# Evaluating Wireless Technologies in Mobile Payments – A Customer Centric Approach

Agnieszka Zmijewska
*University of Technology, Sydney*
*aga@it.uts.edu.au*

## Abstract

*Mobile payments involve the use of a mobile device and one or more wireless technologies. As the field is at an early stage of development, there is still a lot of uncertainty about which of available wireless technologies will lead to the most successful solutions. Cellular networks, Near Field Communication, infrared and Bluetooth are analysed in terms of their suitability for mobile payments. This paper tries to find out which of these technologies can lead to systems that the user will be most likely to accept. Acceptance factors discovered in the author's previous research are used in this analysis: perceived ease of use, usefulness, mobility, trust and cost. The study reveals which of the technologies are likely to best fulfil each of the acceptance criteria.*

## 1. Introduction

Mobile payments (or m-payments) are payments in which at least one part of the transaction is conducted using a mobile device (such as a mobile phone, smartphone, or Personal Digital Assistant) through a mobile telecommunications network, or via various wireless technologies. The mobile device must be highly portable (preferably handheld), and available to use anytime, anywhere. Mobile payments are an important building block of mobile business, since for any transaction to take place there must be a way for the customer to pay.

As implied by the mobile payment definition, there are a number of connection technologies that can be used in such systems. Some of existing m-payment solutions around the world use either a mobile telecommunications network to transfer data, or one of short range wireless technologies, or a combination of both. Mobile payments are at an early stage of development, which may explain the lack of one dominant direction – most projects are still in design or pilot stages, and there is still a lot of uncertainty about what will or will not work. To advance this knowledge, and come closer to finding out what makes a successful m-payment, this study sets out to analyse and understand the potential of connection technologies for their use in mobile payments. It aims to understand which of these technologies could lead to the most successful initiatives. The methods used to achieve such success will also be canvassed.

There have been several studies so far that have focused on user adoption factors in mobile payments. Such studies were looking for characteristics that users need to start using a new payment system. The author's previous research [1] proposed six factors that are likely to influence the user's acceptance or rebuttal of a new m-payment procedure: ease of use, cost, usefulness, trust, mobility, and expressiveness.

This study uses the proposed acceptance factors to analyse the suitability of available technologies to create m-payment systems that the user is likely to accept. It aims to discover the potential suitability of these technologies for providing the required features in mobile payments. This paper analyses how each of the technologies can make an m-payment system easy to use, useful, ubiquitous, cost-effective and trustworthy. If these are the factors that influence the acceptance, then it is important to study which technologies can best fulfil these factors, and how this is achieved. This will hopefully improve system providers' as well as researchers' understanding of which technologies are most likely to create systems that can best meet the user's requirements, and therefore lead to the adoption of a new m-payment procedure.

The focus of this study is on suitability of various wireless technologies for mobile payments, not on suitability of wireless technologies in general. This paper does not try to investigate how good each technology is, but rather how good a mobile payment system based on it could be. Existing wireless technologies are mature and highly developed.

Proceedings of the International Conference on Mobile Business (ICMB'05)
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However, to make sure that the technologies are not used just because they are there, a better understanding of their use for m-payments is required. This paper advocates the use of technology not just for technology's sake, but with a purpose of making a system that the user will want to use. Some excellent technologies may simply not be suitable for mobile payments, since they, for example, may not provide a convenient or fast enough experience in this specific environment.

The methodology of the study is as follows. The next section outlines previous research relevant to the topic. Section 3 discusses the user acceptance factors for mobile payments that resulted from the author's previous research [1]. Section 4 summarizes the available technologies used in m-payments, and their relevant features, such as data transfer rates, or maximum range. Section 5 attempts to match the required user acceptance criteria from Section 3 with available technologies from Section 4. It demonstrates how each technology can help fulfil the required acceptance criteria. It does so by analysing relevant features of various technologies, and using examples of existing systems based on these technologies. Existing systems have been examined in this study since they can best illustrate the features of m-payment methods built on specific technologies; they are also used to support some arguments proposed in this paper. Conclusions and future research are presented in Section 6.

