Technological diffusion of near field communication (NFC)

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Table of Contents

International Journal of Technology Diffusion
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Research Articles

1  DCT Image Steganography Analysis for Privacy Preserving Data Mining
Sahar A. El-Rahman Ismail, Benha University, Cairo, Egypt and Princess Nora bint Abdul Rahman University, Riyadh, Saudi Arabia
Dalal Al Makhdhub, Princess Nora bint Abdul Rahman University, Riyadh, Saudi Arabia
Amal A. Al Qahtani, Princess Nora bint Abdul Rahman University, Riyadh, Saudi Arabia
Ghadah A. Al Shabanat, Princess Nora bint Abdul Rahman University, Riyadh, Saudi Arabia
Nouf M. Omair, Princess Nora bint Abdul Rahman University, Riyadh, Saudi Arabia
Rawan S. Alomerini, Princess Nora bint Abdul Rahman University, Riyadh, Saudi Arabia

10  Social Network Service for Scientists Difficulties Facing E-Publishing over Cloud Computing
Evon M. O. Abu-Taieh, Computer Information Systems Faculty, The University of Jordan - Aqaba, Aqaba, Jordan

21  The Application of Instagram as a Promotional and Communication Tool by Productive Families in the Kingdom of Bahrain
Amera H. Abdulrazzaq, Information Technology College, University of Bahrain, Zallaq, Bahrain
Sharifa Hamad, Information Technology College, University of Bahrain, Zallaq, Bahrain
Marwa Ali, Information Technology College, University of Bahrain, Zallaq, Bahrain
Fatima Mohammed, Information Technology College, University of Bahrain, Zallaq, Bahrain
Walaa S. Kamal, Information Technology College, University of Bahrain, Zallaq, Bahrain

33  Maximising Value Through IT and Business Alignment: A Case of IT Governance Institutionalisation at a Thai Bank
Abrar Haider, University of South Australia, Adelaide, Australia
Sureerat Sae Tang, University of South Australia, Adelaide, Australia

59  Technological Diffusion of Near Field Communication (NFC)
Tom Page, Loughborough University, Loughborough, UK

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Technological Diffusion of Near Field Communication (NFC)

Tom Page, Loughborough University, Loughborough, UK

ABSTRACT
Near Field Communication (NFC) is increasingly being employed in modern consumer devices and until now it has been used for mobile payments. However, on further investigation there are other areas where NFC has a key role. Recent developments in Medical and ticketing based NFC applications show promise for being the so called “Catalyst” for NFC’s integration. The objective of this research was to determine if mobile payments will be the catalyst for a more widespread integration of NFC into society and how NFC technology will impact on everyday life. Research Methods comprised questionnaire and interviews to gain further insight into the current standing of NFC. The findings indicated that NFC will not mature enough to be classified as viral by 2016, especially with contactless payments as no decisions seem to have been made for any progression. It is that most likely outcome that NFC will mature enough at the very latest in 2018, with further development in the years to come for unique serialisation and the internet of things. Managerial implications for this research extend to the medical sector where large gains can be made in better patient care and remote diagnostics leading to a more efficient service.

KEYWORDS
Mobile Payments, Near Field Communication, NFC, Serialisation, Technological Diffusion

INTRODUCTION
This research examines the present uses of NFC technology and how its application is likely to develop in the future. It has been suggested that NFC will increasingly be used for mobile payments and this will be the catalyst for its diffusion. This paper sought to identify the drivers behind NFC’s growth. This paper attempts to answer the following questions.

- How does NFC compare to other similar technologies?
- What can NFC enable currently and what may it offer in the future?
- What factors will determine NFC’s rate of diffusion?
- Is the expectation correct that contactless payments will form the catalyst for NFC integration?

LITERATURE REVIEW
NFC is a subset of Radio Frequency Identification (RFID) that works at close range to form a connection between two devices almost instantly. This technology first appeared in 2006 (The NFC Times, 2011) after significant work from the NFC forum. The technology was first developed to enable secure mobile payments and ticketing applications. It works by magnetic induction over a range of 10cm. This is shorter than typical RFID interactions, lending itself to “touch and go” type
interactions. Figure 1 shows examples of NFC tags. These include mainly stickers, a key ring and a pen but there are many more applications which will be shown through this paper. These can be attached to everyday items, enabling product interactions.

NFC is a way to form connections wirelessly between two devices and whilst there are many other ways to do this, the three technologies closest linked with the area NFC is operating in are outlined and are compared in terms of their main features in the following sections. Bluetooth is a standard wireless connection type that is used commonly to link mobile devices to other devices such as speakers, wireless headphones and is also used in computers for wireless keyboards and mice. The system is very secure, usually needing a pin code, meaning that the time to make a connection is longer. Transfer speed is high compared to NFC at 721Kbps (Kumar, 2010) (Noor, 2009) and at a range of thirty metres maximum it is a very powerful tool.

