangeman, 2007a).

Home Networks

Computer networking was once thought to be exclusively the domain of the office or institution, not the home or public spaces. Those few homes that did have networks typically had a traditional Ethernet network that required an expensive type of wiring called Category 5 (Cat 5). Such a network needed a server, hub, and router. The network needed to be administered, requiring one household member to have computer network expertise. The installation and administration of these early home networks required a major allocation of time, money, and effort on the part of the user. Clearly, they were not for the average home computer user, because the user needed extensive computer and networking expertise, as well as a means of financing it.

Several factors changed the environment to allow home networks to take off: broadband Internet access, multiple computer households, and new networked consumer devices and services. Major uses for home networks include resource sharing, communication, home control, scheduling, and entertainment. Sharing one broadband connection and computer peripherals within the home is an example of resource sharing. Communication is enhanced when one computer user can send files to another computer in the house for review, or perhaps to send reminders. A family can keep a master household schedule that can be updated by each member from his or her computer. Home control includes being able to remotely monitor security systems, lighting, heating and cooling systems, etc. Being able to route digital video and audio to different players within the home are examples of entertainment. The residential gateway allows the home network to have these multiple functions.

Home Networking

There are four basic types of home networks:

- ♦ Traditional.
- ♦ Phone line.
- ♦ Power line.
- ♦ Wireless.

When discussing each type of home network, it is important to consider the transmission rate, or speed, of the network. Regular file sharing and low-bandwidth applications such as home control may require a speed of 1 Mb/s or less. The MPEG-2 digital video and audio from DBS services requires a speed of 3 Mb/s, DVD

(digital videodisc) requires between 3 Mb/s and 8 Mb/s, and compressed high-definition television (HDTV) requires around 20 Mb/s.

Traditional networks use Ethernet, which has a data transmission rate of 10 Mb/s to 100 Mb/s. There is also Gigabit Ethernet, used mostly in business, that has transmission speeds up to 1 Gb/s. Ethernet is the kind of networking commonly found in offices and universities. As discussed earlier, traditional Ethernet has not been popular for home networking because it is expensive to install and maintain, and difficult to use. To direct the data, the network must have a server, hub, and router. Each device on the network must be connected, and many computers and devices require add-on devices to enable them to work with Ethernet. Thus, despite the speed of this kind of network, its expense and complicated nature make it somewhat unpopular in the home networking market, except among those who build and maintain these networks at the office.

Many new housing developments come with structured wiring that includes wiring for home networks, home theatre systems, and other digital data networking services such as utility management and security. One of the popular features of structured wiring is home automation including the ability to unlock doors or adjust the temperature or lights. New homes represent a small fraction of the potential market for home networking services and equipment, so manufacturers have turned their attention to solutions for existing homes. These solutions almost always are based upon “no new wires” networking solutions that use existing phone lines or power lines, or they are wireless.

Phone lines are ideal for home networking. This technology uses the existing random tree wiring typically found in homes and runs over regular telephone wire—there is no need for Cat 5 wiring. The technology uses frequency division multiplexing (FDM) to allow data to travel through the phone line without interfering with regular telephone calls or DSL service. There is no interference because each service is assigned a different frequency. The Home Phone Line Networking Alliance (HomePNA) has presented three open standards for phone line networking. HomePNA 1.0 provided data transmission rates up to 1 Mb/s and was replaced by HomePNA (HPNA) 2.0, which allows data transmission rates up to 10 Mb/s and is backward-compatible with HPNA 1.0. HomePNA 3.1 provides data rates up to 320 Mb/s and operates over phone wires and coaxial cables, which makes it a solution to deliver video and data services. The standard is being shopped to IPTV and “triple play” service providers (HomePNA, 2008).

The developers of power line networking realized that all of the devices that a consumer might want to network are already plugged into the home’s electrical outlets. In addition, there are almost always power outlets in the rooms where a networked device would be placed. Why not network over these power lines? Because the power line networking industry was a few years behind its phone line and wireless competitors, many of the companies in this industry banded together to form the HomePlug Powerline Alliance in 2001 (Handley, 2002). HomePlug introduced their 1.0 specification in June 2001 (Gardner, et al., 2002). HomePlug introduced another standard that built upon HomePlug 1.0: HomePlug AV. This standard’s specification was released on August 18, 2005. The standard was designed to support entertainment applications, in particular, HDTV and VoIP. HomePlug AV offers speeds up to 200 Mb/s in the PHY layer and 100 Mb/s in the MAC layer. The standard is compatible with HomePlug 1.0. HomePlug also has a low-cost, low-power standard called HomePlug Command and Control for networking for home control, lighting, and utility management. It has a much slower speed than the other standards, and is for specific applications that only need a connection over short distances (HomePlug Powerline Alliance, n.d.).

The most popular type of home network is wireless. As of early 2008, there were several types of wireless home networking technologies: Wi-Fi (otherwise known as IEEE 802.11a, 802.11b, 802.11g, and 802.11n), Blue-

tooth, and wireless mesh technologies such as ZigBee and Z-wave. Wi-Fi, Bluetooth and ZigBee are based on the same premise: low-frequency radio signals from the instrumentation, science, and medical (ISM) bands of spectrum are used to transmit and receive data. The ISM bands, around 2.4 GHz, not licensed by the FCC, are used mostly for microwave ovens and cordless telephones (except for 802.11a, which operates at 5 GHz).

Wireless networks are configured with a receiver that is connected to the wired network or gateway at a fixed location. Transmitters are either within or attached to electronic devices. Much like cellular telephones, wireless networks use microcells to extend the connectivity range by overlapping to allow the user to roam without losing the connection (Wi-Fi Alliance, n.d.-b).

The most common standards for wireless networking fall under the umbrella moniker, 802.11. These standards each use a different one-letter suffix, e.g., 802.11b, 802.11a, 802.11g, and 802.11n. Wi-Fi was the consumer-friendly label attached to IEEE 802.11b, the specification for wireless Ethernet. It can transfer data up to 11 Mb/s and is supported by the Wi-Fi Alliance. Wi-Fi has been widely adopted worldwide for both enterprise and home markets. The inhibiting factors to adoption of Wi-Fi include limited bandwidth, radio interference, and security. Radio interference affects the network because the 2.4 GHz band used by Wi-Fi is home to a myriad of technologies including cordless phones, microwave ovens, and the competing but incompatible Bluetooth and ZigBee standards. At the same time as the 802.11b specification was released, the 802.11a specification was released as well. 802.11a operates within a higher frequency band, 5.4 GHz, using OFDM (orthogonal frequency division multiplexing). With data throughput up to 54 Mb/s, 802.11a clearly has a speed advantage over 802.11b's 11 Mb/s and does not have the radio frequency interference problems that come with operating at 2.4 GHz. Because it operates at a higher frequency, 802.11a works at shorter distances than 802.11b.

Because of consumer confusion, Wi-Fi has become the term used to refer to the entire 802.11 family of standards including 802.11a, 802.11b, 802.11g, and 802.11n (Wi-Fi Alliance, n.d.-a). Ratified in 2003, 802.11g is a high-speed wireless networking technology with transmission rates up to 54 Mb/s. The technology is backward-compatible with 802.11b and operates in the same 2.4 GHz spectrum. 802.11n has yet to be ratified by the IEEE as of April 2008 but products are available on the shelves. 802.11n has throughput speeds from 100 Mb/s to 140 Mb/s, and it can cover twice the area as 802.11b or g. One reason it can offer those advantages is because it uses multiple-input/multiple-output (MIMO) technology. This means the router moves data through multiple streams using multiple antennas (Haskin, 2007).

Because wireless networks use so much of their available bandwidth for coordination among the devices on the network, it is difficult to compare the rated speeds of these networks with the rated speeds of wired networks. For example, 802.11b is rated at 11 Mb/s, but the actual throughput (the amount of data that can be effectively transmitted) is only about 6 Mb/s. Similarly, 802.11g's rated speed of 54 Mb/s yields a data throughput of only about 25 Mb/s (802.11 wireless, 2004). Tests of 802.11n have confirmed speeds from 100 Mb/s to 140 Mb/s (Haskin, 2007).

Security is an issue with any network, and Wi-Fi uses two types of encryption; WEP (Wired Equivalent Privacy) and WPA (Wi-Fi Protected Access). WEP has security flaws and is easily hacked. WPA fixes those flaws in WEP and uses a 128-bit encryption (Wireless network security, n.d.). There are two versions: WPA-Personal that uses a password and WPA-Enterprise that uses a server to verify network users (Wi-Fi Alliance, n.d.-b). WPA2 is an upgrade to WPA and is now required of all Wi-Fi Alliance certified products (WPA2, n.d.).

While Wi-Fi can transmit data up to 140 Mb/s for up to 150 feet, Bluetooth was developed for short-range communication at a data rate of 1 Mb/s to 3 Mb/s. Bluetooth technology is built into devices, and Bluetooth-enhanced devices can communicate with each other and create an ad hoc network. The technology works with and enhances other networking technologies. Most of us know Bluetooth because of our mobile phones and computers. Hands-free Bluetooth mobile phone headsets and wireless keyboards and computer mice are popular accessories.

Zigbee is also known as IEEE 802.15.4 and is classified, along with Bluetooth, as a technology for wireless personal area networks (WPANs). ZigBee is low power, but it also has a low data rate making it good for ad hoc mesh networks for home security, home automation, and smart lighting (ZigBee, n.d.). Z-Wave is very similar to Zigbee in that it is a low-power, low-bandwidth technology for wireless mesh networks. Z-Wave is RF based and operates in the 900 MHz range. It is useful for lighting, security, health-care monitoring, and utility control (Z-Wave, n.d.; Castle, 2008). (For more on these wireless technologies, see Chapter 19.)

Usually, a home network will involve not just one of the technologies discussed above, but several. It is not unusual for a home network to be configured for HPNA, Wi-Fi, and even traditional Ethernet. Table 21.1 compares each of the home networking technologies discussed in this section

Residential Gateways

The residential gateway, also known as the broadband router, is what makes the home network infinitely more useful. This is the device that allows users on a home network to share access to their broadband connection. As broadband connections become more common, the one “pipe” coming into the home will most probably carry numerous services such as the Internet, phone, and entertainment. A residential gateway seamlessly connects the home network to a broadband network so all network devices in the home can be used at the same time.

The current definition of a residential gateway has its beginnings in a white paper developed by the RG Group, a consortium of companies and research groups interested in the residential gateway concept. The RG Group determined that the residential gateway is “a single, intelligent, standardized, and flexible network interface unit that receives communication signals from various external networks and delivers the signals to specific consumer devices through in-home networks” (Li, 1998). Residential gateways can be categorized as complete, home network only, and simple.

A **complete residential gateway** operates independent of a personal computer and contains a modem and networking software. This gateway can intelligently route incoming signals from the broadband connections to specific devices on the home network. Set-top box and broadband-centric are two categories of complete residential gateways. A broadband-centric residential gateway incorporates an independent digital modem such as a DSL modem with IP management and integrated HomePNA ports. Set-top box residential gateways use integrated IP management and routing with the processing power of the box. Complete residential gateways also include software to protect the home network, including a firewall, diagnostics, and security log.

Home network only residential gateways interface with existing DSL or cable modems in the home. These route incoming signals to specific devices on the home network, and typically contain the same types of software to protect the home network found in complete residential gateways.

Simple residential gateways are limited to routing and connectivity between properly configured devices. Also known as “dumb” residential gateways, these have limited processing power and applications, and only limited security for the home network.

Table 21.1
Comparison of Home Networking Technologies

	How it Works	Specifications & Standards	Transmission Rate	Reliability	Cost	Security
<i>Conventional Ethernet</i>	Uses Cat 5 wiring with a server and hub to direct traffic	IEEE 802.3xx IEEE 802.5	10 Mb/s to 1 Gb/s	High	High	Secure
<i>HomePNA</i>	Uses existing phone lines and OFDM	HPNA 1.0 HPNA 2.0 HPNA 3.0 HPNA 3.1	1.0, up to 1 Mb/s 2.0, 10 Mb/s 3.0, 128 Mb/s Up to 320 Mb/s	High H	Low	High
<i>IEEE 802.11a Wi-Fi</i>	Wireless. Uses electromagnetic radio signals to transmit between access point and users.	IEEE 802.11a 5 GHz	Up to 54 Mb/s	High	Moderate	High to Moderate
<i>IEEE 802.11b Wi-Fi</i>	Wireless. Uses electromagnetic radio signals to transmit between access point and users.	IEEE 802.11b 2.4 GHz	Up to 11 Mb/s	High	Low	High to Low
<i>IEEE 802.11g Wi-Fi</i>	Wireless. Same as 802.11b	IEEE 802.11g 2.4 GHz	Up to 54 Mb/s	High	Low	High to Low
<i>IEEE 802.11n Wi-Fi</i>	Wireless. Same as 802.11g	IEEE 802.11n	Up to 140 Mb/s	?	?	High to Low
<i>WiMAX</i>	Wireless. Uses electromagnetic radio signals to transmit between access point and users.	IEEE 802.16 Fixed IEEE 802.20 Mobile	Up to 75 Mb/s	High	High	Not yet determined
<i>Bluetooth</i>	Wireless.	Bluetooth V 1.0 2.4 GHz V 2.0 + EDR	1 Mb/s 3 Mb/s	High to Moderate	Low	High to Moderate
<i>Powerline</i>	Uses existing power lines in home.	HomePlug v1.0 HomePlug AV HPCC	Up to 14 Mb/s Up to 200 Mb/s low	Moderate	Moderate	High
<i>ZigBee</i>	Wireless. Uses Electromagnet radio signals to transmit between access point and users	IEEE 802.15.4	250 Kb/s	High	Low	High to Low
<i>Z-Wave</i>	Uses 908 MHz 2-Way RF	Proprietary	9.6Kbps	High	Low	Moderate

Source: J. Meadows

Working Together—The Home Network and Residential Gateway

A home network controlled by a residential gateway or central router allows multiple users to access a broadband connection at the same time. Household members do not have to compete for access to the Internet, printer, scanner, or even the telephone. The home network allows for shared access to printers and peripherals. Using appropriate software, household members can keep a common schedule, e-mail reminders to each other, share files, etc. The residential gateway or router allows multiple computers to access the Internet at the same time by giving each computer a “virtual” IP address, with the household only needing one external IP address. The residential gateway routes different signals to appropriate devices in the home. For example, Web pages are sent to the specific computer requesting them at the same time that entertainment signals in the form of radio, video, and games can be routed to a stereo, television, or digital video recorder (such as a TiVo unit) attached to the network.

