
بسم الله الرحمن الرحيم

Network Security

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What's ahead?

- The Course's Big Picture
- Introduction to Cryptography and Data Security
  - Overview on the field of cryptology
  - Basics of symmetric cryptography
  - Cryptanalysis
  - Substitution Cipher
  - Modular arithmetic
  - Shift (or Caesar) Cipher and Affine Cipher

Why do we need to study Computer/Networks/Information security?

The art of war teaches us to rely not on the likelihood of the enemy's not coming, but on our own readiness to receive him; not on the chance of his not attacking, but rather on the fact that we have made our position unassailable.

—The Art of War, Sun Tzu

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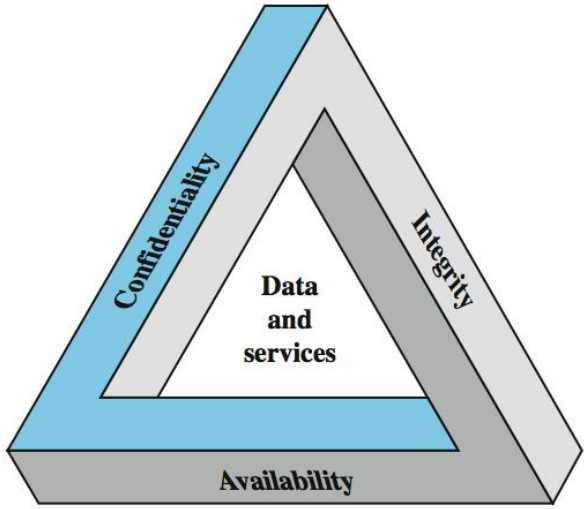
Why these three different terms?

Outline of the Course

- Cryptographic Algorithms
  - Symmetric Ciphers
  - Asymmetric Ciphers
  - Hash Functions
  - Protocols
- Mutual Trust
- Network & Internet Security
- Computer Security

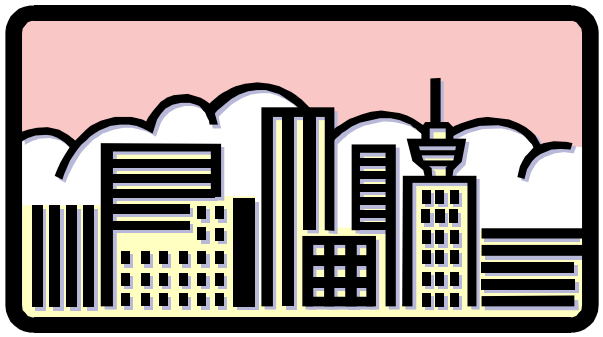
CIA Triad

- Confidentiality
  - Data confidentiality
  - Privacy
- Integrity
  - Data integrity
  - System integrity
- Availability



OSI Security Architecture

- ITU-T X.800 “Security Architecture for OSI”
  - defines a systematic way of defining and providing security requirements
  - for us it provides a useful, if abstract, overview of concepts we will study