QR codes work on a similar process to barcodes, and require an optical or infrared scanner to obtain the information. They are inexpensive and easy to produce and can be printed rather than applied before and after printing. However, scanning can be difficult and they rarely contain enough information to be useful on their own therefore, a URL usually is stored. This is the main competition to NFC for the advertising markets. An example is shown in Figure 2.

It needs to be noted that NFC differs greatly to a typical RFID, especially in terms of range. A RFID tag can communicate at a maximum range of three meters. It can however, only allow one way transfer of data. There has been nearly twenty years of development on RFID. However, it has still not become cheap enough to enable unique serialisation. RFID is mainly used in goods tracking, shown in Figure 3.

NFC is a highly interactive connection, the “touch and go” scenario utilised the short range that NFC is capable. It acts as a key to initiate other interactions in many cases. The ease of interaction is what makes NFC so unique in its uses. If a larger range is needed, then the NFC can act as a passcode to create secure connections for example under Bluetooth. This is what makes NFC so versatile, as NFC can obtain a secure connection quickly (less than 0.1 seconds) as well as having a reasonable transfer speed (around 424kbps) (Noor, 2009).

Where Bluetooth is purely a digital interaction, NFC has become a physical connection. This is because the connection is formed at close range and to initialise the process, the transmitter and receiver are touched together. This gives the user reassurance that the connection is made by having a physical interaction, which other methods do not have. Similar to QR codes in this respect, NFC can link the physical and digital world. NFC however, enables far richer content as it is not limited as much by data restrictions.

Figure 1. Example of NFC “tagged” items. (Page 2013)
Table 1 presents the data from Brooks.com article (Brooks.com, 2013) on RFID and Irnovo.com (Noor, 2009) article on NFC clearly showing set-up and range as well example consumer experience. It also shows how the technologies differ in their uses. It is also important to note that NFC and RFID are the same family of technologies, but NFC allows two way communications whereas RFID can only communicate one way. Although RFID has a larger range it is less versatile.

NFC is being used somewhat widely across new Google Android devices and in some Microsoft Windows 8 devices. Currently the market for NFC relating to mobile phones could be a large potential market for NFC according to literature on the subject. NFC enables data sharing between mobile devices quickly and easily. Android appears the most simplified method of transfer by simply placing the two devices back to back and tapping the screen which is sending the data.
Information transmitted can include pictures, web addresses, music playlists and app suggestions. This is beginning to take over from Bluetooth because of its simplicity to use rather than having to manually set a connection. As NFC acts as a connection maker it also has enabled other interactions that previously had to be set up manually. An example of this is the JBL wireless charging speaker produced for the launch of the Nokia Windows 8 phone. (Nokia, 2012). A connection is still made through Bluetooth, but it is handled through NFC, so gestures as simple as touching the phone to this speaker forms this connection rather than complicated and time-consuming typical Bluetooth interactions as seen in Figure 4. NFC enabled devices can be used to make payments quickly. This does not necessarily need to be a mobile phone or tablet. NFC has been put into Barclaycard credit cards (figure 5) that allow a customer to pay for items (maximum £20) (Barclaycard UK, 2011); this can be used at a number of locations throughout the UK. This can also be completed via mobile devices where the user can check payments instantly. (Barclaycard, 2013)

Currently there are 100,000 terminals (in the UK) where a user can pay with this technology compared to 4 years ago at the time of the first roll out the initial target was 35,000 (Chapman, 2012). This is not a huge jump as it appears because comparing this to the number of card terminals in the UK in 2012 shows that only roughly 10% are contactless ready. These figures are based on calculations formed on numbers posed by “The World Bank” terminals per 100,000 population =

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Table 1. NFC compared to other similar technologies (Noor, 2009)

<table>
<thead>
<tr>
<th></th>
<th>NFC</th>
<th>RFID</th>
<th>Bluetooth</th>
<th>QR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set-up time</td>
<td>&lt;0.1ms</td>
<td>&lt;0.1ms</td>
<td>6 s</td>
<td>Time to focus</td>
</tr>
<tr>
<td>Range</td>
<td>Up to 10cm</td>
<td>Up to 3m</td>
<td>Up to 30m</td>
<td>Optical range</td>
</tr>
<tr>
<td>Transfer Speed</td>
<td>424Kb/s</td>
<td>26Kb/s</td>
<td>721Kb/s</td>
<td>Dependant on data connection.</td>
</tr>
<tr>
<td>Information</td>
<td>High, Given, Security</td>
<td>Partially given</td>
<td>Who are you?</td>
<td>Optical</td>
</tr>
<tr>
<td>protocol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How it’s used</td>
<td>Pay, get access, initiate service, easy set-up</td>
<td>Item Tracking</td>
<td>Networking for data exchange, headsets</td>
<td>Get access, content download</td>
</tr>
<tr>
<td>Customer</td>
<td>Touch, wave, Simple Connect, Two-way transfer</td>
<td>Get information, one-way transfer</td>
<td>Configuration needed. Two-way transfer</td>
<td>Simple connect, one way transfer</td>
</tr>
<tr>
<td>interaction</td>
<td></td>
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</tbody>
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Figure 4. JBL NFC enabled speaker (Page 2013)
2,177 and the census of the UK 2012 showed 62.3m which equates to 1,356,271 card terminals in the UK. This can be explained by the cost involved in setting up the technology. “35,000 checkout lanes in the UK aren’t cheap”, (Shields, 2011).

