ITU-T

International Telecommunication Union

RFID Tutorial

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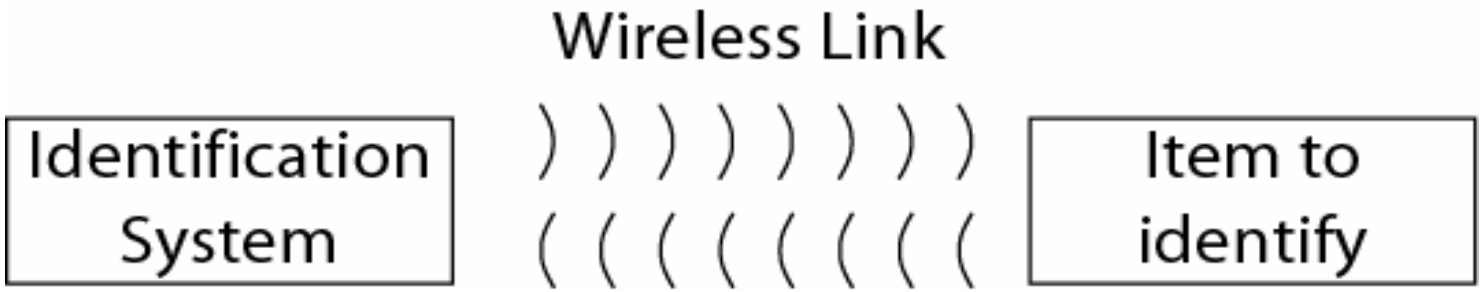
What is RFID?

- Radio Frequency Identification or RFID refers to the set of technologies that use radio waves for identifying objects or people.



Short RFID History

1940	1950	1960	1970	1980	1990	2000

1948
Harry Stockman
"Communication by means of reflected power"

1966
1-bit Electronic Article Surveillance
EAS

1979
First implantable RFID for Livestock

1996
Pet tagging in LA

1950
D.B. Harris patent
"Radio Transmission system with modulatable passive responder"

1992
First RFID Toll collection system

WAL★MART
2003
Walmart mandate

1975
"Short-range radio-telementry for electronic identification using modulated backscatter"
Declassified

