Near Field Communications: The Current Path and the Road Ahead
Near field communications (NFC) is a wireless communications technology protocol that enables devices positioned in close proximity to one another to share information. Because it is generally more secure than other wireless technologies, NFC has been widely adopted as a protocol for financial and payment applications. However, the future for NFC-enabled technologies extends beyond financial transactions to encompass a host of additional uses, including wearable technologies, secured location access, transportation applications and even improved healthcare delivery. As such, devices incorporating NFC technologies are poised for explosive growth in the years ahead.

This UL white paper provides an overview of NFC technology, its benefits and its potential future uses. Beginning with a brief review of the technical foundations of NFC, the paper identifies the current and anticipated uses for devices incorporating NFC technology as well as the projected market growth of NFC-based applications. The paper then reviews the requirements of standards applicable to NFC-equipped devices, and concludes with some recommendations for manufacturers seeking to leverage NFC technology in their products.

**How Does NFC Technology Work?**

NFC-enabled devices operate on the carrier frequency of 13.56 MHz, a segment of the electromagnetic spectrum reserved worldwide for unlicensed use by industrial, scientific and medical (ISM) electronic devices. Historically, ISM frequencies have been utilized primarily by devices that generate powerful electromagnetic emissions, and that are therefore typically immune to electromagnetic interference. However, more recently, ISM spectrum has been allocated for use by low power communications technologies, such as wireless local area networks and cordless phones.

NFC works through the process of electromagnetic induction. In electromagnetic induction, a device emits a small electrical current to create a magnetic field that bridges the physical gap with another device in close proximity and enables the transmission of data. At the other end, the receiving device converts the magnetic transmission back into electrical impulses so that the data can be decoded and verified.

Unlike other wireless communications protocols that rely on radio transmissions instead of electromagnetic fields, NFC is intended for use between devices that are within close proximity to each other. The maximum operating range for NFC-enabled devices is less than 20 centimeters (less than eight inches), although the optimum operating distance is typically about 4 centimeters (about one and a half inches). This compares with Bluetooth-enabled devices, designed to communicate at distances of 10 meters or more, and Wi-Fi-based communications devices that can operate at distances of more than 100 meters.

The limitations in their effective operating range help to make NFC-enabled devices inherently more secure than those utilizing other communications protocols. Further NFC devices transmit data at relatively low rates, generally from 106 to 424 kilobits per
second, and use less than 15 milliamps of power. These lower data transmission rates can result in reduced energy requirements to assure accurate and complete communications.

NFC-enabled devices are typically designed to operate in one or more of the following three modes:

- **Card emulation mode**—In card emulation mode, an NFC device acts much like a smart card, and can be used to store data, to conduct transactions such as contactless payments or to gain access to secured areas like hotel rooms.

- **Reader/writer mode**—In this mode, an NFC-enabled device can detect and read information stored on external, NFC-compatible tags, such as those embedded in labels or on smart posters.

- **Peer-to-peer mode**—In peer-to-peer mode, an NFC device can communicate with other NFC-enabled devices in close proximity to quickly exchange data as well as confidential and/or private information.

Some advanced NFC devices, such as the current generation of smartphones and tablets, are capable of working in all three modes. At the same time, dedicated NFC tags and sensors typically operate exclusively in read-only mode. This flexibility provides manufacturers with the freedom to design NFC-enabled devices in accordance with the specific requirements of unique applications, fostering the development of new NFC-based products and supporting the deployment of the Internet of Things (IoT).

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**Current and Anticipated Uses for NFC**

As a communications protocol, NFC is particularly well-suited for use in a number of diverse applications where close proximity between NFC-enabled devices is predictable. Current and anticipated uses of NFC technology today include applications in the following areas:

- **Payment transactions**—Perhaps the most widespread current use of NFC can be found in contactless payment devices, such as key fobs, cards and readers. These devices enable consumers to quickly and securely process payments for purchases, enhancing self-service options and reducing staffing needs.

- **Wearables**—NFC is a primary communications protocol used in wearable technologies, including smart watches and wrist bands, shirts, caps and other apparel items, and tracking and location devices. NFC technology is even being explored as a possible mechanism for wirelessly charging wearable devices and apparel.

- **Access control**—NFC-enabled devices are already being used to provide users with access to secure areas, such as office buildings and parking garages. For example, some institutions have implemented NFC-based identification systems that provide students with building access and even allow them to pay for meals, all with a single, NFC-enabled identification card. More advanced NFC access control applications allow users to lock or unlock computers and other electronic devices containing private or confidential information.

- **On-demand information retrieval**—When installed in retail settings, NFC technology can help consumers instantly retrieve product information and specifications from point-of-sale...
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displays without assistance from sales personnel. For retailers, NFC tags issued to frequent customers can be used to collect shopping data and to incentivize specific purchasing behaviors. On the street, NFC-enabled posters can provide directions to places of interest, or detailed information about real estate listings.

