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Near Field Communication in Medical Devices

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Abstract

Near Field Communication (NFC) is a wireless communication standard which enables two devices in a short range to establish a communication channel within a short period of time through radio waves in the 13.56 MHz frequency range. NFC can be a useful technology for data transfer between two devices in close proximity to one another. Because it needs the two devices to be in close proximity to one another (less than 10 cm), it is more secure than other wireless technologies like Bluetooth and Wi-Fi. Hence, it can be seen as an easy and secure tool for establishing quick two-way connections for data transfer. While the biggest differentiating factor for NFC over RFID is that it is a two-way communication tool, one of the devices/cards can have a passive NFC tag which can reduce the cost and still behave in the same way as any other RFID tag.

This technology is being increasingly adopted for use in wireless transactions, including money transfer, loyalty coupons, transit passes, tickets, etc. Mobile handset manufacturing companies are increasingly integrating NFC hardware in their phones. Not surprisingly, it is gaining traction in the field of medical devices and electronic health records. However, there are certain challenges that NFC faces in this field, restricting widespread adoption of the technology. This paper looks into the details of this technology, its advantages and disadvantages over existing solutions, and the feasibility of its usability in this highly-regulated area.

Abbreviations

Sl. No.	Acronym	Full Form
1	NFC	Near Field Communication
2	RFID	Radio Frequency Identification
3	ISO	International Organization for Standardization
4	ETSI	European Telecommunication Standard Institute
5	kbps	Kilobits per second
6	MEF	Mobile Entertainment Forum
7	OEM	Original Equipment Manufacturer
8	M2M	Machine to Machine
9	FDA	Food and Drug Administration
10	ECG	Electrocardiogram (also EKG)
11	COPD	Chronic Obstructive Pulmonary Disease

- Near Field Communication standards were first developed by NFC forum which was founded by a consortium of Nokia, Sony and Philips in the year 2004.
- NFC can be a useful technology for intuitive data transfer between two devices in close proximity to one another.
- Frost & Sullivan expects mobile payments through NFC to reach $111.19 billion by 2015 which is a staggering growth rate of 118% compounded over 5 years between 2010 and 2015.

History and Market Trends

Near Field Communication (NFC) standards were first developed by the NFC forum, which was founded by a consortium of Nokia, Sony and Philips in the year 2004. It is a wireless communication standard using radio frequency waves. The devices use the 13.56 MHz frequency which enables short-range data transfer and communication. NFC transfers data at speeds ranging from 106 Kbit/s to 424 Kbit/s, depending upon the protocol used. The devices should be in close proximity to one another to enable communication. The range may vary depending upon the device form, casing and the antennae size, but it is less than 10 centimeters (usually less than 4 cms). The link is established in a very short period of time, ranging from 100-150 milliseconds.

These characteristics differentiate it from other wireless communication technologies like Bluetooth and Wi-Fi. NFC can be a useful technology for intuitive data transfer between two devices in close proximity. It is also more secure and easier to use in applications like contactless money transfer and ticketing, where security and turnaround times are respectively of prime importance.

NFC can also be used in a single way communication mode when using a passive NFC tag. This will reduce the cost of the system and will be suitable for use cases where a RFID tag is used currently.

The market for NFC is continuosly expanding in both active and passive form. Cell phones are turning out to be the largest adopters of NFC technology in peer-to-peer mode. According to Frost & Sullivan, the number of mobile phones which have adopted NFC will increase to 863 million by 2015, which will account for 53% of total mobile phone sales [1]

Apple's non-adoption of NFC in its iPhone 5 has pushed its competitors like Samsung, Nokia and Microsoft to redouble their efforts to incorporate the technology in their phones to differentiate them from the iPhone [2], which is the largest selling smartphone in the world as of Q4 2012 [3]. Frost & Sullivan expects mobile payments through NFC to reach $111.19 billion by 2015 which is a staggering growth rate of 118% compounded over the five years between 2010 and 2015 [1].

- The NFC card has the flexibility to be either active or passive, depending upon its use
- It is more secure than other wireless connectivity protocols like Bluetooth, Wi-Fi, etc.
- NFC is more intuitive, and hence, more suitable for transactions like ticketing and money transfers
- NFC is much more practical for devices for which power consumption is an overriding priority
- The time taken to establish a connection through NFC is on the order of 100ms

Advantages of NFC

NFC-based communication involves an NFC-enabled card and a card reader. The card reader generates a radio frequency field in the 13.56 MHz frequency that can communicate to the card which can be either self-powered or can power itself from the RF waves generated by the reader. This gives the card the flexibility to be either active or passive, depending upon its use. In the active mode, the two devices can engage in a dynamic transfer of data (collection and transmission). In the passive mode, the card reader will be powered only when it makes contact with an active NFC reader. This flexibility allows the card/device holding the passive tag to take a simple and cost effective form factor, just like any other RFID tag.

