2007

LeghornGroup

WHAT IS RFID?

PROTECTION - CONTROL - IDENTIFICATION – TRACKING

ISO 9001

What is RFID?

RFID is an acronym that stands for **"radio-frequency identification"** and refers to a set of systems that can automatically identify objects.

Think of RFID as a barcode that can exchange information via radio waves and update itself over time.

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RFID technology is deeply changing the world of work and it will involve many aspects of our personal life.

RFID is thought to be the technology that will enable the "Internet of Things", i.e. a network globally interconnected that will link not only people but also objects.

<u>Over the next years, innovative RFID applications are expected to increase since currently the potential of this technology has been simply touched on.</u>

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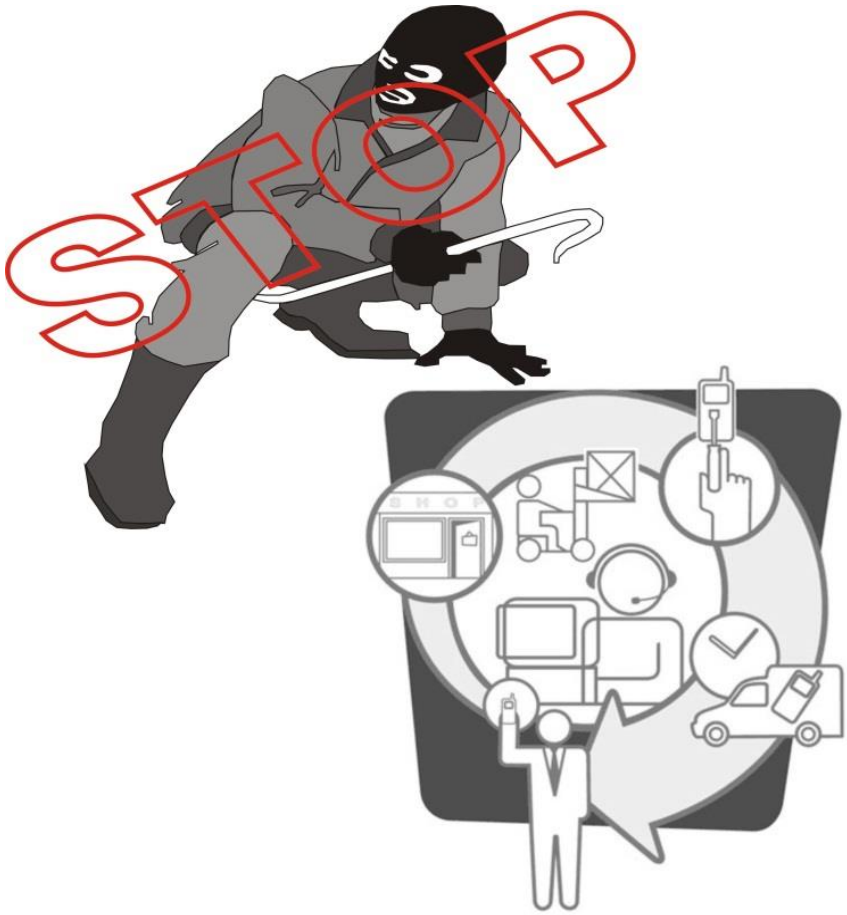
RFID PROSPECTS FOR APPLICATION

For private researchers and universities, RFID is a major challenge since increasingly sensitive and intelligent tags and readers will need to be designed in the next years.



Through RFID it is possible to ensure a more efficient control, security and accuracy in crisis management. This is why RFID is to be taken into account in hospitals, general government, libraries, civil protection and in the army sector.

