RFID
Radio Frequency Identification

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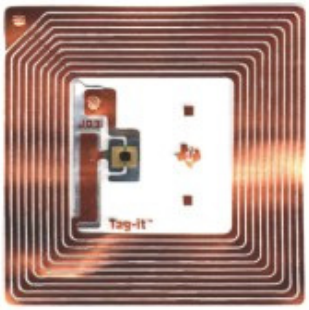
What is RFID?

- **R**adio **F**requency **Id**entification
- Identification system that consists of chip-based **tags** (*transponders*) and **readers**
- Data is stored and retrieved remotely using **radio waves**
  - Product information
  - Onboard sensors



What is RFID?

- Auto-ID data collection system for identifying, tracking and doing management of material flow
- Basic concept behind RFID is same as “Mirror-Sunlight-Reflection theory”

Brief History

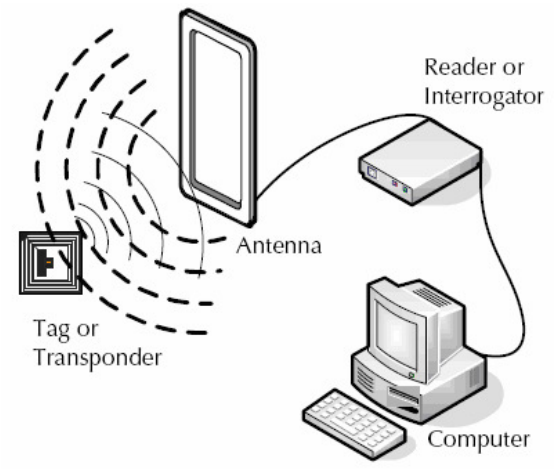
- Invented and used from early 1940’s
- Commercial Operation begun in the 1960’s
- In 1970’s developers, inventors, companies, academic institution and government sectors were actively working on RFID
- Most common applications are
  - Track objects, animals or persons,
  - Identify goods in supply chain,
  - Reusable containers,
  - Track high value items,
  - Security,
  - Controlling access to buildings,
  - Ticketing systems,
  - Payment systems.

Tags Types

- **Passive**
  - Require no internal power source or maintenance
  - Powered by the reader
  - Tag reflects radio signal from reader
  - Short Read Range (cm / m)
- **Active**
  - Require a power source
  - Tag transmits radio signal
  - More reliable and efficient in rugged environments
  - High Read Range (100 m)

Active tag

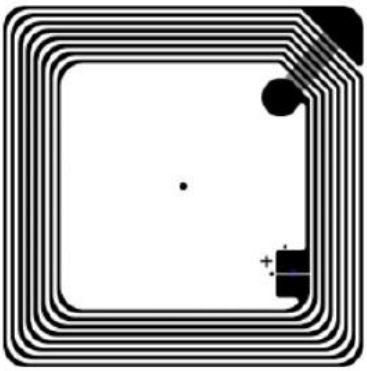
Components of an RFID system



- RF signal transmitted by the reader (through the “antenna”) powers the tag
- Tag becomes active and can receive and “transmit”
- Requires no line-of-sight (like barcodes do)
- Different frequencies can be used (LF, HF, UHF, …)
  - Reader and tag must operate at the same frequency

