Flexible Services

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1 Introduction

1.1 Background: NFC service evolution

Radio Frequency Identification (RFID) is a method for identifying unique items using radio waves. Typical uses of RFID technology include a passive tag, which can be activated and read by a reader from a distance. RFID technology has been extensively used in areas such as supply chain management and transportation.

Near Field Communication (NFC) is a wireless, short-range communication technology primarily intended for mobile phones. It is based on RFID technology and is compatible with ISO/IEC 14443 -compliant smart cards and readers. These cards include travel cards used in public transportations around the world as well as contactless credit cards.

With a large installed base of smart card readers, public transportation has been considered as a potential killer application for NFC services. Public transportation operators can save in costs by issuing fewer physical smart cards, whereas travelers gain in convenience by being able to check their card information and purchase tickets whenever and wherever needed. If the mobile ticketing service becomes successful, it could drive the deployment of NFC technology further and introduce end users to the benefits NFC can provide.

NFC services are by no means limited to mobile ticketing, though. While this service may help introduce end users to NFC and have an effect on the deployment of the technology, the possibilities of the technology are far greater. Mobile phones with NFC may be used to replace physical keys, loyalty cards of retail stores, or library cards. In addition, mobile phones can connect to each other and be used to exchange greeting cards or electronic money.

NFC mobile phones are not restricted to functioning as smart cards or interacting with each other, however. In fact, NFC technology allows the mobile phones to act as smart card readers, and thus mobile phones are about to become the biggest RFID reader infrastructure in the world. When combined with the intuitiveness of NFC's "touch and go" interface, the services that use the mobile phone as a tag reader have enormous potential. For example, placing inexpensive NFC tags on advertising posters allows users to access the information advertised conveniently, without having to look for it themselves. In addition, the users explicitly choose to access this information without having unwanted advertisements pushed into their handsets. Other solutions for services based on NFC tags include music or movie stores, where touching the appropriate tag allows the user to receive a sample of the music or a trailer of the film to his handset [1].

Some NFC applications deal with confidential information such as credit card numbers or personal information. To safeguard this information, many

applications need to be stored on a secure element, where access to them can be controlled. This requirement places some limitations on the handsets that can be used as well as the different actors that need to be involved in those services. However, it is important to remember that not all NFC services require a secure element. Should there be problems with NFC deployment related to secure elements, these other services may be unaffected. In that case, mobile ticketing or payment may not be the first NFC service used by consumers, but NFC adoption may be driven with services with less stringent security requirements.

1.2 NFC substitutes

NFC technology and the services based on it, such as mobile ticketing, aren't without substitutes or competing technologies. Naturally, many existing systems based on smart cards, such as travel cards, are still very viable and will continue to be used in the future. The challenge NFC mobile ticketing faces will be convincing users that having the tickets inside the mobile phone is more convenient than using a traditional travel card. In addition, public transport operators could choose other options, with which the travelers can pay for their tickets. For example, the ticket applications could be added to another smart card such as a credit card, which would result in a co-branded multi-application contactless smart card. Alternatively, PTOs could choose to simply accept direct credit card payments by contactless credit cards. Another option would be to allow users to purchase tickets from an online portal, giving them some of the flexibility NFC mobile ticketing provides. Additionally, some PTOs allow travelers to purchase mobile tickets already, using other technologies such as simple SMS messages.

There are also substitutes for an NFC mobile phone's function as a tag reader. Mobile phones with integrated cameras can be used to read 2D barcodes that can be printed essentially everywhere. However, reading the barcodes with a mobile phone is much more inconvenient than simply touching a NFC tag with the phone. Besides, 2D barcodes are more prone to vandalism and need better conditions in order to be scanned correctly. Moreover, it is important to note that the possibility of using the NFC mobile phone in card emulation mode allows for much easier validation of tickets than, for example, SMS tickets purchased using 2D barcodes.

1.3 The focus of this report

This report is a deliverable of the EDEN WP2 Ecosystem Design. The report examines the Mobile Financial Services (MoFS) work package 4 Mobile Ticketing and aims to provide an analysis of the business models required for NFC services in general and NFC mobile ticketing in particular. In addition, the report examines several NFC pilots and commercial deployments worldwide and makes recommendations for a possible NFC mobile ticketing pilot and roll out. The report is mostly based on a literature review, complemented by a few expert interviews.

Chapter 2 examines several notable pilots and commercial roll-outs that have used NFC technology. Chapter 3 briefly introduces the STOF Model, which is the theoretical framework used for analyzing the mobile ticketing business model. Chapter 4 examines the business model in detail, with chapters 4.1 through 4.4 focusing on the Service, Technology, Organization, and Finance domains, while chapter 4.5 provides a summary of the key issues examined. Finally, chapter 5 summarizes the main conclusions of the report, examines four possible scenarios for NFC deployment, and provides suggestions for a mobile ticketing pilot and roll out.

2 Mobile NFC Ticketing Worldwide

Since the approval of NFC as an ISO/IEC standard in late 2003, there have been hundreds of pilot projects worldwide. This chapter examines some of the most notable recent pilots testing NFC mobile ticketing, and then looks at the first commercial rollouts utilizing NFC technology.

