EPC/RFID Advanced Infrastructure Implementation

Student's Handbook

V1.1

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Document Conventions

Icons

The following icons appear in the Student's Syllabus. We included icons to draw attention to the text beside them and to give an immediate visual clue about the meaning of the material contained in the section.

Useful **information**, often summarised. Hints and tips

This information icon indicates **additional information** or **resources**.

Acknowledgements

This course was created by the following subject matter experts.
Their contribution and expertise made this course what it is.

Table of contents

Chapter 1: INTRO

Welcome to this EPC Advanced Infrastructure Implementation course.

We are happy to present you with this course where you will learn more about implementing the infrastructure required for an EPC/RFID system.

Enjoy the course!

Implementing RFID is similar to implementing a new IT system or a new business process.

To do so efficiently, you will need to follow good project management methodology and define your implementation road map

This implementation roadmap can vary from one company or one industry sector to another.

This course focuses on the implementation aspects that are particular to EPC/RFID infrastructure.

Those aspects are:

- The selection of EPC/RFID system design
- The site analysis
- The installation of the system
- The security of the system
- The monitoring & troubleshooting of the system

and therefore does not cover the others steps of the implementation roadmap such as the cost-benefits analysis, the project management or the communication

This course also does not cover extensively the implementation of EPCIS as this will be covered in a separate course.

This course builds on the knowledge that you have acquired in the "Basics of EPC" and in the "EPC / RFID – Advanced technical aspects" courses.

It is strongly advised that if you're not familiar with EPC and/or RFID, that you first take the "Basics of EPC" course.

It is also strongly advised that you first take the "EPC / RFID – Advanced technical aspects" if you are not familiar with the technicalities of tags, antennas or radiofrequency waves.

Chapter 2: SELECTION OF THE EPC/RFID SYSTEM DESIGN

What is in this chapter?
The basic principle of RFID is that a tag and a reader communicate data by using the same radio frequency. *To select the right frequency for your system, you need to understand how the various performance parameters, such as read range, tag response time, and storage capacity, depend on the frequency.* *This understanding will also help you select the correct hardware components for your RFID system, such as readers, tags, and antennas. The tags are attached to the items that need to be identified and tracked, whereas readers will be mounted at places from where they will read the tags.* *In this chapter, you will learn how to design your EPC / RFID system to best meet your application performance requirements.*

2.1 Selecting the vendor(s)/solution providers

Vendors play a major role in helping you design, implement, and manage your solutions and therefore finding the right vendors who can help you address your business issues is critical.

This means that proper vendor selection often makes the difference between a successful project and a failed one.

For an RFID project, this is especially true because its usage is relatively new in areas such as supply chain where only a small set of industry-wide references, best practices, and case studies are available.

2.1.1 Best-of-Breed approach

The Best-of-Breed approach involves selection of the best vendor for each specific portion of an RFID project.

… you are in control and manage all aspects of the project in house…

For example, you can select the best vendor of tags and readers, select another vendor that is best at installing and testing, and select yet another vendor that is best qualified to do application integration within your enterprise.

The choice of which vendor is the best often depends on the specific application and industry. For example, a vendor may offer the best high frequency (HF) tags and readers for rugged environments but may not be the best choice for UHF tags and readers for inventory management in a packaged goods warehouse.

The Best-of-Breed approach implies that you are in control and manage all aspects of the project in-house.

2.1.2 One-Stop-Shop approach

The One-Stop-Shop approach involves selecting one single vendor to act as the primary contractor vendor for the RFID project.

In this case, the primary contractor often manages the entire lifecycle of the project and is responsible for all phases of the project including the selection of additional vendors/sub-contractors

For example, if the primary contractor is a systems integrator, it is likely to rely on an RFID hardware vendor to select the type of tags and readers most suitable for the project.

… one vendor is primarily in control, manages all aspects of the project …

The One-Stop-Shop approach means one vendor is primarily in control, manages all aspects of the project, and takes responsibility for the overall outcome of the project.

2.1.3 Which approach is best?

Both approaches have PRO's and CON's and you can mix both for example by maintaining the overall project management responsibility in-house and hiring a vendor to act as a trusted advisor

While the Best-of-Breed approach provides more flexibility in substituting another vendor if one does not work out as planned, this approach also requires in-house expertise and in-house resources for the project management.

On the other hand, the One-Stop-Shop approach generally ensures you will have more time to focus on the business aspects and less problems in integrating the different portions of the projects. Having a single point of contact makes it clearer as to who is responsible but failures are expensive in this configuration.

2.1.4 Comparing vendors

In addition to the "generic" criteria such as the size, health and quality service of the vendor, you should consider the following EPC / RFID specific criteria when selecting your vendors:

It is important to determine if these references have deployed projects similar to the ones you are contemplating. The reference should also confirm a track record of high-quality work, on time and within budget.

This criterion is important to consider if you believe that RFID experience is critical to the particular phase of the project for which you are considering the vendor.

This criterion is important regardless of the particular phase of the project for which you are considering the vendor. Without this experience, a vendor is not likely to do a good job that requires taking a holistic approach to implementing a solution.

You should ensure your vendor adheres to EPCglobal standards, open architecture, and Intellectual Property Rights policies as to not being locked into one proprietary system. As a Member of EPCglobal, your vendor will be involved in the standard definition and in collaborative work with other EPC / RFID users and will therefore be best positioned to address your needs.

2.2 Selecting the Operating Frequency

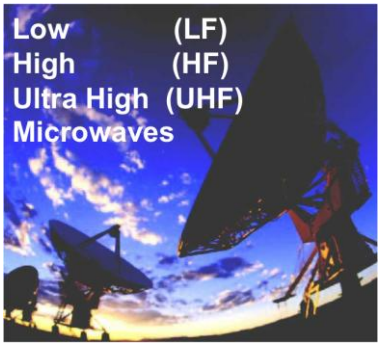
2.2.1 Why is it Important?

A tag and a reader use radio waves of a certain frequency, called the operating frequency, to communicate with each other.

The choice of frequency does affect the system's performance in areas such as speed, range, and accuracy that are critical to your application.

In addition, considering other radio services such as radio, television or mobile phones have operated before the arrival of RFID systems, it is also important to ensure that the selected operating frequency does not disturb these services.

2.2.2 What are the Frequency Ranges?

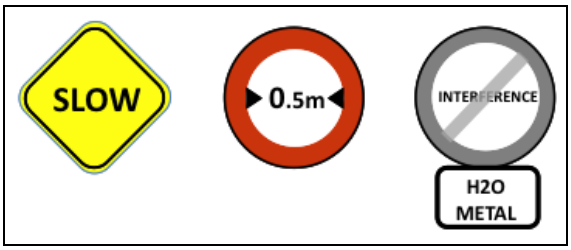


An RFID systems operates in one of the four main ranges of the radio frequency spectrum that are:

- Low Frequency (LH)
- High Frequency (HF)
- Ultra High Frequency (UHF)
- Microwaves.

We will now learn the PROs and CONs of each range and which bands are available for EPC / RFID systems within these ranges.

2.2.3 The Low Frequency Range



While the Low Frequency range extends from 30 KHz to 300 KHz, RFID systems in this range typically operate at 125 KHz and 134 KHz.

RFID systems operating with Low Frequencies have:

- Short read range that is less than half a meter.
- A low reading speed
- Very little interference with the surrounding and absorption or reflection problems due to water or metal.

These characteristics make them suitable for

- access control

- animal and personnel tracking

2.2.4 The High Frequency Range (HF)

The High Frequency range extends from 3 MHz to 30 MHz but most of the HF systems operate at 13.56 MHz which is the only globally accepted radio frequency for RFID systems.

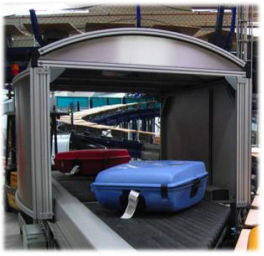
RFID systems operating with High Frequencies have

- A read range of about 3 meters.
- More problems to penetrate through materials than LF signals can.
- A better data transfer speed, compared to Low Frequencies

Typical applications for HF RFID systems are:

- Building access control

- Item-level tracking, including baggage handling



- Libraries

2.2.5 The Ultra High Frequency Range (UHF)

The UHF range extends from 300 MHz to 3 GHz.

The frequencies being used by RFID systems operating in this range are 344 MHz and anywhere between 860 to 960 MHz depending on the regulations of the country or the region.

The regularly updated list of UHF bands available for RFID systems worldwide can be found on the EPCglobal website.

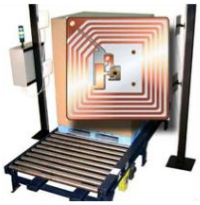
UHF RFID systems have:

- a read range up to 10 meters.
- a higher probability for inferences with the many consumer devices operating in this range and for problems due to absorption by metals or matter.
- a high data transfer
- limited portability as a UHF system that works in one country might not work in another country because the allocated bands are different.

Their higher reading speed and longer read distance make UHF systems attractive for:

- Automated toll collection

- Warehouse management



- Inventory tracking

2.2.6 The Micro Wave Range

While the microwave range extends from 1 GHz to 300 GHz, . RFID systems in this range operate at 2.44 GHz and 5.80 GHz

Microwave RFID systems have:

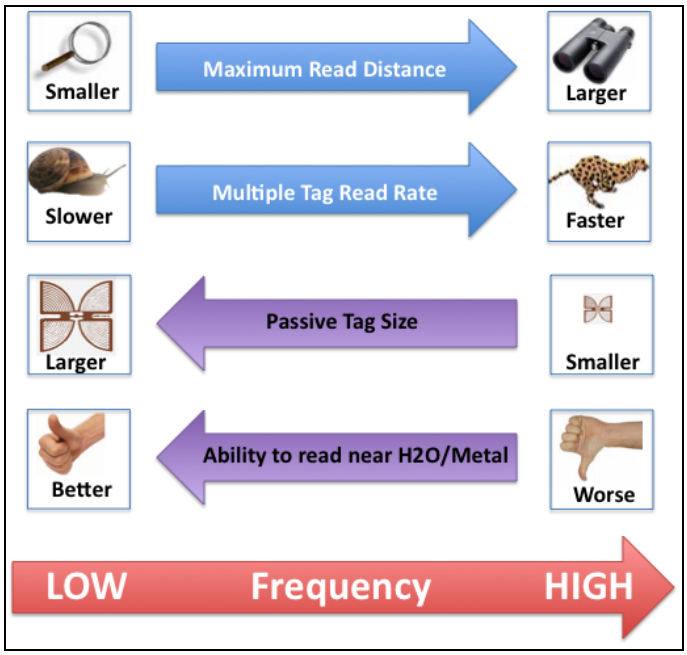
- A long read distance
- A high reading speed and data transfer rate
- Poor performance around water and metal

While these systems are sometimes used for supply chain applications, they are better suited for:

- vehicle identification and

- automated toll collection

2.2.7 Summary



As we have learned, the operating frequency will directly impact the performance of the RFID system.

Therefore, the main factors that you should consider when selecting your operating frequency are your ***application requirements*** and the ***operating conditions.***

The read range requirements for your application will give you a very good idea as to which frequency you should select for your system.

Most application types such as warehouse management have a common set of requirements and are therefore associated with specific frequencies.

You should finally also factor under which conditions your system will operate as higher frequencies are more subject to interferences and problems with materials such as liquids or metals.

2.3 Selecting the Tags

2.3.1 How do I Select the Tags?

To select the right tags for your application, you need to consider various factors such as tag types and classes, operating frequency, read range, data capacity, tag form and size, environmental conditions under which the tags will operate, and the standards and regulations with which you need to comply.

Most of these characteristics are covered in detail in the EPC / RFID Advanced Technical Aspects training course.

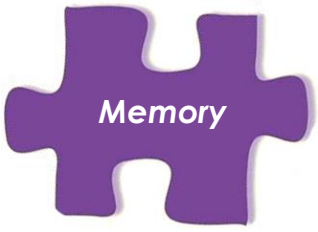
Here we present a brief discussion regarding the role of these factors in selecting tags.

2.3.2 The Kinds of Tags

The type of tag you will select (passive or active) depends upon your application.

If your application simply requires the tag to store some data such as the identification number and provide it on request, you can use passive tags.

On the other hand, you must select active tags if you require a very long read range or real-time features such as sensing the temperature or the humidity.



Similarly, you will select Read Only (RO), Write Once Read Many or Read and Write (RW) tags depending on the data you wish to store on the tag and whether this data is subject to change.

2.3.3 The Read Performance of Tags

The read ***performance*** of a tag depends on the read range, the reading efficiency and the antenna polarization and orientation

The reading ***efficiency***, also called read robustness, is the ratio of the number of successful reads to the total number of read attempts.

The reading efficiency is the ultimate factor that needs to be optimized to improve performance.

Read Performance

- ***Read range?***
- ***% of successful reads?***
- ***Antenna polarization?***
- ***Antenna orientation?***

The read range, on the contrary, should only satisfy the application requirements and should not be maximized as to avoid security and interferences issues.

2.3.4 Other Considerations for the Tags

Choose a tag that has enough data capacity to store the data required by your application.

Increased data capacity makes the tag more useful but also increases its cost.

Ensure your tag has sufficient security in case your application requires security features such as data locking to prevent tempering with the tag data.

Check that the tag is compatible with the item to be tagged and the environment. The tag should have an appropriate size and should have enough ruggedness if in contact with harsh environment such as humidity or corrosive material.

Your tags should comply to EPCglobal standards as to ensure compatibility and interoperability with other systems meeting those standards

2.4 Selecting the Readers

2.4.1 How do I Select the Readers?

The first check you should perform is to ensure the reader operates at your chosen frequency and complies with your country's legal requirements such as the maximum power the reader can emit.

Your reader should also have the correct interface for your application. Most fixed readers would be connected to a host computer or the network with a serial cable while mobile readers are usually wireless readers.