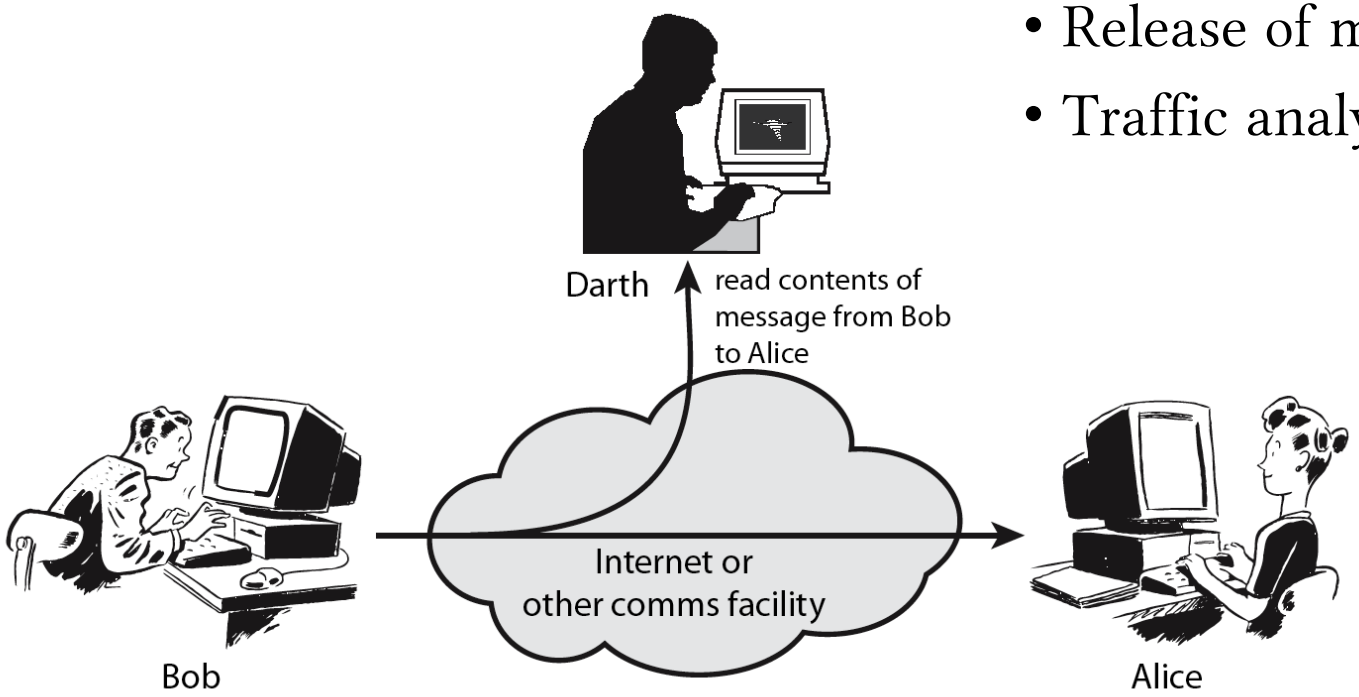
Standards Organizations

- National Institute of Standards & Technology (NIST)
- Internet Society (ISOC)
- International Telecommunication Union Telecommunication Standardization Sector (ITU-T)
- International Organization for Standardization (ISO)

Aspects of Security

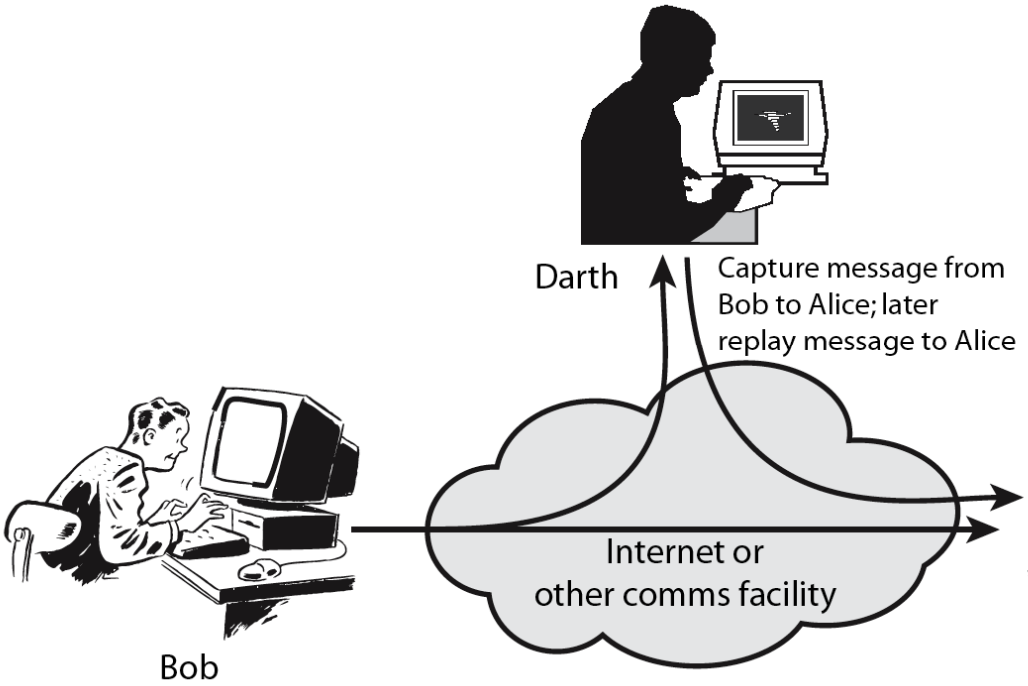
- X.800 considers 3 aspects of information security:
  - security **attack**
  - security **mechanism**
  - security **service**
- note terms (RFC 2828)
  - **threat** – a potential for violation of security
  - **attack** – an assault on system security, a deliberate attempt to evade security services