2.1 Pilots

The O2 Wallet trial in London, UK took place between November 2007 and May 2008. The participants included O2, Transport for London, Transys, Barclaycard, Visa Europe, AEG, Nokia, Giesecke & Devrient as well as a number of other partners. The trial tested having several smart cards in the mobile phone including the Oyster travel card as well as credit cards. The results were very promising, as 67% of trialists found the service more convenient to use than a standard travel card, while 87% said that the availability of the services would be likely to influence their purchase of a new handset. In addition, 22% of the trialists increased their public transport usage during the trial. On the other hand, the users felt that having choice in handsets was crucial, as 85% of trialists considered that the make and model of the handset would influence their decision to take up NFC services. [2]

In San Francisco, USA, Bay Area Rapid Transit District (BART) riders participated in a trial where they could pay their BART fares as well as their meals in Jack in the Box restaurants with a NFC mobile phone. The trial took place from January 2008 to May 2008 and included around 200 participants who made close to 9,000 trips. It was found that more than 80% of the trialists found the mobile wallet application easy to use and that they tapped their phones several hundred times on smart posters in order to obtain directions to the nearest Jack in the Box restaurant. ViVOtech CEO Michael Mullagh touted the success of the trial: “The BART trial results show that transit payment is a killer application for NFC mobile phones providing convenience and speed to customers who take transit and other public transportation frequently. We are also encouraged to see that merchant card payments and opt-in smart poster applications enabled by ViVotech software through the same NFC mobile phone were also highly used by the trial participants.” [3]

Orange planned to launch NFC Services commercially in Bordeaux, France in early 2008. The idea was for subscribers to be able to use their phones to pay travel fares in buses and trams, make purchases in stores, and download promotional information from smart posters. While the rollout was planned to be modest, one of the main purposes of the launch was try to kick the NFC ecosystem into gear and indicate that “we are no longer in the trial phase, and this is the start of a commercial rollout”, as Mung-ki Woo, vice president for payment and contactless at the France Telecom-Orange Group said [4]. However, the planned launch ran into problems later and Orange had to postpone the rollout. Mung-ki Woo commented that “It’s turning out

to be more difficult than we anticipated" and indicated that the delay was partly due to "technical glitches" in setting up the required infrastructure [5]. However, the project ran into further delays, and this time it seemed that having so many players present involved seemed to be causing the problems. One big merchant was reported to have troubles integrating its contactless readers into its payment-terminal system, and putting applications onto the NFC models was problematic [6]. Most importantly, however, the transit operator, Veolia Transport, involved in the project lost its contract with the city's transit authority to Keolis [7, 8]. More than one and a half years since the planned launch of the service, the fate of the project is still unclear.

Some other notable mobile ticketing pilots include Seoul, South Korea, where participants were provided a payment and transport application by SK Telecom that they were able to use for payment and getting travel schedules, as well as Guangzhou, China, where travelers were able to use their Nokia 6131i NFC phones for transit payment, grocery shopping, public pay phone usage, and parking. Additionally, there have been tests in Berlin, Germany, where a system called "Touch & Travel" allows users to utilize their NFC-enabled Motorola phone to travel without having to worry about the correct fares or without buying tickets. Instead, they receive a single bill at the end of the month based on the trips they have taken. [9]

2.2 Commercial roll-outs

The first mobile ticketing NFC pilot in the world was organized in Hanau, Germany, in April 2005. 160 residents tested mobile ticketing in the city's buses, and over 90% of them found the service convenient and wanted to continue using it. Thus, a year later, Hanau became the location of the world's first commercial NFC deployment, when Nokia, Royal Philips Electronics, Vodafone, and the Rhein-Main-Verkehrsverbund (RMV) partnered to bring NFC mobile ticketing to the city's 95,000 residents. In this roll-out, Vodafone sold the world's first NFC phone, Nokia's NFC shell - equipped 3220, in its retails stores. The billing was handled in a post-paid method, with the customers receiving an invoice from the public transport operator at the end of the month based on the best available fares at the time of travel [10]. In addition to the ticketing application, the mobile phones also included a loyalty application, which provided discounts at 14 retail locations [11].

RMV was also involved in a pilot in Frankfurt, Germany, where the users were very pleased with the ticketing service provided. Of the 300 travelers who tested the service for three months, 80% preferred the mobile phone tickets over printed ones, 82% found it easier to buy the ticket with their handsets than from a ticket vending machine, and 25% stated that they were now more likely to use public transport [12]. The main criticism received from the users was that there were too few NFC tags available in the city. Thus, encouraged by the results of the pilot, RMV deployed the NFC ticketing service commercially by placing NFC tags, called ConTags, at all the city's bus stops, metro stations, and ticketing machines. The tags allow the travelers to purchase the mobile ticket called RMV-HandyTicket more

easily, although the ticket can be also purchased with WAP and used even without a NFC-enabled mobile phone. This is because RMV doesn't utilize any NFC-enabled turnstiles or gates, as the ticketing system is honor-based and enforced by random checks of the travelers' tickets by controllers [13]. The NFC tags also allow the travelers to receive current travel information related to the bus stop in question directly to their handsets. This functionality can be used with a NFC-enabled phone even if it doesn't contain the ticketing applications [14]. It is important to note that RMV's NFC mobile ticketing service only allows purchasing single or day tickets and not seasonal tickets and thus it is aimed more towards occasional users of local public transportation.