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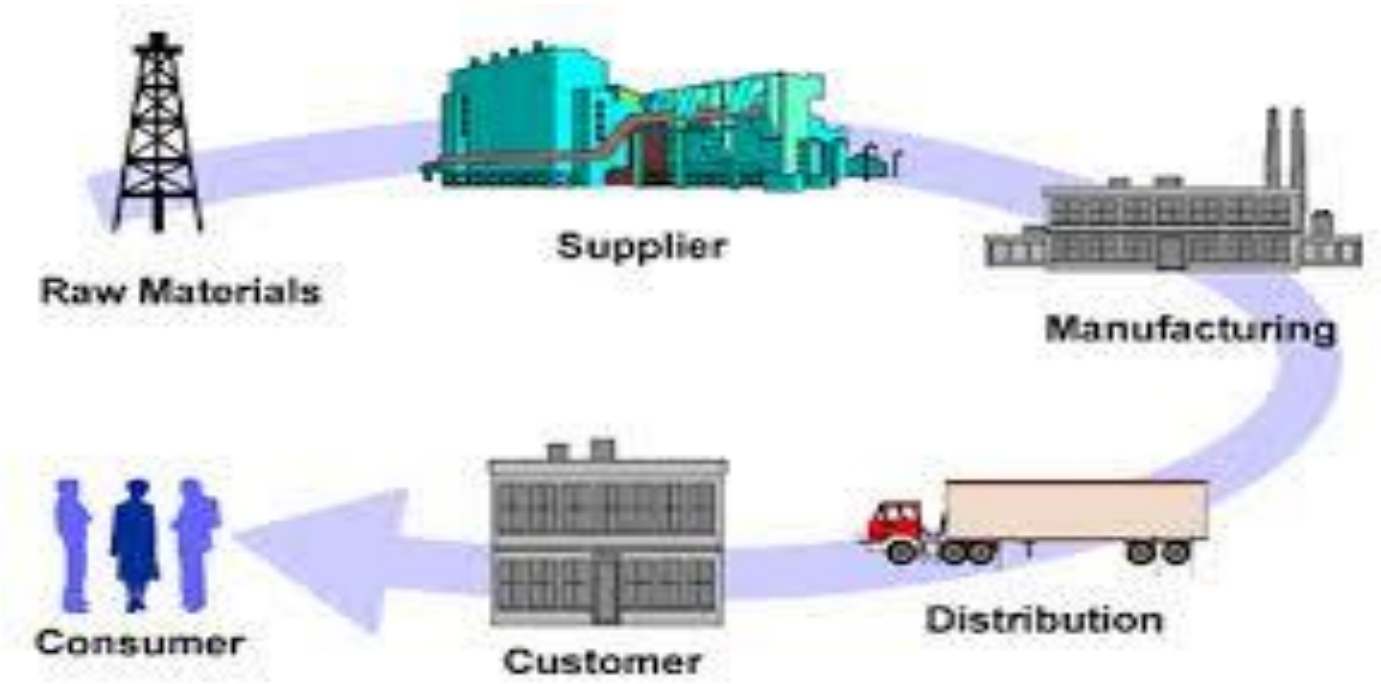
OPPORTUNITIES IN THE SUPPLY CHAIN



RFID is an essential tool for any supply chain professional because, in addition to other technologies, it allows an **extraordinary control** over packages and single products, thereby **speeding up** procedures and **increasing the level of security**.

RFID is a chance for all the shopkeeper because within a few years it will reduce store theft but above all it will improve the “shop experience”, i.e. the way in which consumers interact with the products they want to buy.

In the end, **RFID is one of the most promising markets** of the near future for those who manufacture, integrate and sell technology products, because tags and antennas, which are the two basic elements of a radio frequency identification system, are spreading quickly all over the world.

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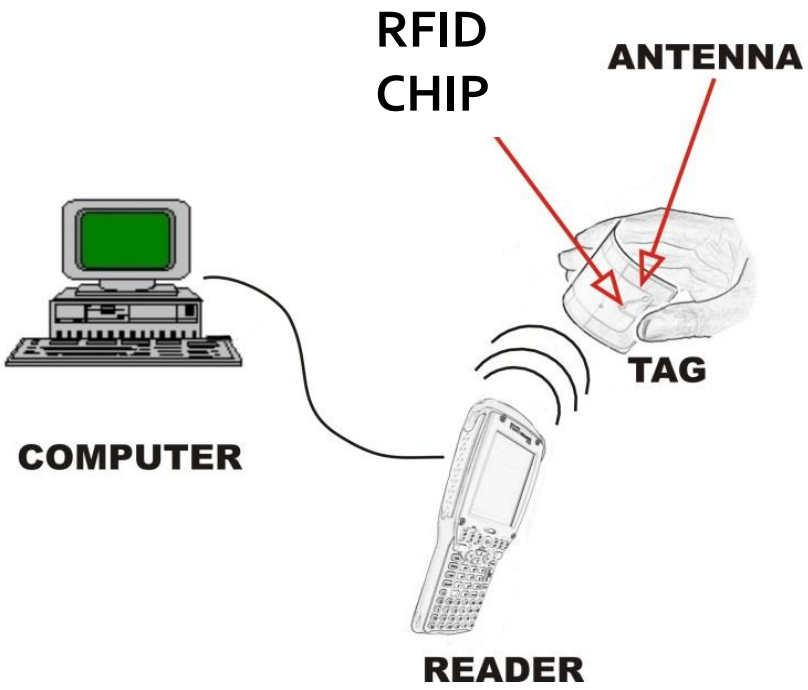
PASSIVE RFID
How does it work?



The identification is possible thanks to the antenna that reads a digital chip (called tag or transponder) applied to the object (or person or vehicle) that must be identified.

