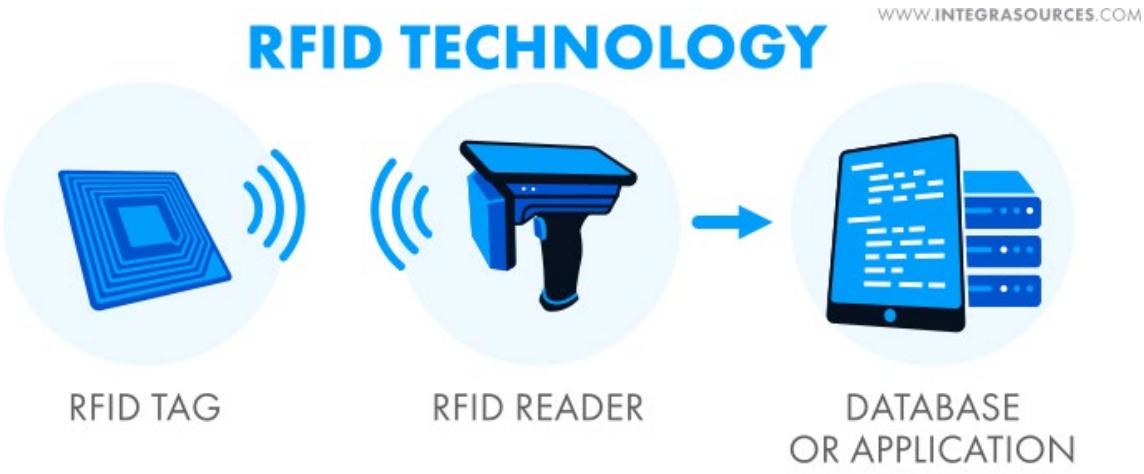
RFID and NFC Systems: Work Principles and Applications

RFID and NFC find use in dozens of industries and spheres: contactless payment, asset tracking, location tracking, marketing, inventory management, and more. This article is dedicated to the differences between these technologies, their benefits for businesses, and applications.

What are RFID and NFC?

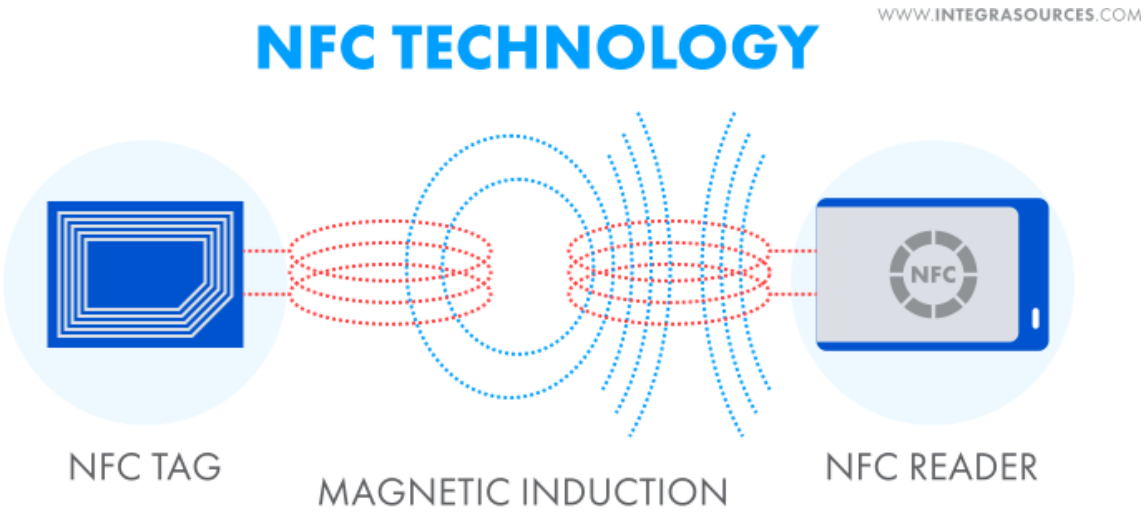
Radio-frequency identification (RFID) is a wireless communication technology that can uniquely identify objects with radio waves. An RFID system consists of a reader, a tag, and software that controls the work of the system and stores the received data if necessary.

The reader sends a signal to the tag. The tag transmits ID information back to the reader. Then, the data can be transmitted to a database for storage or analysis.



ALT: A scheme showing an RFID reader receiving information from an RFID tag and transmitting it to a database or an application.