NFC is also more secure than other wireless connectivity protocols like Bluetooth, Wi-Fi, etc. A connection can be enabled only if the two devices are brought close to one another. This property makes a transaction or data exchange less prone to hacking by a third party. Hence, NFC as a wireless standard will be more acceptable to companies involved in money transactions than other wireless technologies.

NFC is more intuitive, and hence, more suitable for transactions like ticketing and money transfers. It just needs the card and the reader to be brought close to one another. That is more convenient and easy to understand than swiping, choosing from a menu or entering a password. Since it is also based on universally followed standards like the ISO and ETSI (European Telecommunication Standard Institute), interoperability with other existing wireless technologies is not a problem. In fact, NFC, which is inherently more secure, can be used as the identification and authentication procedure for a Wi-Fi or Bluetooth connection to be established for higher data transfer speeds. Craig Ochikubo from Broadcom calls it “Simplified Connectivity” [4].

Another advantage of NFC is that it was purposefully built with lower transfer speeds of 106 kbps to 424 kbps so it consumes less battery. Hence, this is much more practical for devices for which power consumption is an overriding priority. For example, NFC can be a natural choice for an implantable medical device which needs to communicate to an outside device.

The time taken to establish a connection through NFC is on the order of 100 milliseconds, which is much better than other competing technologies which take a few seconds to establish a connection.

- NFC can easily fit the profile of wireless channel for implantable medical devices as it needs to be highly energy efficient and conserve as much power as possible.
- NFC protocol can be used as an aunthetication procedure before other wireless standards take over the function of actual data transmission at higher transfer speeds
- NFC is more intuitive and easy to understand for elderly patients

Benefits of NFC in Medical Devices

Healthcare is seeing a growth of M2M connectivity in its medical devices. As these devices become smart and interconnected, there will be an increase in the demand for data transfer between devices which are present outside the body (In Vitro) and inside the body (In Vivo).

In medical devices domain, the need for a secure communication channel cannot be over-stressed, and it is an overriding priority. Hence, NFC becomes the natural choice for wireless communicating between two medical devices. The FDA and other regulatory bodies are also quite vigilant regarding the security aspects of the devices that must be approved before hitting the market.

Further, the data size generated by medical devices is usually within the capability of NFC to transmit without any undue delay, so it can easily fit the profile for a wireless channel for medical devices. Even if there is a requirement for data transfer rates exceeding its capacity, the NFC protocol can be used as an authentication procedure before other wireless standards take over the function of actual data transmission at higher transfer speeds.

There are a lot of medical use cases, such as implanted devices which reside in the body for years, and have to be highly energy efficient and conserve as much power as possible. NFC protocols are well suited for such applications, as the reader can activate the tag only when necessary and can also transfer power wirelessly.

NFC brings mobility and versatility to a range of medical and lifestyle devices and is perfectly suited for home-based disease monitoring and management. NFC is also more intuitive and easy to understand for elderly patients, making it easier for adoption and usage than other wireless technologies.

Since NFC in its passive form acts just like any other RFID tag, it can be used to keep tabs on pill boxes, blisters and other drug dispensing solutions. This utility has good scope for compliance monitoring, and anti counterfeiting measures particularly for the elderly and for pharmaceutical companies doing clinical trials.

The benefits of NFC are not restricted to small, implantable devices alone. Large devices used for In Vitro Diagnostics (IVD), imaging, molecular diagnostics and other applications can also use NFC for wireless data transmission. Specific use cases for NFC in the medical space will be looked into in later sections.

- The low data transfer speeds exclude them from applications like media streaming that are possible with other technologies
- The range of the devices is limited to 10 cms
- NFC security is not foolproof. Hackers were able to gain full control of the target device and run malicious codes
- NFC is also viewed with skepticism by some industry leaders and opinion makers

Drawbacks of NFC

Some of the advantages listed in the previous section can sometimes turn into disadvantages for NFC. For example, the low data transfer speeds exclude them from media streaming applications like tomographic imaging, digital pathology, etc., that are possible with other technologies.

Although it is more secure, the short range of 10cms can be a disadvantage. Further, the security, while highly resistant to traditional hacking methods, is not foolproof. It has been demonstrated that smartphones with NFC can be hacked into. Hackers were able to gain full control of Android-based smartphones and run malicious code on them. [5]

Another disadvantage of NFC is that, in case passive tags are being used, it needs to be powered by an external reader which can lead to higher power consumption than Bluetooth Low Energy. [6] These disadvantages can be potential roadblocks for adoption of NFC in implantable medical devices where security is paramount, and communication has to reliable over longer distances, particularly if the implanted devices are placed deep in the body, e.g. implantable defibrillators, etc.