Home networks and residential gateways are key to what industry pundits are calling the “smart home.” Although having a refrigerator that tells us we are out of milk may seem a bit over the top, utility management, security, and enhanced telephone services including VoIP are just a few of the potential applications of this technology. Before these applications can be implemented, however, two developments are necessary. First, appropriate devices for each application (appliance controls, security cameras, telephones, etc.) have to be configured to connect to one or more of the different home networking topologies (wireless, HPNA, or power line). Next, software, including user interfaces, control modules, etc., needs to be created and installed. It is easy to conceive of being able to go to a Web page for your home to adjust the air conditioner, turn on the lights, or monitor the security system, but these types of services will not be widely available until consumers have proven that they are willing to pay for them.

Recent Developments

Broadband Internet access and home networking continues to grow in popularity and capabilities. This growth has led to changes in standards, technology, and policy. What is clear, though, is that access to broadband networks remains a top priority, while what people do with those broadband networks is under increasing scrutiny by regulators and service providers as they deal with the increasing amount of bandwidth being used. One estimate reported in the *New York Times* said that, in 2007, YouTube used more bandwidth than the entire Internet used in 2000 (Lohr, 2008).

One way broadband providers are dealing with this issue is to build out FTTN/FTTH networks like Verizon's FiOS and AT&T's U-verse with download speeds up to 50 Mb/s and 10 Mb/s, respectively. Qwest offers a \$105 per month DSL service with 20 Mb/s downloads; 12 Mb/s is only \$52 a month (Fleishman, 2008).

The cable industry has responded with the creation of DOCSIS 3.0, which works over existing hybrid fiber/coax networks and supports speeds up to 160 Mb/s downstream and 120 Mb/s upstream (Lawler, 2006). All of the major cable MSOs (multiple system operators) including Comcast, Time Warner Cable, and Charter Communications plan to use or are using the standard. Comcast's regular Internet service can offer speeds up to 16 Mb/s; with DOCSIS 3.0, they will offer a 50 Mb/s package and hope to offer 100 Mb/s by 2010 (Kumar, 2008). Comcast made good on this promise when they began offering 50 Mb/s service in Minneapolis/St. Paul in April 2008. The service costs \$150 per month. Early adopters are expected to be heavy online gamers. Comcast hopes to offer this service to 20% of its subscribers by the end of 2008 (Spangler, 2008a). Verizon's 50 Mb/s

service costs \$140 per month unless you are from New York, where it is *only* \$90 (Comcast moves, 2008). To make this all possible, Comcast and Verizon are both testing a 100 gigabit per second optical network.

One wireless broadband development of note is that Sprint and Clearwire announced in May 2008 a \$14.5 billion joint venture to deploy wireless broadband using WiMAX. Sprint's wireless broadband unit will merge with Clearwire. Google, Comcast, and Time Warner Cable also have interests in the venture (Sharma & Kumar, 2008b).

Increasing the capacity and speed of networks is one way of handling the ever-increasing amounts of data passing through, but control is another method. The Associated Press reported in October 2007 that Comcast was blocking the traffic of subscribers using file sharing networks BitTorrent, eDonkey, and Gnutella. These services are used both for legal and illegal file sharing. BitTorrent, in particular, is used to quickly send out legal content like software upgrades. These services allow people to share large files because any computer on the network can upload or download a piece of a very large file, distributing the load across the network. Every user is thus a downloader and an uploader, so data transfers happen faster. What happened in the Comcast case was that computers downloading and uploading would get a message from the Comcast network to stop communicating during uploads. Comcast said it needed to manage this traffic because it caused network congestion. This argument is an important consideration because P2P (peer-to-peer) file sharing accounts for 50% to 90% of all Internet traffic (Svensson, 2007).

The revelation of Comcast's actions prompted the FCC to investigate with the conclusion that Comcast did indeed block certain traffic (Hearn, 2008a). Chairman Kevin Martin reported findings that:

- 1) Comcast customers could not do anything they wanted on the Internet.
- 2) The activity was not "content agnostic."
- 3) The technique was widely used, not used only occasionally to help with network traffic.
- 4) Comcast has no evidence that they will stop this approach (Hearn, 2008a).

In March 2008, Comcast and BitTorrent announced they are working together with an agreement where Comcast agrees to develop a capacity management technique that is "protocol agnostic," and BitTorrent will work on ways to manage the traffic of large data files (Comcast, BitTorrent, 2008). BitTorrent also acknowledged Comcast's right to manage their network capacity.

Comcast is not the only broadband service provider to interfere with P2P activities. Vuze, a P2P video distributor, found that AT&T, Cablevision, Charter Communications, Comcast, Cox Communications, Time Warner Cable, Quest Communications, and Verizon slow down BitTorrent file transfers (Spangler, 2008b).

Favoring one Internet service over another is related to the idea of net neutrality. Proponents of net neutrality argue that the Internet should be open to all services and that to allow Internet service providers to slow down the service of one company while favoring another is unfair and anticompetitive. Consider: you are an AT&T Yahoo DSL customer who wants to use Vonage's VoIP service instead of AT&T's service. Should AT&T be able to interfere with Vonage's service? The FCC actually punished Madison River Communications in North Carolina for blocking VoIP traffic in 2005. The FCC ruling stated that people have the right "to access the lawful Internet content of their choice, run applications and services of their choice, and plug in and run legal

devices of their choice" (Mark, 2008). The cable and telephone industries have argued that net neutrality should not be an issue, and any requirement for net neutrality (FCC policy, legislation) would only deter the advancement of broadband network deployment (Hearn, 2007). Representatives Markey (D-MA) and Pickering (R-MS) introduced the *Internet Freedom Preservation Act of 2008* that would take the FCC principles on net neutrality (as determined in the 2005 case noted above) and make them law. The bill (HR 5353) states "the policy of United States" is to maintain Internet freedom, which includes "the freedom to use for lawful purposes broadband telecommunications networks, including the Internet, without unreasonable interference from or discrimination by network operators..." The bill would also require the FCC to hold eight public meetings on net neutrality and report the findings to Congress (Hearn, 2008b).

While the cable and telephone companies have been successful with their broadband services, public Wi-Fi networks and BPL have not shown the success once touted. In February 2008, Earthlink announced that it was pulling out of its role in Philadelphia's much ballyhooed citywide Wi-Fi network. Similar pull outs are happening across the country (Urbina, 2008). Current Communications BPL service in Dallas is ending when the company sells its service to Oncor, which has no plans for BPL. This service was offered to DirecTV customers (Smith, 2008). BPL also took a hit in April 2008 when a U.S. Court of Appeals judge ruled that the FCC needs to rework its BPL regulations and release all BPL testing results. The American Radio Relay League filed the case, arguing that the FCC did not listen to their concerns about interference with HAM radio operation (Bangeman, 2008).

In home networking developments, HPNA released its 3.1 standard for phone line and coax networking. The standard and its compliant devices are being pitched for triple play services including HDTV, VoIP, video on demand (VOD), and broadband Internet (HomePNA, 2008). The ITU standardized HPNA 3.1 in January 2007. HomePlug has two newer standards: HomePlug AV which can be used to distribute large amounts of data like HDTV with speeds up to 200 Mb/s in the PHY layer and 100 Mb/s in the MAC layer. It is also backward-compatible with HomePlug 1.0 and works with HomePlug BPL (HomePlug, n.d.). There is also HomePlug Command and Control (HPCC), which uses low-cost, low-bandwidth networking solutions like ZigBee and Z-Wave for home appliance, lighting, and utility control.

In residential gateways, AT&T's U-verse service offers subscribers a residential gateway that has an 802.11g wireless router as well as Ethernet and a USB (universal serial bus) port for computers. It also allows networking of up to four televisions in the home and connects other personal digital devices such as printers and storage devices (AT&T U-verse Residential, n.d.).

The idea of the networked home seems to come up every year. While many of the networked devices of the past just did not seem that practical, the growth of broadband networks, mobile devices, and digital entertainment and information make the networked home seem more of a reality. John Chambers, CEO of Cisco, described a networked home where digital audio files would move smoothly from the car to the home and across multiple platforms including a digital audio player, cell phone, and television. Chambers argues that the killer application will be video (Reardon, 2007). Utility management may be another. Green products that help users manage energy use are arriving on the market. For example, D-Link has Green Ethernet technology that automatically detects link status and cable length and adjusts power usage; it will put unused ports in sleep mode (D-Link, 2008).

Current Status

The statistics on broadband penetration vary widely. The Organisation for Economic Co-operation and Development (OECD) keeps track of worldwide broadband penetration. According to the OECD, broadband subscribers increased 24% from 2006 to 2007, with 221 million subscribers as of June 2007. Overall penetration of broadband was 18.8 subscribers per 100 homes. Its 2007 report created a stir when it ranked the United States 15th in the world for broadband penetration with 22.1 subscribers per 100 inhabitants. The rankings are presented in Table 21.2. The United States has the largest number of broadband subscribers with 66.2 million. Fiber connections were most numerous in Japan and South Korea with 36% and 31%, respectively.

Table 21.2
Broadband Subscribers per 100 Inhabitants, by
Technology, June 2007

	Rank	DSL	Cable	Fiber/LAN	Other	Total	Total Subs
Denmark	1	21.3	9.7	2.9	0.4	34.3	1,866,306
Netherlands	2	20.4	12.7	.04	0.0	33.5	5,470,000
Switzerland	3	20.5	9.3	0.0	0.9	30.7	2,322,577
South Korea	4	10.1	10.6	9.2	0.0	29.9	14,441,687
Norway	5	22.7	4.5	1.8	0.7	29.8	1,388,047
Iceland	6	29	0.0	0.2	0.6	29.8	90,622
Finland	7	24.4	3.7	0.0	0.8	28.8	1,518,900
Sweden	8	17.9	5.6	4.6	0.4	28.6	2,596,000
Canada	9	11.9	12.9	0.0	0.1	25	8,142,320
Belgium	10	14.5	9.2	0.0	0.1	23.8	2,512,884
U.K.	11	18.4	5.3	0.0	0.0	23.7	14,361,816
Australia	12	18.3	3.4	0.0	0.9	22.7	4,700,200
France	13	21.4	1.1	0.0	0.0	22.5	14,250,000
Luxembourg	14	19.8	2.4	0.0	0.0	22.2	105,134
United States	15	9.3	11.5	0.6	0.7	22.1	66,213,257
Japan	16	10.8	2.9	7.6	0.0	21.3	27,152,349
Germany	17	20.2	1.0	0.0	0.1	21.2	17,472,000
Austria	18	11.4	6.6	0.0	0.6	18.6	1,543,518
Spain	19	13.3	3.6	0.0	0.1	17	7,483,790
New Zealand	20	14.6	1.1	0.0	0.8	16.5	683,500

Source: OECD (2007)

The U.S. government disputed this ranking, and their arguments point to the difficulty in presenting this kind of data. First, these numbers are by individual, not household. Second, the OECD defines broadband as

having speeds greater than 256 Kb/s, while the FCC definition was, at that time, 200 Kb/s. The release of the OECD rankings was questioned by other agencies across the world. In *Networked Nation: Broadband In America 2007*, the NTIA reports, using data from the U.S. Census, that home broadband penetration was 50.8% as of October 2007. The NTIA reports states that, at the end of 2006, DSL had 22.8 million subscribers, cable had 29 million subscribers, and satellite had 700,000 subscribers (NTIA, 2008). In yet another study Leichtman Group reported that 57% of American homes had broadband (OECD broadband, 2007).

The Pew Internet and American Life Project found that 47% of American adults have broadband at home; 23% of Americans who have Internet access from home still use dial-up. Broadband penetration is highest among those 18 to 29, those with college degrees, and those with an income over \$75,000 per year. See Table 21.3 for a summary of these results (Horrigan & Smith, 2007).

Table 21.3

Trends in U.S. Broadband “At Home” Adoption

	% 2005	% 2006	% 2007
All adults	30	42	47
Male	31	45	50
Female	27	38	44
18-29 years old	38	55	63
30-49 years old	36	50	59
50-64 years old	27	38	40
65+ years old	8	13	15
Less than high school	10	17	21
High school grad	20	31	34
Some college	35	47	58
College +	47	62	70
Under \$30K	15	21	30
\$30K-50K	27	43	46
\$50K-75K	35	48	58
Over \$75K	57	68	76

Source: Horrigan & Smith (2007)

The top Internet service provider (ISP) in the United States as of early 2008 is AT&T, with 18.3 million subscribers and 18.6% of the market. It is followed by Comcast with 13.2 million subscribers and 13.5% of the market. AOL, Verizon, and Time Warner make up the rest of the top five (Goldman, 2008). While BPL did not fare too well in 2007 and 2008, some forecasts predict it will grow to 2.5 million households by 2011. Parks Associates' research forecasts that BPL residential subscribers should grow from .4 million in 2007 to .8 million in 2008, 1 million in 2009, 2 million by 2010, and finally 2.5 million in 2011 (Parks Associates, 2007). These predictions may be optimistic because this growth does not mirror what has actually happened in the marketplace thus far.