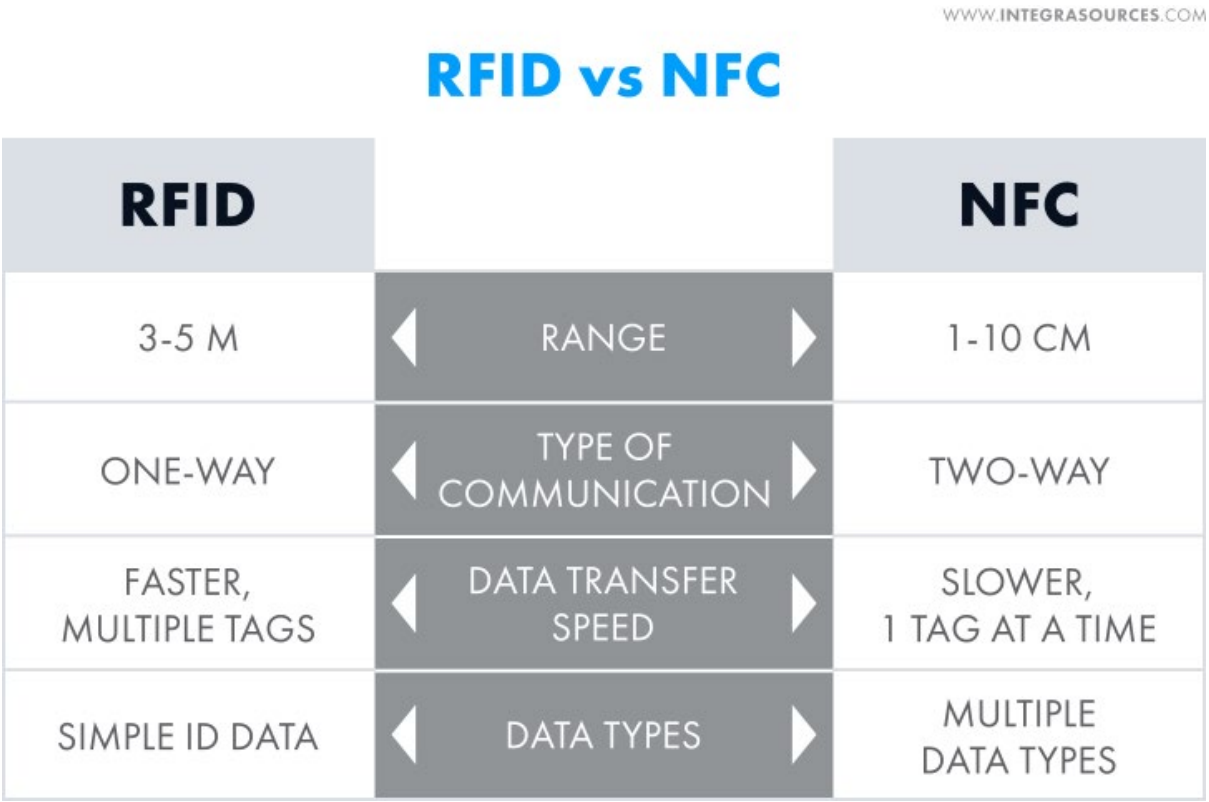
Near field communication (NFC) evolved from RFID. It can be regarded as a subset of radio-frequency identification. Unlike RFID, NFC systems are magnetics transmitters rather than radio transmitters. They consist of similar elements: an initiator (reader), a target (tag), and software. In practice, they work the same way as RFID systems.



ALT: A drawing showing how NFC readers and NFC tags interact through magnetic induction.

RFID vs NFC Systems

Radio-frequency identification and near field communication have similar working principles and applications. However, their characteristics are different, which makes them particularly suitable for different spheres.



ALT: A table that compares the features of RFID and NFC systems.

Range

The range of most civil-grade RFID devices does not exceed 3-5 m. On the other hand, they don’t require the tag to be in the line of sight of the reader. The range of NFC devices is extremely short: 1-10 cm. And the tag must be in the line of sight of the initiator.

Type of Communication

Radio-frequency identification is only capable of one-way communication. The reader receives data from the tag but does not respond to it. NFC devices can work as both readers and tags, by switching roles. In other words, they are capable of two-way communication and can exchange information.

Data Transfer Speed

Near field communication is pretty slow. Its data transfer speed does not exceed 424 kbit/s. Radio-frequency identification devices are usually faster. Besides, RFID readers can scan multiple tags at a time, unlike NFC readers.

Data Types

RFID tags can only store simple ID information. NFC tags can store different data types and have larger memory, which makes them suitable for payment transactions.