The tag contains a certain amount of information concerning the object it is applied to (code, production date, manufacturer), which can be static or change over time.

<u>The tag can be devoid of power supply (electricity) to work: since it is supplied only via the energy of the field beamed by the reader's antenna, the tag is able to capture that little energy required to provide the information, being at short distance.</u>

This is what we call a Passive Tag

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ACTIVE RFID
How does it technically work?

The Telepass system is an example of RFID transponder application

<u>If it is necessary to improve the range of transmission, a completely active solution that uses large batteries and improves the system performance is required.</u>

In the latter case, the tag is called “active”.

The range of application of this technology is infinite and it goes from the industrial production, logistics and clothing sectors to the health sector, general government and in the access control market.

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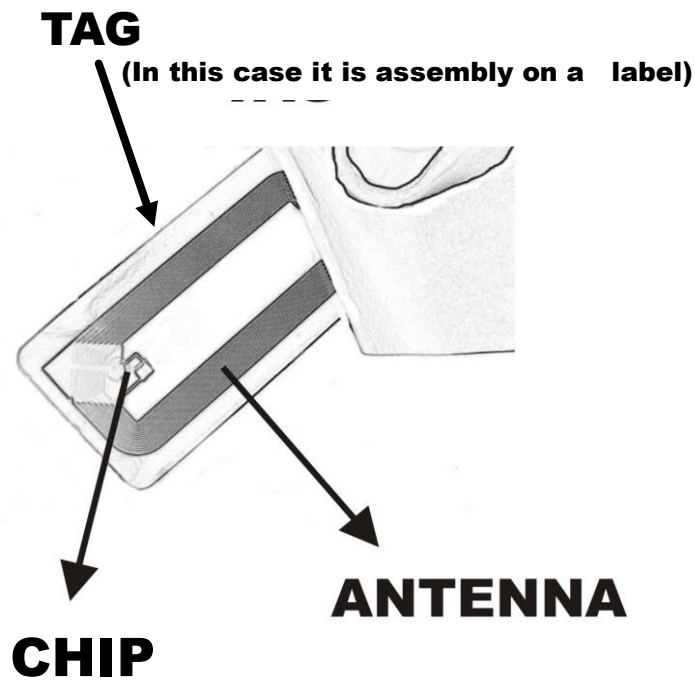
WHAT IS A RFID TAG?



A tag is composed of a chip and a little antenna that are assembled on a small size holder.

While the chip contains different types of memories and is in charge of the different activities of the tag, the antenna allows the communication with the readers of the RFID system.

There are two types of antenna embedded into tags: round shaped, that allows the tag to be read whatever the position of the antenna is and linear shaped, that allows a better reading of the tag depending on the orientation.

Univocal serial number is written in the chip which can store additional data.

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TYPE OF TAGS

PASSIVE TAGS

° Without own power supply
° Short reading distance
° Sensors that provide further information can't be integrated

→ **LOW COST**

SEMI-PASSIVE TAGS

° Are battery-assisted, i.e. a little battery is used for amplify the signal to the reader.
° Long reading distance
° Sensors that provide further information can be integrated

→ **AVERAGE COST**

ACTIVE TAGS

° Own power supply
° Long reading distance
° Sensors that provide further information can be integrated

→ **HIGH COST**

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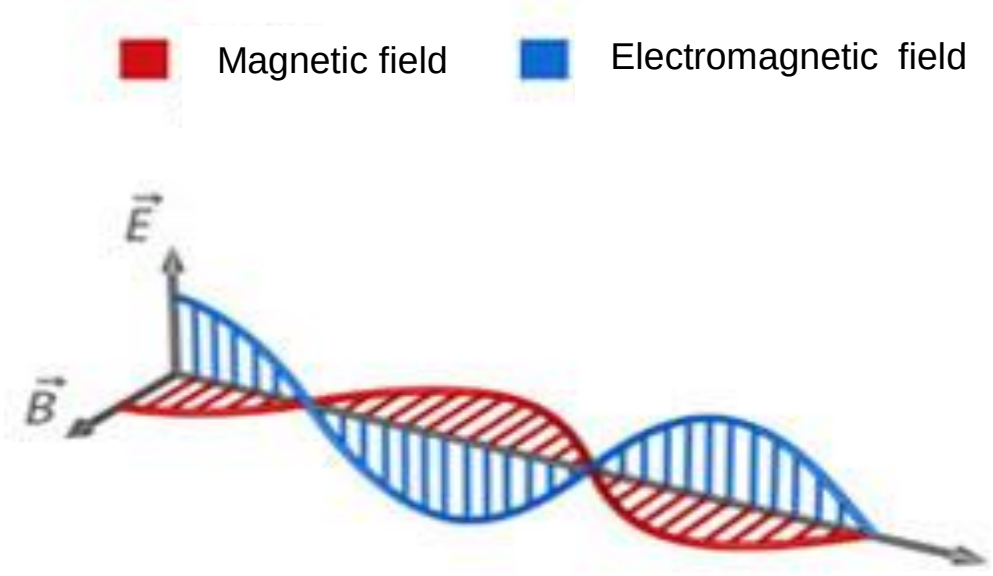
HOW DOES AN RFID TAG WORK



According to the electromagnetic principle, RFID tags can receive and transmit the information contained in the chip.