The most important commercial system that incorporates travel cards and payment cards into the mobile phone is actually not based on NFC, but on Mobile FeliCa. Mobile FeliCa does not comply with the NFC standards, but its functionality is based on the same concepts as NFC's. The mobile wallet service, called "Osaifu-Keitai" was launched in July 2004 [15]. There are currently over 74 million Mobile FeliCa handsets in Japan [16], with over 1.1 million users of the mobile version of the travel card Suica, which was added to the phone in 2006 [17]. The numbers are certainly impressive, and they were reached in large part due to backing from the big players, Sony and NTT DoCoMo, which enjoys a market share of roughly 50% in Japan [18]. As Nokia's director for corporate business development, Gerhard Romen, explained: "In Japan it was easier. It was just the major guys saying, 'This is how it will be.'" [19]. The presence of these players with such a large market power meant that they could tightly define the roles of all the other players. As an example, the service included just one Trusted Service Manager, FeliCa Networks, which is considered to be an important reason for the success of Mobile FeliCa [16]. In addition, NTT DoCoMo can decide the handset features as well as issue electronic money due to looser banking regulations, options which are not available for operators in the EU, for example [20].

While the numbers for Mobile FeliCa adoption are large, they may somewhat misleading. The actual usage of the mobile wallet was somewhat low, with only in four customers using the Osaifu-Keitai function in April 2008 [21]. Daniel Bukenya from the Mobile Consumer Lab in Niigata, Japan explains one reason for this: "One other impediment is that Japan is still a heavily cash driven economy. The fact that customers will need cash for certain transactions and not need it for other transactions has prevented them from fully embracing the mobile contactless payments." [21]. In addition, some people fear losing their mobile phone and all the applications stored there [22]. Nevertheless, transport applications themselves are popular and are making people used to using a mobile instead of having the cards in a wallet [22]. Furthermore, recent reports indicate that the usage of Osaifu-Keitai services has risen, as 60% of the 30 million DoCoMo customers with an Osaifu-Keitai-compatible handset make use of these services [23].

2.3 Conclusions from the pilots and roll outs

NFC mobile ticketing services have been very well received by end users. The travelers find it easier to purchase tickets with a mobile phone and appreciate the convenience the service provides. The approval ratings were as high as 80-90% and the testers would often have liked to continue using the service at the end of the pilots. In addition, the mobile ticketing services had a positive effect on the trialists' usage of public transportation, with over 20% of the users increasing their public transportation use in some pilots.

However, while the results of the pilots and early roll-outs are promising, a full NFC deployment has additional challenges. Where the trials have generally incorporated a single Mobile Network Operator (MNO), Service Provider (SP), and Trusted Service Manager (TSM), the value network of different actors will be much more complicated in a full roll out. NFC services are likely to include multiple MNOs, SPs, and TSMs, supported by several other players. A functioning NFC value network will require these different players to work together in order to create a win-win situation for every actor. Managing such a complex network will not be easy, as was demonstrated by Orange's pilot in Bordeaux, which suffered from delays.

3 STOF Overview

The theoretical framework used for analyzing the mobile ticketing business model in this report is the STOF model, introduced by Bouwman et al. in 2008 [24]. The framework emphasizes the importance of a holistic approach in analyzing business models and consists of four interrelated domains: Service, Technology, Organization, and Finance. Analyzing these domains helps in creating a holistic view of a business model, the ultimate goal of which is to create value for both the customers and the service providers. While the framework can be used for analyzing all kinds of digital services, it was developed primarily for mobile services, making it well suitable for examining the mobile ticketing business model in this report. In addition to the STOF Model, there is a more design-oriented framework called the STOF Method, which presents a step-by-step approach of creating business model designs. This paper can be considered a part of the first step in the STOF Method, the goal of which is to create a business model outline for NFC mobile ticketing. [24]

The Service domain concentrates on the most crucial aspect of a service: the customer value of the service. Thus, the domain analyzes the value proposition of the service and compares the service to existing similar services or previous versions of the service. Some other concepts typically examined in the Service domain include customer segmentation, pricing, ease of use, and the context of use. The Technology domain is influenced by the requirements of the Service Domain and analyzes concepts such as technological architecture, applications, and devices. Other important concepts include security, authentication, and management of user profiles. [24]

The Organization domain analyzes the value network that is required to realize the examined service. The value network consists of actors, who have resources and capabilities. These actors interact and fulfill different roles as well as perform value activities in order to realize their own strategies and goals. The Finance domain describes the financial arrangements in the value network and shows how the actors intend to capture monetary value from the service. The main goal in the Finance domain is to create a win-win situation for all actors and to balance the division and sharing of benefits and costs. Key concepts in this domain include costs, revenues, capital, risks, and their sources. [24]

The four domains are closely linked to each other, as illustrated in Figure 3.1. As an example, the Service domain puts requirements on the technologies used in the Technology domain as well as the value network in the Organization domain, while influencing the revenue sources of the Finance domain. Similarly, the Technology domain influences the delivered value in the Service domain, and the costs in the Finance domain. Likewise, the activities of the players in the Organization domain have a direct influence on the other domains, while the Finance domain, among other things, determines the pricing in the Service domain. [24]