## 2. Literature review

Hort et al. [2] present a short overview of wireless technologies that can be used in mobile payments, briefly evaluating their advantages and disadvantages. These however include such features as high infrastructure costs for 3G networks, or new services enabled by them, so the analysis does not deal with potential of such technologies for mobile payments specifically. Huber [3] also briefly describes some available technologies that can be used in m-payments. Schwiderski & Knospe [4] present an overview of network technologies, however the focus in on mobile payment security only. Ondrus [5] provides a short discussion of advantages and disadvantages of proximity technologies in mobile payments, summarising their range, cost, power consumption, data storage capacity, and interference hazard. To the best of the author's knowledge, there has been no thorough analysis of suitability of available wireless technologies for mobile payments in the literature yet.

## 3. Acceptance factors in mobile payments

Users decide if they will or will not accept a new payment system, so the suitability of available technologies should not be analysed in isolation, but rather through what is known about user preferences. As the user is in the centre of acceptance procedure, the author's previous studies focused on discovering the user's preferences and attitudes. Firstly it had to be discovered what the customer wants, so looking for the best ways to satisfy their requirements can be the next step.

The author's previous research [1] proposed six acceptance factors for mobile payments acceptance. The findings were based on some existing empirical studies [6, 7], as well as extensions of Technology Acceptance Model [8] in e-commerce and mobile fields (mainly [9, 10, 11]). The first factor, perceived '**ease of use'**, is defined as the degree to which the user believes that using a system would be free of effort [8]. In mobile payments, it can include ease of use of the payment procedure, ease of registration, easy access to customer service, minimal steps required to make a payment, appropriate screen size and input capabilities. Perceived **usefulness** is the degree to which the user believes that using a system would enhance their job performance [8]. 'Job' can be replaced with 'everyday life' in regards to m-payments. Useful systems would provide additional benefits and value, such as skipping queues, faster transaction time, replacement of numerous credit and debit cards, eliminating the need to carry cash, and others. Perceived **trust** may be influenced by such factors as confidentiality of data, ability to reverse errors, or confirmation of transaction. **Mobility** refers to the system being available anytime, anywhere. This may be limited by the restrictions on the operator or financial provider that can be used in the payment, the number of accepting points, availability of a device (affected by its battery life) and network coverage**. Cost** includes transaction price, registration fee, or cost of a new device if one is needed to use the system, as well as health hazards. **Expressiveness** refers to the user being able to express their personality with various designs, tones, and other customisable features. It also deals with fashion and the status that the system can provide. Further details about this proposed theoretical model of user acceptance in m-payments can be found in the author's previous work [1]. This study is an attempt to illustrate how this theoretical model can be applied to practice.

The following sections investigate how wireless technologies can affect the m-payment system's perceived ease of use, usefulness, trust, mobility and cost. Expressiveness is not used in the analysis, since