The coupling between the antenna of the tag and the reader is based on physical principles (magnetic and electromagnetic coupling) depending on the frequency band of the tag.

We talk about magnetic coupling at low and high frequencies while for ultra high frequency we talk about electromagnetic coupling.

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HOW DOES AN RFID PASSIVE TAG WORK?

When the tag receives the transmission signal from the reader, the energy runs through the internal antenna to the tag's chip. The energy activates the chip, which modulates the energy with the desired information, and then transmits a signal back towards the reader.

This is how a passive tag works and it is the most widespread tag on the market thanks mainly to the price that makes it suitable in many applications.

Some passive tags are particularly sturdy and resistant to extreme industrial conditions, if specifically designed.

The short reading distance and the unavailability of additional sensors are the limit of the RFID passive tags.

Moreover, they are not suitable for real time location system applications, since they start working once they are in the range of the reader.

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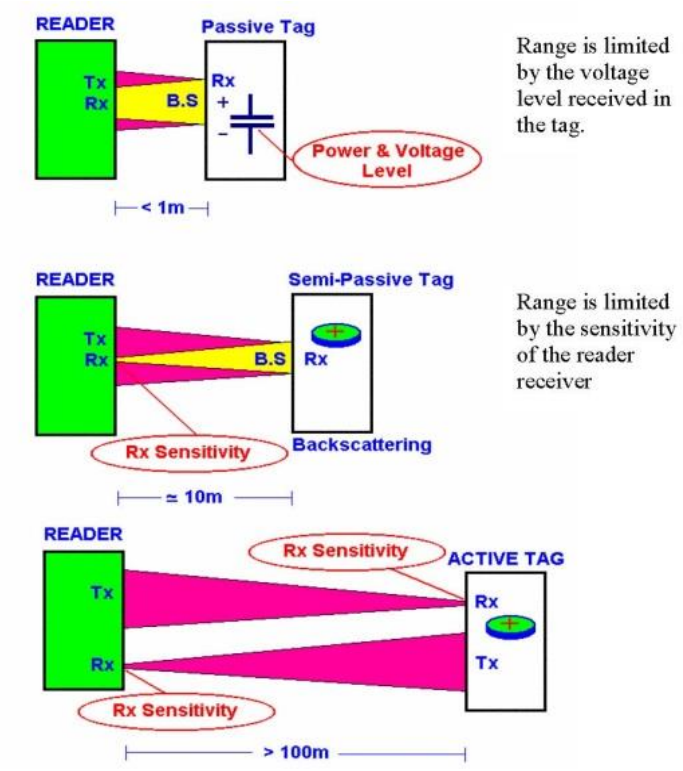
SEMI-PASSIVE TAG



There is another type of RFID tag called SEMI-PASSIVE tag or BAP (Battery Assisted Passive tag).
It substantially works as a passive tag that reflects back the energy to the reader.

SEMI-PASSIVE tags include the battery that:

1. **helps to extend the communication range, keeping the chip in a "stand by" mode.**

The battery allows SEMI-PASSIVE TAGS to have a greater sensitivity than passive tags, since they can work at long reading distances.

2. **powers additional sensors, depending on the type of tag.**

<u>In terms of price, BAP are between passive and active tags, being cheaper than active tags but more expensive than the passive ones.</u>
<u>BAP has an application limit in harsh environments since battery must be preserved.</u>

