Making Regional Manufacturing Globally Competitive and Innovative

RFID

Centria
RESEARCH AND DEVELOPMENT

RFID

Purpose of this presentation is to give some basics of RFID.
It includes a comparison of different RFID systems but focuses on the UHF-version.

Keywords

RFID = **R**adio **F**requency **Id**entification

LF = **L**ow **F**requency

HF = **H**igh **F**requency

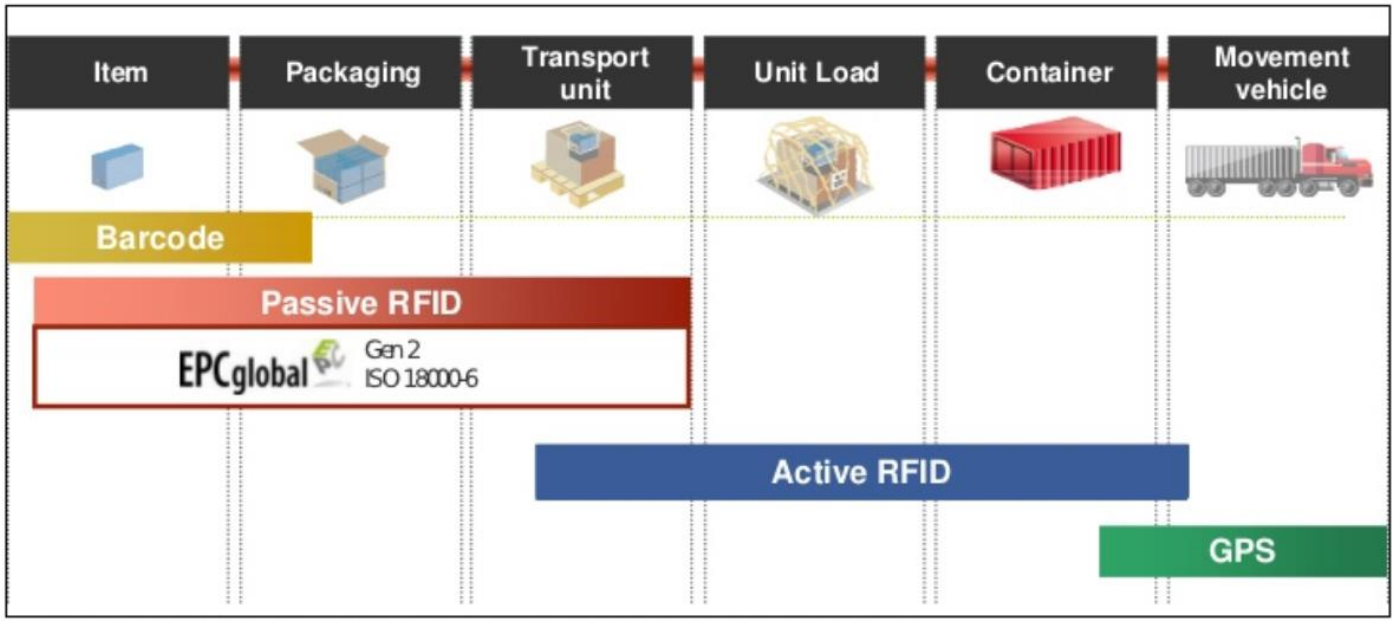
UHF = **U**ltra **H**igh **F**requency

Polarization

Tag memory

RFID obstacles

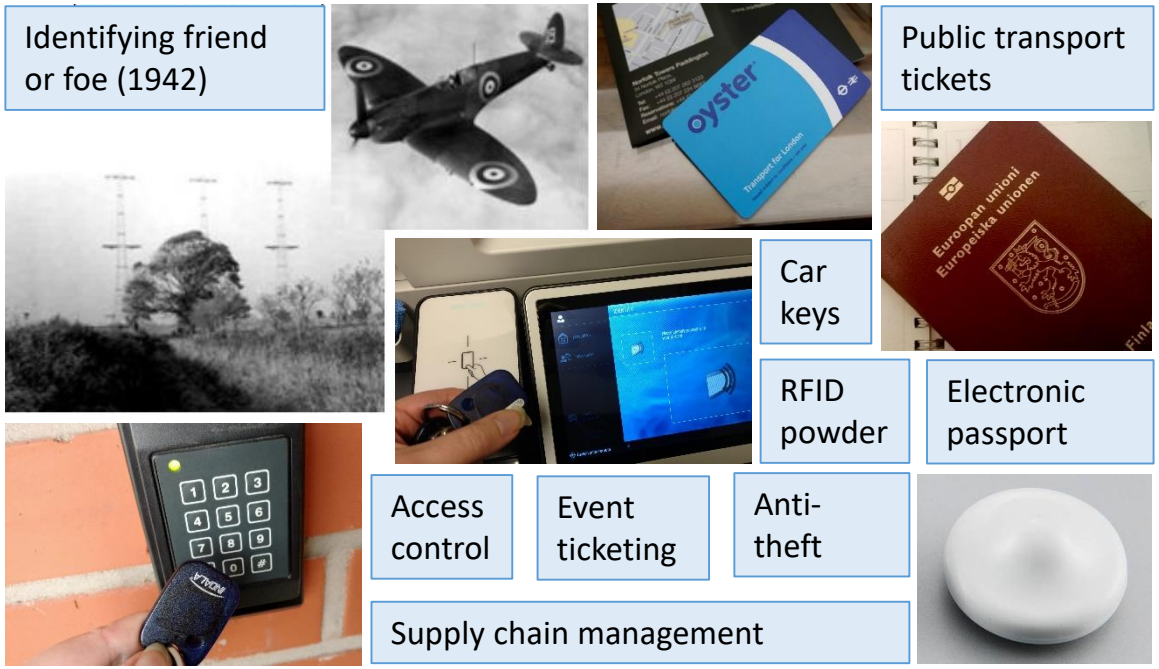
Tracking devices



Read range

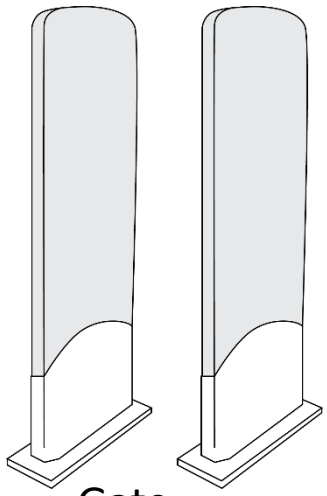
Barcode	- line of sight, max 1 m
Passive RFID	- max 10 m
Active RFID	- max + 100 m
GPS	- globally available