Passive Attacks



- Release of message content
- Traffic analysis

Active Attacks



- Masquerade
- Replay
- Message modification
- Denial of service

A Security Service

- enhance security of data processing systems and information transfers of an organization
- intended to counter security attacks
- using one or more security mechanisms
- often replicates functions normally associated with physical documents
  - which, for example, have signatures, dates; need protection from disclosure, tampering, or destruction; be notarized or witnessed; be recorded or licensed

Security Services

- X.800:

  "a service provided by a protocol layer of communicating open systems, which ensures adequate security of the systems or of data transfers"

- RFC 2828:

  "a processing or communication service provided by a system to give a specific kind of protection to system resources"

Security Services (X.800)

1. **Authentication** - assurance that communicating entity is the one claimed
   - have both peer-entity & data origin authentication
2. **Access Control** - prevention of the unauthorized use of a resource
3. **Data Confidentiality** –protection of data from unauthorized disclosure
4. **Data Integrity** - assurance that data received is as sent by an authorized entity
5. **Non-Repudiation** - protection against denial by one of the parties in a communication

Security Mechanism

- feature designed to detect, prevent, or recover from a security attack
- no single mechanism that will support all services required
- however one particular element underlies many of the security mechanisms in use:
  - **cryptographic techniques**
- hence our focus on this topic

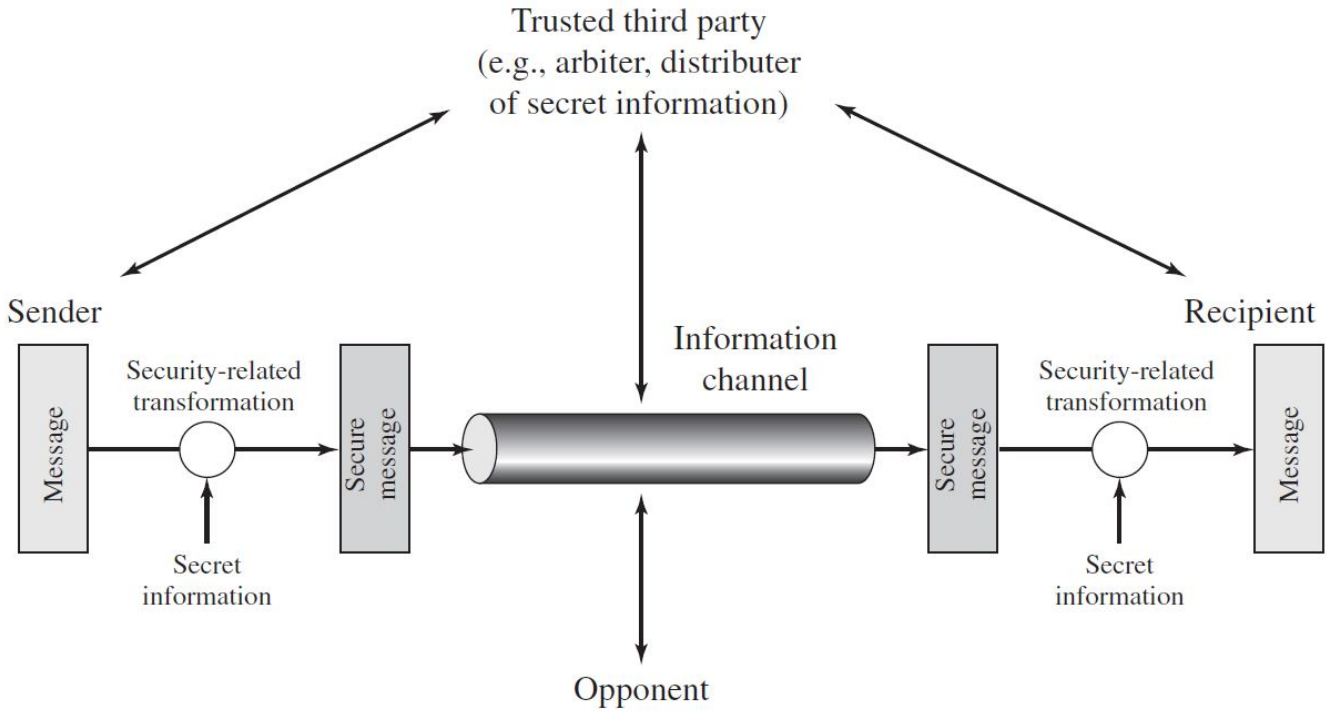
Security Mechanisms (X.800)