With the release of new smart phones NFC is becoming more commonplace, especially in larger cities such as London. Contactless payment cards have been approved for use on Transport for London network of buses, trains etc. with the aim of replacing the Oyster card (Rainer Widmann, 2012). This technology offers more than physical link. As NFC tags can be put onto any object or surface then they can be used for example in shop displays to perhaps show a video of the product or offer discounts in some way (figure 6). Offering this added interaction improves the customer experience.

As a tag has enough internal memory to hold for a short piece of text, a web address or a GPS location then this can be used to interact with advertising, find new places to visit or offer additional information that cannot be shown otherwise. This has been trialed in the Museum of London, where NFC tags were introduced that offered additional content such as sound files for exhibits, discounts at the gift shop and connections to social media (such as Twitter and Facebook). This was trialed for at least a year and the feedback has been positive.

Figure 5. Barclaycard contactless card. (Page 2013)

Figure 6. Interactive shopping NFC tag (Page, 2013)
In 2012, both Sony and Samsung released versions of “tags” that can be used for automation. The Samsung version offers rewritable tags that can be programmed by the phone itself through the companion app “Tec Tiles” (Wired UK, 2012). This includes simplifying tasks such as turning Bluetooth on/off in a car for hands-free by simply touching the phone to a tag on the dashboard.

NFC currently is used in small niche markets and trials, but when the technology reaches a critical mass in terms of enabled devices “tags” will be seen more frequently on advertisements and in shops. Here NFC has the potential to make shopping a more enjoyable process. As an example of this, Tesco in Korea used a smart wall displaying products that could be scanned and saved to a shopping basket for delivery. This example used QR codes, but could easily have been implemented with NFC as NFC would improve ease of use and efficiency of the system. Where this example is clever is that it was placed on subway stations so when people are coming home from work they can shop for groceries while they wait, saving both time and reducing the need for shop fronts.

Smart carts could total up items as you add them to the cart and give live feedback to the shopper about how much they have spent. This then allows the shopper to pay for the items and walk out the shop saving the long queue at the checkout. This acts on two levels, firstly making the experience easier for the customer, but also for the retailer it reduces the number of staff needed and increases capacity of the shop floor (Widman, 2012). Our mobile phones are now an integral part of modern day living, they are being used for more each generation of smartphone that is launched. The integration of NFC into smartphones is natural extension of present trends.

NFC, especially as cashless payments will save vast amounts of money for the retail industry. According to T3 magazine, 1.3% of the purchase price of an item goes directly to cash handling.
This means the retailer turning the money into their account and vice versa. In the same article, it is suggested that €370 billion per year is spent on transferring money from person to person. This could be reduced drastically by making payments on a card or NFC (T3, 2011). Apart from the monetary benefits, NFC has the power to save huge amounts of time for people. Queues will be reduced in size because there won’t be the need for every person to either pay by cash or type in a pin number. The queue for the bus will move far quicker because it will just be a simple tap to pay system. The internet of things (figure 9) refers to assigning a URL address to everything. This idea could link all objects together, improving time management.

Currently modern lives are split into a digital and physical world; NFC forms a physical link to the digital world. As many are more comfortable with products that they can see and feel this gives reassurance. However, the greatest areas of interest are contactless payments and the internet of things. There are a number of ways that NFC could take over many current technologies because it saves users time and hassle doing everyday tasks. These can range from paying for a magazine to unlocking a house/safe/office with the benefit that all are enabled from one device.

Murphy (2011) showed a number of ways that a NFC device could be “attacked”. These include eavesdropping, data corruption and “man-in-the-middle” attack to name a few. The paper concludes that a man in the middle attack is near impossible along with most of the other ways an “attack” may occur. It is believed this is because of the close proximity that the interactions happen.

The foregoing suggests that as long as the device is not lost/stolen NFC is actually a very safe method of transferring secure data. Theft cannot unfortunately be controlled; therefore, other means of resolving the issues are needed. For example, Barclays offer 100% fraud money returns on their NFC enabled card and phone app. Also if a series of transactions are made a pin code is asked for making the transaction. Also the value is limited to £20. All of these measures are helping to give contactless payments viability in a world that ID theft is a constant fear. Mobile payments are of high concern, security for mobile payments is a balance between convenience and safety. Pernet-Lubrano (2010) states: “The authentication process provides a dilemma for NFC mobile payment: on the one hand, the technology is supposed to provide users maximum convenience for shopping, yet on

Figure 9. Example of Internet of things (Page, 2013)
the other hand this raises security concerns. In most cases, convenience is the priority and thus no authentication process is required” Pernet-Lubrano (2010, p. 23).