RFID examples



RFID history = Identifying friend or foe (World War 2)

RFID readers

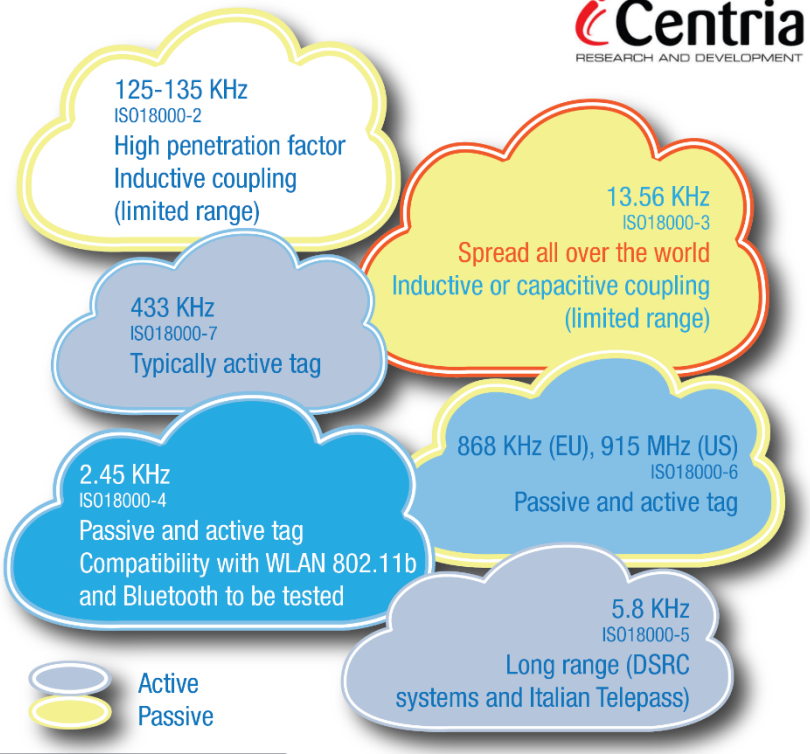


Gate

Handheld

Fixed

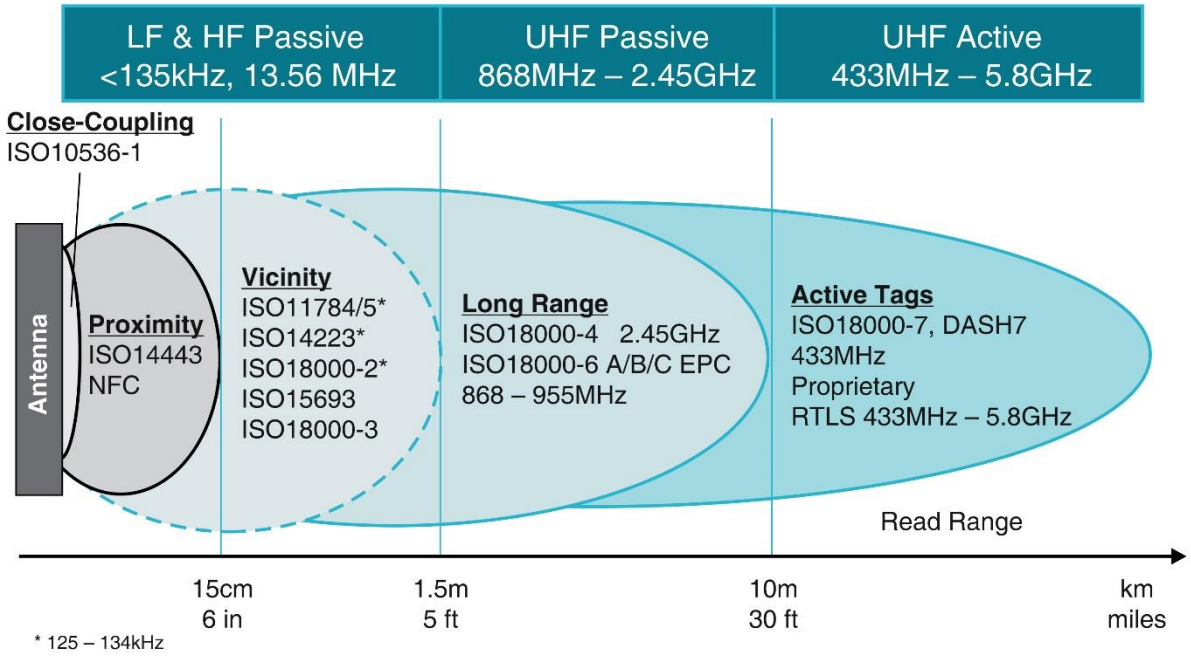
RFID frequencies



Parameter	Technology			
	LF Passive <135 kHz	HF Passive 13.56 MHz	UHF Passive 868 – 950 MHz	UHF Active 433 – 5.8 Ghz
Read distance	high	low - medium	high	highest
Data rate	4 kbps to 8 kbps	6.7 kbps to 848 kbps depending on protocol	Freq/1, LF/2, LF/4, LF/8*	Freq/1, LF/2, LF/4, LF/8*
Multi tag reading	10s	100s	1000s	1000s
Form factor flexibility	high	high	medium	low
Environment				
Tissue/Water Metal	No absorption controllable	Lim. absorption controllable	Strong absorption reflection	Lim. absorption controllable