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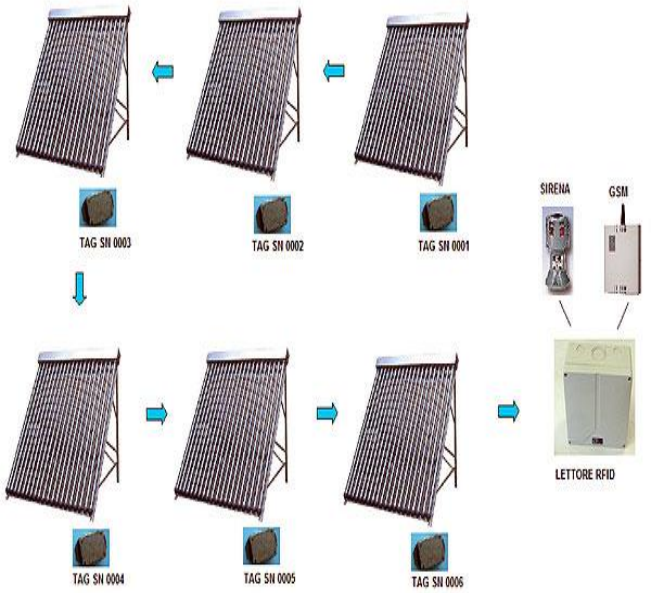
ACTIVE TAGS



A CONFIGURATION EXAMPLE IN A PHOTOVOLTAIC STANDARD SYSTEM MONITORED BY ACTIVE TAGS

Active RFID tags are battery powered and require no energy from the reader to send a signal, since they can integrate a transceiver system such as a reader.

Since they have their own battery, active tags work no matter where the reader is, achieving long reading distances, better than passive tags. Due to the fact that they are always turned on, active tags are used when real-time localisation is required.

Active tags can work continuously or be set at time intervals to preserve battery life. Since they are battery equipped, active tags may have on-board sensors that track environmental parameters, i.e. In order to track temperature and pressure.

Talking about disadvantages, active tags are huge and weighty since batteries are heavy and take up space. Moreover, once the battery runs out, though, you'll need to get a new tag. Active tags are more expensive than passive tags, since they are battery equipped and because of the battery, active tags cannot work in high-temperature environments.

WHICH ARE THE RFID FREQUENCIES?

There are several different frequencies an RFID system can use. Generally, the most common are:

- **Low frequency (LF, between 125 and 134 kHz)**
- **High frequency (HF, around 13 MHz)**
- **Ultra-high frequency (UHF, between 860 and 960 MHz)**
- **Microwaves (more than 2,45 GHz)**

These frequency bands have different characteristics and therefore they are suitable for different applications.

In general, as the frequency increases, the reading distance and the amount of information that can be transferred per unit of time increase too, while tags become more vulnerable to the operating conditions and they are more expensive.

Low-frequency tags (LF) have a long wave-length and are better able to penetrate thin metallic substances. Additionally, LF RFID systems are ideal for reading objects with high-water content, but the read range is limited to 30-40 centimeters.

High-frequency tags (HF) work fairly well on objects made of metal and they can have a maximum read range of about 1 meter.

Ultra-high frequencies (UHF) typically offer much better read range and can transfer data faster. However, their signal is more likely to be attenuated (or weakened) and they cannot pass through metal or water

<u>Solutions with 2,45 GHz tags are used in the "Telepass" electronic toll system.</u>

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INFORMATION CAN BE WRITTEN, OVERWRITTEN OR DELEATED ON THE TAG.

There are different labels:
- **"read only" (just reading),**
- **"write once & read many" or WORM (one writing, many readings),**
- **"read & write" (reading and writing);**

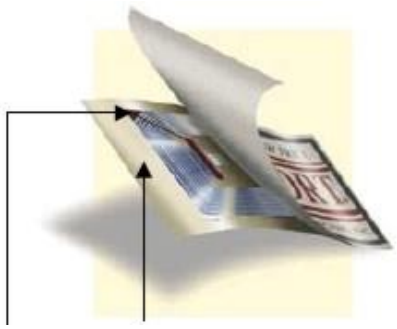
In the first two cases, the RFID tag represents a technological evolution of the barcode because information stored in the microchip cannot be modified once they are written.

1. Read only: JUST READING
2. Write once & read many o WORM: ONE WRITING, MANY READINGS
3. Read & Write: READING AND WRITING

Read & Write tags give users the ability to update or re-write the information stored on the tag at any time, i.e. at all stages of the supply chain.

<u>These tags are little more expensive than Read only tags.</u>

WHICH ADVANTAGES CAN RFID TAGS OFFER COMPARED TO BARCODES?

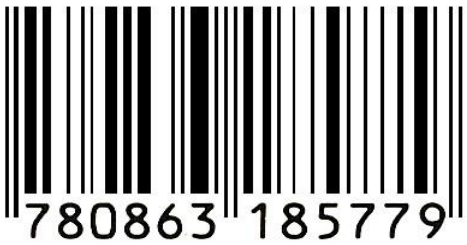


Radio frequency technology provides several advantages compared to barcodes and other identification technologies:

- RFID tags can be read from a greater distance than barcodes.
- RFID tags don't need to be positioned in the line of sight with the scanner.