- **Workplace collaboration**—NFC short range communications are ideal for exchanging content between devices in close proximity. In meetings, for example, participants can quickly share and review important documents without the need to print out paper copies. This capability can help to foster greater and more timely collaboration between employees, increasing the speed of decision-making and other action steps.

- **Travel**—Passports, other forms of personal identification and plane tickets can be easily and conveniently stored on NFC-enabled devices and presented as required. In fact, some airlines are already experimenting with the use of electronic boarding passes sent to NFC-enabled smartphones for efficient scanning and processing. These applications can help speed passage through travel portals and customs, and facilitate reticketing when necessitated by itinerary changes in route.

- **Healthcare**—Perhaps the most promising applications for NFC technology are in the field of healthcare. NFC-enabled applications include sensors that make it easier for patients to check in for examinations or renew prescriptions. In more complex applications, NFC-enabled diagnostic tags can monitor a patient’s vital signs such as body temperature or blood glucose levels, with information directly accessible by health care professionals. NFC tags can also be affixed to patients’ charts to provide direct access to their medical records for more efficient retrieval by physicians. These and other applications can help to increase the efficiency of care and reduce mistakes.

Beyond these applications, using NFC-enabled tags can considerably expand the usefulness of NFC technologies. Some creative and practical examples include:

- **At home**—An NFC tag positioned near the main entrance can change smartphone settings for home use, such as disconnecting Bluetooth connections, enabling Wi-Fi, and increasing the ringer volume.

- **At the gym**—When attached to a sports equipment bag, an NFC tag can be set to automatically switch a smartphone to “do not disturb” mode and queue up a favorite music playlist.

- **In the car**—Similarly, an NFC tag can be programmed to activate Bluetooth connections with an automobile’s sound system and to play podcasts or audio books.

- **In the office**—An NFC tag positioned at a workstation can automatically mute a smartphone or place it in vibrate only mode. The tag can also be programmed to launch specific work-related applications.

- **In your wallet**—Instead of carrying paper business cards, an NFC tag can be programmed to contain all relevant contact information and instantly scanned by others. Physical business cards with embedded NFC chips can help recipients locate your website, or download information.

- **At nighttime**—Finally, NFC-enabled tags in the bedroom can easily switch a smartphone to “do not disturb” mode, set a wake-up alarm, and dim the lights.
These are just some of the many examples of how NFC technology is currently being applied to create greater efficiencies, improve the flow of information and enhance people’s lives. No doubt, the future will see a continued explosion in the development of applications that leverage NFC protocols.

The Projected Market for NFC Technologies

The promise of significant future growth in NFC-enabled technologies is borne out in market projections. Overall, the market for NFC is expected to grow at a compounded annual growth rate (CAGR) of more than 43 percent by 2019, from just $1.07 billion (USD) in 2012 to more than $13.5 billion (USD) in 2019. This projection parallels a separate estimate of a more than 50 percent CAGR during the same period for NFC chips, the integrated circuitry incorporated into mobile devices and point-of-sale terminals to support NFC capabilities.

The future expansion of the NFC market forecasted in these projections is predicated in part on the continued growth in the number and type of NFC-enabled devices. Annual global shipments of smartphones equipped with NFC technology are expected to top 2.2 billion by the year 2020, up from just 750 million projected shipments in 2015. And NFC-equipped smartphones will constitute 64 percent of all smartphones shipped by 2018, up from just 18 percent penetration in 2013.

Contactless payments using NFC technology will also continue to be a major driver in market growth, as the technology becomes more widely available through retailers, and more and more consumers become comfortable using NFC-based payment options. According to one projection, at least five percent of the nearly 650 million NFC-enabled smartphones will be used at least once a month to make contactless payments at retail outlets by the end of 2015. This is a 10 fold increase over the percentage of NFC-enabled smartphones making contactless payments in mid-2014.

These statistics provide strong evidence of the major market opportunities that NFC technology is expected to provide in the near future to manufacturers and application developers.

NFC Standards and Specifications

Internationally-accepted standards for NFC communications protocols and data exchange formats include the following:

- ISO/IEC 18092/ECMA-340, Near Field Communication Interface and Protocol (NFCIP-1)—These identical standards define NFC communications modes, including modulation schemes, codings, transfer speeds and frame format of the RF interface. The standards also define initialization schemes, and a transport protocol that includes activation and data exchange methods. The current versions of these standards were published in 2013.

- ISO/IEC 21481/ECMA-352, Near Field Communication Interface and Protocol-2 (NFCIP-2)—These identical standards specify the technical mechanism required to detect and select the appropriate communication modes required to reduce the potential for interference with other NFC-enabled devices, such as contactless card readers. The current version of ISO/IEC 21481 was published in 2012, while the current version of ECMA-352 was published in 2013.