**EPCGen2 spec in the hundreds of kHz or less*

RFID read ranges



RFID comparison

LF (Low Frequency)

Frequency: 125-134 kHz

Cost Range: 0,40 – 5€

Read Range: contact – 10 cm

Examples: Animal tracking, access control, car key-fob, applications with high volumes of liquids and metals

Pros: Works well around liquids and metals, global standards

Cons: Very short read range, limited quantity of memory, low data transmission rate (read very few tags at once), high production cost

HF (High Frequency)

Frequency: 13.56 MHz

Cost Range: 0,20 – 10€

Read Range: contact – 30 cm

Examples: DVD kiosks, library books, personal ID cards, poker/gaming chips

Pros: NFC protocol, larger memory, global standards

Cons: short read range, low data transmission rate (read fewer tags at once)

UHF (Ultra-High Frequency)

Active

Frequency: 433, 856 - 960 MHz

Cost Range: 25 – 100€+

Read Range: 30 – 100+ meters

Examples: Auto dealership, manufacturing, mining, construction

Pros: very long read range, lower cost readers, write extensive amounts of data, high transmission rates (read more tags at once)

Cons: very high tag cost, cannot be shiped via air transport (if tags are actively beaconing), complex software may be necessary, high amount of interference from metal and liquids, no global standards

Passive

Frequency: 856 – 960 MHz

Cost Range: 0,08 – 25€

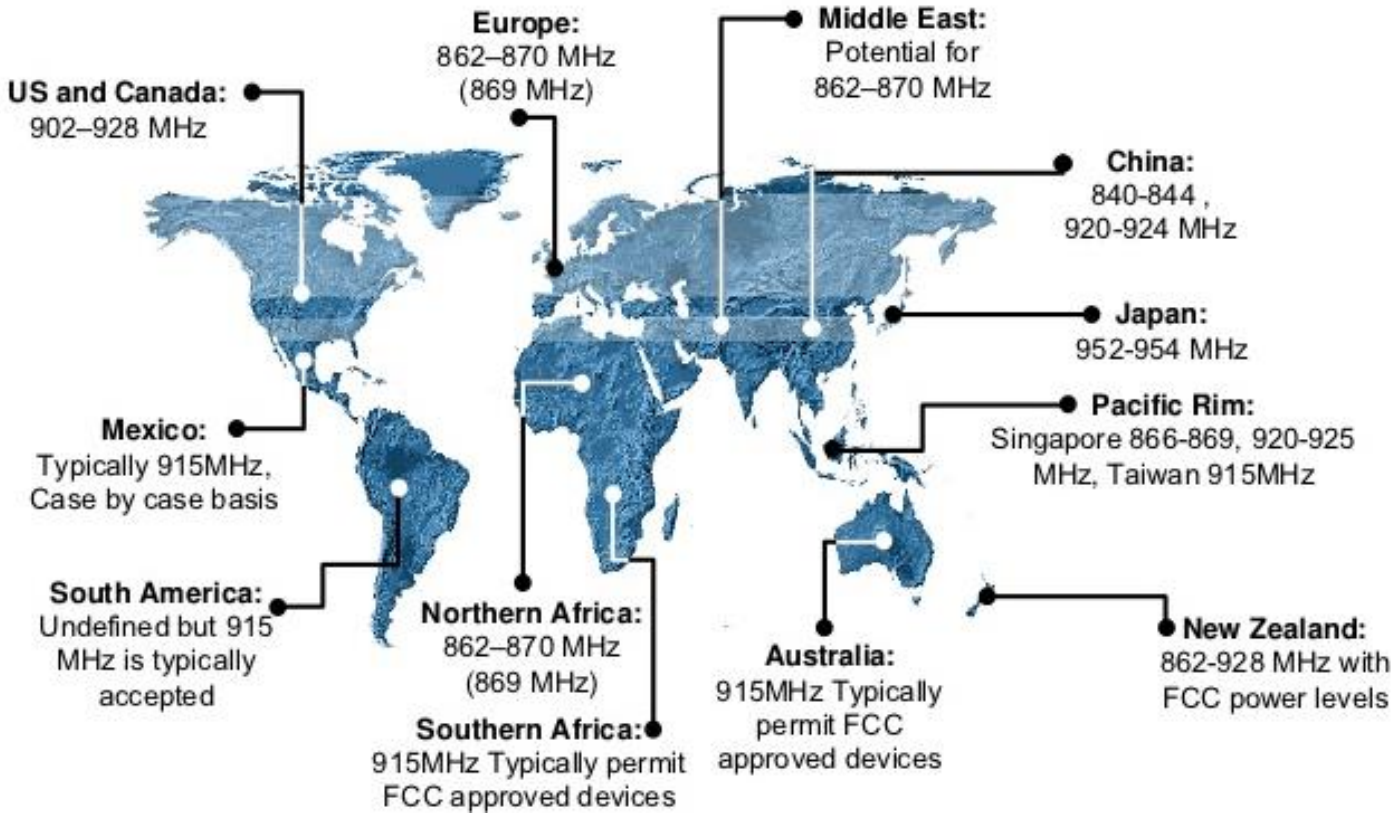
Read Range: near contact – 10 meters

Examples: Supply chain, high-volume manufacturing, pharmaceuticals, electronic tolls, race timing, item and asset tracking