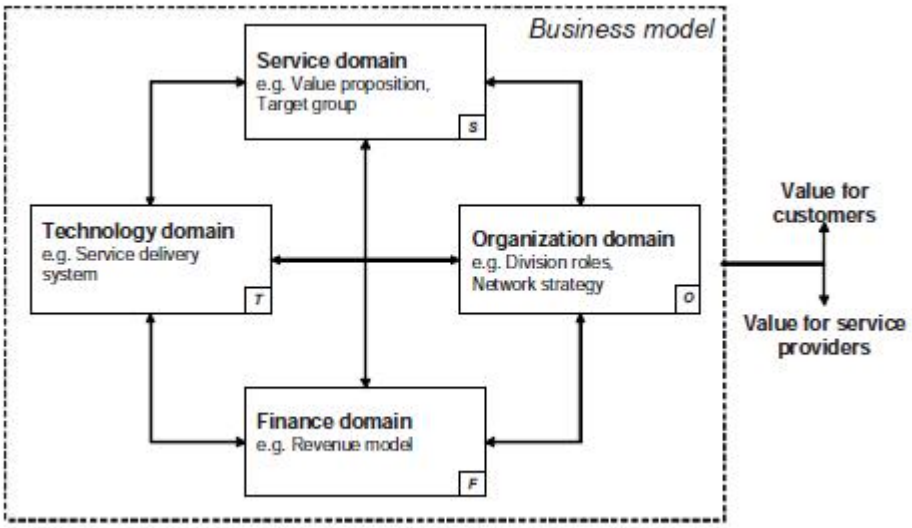

Figure 3.1. STOF Business Model Domains. [24]

The STOF model tries to account for the dynamic nature of business models. Three business model phases (Figure 3.2) are identified in the STOF Model: Technology/R&D, Roll out, and Market. In addition, external forces are summarized into three drivers: market drivers, technology drivers, and regulation drivers. Different drivers may have a different level of impact in certain phases, such as the technology driver having the most significant impact during the Technology/R&D phase. Thus, the business model analysis is meant to be an ongoing process during the lifetime of a service. [24]

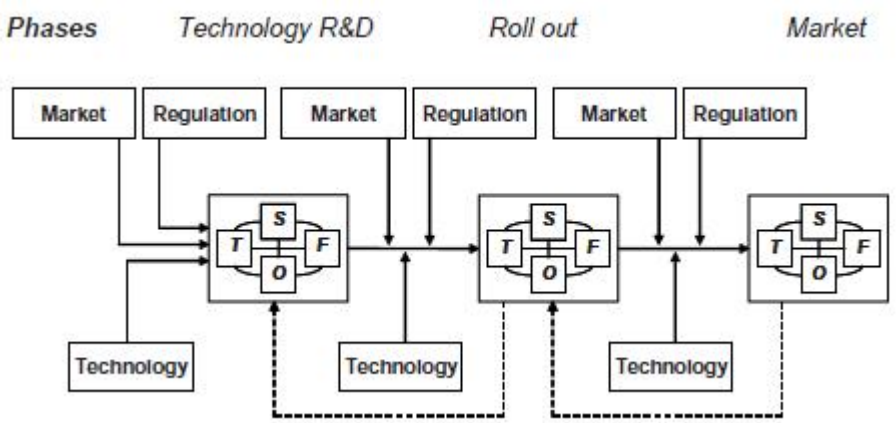

Figure 3.2. The Dynamic STOF Model. [24]

4 STOF Analysis

4.1 Service Domain

4.1.1 Benefits of the service for the end user

A mobile ticketing service based on NFC technology offers numerous benefits for end users compared to previous solutions such as smart card -based ticketing. Unlike smart cards, mobile phones have other uses besides ticketing, so the user is more likely to take the mobile phone with him in the first place and less likely to leave it home. On the other hand, including other functions in the mobile phone such as mobile ticketing, means that the user needs to carry fewer other items, such as smart cards, with him.

Another significant benefit for the end user is being able to purchase tickets with the mobile phone. This ensures that the user no longer has to travel to find a service center, booth, or ticket machine in order to top up his smart card. He also doesn't have to carry any cash with him in order to purchase a ticket. In addition to being independent of place, he can also make the purchases independent of the time of day, buying a ticket even when the service centers are closed or before the ticket will be needed. In addition, the user can automate his purchases so that his travel account is automatically topped up when it reaches a certain threshold. Unlike with a smart card, the user can also review the status of his tickets and account with a mobile phone. This way he can check the remaining value on his account and decide when to top it up. The user could also display information about his past trips, if he chooses to save that information.