Some papers suggest that the power lies in the mobile networks, Orange, O2 and Vodafone have released a joint venture (Shields, 2011). Since this announcement, Google has also produced “Google wallet” which is a huge investment and comes with the companies “Android” software supporting the NFC hardware so is an unsurprising move.

There are a small number of retailers that allow contactless payments around the world such as Eat and McDonalds (Barclaycard, 2013). These companies are taking a risk as NFC may still not take off but every paper, journal, web report and video that has been observed in the writing of this report has shown that NFC will eventually become mainstream. A lacking of retailers backing the system doesn’t push mobile device manufacturers such as Apple to include the technology because it comes at an extra cost. The reasoning behind this is “They won’t do something until they know a lot of their customers will use the service (Guardian, 2012) which although this makes business sense, NFC is being held back by Apple not including it in the iPhone 5.

METHODOLOGY

A survey was posted to a number of online forums and websites as well as distributed to peers to understand the effect of NFC on people from a number of backgrounds. This spread of data will enable trends to be shown in graphical form. Gaining an objective perspective (Kumar, 2011) improved the quality of the data gathered. Numerical and selective data was collected based on ratio/scales and grouping data enabled speedier analysis. The questionnaire was formed by dividing the research questions into sub-areas and targeting questions at these points. The interviews were conducted with professionals with an in-depth knowledge of the area. These comprised semi-structured interviews allowing for changes in the interview questions to make the process less formal.

ANALYSIS OF RESULTS

The questionnaire results revealed some interesting points and identified a potential disadvantage of NFC that was not apparent in the Literature review. Interestingly, sixty percent of respondents who completed the questionnaire actually had heard of NFC even if they owned items that used NFC. This was mainly mobile phones (Samsung) and contactless payment cards. Another very clear statistic was the very few people who had made a payment using contactless technology although many had used the features in some way. This suggests there is little opportunity to use contactless payments. However, those who had made contactless payments stated that it was always faster. Their opinions gave an insight into the scenario. For example, “First time I used it and was so quick, transaction was complete within seconds.” However, there were responses that gave a negative impression. “Was for a low value item and the cashier had to get the receiver out from behind the counter for me to swipe it past” suggesting that NFC payments are far from mainstream and the hardware is of inconvenience to the business. It is in the author’s belief that this occurred as very few people use contactless payments; it is not worth displaying the terminal. When asked about having “all their personal details built into a phone” only 5% showed no concern at all. The finding, whilst not surprising, was not apparent from the literature review. Although this doesn’t conclude much, it also shows that opinion is mixed when it comes to smartphones and their ability to enclose so much personal data.

This could be a contributing factor into why so few of the respondents made contactless payments. When the participants were asked about the maximum amount they would use a mobile device to pay, this was very interesting, as far more people the expected were comfortable paying over £50 with their phone. Currently the maximum is £20 and this was backed up by thirty-three percent of respondents giving this answer, the highest percentage for a single group. In some ways this contradicts
the previous question, but can be explained by stating that the people who were comfortable with having their personal data on a single device were more likely to opt for a higher value in this question.

The final question was to offer ways that NFC could be useful to them. Mainly these responses showed typical already used methods such as device pairing and ID cards. However, there were some interesting responses such as registers in schools, “fluid desktops” where a phone automatically transfers data to a home computer when put on a desktop and adding additional content to CD cases to play the content on a stereo. However, in the author’s opinion the most interesting input was that some respondents who worked in the NHS saw a potential for its use in medical records, patient tracking and in one case a person stated that NFC was already in use, but only in some areas.

Both interviews yielded important information into NFC. While both were targeted at gaining maximum detail on the person’s field of experience, the questions focused on specific areas such as how NFC will develop, when it will happen and what will be the most influential factors in these areas. Both are working on developing technology related to NFC so will have a bias towards it success, but both offered valid reasoning for any statements provided.

With this interview, the focus was on the technical aspects of NFC and how it will develop. It was discussed how RFID (NFC’s parent technology) cannot currently meet the price expectation desired to enable the internet of things. When discussed in detail, the likelihood of NFC being used soon in this manner was ruled out. The likelihood being it is at the very least five years away but could be up to twenty years, mainly due to limitations from patents, manufacturing costs and material prices. The complexity of the integrated circuits (ICs) involved is a considerable factor in their cost. Similar ICs need around 80,000 transistors to function meaning that currently NFC chips cannot be made for less than the fifteen cents (euro) per unit. This shows why it cannot currently be used in unique serialization as this would remove a high percentage of profits for consumables such as bread and milk.