RFID tags can:

- be read at the same time.
- Work in harsh environments and are not susceptible to environmental agents, heat, chemical and mechanical stresses, They are therefore long-term solutions.
- RFID tags carry large data capabilities and information can be rewritten or added.
- RFID tags also work in a fluid, inside the object you want to identify or inside a box.



- RFID tags have an univocal serial number that identifies every single product manufactured in the world, while the barcode only identifies the batch of a product, but not the individual item.
- RFID tags are more expensive than barcodes, but cost-effectiveness is generally advantageous.

<u>The typically mistake here that one can make is to think that RFID will replace the barcode technology. That isn't true. In fact both of them will coexist.</u>

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ADVANTAGES OF RFID COMPARED TO BARCODE

	BARCODE	RFID
EFFECTIVENESS	Barcodes must be read individually and need to be positioned in a line of sight of the reader.	Approximately 200/sec RFID tags can be read at the same time without being positioned in the line of sight of the reader.
RESISTANCE	If barcodes are ripped or damaged there is no way to scan the product	Are very durable and not susceptible to environmental agents that prevent reading.
CAPABILITY	A very limited amount of data can be stored in barcodes.	They have internal memory and a large amount of data can be stored in RFID tags.
FLEXIBILITY	Information cannot be modified.	Stored data can be written and read. Tags are reusable and allow dynamic access to information.

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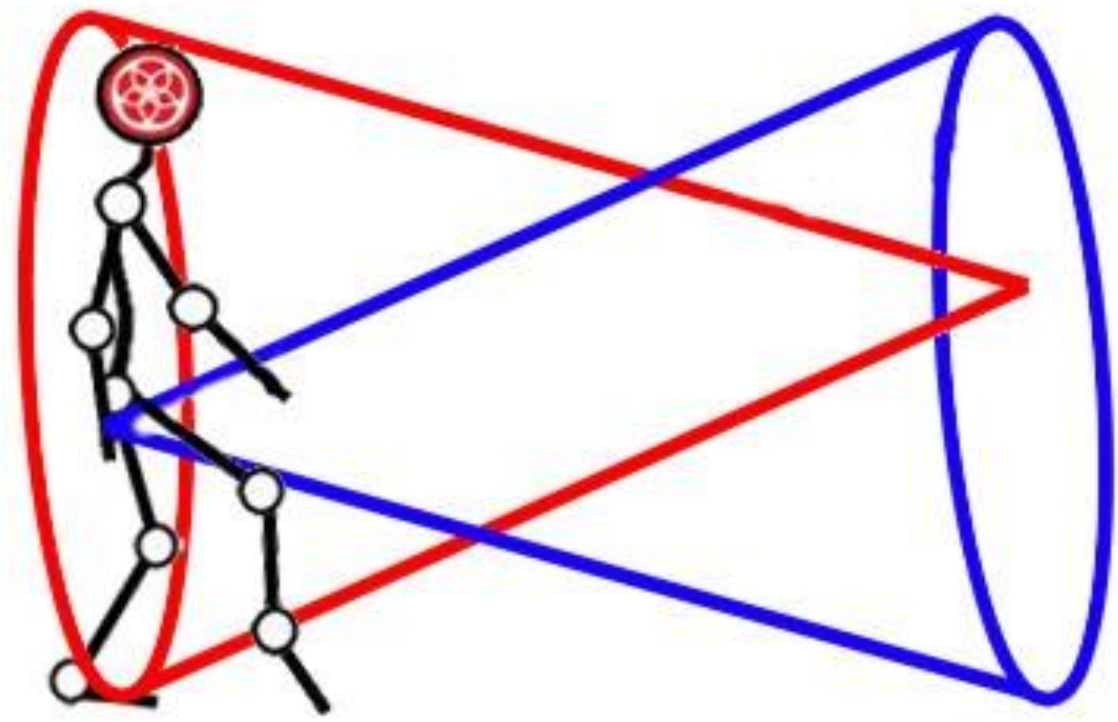
READ DISTANCES AND READ ANGLE (A)



Read distances depend on the type of tag (active/passive) and on the frequency band.

To give some references, passive technology varies as follows:

- **From few mm to tens of centimetres talking about LF**
- **From 10 to 20 cm talking about HF**
- **Up to 4-7 m for UHF**

These data are highly dependent on the size of the tag and the size of the antenna.

For example the reading distance of a button-shaped HF tag with a diameter of 14mm doesn't exceed 25 cm, while the same HF tag with a card shape (80x50mm) can be read even at a distance of 100cm with an appropriate antenna.
Reading distances increase for active tags, reaching more than 10 meters.