Pros: longer read range, lower cost per tag, wide range of tag sizes and types, global standards, high data transmission rates (read more tags at once)

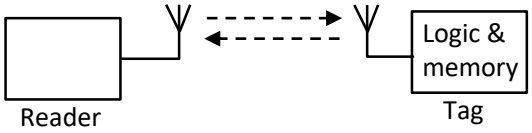
Cons: typically higher associated infrastructure cost, write small amounts of data, high amount of interference from liquids and metal

RFID UHF frequencies worldwide

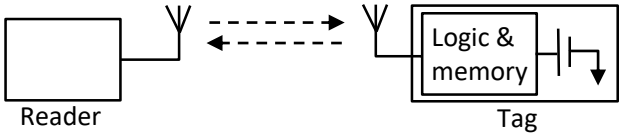


RFID tag type comparison

Passive tag

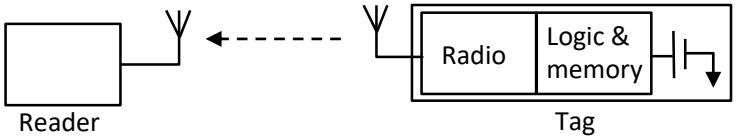


Semi-passive tag



BAP (Battery Assisted Passive) tags use an integrated power source (e.g. battery) to power on the chip

Active tag



There are two main types of active tags: transponders and beacons. Transponders are “woken up” when they receive a radio signal from a reader, and then power on and respond by transmitting a signal back.

Beacon tag will not wait to hear the reader’s signal. Tag will send out its specific information e.g. every 3 – 5 seconds.

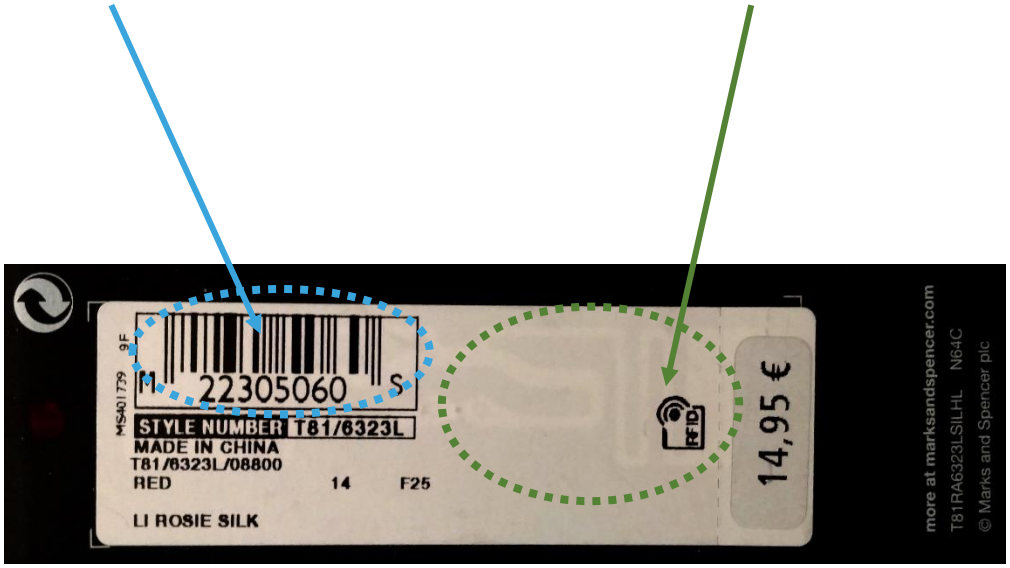
Barcode vs. RFID tag

Barcode only contains the Universal Product Code, ”UPC” (a product Stock Keeping Unit, SKU)

- Defines the product (a product SKU) but not the instance of that product

RFID tag contains the UPC *and* a unique item specific serial number

- Defines *both* the product and the specific instance of that product.



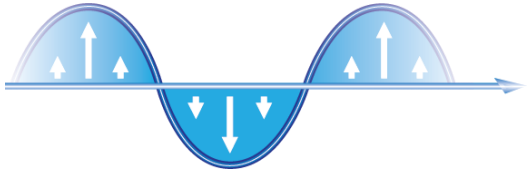
Barcode vs. RFID

+ Barcode	+ RFID
Less expensive than RFID tags	Can read RFID tags from a greater distance than barcodes
Barcodes work with the same accuracy on various materials in which they are placed	RFID tags don't need to be positioned in a line of sight with the scanner.
Barcodes are a universal technology in that they are the norm for retail products	RFID tags can be read at a faster rate than barcodes
	RFID tags are read/write devices
	RFID contain high levels of security; data can be encrypted, password protected or set to include a 'kill' feature to remove data permanently
	RFID tags carry large data capabilities such as product maintenance, shipping histories and expiry dates; which can all be programmed to the tag
	Once these are set up; it can be run with minimal human participation
	RFID tags are more reusable and rugged

- Barcode	- RFID
Barcode scanners need a direct line of sight to the barcode to be able to read	RFID readers struggle picking up information when passing through metal or liquid
In order to read the barcode, the barcode scanner needs to be quite close	Reader collision can occur where two signals from different readers overlap and the tag is unable to respond to both
Barcodes have no read/write capabilities	Tag collision can occur when numerous tags in the same area respond at the same time
They are very labour intensive; as they must be scanned individually	Tags are more expensive than barcode
Barcodes have less security than RFID	
Barcodes are more easily damaged	