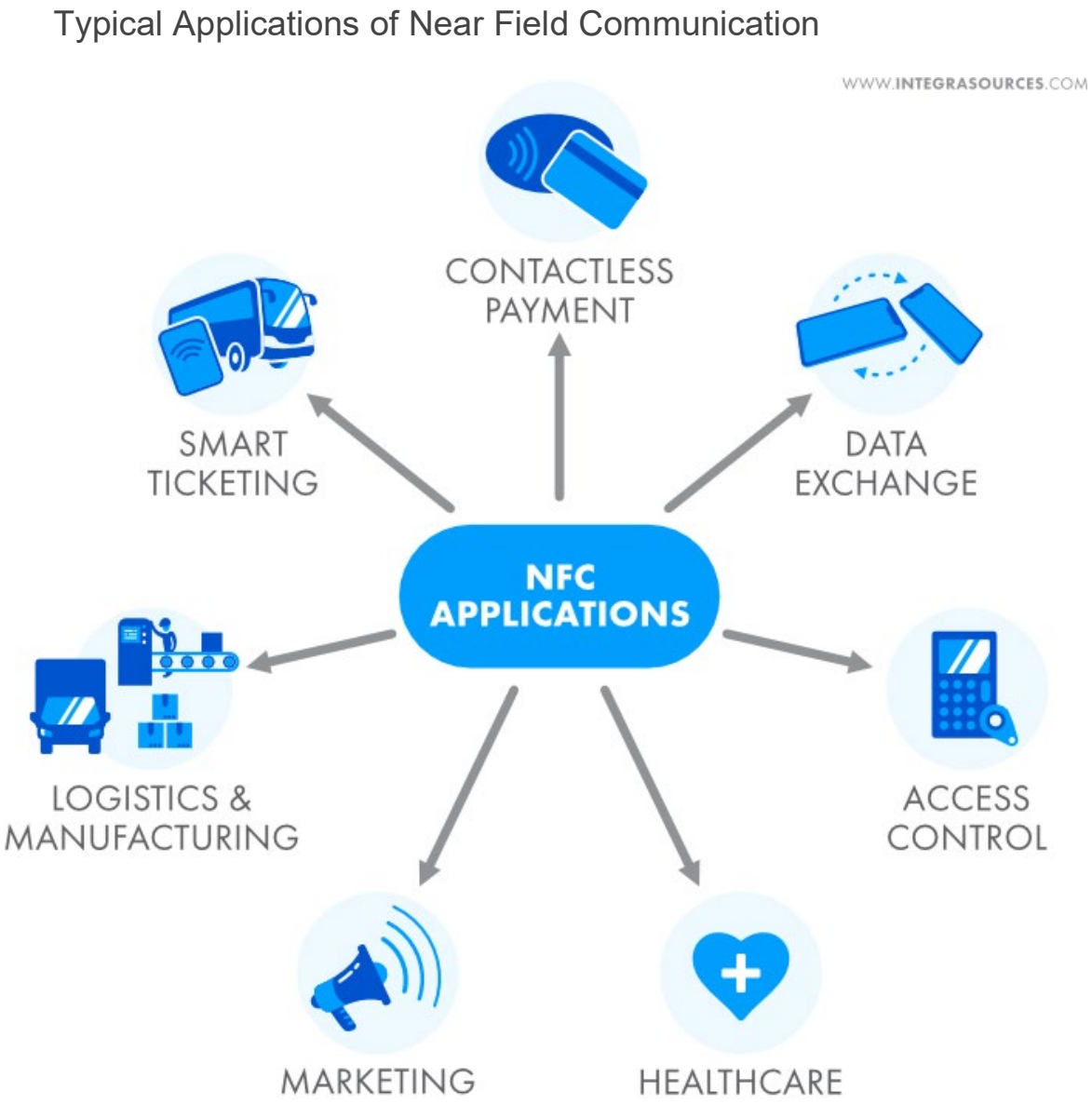
RFID and NFC Applications

Typical Applications of Radio-Frequency Identification

ALT: An infographic showing common applications of RFID systems.

- **Access control**. RFID technology is often used in security. Cards and badges fitted with tags grant access to computers, restricted areas, etc.
- **Real time location systems**. With radio-frequency identification devices, one can track the location of employees, customers, tools, goods, and other assets in real time.
- **Logistics & supply chains**. Certain types of RFID tags are easy to read even when they move. Due to this feature, they are used in vehicle and cargo tracking systems.

