



Real World Applications of RFID

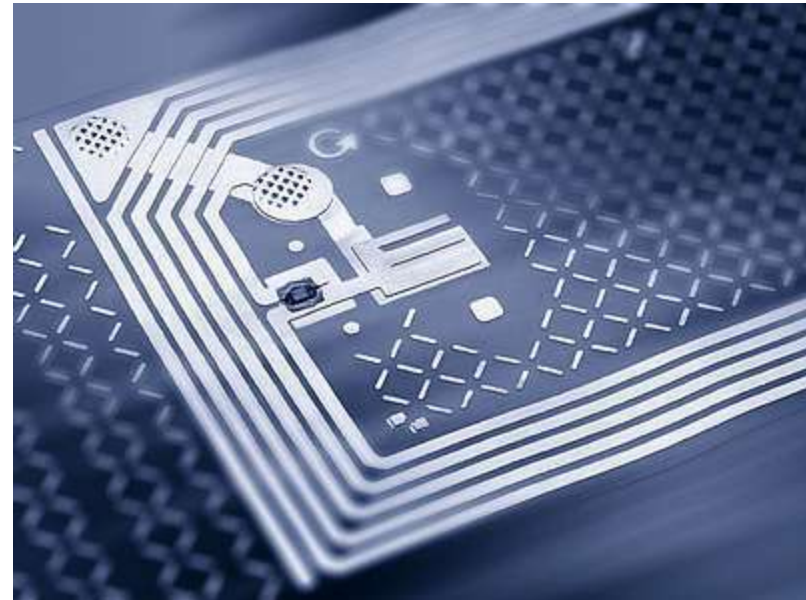
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RFID Overview

- **RFID=**
 - Radio
 - Frequency
 - Identification
- RFID is based on wireless communication over the air that reads or writes information from a tag.



RFID Overview Continued...

<http://www.youtube.com/watch?v=hPqUUR5OFJg&feature=related>



Components of an RFID Deployment

- Transponder (tag) – active, passive frequency, form factor



- Encoder – “printers”

- Interrogator – Transceiver or reader (\$1,000)

- Middleware

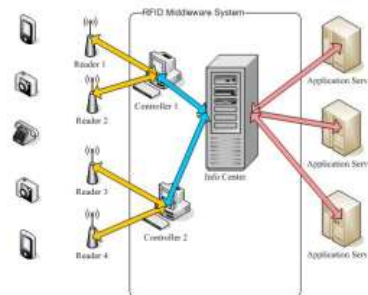


Figure: WRFID Middleware Platform



RFID Definitions

Famous Contributors

RFID is based on a chain of scientific discoveries from some of our most important intellectual pioneers such as:

1846

Michael Faraday: identified that both light and radio waves are part of electromagnetic energy.