Common frequencies of operation

HF (High Frequency)
13,56 MHz



Coupling element: coil

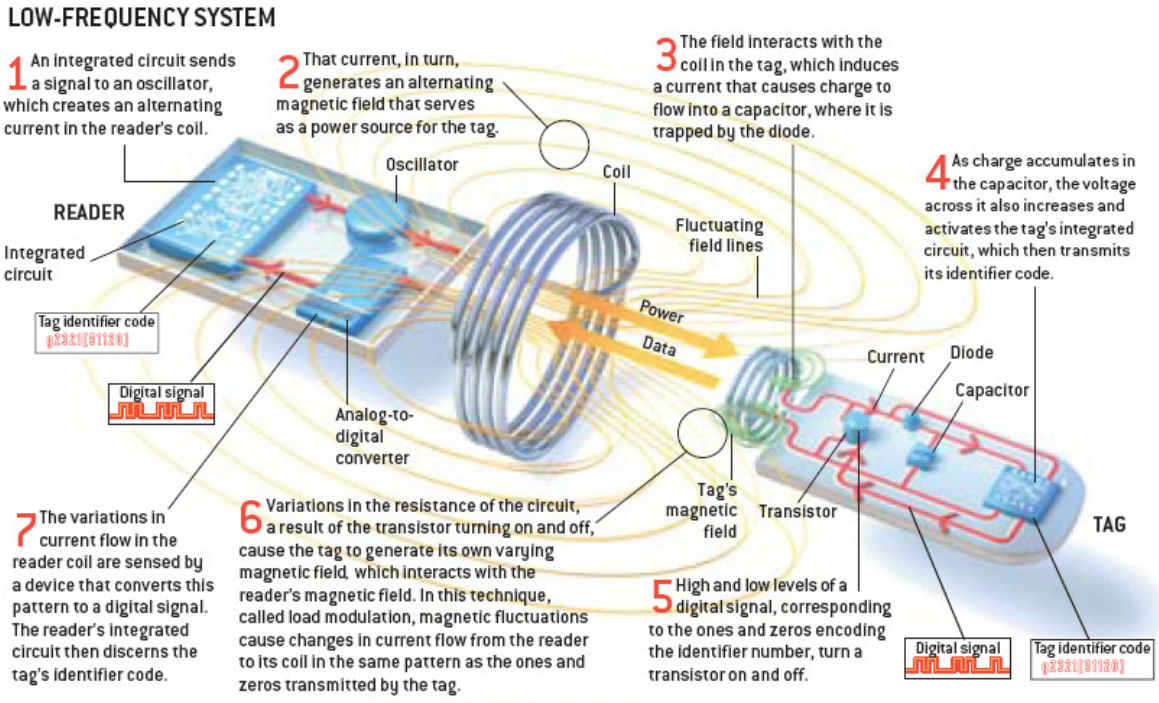
UHF (Ultra High Frequency)
860 - 960 MHz