Some of these benefits can be realized with existing mobile ticketing services that do not use NFC. For example, Helsinki City Transport (HKL) has offered a SMS-based mobile ticketing service since 2001. The service has been quite popular, with mobile tickets comprising a fifth of all tickets and a third of the tram tickets sold [25].With this service, the user can purchase a single ticket that is valid for one hour by sending a text message. Like NFC-based ticketing, this allows the user to purchase the ticket wherever he wants and just when he needs it, without having to have any cash or a travel card with him. However, the user cannot purchase the ticket in advance and activate it when he needs it, as the ticket's validity expires based on when it was purchased. Moreover, the user can only buy one type of ticket and cannot receive any discounts that he might otherwise be eligible for. In addition, the user can only pay the ticket post-purchase on his mobile phone bill, which makes it impractical for the user's employer to pay for the ticket and also causes issues for those users who are not the operator's subscribers. These issues can be solved with the NFC-based approach, which allows users to purchase tickets beforehand and activate them later, to purchase multiple kinds of tickets, and to use different methods of payment. However, a SMS-based mobile ticketing service can be considered easier to use, as the travelers are more used to sending SMS messages than utilizing NFC services. In addition, whereas a SMS service works with all

handsets and UICCs[1], NFC services work with a limited number of handsets and UICCs. Finally, the SMS service can be taken very quickly into use by only sending a SMS message, whereas in the case of the NFC service, the user might first have to download the ticketing application and only then purchase the ticket.

There are also other benefits of NFC services which are not likely to be realized right away in the first commercial roll-outs of the service. One such benefit is the ability to use the electronic money on the user's travel account for making purchases other than the tickets issued by the service provider. These purchases could include tickets issues by other Public Transport Operators (PTOs) but also anything offered by merchants with a compatible point-of-sale infrastructure. However, this would require a bank or credit institution as an issuer of electronic money, which is why this option is not necessarily available from the start. A second benefit would be combining the ticketing application and possibly the NFC chip with third-party, value-adding applications. Some potential applications include using location information for plotting possible routes and purchasing tickets for those routes, as well as displaying the user's travel history on a map and perhaps sharing it with other users.

However, it should be noted that not all users will want to combine their travel card with their mobile phone. Some people feel that bringing the travel card into the mobile phone brings security issues when compared to a normal smart card. Others consider mobile services and their user interfaces cumbersome to use and prefer the simplicity of smart cards. Still others don't want to have anything too private or confidential on their handsets and want to retain the mobile phone as a device they can lend to their friends. Nevertheless, numerous NFC mobile ticketing trials have shown that the users are interested in the technology and feel that mobile ticketing is more convenient than using standard travel cards.

4.1.2 Mobile Ticketing service use cases

4.1.2.1 Downloading the application

Perhaps the most crucial step in trying to get people to adopt mobile ticketing is getting the ticketing application into their handsets. One advantage of combining a smart card with a mobile phone is that the mobile phone already includes a wireless channel that can be used to transmit applications. This OTA (over the air) channel allows transferring the ticketing application into the end user's UICC (Universal Integrated Circuit Card, often called the SIM card), which could function as the secure element. However, while using the OTA channel allows the end user to download the application anywhere and anytime, users have found this to be somewhat problematic in certain cases. MasterCard's trial in Dallas discovered that users had problems downloading the applications to their mobile phones, while similar problems have occurred in Japan with the

[1] Universal Integrated Circuit Card, the 3G version of a "SIM card"

Mobile FeliCa wallet phones [26]. These issues can be mitigated by making the download process as easy and intuitive as possible such as by using NFC tag -equipped smart posters that allow the user to download the application with one click. However, even then there can be issues if the downloads are too slow, taking as much as several minutes [27]. Moreover, if the user has to take further steps to take the application into use, such as installing it manually, he is less likely to go through with the process.

One alternative option for getting the application to the user is to preinstall it on the secure element. In the case of UICCs, the Public Transport Operator would have to work together with a Mobile Network Operator (MNO), who would order the UICCs from the manufacturer and request that the application provided by the PTO be preinstalled on the UICCs. Because the current installed base of UICCs cannot function as secure elements, the user's UICC will need to be changed anyway and the preinstallation would, thus, require no extra steps. In fact, it would be quite inconvenient if the user had to change his UICC and then manually download the application over the air. This preinstallation alternative could be practical with mobile ticketing applications, as these are expected to be the first NFC applications people would use and they are expected to drive NFC adoption. However, this strategy cannot be used with later applications that need to be installed after the UICCs have already been changed.

A third alternative is for customer service people to install the application for the user. See chapter 4.1.2.6 for ideas on how the customer service could be arranged.

4.1.2.2 Purchasing a ticket

After the ticketing application has been installed on the user's phone, the next step is to purchase and download a ticket. The key issue here is usability, which is supported by a clear and intuitive graphical user interface. The user should have no trouble finding the precise ticket type he wants and downloading the ticket (OTA) to his handset. If the space available for the storage of tickets is limited, the user might have to delete another ticket before downloading a new one [28]. However, this can be very awkward for the user and should be avoided if at all possible, either by automatically removing tickets which can't be used anymore or by providing enough space for this not to be a problem. Another issue is entering personal information. Assuming the fare structure of the PTO supports anonymous tickets, the user should be able buy such tickets quickly without entering any personal details. However, he should be able to add his personal information at a later point and buy personalized tickets, which could be discounted. It should be possible to enter these personal details also via an internet portal, as typing these with a mobile phone can be inconvenient. Because purchasing a ticket can involve many steps, renewing tickets that have been purchased previously should be made into a more simple operation requiring only a few clicks.