RFID Tag reading

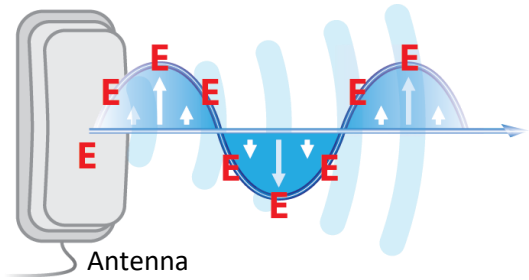
Linear polarization



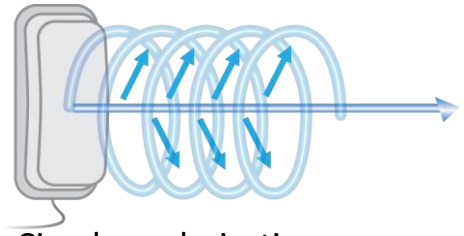
Linear polarization

The direction of the electric field associated with a wave is known as Polarization

Some antennas transmit in a linear way



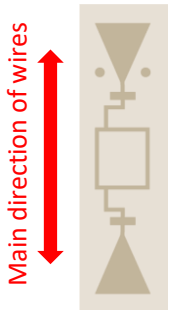
Linear polarizarion delivers more power, improved range as penetration



Circular polarization

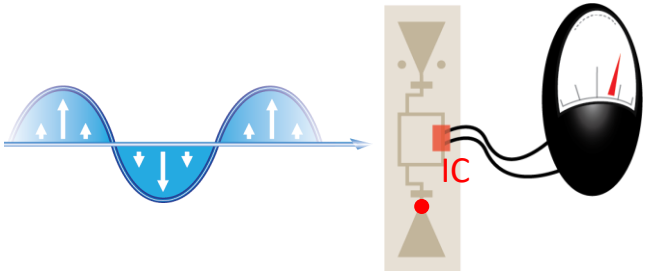
Some antennas transmit a wave, where direction of polarization rotates during each cycle, known as circular polarization

RFID Tag reading

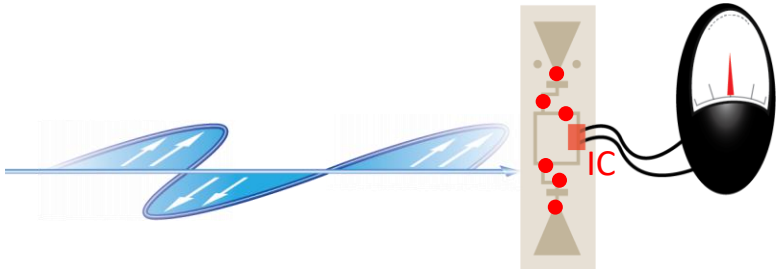


Many tag antennas consist of wires that mostly proceed in a single direction

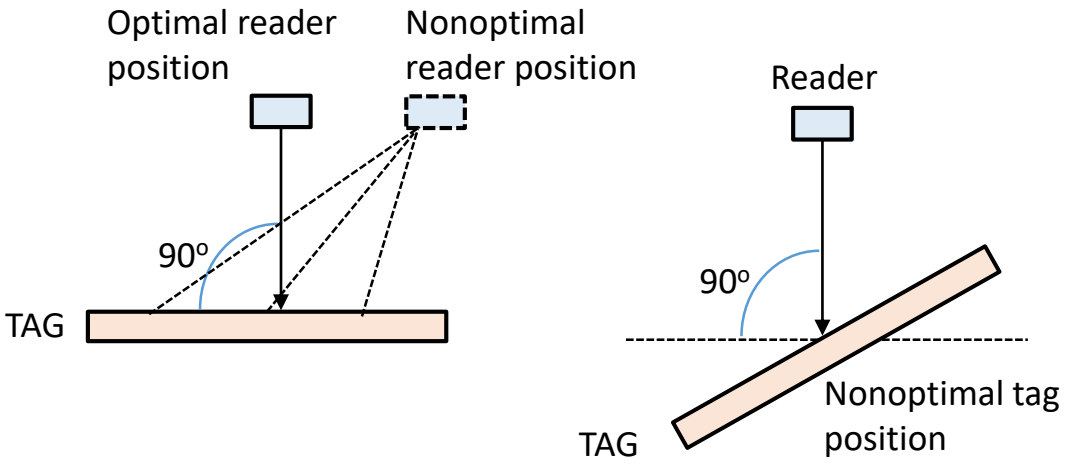
When the tag is exposed to an electronic field in the main direction of its wire, electrons flow along the tag antenna, bigger voltage is generated and the integrated circuit, or IC is activated. Then the tag circuit transmit back the information to the reader.