However, while discussing the current uses of NFC and similar technology, the possibilities for its use with contactless payments are evident. The date on which this happens however differed greatly compared to the literature. One interviewee suggested it is a long way off for a number of reasons but mainly the complex decisions that are involved between the companies providing the services. NFC in the medical field, a company called “Gentag” (Gentag.com) are currently filing patents for “smart patches” that have applications such as “temperature sensors, smart skin patches, drug delivery, glucose monitoring and all those sort of things that you use the phone for”. There were a number of these “smart tags” that could be used to remotely monitor patients both inside and outside of a hospital. Medical uses may be the way to go until contactless payments is ready. Gentag obviously believe this as they predict a 1.6-billion-dollar business from the prostate cancer diagnosis patch alone.

One of the interviewees currently works on developing advertising and ticketing solutions for NFC based applications with some significant companies such as Stagecoach Group and therefore is considered a credible source. He mentioned how NFC can impact on consumers’ decisions in the leisure and travel related area. Firstly, in advertising, adding NFC features to posters for places was suggested to add richer content such as videos and maps. Advertising in his mind is where NFC can start to impact immediately. He described examples of choosing restaurants where download of menus/vouchers from a poster advert would increase the likelihood of visiting the restaurant. He also suggested that as NFC doesn’t need networking or power, they can be put anywhere. This is backed up from the literature on the subject.

Timeframes were discussed about when NFC will go “viral” i.e. become popular. It was suggested that NFC is very close to reaching that point. However, when it comes to payments as this requires more work. He stated “2015 is only two years off; well I would say that’s optimistic for at least having ubiquitous payment”. Later, NFC technology in handsets was discussed in terms of when it will reach a level that NFC is worthwhile investing into. He shared an interesting point that was talked about in the literature about Apple and their latest release of the iPhone 5 and that it did not include NFC. This was a setback for the technology, but he stated that as Apple is no longer the market leaders, Samsung are, and that this has had less of an effect than actually appears. “There are enough handsets out
there to make it worthwhile. Now it is a question of encouraging merchants and people like football clubs and other like that to use NFC”.

Ticketing was also discussed as local bus services have been integrated with NFC readers for use with smart cards and later down the line smart phones. This is being rolled out in a number of different locations including the University of the West of England (UWE). The use of NFC enables the traveller to receive offers and for the bus company to plan its timetable more efficiently. Finally, security of NFC tags was discussed. The author asked “as NFC tags can be rewritten, what is to protect the customer from fraudulent tags?” One interviewee discussed ways that tags could be hijacked to broadcast different information. He called this a “Luscious Linda tag” where data could be overlaid in a new tag that sends the person to a website that they were not expecting. He used an example of phone boxes in London. “Someone has put a tag over the original museum tag about where you can go. This has then been replaced by “luscious Linda’s tag” that takes you to a site on your phone that you were not expecting. There is the solution to that which is the tag signing, but it requires the user to download an app”.

This does show that some caution should be taken with NFC tags, but this can be controlled also by adding security to these tags. The downside of this is the inconvenience of having to verify every tag scanned. Therefore, security will come down to the business model. Most interestingly from the interview was discussion on the possibilities for NFC tags and protection from fakes. This could be applied to high-end fashion products and to pharmaceuticals. It was also suggested a use in translating instructions into different languages. “My smart phone could be set to Finnish and I touch the tag that then takes me to the Finnish instructions so I know what to do with it. That again is an idea that people have had and could easily come to fruition.”

**DISCUSSION**

NFC offers to simplify everyday tasks, personalise relationships between company and customer while advancing how people interact with the digital world. Backed up in both primary and secondary research, there is very little showing that NFC will be negative in anyway. NFC in terms of the effect on customers will be a simplification of transactions, more personalised offers and better service. Interviewee one suggested that: “Now they know their email address and can (with their permission) monitor what journeys they travel and maybe offer deals that are tailored to them”. Using NFC enabled devices can feed back to the company providing the service about how people travel and enable better services as they will know more accurately when people need buses at certain stops. Here NFC is simply an enabling technology, if used well then it could mean that more people use public transport. “They don’t know where to get a ticket, how to pay, how much to pay for the journey they want to take etc. So want to reduce the embarrassment of fumbling in front of a group of people at a busy time of the day”.

This is one example how introducing NFC into a system can improve the experience. NFC is in this case a way to link the two, already functioning systems together seamlessly. This idea can be integrated into many different areas such as retail and sporting event ticketing. In the authors opinion however, the most important use for NFC shown is in the medical field. Here NFC has the potential to save vast amounts of time and money for hospitals and practices all around the world. The patches for example will enable remote monitoring of patients that are healthy enough to be sent home but still need to be monitored for complications. This will help free bed spaces for sick patients, making for a more efficient health service. This will become more relevant as the ever aging population grows (persons over the age of 60 (parliment.co.uk, 2013)) as more care will be needed, putting a strain on resources. “Dr John Peeters, founder of Gentag. With NFC, “we can also discharge people earlier from hospital and allow them to self-monitor at home,” (Clark, 2011)

Similarly, a NFC patch has been developed to test for prostate cancer, allowing the user to test in a comfortable environment, while allowing a professional to view the readings. (Gentag, 2012) The
document states; “. Results can be communicated directly to a physician via cell phone or PC. The market for a consumer-based prostate cancer test is estimated at $1.6B.” (Gentag, 2012)

The ability to self-test also has huge advantages, Gentag’s GT401 prostate cancer detection patch (Gentag, 2012) is the first in a potentially large number of similar style devices that are disposable and can be used at home, while the results can be given to a professional for correct diagnosis. This is predicted to be a billion dollar business for the prostate cancer patch alone. If the figures stated here are correct then the medical market will be one of the major factors in the growth of NFC type technology.