Also, in some use cases like compliance monitoring, if a passive NFC tag is used, it offers very little advantage over an RFID tag which is much cheaper.

Skepticism

NFC is also viewed with skepticism by some industry leaders and opinion makers. According to PayPal President David Marcus, NFC doesn't offer any advantage over traditional methods like swiping a credit or debit card. [7]

Similarly, the Mobile Entertainment Forum (MEF) predicted that NFC will fail to have a significant commercial impact in 2012. [8] Another skepticism is that NFC-based mobile wallets won't take off until NFC readers are installed in a significant number of stores. [9]

However, these predictions are based on the fact that NFC is not being adopted by mobile phone OEMs, and not due to any inherent disadvantage of NFC per se.

The Sony Corporation has developed an NFC Healthcare Library which enables communication between healthcare products embedded with the NFC Dynamic Tag (FeliCa Plug) and healthcare applications installed on smartphones.

Medical Use Cases of NFC

As mentioned in the previous section, there are a lot of use cases for NFC in medical devices and healthcare.

The possible areas include monitoring and management of home-based care. The application may include monitoring systems for a variety of chronic diseases, including but not limited to diabetes, hypertension, cardiac diseases (infarctions, heart failure, arrhythmias and other rhythm abnormalities), pulmonary diseases like asthma and COPD, and neurological abnormalities like seizures, chronic renal failure, etc.

For example, a biometric device called “MiniME” developed by Ergonomidesign monitors various vital parameters like ECG, blood pressure, heart rate, pulse oximetry, body temperature, blood glucose, cholesterol, hemoglobin and prothrombin time, and transmits the data using NFC to the cloud. [10]

Another company working on medical devices with NFC embedded in them is Impak Health. They are involved in home-based cardiac, pulmonary and sleep monitoring. They have incorporated NFC in devices such as “RhythmTrack” that tracks a person’s ECG, and “SleepTrack,” which tracks the sleep cycle and duration. Similarly, FITBIT – a fitness monitoring company – has incorporporated NFC for transferring details like calories burned, number of steps taken and other details from a wristband to the user’s smartphone which houses a user-friendly application. [11]

Gentag, a company specializing in mobile health, is using NFC to transfer data from devices ranging from diagnostic assays to skin patches. [12]

The concept of home-based healthcare using NFC doesn’t end there. Nedap, a Netherlands-based security and identification specialist, has rolled out 50,000 NFC phones for nurses. They are used for recording home visits for the elderly [13]. A similar phenomenon is seen in France. too [14].

NFC is becoming widely accepted for medical devices in some markets like Japan. Sony Corporation has developed an NFC Healthcare Library which enables communication between healthcare products embedded with the NFC Dynamic Tag (FeliCa Plug) and healthcare applications installed on smartphones [15]. This library is available free of charge for a number of OS, including Windows, Linux and Android. Companies like Omron, Terumo and A&D are incorporating Sony’s solution into their devices like BP monitors, pedometers, blood glucose meters, etc. [16].

Various other companies like Qolpac and Identive WPG have brought NFC into the mainstream with uses ranging from medication compliance to X-ray image sharing [17,18].

Conclusion

NFC is a wireless, short-range communication standard using radio frequency waves in the 13.56 MHz frequency range. NFC transfers data at speeds ranging from 106 Kbit/s to 424 Kbit/s between devices that are less than 10 cm from each other. NFC is now attracting attention from medical device manufacturers and other healthcare companies for use in their products.

There are quite a few promising areas where NFC technology has a distinct possibility of breaking into the big league. Characteristics like high security and low battery consumption, along with the option to remain passive, are big advantages for applications in the medical device domain. It is also more intuitive, making it a good candidate for use in the home-based monitoring and management domain, particularly among the elderly. While it is still at the fringes and is waiting for its big break, NFC is being increasingly adopted by a number of organizations.

However, a few pain points remain which have to be addressed before that happens. The adoption of NFC-enabled phones and NFC readers has to proliferate to have any meaningful impact. Certain security-related concerns need to be allayed and the solutions developed around NFC have to be demonstrably secure. Further, there is some skepticism among industry leaders and thought makers that NFC doesn't offer any significant advantage over the present technology

Taking all these factors into consideration, it is reasonable to conclude that:

1. NFC is a promising technology. It has been around for quite a few years, but its adoption in mobile and other devices can be described as moderately successful at best, and disappointing at worst.

2. There are certain characteristics of NFC which give it a distinct advantage for use in medical device applications. NFC is inherently more secure and consumes less battery than other comparable wireless technologies.

