# Module 7 – Evaluation and Selection

RFID systems can be made up of many different components, standards and differing RFID technology; any combination of which can have different performance, cost and implementation implications. So the correct choice of technology/components is crucial if the RFID system selected is to meet the needs that it is intended to meet. These needs typically fall into specific categories:

- Performance – the ability for readers and tags to exchange information within a specific timeframe
- Range – the ability to execute that performance over specific ranges
- Environment - the ability to execute that performance within the target environment taking into account factors such as EMF (Electromagnetic Field) that may interfere with performance
- Cost – a RFID system that is within the available budget
- Integration – a RFID system that can exchange data with other existing or intended systems and applications
- Stability – a RFID system that exhibits the required capability, consistency and capacity to remain stable in use
- Regulation – all of the above while remaining within regulatory compliance for the location of the RFID system

**Main Objectives:**

1. Know how to identify the specific needs that the RFID system is intended to meet
2. Understand relative costs between different types of components
3. Understand relative performance characteristics of different RFID systems/technologies
4. Identify what type of RFID system is best suited to meet those needs and why
5. Know how to select an appropriate combination of system components to meet those needs
6. Know which standards are optimal for tag data
7. Recognize the type of regulatory constraints that may apply

## 1. How to identify the specific needs that the RFID system is intended to meet

All the needs are determined during a site and workflow assessment

- Current data collection system assessment and business process analysis – determines the current systems used and processes deployed, their strengths and weaknesses
- A site survey - provides a physical review, analysis, recommendations and report by qualified RFID Engineers of the site where RFID infrastructure and equipment will be installed so that the RFID processes work 100% of the time

2. **What type of RFID system is best suited to meet those needs and why**
3. **How to select an appropriate combination of system components to meet those needs**

**Technical considerations for tag selection:**

- Material composition of materials being tagged (items as well as container)
- Minimum and maximum read range needed
- Minimum and maximum amount of tags in the read zone at any one time
- Speed of tags travelling through the read zone
- Physical dimensions and tag orientation based on size of the objects tagged

**Technical considerations for reader selection:**

- Reader location for each read point in the process flow, also whether fixed or handheld
- Power source – POE, AC, Battery
- Network connections – Ethernet, Serial, Wi-Fi, Bluetooth
- Number and placement of antennas and antenna ports (bistatic, monostatic)
- Type of peripherals required – lights, horns, motion sensors, electric eyes, PLCs to control other devices like cameras, door locks, gates, conveyors, etc.
- Reader management tools – local, remote, online
- Environmental protection of the reader – to prevent damage in harsh environments, NEMA boxes, etc.

**Technical considerations for antenna selection:**

- Technical characteristics of antenna - gain, high or low.
- Antenna pattern including directivity (length, read zone, etc.)
- Polarization, linear or circular, which would provide the best coverage.
- Number of antennas required and whether bistatic or monostatic would be best.
- Best method for mounting the antenna - knuckle joints (3 axis), mounting plates and brackets, consider special environmental conditions such as vibration,

moisture, limited space, etc.

- Environmental protection – IP rating of an antenna to ensure it will survive the conditions, especially when mounted outdoors or in harsh environments

**Environmental Conditions**

- **Weather** (outside) - rain, snow, wind, temperature, humidity
- **Type of Facility** - industrial / business, Store front, Clean room
- **Condition within the Facility** - temperature extremes, humidity, chemicals, industrial dust / lint, vibration, motion / movement
- **Location of -** heavy machinery, conveyor belts, restricted zones by machines
- **Emissions from Machines:**
  - Heat, steam, chemicals – will damage hardware
  - Electromagnetic Field (EMF) and Electromagnetic Interference (EMI) – will affect system performance and reading tags by interfering with the RF signal
- **Type of storage shelves and cabinets** (metal shelving will block/reflect RF)

**4. Be familiar with relative costs between different types of components**

- RFID Readers
  - Fixed readers - approximately $700 and up, most often around $1000 - 1500
  - Handheld readers – more expensive than fixed readers, approximately $1000 and up
- RFID Printers – more expensive than readers, approximately $1700 and up, most industrial printers around 3 – 4K
- RFID Antennas – from around $50 to few hundred dollars – depending on type
- RFID Cables – from $20 depending on length and rating
- RFID Tags
  - Passive – cheapest, 5 cents in very high volumes for inlays, usually around a $1 for labels for low volumes, several dollars for specialty tags
  - Semi-passive and active tags – more expensive, usually in tens of dollars