4.1.2.3 Using a ticket

When the user has downloaded a ticket, he uses it at some point at a smart card reader. The user might need to select beforehand which ticket to use, so that it is transferred to the NFC chip in the mobile phone. However, if possible, as long as there is a valid ticket on the mobile phone, it should be used as the default ticket. This ensures that the user is able to use the mobile phone for ticketing even if the phone is not turned on or the battery has run out. It should be noted that the current technology allows the handset to emulate a smart card if the battery has run out but not if the battery is completely removed. This might, actually, be the functionality desired by the user, as he would expect to be able to use the handset as a smart card if his battery runs out, but he would expect the ticketing functionality not to work if he completely (and possibly intentionally) removes the battery.

If the user doesn't have a valid ticket, he may purchase a ticket from the reader as long as he has enough value (electronic money) on his phone to do that. The key issue here is that the mobile phone functions exactly like a smart card when shown to a reader. This way the normal usage of the phone, such as voice calls or messaging, are not affected by using the phone for ticketing and, on the other hand, validating a ticket is not any slower with a mobile phone than with a smart card. Similarly, the phone functions like a smart card when it is inspected by a ticket inspector carrying a portable reader.

4.1.2.4 Using a smart poster

Smart posters can be used to support and promote a NFC mobile ticketing service. Smart posters are posters which contain a passive NFC tag that can be read by a NFC-compliant mobile phone acting as a reader, when the user brings the phone close enough to the poster. The tags can contain different kinds of information, and may allow the user to more easily download the ticketing application to his mobile phone or to purchase a ticket at a discount. However, as this is a completely new kind of functionality, the tag mode may not be immediately apparent to users. To make this clearer, it is necessary to promote the NFC functionality of the posters and help users associate the NFC logo with a NFC tag service. There should also be a way to clearly indicate to the users what happens when they activate the NFC tag [29]. In addition, using a mobile phone to scan a poster is a very public act and not something that people are used to doing. This might present a problem for some users, depending on how private they consider their mobile phone usage to be. While one study concluded that people view this activity similar to making a call in public [29], this issue could warrant further study.

4.1.2.5 Viewing ticket and account details

At any point after downloading the ticketing application, the user may view the tickets he has purchased. He should be able to see all the valid tickets he has and how much electronic money, if any, he has on available. It should also be possible for the user to see any used tickets and possibly even

statistics on where and when he has used the tickets. However, the user should explicitly enable this kind of functionality in order to minimize privacy concerns.

4.1.2.6 Contacting customer service

When a user runs into problems with the mobile ticketing service, he should be able to contact customer service. With the mobile ticketing service, the most natural point of contact would be the PTO, which already handles issues with travel cards and which would likely be the organization most visibly branded with the service. However, since many of the issues can be technical in nature, it should be ascertained that the customer service people are familiar with these issues.

Another option, as suggested in [28], would be to use the MNOs' customer service. The MNO personnel should be able to help with any technical problems, they would be able to inform the customer whether his mobile phone or UICC supports NFC services, and they would be immediately able to help the user upgrade his handset or UICC if that is required. However, they would not be as knowledgeable with the issues related to the actual ticketing service, and then the customer service would be fragmented into many different organizations, as all the different MNOs would have to be able to provide help to their customers. Because of this, it would likely be better to have the mobile ticketing customer service centralized in a single unit. This customer service unit could then contact e.g. the MNO or Trusted Service Manager (TSM) if there is an issue that requires actions from them. One such issue would be the customer losing his mobile phone, in which case the TSM could disable the ticketing application on the secure element and prevent anyone from using the existing tickets or purchasing new ones with the mobile phone.

4.1.2.7 Changing the handset or UICC

At some point, the user might wish to change his handset into a new one. In this case, assuming the secure element used is the UICC, the change should be quite simple. If the new handset is NFC-compliant like the old one, the user just has to remove his UICC from the old phone and insert it into the new one. Only if the user interface of the application is located outside the UICC does the user have to download something to get the service working again. However, things are more complicated if the user wishes to change his MNO. In this case, the user's old UICC is disabled and he receives a new one. This new UICC may either contain the ticketing application or the user has to download it again over the air, together with any other applications he had installed in the secure element previously. In any case, the user has to re-enter his personal information and download his tickets again. Any statistics or additional information displayed in the ticketing application should be stored in the system backend and restored to the user once he has entered his personal information again.

4.1.3 Payment methods

One very important part of the mobile ticketing service is how the payment of the tickets will be handled. [30] presents four different solutions: The most common approach for automatic fare collection (AFC) is the prepaid-value model. In this model, the user pays for the ticket beforehand and receives stored value in exchange. This stored value can be a limited number or rides, a time-based period pass, or a certain amount of electronic money that can be used to pay the fares. In the enhanced payment model, a payment application simulating a credit/debit smart card residing on a secure element can be used to pay travel fares directly. In this case, the payment happens essentially in real time as soon as the fare is calculated. This model can also be called the payment-provider-centric model, as the banks or credit card issuers are responsible for issuing the application to the end users and for ensuring that the PTO's systems are compatible with it. The third model is the post-paid model, in which the user's travel fares are paid after the journey, based on recorded usage. Finally, in the combined/enhanced collaborative model, the end user has an NFC-enabled phone with both a ticketing and a payment application. In the combined model, the user can use the ticketing application to purchase tickets using the prepaid or postpaid schemes described earlier and the payment application for making other, unrelated purchases. In the enhanced combined model, the end user can select the payment method and use either the payment application for direct payment of the ticketing application for pre- or post-payments. [30]

The pre-paid model is the most common payment method used in public transportation and has been found to work well in practice. The users can choose their tickets beforehand and know exactly how much they are paying for their journeys. PTOs, on the other hand, don't need to worry about credit risk and have optimized their AFC systems for this method. However, the users have to familiarize themselves with the fare systems that can be very complicated at times and they can't use the electronic money stored on their accounts for any other purchases. The actual payment process in the prepaid model can happen in multiple ways. The user may have a travel account used only for purchasing tickets and funds can be transferred to this account via a web portal using traditional internet banking, for example. Alternatively, while purchasing a ticket, the user may be sent an electronic bill to his mobile phone, which he pays using a separate banking application.

