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What Is NFC (Near Field Communication)? Definition, Working, and Examples

NFC connects two NFC-compatible devices that are in very close proximity, for slow but reliable data transfers.

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IPR2025-00975, U.S. Patent No. 9,832,708
Page 1 of 16

Near Field Communication is a wireless personal area network (PAN) technology that connects two compatible devices in very close proximity of each other, in order to enable slow but reliable data transfer. This article explains how NFC works, with examples.

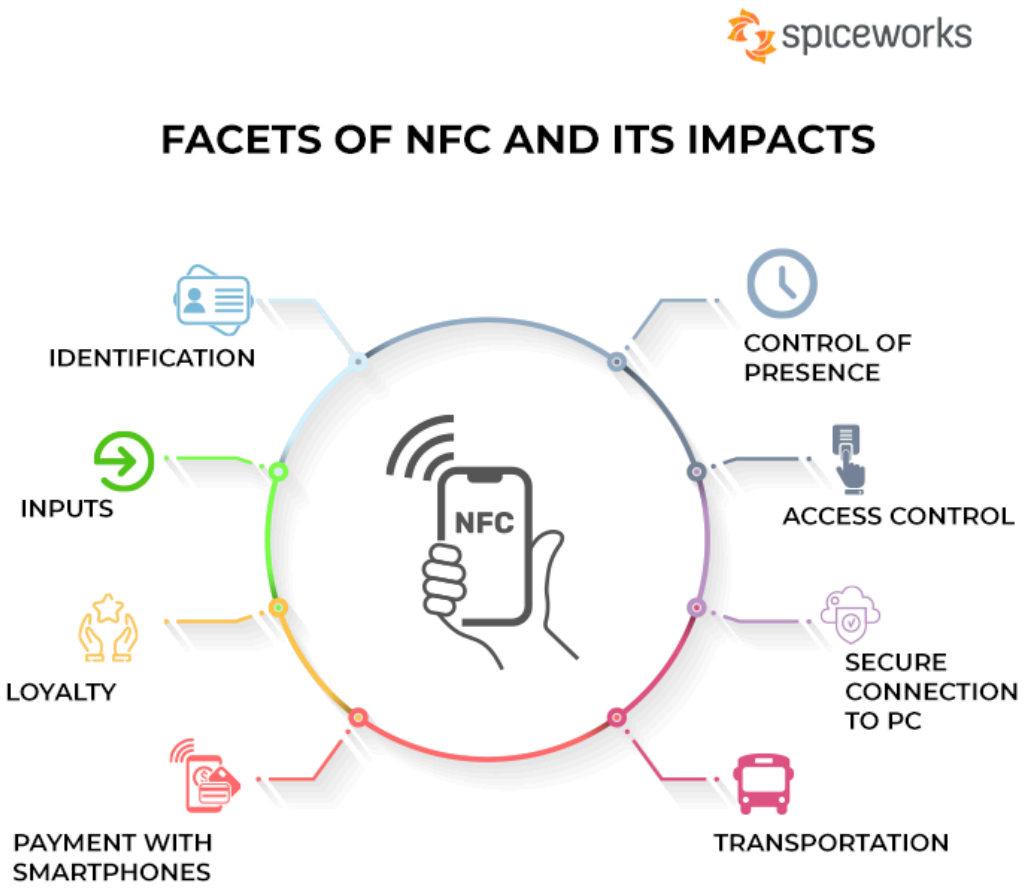
Table of Contents

- What Is NFC (Near Field Communication)?
- How Does Near-Field Communication Work?
- Examples of Near Field Communications

What Is NFC (Near Field Communication)?

Near Field Communication, commonly abbreviated as NFC, is defined as a wireless personal area network (PAN) technology that connects two compatible devices in very close proximity to each other, in order to enable slow but reliable data transfer.

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 2 of 16



The Many Facets of NFC and Its Impacts

The technology known as near-field communication (NFC) comprises a group of communication protocols that make it possible for two compatible devices to communicate with one another across a short distance, often no more than four centimeters. The NFC standard enables mobile devices such as smartphones to share data with one another in a brisk and painless manner with just a single tap. In order for the technology to function, there must be two devices that are compatible with it — i.e., both a target device and an initiator device.

The NFC Forum was formed in 2004 by Nokia, Sony, and Philips to promote awareness of the benefits of using near-field communication. They were also responsible for setting NFC

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 3 of 16

standards and certifying devices that were NFC compliant. Existing radio frequency identification (RFID) standards such as ISO/IEC 14443 and FeliCa served as the foundation for the development of the NFC standards. Maintaining these standards ensures that NFC-compatible devices from different manufacturers can communicate with each other. The lack of encryption in NFC ensures that it is compatible with RFID technologies.