- specific security mechanisms:
  - encipherment, digital signatures, access controls, data integrity, authentication exchange, traffic padding, routing control, notarization
- pervasive security mechanisms:
  - trusted functionality, security labels, event detection, security audit trails, security recovery

Security Service vs. Mechanism?

SERVICE \ MECHANISM	Encipherment	Digital signature	Access control	Data integrity	Authentication exchange	Traffic padding	Routing control	Notarization
Peer entity authentication	Y	Y			Y			
Data origin authentication	Y	Y						
Access control			Y					
Confidentiality	Y						Y	
Traffic flow confidentiality	Y					Y	Y	
Data integrity	Y	Y		Y				
Nonrepudiation		Y		Y				Y
Availability				Y	Y			

Model for Network Security

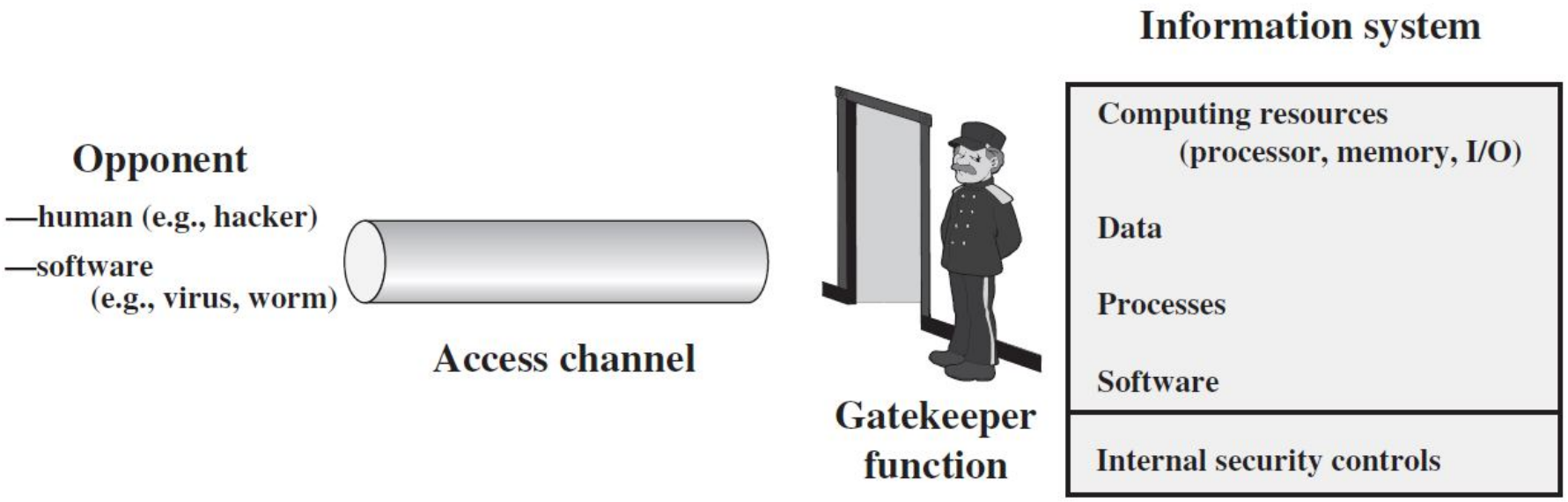


Model for Network Security

using this model requires us to:

1. design a suitable algorithm for the security transformation
2. generate the secret information (keys) used by the algorithm
3. develop methods to distribute and share the secret information
4. specify a protocol enabling the principals to use the transformation and secret information for a security service

