RFID: The Technical Reality

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Brief History of RFID

1846: Faraday: Light and Radio Waves Part of Electromagnetic Energy

1864: Maxwell: Maxwell's Equations

1887: Hertz: Electromagnetic Waves

1896: Marconi: Trans-Atlantic Radio Communication

1906: Alexanderson: Continuous Wave

1926: Baird Patent: Radio Object Detection

1935: Watson-Watt Patent: Radar

1948: Harry Stockman: Communications by means of Reflected Power

1952: Vernon: Application of the Microwave Homodyne

1950's: Harris Patent: Radio Transmission Systems with Modulatable Passive Responder

1966: Sensormatic and Checkpoint EAS

1973: Cardullo Patent: Passive RFID

1975: LASL: RFID Research Released to Public (IDX and Amtech)

1979: Animal RFID

1987: Norway: Motor Vehicle Toll Collection

1991: AAR Standard

1994: All US Railcars RFID Enabled

1999: MIT Auto-ID Center Founded

2003: RFID Container Tracking in Iraqi Freedom

2003: EPC System Version 1.0

2005: Wal-Mart Mandate

2005: DoD Mandate

RFID Tag Functionality

- Communication
- Identifier (Object Identifier)
- Anti-collision algorithm
- On-tag Memory (optional)
    - Mission Critical Information
    - Portable Database (Cache)
- On-tag Functionality (optional)
- On-tag Sensors (optional)

RFID Tags - Communication Classification

Passive - passive communication, no on-tag power source (Wal-Mart Mandate)

Semi-Passive - passive communication, on-tag power source

Active - active communication, on-tag power source
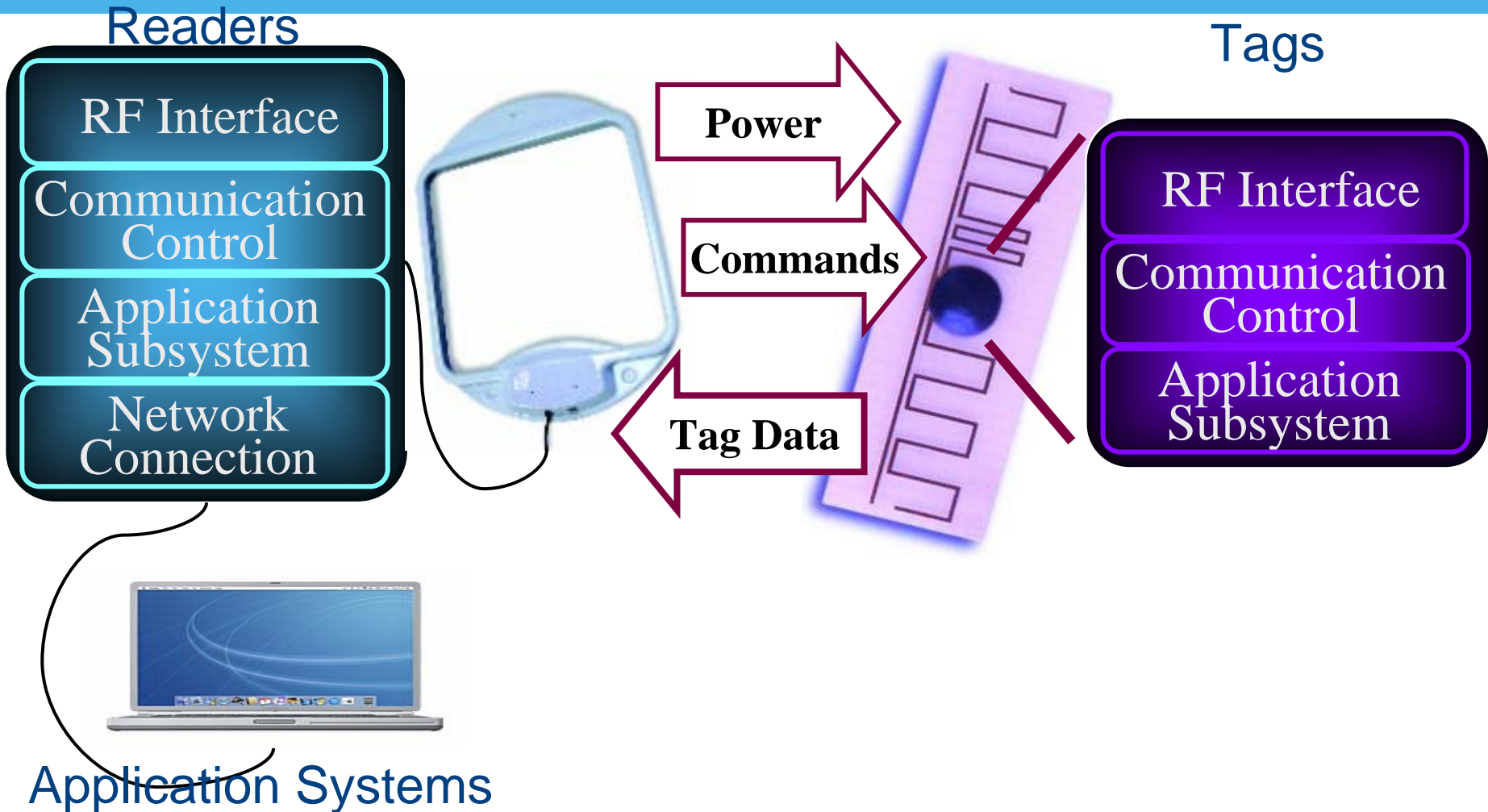
Regulatory Regions

RFID Frequency Comparison

Frequency	Regulation	Typical Range	Advantages	Comments
< 135 kHz	ISM Band, High Power	<10cm (passive)	High Liquid Penetration	Access Control
13.56 MHz	ISM Band, Nearly Identical Regulations Worldwide	<1m (passive)	Medium Liquid Penetration	Smart Cards, Access Control, Vehicle Immobilization
433 MHz	ISM Band, Short Range Communication Devices, Non-uniform Worldwide	<100m (active)	Low Liquid Penetration, Works well around metals	Active Tags
860-960 MHz	Non-uniform Worldwide	<10m (passive US) <4m (passive EU)	Best Passive Communication Range	Wal-Mart, DoD Mandates
2.45 GHz	ISM Band, Nearly Uniform Worldwide	<3m (passive) <50m (SAW)	Alternative to 900MHz	Wi-Fi, Bluetooth

Passive RFID Systems

Readers

Reader Components
RF Interface
Communication Control
Application Subsystem
Network Connection

Tags

Tag Components
RF Interface
Communication Control
Application Subsystem

Power →

Commands →

← Tag Data

Application Systems

EPC UHF 860MHz - 960MHz

Advantages

- Best available frequency for distances of >1m
- Effective around metals
- Range: up to 10m
- Good non-line-of-sight communication
- High identification rate
- Reasonably controlled read zone (through antenna directionality)

Disadvantages

- Absorbed by water
- Difficult to control read zones
- Signal attenuated by objects

EPC Identity Tag Protocol Key Features

- Mandated by Wal-Mart, DoD
- EPC Identifier only
- Kill Command

Summary

- RFID technology has a long history

- Passive RFID systems in wide use since mid-1970s

- RFID performance determined by regulations

- Passive tags harvest energy from reader signal

- 860MHz-960MHz Passive tags
  Wal-Mart mandate
  <10m communication range
  Shielded by metal and liquids