2.4.2 Other Considerations for Readers

Readers have generally from 2 to 4 antenna ports although some readers have up to 8 antenna ports. While the number of ports you need depends of your application, you can't really go wrong by choosing readers with 4 antenna ports as their offer a better flexibility in covering a wide area zone.

So as to save costs in the future, you should also check that your readers can be easily upgraded.

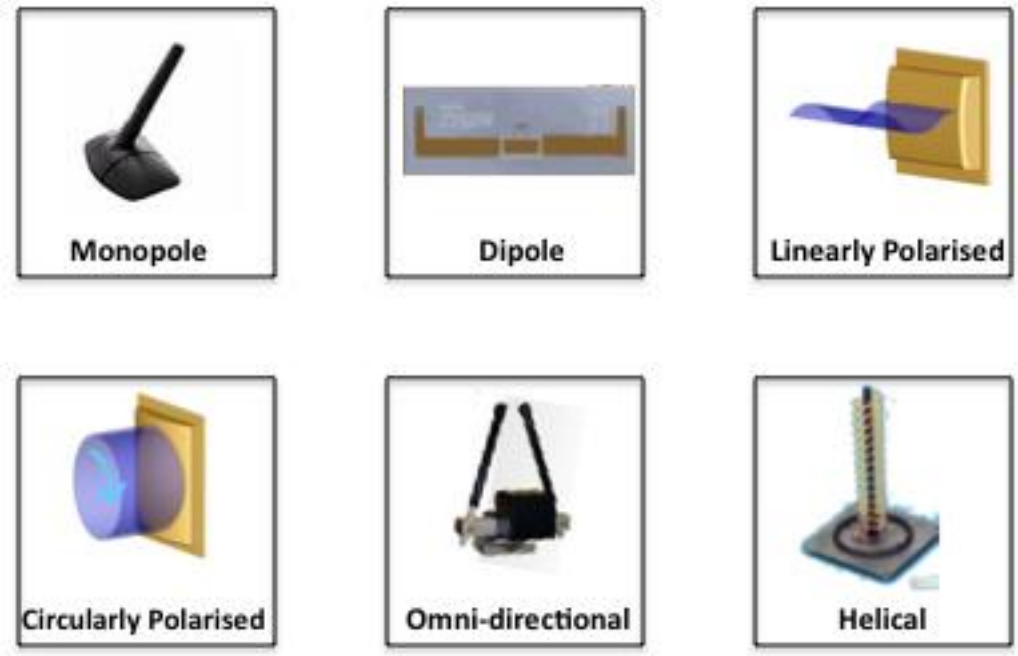
Finally, your application might require your readers to be managed remotely as to being able to diagnose the reader and fix it if needed without visiting the site.

2.5 Selecting the Antennas

2.5.1 What are the Types of Antennas?

Both tags and readers have their antennas and these come in various types.

The main antenna types are:



The types of antennas are covered in detail in the EPC / RFID Advanced Technical Aspects training course and are therefore not covered here..

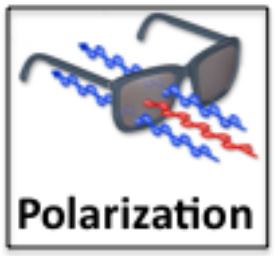
2.5.2 How do I Select Antennas?

Two factors are key for selecting antennas: the ***footprint*** and the ***polarization***

The footprint of an antenna is the ground area over which the antenna delivers the signal. All tags placed within the footprint of a reader's antenna can be read by the antenna. Footprints can be mapped using a spectrum analyzer.

The polarization will depend of the tag orientation:

- If the tag orientation is unknown use a circularly polarized antennas as to ensure some amount of power will be transferred between the reader and the tag antennas, regardless of the tag orientation.
- If the tag orientation with respect to the antennas is known, use a linear antenna to receive the maximum power and thereby increase the read range.



2.6 Selecting the Transmission Lines

A transmission line is a physical medium such as a cable used to connect the signal source of the reader to the antenna.

The optimal transmission line would be the one that transfers the energy from the source to the antenna with minimum power loss.

RFID systems generally use 50 ohms coaxial cables as transmission lines as these have low cable loss. Shielded pair cables are also used frequently.

The length of the cables should be looked at too as the longer the cable, the greater the loss of power.

Finally, you should ensure the impedance of the transmission line matches the input impedance of the antenna as a mismatch would decrease the system's efficiency.

2.7 Selecting the Portals

2.7.1 What is a Portal?

An RFID portal is an area where RFID tags are being read or written to.

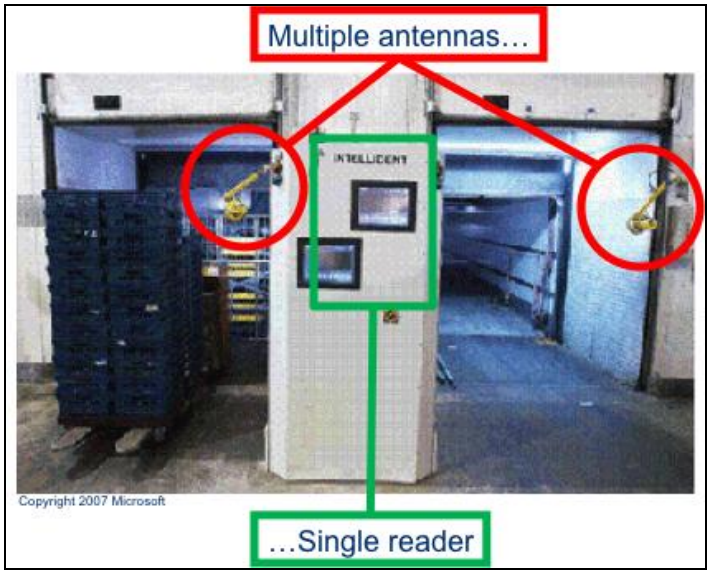
Portals can be **stationary** such as a dock door that waits for the tags to pass through their interrogation zone or can be **mobile** such as a forklift which moves around to read the tags.

The most common portals for mounting your readers are:

- Dock doors
- Conveyers
- Forklifts
- Stretch wrap stations
- Smart shelves

2.7.2 The Dock Doors

A door portal is a door that reads at the pallet level all the tags attached to the items on the vehicles such as trucks, forklift or carts that are passing through its interrogation zone



In general, multiple antennas are mounted in an array on both side of the door as to cover an interrogation zone of about 3 meters high by 3 meters wide.

In mounting the portal, attention should be given to the positioning of the antennas as to form an efficient interrogation zone.

If the readers are activated by the motion of vehicle, they should be turned on rapidly as to ensure the vehicle doesn't have to slow down for all tags to be read.

2.7.3 The Conveyers

A conveyer portal is generally used for case-level tracking such as luggage in an airport or boxes in a distribution center.

Multiple antennas are mounted on gantries around the conveyer as to cover the 4 faces as the item to be read.

For optimal reading, the belt and roller for the conveyer should be made of Radiofrequency friendly material at the read point, not of metal.

The speed of the conveyer should also be adjusted for optimal reading

2.7.4 The Forklifts

Forklifts are especially well suited for reading tags from items on a pallet and they can be connected to data collecting computers for an improving the inventory management for example.

Mounting antennas on forklifts also has some disadvantages such as:

- Forklift based systems require manual intervention from an operator
- The readability of the tags can be affected by various factors such as the metal of the forks, the communication devices of the forklift operator or even the speed of the forklift

2.7.5 The Stretch Wrap Stations

Because a stretch wrap station is usually the final step before shipping, an RFID system at this place guarantees the integrity of the containers.

A stretch wrap station is also extremely attractive for a portal considering the orientation of the tags continuously changes while the pallet spins making their reading very efficient.

2.7.6 The Smart Shelves

Smart shelves have significant advantages such as helping reduce out-of-stocks.

However, because they track the items on the shelves, they require multiple readers and antennas leading to potential overlapping of interrogation zones and signal interferences.

Densely packed items on the shelves could also result in the stationary readers missing some items, which would result in inventory issues.

2.8 Selecting the RFID Peripherals

2.8.1 The RFID Printers

RFID printers are devices printing smart labels that are labels combining a barcode with a RFID tag.

Therefore RFID printers are able to print barcodes on the label and also to read and write the tag inside the label.

RFID printers can be connected to a PC via a parallel, serial or USB port or can be connected to the network using an Ethernet connection.

2.8.2 How do I Select RFID Printers?

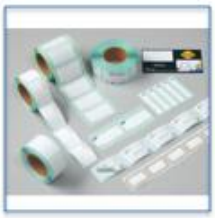
While your RFID printers should obviously be optimal for your application, some of the factors to consider when selecting RFID printers are:

- Does the printer has a feature to automatically void faulty labels for example if the tag does not respond properly to the read/write instruction?

- Has the printer been tested to be EPC compliant?

- Will the printer support the harsh conditions, if any, it will operate in?

- Does the printer supports various label sizes and multiple tag protocols?



- Is the printing speed sufficient for my application now and in the future?

2.8.3 The Label Applicators

Label applicators are machines applying the labels on the products in an automated way.

Pneumatic piston label applicators are machines that detect the product and have a piston to stop it for labelling. The advantage of these label applicators is that the product doesn't have to be moving at a constant speed.

Wipe-on label applicators are machines that detect the product and perform labelling using a roller or a brush to wipe down the label on the package. These machines require the product to be reliably moving at a constant speed

2.8.4 The Feedback Systems

Feedback systems are generally used to report problems with the system or to perform an action when an event is encountered such as activating readers when tagged items are detected.

Feedback systems include:

- **Photo eyes** that detect the presence of something coming or verify if the labels are correctly placed

- **Light trees** that would indicate with a green light that the package has been read successfully and with a red light that something is missing or incorrect

- **Motion sensors** that can be used to indicate the arrival of tagged items at a dock door

- **Real time location systems** that would track and report in real time the location of the assets that are tagged to be tracked

2.9 Chapter Summary

What was in this chapter?

In this chapter, you have learned that you want to design your RFID system to meet your application's performance requirements and that vendors play a major role in helping you do so.

The type of your application, the required read range and the operating conditions will be the key factors for selecting your operating frequency.

From there, you will select your tags and readers based on read performance operating conditions and compliance to standards.

Choosing the right portals will depend upon your application and whether you want to track at the item, case or pallet level.

Finally, you have discovered that RFID peripherals will enhance your system and enable it work in a more automated way

Chapter 3: THE SITE ANALYSIS

What is in this chapter?
The design of your EPC / RFID system is not final until you perform a site survey. *In this chapter you will understand what information you can find in a blueprint to start the site analysis and what information you should enter into the blueprint after finishing your site analysis* *You will also learn how to analyze the environmental conditions so as to identify the potential sources of interference and define where to place your interrogation zones*

3.1 What is a Site Analysis

As you need to determine how your RFID system will fit into the existing site infrastructure, a site analysis is required before you finalize the RFID system design and before you install the RFID system.

The main goal of the site analysis is to ensure that the interrogation zones will function properly, with maximum performance and without interrupting the existing services.

The site analysis also facilitates a smooth integration with existing IT systems for example by identifying the need to upgrade network infrastructure.

You site analysis should be considered as a project and planned accordingly.

Perform your site analysis in 3 steps:

Prepare your site visit that is preparing the needed equipment and looking for the blueprints, which are basically the site diagrams that you will need to visualize the site infrastructure

…Prepare your visit…

Visit the site and perform a physical and an radiofrequency environmental analysis as to determine the interrogation zones where you can mount the readers for reading tags and define exactly where you will install the readers' antennas.

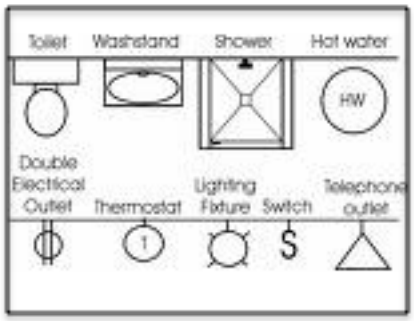
…perform analysis…

Document your results in reports and also include your findings in the blueprints.

Document your results

3.2 Preparing the Site Analysis

3.2.1 What is a Blueprint?



A blueprint is a plan or a facility diagram that helps you visualizing the big picture of the site infrastructure.

It will help you make a preliminary determination of where you can possibly set up the interrogation zones by showing you for example which are the place you need to avoid such as metalic material or motors that can cause interferences.

You will also look on the blueprint where you will be able to get power sources for your RFID system.

Blueprints generally use standardised symbols to represent electrical and telecom devices.

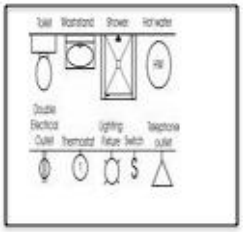
3.2.2 Which Equipment Do I Need?

The main part of the site analysis is to perform a physical and a electrical environment analysis.

To do so, you need equipment for example for measuring the ambient electromagnetic noise.

The equipment that you need consists of:

- The blueprints to visualize the site infrastructure



- A portable computer to record the results

- An antenna covering 360 degrees of RF field (e.g. a half-wavelength dipole antenna)

- A spectrum analyzer to measure the noise and interfering signals

- A tripod stand to support the antennas

3.3 Performing a Physical & Electrical Environment Analysis

3.3.1 How should I perform a Physical Environment Analysis?

Before setting up your interrogation zones, you first want to analyze the physical environment for characteristics or objects that might affect your RFID system.

The various physical conditions you will look for are:

- Harsh environmental conditions such as corrosive material, extreme temperature or humidity which can damage tags or moisture and water contents which can absorb the Radiofrequency signals.

- Electrical devices such as motors and cabling that could create interferences and noise.

- Metallic objects that would reflect the radiofrequency signals.

- Any other physical sources that may have adverse effects on the radiofrequency signal propagation.

3.3.2 Why should I perform a Radio Frequency Environment Analysis?

Since you have performed the physical environment analysis, you have identified some of the potential sources of electromagnetic noise and interferences.

Now you need to perform a radiofrequency environmental analysis for further identifying the sources of interference and noise and measuring them.