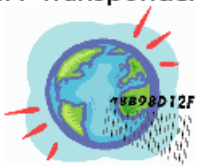
2003
DOD Mandate

1940
Radar in WWII

1959
IFF Transponder

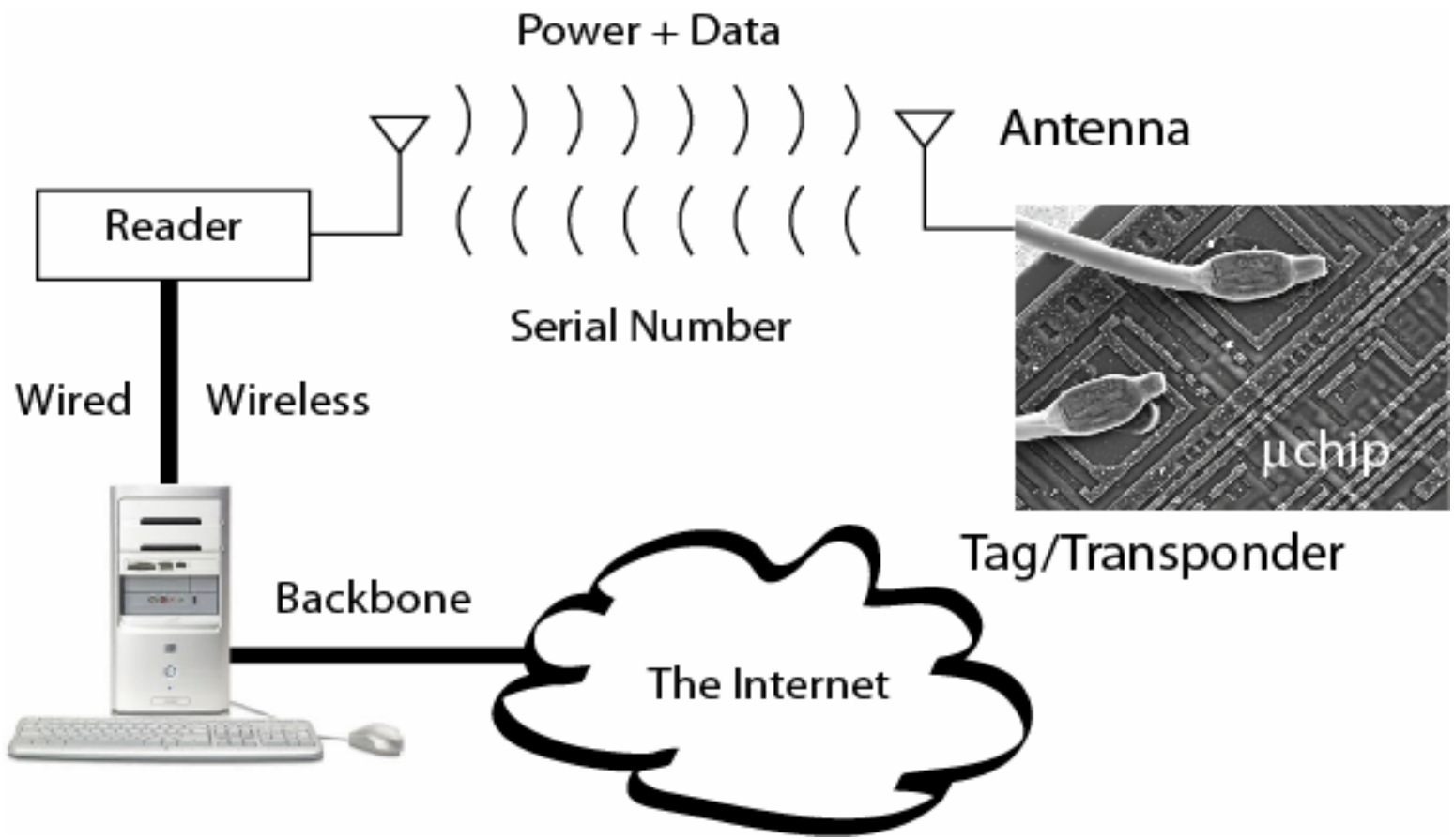
2006
Pet tagging mandatory in Switzerland & Europe

1974
First bar code scanned



1959
Bar code

Components of RFID Systems



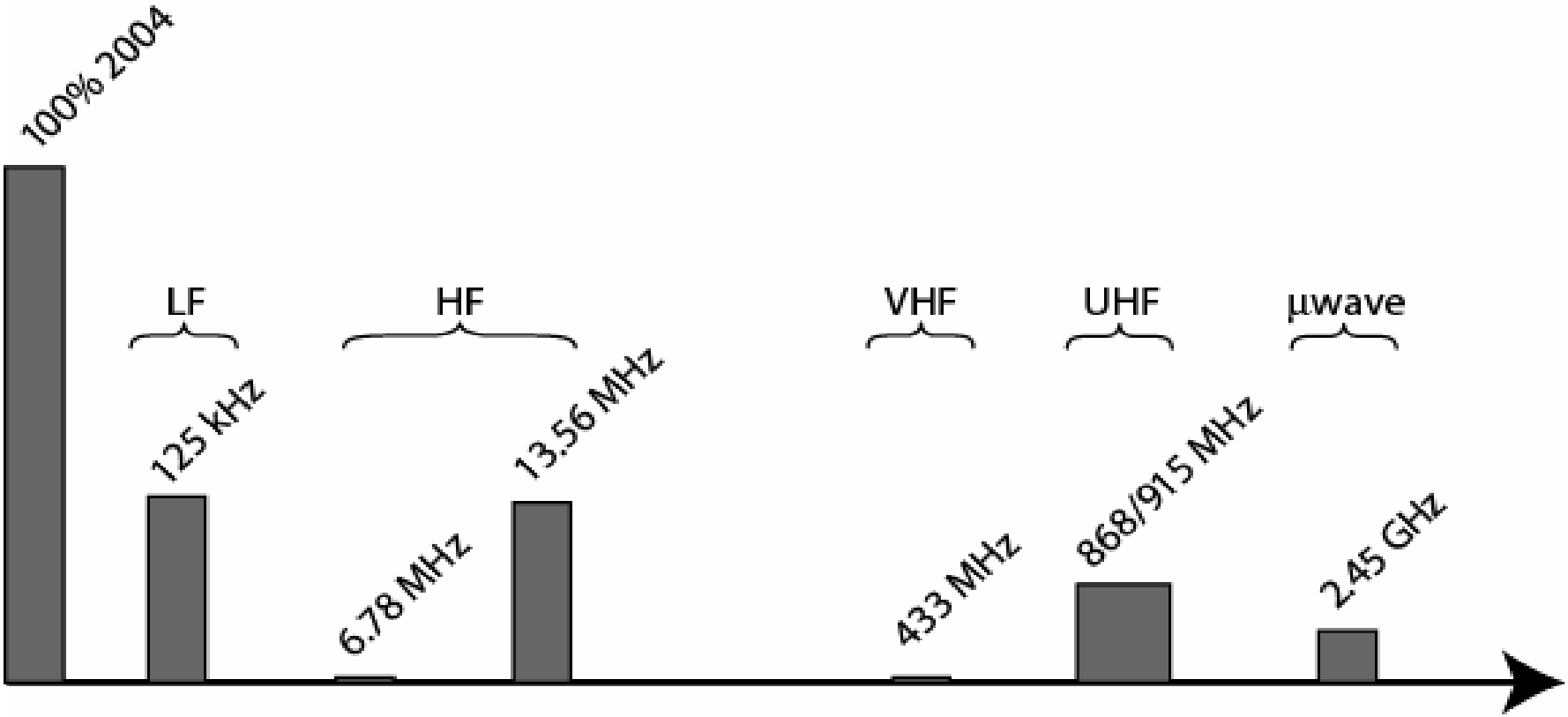
RFID vs Barcode?