Model for Network Access Security



Model for Network Access Security

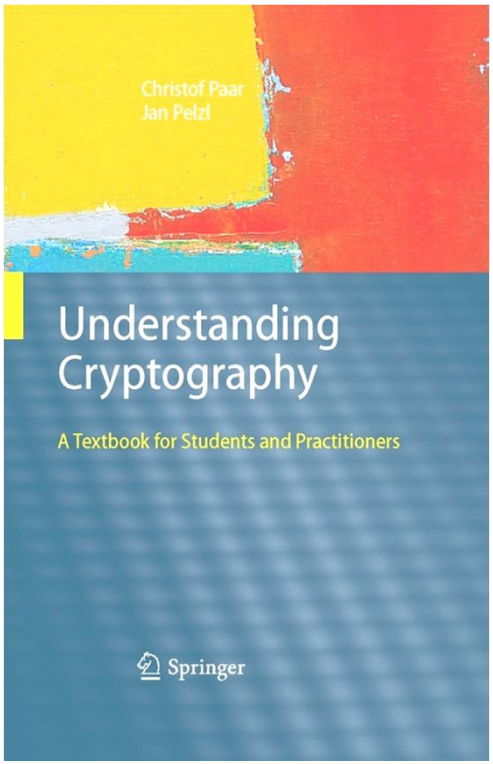
using this model requires us to:

1. select appropriate gatekeeper functions to identify users
2. implement security controls to ensure only authorised users access designated information or resources

Required References

[PP10] Paar, Christof, and Jan Pelzl. ***Understanding cryptography: a textbook for students and practitioners***. Springer Science & Business Media, 2010.

All Chapters



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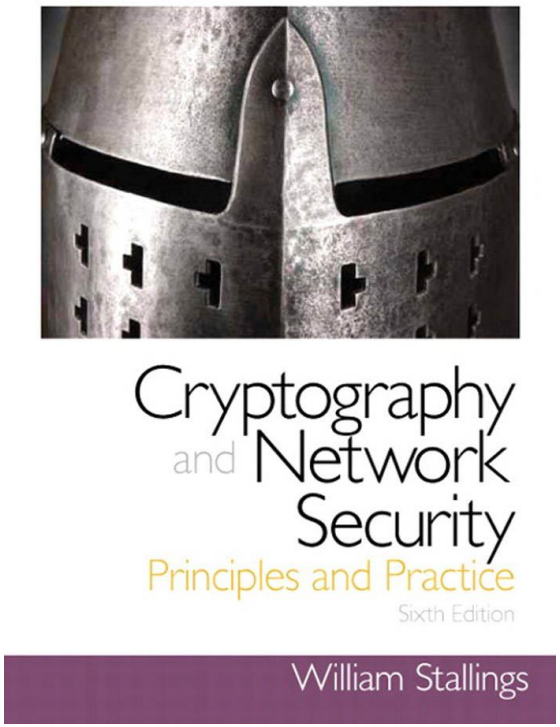


[S14] Stallings, William. **Cryptography and Network Security: Principles and Practice**, 6th Edition. Pearson Higher Ed, 2014.