A similar area that uses NFC for huge gains is anti-counterfeiting. Giving a product a barcode currently is easy to duplicate, companies are always trying to find ways to reduce counterfeiting of their products, especially high price products. Both interviewees suggested positive outcomes as NFC tags can be secured, however the difference again was when it would be viable to use. Interviewee two based his decision on use across full retail saying that it was currently not possible and would take a few years, however interviewee one believes it is possible at the current time, but only for high end products.

Counterfeiting is a huge business worth $1.2 trillion (Gentag, 2010) globally. High end fashion will be the early beneficiaries from NFC but another huge potential is in prescription (over the counter) drugs, where not only it can allow the customer to verify that their purchase is what they intended to purchase but also give them more information on the product. For this however to be used on cheap drugs such as pain killers and allergy relief the price per NFC tag must come down close to the 1Euro cent mark. So therefore the growth in this market will be slow and steady. Much emphasis has been placed on Gentag and its products, to further this investigation other similar companies could possibly be contacted through trade associations to give a broader spread of data for this discussion.

Interviewee two discussed with the author the development from a more technical approach. The discussion was based around the production cost of NFC tags. This then will influence how the tags can be incorporated into different products. Currently a NFC tag can be sold (in mass quantities) for around 15 euro cents per unit. This was stated by interviewee two and is backed up by a study into NFC. This price per tag restricts its use greatly on a large scale, especially as a replacement for something like a barcode. The most likely way to reduce this cost per unit is to produce them by printed electronics rather than standard manufacturing techniques. Only then could the price possibly come down to below 1 euro cent. At this point it would be viable as a replacement for QR and barcodes in the retail environment. However, printed electronics is a relatively new field of manufacturing. When discussed in detail regarding when a product such as NFC tags could be made through printed electronics. Dr interviewee two stated: “We are not going to be able to make 80,000 transistors on there, we can make 5 or 6, but that isn’t going to give us the numbers that we need even for unique serialisation”.

The complexity of NFC chips produced through printed electronics is a long way off. According to interviewee two this could be up to 30 years. Therefore, this extended timeframe would push well past the point at which the mobile networks and banking industry predict. (Mobile contactless payments will become commonplace by 2015) (Murphy, 2011). Compared to this, during his interview, interviewee one (Touché NFC) suggested that NFC, as an everyday product that has penetrated the market enough to have a visible impact on society, may only be a year away. This was based on the point that most companies that produce smart phones are now integrating NFC technology into their new devices. This compared to the findings from the online questionnaire show that over 30% had a NFC phone and bank cards in it and 65% having some level of knowledge of it.

This shows that NFC is more than ready as a platform. The problem however for systems such as ticketing and payments, this requires a huge network of background systems and hardware upgrades that are currently not ready. Therefore, it can be expected NFC will most likely grow in areas such as advertising and less system dependent areas while the infrastructure for more complex systems grows steadily. With nearly eighty percent saying in the questionnaire that they had not paid for anything using contactless payment methods (NFC phones and bank cards) but a majority responding that they
were comfortable with spending over £15 using their mobile device backs up the secondary research on the viability of mobile payments taking over from small change transactions.

As can be seen, there is a huge potential for NFC technology in contactless payments that is simply waiting for the number of devices with the built in technology to enter the market place. The aim is to have NFC a major part of everyday life by 2016 according to marketresearch.com. Until this point, NFC will grow slowly with many trials being run in the meantime. Some predictions from researched literature state that 2013 will be when NFC becomes mainstream, some are less hopeful at 2018.

“Numerous commercial mobile payment offerings will be launched in 2013, and by 2014-2015, greater uptake will follow. The value of transactions made via mobile payment using NFC technology will reach 42.3 per cent in 2015 and 49.6 per cent in 2018” (Sulivan, 2012). As this is only a prediction, this cannot be certain, but coming from a strong source this gives credit. If this is true along with the statement of “Numerous commercial mobile payment offerings will be launched in 2013, and by 2014-2015”, greater uptake will follow in sectors that have less backing in terms of funding such as retail and tourism.

NFC Is set to be of major importance due to its ability to enable links between the physical and digital world. Not focusing on a time deadline and looking forward to the point at which NFC is fully integrated into society and is level with technologies such as Bluetooth and Wi-Fi networks, it becomes a very powerful tool. As stated before, wireless payments take a huge amount of background systems that are partiality able to function on current technology. An example of this is mobile banking and the ability to pay of transfer money between phones using data networks. The literature and responses from professionals has shown that NFC will integrate fully into modern life. But how will this happen? In the authors opinion it will be subtle at first. As it already is being fitted into upgraded hardware such as tills and ticketing machines. Many of the new machines for this purpose come as standard with the NFC built in.