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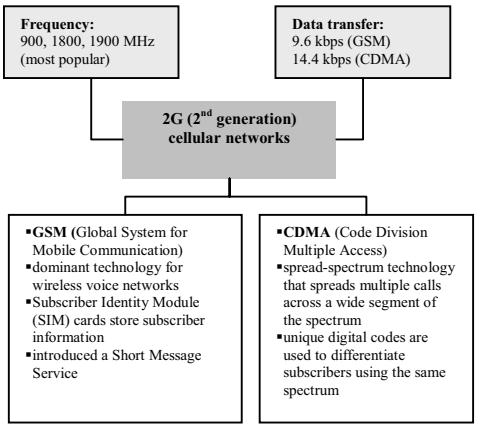
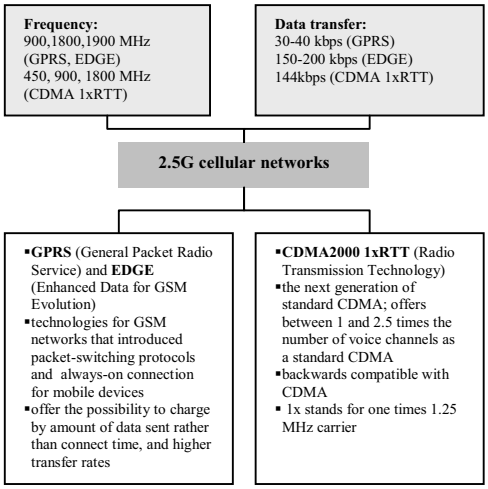
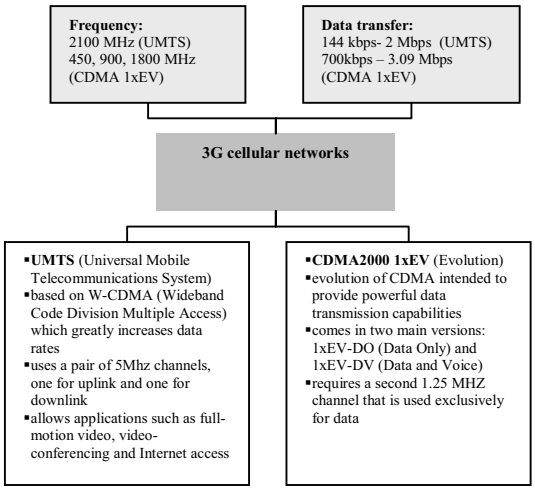
even though it is one of the proposed acceptance factors, it refers to the use of a mobile phone in payments in general, and will not be affected by the use of a specific connection technology. Any payment system using a mobile phone can fulfil the expressiveness requirement because of the number of personalised phone covers and handset designs that allow the user to express their personality. Fashion and status often serve as a gratification of a mobile phone use [12].

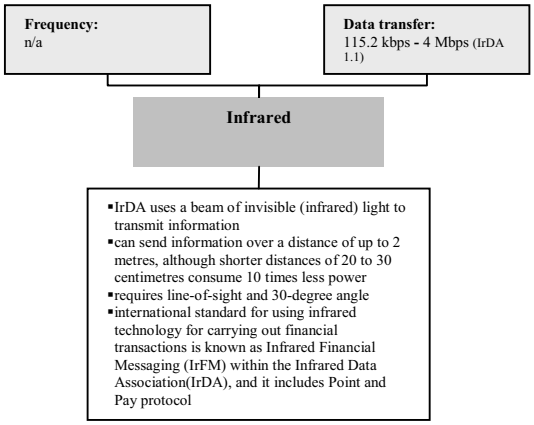
## 4. Mobile payment wireless technologies

Wireless technologies used in mobile payments and their relevant characteristics are summarized in Figure 1. All the technologies are presented together to provide a better overview, and to enable a better comparison between them. The information was collated mostly from official consortia websites [13, 14, 15, 16, 17]. Various 2G, 2.5G, and 3G technologies are grouped together (e.g. GSM and CDMA), since when they share similar capabilities, their use in mobile payments will be the same. ZigBee has not found use in mobile payments since it is used in control and sensory network applications. WiFi (802.11) is used almost exclusively to link portable computers to the Internet, and since there does not seem to be justification for its use in mobile payments, there have been no systems deployed based on this technology.