This analysis will help you decide where to place your interrogation zones and also help you fine-tuning and configuring these zones for optimal performance

The analysis will also ensure that your RFID system will not interfere with the existing radiofrequency systems on the site.

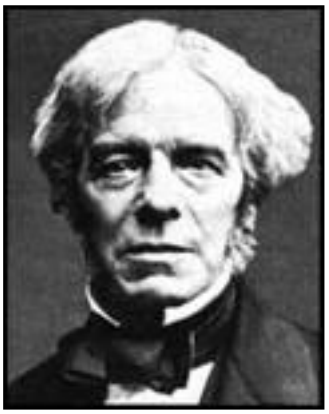
3.3.3 The Radio Frequency Environment Analysis – step 1

The first step is to measure the ambient electromagnetic noise or AEN generated by the electrical devices existing at the site.
The AEN is measured in decibel by a device called spectrum analyzer.
The spectrum analyzer measures the spectrum of an electromagnetic wave and is useful for:

- identifying the sources of radiofrequency interferences
- measuring the radiofrequency output from these interfering sources in terms of distortion, harmonic, modulation, quality and noise
- displaying signal interference if it overlaps the intended signal

3.3.4 The Radio Frequency Environment Analysis – step 2

Now that you have measured the ambient electromagnetic noise, you need to identify these sources of interference and collect data with the help of a spectrum analyzer over a full operational business cycle, which typically is a minimum of 24 to 48 hours.



This analysis, which is called a **full Faraday cycle analysis (FFCA)**, will tell you what frequencies will cause the most problems when you operate your RFID system in your facility.

When you have identified a device that might create electromagnetic noise, turn on this device and measure and record the results in the planned interrogation zone nearby.

3.3.5 The Radio Frequency Environment Analysis – step 3

Now that you have identified the sources of interference and AEN, you will have to protect your EPC / RFID System from these interferences and noise

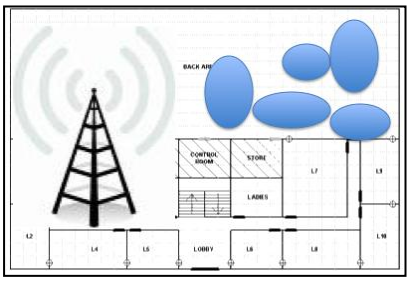
To eliminate or minimize the effects of interference, you can consider implementing the following solutions:

- Remove the source of interference, if possible. For example, it might be possible to ensure that a forklift causing the interference does not operate in the interrogation zone.

- Shield the source of interference or your RFID system next to this source

- Use filters, which permit only selected frequencies to pass through a connected device by rejecting all other frequencies.

3.3.6 The Radio Frequency Environment Analysis – step 4



Metals, liquids and obstacles affect the radiofrequency signal so you need to measure the radiofrequency coverage area for the reader antenna at different spots of your planned interrogation zones.

For each spot, you will set up the antenna and use the spectrum analyzer for measuring the strength of the signal emitted by the antenna

You will measure in different directions and mark down for each direction at which distance from the antenna the signal becomes too weak to be useful.

You will notice that the signal coverage area will decrease around spots near obstructions, such as metallic equipment.

3.3.7 The Radio Frequency Environment Analysis – step 5

Once you have determined the location of an interrogator zone, you can perform a **path loss contour analysis (PLCA)** *as to map* how the field strength and shape of the radiofrequency coverage in an interrogation zone varies in the zone.

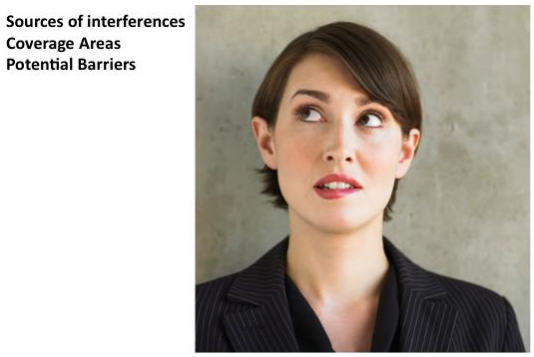
A PLCA will show how radiofrequency signals are degraded and distorted and how the shape of coverage changes throughout the interrogation zone.

The PCLA will help you determining the location of the antenna in the interrogation zone, the alignment of the antenna and the optimal emitted power

3.4 Documenting Your Results

You will report on your blueprints or some other documents your findings as these will be very useful during the installation and deployment of your EPC / RFID system

You should therefore document on your blueprint the sources of interferences and the coverage areas of your planned interrogation zones



You should also mark down any potential barrier that can affect the radiofrequency signal propagation such as doors, metals, liquids or areas of high humidity.

3.5 Chapter Summary

What was in this chapter?

In this chapter, you have learned that the purpose of site analysis is to determine how the proposed RFID system will fit into the existing site infrastructure.

You understood that a site analysis has 3 phases that are:

- *Preparing the equipment and the blueprints*
- *Performing a physical and a radiofrequency environmental analysis.*
- *Document your results*

Finally, you have also learned in more details how to perform the radiofrequency environmental analysis using a spectrum analyzer

Chapter 4: INSTALLATION OF THE EPC/RFID SYSTEM

What is in this chapter?

In this chapter, you will understand how you can successfully install your EPC / RFID system.

You will discover the 4 steps of the installation process that are:

- *Preparing the installation*
- *Installing and configuring the hardware*
- *Setting up the portals*
- *Integrating the infrastructure with the application*

Finally, you will learn how to ensure safety for your EPC / RFID system and for the personnel in the area

4.1 Preparing the Installation

4.1.1 Which Documentation is Needed?

During the selection of the EPC/RFID system design, you have understood the various RFID solutions available in the context of your application requirements.

Equipped with that understanding, you have performed the site analysis and determined how the RFID system will fit into the existing site infrastructure.

You will now use the information collected and documented during the system design and the site analysis to get your RFID components from your vendors and install the system.

But first you need power for your system, don't you?

4.1.2 Where Can I Find Power?

The readers and tags need power for their operation so you should ensure you get from your vendors the needed power sources and cabling to power your EPC / RFID system

Passive tags get their power from the RF signal emitted by the reader, whereas active tags have their own power source, typically a battery.

The characteristics of the battery such as its lifetime or its operating temperature are defined by your application.

Readers can use various power sources, including:

- Power Supply Units (PSUs),

- Uninterrupted Power Supply (UPS),

- Power over Ethernet (POE).

4.1.3 Getting a Solution from the Vendors

We have seen in Chapter 2 the main criteria for selecting your components and your vendors.

Based on your system design and site analysis documentation, you will now ask your vendors for a solution that would meet your application requirements.

The vendor's solution generally combine the components of your EPC / RFID system and support from the vendor for installing these components. We have seen in chapter 2 the main criteria for selecting your components and your vendors.

4.1.4 Which Solution Should I Choose?

If cost permits, you should go for the solution that meet best your application performance requirements but first you should:

Ensure your components are compatible, consistent with the selected operating frequency and will withstand the operating conditions

Ensure your antennas are of the correct type and have an appropriate maximum power radiated and coverage area

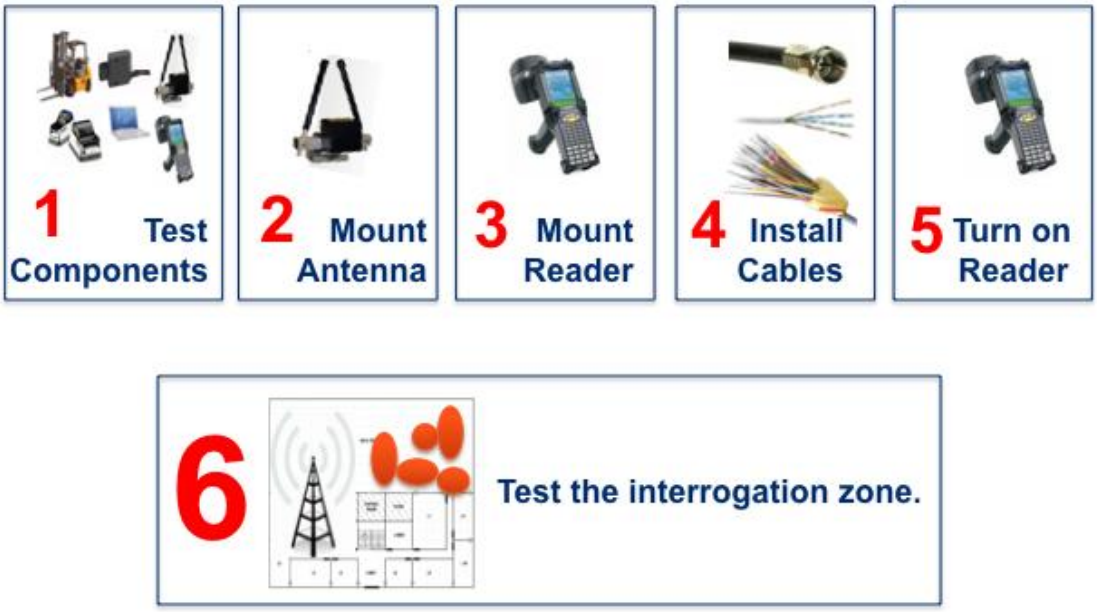
Ensure the readers will read the tags efficiently for all the different products to be tagged

Ensure the proposed solution can be easily integrated with your existing network and application and can be easily maintained

4.2 Installing the Hardware

You have received from your vendor your EPC / RFID system components so now the installation of the hardware and possibly the software can really begin.

The typical process for installing the core hardware for an EPC / RFID system is:



4.2.1 Testing The Components

You need to validate that a particular component of a system (software, hardware, or both) is functioning properly with the promised performance before installing it.

For example, you should test that a reader meets the performance specifications, such as read range and multiple tag read rate, as specified by the vendor.

4.2.2 Mounting The Antenna

Obviously, an antenna will be mounted somewhere in or near the interrogation zone in a place that maximizes the propagation pattern.


PATH LOSS CONTOUR ANALYSIS

The map you got from your path loss contour analysis (PLCA) will help you determine the exact location of an antenna in a given interrogation zone and to configure and fine-tune the antenna.

Because antennas are communication elements, they are usually the most exposed components of an RFID system and you should therefore consider their protection from damage.

Depending on the situation, an antenna can be attached using drills and screws, or you might use a rack that would hold the antenna, the reader, the power supply such as UPS, and the cables.

Racks are good to protect your system from harsh environmental conditions such as dust, humidity, and moisture.

4.2.3 Mounting The Reader

Now that your antennas are installed, you should look at a mounting spot for the reader

You can mount the reader in a rack or on some surface or edge, such as a wall or gantry placed around a conveyor.

Consider the following factors when mounting the reader:

- Leave some space around the reader for the cables and to keep the air flowing so that the reader will stay cool.
- Avoid placing readers close to each others to minimize reader collisions
- Avoid placing readers close to sources of interferences
- Avoid spots of harsh environmental conditions
- Choose a spot in which the reader will be safe from accidental physical damage

4.2.4 Installing the Cables

You will need cables for various purposes such as:

- Connecting the antenna to the reader port
- Powering your components
- Enabling your data transfer, for example from the reader to the host computer

When installing cables you should:

- Use the correct standard cable for a given connection
- Keep the cables away from sources of electromagnetic waves such as motors and electronics.
- Use labels to identify the cables and keep a cable layout to avoid confusion and to have easy access for maintenance.
- Use protective caps to cover the exposed parts of the cables, such as cuts.

4.2.5 Turning The Reader On

You have installed the reader, antenna and cables and connected the readers to the network or host computer, so it is now time to turn the reader on.

By doing so, you defined an interrogation zone that is the area around the reader within which the reader can successfully communicate with a tag.

4.2.6 Testing the Interrogation Zone

To test the interrogation zone, you will:

1. Determine the boundaries of the coverage area (interrogation zone) by measuring the signal strength at various points around the antenna, as described in the previous chapter.

2. Use the spectrum analyzer to verify the map of the path loss contour analysis or PLCA determined during the site analysis

3. Use the map of the PLCA to fine-tune and configure the RFID system.

4.2.7 Configuring the Interrogation Zone

For your interrogation zone to work properly, it should be configured taking into account the following aspects:

- The read rates required by the tag traffic

- The power required by the reader and the tags

- The distance required or available between the interrogator and the tags

Configuring the interrogation zone involves configuring the reader's commands and settings and adjusting the power of the reader to an optimal value

4.2.8 Configuring the Reader's Commands

Reader's commands are usually issued on the host computer, either by an application or using a Graphical User Interface or GUI.

Common reader commands are:

- **QUERY** to initiate the communication with the tag
- **READ** to get the data on the tag
- **WRITE** to write data on the tag
- **LOCK/UNLOCK** to prevent or allow writing data on the tag
- **KILL** to disable the tag permanently

Additional commands such as **SELECT, INVENTORY** or **ACCESS** can also be available as to help your isolate group of tags or isolated tags from a group.

4.2.9 Configuring the Reader's Settings

Reader's also have settings and features that will allow you to:

- Adjust the power output of the reader.
- Set the operating frequency for the reader
- Select the RFID protocol used by the reader such as the anti-collision protocol
- Set if the reader will communicated in duplex or half duplex mode
- Be notified when a certain event occur. For example if the number of tags in the interrogation zone exceeds a threshold
- Filter which kind of tags you want to read and which you want to ignore
- Define the computers that are allowed to communicate with the reader and the users that are allowed to use it.

4.2.10 Optimising the Interrogation Zone

You now want to optimize your interrogation zones so that your RFID system is more reliable and robust.
To do so, consider the following:

- As your network has a limited bandwidth and as reader's read cycles consume this bandwidth, you should monitor your network traffic

- You will adjust the power output for your reader so that you attain the required read range while avoiding zone overlaps and staying in the limits set by safety regulations.