Security is the key to NFC payment/ticketing success and was highlighted in the questionnaire. Unless people are comfortable using their smartphones as a method of payment or ticketing, the system will be useless. There have been a number of attempts to detail the potential threats of using mobile devices as a method of payment, including papers written by Vermaas (2013) and Ba (2012) who analyse in depth the details of making transactions. These papers suggest that there are flaws in the security of these transactions. For example, the paper by Ba (2012) suggest that the most likely source of an “attack” on a transaction is through the internet, probably through a malware built into 3rd party applications quoting from the paper: “PCI Security Standards Council indicated that malware is one of the top security threats to mobile payment.” (Ba, 2012)

While offering a similar response to Ba (2012), Vermaas (2013) suggests that the lowest risk comes from directly “infesting a terminal with malware using an NFC device or RFID token is pretty much impossible. Infecting the terminal using other means of injection, like an Internet connection, is far more likely.” Other methods of “attacking” NFC have been discussed in this paper such as “Man in the middle” and “Luscious Linda” tags. These methods of attacking a NFC enabled device are possible, but unlikely. Security of mobile devices is being improved all the time and there is little to concern users of these devices, only to be cautious about how they use their phones.

With such a reasonable response of people from the questionnaire stating that they were 4/5 or higher when asked how comfortable they were using their phone to make payments shows that people are ready to try contactless payment.

Based on literature NFC could become widespread as early as 2015, which is predicted to be the point contactless payments will be commonplace. However primary research has shown otherwise. interviewee two suggests that NFC will reach a useful level through printed electronics in a minimum of 5 years but could be up to 20 years depending on how manufacturing grows. Interviewee one believes that NFC will be viral in one year. However, his area of advertising and ticketing for travel are based on a less complex background system compared to interviewee two’s area of suggested use.
From the questionnaire Interviewee one point seems more accurate as 49% had either a mobile phone or payment card that included NFC. This shows that NFC smartphones are close to reaching a critical mass. The lack of trust in mobile devices will hold back the inclusion of NFC into society. The trust in the system will grow over time being a greater affect than the number of NFC handsets. Retail serialisation requires the price of NFC tags to come down to below one euro cent per unit. This is a long way off and relies on new methods of manufacture that require time to mature. Whereas advertising especially can begin to grow in use more easily as it doesn’t require specialist background systems to be used.

NFC tagging in advertising will begin to emerge very soon. With the growth in NFC enabled smartphones soon, larger advertisers will realise its potential and produce content that adds value to poster advertising. There are small companies such as Touché and Airtag that are introducing the use of NFC enabled smart posters and terminals to companies. This introduction seems positive as companies such as McDonalds, Space-coach and Carre-Four City have at least trailed NFC in their business.

There is a lack of hardware and background systems to support the services, pay booths, security protocols and payment schemes. This is most likely because the parties concerned with delivering the services cannot agree what percentage of the transaction fees each gets. (It would be of interest to gain these companies options on the points suggested.) Once this can be resolved then payments and ticketing can grow quickly. This however, is most likely beyond the 2015 intended date as until these decisions are made, there will not be any consistency with quality of service. This has the potential to lose the confidence of the small percentage of customers that currently use contactless payments. This is backed up by the questionnaire as many who responded had not used contactless payment and if they had they were not completely certain of their security. The production cost of NFC chips (tags) are expensive presently due to the complexity. The current production cost per NFC chip is around 10-20 Euro cents per unit. For NFC to be a viable source for the internet of things. The price would have to come down to below 1 cent per unit and this cannot be achieved now with current production techniques. However, for other applications such as ticketing and anti-counterfeiting of goods the price is small compared to the impact of the technology and benefits it brings to the supplier. Similar principles apply to the medical applications discussed previously. To produce a chip that is cheap enough to enable the internet of things different manufacture techniques need to be used like printed circuitry, which whilst currently cannot produce complex circuitry, is expected to be possible in the future. Printed circuitry refers to the process of using technologies, similar to inkjet printing to print directly onto a product. “20 years before we get sophisticated printed electronics and circuitry that can match the requirements of RFID on items. So it could be in the next 20 years, but I don’t think it will be in the next 5 years, certainly 5 years plus” - interviewee two.