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Additional application software is required for NFC-enabled devices, such as smartphones, in order for such devices to function as their manufacturers intended them to. Without this application software, smartphones cannot make payments or read smart NFC posters. NFC technology is used to facilitate contactless payments in Apple Pay and Samsung Pay for smartphone users, to wirelessly charge wearable fitness devices, and to provide key card access to offices and schools.

Communication can occur between two NFC-compatible devices if they are both active or if one is active and the other is passive. A modified form of Miller coding with 100% modulation is used whenever an active NFC device performs a data transfer at 106 kbit/s. On the other hand, Manchester coding with 10% modulation is used if the speed fluctuates between 212 and 424 kbit/s.

- **Active communication mode**: In this mode, both the target and initiator devices are active devices. That is, both of them have a power source, and they can alternately generate a field through which they can communicate. An active device deactivates its radio frequency (RF) field while waiting to receive data.
- **Passive communication mode**: The initiator device supplies a carrier field while the target device is responsible for modulating the field that is already present in this mode. The passive device lacks power and has to draw its power from the electromagnetic field of the initiator device.

Using NFC offers several key advantages. It is inexpensive, and its benefits outweigh the costs. It allows for faster and more automatic communication between devices. It is

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 4 of 16

backward compatible with other RFID devices. Using NFC does not require expertise. Users with decent technological know-how can use it.

However, NFC also has a few constraints. It only operates within a very short range and is prone to security vulnerabilities such as eavesdropping, which may lead to the loss of information. NFC has a very low rate of transferring data, making it unsuitable and slow for transferring large files between peers.

How is NFC different from other wireless technologies?

While NFC is also a way of transferring data wirelessly between local devices, it is different from other technologies like Wi-Fi and Bluetooth. Wi-Fi is used to transfer data over relatively long ranges in a Local Area Network (LAN). NFC, on the other hand, is a peer-to-peer technology that operates across shorter distances.

It is also less powerful than Bluetooth. Bluetooth version 2.1 (V2.1) has the fastest maximum data transfer rate of 2.1 Mbit/s and can operate within a range of 100 m. Bluetooth version 4 (V4), also known as Bluetooth Low Energy or Bluetooth LE, has a data transfer rate of 1 Mbit/s and can operate within a range of 50 m. Meanwhile, NFC has a data transfer rate that is capped at 424 kbit/s and it can only operate within a range of 20 cm.

However, it does offer a few unique upsides. A connection between two NFC-compatible devices is automatic, while that of Bluetooth requires devices to be manually paired to transfer data. NFC also requires less time to set up, approximately 0.1 seconds. However, Bluetooth v2 takes more time to set up (approximately 6 seconds).

Transferring data via Bluetooth requires both devices to be active, while the transfer of data using NFC can be done even in situations where one device is passive. Additionally, the transfer of data in NFC is bi-directional while that in Bluetooth is directional.

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Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 5 of 16

How Does Near-Field Communication Work?

Near-field communication is a wireless connectivity technology that is based on RFID. It uses induction coupling to enable communication between two compatible devices that are close. It enables users to automatically transfer data bi-directionally between two NFC-enabled devices by just touching both of them or by bringing them close to each other.

NFC operates at the globally unlicensed 13.56 MHz frequency. It has three different data transfer rates – i.e., 212 kbit/s, 106 kbit/s, and 424 kbit/s.

There are two modes through which two NFC-compatible devices can cooperate to facilitate the transfer of data between themselves when they are brought into proximity. The first is the active mode. In this mode, two active devices with a power source transmit data bidirectionally between themselves.

Examples include transferring files between two NFC-compatible smartphones or transferring virtual rewards between two gaming controllers. When two NFC-compatible smartphones are brought within proximity of each other a connection will automatically be created. Then they will alternate to generate an RF field through which data transfer occurs. After the users select the file they wish to send, the smartphone receiving the file will stop generating an RF field to receive the file. Data can be transferred at a maximum speed rate of 424 kbit/s.

The second mode is the passive mode. In this mode, an active device can read data from an NFC tag. For instance, a smartphone can be used as a keycard to access entry into office buildings. When the smartphone is brought into proximity to the NFC tag, it generates a carrier field which the NFC tag modulates. The electromagnetic field that is produced by the smartphone supplies the tag with the electricity it needs to function. Because of this, data may be moved back and forth between the two devices. It also enables the smartphone to read the data contained in the NFC tag, and if the user is allowed to access that office, the door automatically unlocks to allow them entry.