- **Inventory management**. With radio-frequency identification, inventory count becomes much faster. The technology is also useful for retailers who want to track assets at multiple points of sales.
- **Animal tracking**. Some RFID devices use frequencies capable of penetrating through the water in animal bodies. It makes them perfect for animal tracking solutions.
- **Marketing**. Marketing specialists find creative ways to benefit from this technology. It is used in advertising posters, smart items, mobile applications, etc.
- **Vehicle access**. One can protect their car from thieves with RFID starters, immobilizers, and entry systems.
- **Theft prevention**. RFID tags are attached to clothes in stores to prevent theft attempts.
- **Race timing**. Tags are attached to the sports uniform. It allows the administration to track the participants and the precise time they cross the finish line.



ALT: An infographic showing common applications of NFC systems.

- **Contactless payment**. Since near field communication has a very short range, its signals are difficult to intercept. It makes the technology secure for contactless payments.
- **Data exchange**. NFC is capable of two-way communication, which allows two devices to exchange data.
- **Access control**. Near field communication is also used for keyless access to vehicles or restricted areas.
- **Healthcare**. NFC technology is widely used in healthcare. NFC tags allow personnel to track patients' status and records, check schedules, and access the necessary equipment.
- **Smart ticketing**. Smart tickets use near field communication to grant access to public transport, concerts, movies, etc.
- **Manufacturing and logistics**. Tags can be used to identify products at different stages: production, packaging, shipment, etc. They can also be useful for logistics.
- **Marketing**. Many smartphones have NFC modules. Marketers capitalize on this fact, by advertising products and events through NFC, offering coupons and discounts, or leading potential buyers to websites, blogs, and videos.

Both RFID and NFC systems find use in unexpected applications as well. They are used to track luggage at airports, find balls on golf courses, and even track food "from production to plate". NFC tags are used in laundry-related tasks and document tracking. Some companies even microchip employees for access control. The number of possible applications of these technologies is enormous.

Certification of RFID and NFC Systems

Radio-frequency identification and near field communication devices are radio emitters. Despite their short range, they can still interfere with the work of other wireless devices. As a result, such systems must comply with various standards and regulations.

As a rule, new NFC and RFID systems must comply with the FCC requirements in the United States and CE RED requirements in the European Union. The devices may require other certifications as well: UL (may be required by retailers), California Proposition 65, ATEX, IECEx, IP, IK, ARC, and more.

NFC Application Cases

The following cases describe examples of using NFC technology for different purposes or to complement another technology.

One of such projects is a smart home automation system. Among other things, the developers were asked to design an access control system for its control panel. Here they used an NFC module. With an NFC-enabled card, a user can quickly get access to the system.

Here is another example of using NFC for complementing a system based on another technology. The system was developed for a restaurant. It is composed of multiple wireless devices that create a mesh network. The devices are placed on the tables in the restaurant. When activated, they send a signal to a waiter and perform other functions as well.

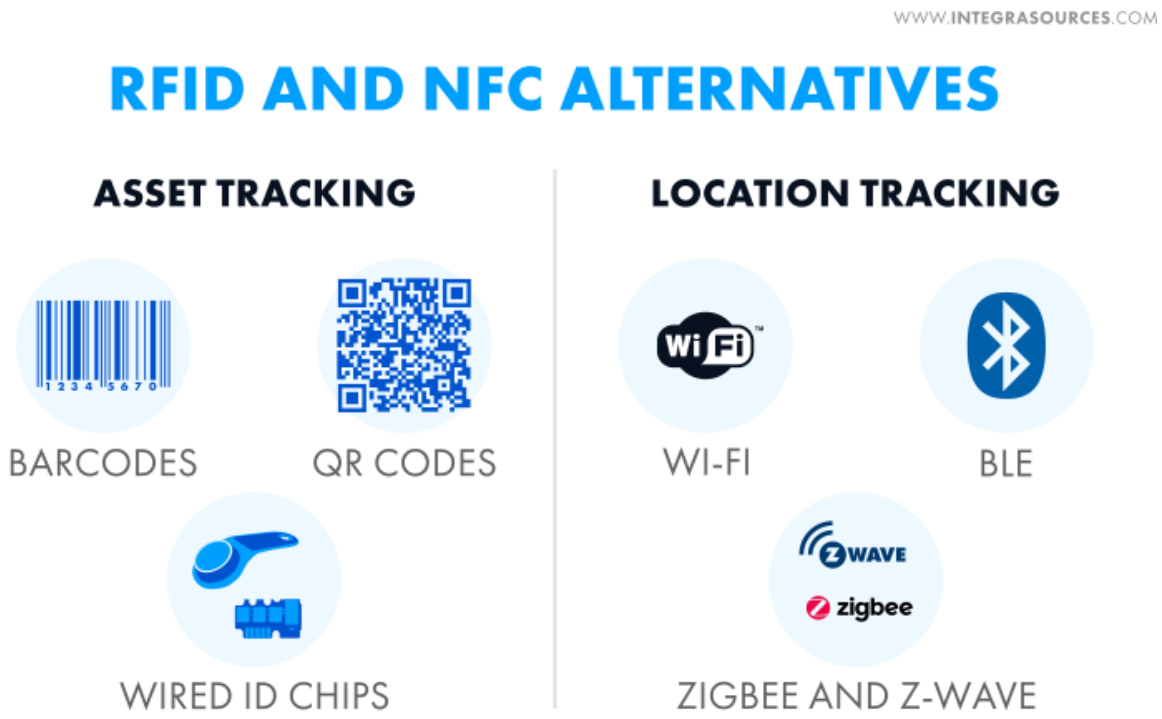
The devices are battery-powered and require recharging. As a result, they are regularly replaced with other devices. Each of them is equipped with an NFC reader. Each table has an NFC tag attached to it. When a new device is placed on a table, it reads the tag and automatically changes its location settings. Simply put, the device understands on which table it is placed right away.