When the electric field is perpendicular to the main direction of the tag antenna, little voltage is generated, and the tag integrated circuit cannot turn on



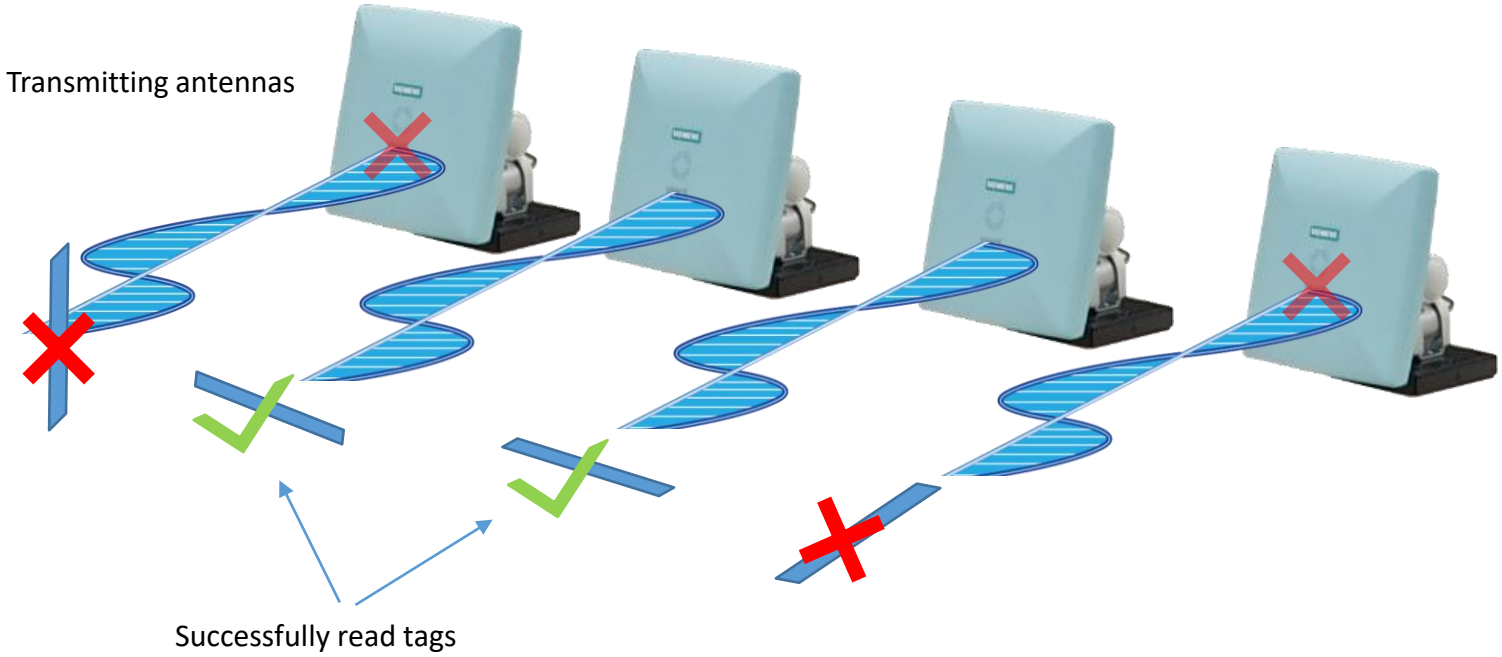
RFID Tag reading



Orientation (polarization):

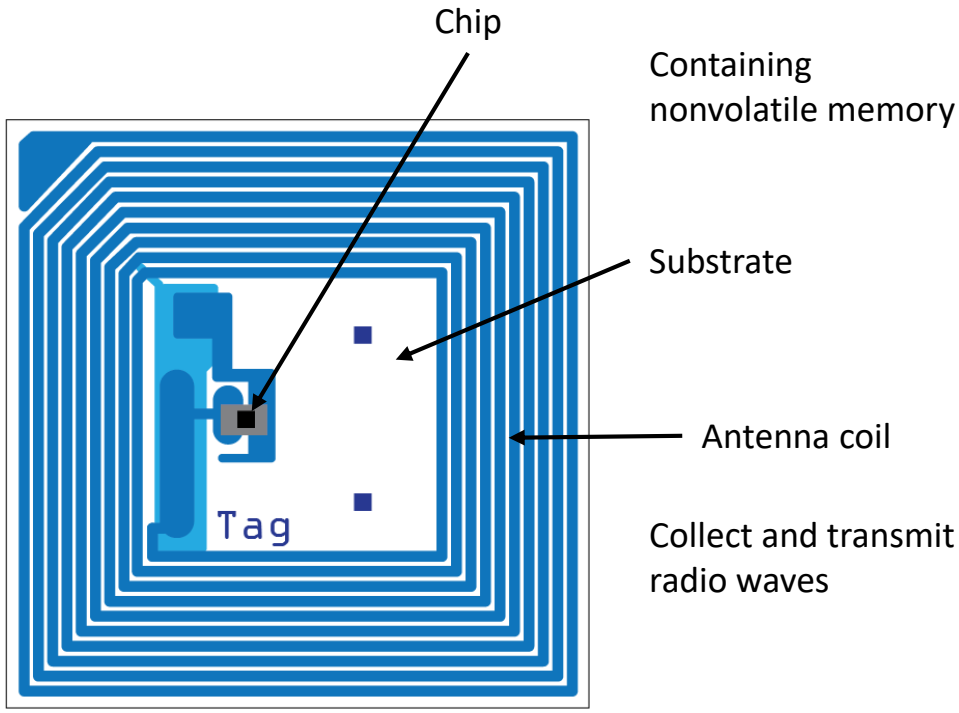
The read range depends on antenna orientation. How tags are placed with respect to the polarization of the reader's field can have a significant effect on the communication distance for both HF and UHF tags, resulting in a reduced operating range of up to 50%, and in the case of the tag being displaced by 90° and not being able to read the tag at all. The optimal orientation for HF tags is for the two antenna coils (reader and tag) to be parallel to each other. UHF tags are even more sensitive to polarization due to the directional nature of the dipole fields.