## 5. Relative performance characteristics of different RFID systems/technologies

| Frequency Bands | Performance around water | Data & Speed | Read Range | Usage |
|---|---|---|---|---|
| **Low Frequency (LF)** 125 kHz – 134 kHz | Great | - Low Read Speeds - Small Amount of Data (16 bits) | Short to Medium 3-5 feet | - Access Control<br>- Animal Tagging<br>- Inventory Control<br>- Car Immobilizer |
| **High Frequency (HF)** 13.56 MHz | Good | Medium Read Speed Small to Medium amounts of data | Short 1-3 feet | - Smart Cards<br>- Item or Case level tagging<br>- Proximity Cards<br>- Vicinity Cards |
| **Very High Frequency (VHF)** 433 MHz – Active Tags | Bad | High Read Speed Large Amounts of Data | High 1-1000 feet (active) | - Asset Tracking<br>- Location<br>- Container Tracking |
| **Ultra High Frequency (UHF)** 860 MHz – 960 MHz | Bad | High Read Speed Small to Medium amounts of data | Medium 1-50 feet | - Pallet or case level tagging<br>- DOD & Walmart Mandates |
| **Microwave Frequency** 2.45 GHz & 5.4 GHz | Bad | High Read Speeds Medium Amount of Data | High 1-300 feet (active) | - Patient Tracking<br>- Container Rail Car<br>- Auto Toll Roads<br>- Pallet Level Tracking<br>- RTLS (UWB Freq.) |

## 6. Which standards are optimal for tag data

- **ISO/IEC 15961** - Data Protocol: Application Interface (defines AFI = Application Family Identifier, equivalent to EPC Header)
- **ISO/IEC 15962** - Data Protocol: Data Encoding Rules and Logical Memory Functions
- **ISO/IEC 15963** - Unique Identification for RF Tags (related to TID Memory)

- **GS1/EPC Global** - EPC Tag Data Standards, Version 1.9

  This standard defines EPC tag data formats for Generation 2 tags. It defines how the EPC is encoded on the tag and how it is encoded for use in the information systems layers of the EPC Systems Network. The standard includes specific encoding schemes for EPC General Identifier (GID). It also defines encoding of six other numbering systems for 96 bits used in global trade:

  - SGTIN (Serialized GTIN) - Serialized EAN.UCC Global Trade Item Number
  - SSCC - EAN.UCC Serial Shipping Container Code
  - GLN - EAN.UCC Global Location Number
  - GRAI - EAN.UCC Global Returnable Asset Identifier
  - GIAI - EAN.UCC Global Individual Asset Identifier
  - DoD - US Department of Defense number

GID FORMAT

| - | HEADER | GENERAL MANAGER NUMBER | OBJECT CLASS NUMBER | SERIAL NUMBER |
|---|---|---|---|---|
| Decimal capacity | 0011 0101(actual value) | 268,435,455 | 16,777,215 | 36 bits |
| GID-96 | 8 bits | 28 bits | 24 bits | 24 bits |

*The standard also defines encoding of other numbering systems for 96 bits used in global trade.*

## 7. The type of regulatory constraints that may apply

- Radio Licensing Regulations
- Radio Use Regulations
  - Transmission power levels
  - Transmission channels
  - Frequency use
- Health and Safety regulations

- FCC Part 15.247 – governs allowed transmitted power from the reader/interrogator (maximum 4 W EIRP), frequency hopping channels (50) and the channel width (500 kHz).
  - For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands, the maximum peak conducted output power of intentional radiators is 1 watt.

- ETSI 302 208 (newer)
  - 865.0 – 868.0 MHz
  - 15 channels – 200 kHz each
  - Three sub-bands
  - Up to 2 W ERP in subband 865.6 – 877.6 MHz (10 channels)
  - Required Listen Before Talk (LBT)
- ETSI 300-220 (older, restrictive)

Each country has their own organization and regulations, often they take guidelines from the FCC or ETSI.

**Study List**

For additional information and detailed explanation, please read:
What is RFID
Frequencies
Criteria for Tag Selection
RFID Interrogation Zones
Site Analysis
RFID Regulations
EPC Gen 2 Memory
Standards and Mandates