- *Does not require line-of-sight*—Barcodes have to be properly oriented, often by hand, for laser scanning.
- *Can withstand harsh environments*—Barcode life is limited by how long the printed symbols remain readable.
- *Can be reprogrammed and reused*—New data cannot be written to barcodes.
- *Can be read in groups*—Barcodes must be read individually, whereas an RFID reader can scan multiple items simultaneously.
- *Secures data*—Tag memory can be programmed, permanently locked (optionally), or erased to protect privacy.

What are the different tag families?

	Active *33% (2004)*	*Passive* *67% (2004)*	*Semi-Passive*
Battery	Yes (used for communication)	No	Yes (not used for communication)
Distance	< 300 m	< 20 m	< 50 m
Price	> 5 €	> 0.1 €	> 1 €

Frequency spectrum & 2004 Market



Low Frequency Features (Passive tags)

- Low sensitivity to environment
- Works on metal
- ISO Standards (animals)
- Reading range < 1m
- Low datarate
- No or bad anti-collision

High Frequency Features (Passive tags)

- High datarate
- Anti-collision
- ISO Standards (smart cards application)
- Reading range < 1m
- More sensitive to environment than LF

UHF Features (Passive tags)

- Very high datarate
- Anti-collision
- Directivity
- ISO Standards (item management application, EPC, GTAG initiative)
- Reading range < 20m
- Very sensitive to environment

Standards (non-exhaustive list)

- Animal
  - ISO 11784
  - ISO 11785
  - ISO 14223
- Smart card
  - ISO 10536
  - ISO 14443
  - ISO 15693
- Item management
  - ISO 18000 series
  - EPC Global
  - GTAG initiative
- Test methods
  - ISO 10373 (Smart Card)