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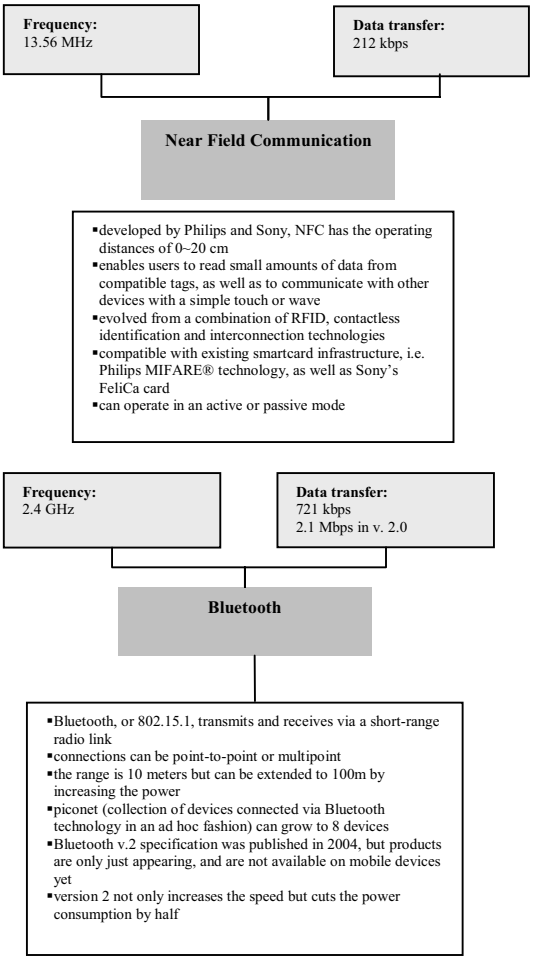


**Figure 1. M-payment wireless technologies overview**

## 5. Wireless technologies and m-payment user acceptance factors

### 5.1. Cellular 2nd generation networks

CDMA and GSM networks offer high quality voice calls and a Short Message Service, but their use for other data services is limited because of slow data transfer rates (see Figure 1). Mobile payment systems using 2G networks rely on the mixture of voice calls and SMS capabilities of cellular networks.

Such systems are not particularly convenient and **easy to use**. Many of them, such as three Australian initiatives, Telstra's 'Pay for Parking' and 'Dial-a-Coke' vending machines, as well as the mPark parking system, require the user to call a displayed number. Recorded instructions are then provided. In Germany, it was the Paybox system which called the customer when the shop assistant initiated the transaction. SMS-based systems seem more convenient especially for the young who have taken up SMS enthusiastically. Mobipay in Spain, one of the most successful m-payment procedures relying on 2G networks, uses SMS technology to both send a customer a message with payment details, and to receive their PIN as authorization. The ease of use of such systems is affected by the requirement to register on the internet beforehand. In both voice-based and SMS systems, the consumer has to first register for the service, providing their credit or debit card details. This means that the user must have prior intention to use the service. The biggest advantage of such procedures in terms of ease of use lies in the familiarity of most users with using mobile phones and SMS service.

**Usefulness** of such solutions is limited since the time that it takes to make a payment is quite long, especially compared to cash payments. The main benefit is eliminating the need to carry cash or credit cards, or to always have a small change as in the case of mPark.

At no time are credit card details transferred on the network, therefore perceived **trust** in such systems can be high. This is however only possible because the credit card details had to be registered earlier on the Internet, which can still be a security concern to some users.

CDMA and GSM networks provide almost ubiquitous coverage in many countries, however most of the voice/SMS systems do not offer a true **mobility.** These initiatives are often proprietary, and only subscribers of a particular mobile operator can use them. The Telstra service is only available to 1/3 of mobile phone users in Australia, since only Telstra subscribers (excluding pre-paid customers) can participate. Only few systems, such as mPark or Paybox, have the advantage of being available to customers of any network. The disadvantage of all the systems mentioned in this section is that when the phone battery is down, there is no way to make a payment. Similarly, when the networks are congested, for example at New Year's Eve, a customer who normally relies on such a system may be left with no way to pay.

**Cost** is an issue in many of the initiatives since the user usually has to pay for each call, and/or for sending messages. Such cost may be quite relevant, especially if paying for low cost soft drinks or parking. Some systems additionally require yearly registration. Health concerns about the safety of using mobile phones may still be an issue for some people.


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### 5.2. Cellular 2.5 and 3G networks

The 2.5G and 3G networks, with their high data transfer speeds, can enable many revolutionary applications. This does not, however, directly influence mobile payments as they do not require large amounts of data to be transferred anyway. Because these networks provide packet-based connections, no connection setup to access data services is necessary. Users can quickly access the service, and location-based services are also possible. This, as well as faster data speeds, has had a big impact on availability of digital content that can be delivered to the user's devices. Such content includes news stories, ring tones, icons, timetables, songs, video clips, etc. The only way the user can pay for such content in current systems is by adding the charge to their monthly mobile phone bill, hence the indirect impact of these new technologies on mobile payments.