As far as home networking goes, penetration has not changed much over the past few years, with 30% of U.S. households with home networks (CEA, 2008). Parks Associates reported that 35 million homes have data networks as of the end of 2007 (CEA, 2008). Home networking worldwide is growing, with significant year-by-year growth in Asia-Pacific, Europe, and North America. Parks Associates has predicted that home networking penetration will grow by 50% worldwide from 2006 to 2008. 114 million households worldwide had home networking at the end of 2006. This number should grow to 170 million by the end of this year. Europe's growth is tied to service provider-deployed residential gateways. Eleven million homes in Europe had a residential gateway in 2007; that number should grow to 16 million by the end of 2008 (Parks Associates, 2008).

Closer to home, bundled services that work over a broadband connection are predicted to grow. Once you have broadband, then it is time to find ways to use it. One prediction from Parks Associates is that, by 2010, there will be more than 80 million broadband households, 65 million bundled-services subscribers, 30 million bundled-VoIP subscribers, and 6.5 million IPTV subscribers. Sales of network storage devices will grow, and networked entertainment households should grow to 30 million (Scherf, 2007).

Factors to Watch

Broadband

Probably the biggest issue to watch in broadband is net neutrality. With a new bill introduced in early 2008 and congressional hearings in May 2008, it will be interesting to see what the outcome will be. Past attempts at net neutrality legislation have failed. ISPs generally argue against net neutrality, while the providers of Internet-based services argue for it. What is in the best interest of the user? It is hoped that will be of the utmost concern of the legislators and policy makers in Washington.

Faster download and upload speeds are coming, and they are coming for less money. Right now, the FTTN/FTTH services and new DOCSIS 3.0 services will cost a user around \$150 per month. That price will probably limit adoption to heavy Internet users like MMORPG players. As new services that use a lot of bandwidth such as streamed HDTV proliferate, users will begin to see the utility of download speeds in excess of 50 Mb/s. As competition grows in the broadband market, prices should decline. Perhaps the bigger issue is availability. For example, AT&T's U-verse and Verizon's FiOS services are not widely available yet, and concern has been made for their provision in lower income residential areas.

Home Networks

The market for home networking and networked devices in the home is only going to grow. One good first step for many homes will be a network connection between the television and the computer. Apple's Apple TV does this by using 802.11n to stream video from iTunes onto an HDTV (Apple, 2008). Another popular use should be networked gaming both inside and outside of the home. Within the home, multiple family members can play over the home network and also play against people around the world over the broadband connection. All of the major consoles released recently, Xbox 360, Playstation 3, and Wii, have networked abilities. MMORPG players will also take advantage of this service. A wireless network can connect players on multiple platforms including PCs, mobile phones, consoles, and handheld gaming devices.

Look for new applications of home networks. With the aging of the baby boomers, medical care—home health care in particular—is fast becoming a major issue. Home networking technologies can be used to remotely monitor senior citizens, allowing them to live independently. For example, 4HomeMedia has the Home HealthPoint gateway connected to a broadband connection that can monitor the home and person with motion detectors, an advanced pill box, and even a scale, blood pressure cuff, or glucose meter (4HM, 2008).

Green technologies should also increase their presence in the home networking market. Green networking devices help users save energy by monitoring energy usage throughout the day and even allocating energy use in response to energy load. Z-wave, ZigBee, and HomePlug Command and Control based products are on the market as of mid-2008.

The biggest barrier to all of these technologies is the learning curve it will take to implement them. Simple, easy-to-use, intuitive home networking products will be adopted faster. There are so many different standards for home networks, making sure that devices will be able to seamlessly communicate across different standards is important. If it becomes too complicated to get your devices to speak to one another, then building the network becomes a burden rather than a help.

Finally, with broadband and a home network connecting everything around us, will our lives become easier or more complicated? Will all of this quick and easy access to information and entertainment make us better citizens, friends, and family members? Will they make our lives better? The answer to that questions remains to be seen, but there is no question that these technologies will have a major impact on your life.

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Teleconferencing

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Teleconferencing has always held out the promise of increased productivity and efficiency, improved communications, enhanced business opportunities, and reduced travel expenses. But “we humans are a ‘touchy-feely’ species, who, in general, prefer travel and face-to-face encounters over the more impersonal [teleconference] experience” (Kuehn, 2002). As if to underscore this preference for face-to-face meetings, business travel slowly began to recover in 2003 (Destination Marketing Association, 2006) following an abrupt drop after September 11, 2001. It recovered so much that, by 2007, business travel accounted for about \$165 billion of the roughly \$700 billion spent each year on U.S. domestic travel (Sharkey, 2007). Mirroring this trend globally, a 2008 travel industry forecast by BCD Travel—a Netherlands-based corporate travel conglomerate—stated that, “[international] passenger traffic grew by 6.3% with an increased average load factor of 75.7% in the first half of 2007, only slightly higher than the growth seen in 2006” (BCD Travel, 2008, p. 6). IATA further projected that passenger numbers would increase by 500 million by 2020, bringing the annual total of travelers to 2.5 billion. The largest forecasted growth is within Asia, followed by travel within Europe and U.S. domestic traffic (BCD Travel, 2008).

However, by the second quarter of 2007, there were signs that passenger demand growth had begun to weaken due, in large part, to airfare increases, escalating service issues, and airport congestion. It is equally likely that the slowdown also reflected lower-than-expected economic growth in the United States and Europe, even as overall global travel demand remained positive (BCD Travel, 2008). Indeed, sharply higher oil prices and the softening U.S. economy continues to drive travel demand lower. As a result, “[most] major U.S. airlines are already reducing capacity on domestic flights, and business travelers will most likely see more service cuts” (Grossman, 2007). As if to underscore this point, an American Express global business travel forecast projected the global average for domestic/short-haul travel costs to rise 1% to 4% in 2008, while international/long-haul travel costs could increase by as much as 5% to 8% (American Express, 2007). Thus, business travelers are feeling increasing pressure to seek alternative methods of conducting business.

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Paralleling trends in the travel industry in the immediate aftermath of September 11, many telecommunications companies reported seeing their videoconferencing usage increase by as much as 85%, while audioconferencing rose by almost 30% (Perera, 2001). Indeed, companies that tried teleconferencing as a stopgap measure after 9-11 became more open to using the services on a regular basis. However, according to a Frost & Sullivan white paper (2006a), many Americans, along with Europeans, are choosing teleconferencing not because of anxieties about safety and security issues associated with travel, but instead cite saving money and time as primary motivators. In fact, 55% of Americans stated that they see audio-, video-, and Web-conferencing as good alternatives to face-to-face meetings; while 56% of their European and 55% of their Asia-Pacific counterparts felt the same (Frost & Sullivan, 2006a). Although U.S. business professionals agree with their international counterparts that travel is an essential part of business (Frost & Sullivan, 2006a), travel appears to no longer be the first choice, nor even the preferred choice, for conducting business globally. With newer teleconferencing technologies and more teleconferencing services to choose from, people are better able to communicate interactively. As we enter a new era of communication and collaboration, business professionals are no longer bound by the limitations of time, location, or the traditional office. Teleconferencing provides the power of choice for interactive communication and offers a positive alternative for many business professionals to have the ability to remain productive and maintain relationships without extensive travel.

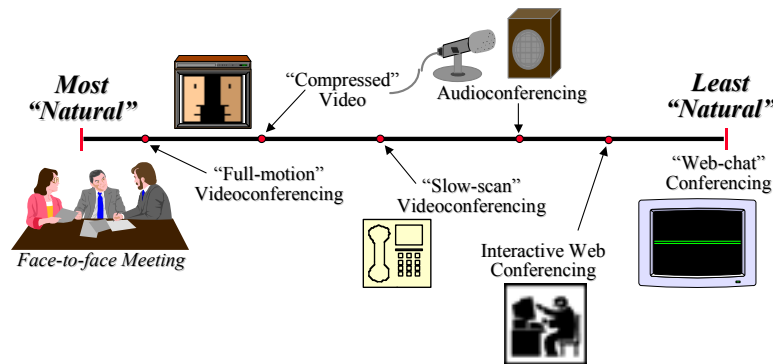
Definitions of what exactly constitutes “teleconferencing,” however, tend to differ across the industry. Attempts to find a consensus in defining terms is not entirely an academic exercise. It has been the experience of many industry professionals that disputes over the feasibility of teleconferencing are often perpetuated by the fact that few of the negotiating parties know exactly what the other party believes a teleconference to be (Hausman, 1991).

In the broadest sense, teleconferencing can be defined as “small group communication through an electronic medium” (Johansen, et al., 1979, p. 1). Similarly, *Electronic Telespan* defines teleconferencing as “an electronic meeting that allows three or more people to meet, be it across time zones or across office cubicles” (Gold, 2004). However, these very broad definitions have not proven very useful in defining the widely varying means of conducting “electronic meetings.” Jan Sellards, then president of the International Teleconferencing Association, defined the term in 1987 as, “the meeting between two or more locations and two or more people in those remote locations, where they have a need to share information. This does not necessarily mean a big multimedia event. The simplest form of teleconferencing is an audioconference” (Hausman, 1991, p. 246). Some practitioners prefer to call conferences using video “videoconferences,” those employing mainly audio “audioconferences,” and those using a range of computer-based technologies either “computer-conferences” or “Web-conferences”—oftentimes arranged on a continuum to distinguish those technologies that facilitate the “most natural” type of meetings from those that are “least natural” (see Figure 23.1). More typically, the term “teleconferencing” is used as a shorthand term to represent an array of technologies and services ranging from a three-way telephone conversation to full-motion color television to highly interactive, multipoint Web-based electronic meeting “spaces” to even the experience of “being there without being there” via telepresence technologies—each varying in complexity, expense, and sense of immediacy.

Recently, “integrated collaboration” has emerged as a preferred term used to emphasize the functionality of teleconferencing without dwelling excessively on the technology. Whereas most definitions of teleconferencing focus on the use of audio/video communications to facilitate meetings without the burden of travel, “integrated collaboration is a *process* that allows two or more users to interact with audio, video, and/or data streams in both real-time and non-real-time communications modes across packet and circuit switched networks” (Davis, 1999, p. 5, emphasis added). According to Andrew Davis, Managing Partner at Wainhouse Consulting Group, teleconferencing is primarily about meetings, but “integrated collaboration is about meetings,

corporate communications, sales, training, and enhanced customer services" (Davis, 1999, p. 5). Interestingly, Americans are more comfortable using teleconferencing technologies (72%) compared with counterparts in Europe (55%) or the Asia-Pacific region (52%), even though globally, seven out of 10 must collaborate with people in different locations (Frost & Sullivan, 2006a). This could be due to the fact that American companies are more likely to provide collaboration capabilities such as Web-conferencing to their employees (60%) than those in other geographic areas (Europe 40% and Asia-Pacific 44%) who also feel they lack the training to use conferencing and collaboration technologies effectively (Frost & Sullivan, 2006a).

Figure 23.1
Teleconferencing Continuum



Source: M. Ogden

As what constitutes teleconferencing continues to evolve, users look for easy-to-use, standards-based solutions that can integrate across all their communication needs. Whether referred to as "integrated collaboration," "collaboration solutions" (Glenwright, 2003), "conferencing and collaboration" (Polycom, 2003), or any of the other process-oriented, use-based terms, multimedia communications are fueling a paradigm shift as geographically-dispersed work teams become the rule rather than the exception, and as price reductions and connectivity improvements make the various technologies of teleconferencing more dynamic and available to a wider constituency.

While seeking a meaningful definition for "teleconferencing," it is also important to distinguish between the two different "modes" of teleconferencing: *broadcast* and *conversational*. In broadcast teleconferences, the intention is to reach a large and dispersed audience with the same message at the same time, while providing a limited opportunity to interact with the originator. Typically, this takes the form of a "one-to-many" video broadcast with interaction facilitated via audience telephone "call-ins." These events (e.g., "state of the organization" addresses, employee relations conferences, new product kickoffs, etc.) require expensive transmission equipment, careful planning, sophisticated production techniques, and smooth coordination among the sites to be successful (Stowe, 1992).

On the other hand, conversational teleconferences usually link only a few sites together in an "each-to-all" configuration with a limited number of individuals per site. Although prior arrangement is usually necessary, such meetings are often more spontaneous, relatively inexpensive, and simple to conduct. They seldom require anything more complicated than exchanging e-mail messages, synchronizing meeting times (especially if across time zones), and/or making a phone call to a colleague. Conversational teleconferencing supports numerous

kinds of business activities from management and administrative meetings (e.g., project, budget, staff, etc.), to marketing, sales, finance, and human resources (Stowe, 1992).

Another way to categorize teleconferencing applications is according to whether the facilities are used *in-house* as part of the normal routine, or *ad hoc*, only occasionally as the need arises. Once the exclusive domain of Fortune 500 firms, in-house or institutional teleconferencing—dedicated, room-based, and/or roll-about audio- and/or videoconferencing systems—are becoming more commonplace across a wide spectrum of organizations (e.g., schools, churches, hospitals, etc.). For example, Tribal Data Resources (TDR), a company that provides American Indian tribes and tribal service organizations with the tools and training necessary to increase self-sufficiency and administrative resources, began using Web-conferencing for customer support and training in 2002. The company found Web-conferencing to be cost-effective and so valuable and intuitive to use that they integrated the Web-conferencing functionality directly into the latest version of their membership and enrollment data management software (iLinc, 2007).