Animal applications

Ear tag

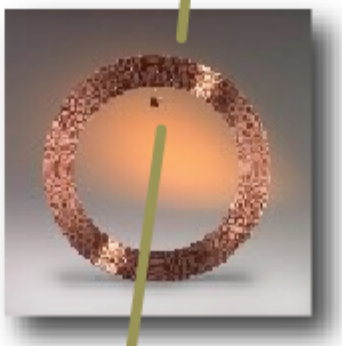
Hand reader

Portal reader

Animal tags

Implantable tag

Tag for integration



microchip
is directly bonded

Access Control applications

Reader

Tag formats

RFID enabled laundry

Each cloth has a tag

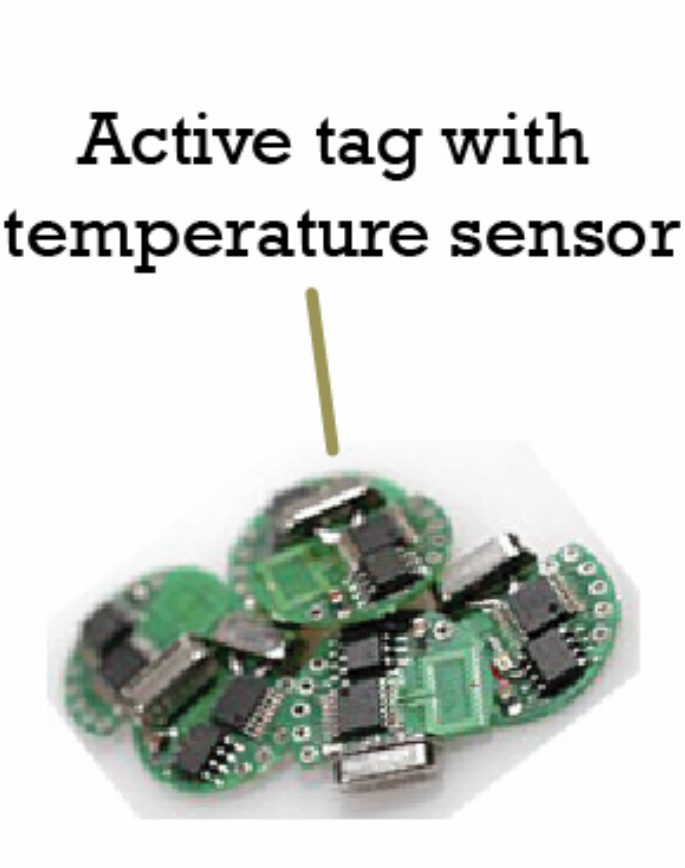
Readers identify and automatically route garments