Current systems that add payments for digital content to the operator's phone bill include i-mode, Vodafone m-Pay, and Simpay. Japanese NTT DoCoMo charges i-mode content providers a 9% fee for the service.

Such systems are **easy to use**, since they rely on users' familiarity with using a mobile phone. They usually require just one click of the button to select the logo of this payment method on the screen, followed by the customer's PIN.

**Usefulness** of such solutions is limited, since the only application is payment for digital content. This seems to work very well for small payments, but would not work with higher purchases. Adding higher value purchases to a mobile phone bill would likely lead to a bill shock for some customers, and it is the mobile operator's service that could be perceived as expensive.

There are few **trust** issues in such systems, since payments are usually very low. The use of PIN ensures that only authorized transactions take place.

In terms of **mobility** and ubiquity, these services are still proprietary. Vodafone m-Pay allows only Vodafone customers to pay for digital content, and earlier registration is also required. The i-mode system in Australia is offered to Telstra customers only. Simpay is the first system that promises to be truly interoperable across many networks and countries in Europe, but it has not been deployed yet.

There is no **cost** for the user to use the payment system. Customers are charged for data transfers, accessing some websites, and downloading content, but there is no fee attached to the billing payment procedure.

### 5. 3. Infrared

In January 2002, Visa International established technical specifications for short-range data communications using infrared technology called Visa Proximity Payment Specifications. Several months later, two independent projects were launched in South Korea: Harex and SKT built the first credit card mobile payment systems using infrared communication. The systems were compliant with both the Visa standard, and IrFM (see Figure 1). The SKT program was rolled out to more than 30,000 merchants in Korea. Two million infrared-enabled handsets were distributed [18].

In 2003 DoCoMo and Visa conducted similar trials in Japan, too. Another recent initiative in Japan is called JCBeam trial, which is a 3-month pilot system conducted by the JCB credit card company.

In the Harex trial, special payment terminals with infrared receivers were placed in department stores, supermarkets, restaurants, vending machines, highway tollbooths, and other locations. A phone would exchange information necessary for authorization via infrared with such a terminal.

In terms of **ease of use**, the Harex system simply required the user to type in their passcode on the phone keypad, point the phone at a receiver on the counter, and press a 'hot key'. Considering mobile device limited input capabilities and small keypads, the fact that hardly any typing is required is a significant advantage. The pointing part however is why infrared is often perceived as less convenient than other technologies. It requires a special effort, line-of-sight, and pointing at the right direction, as it operates within a narrow angle (a 30-degree maximum cone) and at a very short range.

When it comes to **usefulness** of infrared-based m-payments, only 5 percent of all the phones equipped with infrared actually use the technology [19]. However, in terms of using a phone as a mobile wallet (storing card information), infrared does provide a range of additional benefits. There is no need to carry several credit cards. Such systems can also replace cash. They can be used in places that would normally not accept traditional credit cards (e.g. fast food restaurants). ID cards, keys, and multiple cards can be all stored in a mobile phone. Two-way communication makes it possible to include additional applications, such as downloading tickets and coupons.

Infrared systems can be perceived as more **trustworthy** than radio frequency technologies. The same features that make infrared less convenient to use, increase its security. Because of its very short range and point-to-point link, it is hardly possible to


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tap into the communication. Since the specific 30-degree angle is required, unintended communication is avoided. The payment device remains under the control of the consumer throughout the transaction, and only face-to-face payment is possible. There is also no interference with other sources.

Ubiquity of infrared-equipped devices makes this technology ideal for m-payments in terms of **mobility** requirement. There were approximately 150 million phones in the world equipped with infrared in 2004 [19]. Infrared mobile payments can be used in places such as hospitals, gas stations, or inside airplanes, where radio frequency use may be restricted. It also uses less power than other wireless technologies.