Ad hoc teleconferencing, more commonly referred to as “conferencing on demand,” accounts for the majority of corporate meetings and can run the gamut from large-scale, one-off regional sales meetings via videoconferences, to much smaller-scale, client review desktop conferences. Many of the major hotel chains (e.g., Holiday Inn, Hilton, Marriott, Sheraton, Hyatt, etc.) first began offering teleconferencing services in the 1980s to attract corporations and professional associations (Singleton, 1983), and several business copy centers such as FedEx Kinko’s have developed their own teleconferencing networks tailored for occasional use by small businesses and/or individuals. For the much smaller-scale solutions, there is no need to schedule special rooms or equipment, “just push the conference button on your touchtone phone, switch on the...camera on top of your PC, and you’re ready to meet with others in your organization or outside it” (Weiland, 1996, p. 61). Internationally, companies such as Conference Genie in the United Kingdom have carved out a business niche for themselves by offering relatively inexpensive, ad hoc domestic and international conference calling for up to 12 people for their standard service, and up to 100 using Conference Genie Plus (Conference Genie, 2008).

As a recent case in point, over the past seven years, the Government of Alberta, Canada had been slowly migrating to a consolidated IT (information technology) infrastructure based largely on Microsoft’s Office Live Communications Server 2005. It was later decided to migrate to Office Live Communications Server 2007 (OCS 2007) in order to provide a more comprehensive collaboration solution with the addition of a Web-conferencing service. Although most ministries could hold video- and audioconferences between boardrooms, employees wanted to be able to initiate conferences from their workstations. As a result of the change to OCS 2007, the Government of Alberta was able to accelerate collaboration, revolutionize their use of conferencing technologies, provide for future cost savings, and improve productivity and efficiency. “One of the biggest benefits we’ve realized so far is improved collaboration,” notes Brian Murphy, an Exchange Analyst for the Government of Alberta. “You can see people’s presence information so you know if you’re going to be able to reach someone by phone or if it would be better to send an instant message. It’s also a lot easier to upgrade from an instant message to a phone call, and then upgrade to a Web conference. Whereas in the past, without this tool, you might have to physically go to somebody if you really wanted to collaborate at that level. People also wasted time sending a lot of e-mail messages back and forth” (Microsoft, 2007).

Beyond the obvious elimination of direct expenses, the key benefit of teleconferencing is that it removes the need for travel and eliminates the hours of downtime and days away from the office. Even with the proliferation of handheld communication devices (cell phones, personal digital assistants, etc.), people in transit are not able to conduct business as efficiently as they can from their offices. When executives come to understand the real costs associated with a day-and-a-half trip to attend an hour-and-a-half meeting, they soon begin to

appreciate how teleconferencing can help save them money, reduce wear-and-tear and stress in their business and personal lives, and boost personal productivity at the same time. Multiply this benefit by the number of executives traveling to meetings, and the total savings can be significant.

After years of false starts and unfulfilled promises, teleconferencing and integrated collaboration solutions have reached reliability, ease-of-use, and utility levels such that the technologies are finally being integrated into everyday business processes. Although there are no “true” substitutes for in-person meetings, those who subscribe to the “integrated collaboration” model of teleconferencing believe that the long-term growth of the industry will contribute real human value only to the extent that it improves the productivity of its users beyond the conservation of time and material resources expended in travel. Given the ease and flexibility of today’s teleconferencing options, the most difficult challenge will be to hold more meaningful and productive meetings instead of just more meetings.

Background

The basic technology for teleconferencing has existed for years. In its simplest form, teleconferencing has been around since the invention of the telephone—allowing people for the first time to converse in “real time,” even though they were separated physically (Singleton, 1983). Today, we understand teleconferencing to be more involved than a simple telephone conversation. Some contend that teleconferencing has its roots in comic strips and science fiction. Certainly, comic strips such as *Buck Rogers*, popular in the early 1900s, made it easy to imagine people of the future communicating with projected images, or *Dick Tracy* calling instant meetings through a communication device on his wrist. The videophone in Stanley Kubrick’s *2001: A Space Odyssey* furthered the notion of interactive video communications as a common feature of our near future. Likewise, *Star Trek*’s holodeck popularized the notion of fully-immersive virtual environments for diversion or business as accepted conventions of our far future.

The teleconferencing gear that invaded science fiction was pioneered by AT&T in the 1950s and 1960s. These early efforts were impressive for their time, but were also considered little more than novelties and failed to catch on with consumers (Noll, 1992). Today, these visions have been brought to life in three alternatives to face-to-face meetings easily classified by their broad medium of application: audio, video, and computer-mediated teleconferencing.

Audio

With over 20 billion minutes of use per year and an annual unit volume growth rate of over 20%, audioconferencing remains the most commonly-used form of teleconferencing today (Davis & Weinstein, 2005). Audioconferencing relies primarily on the spoken word, with occasional extra capacity for faxing documents or “slow-scan” image transmissions (see discussion under Video below). Historically, audioconferencing began with the familiar “conference call,” generally set up by an operator working with the local telephone company (Stowe, 1992). Today, an audioconference can be implemented in a variety of ways. For a basic telephone conference involving a limited number of participants between two sites, a telephone set with either a three-way calling feature or a conferencing feature supported by the PBX (private branch exchange) or key system is all that is required. If participants are expected to be in the same room at each location, a speakerphone can be used. Adding additional sites to an audioconference requires an electronic device called a *bridge* to provide the connection (Singleton, 1983)—simply plugging several telephone lines together will not yield satisfactory

results. Audio bridges can accommodate a number of different types of local and wide area network (LAN and WAN) interfaces and are capable of linking several hundred participants in a single call, while simultaneously balancing the volume levels (allowing everyone to hear each other as though they were talking one-on-one) and reducing noise (echo, feedback, clipping, dropout, attenuation, and artifacts) (Muller, 1998).

A bridged audioconference can be implemented in several ways: dial-out, prearranged, or meet-me. In the dial-out mode, the operator (or conference originator) places a call to each participant at a prearranged number and then connects each one into the conference. Prearranged audioconferences are dialed automatically, or users dial a predefined code from a touch-tone telephone. In either case, the information needed to set up the conference is stored in a scheduler controlling the bridge. In the meet-me mode, participants are required to call into a bridge at a prearranged time to begin the conference. Regardless of the mode of implementation, the more participants brought into an audioconference through the bridge, the more free extensions are required (Muller, 1998).

Video

Humans are inherently visual beings—we want to see as much as we want to hear. Since AT&T demonstrated the Picturephone at the 1964 World's Fair, corporate America has had an on-again/off-again fascination with video communications (Borthick, 2002). The assumption behind videoconferencing, usually unquestioned, has been that the closer the medium can come to simulating face-to-face communications, the better (Johansen, et al., 1979). Engineers have thus struggled to make video images more lifelike in size and quality. As a result, full-motion videoconferencing offers glamour, but has yet to catch on as a routine business tool. Also, videoconferencing has traditionally had a technical complexity that tended to limit its scale and scope, despite periodic engineering breakthroughs, steady price/performance improvements, and gradual market growth.

Still, the videoconferencing industry today is undergoing its most important transformation since the early 1980s. While room conferencing systems continue to provide improved audio and video quality and ever-more impressive features and functions at ever-decreasing prices, the real action is at the desktop where multiple vendors with multiple strategies are vying for the enterprise user base (Davis & Weinstein, 2005). There are only a few large players that dominate the videoconferencing hardware market.

Andrew Davis, of the research and consulting firm Wainhouse Research, noted that 2006 was a banner year for the videoconferencing industry with outstanding annual growth rates of 28.7% in revenues and 21.7% in units recorded (Davis, 2007). Showing no signs of letting up, just one year later, industry growth was described as “spectacular” with revenues up 38% based upon 27% growth in units shipped industry-wide (Davis, 2008a). These numbers represent a compounded annual growth rate of 39% in revenues based upon a 29.7% growth in units shipped (Davis, 2008a). Although Polycom has seen its market share erode from 61% market share in 2000, it continues to be the market leader with a 36% market share (based on videoconferencing group unit, n=212,600). Tandberg has increased its market share from 16% in 2000 to 28% in 2007 and actually leads in revenue at 41% (compared with Polycom's 36%). Other competitors in the videoconferencing industry include Sony with 8% market share, Aethra with 6%, and other vendors combining for 22% of the market (Davis 2008b). However, according to some, Microsoft represents the proverbial “elephant in the videoconferencing room” with the recent introduction of its RoundTable videoconferencing hardware meant to integrate with Microsoft's Office Communications Server 2007 (Davis, 2008c). Although Microsoft's videoconferencing solution is proprietary, Radvision and Tandberg have announced plans to providing robust MCUs (multipoint control units) allowing RoundTable and OCS 2007 users to connect with their existing non-Microsoft

H.323 and H.320 videoconferencing systems (Davis, 2008c). Clearly, Microsoft is positioning itself to become a player in the unified communications market with this new videoconferencing option.

Videoconferencing systems are frequently grouped into two main types of end-point systems: group systems and personal systems. The growing popularity of videoconferencing and the maturity of the market are confirmed by the fact that, in 2007, the market size was estimated to be over \$1.1 billion and nearly 213,000 installed units (Davis, 2008b). Not included in these estimates is annual infrastructure revenue. Tandberg leads in videoconferencing infrastructure revenue with 27%, Polycom brings in 23%, Radvision at 21%, and all the others account for 29% combined (Davis 2008b). In addition, there is growing demand for desktop or personal videoconferencing systems, with close to 40,000 such systems installed each year, and between three-quarters of a million and one million PC-video systems are purchased each year by consumers—often used to keep in touch with relatives via videoconferencing (Gold, 2004). Rack-mounted codecs for room-based group videoconferencing systems—such as Polycom’s ViewStation FX, which is designed for boardrooms, large conference rooms, or classrooms (Polycom, 2002)—can range from \$5,000 to \$10,000, and are typically found in end-user systems costing 10 to 30 times as much, depending on options and/or equipment add-ons (Davis 2005).

Roll-about group videoconferencing systems—once considered viable solutions for organizations that did not have extensive need for dedicated videoconferencing facilities—are on the wane as the range of options available for set-top and personal videoconferencing systems increase in popularity. Typical roll-about systems consist of a television monitor, a video codec, a single camera, and microphone (the last three items are usually packaged as an integrated unit) on a mobile cart. They range in price from \$2,000 to \$14,000, depending on options (Davis, 2005). Fully-equipped desktop videoconferencing systems are available in the \$599 to \$5,000 per unit range, depending on options (Gold, 2004). In 2003, with the slogan “videoconferencing for the rest of us,” Apple Computers introduced the iChat AV videoconferencing software application along with the iSight digital video camera as a low-cost, two-way desktop videoconferencing solution for the Macintosh. Starting with the Tiger operating system (Mac OS 10.4) and continuing with Leopard (10.5), iChat AV takes advantage of the H.264 video codec and launches a multi-way video- and audioconference directly on the desktop with a sharper picture and improved color accuracy. Also, iChat allows for high-quality audioconferences with up to 10 participants, integrated instant text messaging, and drag-and-drop file sharing (Apple, 2006). New features in iChat include the ability to share Keynote slide presentations, control a single desktop for collaboration with colleagues, and the ability to record the iChat session (audio or video) playable in either iTunes or QuickTime (Apple 2008). With today’s options, videoconferencing becomes just another application running on the user’s computer desktop.

Videoconferencing between more than two locations requires a multipoint control unit. An MCU is a switch that acts as a video “bridge” connecting the signals among all locations and enabling participants to see one another, converse, and/or view the same graphics (Muller, 1998). The MCU also provides the means to control the videoconference in terms of who is seeing what at any given time. Most MCUs include voice-activated switching, presentation or lecture mode, and moderator control (Muller, 1998). Likewise, because of the large amount of information contained in an uncompressed full-motion video signal (about 90 million bits per second), two-way videoconferencing that even remotely approaches broadcast television quality would require incredible bandwidth at equally great cost. Therefore, all but the most expensive full-motion videoconferencing options utilize video compression/decompression technology to take advantage of the fact that not all of the 90 million bits of a video signal are really necessary to reconstruct a “watchable” image. In fact, the majority of the information in a typical videoconferencing image is redundant: most of the image remains exactly the same except for the speaker’s head movements and occasional gestures.

Video compression techniques take advantage of this and other factors to greatly reduce the number of bits that must be transmitted, and thus reduce the bandwidth requirements (Stowe, 1992). A popular transmission rate for higher-end videoconferencing technology is about 1.5 Mb/s (Megabits per second). This is only about 1/60th of the original information in the video image, but it produces acceptable pictures for most purposes. More important, this rate corresponds to the telephone T1 rate so that, with the proper equipment, such videoconferences can be transmitted by telephone circuits in and among most major cities (Stowe, 1992). Other videoconferencing systems have been developed that run at varying rates up to 384 Kb/s (kilobits per second), while smaller roll-about and/or desktop systems typically run at 128 Kb/s. However, at lower data rates, some design tradeoffs are made in the relationship between quality per frame and frames per second. “Some vendors have engineered their products to maintain a constant frame rate by sacrificing clarity when there is a high motion component to the image. This compromise presents a problem, since there are no established units of measurement for how clear an image appears, or whether the video is smooth or choppy” (Finger, 1998).

Computer-Mediated

Whereas videoconferencing is about “see me,” computer conferencing—and Web conferencing in particular—is about “see what I see” (Davis & Weinstein, 2005). Murray Turoff developed one of the first computer conferencing systems in 1971 for the Office of Emergency Preparedness (EMISARI, a management information system) to deal with the wage-price freeze (Lucky, 1991). Since then, the capacity of two or more personal computers to interconnect, send, receive, store, and display digitized imagery has expanded rapidly—thanks, in large part, to rapid developments in computer hardware and the spread of the Internet. At the most basic level, computer conferencing is the written form of a conference call. Participants in a computer conference could communicate via a simple conferencing application such as Internet Relay Chat (IRC) or AOL’s Instant Messenger, both of which provide a simple text-based chat function.