The enhanced payment model offers clear benefits for the end user. He can use his credit/debit card on his mobile phone for all kinds of purchases, and the PTO is just one merchant among others. This means that the user doesn't have to worry about maintaining a single account that can only be used for purchasing tickets. In addition, the user doesn't have to be familiar with the PTO's fare systems, as the correct fare is automatically calculated based on the trip taken.

The post-paid method has some advantages for the end user compared to the prepaid and enhanced payment models. Unlike in the prepaid model,

the end user doesn't have to prepare for the journey by purchasing a ticket or electronic cash beforehand. The post-paid model, like the enhanced payment model, also eliminates the need to be familiar with the local fare system. Additionally, unlike in the enhanced payment model when using a debit card, the user doesn't have to pay for the fare until he receives the bill. However, the post-paid model has disadvantages as well. First, the end user is used to paying the tickets beforehand or each time he travels, and a large monthly bill may not be preferable. Second, the user might want his employer to pay the bill, and this is likely to be impractical if all his journeys are billed on the same invoice. Additionally, the PTO is not used to sending its passengers monthly bills or having to bear the credit risk. One way to solve this issue would be to outsource this activity to another actor such as a MNO (suggested in [28]). A MNO is good at collating numerous micropayments into a larger bill, it already sends these bills to its customers, and it is also used to handling the credit risk of its customers. Further, the MNO subscribers are already used to receiving monthly invoices from the company. However, having the MNOs handle the billing would involve making an agreement with each MNO separately. Moreover, the billing would then be tied to the MNO subscriber, which might not be the same person as the one using the mobile phone. One version of the post-paid method used with NFC technology is currently in pilot testing in Deutsche Bahn's Touch & Travel project [31].

The enhanced combined model offers the clearest benefits for the end user. He can choose the payment model which suits his needs the best in a given situation. For example, he might use the enhanced payment model to charge his VISA card when he is visiting a city, the fare system of which he is not familiar with. On the other hand, he might use the prepaid model to purchase a one-month period ticket when he returns to his home city and knows the fares and his travel needs more precisely.

When mobile ticketing services will be rolled out, only one or a few of these solutions may be supported. However, it is a good idea to support multiple payment solutions in the long run, as this will ensure that end users can choose the option that is the most convenient to them.

4.1.4 Targeting the service to end users

Previous research [32] based on SMS ticketing suggests that use context matters in end user acceptance of mobile services. SMS ticketing was found to be most useful in situations where the users were in a hurry, where other ticketing alternatives were not available, when the need for a ticket was unexpected, or where there were queues at the ticketing point-of-sale locations.

Taking into consideration these implications, a NFC ticketing service could target the people who would rather not use the smart card -based ticketing service because of contextual factors. This has been accomplished quite well with SMS ticketing, but an NFC-based service could add value to this by offering more options such as different payment methods and more

flexibility with the types of tickets that can be purchased. However, in order to attract the people who need the ticket when they are in a hurry or need the ticket unexpectedly, the ticketing service should be both easy and quick to use. If ordering the first ever NFC ticket is seen as too complicated or slow by the users, they might refrain from using mobile ticketing or prefer a SMS-based solution. Nevertheless, allowing people to purchase tickets quickly and conveniently based on their contextual needs could introduce them to the NFC ticketing service. After the users have become familiar with the service, it could then be possible to encourage these users to adopt the more advanced options of the service and even to forgo using a traditional travel ticket altogether in favor of the NFC mobile ticketing service. This way, the service could reach the regular users of public transportation who constitute the majority of the users.

4.2 Technology Domain

4.2.1 RFID & NFC General

Perhaps the biggest technical benefit of NFC is that it is compatible with previous short-range RFID technologies, most notably ISO/IEC 14443, as well as the proprietary technologies MIFARE (NXP) and FeliCa (Sony). This means that mobile phones with NFC chips can emulate smart cards, and existing smart card readers will see them as normal smart cards. In a 2008 global expert survey, 80% of the respondents considered compatibility as an important NFC driver [30].

In addition to the emulation mode, a mobile phone with NFC can act in reader mode. This means that the mobile phones can read NFC tags, which can be placed in numerous places, such as in posters, product labels, magazines, and so on. Reading these tags with a mobile phone allows the users quick access to NFC services without having to go through many manual steps such as opening a mobile browser and finding the correct URL. In fact, the touch-based interface of NFC is one its strong points, as end users find it easy and intuitive.