RFID Tag reading



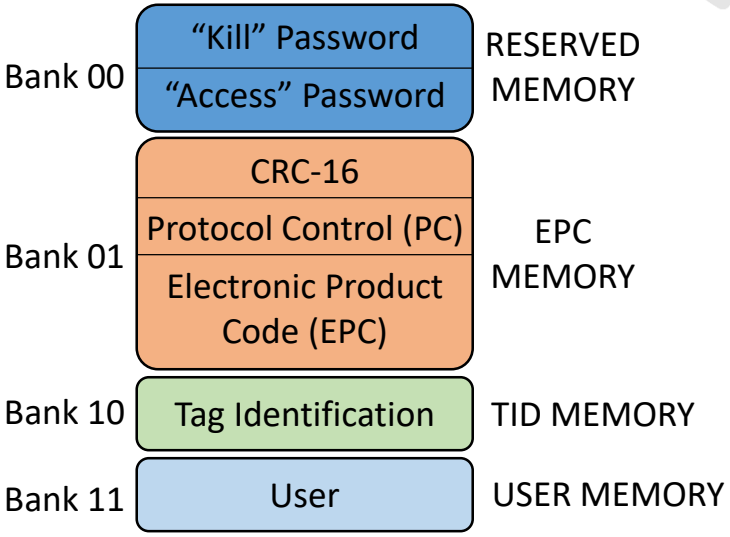
Passive RFID Tag

The chip contains circuitry that stores a unique binary number in its memory and the antenna serves as the receiver and transmitter of information.



RFID Tag

RFID tag memory structure



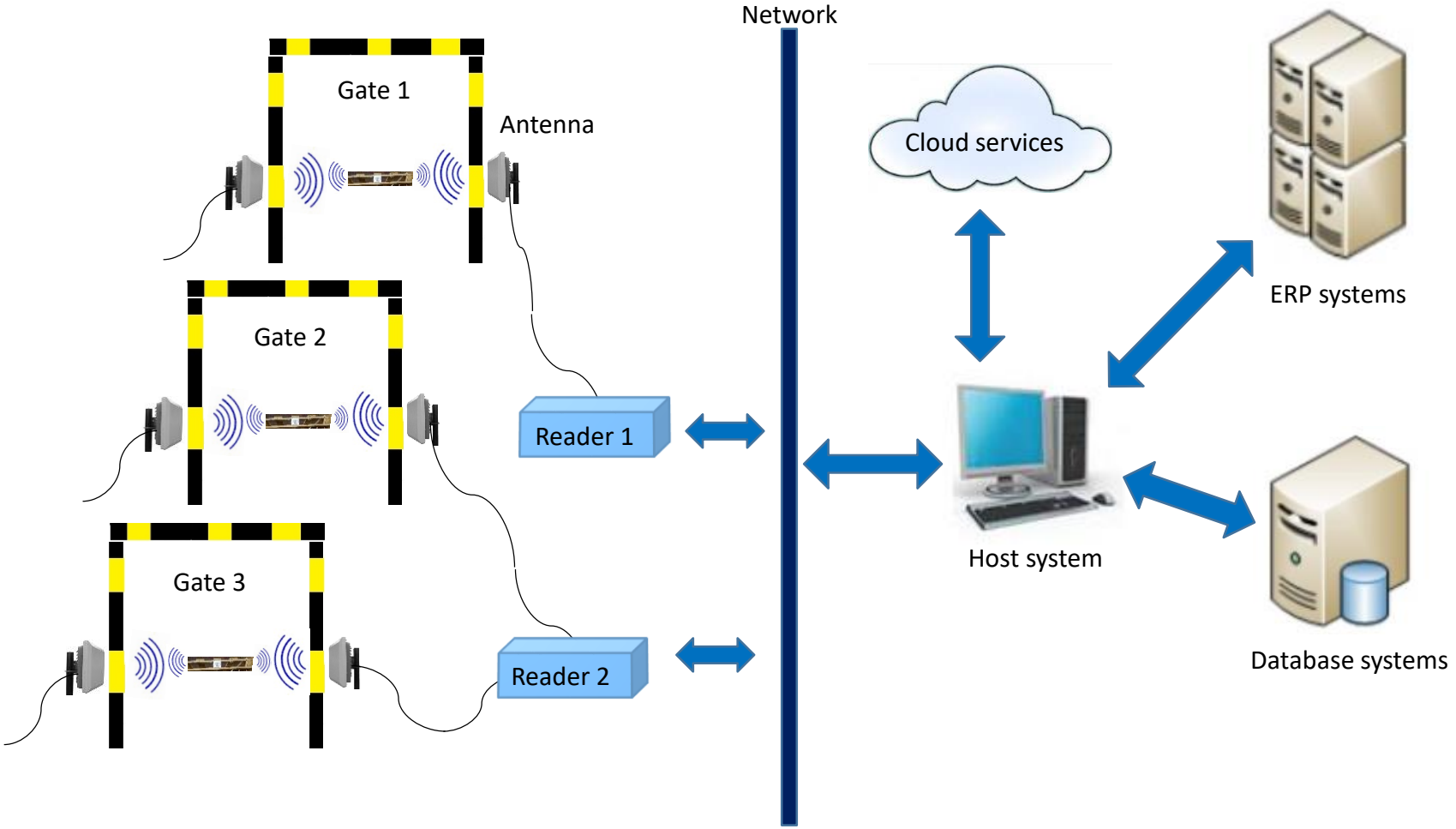
Reserved Memory stores the kill password and the access password (each are 32 bits). The kill password permanently disables the tag (very rarely used), and the access password is set to lock and unlock the tag's read/write capabilities.

EPC Memory stores the EPC code, or the Electronic Product Code. It has a minimum of 96 bits of writable memory. The EPC memory is what is typically used in most applications if they only need 96 bits of memory.