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 6 of 16

Modes of operation

The communication method in each mode of operation of NFC is different. These differences affect the field of operation and how it is used.

- **Peer-to-peer mode**: This mode is compliant with ISO/IEC 18092 standards. It supports communication and the transfer of information between two NFC-compatible devices. At any point, any device can act as the initiator or a target.
- **Reader/writer mode**: This mode is compatible with the standards established by ISO/IEC 14443 and FeliCa. It allows devices to read NFC tags, such as those that are integrated into smart posters.
- **Card emulation mode:** In this mode, data stored on cards such as smart cards are read by an NFC reader. In this mode, a device that is capable of NFC communication connects with an NFC reader in the same way as a smart card can. Users utilize smartphones to gain access to information, such as ticketing information.

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Understanding NFC tags

In order for near-field communication (NFC) to function properly, tags are necessary. This is especially true in the context of Internet of Things (IoT) device use cases. These tags are passive devices that allow for communication with active devices. They are categorized based on their formats and capacity. The ISO 14443 Types A and B as well as the Sony FeliCa standard serve as the foundation for the NFC tag type formats. These formats are similar but differ in the way they communicate.

- **Type 1:** The standards of the ISO/IEC 14443A standard were used as the basis for this tag. It is a simple and cost-effective tag that is ideal for use in several NFC

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 7 of 16

applications. This tag is read and read/write capable. It has no data collision protection and has a memory of 96 bytes that can be expanded to 2K bytes. It has a communication speed of 106 kbit/s. Examples of common applications of this tag are in mobile payments and connecting Bluetooth devices.

- **Type 2**: This tag is similar to the type 1 tag, albeit it is faster. It adheres to the standards outlined in the ISO/IEC 14443A document. This tag is read and read/write capable. It has anti-collision support and a memory of 96 bytes that can be extended to 2K bytes. It also has a communication speed of 106 kbit/s. Examples of common applications of this tag are in the processing of event and transit tickets.
- **Type 3:** Based on the JIS X 6319-4 standard, this tag is more prevalent in Japan.This tag is read and read/write capable. It is more expensive per tag and has a memory capacity of up to 1 M byte. It has anti-collision support and a communication speed of 212 kbit/s. Examples of common applications of this tag are in health care devices and membership cards.
- **Type 4**: This tag is also similar to the type 1 tag.It is based on the standard specifications ISO/IEC 14443A and ISO/IEC 14443B.This tag is read and read/write capable. It has anti-collision support and a maximum memory capacity size of 32k bytes. It also has a communication speed of 106 kbit/s.

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Examples of Near Field Communications

There is essentially no limit to the applications of NFC. Here are 10 examples of use cases that illustrate the potential of near-field communications:

1. Ticketing

Setting up concerts is a painstaking process for event organizers. The tedious process begins by printing out tickets and then counterchecking them. It also requires manpower, which

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 8 of 16

translates into huge costs. Consumers also report having bad experiences where the process of entry takes longer than the performance itself.

Event organizers can leverage NFC technologies to minimize the wastage of paper resources and reduce the time taken for consumers to gain entry. This makes NFC technologies eco-friendly, and they also enhance the consumer experience. Consequently, they can translate into huge cost savings. Similarly, airports, bus companies, and train stations can leverage NFC to shorten boarding time by increasing the speed and ease of counterchecking tickets, enhancing the consumer experience.

2. Contactless payments

Smartphones with NFC compatibility may replace purses, bank cards, and card payments.Contactless payments improve smart card payment systems by providing ease of use, convenience, and a more secure mode of payment. They also don't experience the wear and tear issues that come with contact smart cards. In general, cell phones require users to have a subscriber identification module (SIM) card that is used to authenticate them to a cellular network.

The SIM card contains a secure storage area that performs data encryption and decryption and provides security conditions such as requesting users to provide personal identification numbers (PINs) before authorizing transactions. This promotes secure payment transactions.The SIM card area is used by mobile network operators (MNOs) and network operators like banks to deliver mobile financial services to consumers.

The SIM card functions as a zero contact smart card while the cellphone functions as a wallet app when cellphones are used to make payments.Examples of smartphone contactless payments are Android Pay, Apple Pay, and Samsung Pay.

3. Easy data transfers

Transferring data between peers using technologies such as Bluetooth requires the communication link between the devices to be manually paired, which is a time-consuming

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Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 9 of 16

process. NFC technologies can be used to bootstrap and improve the ease of connectivity between the two devices. Files can be transferred between NFC-compatible devices by just touching both of them. Consequently, this leads to an enhanced consumer experience and reduced time wastage.