The following case is another example of a non-standard application of NFC technology, particularly for orienteering and location-based games. NFC tags are placed on control points and can be read with a special reader. The reader transmits the information to the administration and confirms that the participants have reached the point.

ALT: A drawing showing an NFC system used for orienteering events and location-based games.

In this case, the team had to pay a lot of attention to the reader to make it water- and shockproof. They also implemented additional functions such as geolocation, emergency button, etc.

RFID and NFC Alternatives



ALT: List of technologies that can serve as alternatives to RFID and NFC systems.

There are technologies that find similar or identical applications as RFID and NFC. For asset tracking and inventory management, one can use barcodes and QR codes. These technologies were predecessors of radio-frequency identification and near field communication in this field. Despite certain disadvantages, they are cheaper. Another alternative is wired ID chips.

Wi-Fi, BLE, Zigbee, and Z-Wave are sometimes used for location tracking, which is somewhat exotic. Their most common fields of application include home automation and entertainment. They feature a longer range and higher data transfer speed. In the case of Wi-Fi, one can capitalize on the already existing infrastructure to save money.

These NFC and RFID alternatives lack compactness and require electric power (unlike passive RFID tags, for example). Also, RFID and NFC usually don’t require complex security methods. Nevertheless, in some cases, the alternatives mentioned above can replace RFID and NFC.

5 Things to Consider When Choosing RFID and NFC Tags

Reading distance

The distance from which a reader can scan tags depends on two factors: the frequency range the devices use and the transceiver power. While NFC tags operate at 13.56 MHz only, RFID tags operate at various frequency bands: mostly at low-frequency, high-frequency, and

ultra-high frequency. In general, the higher the frequency, the longer the rage. But this, in turn, decreases the ability of the radio waves to penetrate certain materials.

The range of the devices can be increased with active and semi-active tags that have their own power sources. However, this will require regular battery replacement.

Contents of the tagged objects and their composition

The reading range also depends on what materials the tagged items are made of and what they contain. Particularly, liquids decrease the readability of the tags. Most RFID tags don't work when placed on metal surfaces. Such items will require special anti-metal tags. Take this into account when choosing tags for your system.

Size and form factor

Tags come in many sizes and shapes. Some of them are quite big and noticeable. Others are tiny and flexible, which allows them to be attached to paper sheets and similar surfaces. Tags also use different mounting methods from glues to screws and nails. Note that tags with batteries and large antennas (and a longer range) are usually bigger than passive tags with small antennas.

Environmental conditions

Like all electronics, tags are sensitive to environmental conditions: moisture, heat and cold, vibration, chemical agents, etc. Certain applications require that tags are housed in a strong housing. But if the tags are supposed to be used in a mild environment (for example, for tracking books in a library), such protection is excessive.

Memory capacity

If there is a need to write more information on the tags, you may want to use tags with a larger memory size. On the other hand, the problem can be solved by combining low-memory tags with an online database. In this case, the additional information about the item can be stored in the database.

Final Thoughts

Radio-frequency identification and near field communication are widely used in many industries from retail to manufacturing and logistics. The versatility of the technologies allows businesses to find unusual and even extraordinary applications for such systems. They let entrepreneurs measure the staff's efficiency, improve the floor plan of their stores, know where and how many valuable resources they have, and more.

One can use off-the-shelf components to create an NFC or RFID system or order a custom design from an electronics development company for specific purposes. For more details about RFID and NFC systems, their applications, and hardware design, visit Integra Sources' blog.