It enables electronics cheap enough to be put into something such as cereal boxes to add value to the packaging. Printed electronics is far cheaper than conventional electronics, the sophistication is at a low level presently and therefore it will be many years before it could be used with NFC chips in low value goods. “We are not going to be able to make 80,000 transistors on there, we can make 5 or 6, but that isn’t going to give us the numbers that we need even for unique serialisation” - interviewee two. In reality no precise date can be given when NFC will be commonly used. However, an estimate can be suggested based on the research conducted through the writing process. Taking into account all of these factors and their different dates, the author is confident NFC will not mature enough to be classified as viral by 2015, especially with contactless payments as no decisions seem to have been made for any progression. In the authors opinion the most likely outcome is that NFC will mature enough at the very latest in 2018, with further development in the years to come for unique serialisation and the internet of things. (Clark, 2012) This date relates to statement that payments will be over 40% in 2018 from the literature. This seems reliable when cross referenced with information from other literature and the professional interviews conducted. After this advances in manufacture will help enable its use in more complex systems such as unique serialisation and payments. There
however may be a sudden growth before then, especially if parties can agree on transition fee charges for contactless payments. NFC will have applications in some important areas such as medical and anti-counterfeiting which are relatively low volume but of significant benefit to the goods/service supplier.

CONCLUSION

When compared to similar technologies discussed in this paper NFC has a shorter set up and two-way data transfer which makes it suitable for close range connections. The connection is formed by a physical interaction with the device making it more personal. It can also act as a “key” by initiating other methods of data transfer. NFC is installed in some of the latest generation of smart phones from Samsung, Nokia etc. although it is noteworthy that it has not yet been included by Apple. The mobile phone market was identified in the literature review as a large market and specifically, in the area of mobile payments. The roll out of NFC began in this area four years ago but presently, less than 10% of point of sale outlets in the UK has NFC capability. NFC is beginning to be used in advertising and marketing for product interactive displays. This would benefit both the individual and the advertiser who would be able to gather information about which individuals are interested in their products/services. While gathering primary data, it was identified that NFC is also being used in ticketing with some national bus companies seeing the benefit of shorter queuing and more information on their customers.

The most important use for NFC in the future will be in the medical sector. Large gains can be made in better patient care and remote diagnostics leading to a more efficient service. This could be further investigated through interviews with companies working to develop NFC based medical devices. Medically based NFC tags are a relatively new area, but with such a large potential market, it is difficult to see any lacking of investment in the area, especially for remote monitoring/diagnosis tools that would usually take far greater time and effort. This alone makes NFC a powerful technology, when considered alongside ticketing and advertising, NFC stands to be a large impact on society once fully integrated.

Security of the systems will be integral to the trust in these devices with smartphones containing more personal information with each new generation. Shown in the questionnaire was this concern, therefore the companies providing the services must maintain a high level of trust. Although the questionnaire shows trust in these devices, people appeared concerned about the amount of personal data on these devices; interestingly this was not so prominent in the literature available. Similarly, the scope for fraudulent attacks is a consideration although NFC has benefits over other technologies through the physical contact that is required for a transaction and measures to counter fraudulent attacks have already been researched.

By far the biggest impacts on the rate of growth will be hardware considerations such as tag price (currently far too high to enable product serialisation) numbers of handsets with the technology built in and acceptance by companies of the new systems. For the user however the link between physical and digital is where NFC will have the biggest impact on, simplifying and enhancing experiences in what are currently complex and sometimes stressful situations. Due to its simplistic nature it is extremely easy to understand the “touch and go” interaction needed. The interaction feels natural and even those who lack technical skills or more importantly speak the same language can understand what to do. Linking these interactions to a smart phone simplifies the process further removing the need for complex interfaces on machines like ticket booths or chip and pin machines. When it comes to the typical user, there won’t be an immediate impact on their lives as NFC has to develop further to be of significant use in terms of time saving, however they will start to see it in advertising and ticketing over the next 1-2 year as it begins to roll out around the world.

The integration of NFC will be a slow and steady process over the next few years, but the benefits will be vast. This could be proven with a series of experiments, exposing people to NFC and its uses.
The benefits will range from reduced waiting times at bus stops to the ability to leave hospital earlier than previously possible thanks to remote monitoring smart patches. There is no doubt that NFC will be of positive impact on society and the very few negative impacts will be of little significance. Much of the literature points towards mobile payments being the catalyst for NFC, whereas results from the primary research show a very different story. This leads onto the point that it will most likely be another area that forms the platform of NFCs early success, most likely the medical sector. With companies such as Gentag developing stand-alone products that can save large sums of money for the health service and improve patient care. Even from a monetary perspective, expected turnover of 1.6 billion dollars for the prostate screening patch (Gt401) shows how this field is going to be a big part of NFC’s success.

Furthermore, ticketing will be an important factor to NFC’s growth, with schemes such as the one being run at UWE are proof that there is a market. This can lead to developments in mobile payments, but until that point NFC acts as a viable way to improve customer experience in many areas and could be applied to event tickets (football matches, concerts), other methods of transport such as flight tickets. Transferring to this method would also improve anti-counterfeiting measures as discussed in Interviewee one’s interview. Whatever happens in other areas, it is more than likely that mobile payments will be a factor in the growth of NFC, but will be a smaller part then the literature appears to show. It is too reliant on background systems and agreements that do not appear ready. Mobile payments will begin to take over from small change transactions, but the likelihood is that this is going to be later than the predicted 2015 because of the lacking of hardware in many shop fronts.
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