- If the tags are in motion, you need to balance the tag speed with the reader's read speed

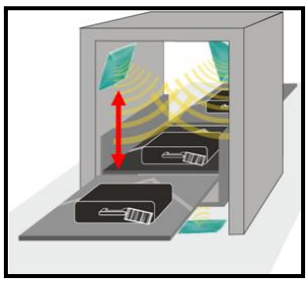
Now that your interrogation zones are optimised, you are ready to set up your portals

4.3 Setting Up The Portal

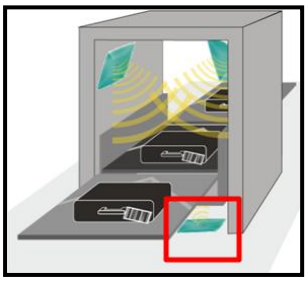
4.3.1 Setting Up A Conveyor Portal

When setting up a conveyor portal, you should :

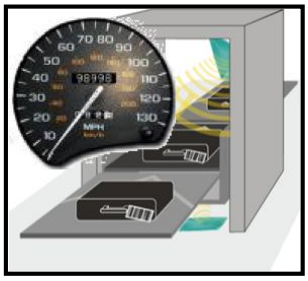
- Keep the antennas about 45 centimeters or 1.5 feet away from the conveyor edges as to avoid signal reflection by metal and other adverse effects



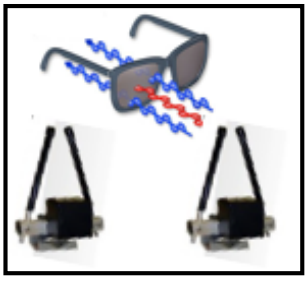
- One of the four antennas should be designed for optimal operations under the conveyor.



- As a reader must be able to make multiple attempts to read a tag, keep in mind the speed of the conveyor while configuring the reader.



- The polarization and alignment of reader antennas should be compatible with random orientation of tags.



4.3.2 Setting Up A Dock Door Portal

UHF systems are usually providing the required read range for dock door portals.

When setting up a dock door portal, you should:

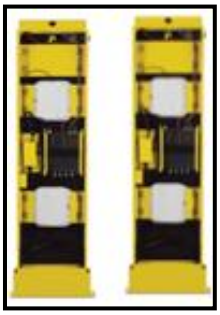
- Keep the cables out of harm's way.

- Make sure that the antennas are protected against accidental damage.

- The number of antennas should be large enough to cover the width and the expected height at which the tagged items will be passing however too many antennas could create a dense interrogator environment problem

- Most dock doors have two or four antennas on each side of the door

- Make sure the antennas from the two sides of the door are not directly pointing at each other as this could cause interferences.



4.3.3 Setting Up A Shelf Portal

HF systems are generally used for shelf portals as these system have sufficient read range and will be relatively less affected by metals and liquid content

When setting up a shelf portal:

- The reader antennas should be properly placed, configured, and oriented to avoid interference between neighboring antennas.

- You can create a multi-shelved portal with one antenna per shelf using a multi-antenna reader. In this case, you can configure the reader to use the antennas for reads in some sequential order.

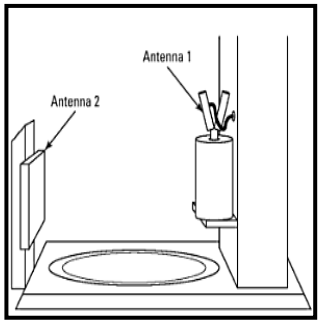
- If the change in the number of items on the shelf needs to be detected, the readers should be configured to either continuously keep reading the tags or have read cycles at preset intervals.

4.3.4 Setting Up A Stretch Wrap Station Portal

Stretch wrap station portals have generally 2 antennas, one on the arm that moves with the roll of stretch wrap and the other one just next to the stretch wrap machine.

When setting up a stretch wrap station portal:

- Protect the cabling of the first antenna taking into account the arm movement that is give extra length to the cable so that it can follow the arm up and down
- Make sure the second antenna is not in the way of the forklift that will drop and pick up the pallet



4.3.5 Setting Up A Forklift Portal

When setting up a forklift portal:

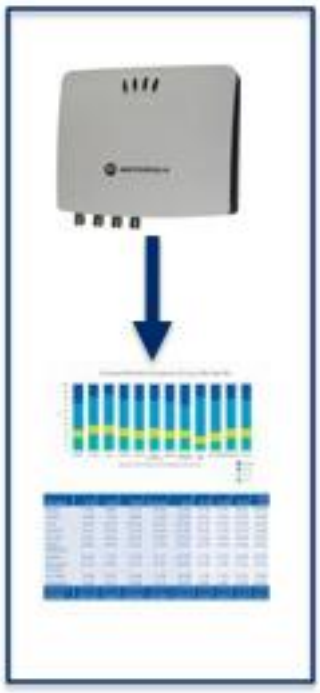
- You can mount the reader on either the interior or the exterior of the vehicle.
- In case you decide to mount the reader on the exterior of the vehicle, consider the adequate clearance from external objects such as doorways.
- The reader must be protected against mechanical shocks and vibrations.
- The mobile RFID system will most probably be using the wireless network for transferring data to a central location. Therefore, the possibility of interference with other electromagnetic devices should be considered

4.4 Integrating the infrastructure with the application

4.4.1 Why Is It Important?

Tag and readers are only able to capture RFID data.

To uncover the operational benefits of EPC / RFID, like reducing out-of-stocks or have a better visibility along your supply chain, you must process the incoming RFID data and intelligently integrate it into your business application.



To route the EPC / RFID data between the readers and your enterprise systems, you need software or what is also called RFID middleware.

The RFID middleware will:

- Ensure the RFID data is valuable for example by eliminating duplicate reads and filtering
- Accommodate that readers can speak different languages
- Pass the RFID data in the correct format to the various applications such as a Warehouse Management System requiring this data

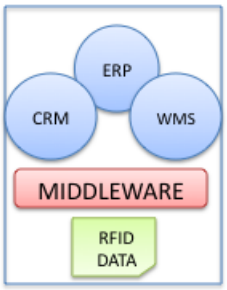
4.4.2 What Should The Middleware Do?

Typically, your middleware should include 7 core capabilities that are:

1. ***Reader and device management*** as to allow the users to configure, deploy and issue commands to the readers through a common interface.

2. ***Data management*** as to ensure the captured data is intelligently filtered and routed to the appropriate destinations

3. ***Application integration*** as you need these messaging, routing and connectivity features to reliably integrate the RFID data into your existing systems such as your ERP, WMS or CRM systems



4. ***Partner integration*** as you need B2B integration features such as partner profile management and communication protocols to efficiently integrate with your partner's data over EDI or web-based systems

5. ***Process management*** as to allow you to orchestrate RFID related end-to-end processes. As an example you might want to link your receiving process to your inventory and to your point-of-sale process so that the system automatically reorders more products without human intervention when the inventory is too low

6. ***Packaged RFID content*** as you don't want to start from scratch developing your RFID applications such as shipping or asset tracking.

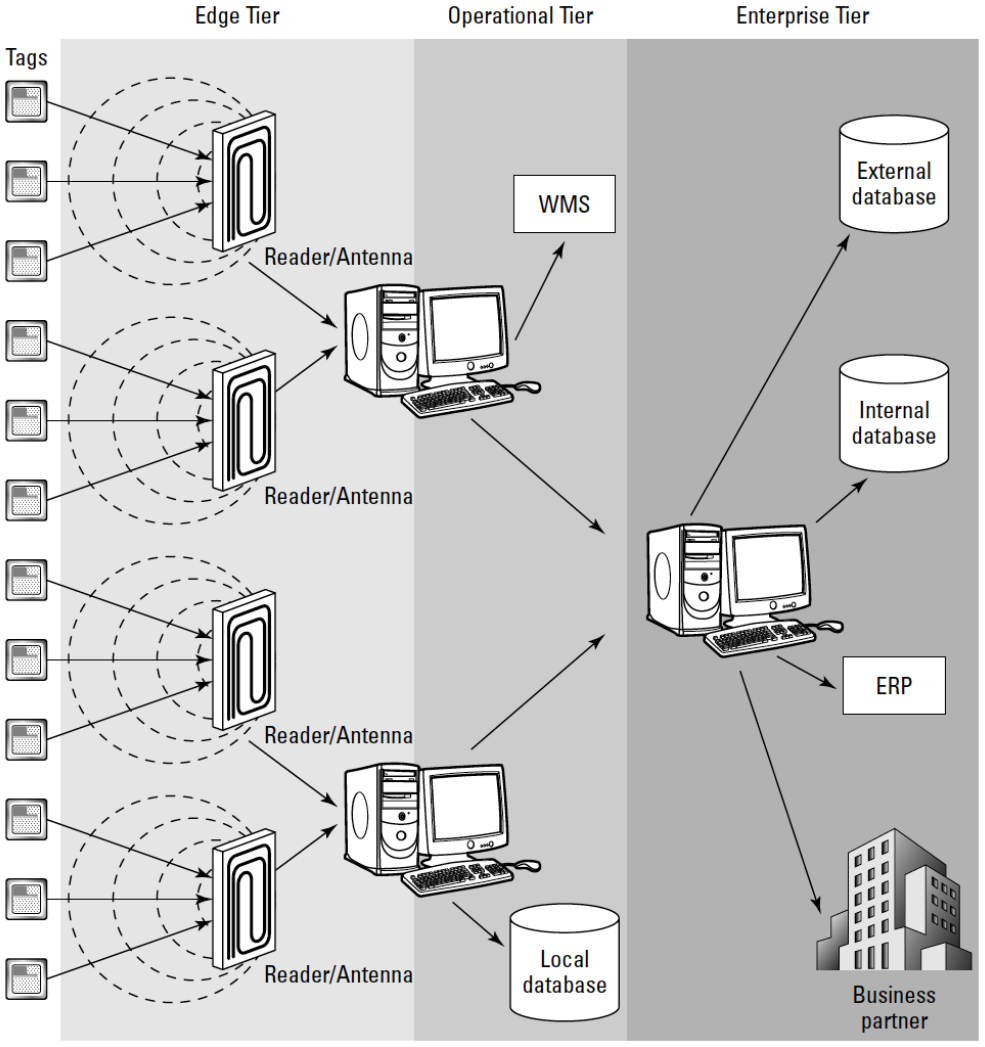
7. ***Architecture scalability*** as you want your system to balance the processing load across your multiple servers and reroute the data automatically if a server fails

4.4.3 Where Should The Middleware Go?

To process EPC / RFID data efficiently, your middleware needs to be distributed with the right level of logic placed at the right location or tier of your RFID architecture.

While your RFID architecture is dependant of your business requirements, let us show an example of a 3-tiers architecture where:

- The edge tier will filter the data, remove duplicate reads and group the data
- The operational tier that will decide where to route the data and raise flags when exception occurs such as a missing case for a shipment
- The enterprise tier that will connect with the enterprise applications such as the ERP or CRM and also with the partners.



Source: Forrester Research, Inc.

4.5 Ensuring Safety

4.5.1 Ensuring safety is a Requirement

Ensuring safety for your EPC / RFID system and for the personnel working in the zones where your system is installed is a mandatory step of the installation process

We have already learned that racks or similar protections can be used for protecting components of your system from shocks or harsh conditions.

You also have to protect your system and the personnel operating it from electrostatic discharges by installing for example wrist straps or floor mats

4.5.2 Grounding

You should ground the components of your system as it will prevent electric shock or fires caused by a voltage difference between the earth and a conducting metal.

Similarly, grounding will also protect your personnel and equipment from lightning strikes.

Grounding will also reduce the noise and interference coming from your computers and readers ensuring your system has minimal impact on the already existing radiofrequency systems.

Finally, you should protect your system and personnel from ground loops by ensuring that the conductor used for grounding is short enough and that all the readers are connected to the same grounding system.

4.6 Chapter Summary

What was in this chapter?

In this chapter, you have learned that the implementation of an EPC / RFID system is a process that starts with the documentation collected during the system design and the site analysis.

You have learned how to install your hardware components such as antennas, readers and portals and how to integrate this infrastructure with your application by using the middleware.

Finally, you have been reminded that you must safely protect your system's components as well as the personnel operating close to your system

Chapter 5: THE MONITORING & TROUBLESHOOTING OF THE SYSTEM

What is in this chapter?

Now that you have designed and installed your RFID system, you have to expect to encounter problems such as reader failure, tag failure or network connectivity problems.
Therefore you need to monitor and troubleshoot your system and this chapter will explain you how to do it successfully.
You will learn that monitoring your RFID system involves status monitoring and performance monitoring
You will also learn that you will need to troubleshoot the system for finding the causes for the problems identified during the monitoring and fix these problems.

5.1 What Is Monitoring?

5.1.1 Status Monitoring

Status monitoring consists of monitoring the basic status of the system and the devices in the system, such as the following:

- Is the device connected to the network?

- Are the devices powered?

- Are the antennas operating?

- Is a reader reading the tags successfully?

Please note that some solutions include a status indicator panel on your desktop that will allow you to monitor the status of all readers from one location.

Feedback systems such as light tree and horns, discussed in Chapter 2, can also play an important role in status monitoring.

5.1.2 Performance Monitoring

Performance monitoring consists of monitoring the performance of a system and the devices in the system, such as the following:

- Read rates of readers

- Reading accuracy

- Error frequency: how frequently an error occurs

The performance data on predetermined metrics such as read rates helps determine the normal behavior of the system and identify the variance in the normal behavior and hence a problem.