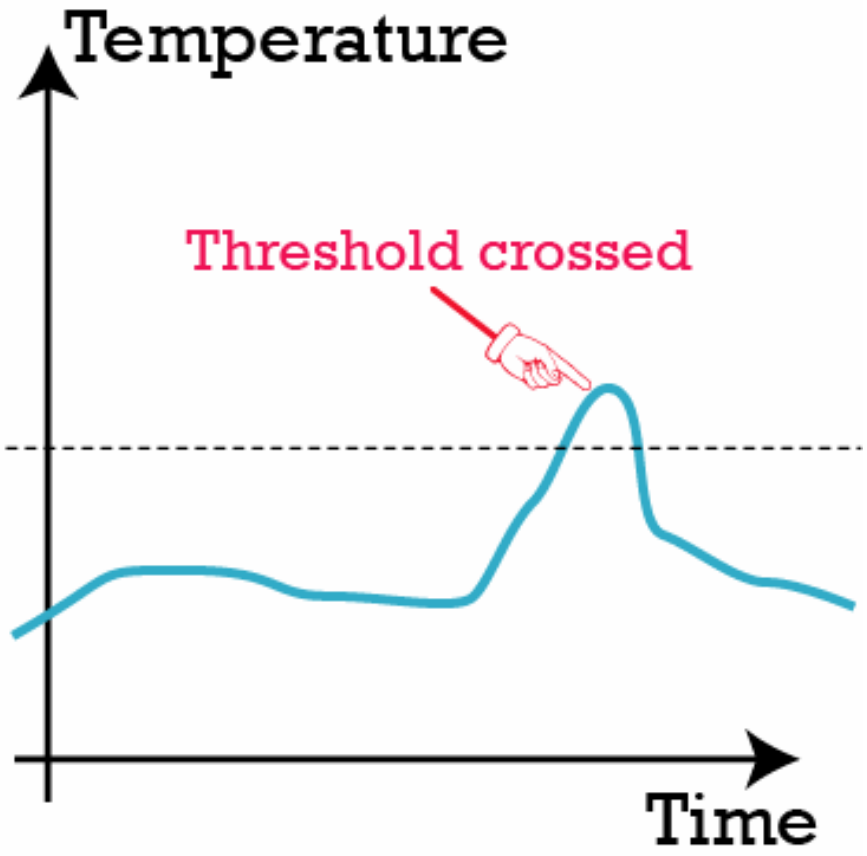
E-Passport

E-Passport

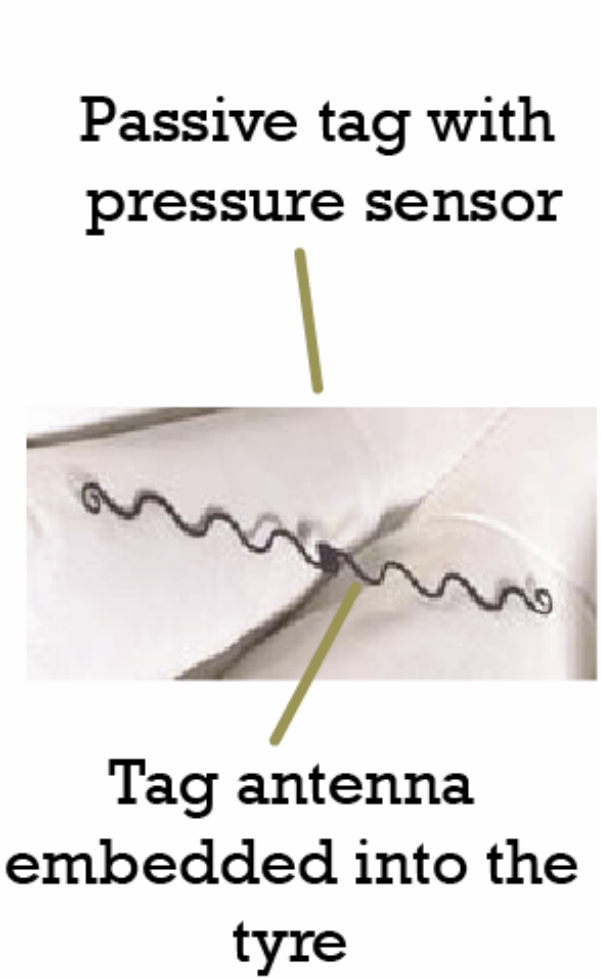
E-Passport & Reader

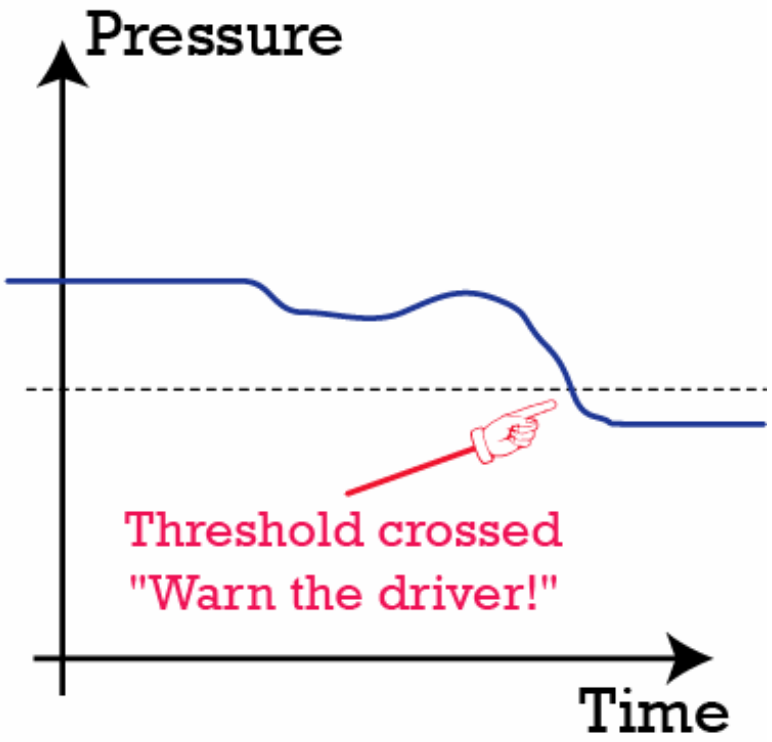
Temperature monitoring





Pressure monitoring





What else?