Parts 4 to 6

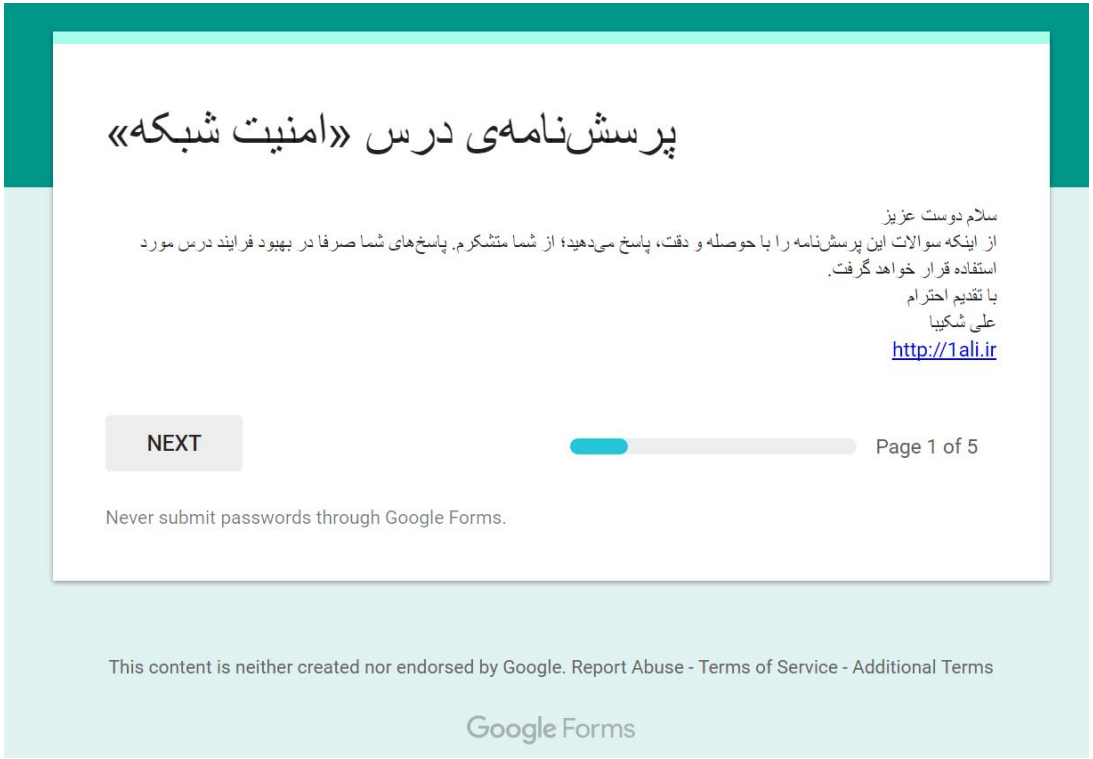
Evaluation

Title		Grade	Description
Exercises		5	At least 10 series, weekly
Project	Written Report	3	
	Presentation	2	
Written Exams	Midterm	4	Thursday, 4th Azar 1395
	Final	6	Consult EDU
Excellence		+2	
Total		**20 + 2**	

Course Page:

http://1ali.ir/network-security-95-1.html

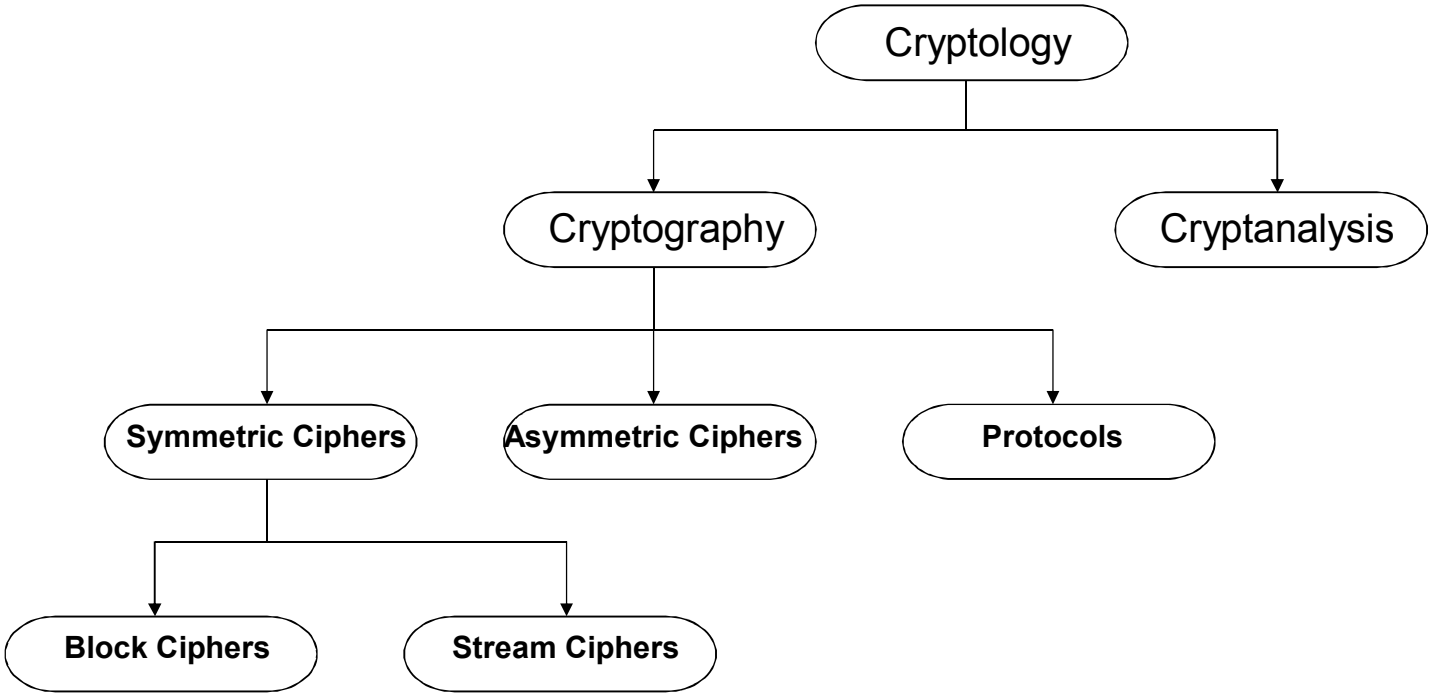
Fill in the SURVEY by the next session, please!