Another form of computer conferencing takes advantage of the ability to “time-shift” a presentation via Webcasting. Many “meetings” are actually one-way presentations with limited questions and answers. In such situations, a Webcast or Webinar may actually be a better choice. For such Web-based information sharing, the originator tries to anticipate the viewer’s questions and concerns during the recording of a presentation, then makes the finished product available to anyone who wants to stream or download it at a time more convenient to the viewer—sort of an asynchronous broadcast on the Web. To make a computer-based meeting more interactive, however, most users want to do either real-time audio or video (or both), while sharing documents or a common workspace. Enter Web conferencing, perhaps one of the fastest-growing sectors in teleconferencing. Frost & Sullivan define Web conferencing as “a set of technologies and services that allow people to hold real-time and synchronous conferences over the Internet. In order to hold a Web conference, each participant needs to use a PC and a Web browser to share information. The most basic feature of a Web conference is screen sharing, whereby conference participants see whatever is on the presenter’s screen. Additionally, audio communication in a Web conference can either be done through traditional PSTN [public switched telephone network] networks or through VoIP” (Frost & Sullivan, 2006b). Web conferencing market revenue is forecast to increase from \$136.3 million in 2006 to \$538.0 million by 2011. Some of the key factors driving the Web conferencing market include the increasing globalization of large companies, recognition of the downside of business travel, and the need for businesses to become more competitive (Frost & Sullivan, 2007a).

The Web conferencing industry has quickly differentiated itself into three deployment options for users to choose from. In the hosted model, the field of providers—including WebEx (acquired in 2007 by Cisco Systems, Inc.), Genesys, Adobe (which acquired Macromedia’s Breeze conferencing service), Citrix, Microsoft, and others—is a crowded one. While most offer product lines tailored to small businesses, comparing their

functionality can be a daunting task. Pricing options make it still harder; providers charge per-minute, by the month, or through licensing agreements (Foley, 2006). The service provider's Web conferencing software is "hosted" on the vendor's (or a partner's) system, and the user accesses the capabilities over the Internet, paying a "one-time" or monthly subscription fee based on the number of users. The on-premises model, such as Polycom's WebOffice, Oracle's Collaboration Suite, or even Apple's iChat, installs software on systems owned-and-operated by the business and uses the business's existing Internet connectivity. The blended model, from companies such as Interwise, combines both of these, typically recommending the use of a telephone to augment the poor sound quality of some computers. Typically, everyday meetings are run using on-premises facilities, while large, multi-nodal meetings use software running on external servers. Obviously, the most affordable is on-premise Web conferencing, running on a typical office computer with little or no added equipment beside a Webcam.

There is no denying that Web conferencing is an area of high interest to conferencing users. Effective organizations are using Web conferencing as more than just a substitute for face-to-face meetings. Web conferencing can help people work together with colleagues and business partners, share information, make better decisions, work on more projects simultaneously, and increase the impact of their work provided they are afforded a minimum of functional tools. Users expect all participants to be able to see presentations, share desktops and/or applications, have the ability to exchange real-time text messages with other participants, and have a shared whiteboard (Mann & Latham, 2005). Increasingly, service and software vendors are offering more advanced optional features in an effort to differentiate themselves, including integrated PSTN audio, integrated VoIP (voice over Internet protocol) audio, videoconferencing, file sharing, remote control, archiving, feedback, and polling. The technology has seen explosive growth because it faces less technological barriers than videoconferencing, has better "presence" than audioconferencing, and delivers a unified conferencing platform that integrates voice and video bridging capabilities with the ability to share and view data collaboratively (Heyworth, 2004).

Obviously, choosing the right teleconferencing technology for the right purpose is the subject of great concern for many business executives. The key to a successful and effective collaboration experience is achieving a level of "connectedness" between the participants. Social psychologists have pointed out that "in terms of the immediacy [i.e., 'connectedness'] that they can afford, media can be ordered from the most immediate to the least: face-to-face, [videoconferencing], picturephone, telephone, [below this, synchronous and asynchronous computerized conferencing]...the choice of media in regard to intimacy should be related to the nature of the task, with the least immediate or intimate mode preferable for unpleasant tasks" (Hiltz & Turoff, 1993, p. 118). This would suggest that, for the less intimate task, the most immediate medium (face-to-face) would lead to favorable outcomes. In this same vein, a slightly more intimate task would require a medium of intermediate immediacy (videoconferencing), while those tasks that are highly intimate, perhaps embarrassing, personal, or charged with potential conflict would benefit from using a medium of lowest immediacy (audioconferencing or even computer conferencing).

Interestingly, though, Hiltz and Turoff (1993)—reporting the results of a 1977 study—indicated that "numerous carefully conducted experiments...found all vocal media to be very similar in effectiveness [including face-to-face, audio, and video]. However,... people *perceived* audio to be less satisfactory than video" and both to be less satisfactory than face-to-face (emphasis added, p. 121). Little recent experimentation has been done in this area, and it appears that there is still a great deal of room for further research.

Recent Developments

Opinions vary, but past circumstances have led many corporate IT managers to take a long, hard look at teleconferencing and other collaboration tools in light of rapidly-expanding corporate communication needs. With multiple devices and interfaces to access content, learning curves and complexity become major challenges. On the other hand, reaching out in real-time to communicate with individuals or multiple team members (many in diverse locations) becomes increasingly difficult in an increasingly fragmented communications world (Insignia, 2007). Thus, unified communications (UC) has emerged as the catch-phrase du jour to describe the planned, coordinated use of key technologies for integrated collaboration. "UC is a direct result of the convergence of communications and applications. Differing forms of communications historically have been developed, marketed, and sold as individual applications. In some cases, they even had separate networks and devices. The convergence of all communications on IP networks and open software platforms enables a new UC paradigm and is changing how individuals, groups, and organizations communicate" (Elliot, 2007). UC applications are, therefore, expected to include such facilities as VoIP, PC-based presence, e-mail, audio and Web conferencing, videoconferencing, voice mail, find-me/follow-me capabilities (for call routing), unified messaging, Wikis/blogs, mobile clients, and IM and social networking capabilities—all used to serve a wide array of communication needs and goals in a "click to communicate" interface (Elliot, 2007).

Although talk of UC has been around for several years, 2007 is the turning point for the market, as major players including Cisco, IBM Lotus, and Microsoft strengthened their offerings, bolstered critical partnerships, and started spending significant dollars on sales and marketing (Frost & Sullivan, 2007b). During 2006 and the first half of 2007, the North American unified communications market was so nascent as to be virtually non-existent, totaling well under \$10 million. However, this emerging market is expected to experience healthy growth rates over the next several years, spurred by improved and more feature-rich technology, declining price points, and increasing awareness of the need for UC tools in the enterprise (Frost & Sullivan, 2007b). Hosted and telecom UC service providers showed worldwide revenues of \$2.6 billion in 2006, with growth projected to account for nearly \$19.7 billion by 2010 (Kowalke, 2006). Suppliers represent a significantly smaller proportion of the UC pie; for that segment, 2006 revenues are \$599 million and projected to grow to almost \$1.5 billion by 2010 (Kowalke, 2006).

Several business and IT-related trends are contributing to this, but the largest is the growth of the virtual workplace, in which an increasing number of employees work in a location that is different from that of their coworkers or managers. These employees must continue to communicate and collaborate, but they have the challenge of having to do so over the telephone and the Internet, rather than in person—and they require technology to help them do so. Also impacting the need for UC tools is the need to support global business, the desire to cut back on travel for budgetary and productivity reasons, the spread of IP (specifically, voice over IP) in the enterprise, and the need to cut cycle times around production and decision making (Frost & Sullivan, 2007b). Still, skeptics of UC exist. Elliot Gold of Electronic Telespan sees a rush toward the UC enterprise, but remains convinced that "...while the sales pitches and even the RFPs out there will talk loudly about UC, the majority of the usage will be plain old voice, as it is today, and will be for many years to come. Yes, we will see Web; yes, we will see video in UC on desktops, available from the new media servers, but in the beginning, and frankly for some time to come, the applications will come out of people's mouths and into their ears" (I can see, 2007).

Unified communications efforts notwithstanding, many business people still maintain that face-to-face meetings will always offer the best level of interactivity. They are also beefing up their Web sites for actual end

users "...using animation for demonstrations of products as well as using streaming video for testimonials" (Vinas, 2002, p. 32). The key point in the use of teleconferencing is ease-of-use and ease-of-access.

The other obstacles to ubiquitous adoption are cultural—many people are uncomfortable speaking to a camera and very uncomfortable knowing they are being recorded. Paul Saffo, a director of the Institute for the Future in Menlo Park (California), believes this is normal. "It takes about 30 years for new technolog[ies] to be absorbed into the mainstream. Products for videoconferencing [and by extension, Web conferencing]... invented 15 to 20 years ago are just now beginning to come into their own" (Weiland, 1996, p. 63). By Saffo's standard, U.S. society is probably entering its second stage of acceptance of teleconferencing technology—perhaps accelerated by the events of September 11, 2001. While this transformation is underway, the industry may seem in a constant state of flux and somewhat confusing. The most confusing and yet promising of the newest teleconferencing developments are not in hardware or software, but in the international standards that make it all work.

Standards

Certain international standards for teleconferencing have been worked out by the International Telecommunications Union (ITU). These standards have set the foundation for network transmission technologies and vendor interoperability in the teleconferencing industry, especially videoconferencing. Prior to the establishment of these standards, vendors employed a range of proprietary algorithms and packaged hardware and software so that systems from different vendors could not communicate with each other. By establishing worldwide teleconferencing standards, the ITU helps ensure that teleconferencing technologies can "talk" to each other regardless of brand. Likewise, as new innovations are developed, the new systems remain "backward-compatible" with existing installed systems. The most important standards for the implementation and adoption of teleconferencing are under the umbrella standard of H.320 that defines the operating modes and transmission speeds for videoconferencing system codecs, including the procedures for call setup, call teardown, and conference control (Muller, 1998). All videoconferencing codecs and MCUs that comply with H.320 are interoperable with those of different manufacturers. Other important standards for the implementation and adoption of teleconferencing are:

- ♦ *H.322*—LAN-based videoconferencing with guaranteed bandwidth (ITU, 1996).
- ♦ *H.323*—LAN-based videoconferencing with non-guaranteed bandwidth such as LAN and WAN networks using packet switched Internet protocol (ITU, 2000). This standard supports the move by many desktop teleconferencing systems to sophisticated bridging systems and IP multicasting software that reduces desktop clutter and frees up valuable bandwidth on the network. Microsoft's NetMeeting, Polycom's WebOffice, and one of the biggest names in Web conferencing, Cisco System's WebEx, all utilize H.323 IP videoconferencing specifications to deliver their services to the desktop. Likewise, many popular Web browsers have H.323-compliant videoconferencing capabilities embedded into their latest versions (Lafferty, 2002).
- ♦ *H.324*—Originally developed to facilitate low bit-rate video telephony by specifying a common method for video, voice and data to be shared simultaneously over modem connections via standard analog telephone lines (ITU, 1998). In 2002, this protocol was modified for 3G wireless networks (H.324M or 3G-324M) by adapting the circuit switched network to support the delivery of delay-sensitive applications (video streaming, video conferencing) enabling real-time conversa-

tional multimedia communication services and applications on 2.5G and 3G mobile devices (Radvision, 2002).

- ♦ *H.263*—This video coding protocol for low bit rate communication has been the codec in use for the past several years supporting 30 frames per second video at the narrow bandwidths used in videoconferencing. Prior to compression, one field is tossed aside (every other line) by H.263. Thus, each compressed video frame corresponds to only one of two input video fields. The result is a somewhat lower video resolution quality of 352×288 pixels (North Central Educational Service District, 2003).
- ♦ *H.264*—A more advanced video codec for audio/visual services, H.264 is a relatively new ITU protocol that improves the video resolution quality in the H.323 protocol suite by encoding and transmitting two interlaced fields for each frame. This process allows the decoded video to be more fluid and lifelike. The result of this enhancement is a substantially higher resolution that approaches or matches MPEG-2 quality at a 64% lower bandwidth. H.264 (also known as MPEG-4 part 10) also handles the encoding of the pixel blocks more efficiently than H.263, practically eliminating the tiling or pixilation seen on videoconferences today when there is a lot of motion (North Central Educational Service District, 2003). Recently, H.264 was adopted for use in videoconferencing systems by such major industry players as Polycom and Tandberg (Siglin, 2005).

It is important to note that the ITU audio coding recommendations for teleconferencing for all H.3xx videoconferencing recommendations (except H.324) mandate the G.711 recommendation for audio. G.711 is the oldest compression algorithm and codes toll-quality (3 KHz analog bandwidth) audio into 48 Kb/s, 56 Kb/s, or 64 Kb/s. Mandatory for H.324, but optional for all other H.3xx recommendations, is G723.1 which codes toll-quality audio into 5.3 Kb/s or 6.3 Kb/s (Paul, 2000). In addition to these important video and audio recommendations, the ITU has also generated recommendations for multiplexing, control, multipoint services, security, and communications interface (see <http://www.itu.int>).

Current Status

It is ironic that some of the simplest ideas can be put into practice only when a very complex level of development has been reached in a related field. As technologies have expanded, morphed, and matured, teleconferencing options have transformed and expanded as well. As discussed earlier, teleconferencing is no longer a simple conference call, nor is it exclusively the domain of complex two-way video hook-ups. For example, in 2005, Polycom announced QSX, a voice and content solution that enables anyone using a Polycom conference phone (of which Polycom claims to have shipped 1.7 million) to easily and securely share computer content with remote meeting participants with no monthly service fees or per-minute charges (Polycom QSX, 2006; Davis, 2005). QSX enables fast, ad hoc content sharing for anyone in the conference call without requiring special software applications or document uploading. The device connects to the conference phone, projector, and the Internet, and then handles all the protocols transparently. Participants see content in one of two ways:

- 1) QSX-enabled rooms (up to five) see the content automatically through the room's projector or display system.