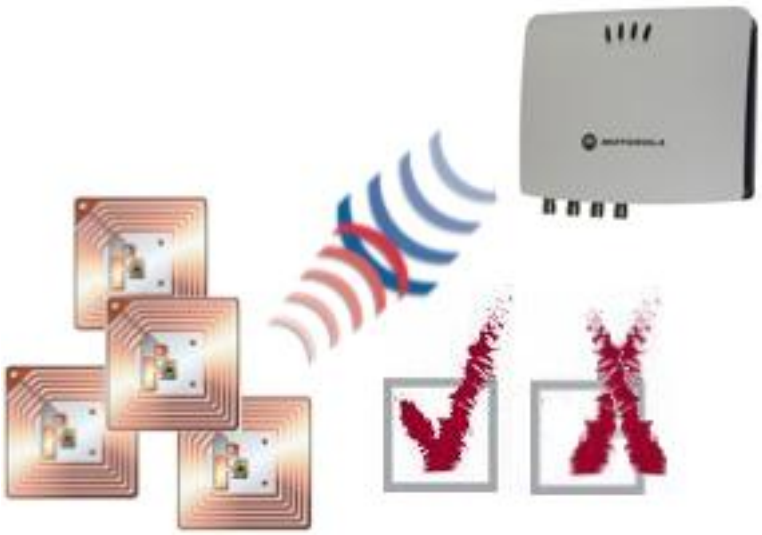
5.2 Monitoring the Interrogation Zones

5.2.1 What Should I Look For?

Now that you have understood the basic principles of monitoring, you can start monitoring your interrogation zones.

Your interrogation zone has several parameters characterizing it such as:

- Number of tags passing through the zone
- Number of tags being successfully read
- Number of tag that can't be read or read errors
- Reader failure



We will now see which metrics derived from these parameters are generally used to monitor RFID systems

5.2.2 Mean Time Between Failure

Mean time between failures (MTBF) is the average time between two consecutive failures of a device or a system.

MTBF indicates the robustness of the system measured in the past and, based on that measurement, predicts the rate of failure in the near future.

MTBF is calculated as the total lifetime of the device divided by the total number of failures recorded.

For example:

- you have 20 readers on your system
- over the past 10 days you have had 6 of them failing once and 1 more reader failing twice

You have 20 readers times 10 days that is 200 reader days of operation

You have had 6 + 2 that is 8 failures during that time so your MTBF is 200 / 8 that is 25 days / failure

5.2.2 Average Tag Traffic Volume

Average Tag Traffic Volume (ATTV) is the average number of tags passing through an interrogation zone during an interval of time (e.g. minute or hour).

The monitoring system collects the tag counts and time at which the tag was counted from the readers.

E.g. your time interval is one hour and during the last 4 hours, 10, 20, 30 and 40 tags respectively were detected.

ATTV is calculated as 10 + 20 + 30 + 40 = 100 tags divided by 4 = that is in average 25 tags per hours were detected.

From the ATTV measurements, you can predict how much traffic is expected to pass through an interrogation zone during a certain period.

5.2.3 Actual Versus Predicted Traffic Rate

Actual versus predicted traffic rate (APTR) is the variance of the actual tag traffic from the predicted tag traffic through an interrogation zone over a time period.

A significant variance could indicate a problem with the system.

The APTR is calculated as the difference between the current Average Tag Traffic Volume or current ATTV and the predicted ATTV from the past measurements.

Building on the previous example, we have a current ATTV of 25 tags per hour for the past 4 hours. If the predicted ATTV from past measurement is 15 tags per hours, the variance is 10 tags per hour that we are seeing more than predicted.

Make sure you are comparing the actual value to the predicted value for the same time interval for example from 2.00 to 6.00 pm as tag traffic can be different at different hours of the day.

5.2.4 Read Error To Total Read Rate

Read errors to total reads rate (RETR) is the total number of read errors divided by the total number of read attempts.

Example:
450 tags read successfully
50 tags couldn't be read

RETR: 50 / (50 + 450) = 1/10

That is, you have a problem with one tag every 10 tags.

A high value for RETR should be taken as an alarm for a problem with the RFID system that can be:

- either an internal problem such as a faulty antenna or a low signal strength
- or due to adverse environmental effects such as absorption and interference.

5.3 Monitoring The tags

5.3.1 Why Is It Important?

Even though the process of manufacturing tags and their application to items has significantly matured, tag failures do still occur due to various reasons.

Therefore, monitoring tags is an important task for an RFID professional.

First of all, you need to ensure that the tags are properly placed on items.

Furthermore, you need to know the reasons the tags can fail and how to manage tag failures.

The tags are placed on items to be tracked before the items get out into the world. So, the first step in monitoring tags is to identify improperly tagged items.

5.3.2 Identifying Improperly Placed Tagged Items

There are four kinds of improperly tagged items:

- Items that are tagged with faulty tags.

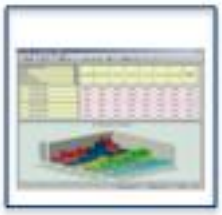
- Items on which the tags are placed incorrectly, where they cannot be read properly by the reader.

- Items on which the tags are placed at the correct spots but on which the tags are applied incorrectly, perhaps bent or folded.

- Items on which the tags are not properly oriented when correct orientation is required for efficient reading.

Following are some of the methods for identifying improperly tagged items:

- ***Inventory discrepancies*** can indicate improperly tagged items because the tags on the items were not properly read; hence the items were not counted.



- Some ***feedback devices,*** such as photo eyes and motion sensors, provide the presence information of an item and instruct the reader to read it. If the reader cannot see it, it could be an improperly tagged item.

- Improperly tagged items can be identified during automatic application of labels by placing an ***interrogation porta***l right after the application point. If the tag cannot be read, it might be defective or improperly placed.

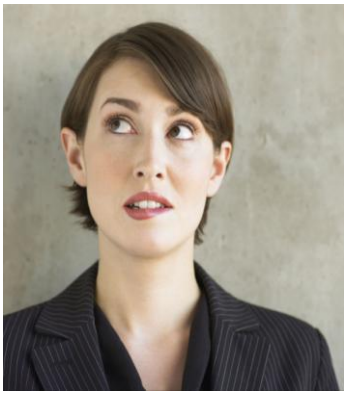
- You can also identify improperly tagged items via ***manual inspection***, perhaps before shipping.

5.3.3 Identifying Reasons for Tag Failure

While the tags on improperly tagged items are prime for failure, there are, however, additional reasons why a tag would fail.

Following are the main reasons for tag failures:

- ***Defects introduced during manufacturing***. These can sometimes be detected by device itself for example a smart label printer would identify which tags it printed incorrectly
- The ***wrong tag type*** was applied for a given application.
- An ***electrostatic discharge*** has damaged the transistors in the tag's integrated circuit
- The tag has suffered from ***harsh environmental conditions***
- The tag is ***misplaced***
- There is a ***dense tag environment*** and tags are shadowing each other.



5.4 Troubleshooting

5.4.1 Identifying The Problem

Now that you have identified the problem, it is time to solve it by using standard troubleshooting procedure.

The first step is to clearly identify and define the problem.

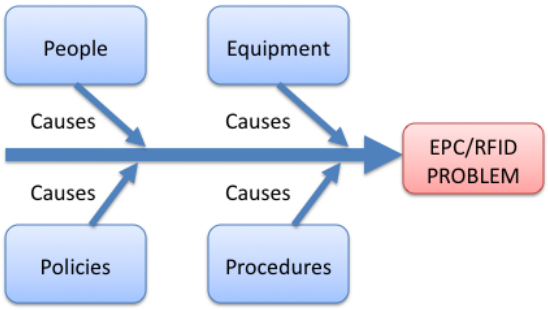
You should do so by documenting the symptoms and by identifying the affected area

If you have identified and defined the problem, in most cases you should be able to reproduce it.

5.4.2 Identifying The Causes Of The Problem

Once you have identified and defined the problem, the next step is to find what is causing the problem.

You will use the Root Cause Analysis method as problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious symptoms



The first step toward finding the cause is to ask what has changed since the last time the system was working fine.

Use the method of elimination to narrow down and isolate the real cause.

This involves eliminating relatively obvious causes or problems and making your way to more complex causes or problems.

5.4.3 Solving The Problem

Now that you have a good understanding of the problem and that you have identified possible causes you will select the most probable cause and work on it.

Work on one cause at a time, and make one change at a time, else you will not be able to map the effects with the cause.

Next, you will plan and implement a solution such as repairing or replacing a component.

Of course, you will test the solution you have implemented and see if it solves the problem.

Finally, document the solution as to save you a lot of time and effort if the same problem appears again in the future.

5.5 Summary

What was in this chapter?

In this chapter, you have learned that the monitoring and troubleshooting are essential parts of running an effective RFID system.

You understood that status monitoring consists of monitoring the status of a system and its devices while performance monitoring consists of measuring the performance metrics of the system or device.

Significant variation in the values of some of these performance metrics can indicate instability of or problems with the system that you will need to troubleshoot.

The standard troubleshooting procedure is identify the problem, identify the cause, implement the solution, test the solution, and document the solution.

Chapter 6: SLIDEDECK OF THIS COURSE

EPC Advanced Infrastructure Implementation Training

Chapter 1
Introduction

Introduction

Welcome to this EPC course.

We are happy to present you with the EPC Advanced Infrastructure Implementation course where you will learn more about implementing the infrastructure required for an EPC / RFID system

Enjoy the course!

3

Preface

Implementing RFID is similar to implementing a new IT system or a new business process.

To do so efficiently, you will need to follow good project management methodology and define your implementation road map

This implementation roadmap can vary from one company or one industry sector to another.

4

Scope

This course focuses on the implementation aspects that are particular to EPC/RFID infrastructure.

Those aspects are:

- The selection of EPC/RFID system design
- The site analysis
- The installation of the system
- The security of the system
- The monitoring & troubleshooting of the system

and therefore does not cover the others steps of the implementation roadmap such as the cost-benefits analysis, the project management or the communication

This course also does not cover extensively the implementation of EPCIS as this will be covered in a separate course.

5

Pre-requisites

This course builds on the knowledge that you have acquired in the "Basics of EPC" and in the "EPC / RFID – Advanced technical aspects" courses.

It is strongly advised that if you're not familiar with EPC and/or RFID, that you first take the "Basics of EPC" course.

It is also strongly advised that you first take the "EPC / RFID – Advanced technical aspects" if you are not familiar with the technicalities of tags, antennas or radiofrequency waves.

6

Chapter 2 –

Selection of the EPC/RFID system design

What is in this chapter?

Selecting the Vendor(s)/Solution Providers
Selecting the Operating Frequency
Selecting the Tags
Selecting the Readers
Selecting the Antennas
Selecting the Transmission Lines
Selecting the Portals
Selecting the RFID Peripherals

8

2.1 Selecting the vendor(s)/solution provider(s)

Why is it important?

Vendors play a major role in helping you design, implement, and manage your solutions and therefore finding the right vendors who can help you address your business issues is critical.

This means that proper vendor selection often makes the difference between a successful project and a failed one.

For an RFID project, this is especially true because its usage is relatively new in areas such as supply chain where only a small set of industry-wide references, best practices, and case studies are available.

10

The Best-of-Breed approach

- Selection of the best vendor for each specific portion of an RFID project.
- The choice often depends on the specific application and industry.

IMPLICATION:

You are in control and manage all aspects of the project in-house.

11

The One-Stop-Shop approach

- Involves selecting one single vendor to act as the primary contractor vendor for the RFID project.
- Primary contractor often manages the entire lifecycle of the project and is responsible for all phases of the project including the selection of additional vendors/sub-contractors

IMPLICATION:

one vendor is primarily in control, manages all aspects of the project, and takes responsibility for the overall outcome of the project.

12

Which approach is best?

- Both approaches have PRO's and CON's and you can mix both for example by maintaining the overall project management responsibility in-house and hiring a vendor to act as a trusted advisor

Best-of-Breed	One-Stop-Shop
More flexibility in substituting another vendor if one does not work out as planned	Generally ensures you will have more time to focus on the business aspects and less problems in integrating the different portions of the projects.
Requires in-house expertise	Having a single point of contact makes it clearer as to whom is responsible
Requires in-house resources for the project management	Failures are expensive in this configuration.

13

How do I compare vendors?

Generic Criteria +

14

2.2 Selecting the operating frequency

Why is it important?

Tag and reader use radio waves of a certain frequency (operating frequency), to communicate with each other.

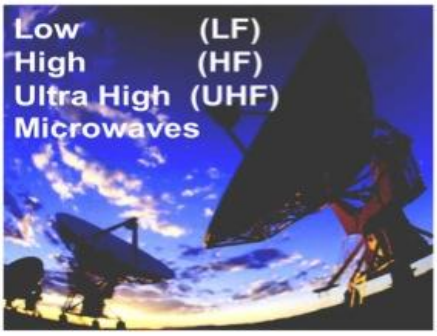
The choice of frequency does affect the system's performance in areas such as speed, range, and accuracy that are critical to your application.

In addition, considering other radio services such as radio, television or mobile phones have operated before the arrival of RFID systems, it is also important to ensure that the selected operating frequency does not disturb these services.

16

What are the frequency ranges?

An RFID systems operates in one of the four main ranges of the radio frequency



We will look at the PROs and CONs of each range and which bands are available for EPC / RFID systems within these ranges.

17

The Low Frequency (LF) range

LF range: **30 KHz - 300 KHz,**
RFID systems: **125 KHz &134 KHz.**

Characteristics of RFID systems at LF:

- Short read range (<0.5m)
- Low reading speed
- Very few interferences with the surrounding and absorption or reflection problems due to water or metal.

Applications:

- access control
- animal and personnel tracking

18

The High Frequency (HF) range

HF range: **3 MHz - 30 MHz**
RFID systems: **13.56 MHz**
(only globally accepted radio frequency for RFID systems)

Characteristics

- Read range: +/- 3 m.
- More problems to penetrate through materials (vs LF)
- Better data transfer speed (vs LF)

19

The High Frequency (HF) range

Applications:

Building access control

Item-level tracking, including baggage handling

Libraries

20

The Ultra High Frequency (UHF) range

UHF range: **300 MHz - 3 GHz.**
RFID systems: **344 MHz & 860 - 960 MHz**
(Depending on country/region regulations)
List of UHF bands available for RFID systems -> EPCglobal website.