Let's Start Our Journey!

The Empire of Cryptology

Classification of the Field of Cryptology



Some Basic Facts

- **Ancient Crypto:** Early signs of encryption in Eqypt in 2000 B.C.
  Letter-based encryption schemes (e.g., Caesar cipher) popular ever since.

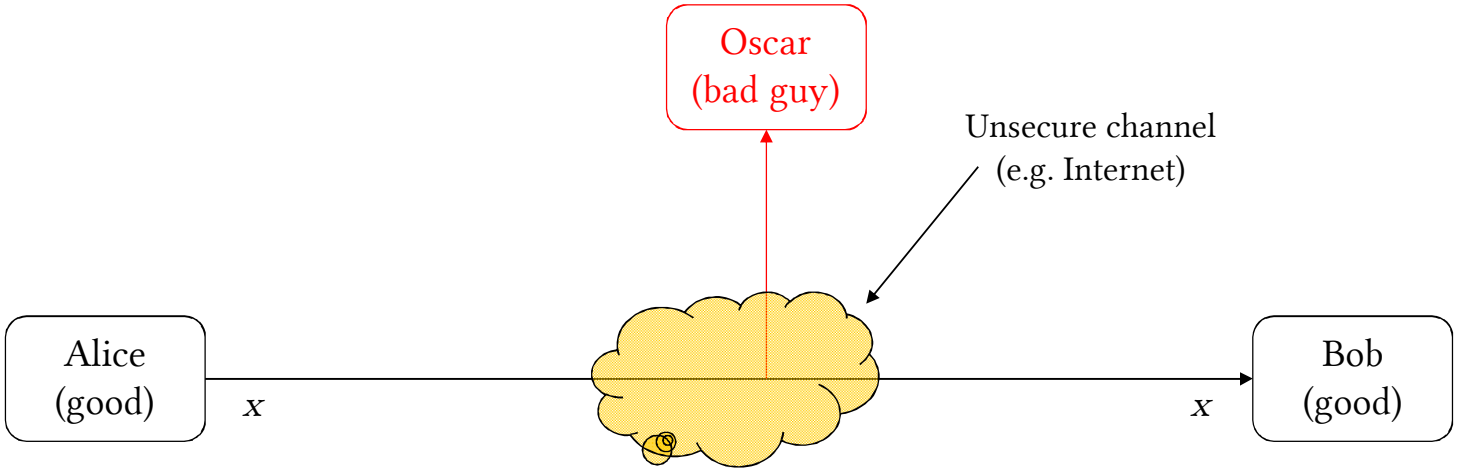
- **Symmetric ciphers:** All encryption schemes from ancient times until 1976 were symmetric ones.

- **Asymmetric ciphers:** In 1976 public-key (or asymmetric) cryptography was openly proposed by Diffie, Hellman and Merkle.

- **Hybrid Schemes:** The majority of today‘s protocols are hybrid schemes, i.e., the use both
  - symmteric ciphers (e.g., for encryption and message authentication) and
  - asymmetric ciphers (e.g., for key exchange and digital signature).

Symmetric Cryptography

- Alternative names: **private-key**, **single-key** or **secret-key** cryptography.