- 2) Locations without QSX (up to 10) can see the content through a standard, Java-enabled Web browser.

Since the presenter connects simply with a VGA cable, anyone who walks into the room can present content instantly to everyone on the call, even if they are a visitor using a Macintosh without any individual access to the LAN (Davis, 2005).

Likewise, the cost of video codecs and other end-user equipment continues to fall. Ten years ago, a standard videoconferencing system could cost \$75,000 or more, and for that, you could buy only enough gear to outfit a couple of conference rooms. Now, such room-based systems can be found for as little as \$10,000, and desktop PC-based Webcams and software are available for a few hundred dollars, making videoconferencing much more attractive than ever before. Also, early videoconferencing systems depended on ISDN (Integrated Services Digital Network) lines to transmit data because they were the only connections that provided the bandwidth and stability that videoconferencing applications needed. Starting a few years ago, however, videoconferencing vendors shifted from ISDN lines, which were expensive and required special skills to manage, to IP networks. IP has become the de facto networking standard for most conferencing networks and a wide variety of applications, such as electronic messaging, telephone services, and data sharing (Videoconferencing..., 2007).

Not to be counted out, audioconferencing has also jumped on the IP bandwagon. Paul Berberian, co-founder, president, and CEO of audio and data conferencing provider Raindance Communications, notes that, “for every boardroom-type videoconference, there are thousands of audioconferences” (Borthick, 2002). Audioconferencing over IP networks (VoIP) has garnered much attention lately as Internet telephony software makes it possible for users to engage in long-distance conversations between virtually any location in the world without regard for per-minute usage charges. In most cases, all that is needed is an Internet-connected computer equipped with telephony software, a sound card, microphone, and speakers or a headset (Muller, 1998). One of the most popular business features of Skype—a computer program that allows users to make phone calls over the Internet—is their free conference calling, now capable of handling up to 10 individuals per conference session and point-to-point video calls are also easy to set-up—all you need is a Webcam (Skype, 2008). However, because the voice of each party is compressed and packetized, there may be significant delays that result in noticeable gaps in a person’s speech. In the future, some industry analysts contend VoIP’s use of the session initiation protocol (SIP) signaling protocols will provide increased reliability and enable new audioconferencing features such as breakout sessions, sub-conferencing sessions, and real-time failover without losing connectivity (Borthick, 2002).

Web-based conferencing systems are gaining in popularity. According to Wainhouse Research, of Duxbury (Massachusetts), 75% of small business respondents see the ability to use Web conferencing to reach more people and save time and travel costs as its major benefits (Foley, 2006). Also, 59% said it made meetings more productive. It is no surprise that the Web conferencing market is white hot and projected to grow by 24.4% to \$2.9 billion by 2011, according to Frost & Sullivan the global consulting firm (Foley, 2006). In the Web conferencing arena, WebEx is the senior player. The company offers products for online meetings, seminars, training, and audioconferencing. There is even a version with integrated remote-control technology for staffers who need to support customers over the Web. In 2008, WebEx unveiled its latest new offering, MeetMeNow, which is aimed at servicing the collaborative meeting needs of small businesses. “The company offers two closely-related versions. The first, called Pay-Per-Use Meetings, has the same features as MeetMeNow, but you pay a per-minute charge (33 cents), and your meeting must have 10 or fewer members. The second, Meeting Center, is still a Web-collaboration product, but it has more features than MeetMeNow, supports from five

to 500 attendees, and is priced differently” (Rist, 2008a). Having both the largest collaborative Web conferencing network and backing from Cisco confers advantages. According to Cisco Systems, WebEx’s vast network means greater capacity for large meetings and better reliability (Rist, 2008a). But if your small business is using MeetMeNow as a way of bringing geographically disparate workers together, network reliability will depend more on your local Internet provider than anything Cisco does. On the upside, Cisco’s technology does allow WebEx to offer network-style security features, like advanced encryption for your ultra-secure Web meetings and the ability to erase any trace of your meeting after it happens (Rist, 2008a).

Microsoft entered the nascent Web conferencing market with the roll-out of NetMeeting 3.0 software back in 1999 as part of the Windows Operating System. According to some product reviewers, NetMeeting 3.0 was (and still is) a great Web conferencing application—it is free, and it offers Windows users H.323 compatibility, whiteboard function, text chats, audio, video, and application and file sharing (Microsoft NetMeeting, 1999). Unfortunately for Microsoft, in December 2003, after a U.S. District Court in Richmond (Virginia) found Microsoft had violated patents with its NetMeeting software, Microsoft agreed to pay SPX and its Imagexpo unit \$60 million for the right to use the whiteboard technology covered under patent #5,206,934 (Festa, 2003). Whereas NetMeeting is still available as a free download, effort shifted to promoting Microsoft Office Live Meeting. Live Meeting is Microsoft’s Web conferencing service that can be integrated in a corporate Intranet environment with extensive branding capabilities or facilitate interactive meetings via the Internet in real time at a moment’s notice with everyone participating from their desktops (Microsoft, 2004). In February 2006, Steve Ballmer, CEO of Microsoft, announced the availability of Microsoft Office Communicator Mobile for Microsoft Office Live Communications Server 2005 (Microsoft unveils, 2006). “Communicator Mobile is one of Microsoft’s steps in extending Live Communications Server’s capabilities to mobile devices, enabling companies to deploy IM [instant messaging] and presence-enabled solutions that provide a consistent real-time communications experience across PCs and smart mobile devices...putting people at the center and enabling information workers to have access to real-time communications capabilities virtually anytime, anywhere, on any device” (Microsoft unveils, 2006).

Rolled-out in 2007 with Microsoft’s OCS software, RoundTable, is “an advanced collaboration and conferencing device that provides participants with an engaging and immersive remote meeting experience” (Microsoft, 2008). Listing for approximately \$3,000, RoundTable is actually an unusual Webcam that gives remote participants a 360° view of the conference room. (Yes, it is a room-based group videoconferencing system.) RoundTable also requires Microsoft OCS 2007 (retailing for \$3,650) or Microsoft Office Live Meeting 2007. So, it is not your everyday room videoconferencing system either (Davis, 2008c). The device uses real-time software to stitch together five images into a panorama. The resolution of the camera is 3,700 × 600 pixels, but the panorama display resolution is only 1,056 × 144 pixels. The frame rate is 15 fps (60 Hz) or 12.5 fps (50 Hz), so lip synch can be a problem. While the general videoconferencing market is moving toward high definition, RoundTable is heading in the opposite direction. With 1,056 pixels spread across a 360° field of view, this calculates to 2.9 pixels/degree (Microsoft, 2008). By comparison, a typical low-end Webcam with 640 horizontal pixels spread across a typical 78° field of view provides 8.2 pixels/degree. The executive HD systems from Polycom and Tandberg provide 1,280 pixels across a 65° field of view, or 19.7 pixels/degree. When questioned about this, Microsoft’s Technical Product Manager Huat Chye Lim responded that HD was one of the tradeoffs Microsoft made consciously in order to take RoundTable to market at a price point that enables broad deployment. In Microsoft’s view, RoundTable is videoconferencing for the masses, not an executive solution that benefits a small segment of an organization. RoundTable is intended to have much broader reach (Davis, 2008c; see also, Microsoft, 2006).

A relative newcomer to the Web conferencing market, Adobe Connect (formerly known as Macromedia Breeze) offers a number of advantages that competitive products, such as WebEx and Genysys Conferencing, do not: rapid time to deployment, Flash technology, and a large base of designers. Recently, Adobe Systems rolled out Acrobat Connect Professional as a complete Web communications solution with many of the same features of the former Macromedia Breeze (Adobe Acrobat Connect Professional, 2008). According to the corporate Web site, Acrobat Connect Professional allows users to “effectively share a wide range of content, including Microsoft PowerPoint slides, live and recorded video, Adobe Flash movies, live screens, applications, audio, and multi-user text chat. Using the rich media advantages of Flash technology, Acrobat Connect Professional delivers an engaging and user-friendly online communication experience” (Adobe Acrobat Connect Professional, 2008). It still lags somewhat behind WebEx's many services and even Microsoft's Live Meeting in terms of popularity, “but Adobe Acrobat Connect Professional is a super-slick combination of the company's Web development expertise and all the tools you'd expect from a Web conferencing and e-learning solution” (Rist, 2008b).

Factors to Watch

As the teleconferencing and real-time, integrated collaboration (i.e., unified communications) industries go through fast—and at times, monumental—changes, the ability to understand the macro process taking place, as well as the future direction(s) they will follow, is difficult. “The evolution of collaboration systems and the ability of Web conferencing development companies to truly understand and integrate an effective approach to collaboration... has to be fundamentally different from what [is currently being offered now]” (Good, 2003). Over the past few years, a lot of consolidation has occurred in the multimedia conferencing market. The “integration between Yahoo IM and WebEx [and the subsequent acquisition of WebEx by Cisco] and the similar integration between LiveMeeting and MS Messenger” is just the start (Good, 2003). Growing industry interest in “rich media communications and real-time conferencing” has been borne out by Collaborative Strategies senior analyst Lewis Ward's research, showing that the fastest-growing type of teleconferences are those in which conferees can talk with each other while viewing the same Web-based data (Borthick, 2002; Ward, 2002). Whereas most organizations use standard telephone bridges for the audio portion of their Web conferences, there is rapid movement toward VoIP. Indeed, the widespread growth of IP telephony has introduced many companies to the potential power of converged communication networks. Many IP telephony systems have produced real payback for the companies that have adopted them and may only be a preview of further benefits to be mined from Web conferencing using converged network technologies (Sage Research, 2006).

Of course, industry keynoters rarely leave full-motion video off their list of future “killer” applications. Many in the end-user community are very familiar with videoconferencing; a solution set that has been around for over 20 years. Videoconferencing provides two-way, interactive audio and video communications between two or more end points. In the past decade, videoconferencing technology and products have advanced along multiple fronts:

- ♦ The move to IP networks that provide higher bandwidth, lower costs, and vastly improved connection reliability.
- ♦ The evolution from low-resolution to high-resolution images and now to high definition (720p and 1080i) video.

- ♦ Equally important, the advances from tinny, low bandwidth (3 kHz) AM-quality audio to 7, 14, and even 22 kHz wideband, stereo, spatial audio that is equivalent to CD quality, greatly improving speech intelligibility while vastly reducing “meeting fatigue” (Wainhouse Research, 2008).

For example, in mid-2005, LifeSize Communications, based in Austin (Texas), made public the world's first high-definition videoconferencing system. By leveraging high-power compression hardware and efficient encoding and decoding standards (such as the ITU H.264 standard), LifeSize Communications' solution increases “video realism” by providing up to 10 times the resolution of standard videoconferencing images. Other videoconferencing manufacturers, including Polycom, Sony, Tanberg, and Teliris, followed suit with the announcement of HD systems of their own within the same year. The true benefit of higher resolution for videoconferencing is that it allows users to enjoy clear, non-pixelated images, thereby supporting images with finer detail and the ability to sit closer to the screen, which, in turn, enables images to be more life-sized without being grainy (Davis, 2006).

As exciting as this development may be, two obstacles remain to HD videoconferencing's wider adoption. First, with 10 times the pixel count in the video image, HD requires more processing power than many installed videoconferencing systems can currently provide—most legacy systems just will not be up to the task (Davis, 2006). The second obstacle is bandwidth. Many videoconferencing systems today operate at 384 Kb/s, a legacy from the old ISDN days. As users migrate from ISDN to IP videoconferencing, many are also moving to 512 Kb/s and 768 Kb/s; HD videoconferencing requires even higher bandwidths: between 1 Mb/s to 3 Mb/s, depending on different factors (Davis, 2006). Then, there is the cost. Sample costs for some of these systems include: LifeSize Room, \$12,000; HP Halo at \$600,000 per room for installation and \$18,00 per month per room for operation; Teliris, \$8,000 to \$12,000 per month; and Destiny Conferencing, \$100,000 per room installation, plus \$2,000 to \$8,000 per month for operation (Davis, 2006). Exactly how these issues will impact the adoption rate of HD videoconferencing remains to be seen. Although the near future does not seem likely to promise the replacement of face-to-face meetings with electronic togetherness—video, Web, or otherwise—new kinds of computer-mediated interactions among people are nevertheless likely to be facilitated where participants can share an aural as well as visual virtual meeting space (Lucky, 1991).

What is the next step in pursuit of a more realistic virtual meeting? Some would say the answer is “telepresence.” Cisco Systems President and CEO, John Chambers, stated at Interop Las Vegas 2006 that “[t]elepresence blends high-bandwidth IP communications into a high-resolution video- and voice-conferencing system. Such solutions will be so refined that users will be able to detect subtle nuances in the responses of other participants and follow them around a room” (Neel, 2006). The result is a “shared, simulated environment that makes it appear as if everyone is in the same room” (Ditlea, 2000, p. 28) by integrating the cameras, displays, and other technologies into the meeting room environment (Weinstein & Lichtman, 2005).

So, what's the difference between telepresence and HD videoconferencing? Wainhouse Research has defined telepresence as conferencing “solutions [that] use video- and audioconferencing components as well as other ‘arts and sciences’ to create a two-way immersive communications experience that simulates an in-person, interactive encounter” (Wainhouse Research, 2008). In fact, many elements embedded in “traditional” videoconferencing systems (self-view, moving cameras, etc.) are intentionally left out of telepresence systems since they would break the “immersive” experience or shatter the “sitting across the same table” illusion.