Because a large number of phones come with infrared communication as a standard feature, there is often no need for the user to replace their device, and so the service can be accessed utilizing the phone that the user would normally have. This also means that there would be hardly any additional **cost** for many users, which was important to 97 percent of the participants in a study on conditions of acceptance of m-payment procedures [7]. The cost of installing infrared communication on terminals is low as well so there is a minimal disruption to a merchant.

### 5.4. Near Field Communication

Contactless smart cards have been successfully used around the world either as a payment mechanism, or as transport passes. As discussed in the Introduction, mobile payments require the use of a mobile device. Near Field Communication is a technology that makes it possible to put a smartcard on a mobile phone.

In two major initiatives, existing successful smartcard solutions, PayPass and FeliCa, have been made part of the mobile payments field by storing them on a mobile phone. A smartcard chip was also put on a new Nokia phone shell. Special terminals can read data from such chips using NFC.

PayPass is a Mastercard with built-in technology that enables contactless payments by waving the card in front of a special terminal. According to Mastercard, its PayPass trials in the US have been very successful. The decision to put PayPass on a mobile phone, late in 2004, was made because of the number of people who carry phones with them all the time [20]. PayPass is now embedded in Motorola phones for a trial in the US. The phones use NFC to transmit information from PayPass to readers at shops.

A similar initiative, but not limited to only Mastercard credit cards, is the recently announced Nokia NFC Shell for the 3220 phone, to be available in mid-2005 [21]. The phone shell includes a Java contactless smartcard chip (see Figure 2), which enables storing of various payment and ticketing applications into the mobile phone. Consumer's payment credentials, such as debit and credit cards, are securely stored in the integrated smart card chip of the shell.

**Figure 2. Nokia NFC shell [21]**

FeliCa is another contactless IC (Integrated Circuit) card technology, developed by Sony. It has been used by millions of people around the world, mainly in Asia, for transport and as electronic money. Hong Kong's Octopus system, Japan Railways, and EDY electronic money are the most notable systems using FeliCa cards. The first trials to put the card on a mobile phone were simply by adding a phone cover that would hold Octopus transport cards in Hong Kong in 2002. Nokia's Xpress-on covers were specially designed to incorporate a mini Octopus card. They did not have any link to a phone, and, similarly to popular watches sold with Octopus FeliCa cards built-in, these phones were just a fashionable and convenient 'carry case' for the card.

In mid-2004, a Japanese mobile operator NTT DoCoMo released four handsets containing FeliCa contactless IC chip. It integrates a controller, 5 kilobytes of memory and an antenna. It measures 7 $mm^2$ and comes in a 1-mm-thick package [22].

All such initiatives rely on mobile Internet service to download the required applications and payment credentials before using the system for the first time. More cash can be downloaded via i-mode or other mobile Internet service. These IC chips operate by detecting weak electronic signals emitted by an external reader/writer.

**Ease of use** and convenience are usually stressed as a significant advantage of these solutions. Customers can pay for their goods simply by waving their phones at the terminal reader. Simplicity is facilitated by employing the natural human behavior of touch. The phone can even stay in a handbag. PayPass trials in Dallas with Nokia, AT&T Wireless and JPMorgan Chase showed payments by phone to be six seconds faster than those conducted via PayPass cards [23]. NFC technology works without manual intervention. All the user has to do is hold the sending device near a reader and the data gets picked up automatically. That makes it easier to use than Bluetooth that requires


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IPR2025-01238
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initial setup steps, and infrared that requires a line-of-sight and pointing at a specific angle.

In terms of **usefulness**, while first Octopus cards were simply mounted on mobile phones as a matter of convenience, with PayPass, NTT DoCoMo's FeliCa, and the Nokia Shell, it is more than 'attaching' a smartcard to a phone. To all the smartcard functionality, mobile phones add the connectivity, input and output capabilities. The user can connect through their mobile network to charge what is stored on the chip. They can get access to additional content. With a usual smartcard, the user cannot see the contents/balance of the card without using a special terminal. Using a mobile phone screen, the balance can be checked, or purchase history displayed. The user can view information, and type in new information.