- **Problem Statement:**

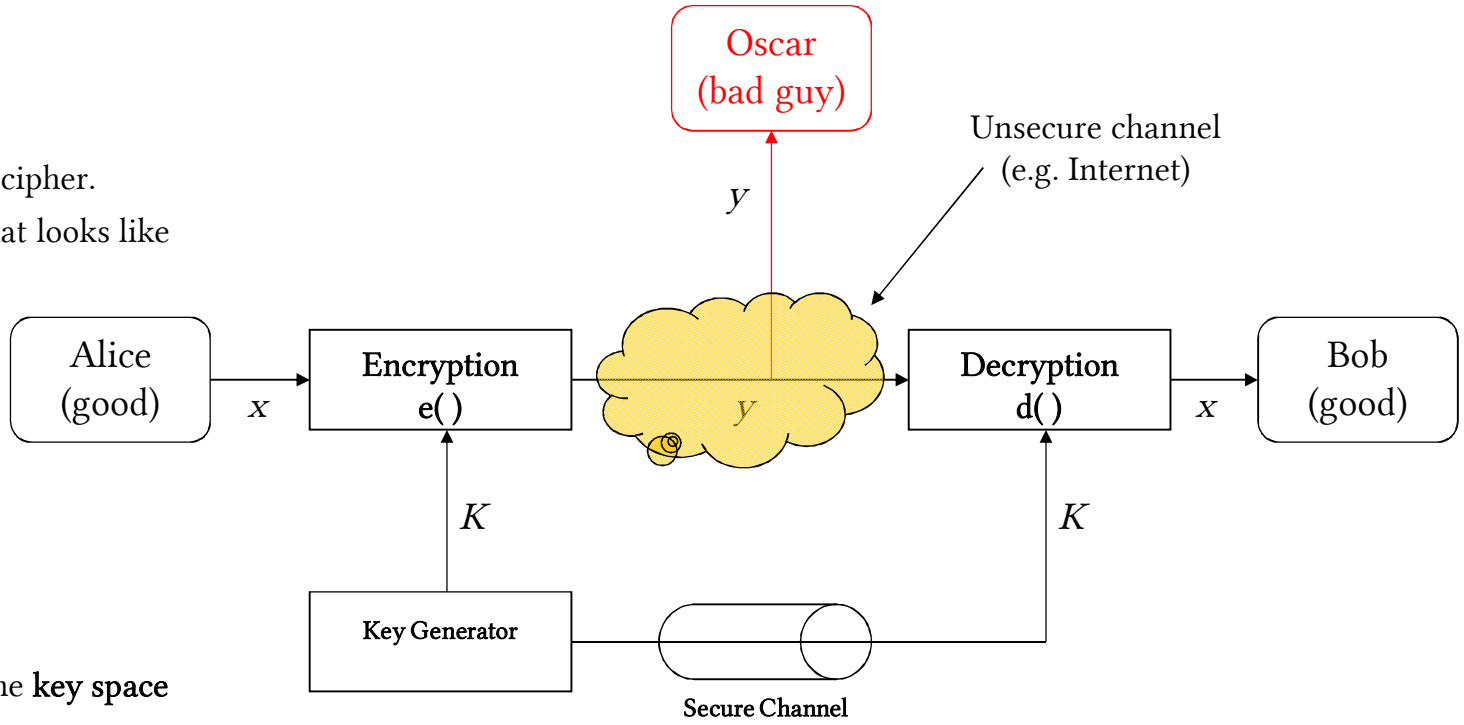
  1) Alice and Bob would like to communicate via an unsecure channel (e.g., WLAN or Internet).

  2) A malicious third party Oscar (the bad guy) has channel access but should not be able to understand the communication.

Symmetric Cryptography

Solution: Encryption with symmetric cipher.

⇒ Oscar obtains only ciphertext y, that looks like random bits



- x is the. **plaintext**
- y is the **ciphertext**
- *K* is the **key**
- Set of all keys {*K*1, *K*2, ...,*Kn*} is the **key space**

Symmetric Cryptography

- Encryption equation $y = e_K(x)$
- Decryption equation $x = d_K(y)$

- Encryption and decryption are inverse operations if the same key K is used on both sides:

$$d_K(y) = d_K(e_K(x)) = x$$

- Important: The key must be transmitted via a **secure channel** between Alice and Bob.
- The secure channel can be realized, e.g., by manually installing the key for the Wi-Fi Protected Access (WPA) protocol or a human courier.
- However, the system is only secure if an attacker does not learn the key K!

⇒ The problem of secure communication is reduced to secure transmission and storage of the key K.