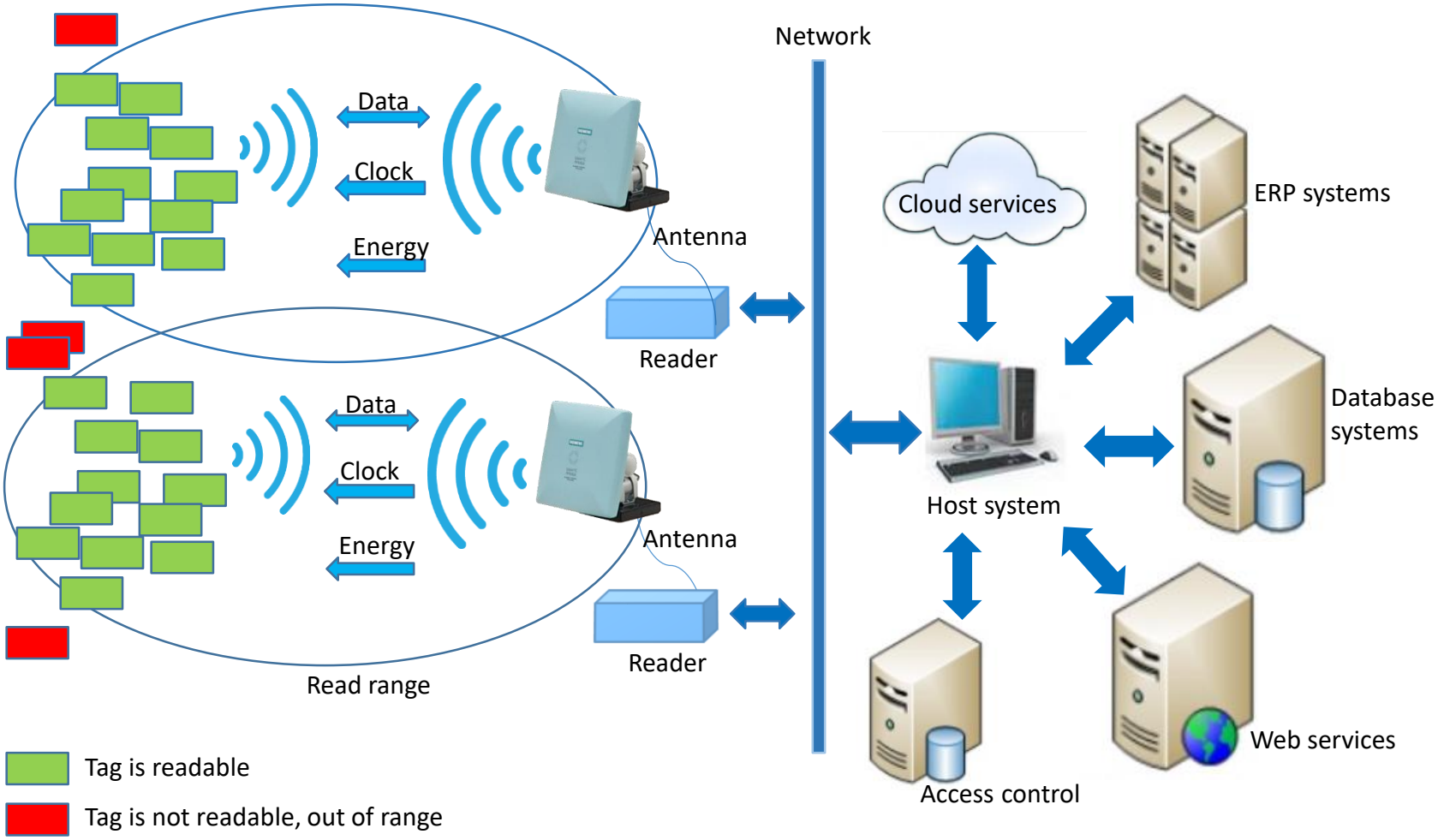
TID Memory is used only to store the unique tag ID number by the manufacturer when the IC is manufactured. Typically, this memory portion cannot be changed.

If the user needs more memory than the EPC section has available, **user memory** can be utilized. Typically, the extended memory is no more than 512 bits, but there are some high memory tags with up to 4K or 8K bytes of memory.

RFID system for gatecontrol



RFID system


Network
Data
Clock
Energy
Antenna
Reader
Data
Clock
Energy
Antenna
Reader
Read range
Cloud services
ERP systems
Host system
Database systems
Access control
Web services
Tag is readable
Tag is not readable, out of range

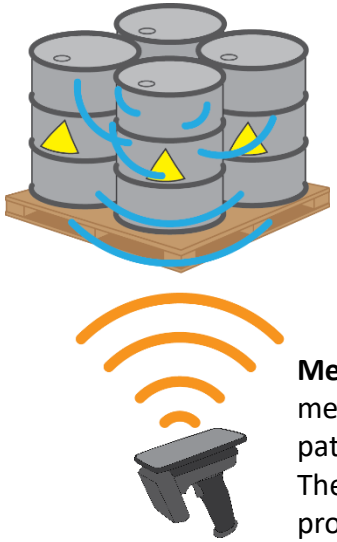
RFID obstacles

Cardboard, Wood, Fabric, Plastic, paper etc. – Most standard packaging materials provide a strong return signal, when scanning.

Strong return signal

Weak return signal

Liquids – Liquids absorb radio signals and have a weak signal returned to the reader.



Metals – The highly reflective nature of metal can create return signals patterned in many different directions. The shape of the products may also be problematic.

Thank You!

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