1864

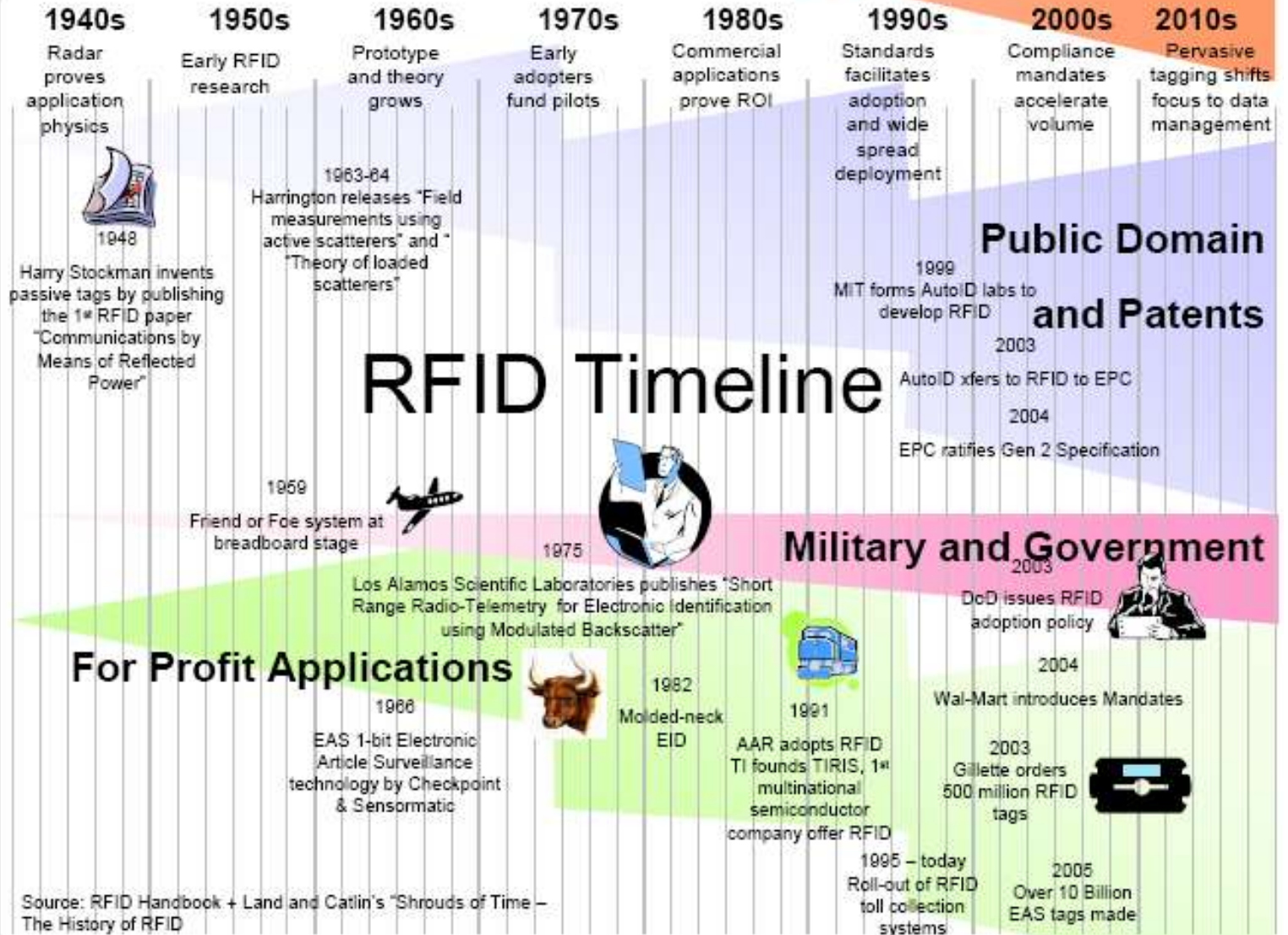
James Maxwell: in 1864 propounded his theory that electric and magnetic energy travel in transverse waves at the speed of light.

1887

Heinrich Hertz: proved Maxwell's theory and showed that radio waves may be reflected, refracted, and polarized like light.

1895

Guglielmo Marconi: demonstrated wireless transmission of radio waves.



Shoplifter or not?

<http://www.youtube.com/watch?v=eob532iEpqk&feature=related>



Future Supermarket?

- **When you go to the grocery store, how do you pay for your items?**
- **Is this process easy or time-consuming?**
- **What is the name of this item which cashiers use to check-out a product?**
- **How does this item work?**

RFID vs the Barcode

- **Barcode revolutionized Supply Chain Management**
- **RFID offers the benefits as the Bar Code – but also a whole lot more**



- **Barcode**

- *Strengths*

- Mature technology
 - Established standards
 - Low implementation cost
 - Human readability

- *Weaknesses*

- Requires clean line of sight
 - Orientation sensitive
 - Sensitive to printing and abrasion
 - Static data content



Bar Code vs RFID

- **RFID**

- *Strengths*

- Line of sight NOT required
 - Passive data collection
 - Not sensitive to environment
 - Dynamic data content
 - Data Capacity

- *Weaknesses*

- Emerging technology
 - Lack of standards
 - Cost moderate to high today



Real World Examples of RFID

- Shop Lifting Systems
- Animal Tagging
- Toll Roads
- ID's and Passports
- Keyless Entry
- Marathon Tracking
- Manufacturing
- Freight Transportation
- Distribution Center
- Retail Stores
- Medical Equipment
- Military/DOD

The key word today
in industry is

VISIBILITY

Visibility

- **Information has Replaced Inventory**

- **Technology**

- Internet
 - **Supply Chain Software**
 - And now RFID



- **Knowledge of what is in the pipeline allows the supply chain to hold less inventory**

• What do we know about Inventory?

– It is Expensive

– *Inventory as a percent of total assets*

- Sarah Lee – 1998 – 25% 2007 – 9%
- Wal-Mart – 1998 – 36% -- 2008 – 22%



– It is necessary

- Stockouts cost money
 - P&G in 2003 – average out-of-stock was 10%
 - » Cut that to 5% in 2005



RFID – Why Now?

- **Mandates:**

- Wal-Mart

- Target

- DoD

- Albertsons

WAL★MART®

 **TARGET®**

- **EPC compliant hardware is emerging**

- **EPC standards ratified in 12/04**

- Gen-2 tags

Why the Mandates?