3. Therefore, NFC is becoming more popular and is being increasingly used in the medical device domain.

4. However, there is no pathbreaking difference between current technology and NFC which will revolutionize the field and change the way healthcare is consumed.

5. Hence, we predict accelerated adoption of NFC in medical devices where this technology will help increase the security and ease of data transfer between medical devices, but it may not revolutionize the field by bringing the costs down or improving the reach of technology.

References

[1] Frost & Sullivan's Digital Identification Research and Consulting Practice. Retrieved on 15th March 2013 from http://www.frost.com/prod/servlet/svcg.pag/AEST

[2] "Near Field Communication slips, slowly, into the mainstream" By Mary Catherine O'Connor. Published in Smart Planet. Retrieved on 15th March 2013 from http://www.smartplanet.com/blog/report/near-field-communication-slips-slowly-into-the-mainstream/257

[3] "Apple's iPhone No. 1 in Smartphone Sales" By Connie Guglielmo. Published in Forbes. Retrieved on 15th March 2013 from http://www.forbes.com/sites/connieguglielmo/2012/02/15/apples-iphone-no-1-in-smartphone-sales/.

[4] "Near Field Communications: More Than Mobile Payments". Guest post written by Craig Ochikubo, VP and General Manager for wireless personal area networking for Broadcom. Published in Forbes. Retrieved on 15th March 2013 from http://www.forbes.com/sites/ciocentral/2012/05/16/near-field-communications-more-than-mobile-payments/.

[5] "Black Hat 2012: On-stage NFC hack highlights NFC security issues" By Michael S. Mimoso. Published in Search Security. Retrieved on 15th March 2013 from http://searchsecurity.techtarget.com/news/2240160292/Black-Hat-2012-On-stage-NFC-hack-highlights-NFC-security-issues

[6] "Near Field Communication (NFC)" By Joseph Zaloker. Page No.5 of 5. Retrieved on 15th March 2013 from http://www.arrownac.com/solutions-applications/machine-to-machine/files/atd-nfc.pdf

[7] "Looking Ahead to 2013" By David Marcus. Publsihed in The Paypal Blog. Retrieved on 15th March 2013 from https://www.thepaypalblog.com/2012/12/looking-ahead-to-2013/

[8] "MEF's Top Prediction: NFC will fail to have a Significant Commercial Impact in 2012 despite increased Investment and Spectacular Trials". Retrieved on 15th March 2013 from http://www.mediabuzz.com.sg/asian-emarketing/january-2012/1466-mefs-top-prediction-nfc-will-fail-to-have-a-significant-commercial-impact-in-2012-despite-increased-investment-and-spectacular-trials

[9] "The Ever-Elusive Mobile Wallet: Why NFC Chips Are Overhyped And Will Underdeliver". By Erick Schonfeld. Published in Tech Crunch. Retrieved on 15th March 2013 from http://techcrunch.com/2011/03/16/mobile-wallet-nfc-overhyped/

[10] The World's Most Personalised Medical Device". Ergonomidesign. Retrieved on 15th March 2013 from http://www.ergonomidesign.se/CASES/Interaction-Design/miniMe-Personalised-Medical-Device-of-the-Future.aspx

[11] FitBit Flex. Retrieved on 15th March 2013 from http://www.fitbit.com/flex

[12] Gentag Applications. Retrieved on 15th March 2013 from http://www.gentag.com/applications.html

[13] "50,000 Dutch nurses now using NFC phones". By Sarah Clark. Publsihed in the NFC World. Retrieved on 15th March 2013 from http://www.nfcworld.com/2011/09/06/39716/50000-dutch-nurses-now-using-nfc-phones/

[14] "French carers to use NFC". By Mike Clark. Published in the NFC World. Retrieved on 15th March 2013 from http://www.nfcworld.com/2012/11/12/321066/french-carers-to-use-nfc/

[15] Sony Healthcare Library. Retrieved on 15th March 2013 from http://www.sony.net/Products/felica/business/products/NFC_healthcare.html

[16] Sony Felica in Use in Healthcare Devices. Retrieved on 15th March 2013 from http://www.sony.net/Products/felica/casestudy/healthcare.html

[17] Qolpac Products. Retrieved on 15th March 2013 from http://www.qolpac.com/what-we-do.html

[18] "Identive and WPG Americas Team to Deliver NFC Pairing Solution for Transferring Medical X-Rays". Retrieved on 15th March 2013 from http://www.identive-group.com/en/updates-and-news/press-releases/2012/identive-and-wpg-americas-team-to-deliver-nfc-pairing-solution-for-transferring-medical-x-rays

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