Characteristics:

- Read Range <= 10 m.
- Higher probability for interferences (consumer devices)
- Higher probability for problems due to absorption by metals or matter.
- High data transfer
- Limited portability

21

The Ultra High Frequency (UHF) range

Applications:

- Automated toll collection
- Warehouse management
- Inventory tracking



22

The Microwave range

Microwave Range: **1 GHz - 300 GHz**
RFID systems: **2.44 GHz and 5.80 GHz**

Characteristics:

- A long read distance
- A high reading speed and data transfer rate
- Poor performance around water and metal

23

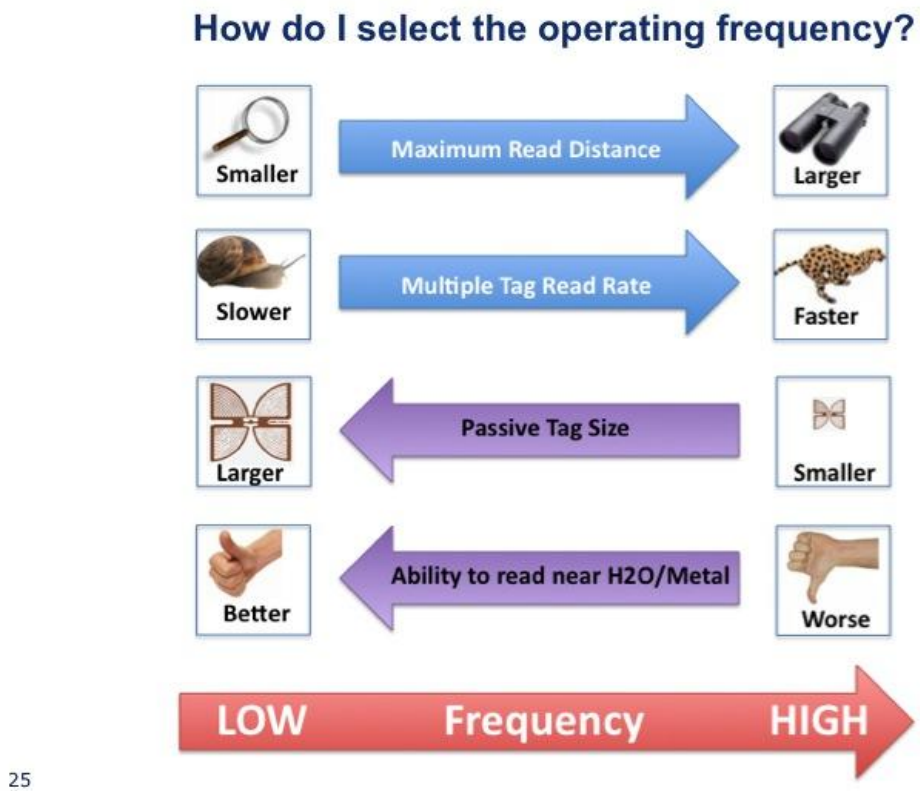
The Microwave range

Applications:

- vehicle identification

- automated toll collection

24



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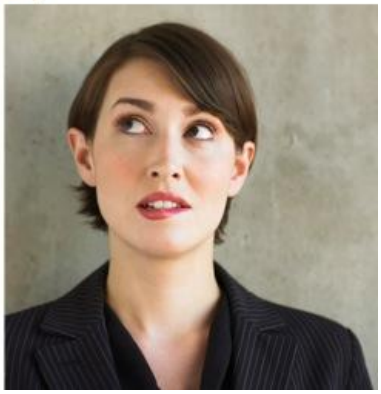
2.3 Selecting the tags

How do I select the tags?

Consider various factors:

- tag types and classes,
- operating frequency,
- read range,
- data capacity,
- tag form and size,
- environmental conditions,
- standards and regulations



27

The kinds of tags

Type of tag depends on your application:

Passive

Requires tag to store some data (e.g. ID) & provide it on request

Active

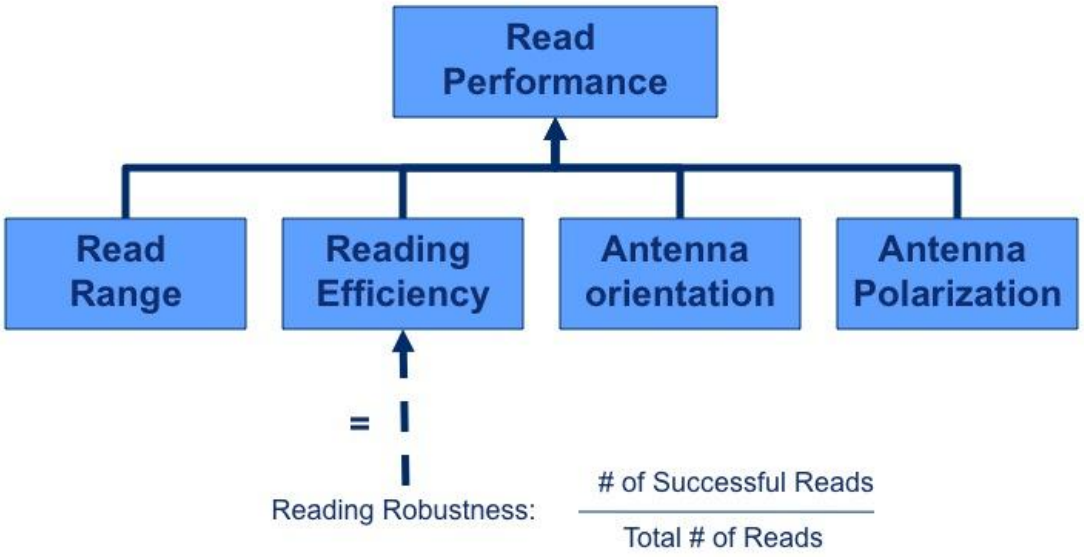
Requires a very long read range or real-time features such as sensing the temperature or the humidity.

Memory

Read Only (RO), Write Once Read Many (WORM) or Read and Write (RW) tags depending on the data you wish to store on the tag and whether this data is subject to change.

28

The read performance of the tags



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Other consideration for the tags

More data capacity = more useful
= more cost

Data locking prevents tampering with the tag data.

With item to be tagged and environment.
Appropriate size
Enough ruggedness if in contact with harsh environment humidity or corrosive material.

Tag compliance with EPCglobal standards ensures compatibility and interoperability with other systems meeting those standards

30

2.4 Selecting the readers

How do I select the readers?

- Ensure reader operates at your chosen frequency
- Ensure reader complies with legal requirements (e.g.maximum power).
- Ensure reader should has correct interface for your application.

32

Other considerations for the readers

Readers usually have 2-4 antenna ports.
Some readers have up to 8 antenna ports.
Offer a better flexibility in covering a wide area zone.

Readers that can be easily upgraded save costs.

Application might require readers to be managed remotely for diagnosis and fixing without visiting the site.

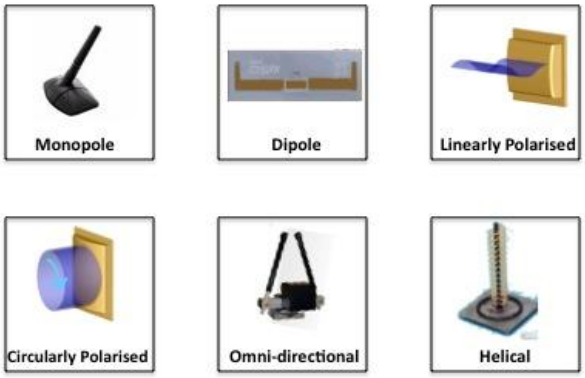
33

2.5 Selecting the antennas

What are the types of antennas?

Both tags and readers have their antennas and these come in various types.

The main antenna types are:

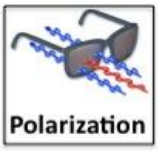


35

How do I select the antennas?

Two key factors: the **footprint** and the **polarization**

- Ground area over which the antenna delivers the signal.
- All tags placed within the footprint of a reader's antenna can be read by the antenna.
- Footprints can be mapped using a spectrum analyzer.



- Depends on the tag orientation with respect to the antennas:

UNKNOWN	KNOWN
Use **circularly polarized** antennas. This ensures some amount of power will be transferred between the reader and the tag antennas, regardless of the tag orientation	Use a **linear** antenna to receive the maximum power and thereby increase the read range.

36

2.6 Selecting the transmission lines

How do I select transmission lines?

Transmission line:
physical medium (e.g. cable),connects signal source of reader to antenna.

Optimal transmission line:
transfer energy from source to antenna with minimum power loss.

RFID systems generally use 50 ohms **coaxial** cables as transmission lines as these have low cable loss.
Shielded pair cables are also used frequently.
The longer the cable, the greater the loss of power.
Impedance of transmission line should match input impedance of antenna.

38

2.7 Selecting the portals.

What is a portal?

Area where RFID tags are being read or written to.

Types of Portal:

Stationary:

- Dock doors
- Conveyers
- Stretch wrap stations
- Smart shelves

Mobile:

- Forklifts

40

The dock doors

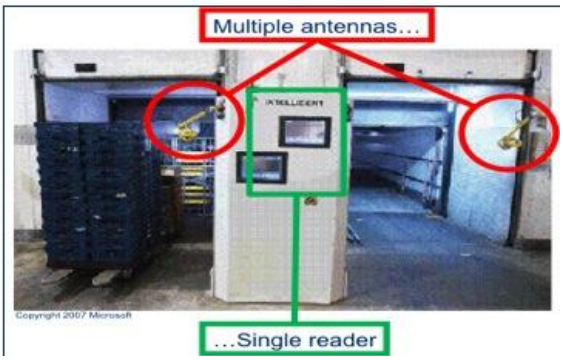
Read at pallet level all tags attached to items on vehicles passing through its interrogation zone

Multiple antennas mounted in array on both sides of door

(covers interrogation zone of +/-3 m x 3m HxW)

Position antennas to form an efficient interrogation zone.

Readers activated by motion of vehicle: should be turned on rapidly so vehicle doesn't have to slow down for all tags to be read.



41

The conveyers

- Generally used for case-level tracking
  (e.g. luggage in airport or boxes in distribution center.)
- Multiple antennas mounted on gantries around conveyer to cover the 4 faces as item to be read passes.
- Optimal reading: belt and roller for conveyer to be made of Radiofrequency friendly material at read point (not of metal).
- Speed of conveyer to be adjusted for optimal reading

42

The forklifts

Especially well suited for reading tags from items on pallets
Can be connected to data collecting computers
(e.g. for improving inventory management).

Disadvantages of mounting antennas on forklifts:

- Forklift based systems require manual intervention from operators
- Tag readability can be affected by various factors:
  - metal of the forks,
  - communication devices of the forklift operator
  - speed of the forklift

43

The stretch wrap stations

Usually final step before shipping, so, RFID system at this place guarantees integrity of the containers.

Extremely attractive for a portal because orientation of tags continuously changes while the pallet spins
(making their reading very efficient).

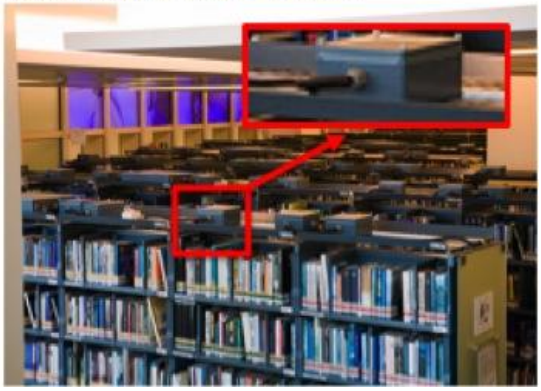
44

The smart shelves

Significant advantage: helping reduce out-of-stocks.

Disadvantage:

- Require multiple readers and antennas
- Potential overlapping of interrogation zones and signal interferences.
- Densely packed items on the shelves could result in stationary readers missing some items resulting in inventory issues.



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2.8 Selecting the RFID peripherals

The RFID printers

Devices printing smart labels (labels combining barcode with RFID tag.
Able to print barcodes on label and read &write tag inside label.
Can be connected to PC via parallel, serial or USB port
Can be connected to network using Ethernet connection.

47

How do I select the RFID printers?

Factors to consider when selecting RFID printers:

- Automatically void faulty labels?

- EPC compliant?

- Support for harsh conditions?

- Support for various label sizes and multiple tag protocols?

- Printing speed sufficient for application now and in the future?

48

The label applicators

Machines applying the labels on the products in an automated way.

Pneumatic Piston

Pneumatic piston label:
Detect product and have piston to stop it for labelling.

Advantage:
product doesn't have to be moving at a constant speed.

Wipe-on

Wipe-on label applicators:
Detect product and perform labelling using roller or brush to wipe down label on package.
Require the product to be reliably moving at constant speed

49

The feed back systems

Generally used to report problems with system or to perform action when event encountered: (e.g. activating readers when tagged items are detected).

Photo Eye

Feedback systems include:

- ***Photo eyes:*** detect presence of something coming or verify if labels are correctly placed

Light Tree

- ***Light trees:*** indicate with green light that package has been read successfully, and with red light that something is missing or incorrect

Motion sensor

- ***Motion sensors:*** indicate arrival of tagged items at dock door

RTL System

- ***Real time location systems:*** track &report in real time location of assets tagged to be tracked

50

2.9 Summary

Summary

In this chapter, you have learned that you want to design your RFID system to meet your application's performance requirements and that vendors play a major role in helping you do so.

The type of your application, the required read range and the operating conditions will be the key factors for selecting your operating frequency.

From there, you will select your tags and readers based on read performance operating conditions and compliance to standards.

Choosing the right portals will depend upon your application and whether you want to track at the item, case or pallet level.

Finally, you have discovered that RFID peripherals will enhance your system and enable it work in a more automated way

52

Chapter 3 –
The site analysis

What is in this chapter?

Design of EPC / RFID system not final until site survey performed.

Understand what information is in blueprint to start site analysis and what information to be entered into blueprint after finish of site analysis.

How to analyze environmental conditions to identify potential sources of interference and how to define where to place interrogation zones

54

3.1 What is a site analysis?

Why is it important?