These standards are based on the current radio frequency identification (RFID) standard, ISO/IEC 14443, Identification cards—Contactless integrated circuit cards—Proximity cards, as well as the technical requirements of Sony Corporation’s FeliCa RFID smart card system. As a result, devices compliant with ISO/IEC 18092 and ISO/IEC 21841 are backward compatible with RFID systems, potentially providing broader and more rapid acceptance in the marketplace.

In addition to these internationally-accepted standards for NFC technologies, the NFC Forum has been in the forefront of developing NFC technical specifications for more than a decade. Originally formed in 2004 by Nokia, Sony and Philips Semiconductors, the NFC Forum now includes hundreds of member companies and organizations from around the world committed to expanding the deployment of NFC technology by developing and promoting interoperability specifications for most NFC devices and applications.

At present, there are 20 adopted specifications that have been developed by the NFC Forum, as well as an additional four candidate specifications awaiting final adoption by Forum membership.
These specifications include protocol technical specifications, data exchange specifications, tag type technical specifications, record type technical specifications and reference application technical specifications. Specifications and requirements applicable to specific devices are set forth in the current version of the NFC Forum’s Device Requirements document (v1.3, effective January 2014).

The NFC Forum also maintains active relationships with other groups and consortiums involved in the development of standards and technical specifications for wireless technologies and their application. These groups currently include the Wi-Fi Alliance, the Bluetooth Special Interest Group (SIG). The NFC Forum also works closely with consortiums focused on industry-specific applications of NFC, such as the EMVCo (credit cards and credit card terminals), the Consumer Electronics for Automotive (CE4A) Consortium and the Japan Automotive Software Platform and Architecture (JASPAR) Consortium. These alliances allow the NFC Forum to closely coordinate its own specification development efforts with those addressing complementary technologies.

**NFC Forum Certification**

In addition to developing technical specifications for NFC technologies, the NFC Forum sponsors a voluntary certification program for NFC-enabled devices and applications. The purpose of the certification program is to provide manufacturers and developers with a mechanism for formally demonstrating their product’s compliance with NFC Forum specifications and requirements. In this way, certification fosters the broader adoption of the technology and further supports the goal of universal interoperability.

Products seeking NFC Forum certification are evaluated by Forum-authorized testing laboratories located around the world for compliance with NFC Forum specifications, including radio frequency and protocol interoperability. Companies whose products are found to meet specification requirements as a result of this evaluation and testing are then authorized to display the NFC Forum Certification Mark on product packaging, as well as on sales and promotional materials. NFC Forum-certified products are also eligible to apply the Forum’s N-Mark to their product to indicate the contact point on the product that will trigger a connection with other NFC-enabled devices.

NFC Forum certifications are granted for the life of the product, and subsequent recertification is necessary only when a change in the product’s design affects its radiofrequency interoperability. In addition, specific NFC protocols for digital, LLCP and SNEP that have been used within a previously certified product can also be “inherited” for use in a second product without the need for additional testing (analog test results from a previously certified product cannot be inherited).

A list of all NFC Forum-certified products are maintained in a publically-accessible directory available at the NFC Forum website (www.nfc-forum.org).

Only companies who are members of the NFC Forum are eligible for testing and certification under the Forum’s certification program. However, the goals of the NFC Forum’s certification program are complemented by regularly scheduled NFC Forum-sponsored “Plugfest” events, which are open to both members and non-members of the Forum. At Plugfest events, product developers can evaluate and verify the interoperability of their product with other NFC-enabled products and technologies, in a safe testing environment that simulates real-world conditions.

**Summary and Conclusion**

The market for NFC technologies will grow dramatically in the coming years, driven by the broader use of NFC in more diverse applications, an increase in the overall number of NFC-enabled devices, and greater acceptance by consumers. At the same time, demonstrable interoperability with existing NFC technologies will be critically important for companies seeking to take advantage of market opportunities in this area. Therefore, thorough pre-market testing is highly recommended as a method for determining compliance with applicable standards and specifications. NFC Forum certification can also provide prospective customers with documented evidence of interoperability with other NFC technologies, and may be a prerequisite for meeting NFC technology partner requirements.

Through its active participation in the NFC Forum, UL is committed to the continued development and widespread deployment of NFC technologies in support of the Internet of Things (IoT) ecosystem. UL senior technical experts...
serve in key leadership positions in NFC Forum technical working groups, marketing working groups and Tiger Teams, including the NFC PlugFest working group and the Minimum Level of Interoperability working group, as well as the Healthcare Use Case Committee and the Automotive Committee. UL is also involved in the Forum’s Certification Committee, specifically in the areas of NFC Functionality and Bluetooth Connectivity Testing.

UL is also one of just two NFC Forum-authorized testing laboratories in North America, authorized to test and certify technologies for compliance with all NCF protocols, including RF analog, digital, LLCP and SNEP. UL can also conduct NFC tag type testing, and provide device manufacturers with engineering evaluations and pre-testing for products under development. Finally, UL has extensive experience with wireless and contactless technologies, and can conduct compliance testing at locations through North America, the European Union and Asia.

References