Apart from various credit cards and prepaid electronic cash, other applications that can be downloaded include loyalty schemes, parking and transport tickets, access control cards, or membership cards for clubs, which helps explain why the service is referred to as 'mobile wallet'. People do not have to carry both their wallet and their mobile phone with them, but just one item. A use case described by Nokia illustrates the possible usefulness of NFC in mobile payments: when the user sees a poster with a movie they are interested in, they can simply touch the poster with their phone so the data from the ID tag in the poster is read into it; the service shortcut that was read to the phone allows the user to purchase tickets to the movie; it is also possible to book several tickets for friends, and only pay for one at this stage; on the arrival to the cinema, the user can touch their friends' NFC phones to transfer the tickets so they can pay on their own; at the entry to the theatre the customers touch the ticket reader with their phones [24].

Perceived **trust** is increased in such systems because communication takes place over such a short distance (20 cm maximum). The DoCoMo handsets are supposed to include a number of security features. If the handset equipped with FeliCa technology is lost or misplaced, its smartcard functions or all phone functions can be locked remotely by calling the handset from a preset phone number. Malicious use can also be prevented with the use of either an ID number or the handset's fingerprint sensor to authorize a transaction [25].

Regarding the **mobility** requirement, NFC mobile payments solutions benefit greatly from already established infrastructure for smartcards, including smart card readers. When FeliCa was introduced on mobile phones, Sony had already issued more than 52 million units [22]. A significant advantage is the already huge infrastructure of smart cards readers, which are compatible with the new systems. This however only applies to countries with high smartcard penetration. The weakness of use of this technology is a limited number of phones with such an integrated chip. This is not yet a common feature of a mobile phone, as opposed to infrared, and increasingly Bluetooth. One feature that makes NFC m-payments truly mobile is the fact that the chip can even function when the phone is turned off. Therefore, when the battery is down or where there is no coverage, a payment can still go through. Philips and Sony have also made it clear that they want NFC to be an open standard that is embraced by other vendors to ensure global interoperability.

**Cost** could have negative impact on adoption of current NFC solutions, since it is only available on several high-end phone models. Only four advanced handsets incorporate it at the moment. According to DoCoMo, FeliCa support will come to its new range of phones when the technology gets cheaper [25].

### 5.5. Bluetooth

While traditional Bluetooth applications in cellular phones include wireless headphones, or synchronizing phones with PCs, the use of this technology in m-payments has only been in mobile Point-of-Sale terminals so far. Ingenico makes portable terminals equipped with Bluetooth technology that allow waiters to accept credit card payments at a table. Such terminals link to the base via Bluetooth. In Sydney, Card Access Services (CAS) has recently launched a Bluetooth credit card and smart card reader (CASPad), which now enables mobile merchants to take card present transactions in real time, in the field. A card is scanned using a portable (less than 13cm long) CASPad, which encrypts data using triple DES and sends it via Bluetooth to a merchant's mobile phone, from where it is sent on via a mobile telecommunication network to the Bank Gateway. The CasPay software needs to be installed on a mobile phone, which will also provide entry and read screens. CASPad is targeted at mobile merchants, tradespeople, taxi drivers, and it also used on cruise ships, according to the CAS managing director (Stanford, N., email comm., 7 March 2005).

Bluetooth is not as **easy to use** as NFC. Users cannot transmit payment data by quickly waving a handset past a reader since Bluetooth requires a relatively complex setup process. On the other hand, Bluetooth does not require line of sight as infrared does. For Card Access, this was the main reason why the company decided not to use infrared in their system. Infrared was used in the first attempts to market the system, it failed most user tests however


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because of the difficulty in holding two items accurately in-line for the beams to be reliable (Stanford, N., email comm., 7 March 2005).