- Need to determine how RFID system will fit into existing site infrastructure
- Site analysis required before finalizing RFID system design
- Site analysis required before you install the RFID system

Main goal of site analysis:

To ensure that interrogation zones will function properly, with maximum performance and without interrupting existing services.

- Site analysis also facilitates smooth integration with existing IT systems (e.g. by identifying need to upgrade network infrastructure)

56

What are the steps of a site analysis?

You site analysis = ***project*** and should be planned accordingly!

Perform your site analysis in **3 steps**:

- ***Prepare*** your site visit
- ***Visit*** the site and perform a physical and an radiofrequency environmental analysis
- ***Document*** your results in reports and include findings in blueprints.

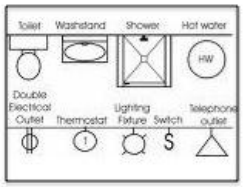
57

3.2 Preparing the site analysis

What is a blueprint?

Plan or facility diagram that helps visualizing big picture of site infrastructure.

- Preliminary determination of where you can possibly set up interrogation zones by showing for example which are the places you need to avoid such as metalic material or motors that can cause interferences.
- Look on blueprint where to get power sources for RFID system.
- Generally uses standardised symbols to represent electrical and telecom devices.



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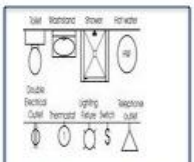
Which equipment do I need?

Main part of site analysis is to perform physical and electrical environment analysis.

The equipment that you need consists of:



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3.3 Performing a physical and an electrical environment analysis

How should I perform a physical environment analysis?

Look for ***physical conditions*** or ***objects*** that might affect RFID system:

Harsh environmental conditions
E.g. corrosive material, extreme temperature or humidity which can damage tags
moisture and water contents which can absorb the Radio Frequency signals.

Electrical devices (e.g. motors & cabling) that could create interferences and noise.

Metallic objects that would reflect the Radio Frequency signals.

Any other physical sources that may have adverse effects on the radiofrequency signal propagation.

62

Why should I perform a radiofrequency environment analysis?

Since you have performed the physical environment analysis, you have identified some of the potential sources of electromagnetic noise and interferences.

Now you need to perform a radiofrequency environmental analysis for further identifying the sources of interference and noise and measuring them.

This analysis will help you decide where to place your interrogation zones and also help you fine-tuning and configuring these zones for optimal performance

The analysis will also ensure that your RFID system will not interfere with the existing radiofrequency systems on the site.

63

The radiofrequency environment analysis – step 1

Measure ambient electromagnetic noise (AEN) generated by electrical devices existing at site.

AEN = measured in decibel by spectrum analyzer.
Measures spectrum of electromagnetic wave, helps:

- To identify sources of radiofrequency interferences
- To measure RF output from these interfering sources in terms of distortion, harmonic, modulation, quality and noise
- To display signal interference if it overlaps intended signal

64

The radiofrequency environment analysis – step 2

Identify sources of interference and collect data with the help of a spectrum analyzer over a full operational business cycle (typically minimum 24 to 48 hours).

Called *full Faraday cycle analysis (FFCA)*

Will tell what frequencies cause most problems when operating RFID system in facility.

When device that might create electro-magnetic noise is identified:

1) Turn on device
2) Measure and record results in planned interrogation zone nearby.

65

The radiofrequency environment analysis – step 3

Protect your EPC / RFID System from the interferences and noise.

To eliminate or minimize the effects of interference, you can consider implementing the following solutions:

Remove source of interference, if possible. E.g. may be possible to ensure forklift causing interference does not operate in interrogation zone.

Shield source of interference or your RFID system next to this source

Use filters, which permit only selected frequencies to pass through a connected device by rejecting all other frequencies.

66

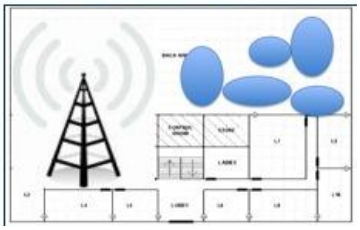
The radiofrequency environment analysis – step 4

Metals, liquids and obstacles affect radiofrequency signal: measure radio-frequency coverage area for reader antenna at different spots of planned interrogation zones.

For each spot:

- Set up antenna
- Use spectrum analyzer for measuring strength of signal emitted by antenna
- Measure in different directions
- Mark down for each direction at which distance from antenna signal becomes too weak to be useful.

Signal coverage area decreases around spots near obstructions, (e.g.) metallic equipment!



67

The radiofrequency environment analysis – step 5

Perform a path loss contour analysis (PLCA) to map how field strength and shape of radio-frequency coverage in interrogation zone varies in zone.

- Shows how radio-frequency signals are degraded and distorted and how shape of coverage changes throughout interrogation zone.

- Helps determining location of antenna in interrogation zone, alignment of antenna and optimal emitted power.

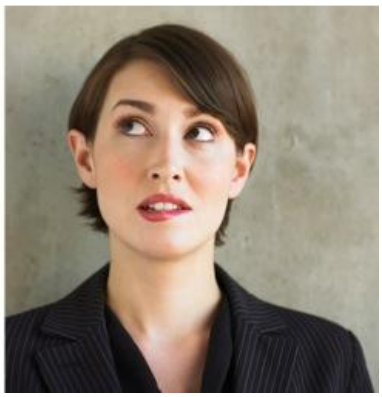
68

3.4 Documenting your results

What should I document?

Report findings on blueprints or some other documents:
Very useful during installation and deployment of EPC / RFID system

-Sources of interferences
-Coverage Areas
-Potential Barriers



70

3.5 Summary

Summary

In this chapter, you have learned that the purpose of site analysis is to determine how the proposed RFID system will fit into the existing site infrastructure.

You understood that a site analysis has 3 phases that are:

- Preparing the equipment and the blueprints
- Performing a physical and a radiofrequency environmental analysis.
- Document your results

Finally, you have also learned in more details how to perform the radiofrequency environmental analysis using a spectrum analyzer

72

Chapter 4 –

Installation of the EPC/RFID system

What is in this chapter?

In this chapter, you will understand how you can successfully install your EPC / RFID system.

You will discover the 3 steps of the installation process that are:

- Preparing the installation
- Installing and configuring the hardware
- Setting up the portals
- Integrating the infrastructure with the application

Finally, you will learn how to ensure safety for your EPC / RFID system and for the personnel in the area

2

4.1 Preparing the installation

Which documentation is needed?

During the selection of the EPC/RFID system design, you have understood the various RFID solutions available in the context of your application requirements.

Equipped with that understanding, you have performed the site analysis and determined how the RFID system will fit into the existing site infrastructure.

You will now use the information collected and documented during the system design and the site analysis to get your RFID components from your vendors and install the system.

But first you need power for your system, don't you?

4

Where can I find power?

Readers and tags need power for their operation:
Get needed power sources and cabling from your vendors

Passive tags get power from RF signal emitted by reader

Active tags have own power source (typically battery)
Lifetime or operating temperature defined by application.

5

Where can I find power?

Readers can use various power sources, including:

Power Supply Units (PSUs)

Uninterrupted Power Supply (UPS)

Power over Ethernet (POE)

6

Getting a solution from the vendors

We have seen in chapter 2 the main criteria for selecting your components and your vendors.

Based on your system design and site analysis documentation, you will now ask your vendors for a solution that would meet your application requirements.

The vendor's solution generally combine the components of your EPC / RFID system and support from the vendor for installing these components.

7

Which solution should I choose?

First ensure:

Components

- Compatibility,
- Consistency with operating frequency
- Withstanding operating conditions

Antennas

- Correct type
- Appropriate maximum power radiated and coverage area

Readers

- Read tags efficiently for all different products to be tagged

Proposed solution can be easily integrated with existing network and application and can be easily maintained

8

4.2 Installing the hardware

How should I install the hardware?

Typical process for installing core hardware for EPC / RFID system:

10

Testing the components

You need to validate that a particular component of a system (software, hardware, or both) is functioning properly with the promised performance before installing it.

For example, you should test that a reader meets the performance specifications, such as read range and multiple tag read rate, as specified by the vendor.

11

Mounting the antenna

Somewhere in or near interrogation zone maximizing propagation pattern.

Map from path loss contour analysis (PLCA) helps:

- Determining exact location of antenna in given interrogation zone
- Configuring and fine-tuning the antenna.

Consider protection from damage:

- Attach using drills and screws,
- Use a rack holding antenna, reader, power supply (UPS), and cables.
- Racks are good to protect your system from harsh environmental conditions such as dust, humidity, and moisture.

12

Mounting the reader

Mount reader in rack or some surface or edge (e.g. wall or gantry placed around conveyor).

Consider the following factors when mounting the reader:

Leave space around reader:

- for cables
- to keep air flowing (reader stays cool)

Avoid:

- placing readers close to each other (minimize reader collisions)
- placing readers close to sources of interferences
- spots of harsh environmental conditions

Choose spot in which reader is safe from accidental physical damage

13

Installing the cables

You will need cables for various purposes such as:

- Connecting the antenna to the reader port
- Powering your components
- Enabling your data transfer, for example from the reader to the host computer

When installing cables you should:

- Use the correct standard cable for a given connection
- Keep the cables away from sources of electromagnetic waves such as motors and electronic
- Use labels to identify the cables and keep a cable layout to avoid confusion and to have easy access for maintenance.
- Use protective caps to cover the exposed parts of the cables, such as cuts.

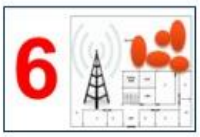
14

Turning the Reader on

Turn the reader on:

This defines interrogation zone
(area around the reader within which the reader can successfully communicate with a tag).

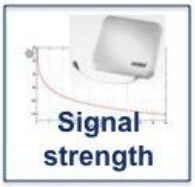
15



Testing the interrogation zone

To test the interrogation zone, you will:

- Determine the boundaries of the coverage area (interrogation zone) by measuring signal strength at various points around antenna
- Use spectrum analyzer to verify map of the path loss contour analysis (PLCA) determined during the site analysis
- Use the map of the PLCA to fine-tune and configure the RFID system.



16

Configuring the interrogation zone

Take into account the following aspects:

- Read rates required by tag traffic
- Power required by reader and tags
- Distance required/available between interrogator and tags

Configuring the interrogation zone involves configuring the reader's commands and settings and adjusting the power of the reader to an optimal value

17

Configuring the reader's commands

Commands usually issued on host computer
(Either by application or using Graphical User Interface/GUI).

Common reader's commands are:

- **QUERY** initiate the communication with tag
- **READ** get the data on tag
- **WRITE** write data on tag
- **LOCK/UNLOCK** prevent or allow writing data on tag
- **KILL** disable tag permanently

Additional commands such as
SELECT, INVENTORY or ACCESS
can also be available to help you
isolate group of tags or
isolate tags from a group.

18

Configuring the reader's settings

Settings and features allow to:

- Adjust power output of reader.
- Set operating frequency for reader
- Select RFID protocol used by reader (e.g. anti- collision protocol
- Set if reader will communicate in duplex or half duplex mode
- Be notified when certain events occur.
  E.g. if number of tags in interrogation zone exceeds a threshold
- Filter which kind of tags to read and which to ignore
- Define computers allowed to communicate with reader and users allowed to use it.

19

Optimising the interrogation zone

Consider the following:

- Network has limited bandwidth and reader's read cycles consume this bandwidth:
  monitor your network traffic

- ***Adjust the power output for reader***: attain required read range while avoiding zone overlaps and staying in limits set by safety regulations.

- If tags are in motion:
  balance tag speed with reader's read speed

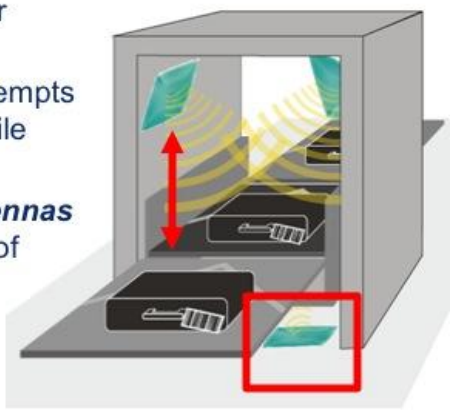
20

4.3 Setting up the portals

Setting up a conveyer portal

Keep in mind:

- ***Keep antennas +/- 45 cm (1.5 ft) away from conveyor edges.***
  This avoids signal reflection by metal and other adverse effects
- ***One of the 4 antennas*** to be designed for optimal operations ***under conveyor***.
- Reader must be able to make multiple attempts to read tag: ***mind speed of conveyor*** while configuring reader
- ***Polarization & alignment of reader antennas*** to be compatible with random orientation of tags.



22

Setting up a dock door portal

UHF systems provide required read range for dock door portals.

When setting up a dock door portal, make sure:

- To keep the cables out of harm's way.

- Antennas are protected against accidental damage.

- # of antennas is large enough to cover width and expected height at which tagged items will be passing
- Not to have too many antennas: creates dense interrogator environment problem

- Most dock doors have 2 or 4 antennas on each side of door
- Antennas from the 2 sides of door are not directly pointing at each other: could cause interferences.

23

Setting up shelf portal

HF systems are generally used for shelf portals:

- sufficient read range
- relatively less affected by metals and liquid content

When setting up a shelf portal:

- Reader antennas to be properly placed, configured & oriented to avoid interference between neighboring antennas.

- You can create multi-shelved portal with 1 antenna per shelf using a multi-antenna reader. Configure reader to use antennas for reads in some sequential order.

- If change in # of items on shelf needs to be detected: readers to be configured to either continuously keep reading tags or have read cycles at preset intervals.

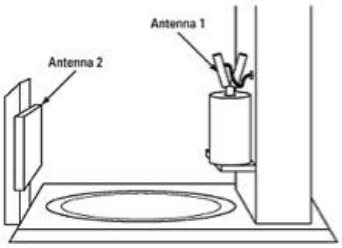
24

Setting up a stretch wrap station portal

Stretch wrap station portals have generally 2 antennas, one on the arm that moves with the roll of stretch wrap and the other one just next to the stretch wrap machine.