An early pioneer in the development of telepresence, Cisco Systems announced in April 2008 that only 18 months after the initial roll-out of TelePresence (see Figure 23.2), they had surpassed the 500 unit milestone for the high-definition enterprise-class videoconferencing piece of Cisco's unified communications product line

(Cisco Notches Telepresence Milestone, 2008). Most of the units are already deployed in what Cisco calls “TelePresence room” that house up to three massive high-definition screens. There are now about 200 such rooms globally in 29 countries and 95 cities worldwide (Cisco Notches Telepresence Milestone, 2008). As one would expect, telepresence systems are expensive. With high end compression engines, high-quality cameras, large flat panel displays, and carefully designed and integrated furniture and room elements, telepresence systems cost much more than standard “vanilla” videoconferencing solutions. Most telepresence systems currently fall in the range of \$200,000 to \$400,000 each, with \$300,000 list price perhaps representing the average for a six-seat room. In contrast, videoconferencing systems range from \$10,000 to \$65,000, with perhaps \$25,000 representing a good industry average (Wainhouse Research, 2008). In addition, because they strive for the highest-quality images, telepresence systems require more bandwidth. Many vendors are recommending 10 Mb/s to 15 Mb/s connections for each telepresence room, while high-end standard definition conference room videoconferencing systems typically operate between 384 Kb/s and 1.5 Mb/s and high-definition videoconferencing systems typically operate at 2 Mb/s (Wainhouse Research, 2008).

Cisco counters that TelePresence rooms are used an average of five hours per day, compared with an average of only 30 minutes for other teleconferencing offerings. Based on this data, Cisco estimates that its customers have saved “more than \$60 million in productivity improvement” (Cisco Notches Telepresence Milestone, 2008). Just how Cisco came up with their numbers is not very clear; nevertheless, a clear pattern of usage has emerged—“system usage increases over time and as the number of systems increases” (Wainhouse Research, 2008). In a company with two telepresence rooms, usage typically starts at a few hours per day and increases regularly until it stabilizes at a rate that is often location dependent. To some extent, usage also increases as the number of systems increase—a classic illustration of Metcalfe’s law: the value of a network is proportional to the square of the number of endpoints; or the value of an endpoint is proportional to the square of the number of endpoints to which it can connect (Wainhouse Research, 2008). According to a Sage Research report on future benefits of telepresence, employee collaboration benefits are among the top improvements companies expect (Sage Research, 2006). Other anticipated benefits include improved productivity and cost savings from cut-backs in business travel and other conference services (video-, Web- and audioconferencing).

As one of the principal applications anticipated for Internet 2—tomorrow’s much faster, next-generation Internet—“tele-immersion visually replicates, in real time and in three dimensions, slabs of space surrounding remote participants in a cybermeeting” (Neel, 2006). Demonstrated for the first time in May 2000, researchers at Advanced Network and Services in Armonk (New York), the University of Pennsylvania in Philadelphia, and the University of North Carolina at Chapel Hill tested a three-dimensional virtual meeting room where participants could see and interact with their life-sized colleagues viewed through “windows”—each participant physically located hundreds of miles away from the others (Ditlea, 2000). Although described as being somewhat crude, requiring users to wear awkward goggles and head tracking devices (not to mention requiring nine separate video cameras per participating location), the test provided vindication for two years of collaborative research between the participants and afforded a brief glimpse of what might lie beyond today’s videoconference room. Jaron Lanier, chief scientist for the project and one of the primary scientists who helped invent and popularize virtual reality in the 1980s and 1990s, believes the test demonstrated viewpoint-independent, real-time scene sensing, and reconstruction (Ditlea, 2000). Despite suffering from video glitches, Lanier states that the ultimate tele-immersion experience is meant to be seamless (Ditlea, 2000). As discussed in Chapter 13, scientists continue to work on autostereo screens (for three-dimensional views without bulky headgear) and advances in haptics (for tactile simulations).

Figure 23.2

Cisco System, Inc.'s TelePresence Screen Shot



Source: Cisco Systems, Inc.

As broadband access continues to increase, fully-immersive virtual conferencing may become a reality, but today, it is still awkward and “kludgy” at best. Still, if we go back just three or four years, who would have imagined that virtual events—real-time integrated collaboration via audio-, video-, and Web conferencing—would be a business reality today?

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Section IV ♦ Networking Technologies

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The Mobile Revolution

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The history of communication technology is characterized by a series of revolutions, each related to the introduction of new communication technology. The printing press made universal literacy possible. The telegraph, telephone, and wireless enabled long distance communication to occur instantaneously. Radio and television brought mass entertainment into homes. Most recently, the Internet has revolutionized information delivery and retrieval, entertainment, and commerce.

One lesson that may be drawn from reading the previous chapters is that we are at the threshold of yet another revolution: the mobile revolution. The combination of the Internet and IP-based technology has yielded a new technology system that has the potential to revolutionize society as much as any previous communication technology. The purpose of this chapter is to explore this mobile revolution, characterize the nature of the revolution, put the revolution into context, apply theory to help understand the revolution, and define limits to the revolution.

The enabling technology behind the mobile communications revolution is the infrastructure that has been created to support cellular telephony, discussed in Chapters 17, 18, and 19. As cellular telephones have diffused throughout societies, service providers have recognized the value of using their networks to provide advanced services in the same fashion that they provide telephone service. With the advent of digital technology, with virtually any type of information encoded as a binary data stream, it is natural for messages and communication created for one medium to migrate to other media. From a strictly technological perspective, the advances in mobile communication that we have explored in this book do not constitute a revolution; rather, they are simply another step in the evolution of the technology.

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The revolution will occur in the manner in which these technologies are utilized to alter basic social institutions. The most important of these are health care, education, commerce, and entertainment and information retrieval.

The heart of the mobile revolution is a personal communication device connected to a mobile network. The most common of these are mobile telephones. Of course, the term “mobile phone” barely begins to describe the capabilities of these devices. Today’s typical mobile telephone includes a camera, the ability to send and receive text, the ability to capture and view photos, and the ability to even record and watch video. Many include MP3 players as well. So-called “smart phones” include more advanced processors and increased memory, allowing these devices to be used for word processing, spreadsheets, games, and virtually any other application found on a computer.

As we explored in Chapter 19, other devices are taking advantage of the same underlying technologies. There is a new generation of mobile communications devices that combine the portability of mobile telephones, the bandwidth of mobile telephone networks, and the ubiquity of wireless networks in general. These devices can be embedded in cars to provide GPS (global positioning systems), telephone service, and vehicle tracking. They are used in retailing and shipping to track transportation of goods and locate assets. They are used in law enforcement to enhance security and provide forensic information. In short, nearly every area of commerce and public safety has the potential to evolve as part of the mobile communications revolution.

Personal Communication

The first manifestation of the mobile communications revolution is simple and obvious. Telephones, which used to be associated with places, are now associated with people. There are numerous implications to this change. For example, individuals are much more concerned about protecting the privacy of their person than they are concerned with the privacy of a dwelling or an office. As a result, at least in the United States, telephone directories are limited to those telephones that are connected with a place. There are widely accessible directories of cellular telephone users, and companies that have attempted to establish such directories have been disappointed by the lack of consumer interest in sharing their mobile telephone number with the world.

The next dimension of the mobile communications revolution is the ubiquity of communication access. The day of waiting to make a phone call until a person arrives at home or the office is over. In fact, it is unusual for a person to not have telephone access. There are some interesting implications to this aspect of the revolution. For example, emergency services response times to automobile accidents has been shortened because accidents are reported more quickly, usually by people observing the accident and calling for emergency service within seconds of the event. Ironically, there is also concern that the number of accidents has increased because of drivers being distracted while talking on the telephone.

As telephone service has become ubiquitous, other communication media have leveraged the wireless telephone networks and underlying technology to deliver a more portable experience. Any type of information or entertainment that was formerly consigned to a specific location may now be available in mobile form. It may be argued that the resolution of today’s mobile phone screens is not high enough to support delivery of high-quality television or video images, but the mere presence of the application allows the opportunity for a market for higher-definition mobile screens to be developed.

It is not likely going to be the traditional media organization that will be impacted most by this revolution. News organizations have consistently adapted themselves to new media, finding ways to deliver existing content to audiences through new channels. There are other institutions, including some that are usually slower to change, that should be impacted even more by the mobile revolution. The following sections explore these impacts.

Education

The mobile communications revolution has the potential to revolutionize social institutions not typically associated with mobile media, including educational systems and institutions. In addition to revolutionizing educational tools such as libraries and books, these technologies have the potential to redefine education.

The biggest impact in this area is likely to be upon libraries. Libraries were created as a storehouse of knowledge, holding collections of books because books were the medium in which knowledge is stored. As other media began to supplant print technology, libraries paid increasing attention to these other media, but still focused primarily upon gathering books, periodicals, and other printed information. The core task of librarians remains organizing and cataloging information, and that task is equally relevant to the distribution of information as it is to the storage of information.

The impact of the mobile revolution upon libraries will be a change in function from places visited to retrieve information to agencies engaged in the cataloging and distribution of information. There will certainly be copyright and other challenges associated with ownership of information along the way, but the capability of the library to deliver information to its users, or anyone in the world, will likely become their most important role in the future.

The next impact of the mobile revolution is closely related: that is, its impact upon education. One major dimension of education is the organization and provision of information. The most basic tool used in education is books, because books convey a great deal of stored information in an organized fashion. Mobile communications technology has the potential to deliver the same information with three major improvements:

- 1) Through a mobile network, information can be updated almost instantaneously.
- 2) The same network can make information available anytime/anywhere.
- 3) The process of retrieval of information will become much more interactive.

There is still a question about how effective teaching and learning is at a distance. Some types of information, for example, information that is unambiguous, can easily be communicated through low-bandwidth media (Daft & Lengel, 1984). On the other hand, lessons that involve interpretation, discussion, or levels of ambiguity may not be as effectively taught through mobile communications media as through the traditional face-to-face educational process.

Health Care

The most far-reaching impact of the mobile communications revolution may be to revolutionize health care. These technologies will offer greater access to health resources and information than ever, but the implications go much deeper as the health-care system utilizes the ubiquity of mobile communication.

Mobile technologies will enable continuous monitoring and evaluation of a full range of medical conditions, with the capability to summon help as well as recording vital signs and behaviors. Imagine a sensor worn by a person at risk for heart attack (or any other condition) that can automatically summon help when it is needed—perhaps before a patient even realizes they are ill.

Using these technologies, a person's entire medical record can be accessed anytime, anywhere, increasing cooperation and communication among physicians, specialists, and other health-care providers. The applications in monitoring, diagnosis, and treatment will be limited only by the cost of implementation. As health-care costs increase, the potential of mobile media to reduce the cost of health care will be directly related to the speed of adoption of mobile health-care technologies.

Mobile Commerce

As with other communication technologies, most notably the Internet, mobile communications technologies enable a wide variety of commercial applications. Information and entertainment services such as music and ring tones that have proven profitable for mobile telephone companies will be supplemented with additional information and entertainment content.

Mobile commerce should soon expand to include purchase of any products available in catalogs or retail stores, with Web-style mobile commerce sites developing to serve the particular needs of consumers on the go. The possibilities range from online catalogs to virtual malls, with the limits of the technology being pushed by the profit motivation.

Other Social Institutions

The mobile revolution will impact other social institutions as well. Law enforcement, for example, will benefit from a variety of new forensic information created by the mobile revolution, including digital trails, video surveillance, and records of crime scenes made by cameras and mobile phones. One example is a program announced in 2007 by General Motors, which is equipping its mobile OnStar system with technology that will allow police to remotely slow and stop any OnStar-equipped vehicle they are pursuing (Gilroy, 2007).

Similarly, social scientists and consumer researchers will have new capabilities for monitoring the behavior of individuals. This behavioral research should yield much greater insight into consumer behavior than traditional interviews and survey techniques.

Even religion may be profoundly impacted by the mobile revolution. Instead of a church being seen as the place for people to go to worship, mobile communications technologies have the potential to connect members of the congregation, anytime and anywhere, especially when a person needs support from his or her church. The development of any such “virtual church” will certainly intensify the involvement of church members in the congregation.

Traditional Media Applications: Information and Entertainment

As discussed in the introduction to this chapter, traditional media organizations should be expected to make extensive use of mobile communications technologies to enhance the delivery of information and entertainment, as well as strengthening the relationship that individual audience members have with the media organization.

News organizations have been among the first to make use of the capabilities of the mobile communications revolution, beginning with the redistribution of Web content and now including video and other types of news. These organizations have barely begun to scratch the surface of what will be possible in delivering information over mobile media. Just as television news began with a similar repurposing, i.e., people reading the newspaper into a TV camera, then evolved to deliver an entirely new type of news, so can we expect mobile media to undergo a similar evolution, with new formats and unique content.

In a similar manner, new forms of entertainment will evolve from existing movies, TV programs, music, and games. One characteristic of mobile entertainment is likely to be increased opportunities for interactivity, as mobile media leverage the capabilities of wireless networks.

Theoretical Perspectives

Studies of the diffusion and adoption of communication media over the past 100 years have indicated a number of patterns and underlying principles that help to predict not only the potential for success like the pattern of adoption of new media. Diffusion theory (Rogers, 2003), collective action (Olson, 1965), critical mass (Markus, 1987), and pre-diffusion theory (Grant, 1990) can be combined to offer clues regarding the manner in which the individual technologies discussed above will diffuse.

Diffusion Theory

As discussed in Chapter 3, Rogers (2003) identified five attributes of innovations that play a part in predicting the success of the innovation: trialability, observability, complexity, compatibility, and relative advantage. For this discussion, two of these bear special attention: observability and compatibility. Mobile communications technologies have a distinct advantage in the adoption process over many other technologies because of their observability. By their nature, these technologies can be used in a variety of public environments, allowing prospective adopters the opportunity to see others using the technologies, increasing the likelihood of adoption.