4. Electronic voting

Electronic voting provides a secure, convenient, and easy means by which a population can perform their civic duty of electing leaders. It can be used across all levels, such as college, state, or even national levels of voting. With electronic voting, more people can vote without engaging in the time-consuming process of queuing for hours, thus promoting productivity. In electronic voting, when users register their details in a secure application, they are allocated an NFC tag. They can use this tag to vote for their preferred candidate from any location. The candidate's information is also stored on an NFC tag.

5. Healthcare and fitness

With technology, people can now track their fitness levels from their smartphones with ease. For instance, FITBIT, a fitness company, incorporates NFC technology to enable users to transfer details such as the number of calories burned and the number of steps taken from their wristbands to their smartphones, where they can monitor them. Similarly, health companies that monitor sleep leverage NFC technologies in devices such as Rhythm Track to enable them to track their patients' sleep cycles and duration.

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6. World Cup tickets

Since the year 2006, the organizers of the World Cup have embedded RFID tags on their tickets. While it is more costly to embed tickets with RFID, the benefits outweigh the cost. Unlike conventional football tickets, these cannot be duplicated. This ensures that FIFA gets

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 10 of 16

the maximum benefits while avoiding issues such as double booking of seats and unauthorized entry without payment. By leveraging NFC technology, FIFA can collect useful data on spectators to analyze, such as age and gender.

7. Advertising

People can leverage NFC to scan and read information from smart posters. Smart posters store information in a scannable tag. Interested people only have to scan the posters with NFC-compatible devices to read them at their convenience from anywhere, and they do not have to attract unwanted attention while standing in front of these posters. This results in benefits for both the advertisers and the consumers. With NFC, advertisers do not have to limit the amount of information they give or worry about the size of their banners, thereby increasing the quality and quantity of information that can be exchanged.

8. Record keeping

NFC can be a useful tool for keeping records. They are less prone to human errors, more accurate, reliable, and can be easily accessible. Several sectors, such as health, supply, and logistics, can leverage NFC technologies to help them keep updated records. In the health sector, NFC tags can be created to keep records of information on the medical history of patients. In the logistics and supply sectors, NFC tags can be used to track inventory. As a result, time is saved, and resources used to document this vital information are reduced.

9. Automatic check-in systems

The hospitality industry can leverage NFC to enhance its consumer experience. For instance, they can enable their consumers to use their NFC-enabled smartphones as room keys. Incorporating NFC technology can also allow them to eliminate waiting times and standing in queues during check-in and check-out. Organizations can also use NFC to allow controlled access to certain floors and offices by their employees and visitors. They can also track working hours and entry and exit times without being intrusive. Governments and

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 11 of 16

private road owners can also leverage NFC technology to allow controlled road access at unmanned toll stations.

10. Home automation

Owners of smart homes can leverage NFC technology to easily connect new devices to their existing ones. With NFC, new devices can easily be configured to coexist with existing home settings. Recalling passwords each time before accessing restricted devices at home can be a hassle, and can also engender password security. Smart homeowners can easily and securely access them with no need to recall all the passwords. Similarly, NFC tags can be configured to enable users to set alarms, call specific contacts, or even open doors and windows.

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Takeaway

NFC, or near-field communication, has existed for some time, but it has only just come into its own. During the pandemic, NFC enabled safe and contactless payments, which is why its use has surged across the world.

According to a 2022 study by ABI Research, 85% of consumers across nine countries have used NFC. It is particularly important when one considers the rise of the Internet of Things, marked by smart homes, 100% automated stores, and intuitive services. As a result, organizations should prepare NFC implementation, which could simplify and automate several tasks within the local network.

Did you find this article helpful in your research on NFC? Tell us on Facebook, Twitter, and LinkedIn. We'd love to hear from you!

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 12 of 16

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Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 13 of 16

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Table of Contents

- What Is NFC (Near Field Communication)?
- How Does Near-Field Communication Work?
- Examples of Near Field Communications

Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 14 of 16

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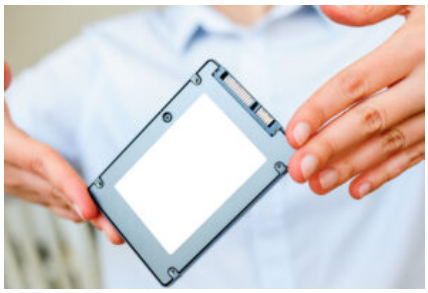

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Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 15 of 16

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Telcom Ventures Exhibit No. 2011
Samsung Elec. v. Telcom Ventures LLC
IPR2025-00975, U.S. Patent No. 9,832,708
Page 16 of 16