- **Wal-Mart -- \$3.5 billion in lost sales**
- **Need product on the shelf.**

RFID Technology

- **Tags – Most important element**
- **Different types of tags**
 - **Active vs Passive**
 - **Low Frequency**
 - **High Frequency**
 - **Ultra High Frequency**

RFID Tags

- **Passive Tag**

- Energy from the reader “wakes up” the tag and powers its operation.
- The tag then reflects a signal that can be decoded from the reader

- **Active Tag**

- Transmit a signal using its own power source (battery) without initiation

RFID Frequency

| Low Frequency (LF) | | | | High Freq. (HF) | | | Very High Freq. | | | Ultra High Freq. (UHF) | | | |
|---|---------|-----------|---------|---|-----------|--------|-----------------|--|---------|---|--------------------------|----------|-------|
| 30 KHZ | 125 KHZ | 134.2 KHZ | 300 KHZ | 3 MHz | 13.56 MHz | 30 MHz | 31 MHz | | 300 MHz | 300 MHz | 433 MHz | 2.45 GHz | 3 GHz |
| Access Control, Lot-ID Chemical Process, Logistic, Distribution | | | | Logistic, Warehouse Management, Automotive, Retail, Library, Parcel, Baggage Check Plagiarism Security | | | | | | Tracking, Outside ID, Pckto light, Logistic, Truck- Car- Train- ID, Long Range Application | | | |
| | | Tiris ® | | | ISO 15693 | | | | | | 868 MHz EU 915 MHz US | | |

http://www.brooks-rfid.com/uploads/pics/rfid_frequencies_01.gif

RFID Tags

Low Frequency

- Typical Range – 10 feet
- Tag – 3-6 inches
- 50 tags can be read at once
- Cost \$3-\$10
- Not Wal-Mart compatible
- Used for animal tracking, ID badges
- Not EPC compatible



RFID Tags

High Frequency

- Typical Range – 10 feet
- Tag – 3-6 inches
- 50 tags can be read at once
- Cost \$0.50-\$5
- Not Wal-Mart compatible
- Used for Industrial, Scientific and Medical – Smart Card Security
- EPC compatible



RFID Tags

Ultra High Frequency

Typical Range – 40 feet

200-1000 tags can be read at once

Cost \$0.20- Target is \$.08

Wal-Mart compatible

Used for Retail and Supply Chain Management

EPC compatible





UPC vs. EPC

Universal Product Code
or
Electronic Product Code

ELECTRONIC PRODUCT CODE TYPE I

01.0000A89.00016F.000169DC0

Header
8-bits

EPC Manager
28-bits

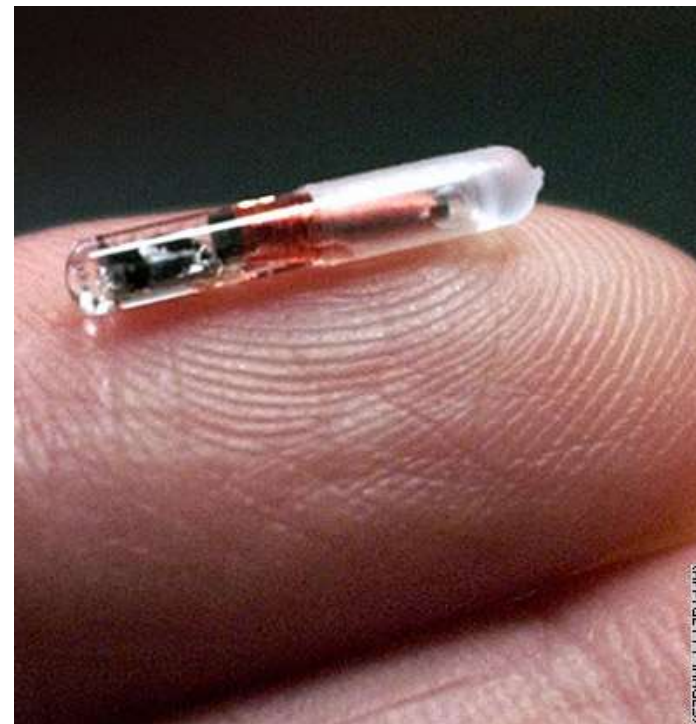
Object Class
24-bits

Serial Number
36-bits

Threats to RFID

- **Tag Cost**
- **Cost of Implementation**
- **Lack of Standards**
- **RF transmission distance**
- **Tag/Reader sensitivity**
- **Privacy Concerns**
- **Security**

<http://www.youtube.com/watch?v=PoZ8B1qFW8>



RFID Assignment

- **Research real-world applications of RFID on the internet**
- **Pick one application and create a two-minute presentation with a partner discussing this item**
- **You will be graded on this presentation with the RFID Grade Rubric**