The fact that these technologies are compatible with the existing technological infrastructure also increases the potential for adoption of each of these mobile technologies. Rather than requiring an entirely new infrastructure to support new applications, the existing infrastructure allows a more rapid growth of new mobile communication applications, with lower investment costs and shorter time to market.

Critical Mass

Many mobile technologies fall into a special class of communication technologies: interactive technologies. Markus' (1987) theory of critical mass of interactive technologies indicated that adoption of interactive technologies such as the telephone and fax machine is as dependent upon social factors as upon attributes of the technology and the adopter. Following the collective action work of Olson (1965) and Oliver, Marwell, & Teixeira (1985), Markus theorized that the pattern of adoption of interactive media technologies was characterized as an accelerating production function, with early adopters making comparatively little contribution to the public good. The rate of initial adoption for these technologies is thus very slow because most prospective adopters see little value in the technology. Each subsequent adoption, however, increases the value of the technology to all other prospective adopters. At the "critical mass" point, the number of adopters is sufficient to spur adoption by non-adopters, with adoption then quickly increasing to include all or nearly all potential adopters.

The implications of critical mass theory for mobile communications technologies cannot be understated. Novel applications that require a substantial degree of interactivity or adoption by others in order to have value for prospective adopters, such as videophones, will take much longer to diffuse because of the time needed to reach critical mass. It is just as important to note, however, that once the critical mass is reached, rapid adoption takes place among the remaining members of the social system. (This is one reason the stages of adoption of many interactive technologies resemble a revolution rather than an evolution.) Rice, et al. (1990) tested Markus' theory, finding an "all or none" phenomenon related to adoption and use of e-mail in an organization.

Markus (1987) also identified compatibility with existing technologies as a major factor in predicting the success of interactive media technologies. The more compatible the technology is with other, existing technologies, the more likely it is that the technology will reach the critical mass point and succeed in the marketplace. Again, mobile communications technologies have the distinct advantage of being compatible with a host of existing technologies, ranging from devices used by end users such as mobile telephones and laptop computers to the underlying networks that connect users with each other and with other resources through the Internet.

Pre-diffusion

It is also instructive to examine the process that must take place before the first consumer adoption of a technology can take place. In previous research (Grant, 1990), this process has been termed "pre-diffusion." The process of pre-diffusion focuses on attainment of a "diffusion threshold," defined as the point at which the infrastructure is in place to enable the first consumer adoption of a media technology to take place.

While diffusion theory focuses on attributes and resources of individuals to predict adoption of a technology, pre-diffusion theory addresses provision of the technology by organizations, including those involved in production of hardware and content, as well as distribution of hardware and content.

Pre-diffusion theory suggests that adoption of mobile communications technologies cannot take place until all relevant production and distribution functions are served by appropriate organizations. One obvious principle of pre-diffusion theory is that the mobile communications technology that is compatible with existing communication systems will more quickly attain the diffusion threshold, making it easier for consumer adoption to begin. The other primary lesson of pre-diffusion theory is that proponents of new mobile communications technology must ensure that all levels of production and distribution of hardware and software be in place so that consumer adoption can begin.

Limitations to the Mobile Revolution

It is easy to predict that the mobile revolution will dominate commerce, social systems, and everyday life, but, as with other technological revolutions, there are a number of social factors that will limit the extent of the mobile revolution. These include social, technological, regulatory, and economic barriers. Although mobile communications technology has the potential to connect us almost anywhere, social customs will likely prohibit many applications in a variety of social settings.

The technological barriers may be among the most frustrating to users. Individuals who are used to connecting anytime/anyplace, will find that every network has limitations, areas that the network does not serve for either technological or geographical reasons. Furthermore, new technologies may be applied to deliberately interfere with communication networks, thereby creating “quiet zones” where individuals are cut off from wireless networks.

Access to mobile communications technologies may also be proscribed by regulators seeking to control behavior or information access in the public good. Although regulation of communication technology typically lags adoption of these technologies, it can be a powerful force to inhibit widespread adoption of new media technologies.

Economic factors will certainly play a part in the success or failure of mobile communications technologies. Applications designed to generate a profit for those companies providing the technology will certainly make it to market more quickly than those with little or no profit potential, and greater promotional efforts will be made for these technologies.

Following the work of Jacques Ellul, Rogers (1986) stressed that communication technologies are as likely to have negative effects as positive effects. He indicated that the desirable effects were more likely to be direct effects that are anticipated, while the undesirable effects are more likely to be indirect and unanticipated. The lesson is that the mobile revolution is likely to yield as many negative social implications as positive ones, and, although the negative implications will be indirect and unanticipated, they must still be considered and studied as part of the mobile revolution.

Conclusions

It is not an understatement to characterize the changes that will be brought about by mobile communications technologies as a revolution. The technologies that have the potential to provide anytime/ anywhere con-

nectivity to virtually any person, organization, or information resource will change communication and commerce as much as the Internet has done.

The key to understanding these changes is the knowledge that there are attributes of these mobile technologies as interactive that makes the process of diffusion, adoption, and effects of these technologies different from other, non-interactive technologies. As with other revolutions, the best way to predict or understand the mobile revolution is to study previous communication revolutions. The 20th century has given us an abundance of such lessons to study, and those who take the time to understand the previous communication revolutions will be best positioned to take advantage of the mobile communications revolution.

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Conclusions

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The preceding 23 chapters reflect a number of important trends in communication technology. Many of these trends cross multiple technologies. They include major analog-to-digital transitions, content creation and control, use of the Internet, and convergence and regulation. The primary thing these trends have in common is that they are the result of political and social factors.

Since the publication of the first edition of this book in 1992, the chapter lineup has changed many times, but these factors remain the consistent forces that shape the technologies discussed. Because these technologies will continue to change over the next decades, the most useful information to retain from this book is the manner in which the social forces discussed above will impact the technologies and systems that are yet to be conceived.

This discussion therefore begins by identifying some important trends that have been a consistent concern over the past decade. For example, analog-to-digital conversion remains an issue for the traditional broadcast media: television and radio. A hard analog spectrum cut-off date (February 17, 2009) has been established for over-the-air television broadcasting in the United States. At the time this book went to press in late spring 2008, no full-scale test has been conducted of what will actually happen when the analog signal is cut off. The stakes are huge. Millions of American homes rely on over-the-air television. Will they be prepared? The Federal Communications Commission (FCC) announced that a full-scale test will take place in Wilmington (North Carolina) on September, 8, 2008. Wilmington is a small market, ranked 135 among all U.S. television markets. Only 7.4% of the population relies on over-the-air television, with the other 92.6% having either cable or satellite television service (Hearn, 2008). This small market test is an important, early step in the biggest transition that has ever taken place in American broadcasting.

Speculation abounds regarding what will happen in February 2009, with some claiming that broadcasters' information campaigns will have the majority of viewers prepared, and others predicting dire consequences for

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viewers and advertiser-supported, over-the-air television. It is useful to find an historical comparison. At the turn of the century, the computer industry expressed great concern over the “Y2K problem” when people were predicting the world’s computers would malfunction at the stroke of midnight on December 31, 1999. In that case, nothing catastrophic happened, perhaps because the problem was not that big or perhaps because companies spent billions of dollars rewriting computer software before that date to be prepared. The question is: Will the television industry be equally prepared?

Radio, on the other hand, is struggling to complete a conversion to digital transmission with no government mandate, and (so far) little consumer interest. HD (high-definition) radio technology allows users to choose whether to keep and use their analog radios and/or to adopt HD radio rather than being forced to switch. The fact that there is not a mandated switchover and that adoption is voluntary for both stations and consumers contributes to the slow adoption of this technology. Broadcasters have to highlight the advantages of switching such as the additional channels of programming available over HD radio. Most large radio markets already have at least some stations broadcasting in HD radio, but small markets have been slower to convert. For these stations, it is not about the technology, but instead is an economic decision. When a small market broadcaster is running a station on a small budget, is it worth it to the station to upgrade? If they do, will people buy the radios and actually listen? Scarce radio frequency spectrum will be freed up with the digital television transition, but not with a transition to HD radio. So is there any reason for a regulatory push? The fate of digital radio in the United States is therefore centered on the interplay of economics and regulation.

While the transition from analog to digital television and radio has a cloudy future, the future of social networking and user-generated content is relatively clear, in the short term, at least. Many of the technologies discussed in this book have incorporated some way for users to connect with others using social networks. Obviously, MySpace, Facebook, Bebo, Orkut, and Friendster are connecting millions of users everyday, but social networking is being expanded to integrate with other technologies such as Internet television, e-commerce, and digital photography. For example, Flickr users can share galleries of photographs available to a whole community of digital photography fans. The group can be private or open to all. Groups also form around interests such as knitting, lacrosse, or collecting classic Ford Mustangs.

Much of what is shared over social networks is user-generated content. User-generated content impacts not only traditional media like television and radio, as well as all forms of journalism, but it is also impacting hardware and software makers. People making content need the tools for the production. Then, they also need a means for distribution. What would YouTube be without digital video cameras, personal computers, broadband Internet connections, and video editing software?

A Pew Internet and American Life study found that 64% of online teens 12 to 17 have created content to post online (Lenhart, et al., 2007). Sociologists and educators should pay close attention to the format of the content being created. Traditional education emphasizes the grammar and organization of written communication, but the millennial generation is creating a new grammar and structure for video, graphics, and text messaging, providing a much richer media environment than black letters on white paper. This generation and the ones that follow will continue to create and share content online, establishing the rules and standards for communication for generations to come. Sharing this content over social networking sites such as MySpace is just the beginning; another application is certain to follow that will provide connectivity and features that will make MySpace seem old.

Another trend to watch is the increased level of control that the new generation of technologies will provide. Increasingly, users can choose where to get content, what devices to hold and manipulate that content,

and when and where to consume that content. For example, one can listen to the radio on an analog or HD radio, online as a stream, as a podcast on a digital media player, on a mobile phone, and through a satellite service. Not only is there more choice in what content to consume, but also where and how to get it and then how to use it. The success of individual technologies in such a competitive market will depend on how easy it is for the consumer to control the content. For example, if a person buys a movie online, it should be easy to move that movie to different computers, to a television set, to a mobile device like a cell phone or iPod, and save it on a hard media like a DVD (digital videodisc) or flash memory device. Digital rights management (DRM), then, becomes an issue. Many copyright holders want to limit how people can control the content that they purchase. That turns off users to the technology, and if the history of the music industry is any indication, consumers will find ways around the restrictions—legally or illegally.

Blending content and technologies is a form of media convergence, another important trend to consider. Journalism is probably the field that has been most impacted, with most news organizations delivering content through multiple media, including the Internet. Convergence is also being felt in entertainment—you could say the mobile phone is fast becoming the killer convergent device. Consider the iPhone and other smart phones. These devices allow users to talk to others, send text messages, watch video, listen to music, take pictures, and use the Web with a fully functional Web browser. That means just about anything you can do on the Web, you can do on a smart phone. These devices are going to become even more sophisticated. For example, GPS is increasingly a standard feature in mobile phones and devices, enabling location-based services such as advertising and directions. Imagine arriving in a new city and having your mobile device automatically send you information on local services that interest you, using your past behaviors as a guide.

Another interesting development that needs continued study is community-generated content such as Wikipedia. When the 10th edition of this book was being written in 2006, wikis and Wikipedia were a hot technology. The power of peer production as exemplified by Wikipedia was being touted as *the* way to build and share information. As Anderson (2006) writes, the speed of change on the Internet allows the information on Wikipedia to be updated quickly, unlike a published paper book. With a hard copy of a book, once it is printed, it is pretty much impossible to go back and fix or change anything. The problem with Wikipedia that became especially evident in 2007-2008, is that anyone can change Wikipedia entries. The initial goal was that, if information was incorrect, another user could correct it. As with many noble goals, the practice has occasionally been perverted, with people (and companies) deliberately changing information to delete unfavorable content. Or sometimes, users would deliberately sabotage entries. It has become almost a game. The result is that people started to consider wikis and the “power of peer production” as unreliable sources of information some of the time. Much of what is on Wikipedia is valid, but how can a user really tell? The reliability is low enough that authors of chapters in this edition of the *Communication Technology Update and Fundamentals* were asked not to use Wikipedia as a source.

One single event stands out as having the potential to impact the widest range of technologies: the 2008 U.S. presidential election. No matter who becomes the next president, the regulatory environment and the administration of the Federal Communications Commission (FCC) will change. The impacts of this change probably will not be felt until 2009, but it is possible to predict some of the bigger issues that will be impacted. These issues include ownership limits, net neutrality, and obscenity and indecency.

Finally, most of the people reading this book probably do not remember a world without computers and the Internet and consider them essential for everyday life. Think about the technologies that the next generation will consider essential. Do you want to simply be a user of these technologies, or do you want to step up to be a creator of the next generation of communication technologies? If you want to be a creator, consider the

lessons in the “Fundamentals” section that begins this book. Your chances of succeeding will be infinitely better by applying history and theory, and developing your technology to work within the organizational and regulatory structure of the communication industries.

In reviewing the preceding 23 chapters, you should note that there is almost no mention of any revolutionary new technology that could fundamentally change the hardware that has been discussed. Widespread application of basic developments in technology only happens about once or twice a decade (transistors and lasers in the 1960s, microprocessors in the 1970s, IP and digital technology in the 1980s, and compression technologies in the 1990s). Technological developments are surely pending, but they are rarely as important to follow as those in regulation, economics, culture, and organizational infrastructure.

It is the interplay of all of these forces that makes the study of communication technology so exciting. Any day could begin with an announcement of a new discovery, merger, regulation, or fad that could change the trajectory of any technology discussed in this book. At the end of the day, these technologies share a common purpose, providing a means for humans to communicate.

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