Coupling element: antenna

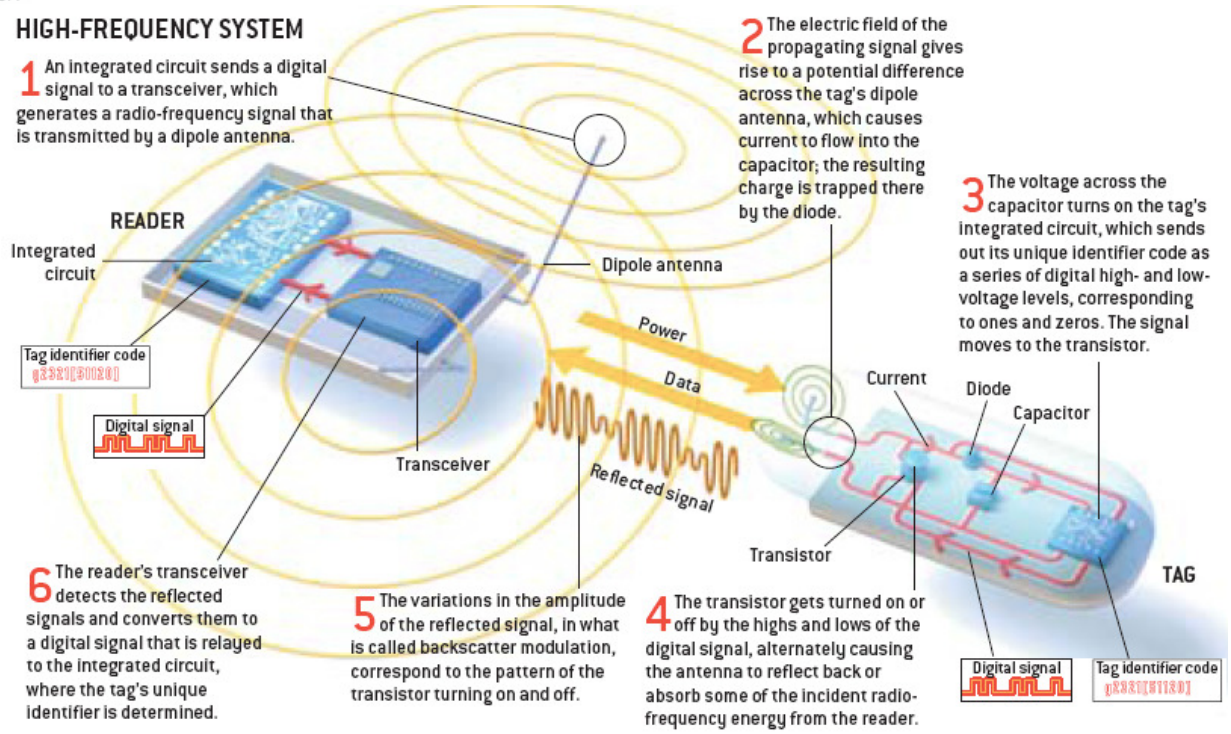
LF (Low Frequency)
< 135 KHz

Coupling element: coil

Interaction details (LF+HF)



Interaction details (UHF)



RFID Standards

- Tracking Animals
  - ISO 11784 – Specifies the structure of the ID code
  - ISO 11785 – Specifies how transponder (*tag*) is activated
  - ISO 14223/1 – Specifies RF code for advanced transponders
- Credit Cards
  - ISO 15693 – Specifies modulation and coding schemes
- Passports and proximity cards
  - ISO 14443 – Specifies modulation and coding schemes
- General Frequency bands
  - ISO 18000 series

Standard RFID Operating Frequencies

- ISO 18000-2
  - <135 KHz — **LF**
- ISO 18000-3
  - 13.56 MHZ — **HF**
- ISO 18000-4
  - 2.45 GHz
- ISO 18000-6
  - 860-960 MHz — **UHF**
- ISO 18000-7
  - 433 MHZ (active) — Used in active tags

ISO 18000-2 (LF)

- Operates at <135 KHz
- Inductive (uses a coil)
- Short range (a few centimeters)
- Low data rate
- Unaffected by presence of water
- Fairly costly because of coil in tag

ISO 18000-3 (HF)

- Operates at 13.56 MHz
- Inductive (uses a coil)
- Mid range: 70 – 125 cm
- Moderate data rate
- Not to much affected by water
- Low cost
- Read / write capable
- Thin flexible form factor (smart label)

ISO 18000-6 (UHF)

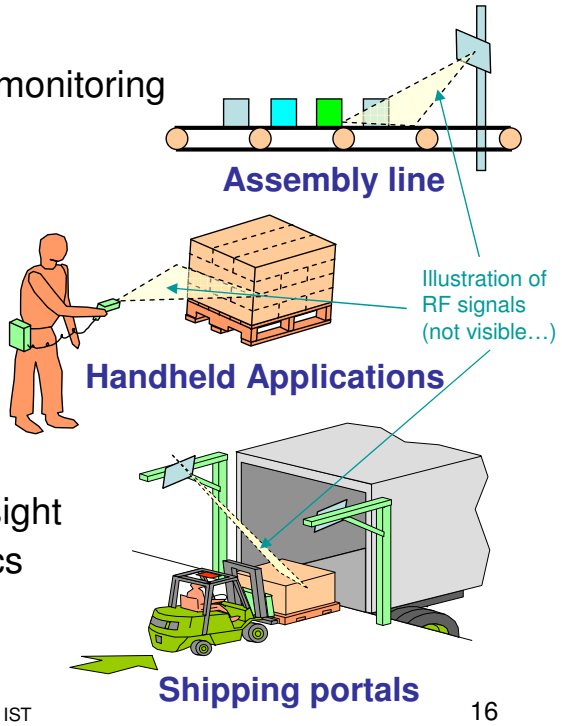
- Operates between 860 – 960 MHz
- Propagating (uses an antenna)
- Long range: 2 - 5 meters
- High data rate
- Can be problematic near metal and water
- Low cost
- Read / write capable
- The future for mass application RFID