- Food Production Control
- Blood Analysis Identification
- Water Analysis
- Refuse Collection Identification
- Timber Grade Monitoring
- Road Construction Material Identification
- Toxic Waste Monitoring
- Vehicle Parking Monitoring
- Pigeon Flight Monitoring
- Valuable Objects Insurance Identification
- Oil Pipe Identification
- Machine Tool Management
- Gas Bottle Inventory Control
- Duty Evasion
- Asset Management
- Stolen Vehicle Identification
- Production Line Monitoring
- Car Body Production
- Parts Identification
- Beer Barrel Stock Control
- Security Guard Monitoring
- Etc.

Near Field Communication (NFC)

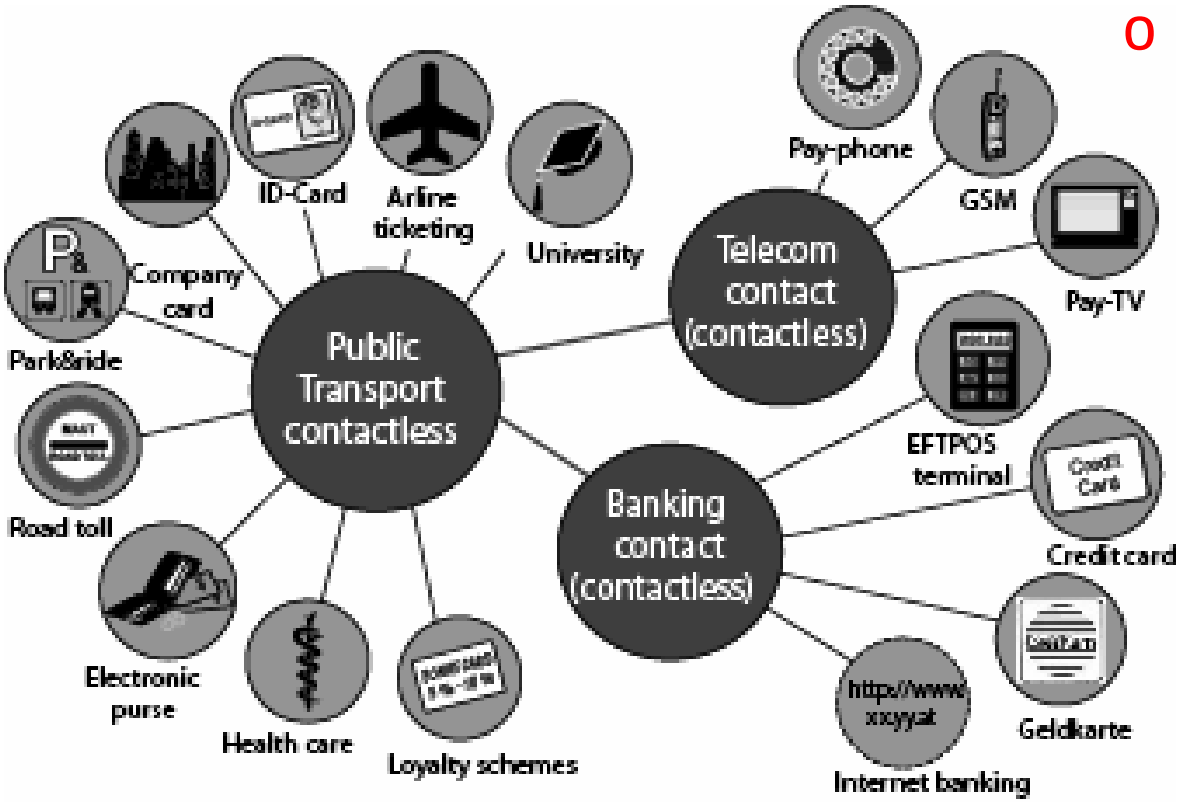
- Ultra low power wireless technology
- Easy connection between two devices (typ. for configuration purpose)
- NFC devices are both an *RFID reader* and a *tag*
- ISO 14443 compatible
- Max. 10 cm operating range
- Mobile phones already integrate this technology

NFC typical applications

Transportation in Oulu Finland

NFC enabled mobile phone playing a tag role in this case

Distributed applications



- Interoperability
  - Think of the GSM standard in Europe.
  - *Roaming* concept can be an idea for networked RFID systems, e.g. for transportation.

Impacts on Communication Networks & Conclusion

- Routing all these data needs robust networking infrastructures
- How do you filter necessary RFID data?
- Are standard IP networks sufficient?
- How do you handle security and privacy?
- etc…