READ DISTANCES AND READ ANGLE (B)

Read angle is another important factor as for the orientation previously discussed. In summary, LF and HF tags are highly sensitive to the read angle in connection with the antenna reading range (because the turn area which is able to connect the magnetic field is reduced).
Even a small angle of 45° could cause a decrease in the tag's read range.

For UHF tags, read angle depends on the polarisation of the field performed by the reader or on the type of antenna (linear or circular polarization).
While LF and HF tag aren't able to work at a read angle with more than 60° between their orientation and the wave front, for UHF tags there are no significant problems.

It goes without saying that the cost of the two types of tags is very different, with a ratio that can also be 4 to 1.

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HOW MANY TAGS CAN BE READ AT THE SAME TIME?

This issue occurs especially for passive tags, since they are structurally designed to be used for large volumes and therefore in contexts in which you have to read many tags in a short time.

This depends on the frequency of the tag, the number of channels that the particular protocol reserves to the tag/reader communication and the type of anti-collision algorithm used, beyond of course the correct orientation of the tags in the field.

It can be said that for an UHF tag, with a tunnel configuration with 4 or more antennas, up to 200/300 tags can be read in less than 3 seconds.

On the contrary, HF applications, and especially LF ones, are limited in this respect, with the possibility to read no more than 10 and 3 tags per second respectively.

UHF TAG	**100 per second**
HF TAG	**10 per second**
LF TAG	**3 per second**

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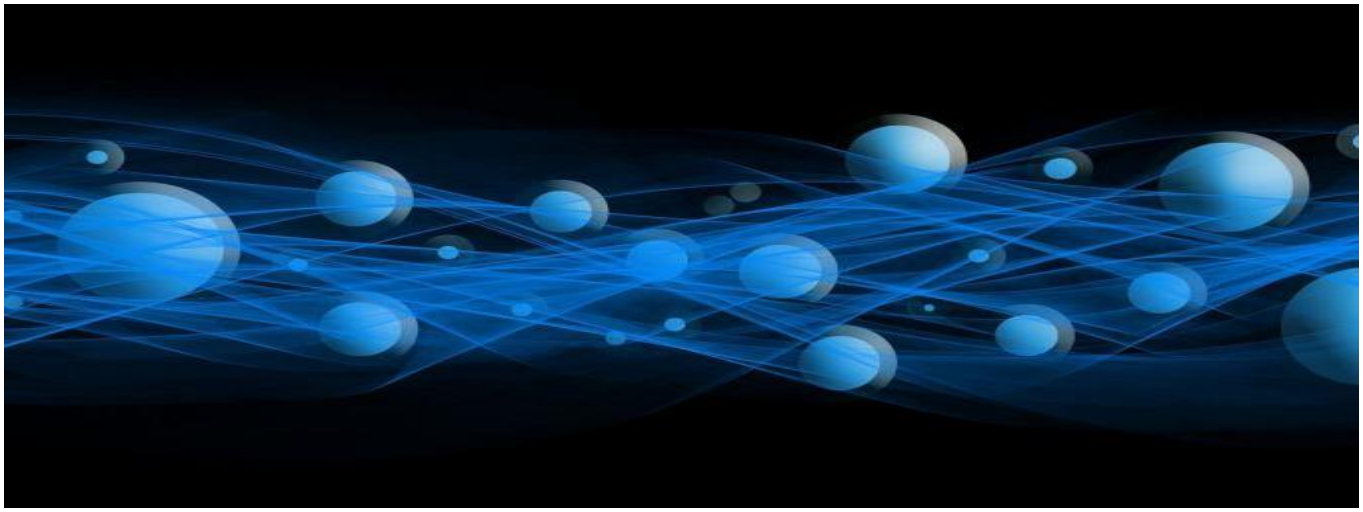
HOW LONG DOES DATA REMAIN ON AN RFID TAG? (A)

There are three different types of memory of a tag:

- **Read only memory (ROM), used to save the unique identification code of the tag that is written once the tag is manufactured, according to the ISO standard;**
- **Write once & read many (WORM), that can be written once and read several times;**
- **FLASH MEMORY, that can be written several times.**