When setting up a stretch wrap station portal:

- Protect the cabling of the first antenna taking into account the arm movement that is give extra length to the cable so that it can follow the arm up and down
- Make sure the second antenna is not in the way of the forklift that will drop and pick up the pallet



25

Setting up a forklift portal

When setting up a forklift portal:

- Mount reader on either interior or exterior of vehicle.
- If exterior mounted: consider adequate clearance from external objects such as doorways.
- Reader to be protected against mechanical shocks and vibrations.
- Mobile RFID system will most probably be using wireless network for transferring data to central location: possibility of interference with other electromagnetic devices should be considered.

26

4.4 Integrating the infrastructure with the application

Why is it important?

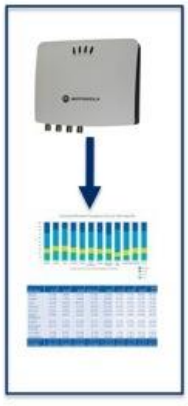
Tag and readers are only able to capture RFID data.

To uncover operational benefits of EPC / RFID
(e.g. reducing out-of-stocks or better visibility along supply chain) :

- incoming RFID data to be processed
- incoming RFID data intelligently to be integrated into business application.

Software is needed to route EPC / RFID data between readers and enterprise systems ("RFID middleware"):

- Ensures RFID data is valuable (e.g.by eliminating duplicate reads and filtering
- Enables readers speaking different languages
- Passes RFID data in correct format to various applications (e.g. Warehouse Management System requiring the data)



28

What should the middleware do?

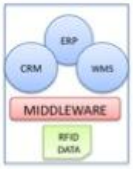
Middleware should include 7 core capabilities:

1) Reader and device management

Allows users to configure, deploy & issue commands to readers through common interface.

2) Data management

Ensures captured data is intelligently filtered & routed to appropriate destinations



3) Application integration

You need messaging, routing & connectivity features to reliably integrate RFID data into existing systems (e.g. ERP, WMS or CRM)

4) Partner integration

You need B2B integration features (e.g. partner profile management & communication protocols) to efficiently integrate with partner's data over EDI or web-based systems

What should the middleware do?

5) Process management

Allows orchestrating RFID related end-to-end processes.
E.g. link receiving process to inventory & POS process so system automatically reorders more products without human intervention when inventory is too low

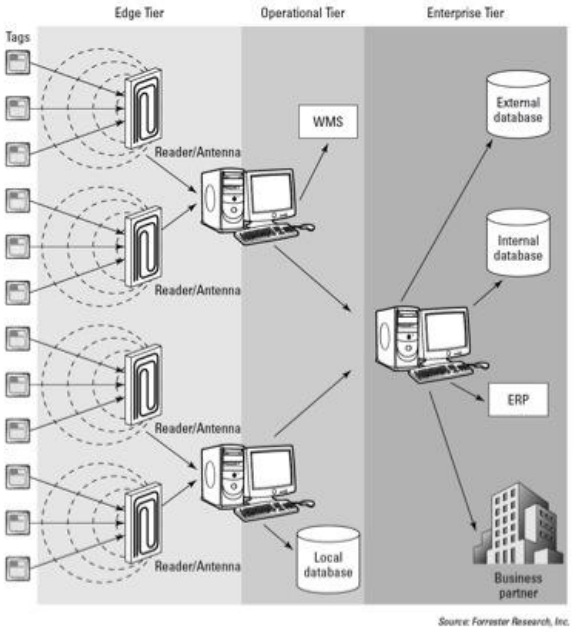
6) Packaged RFID content

You don't have to start developing RFID applications (e.g. shipping or asset tracking) from scratch .

7) Architecture scalability

Allows system to balance processing load across multiple servers & reroute data automatically if a server fails.

Where should the middleware go?



31

4.5 Ensuring safety

Ensuring safety is a requirement

Ensuring safety for EPC / RFID system & personnel working in zones where system is installed is mandatory step of the installation process

We have already learned that racks or similar protections can be used for protecting components of your system from shocks or harsh conditions.

You also have to protect your system and the personnel operating it from electrostatic discharges by installing for example wrist straps or floor mats

33

Grounding and ground loops

System Components must be ***grounded:***

- ***To prevent electric shock or fires*** caused by voltage difference between earth and conducting metal.
- ***To protect personnel & equipment*** from lightning strikes.
- ***To reduce noise & interference*** coming from computers & readers ensuring system has minimal impact on already existing radiofrequency systems.

Protect your system and personnel from ***ground loops*** by ensuring that the conductor used for grounding is short enough and that all the readers are connected to the same grounding system.

34

4.6 Summary

Summary

In this chapter, you have leaned that the implementation of an EPC / RFID system is a process that starts with the documentation collected during the system design and the site analysis.

You have learned how to install your hardware components such as antennas, readers and portals and how to integrate this infrastructure with your application by using the middleware.

Finally, you have been reminded that you must safely protect your system's components as well as the personnel operating close to your system

36

Chapter 5 –

The monitoring & troubleshooting of the system

What is in this chapter?

Now that you have designed and installed your RFID system, you have to expect to encounter problems such as reader failure, tag failure or network connectivity problems.

Therefore you need to monitor and troubleshoot your system and this chapter will explain you how to do it successfully.

You will learn that monitoring your RFID system involves status monitoring and performance monitoring

You will also learn that you will need to troubleshoot the system for finding the causes for the problems identified during the monitoring and fix these problems.

2

5.1 What is monitoring?

Status monitoring

Monitoring of basic status of system and devices within it, e.g.:

- Is the device connected to the network?
- Are the devices powered?
- Are the antennas operating?
- Is a reader reading the tags successfully?

Please note

Some solutions include status indicator panel on your desktop allowing to monitor status of all readers from one location.

Feedback systems (e.g. light tree and horns) discussed in Chapter 2, can also play an important role in status monitoring.

4

Performance monitoring

Monitoring performance of a system and the devices within it, e.g.:

- Read rates of readers

- Reading accuracy

- Error frequency

Performance data on predetermined metrics (e.g. read rates) helps determine normal behavior of the system & identify the variance in normal behavior and hence a problem.

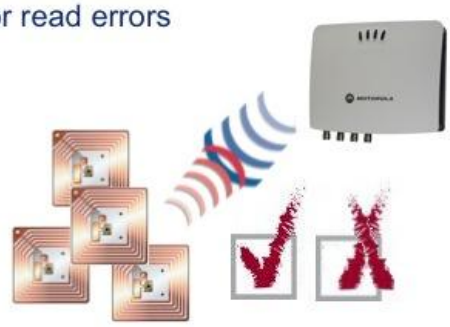
5

5.2 Monitoring the interrogation zones

What should I look for?

The Interrogation Zone has several parameters characterizing it:

- Number of tags passing through the zone
- Number of tags being successfully read
- Number of tag that can't be read or read errors
- Reader failure



7

Mean Time Between Failure

MTBF:

Average time between two consecutive failures of a device or a system.

- Indicates robustness of system measured in the past & predicts rate of failure in near future.
- Calculated as: $\frac{\text{total lifetime of the device}}{\text{total number of failures recorded}}$

Example:

- 20 readers on system
- In 10 day period: 6 readers fail once
  1 reader fails twice
- 20 readers x 10 days = 200 reader days of operation
- MBTF: $\frac{200 \text{ days}}{6+2 \text{ failures}}$ = 25 days/failure

8

Average tag traffic volume (ATTV)

Average number of tags passing through an interrogation zone during an interval of time (e.g. minute or hour).

- Monitoring system collects tag counts and time at which tag was counted from readers.
- Example:

  Time interval = 1hour

  During the last 4 hours, 10, 20, 30 and 40 tags respectively were detected.

  ATTV is : $\frac{\text{10+20+30+40 tags}}{\text{4 hours}} = \frac{\text{100 tags}}{\text{4 hours}} = \text{25 tags/hour}$

From the ATTV measurements, you can predict how much traffic is expected to pass through an interrogation zone during a certain period.

9

Actual Versus Predicted Traffic Rate (APTR)

Variance of actual tag traffic from predicted tag traffic through interrogation zone over a time period.

A significant variance could indicate a problem with the system.
APTR = ***Current Average Tag Traffic Volume (ATTV) - predicted ATTV***

Example:

Current ATTV:	25 tags/hour for the past 4 hours.
Predicted ATTV:	15 tags/hour
Variance :	10 tags/hour more than predicted
APTR:	$\frac{25}{15} = 166\ \%$

Compare actual value to predicted value for the ***same time interval & period of day*** (e.g. from 2.00 to 6.00 pm) as tag traffic can be different at different hours of the day.

10

Read Error to Total Read Rates (RETR)

Read errors to total reads rate (RETR) is the total number of read errors divided by the total number of read attempts.

Example:

450 tags read successfully

50 tags couldn't be read

RETR: $\frac{50}{50+450} = \frac{50}{500} = 10\ \%$

I.e. You have a problem with 1 tag every 10 tags.

High RETR value is alarm for problem with RFID system:

- ***internal problem:***
  faulty antenna or low signal strength
- ***adverse environmental effects:***
  absorption and/or interference.

11

Read Error to Total Read Rates (RETR)

High RETR value is alarm for problem with RFID system:

- ***internal problem:***

  faulty antenna or low signal strength

- ***adverse environmental effects:***

  absorption and/or interference.

12

5.3 Monitoring the tags

Why is it important?

Process of manufacturing tags & application to items has significantly matured, still tag failures do occur.

- Monitoring tags is important task for RFID professional.
- Ensure tags are properly placed on items.
- Know the reasons why tags can fail and how to manage these failures.
- Tags are placed on items to be tracked ***before*** the items get out into the world.

The first step in monitoring tags is to identify improperly tagged items.

14

Identifying improperly tagged items

There are four kinds of improperly tagged items:

- Items tagged with ***faulty*** tags.
- Items on which tags are placed ***incorrectly*** (where they cannot be read properly by the reader).
- Items on which tags are placed at ***correct spot*** but they are ***applied incorrectly***, (e.g. bent or folded).
- Items on which tags are ***not properly oriented*** when correct orientation is required for efficient reading.

15

Identifying improperly tagged items

Methods for identifying improperly tagged items:

- ***Inventory discrepancies***
  Tags on the items were not properly read; hence the items were not counted.

- ***Feedback devices, (photo eyes, motion sensors, …)***
  Provide presence information of item + instruct reader to read it.
  If reader cannot see it, it could be an improperly tagged item.

- ***Placing interrogation portal right after application point***
  If the tag cannot be read, it might be defective or improperly placed.

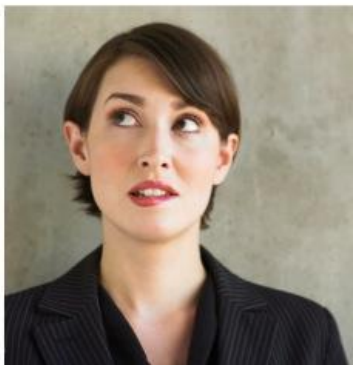
- ***Manual inspection***,
  Perhaps before shipping.

16

Identifying Reasons for Tag Failures

Main reasons for tag failures:

- ***Defects introduced during manufacturing***.
  Can sometimes be detected by device itself
  Smart label printer identifies which tags it printed incorrectly
- ***Wrong tag type*** was applied for a given application.
- ***Electrostatic discharge*** has damaged the transistors in the tag's integrated circuit
- Tag has suffered from ***harsh environmental conditions***
- The tag is ***misplaced***
- There is a ***dense tag environment*** and tags are ***shadowing*** each other.



17

5.4 Troubleshooting

Identifying the problem

Now that you have identified the problem, it is time to solve it by using standard troubleshooting procedure.

The first step is to clearly identify and define the problem.

You should do so by documenting the symptoms and by identifying the affected area

If you have identified and defined the problem, in most cases you should be able to reproduce it.

19

Identifying the causes of the problem

Once problem has been identified and defined, find what is causing the problem.

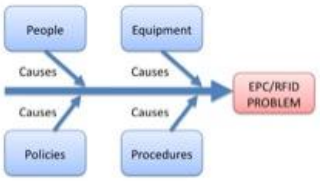
Root Cause Analysis method

Problems are best solved by attempting to correct or eliminate root causes, (vs addressing immediately obvious symptoms)

Ask what has changed since last time system was working fine.

Use *method of elimination* to narrow down and isolate the real cause.

- Eliminate relatively obvious causes/problems
- Make your way to more complex causes or problems.



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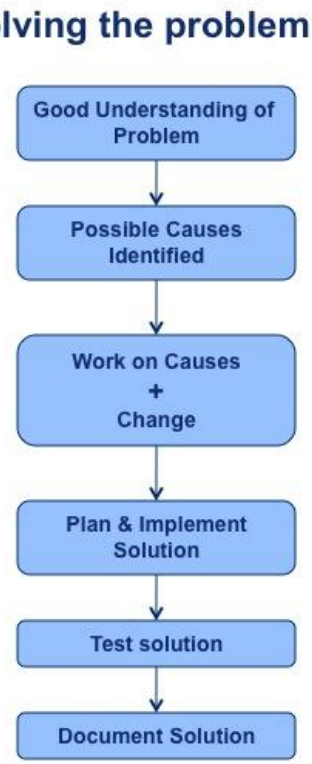
Solving the problem
Good Understanding of Problem
Possible Causes Identified
Work on Causes + Change
Plan & Implement Solution
Test solution
Document Solution

5.5 Summary

Summary

In this chapter, you have learned that the monitoring and troubleshooting are essential parts of running an effective RFID system.

You understood that status monitoring consists of monitoring the status of a system and its devices while performance monitoring consists of measuring the performance metrics of the system or device.

Significant variation in the values of some of these performance metrics can indicate instability of or problems with the system that you will need to troubleshoot.

The standard troubleshooting procedure is identify the problem, identify the cause, implement the solution, test the solution, and document the solution.

23