Tags can be attached to almost anything

- Pallets or cases of products
- Vehicles
- Company assets
- Personal items such as apparel, luggage, laundry
- People, livestock, or pets
- High value electronics such as computers, TVs, …

Applications

- Manufacturing and Processing
  - Inventory and production process monitoring
  - Warehouse order fulfillment
- Supply Chain Management
  - Inventory tracking systems
  - Logistics management
- Retail
  - Inventory control and customer insight
  - Auto checkout with reverse logistics

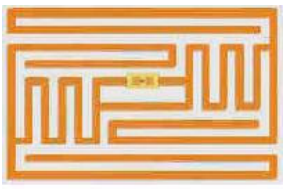


Applications

- Security
  - Access control
  - Counterfeiting and Theft control/prevention
- Location Tracking
  - Traffic movement control and parking management
  - Wildlife/Livestock monitoring and tracking

Applications

- Electronic Product Code (EPC)
- Proximity cards
- Keyless entry



Applications

- Payment tokens
  - Contact-less credit cards
  - Automatic toll-payment
- Ticketing systems
- Passports

Applications

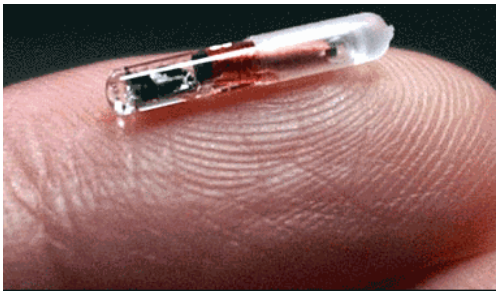
- Tracking books in libraries / bookstores

  Used for identification
  and as security device

- Inventory control
- Hospital patients tracking

Applications

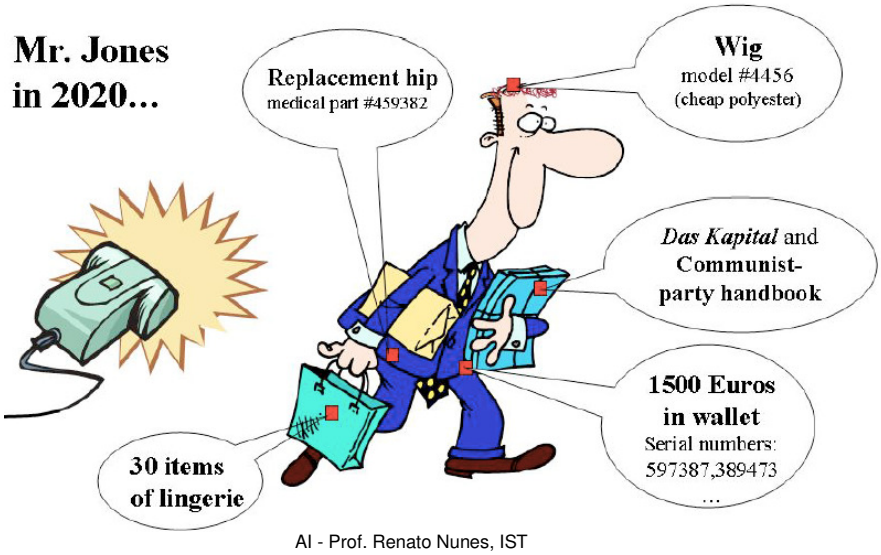
- Animal and human tracking



RFID-privacy legislation…

Privacy Concerns

- Clandestine tracking
- Inventorying



Protecting Privacy

- Kill function
- Normal tags
  - Prevents unauthorized readings
  - Blocks electric waves
  - Jamming and interference
- Smart tags
  - Rewritable memory
  - Anonymous-ID scheme

Requirements for consumer use

- Notify the consumer
- Visible and easily removable tags
- Disabled at point of sale
- Tag the product's packaging

Open issues

- Rogue scanning and eavesdropping
  - Rogue scanning range
  - Tag-to-reader eavesdropping
  - Reader-to-tag eavesdropping
- Authentication
- Denial of service

Conclusion

- RFID has many potential uses
- Privacy and security concerns must be addressed
- Cost is still high for many applications