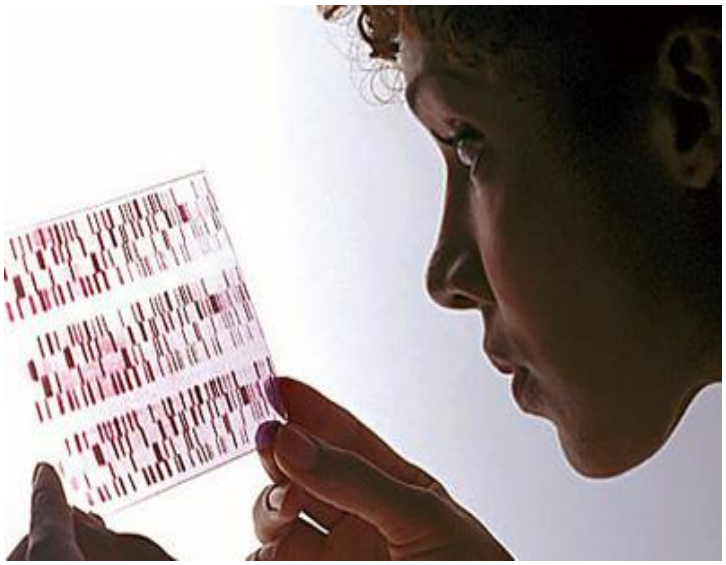
Read only memory last several tens of years, as for all the electronic devices with ROM.

Thanks to their technology, all the rewritable memories last at least 10 years.



HOW LONG DOES DATA REMAIN ON AN RFID TAG? (B)

Currently, there is no empirical evidence on the real duration of the data written in the rewritable memories of the tag.



As discussed above, the possible impact of the operational context should also be taken into account talking about memory, as the exposure of the tag with strong magnetic fields or other radiation sources could lead to the deletion of the stored data.

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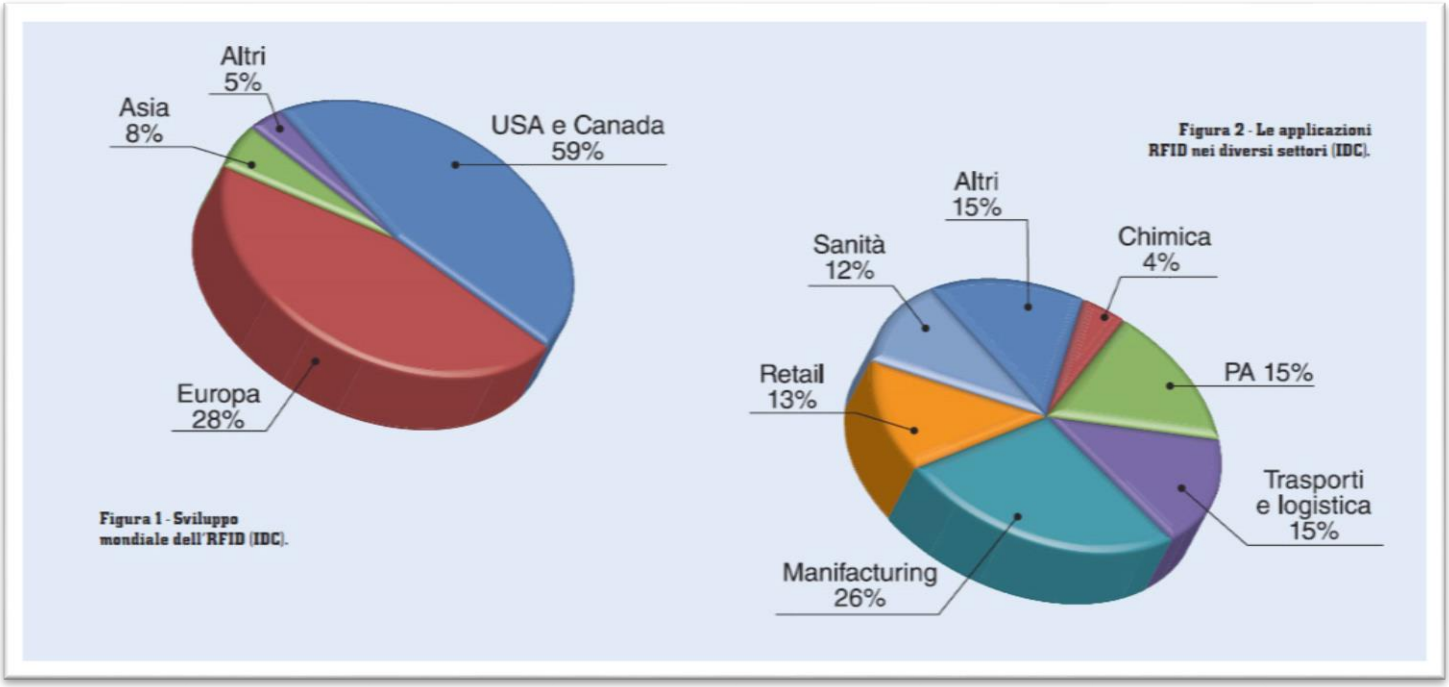

Figura 1 - Sviluppo mondiale dell'RFID (IDC).

Figura 2 - Le applicazioni RFID nei diversi settori (IDC).

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