In terms of **usefulness**, Bluetooth-enabled products are designed to automatically seek each other out and configure themselves into piconets (networks of two to eight devices). This seems to be very useful in places like a restaurant, where several waiters' portable terminals can connect to one base. CAS system also seems very useful for mobile tradespeople, where a plumber, for example, can take a real-time payment on the spot. There does not seem to be any justification however to use Bluetooth technology in payments using the customer's mobile device.

Bluetooth devices are not associated with high **perceived trust**. Bluetooth broadcasts to everyone in the certain range, and transmits over long distances, so it poses a greater threat that it can be intercepted. A long range and the fact that Bluetooth signal can pass walls can be an advantage in numerous other applications, but in mobile payments it poses a security threat. There are general concerns about using Bluetooth-enabled devices. It can be used to send messages to consumers with Bluetooth-enabled mobile phones at a range of up to 10 metres. Doing so by 'forcing' communication on unsuspecting mobile phone users is known as Bluejacking [26]. Security threats seem too high to justify the use of the customer's Bluetooth-enabled mobile phone for payments. Such concerns have however been solved in the mobile merchants' CAS system, since the CASPad device provides strong encryption before it starts transmitting data.

Bluetooth is available in millions of devices so it can fulfil the **mobility** requirement. Recent report from ARC Group [27] predicts that shipments of Bluetooth smart phones will reach 87.5 million units - about 70 percent of the smart phone market - by 2009. Regarding power consumption, Bluetooth version 2 promises to cut it by half. Availability of Bluetooth in many commodity and personal electronic devices was one of the main reasons behind the Card Access decision to use the technology (Stanford, N., email comm., 7 March 2005).

When it comes to perceived **cost**, Bluetooth is much more expensive than RFID-based NFC. The retail price of a CASPad device is AUD$300 for a merchant. This price, however, according to Card Access, does not seem to be a prohibitive factor to their mobile merchant customers.

## 6. Conclusions

This study investigated how the wireless technologies used in mobile payments can provide the features that are likely to improve user acceptance of such procedures. Systems built on NFC technology seem the most **easy to use**. Billing the customer for digital content on a monthly phone invoice is also a convenient method. Ease of use suffers with voice call back to base for set up and SMS-based systems, as well as in infrared-based initiatives. Bluetooth provides solutions that are easier to use than infrared, but not as convenient as NFC.

The most **useful** systems seem to be provided by NFC again, with infrared offering some, but not all, of the same benefits. Bluetooth seems to provide value for mobile merchants only. Mobile operator billing is limited to low value digital content purchases only, while voice and SMS-based systems on 2G networks provide a benefit of cash and credit card replacement, but do not offer much additional value.

Perceived **trust** seems high in infrared and NFC systems, as well as in low value digital content purchases. 2G solutions require the credit card details registration on the internet so the only concern may be for customers who are not yet comfortable doing that. Bluetooth security concerns require the use of encryption mechanisms before data is transmitted.

In terms of **mobility**, a high number of infrared and Bluetooth-enabled devices makes them well suited to mobile payments. NFC solutions can provide true mobility in countries where smartcard infrastructure is well established. Systems relying on cellular networks are not truly mobile, since they are often limited to one operator's customers. Simpay can be the first system to overcome this limitation.

Billing on a monthly phone invoice is very **cost-effective** for users. Low cost also makes infrared technology ideal for mobile payments, while NFC phones are still expensive. Using Bluetooth in mobile terminals is also costly. The highest cost seems to be incurred by a customer in voice and SMS-based solutions.

As the study reveals, none of the technologies fulfil all the required acceptance criteria. Very cost-effective infrared-based systems are not particularly easy to use, for example. Therefore, the next phase of this research will involve two stages of web-based surveys (one exploratory and one testing hypotheses formulated after the first stage) with the aim of discovering the importance of each of the acceptance factors for the user. This research will try to find out which of the acceptance factors have higher significance to the consumer. They may be willing to accept non-


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fulfilment of some criteria, but reject the system based on lack of one specific factor. This may affect the providers' decisions regarding the use of a specific technology, depending on whether it fulfils the most desired criteria. This future research will hopefully lead to an even better understanding of how successful and widely accepted mobile payment systems can be created.

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