The third mode that can be used in NFC-equipped mobile phones is the peer-to-peer mode. This mode allows users to connect to each other's handsets and, for example, exchange greetings cards or transfer electronic money. In addition, the NFC peer-to-peer mode can be used to initialize a connection between two devices, and the actual connection will occur with another technology such as Bluetooth. This makes it easier for users to set up connections between two devices, as they can select which two devices they want to pair by bringing them close together without having to find the devices from on-screen menus. Furthermore, NFC setup times are faster than with Bluetooth, which means that the users can just briefly bring their handsets in contact with each other, and then comfortably continue the communication using Bluetooth at a longer distance.

One of the key requirements of NFC is that the handsets can function in passive mode, in which case they get the required power from the active RF field and need very little battery power to operate. This ensures that the

devices will function even if they don't have enough power to be turned on, although NFC functionality with the battery completely removed is not technically feasible at this time. Then again, the users might prefer this feature, as they could remove the battery and be sure that the mobile phone does not communicate at all.

4.2.2 NFC handset availability

One issue that has constantly been cited as the reason behind slow NFC deployment has been the limited availability of NFC handsets. For example, in the previously mentioned survey, 69% of respondents considered the lack of NFC devices as slowing NFC adoption [30]. Because there are few handset models available, the number of NFC mobile phones sold so far has been very low. Yankee Group [33] predicts that there will only be 34,600 NFC mobile phones in use by the end of year 2009, most of them in Europe. According to this forecast, the tipping point would not come before 2013, when the number of NFC handsets will reach 80.8 million.

There are several reasons why there are so few NFC handsets in the market right now. First, standardization of certain key protocols took time and mobile phones supporting these standards could not be produced until recently. In particular, the Single-Wire Protocol (SWP, ETSI TS 102 613), which specifies the interface for low-level communication between the UICC and NFC chip, has only recently been incorporated in handset designs, such as Nokia's 6216 Classic, which should be available later in 2009. Second, the end user demand has been non-existent. The reason behind this is the classic chicken-or-egg problem: There are few NFC services because there are few handsets available; on the other hand, there is little end user demand for NFC handsets, because there are few NFC services.

The third reason for the slow deployment of NFC is that the business models behind NFC services are still unclear. This was also found to be a significant NFC restraint in the expert survey by 82% of respondents [30]. In particular, Mobile Network Operators (MNOs), who subsidize handsets in many markets, are reluctant to order the devices from the manufacturers without a clear vision of how their investments will be recouped. It is precisely these orders from MNOs that the handset manufacturers are waiting for. As Gerhard Romen, the head of NFC business development at Nokia at the time put it, "You tell me you want to buy 100,000 phones or a million; fine, we're happy to serve you." [34] However, the order sizes have to be large enough for some handset manufacturers to start producing the phones. "Basically, we won't build phones unless it's a million of them (ordered)," says Tom Mockridge, business development director for converged networks at Motorola [35].

Getting just one suitable handset model into the market is unlikely to be enough to significantly drive NFC adoption. In London's NFC trial, 85% of the trialists felt that the make and model of the handset will have an impact on whether they will take up NFC services [2]. While 87% of London's trialists said that the availability of NFC services could influence their purchase of a new handset, users are unlikely to purchase a new phone these services

alone, as has been found in Japan [34]. According to a manager of the Dutch operator KPN, “One handset is no handset. Customers want a choice.” [34]. According to Cyril Annarella, senior VP of Asia marketing for the telecom business unit of Gemalto, “If you want to develop the whole ecosystem, you need to have more than 20% of handsets on the market to support NFC, so it’s going to take some time to get there.” [36]. Consequently, Nokia’s Romen sees that NFC will be adopted in handsets in the same manner as Bluetooth: first in a few devices, finally as a standard part of all new handsets [37].

4.2.3 Secure Element

While many NFC applications can function perfectly well without storing confidential information on the mobile phone, those applications, such as payment and ticketing applications, that do need to handle confidential data require a safe storage place for this information. This safe storage place is a hardware component called a Secure Element.

There are three different solutions that are widely considered as Secure Element alternatives. The first solution is to have the secure element integrated into the handset as an embedded chip. While this has been the solution in the early NFC handsets and trials, the embedded chips are not widely standardized and may differ from handset to another. Moreover, changing one handset to another requires the user to transfer all the information stored on the embedded chip on the old handset to the new one, and the integrated chips increase the cost of the handsets. The second solution is a removable, secure memory card. This option also suffers from a lack of standardization as well as incompatibility between different handsets. However, any stakeholder can issue secure memory cards, which means that service providers don’t have to place their applications on hardware controlled by another party. On the other hand, this could present a problem for end user, who might have to switch between multiple memory cards.

The third option for a secure element, the Universal Integrated Circuit Card (UICC), is currently considered the most promising solution for a Secure Element. The UICC is the furthest standardized SE option, and while UICCs are not yet widely installed in MNO subscribers’ handsets, they are expected to be distributed globally by the MNOs. As UICCs already have other uses besides functioning as a secure element, this removes the need to market the secure element. UICCs also have a long operational lifecycle, and will need to be changed much more rarely than handsets. UICCs are widely accepted as the SE of choice in the first larger NFC service roll-outs. For example, Mobey Forum, the financial industry -driven organization, supports the use of UICC as the preferred SE [27].

However, service providers, and especially financial institutions, have had their reservations about placing their applications on the UICC. A big issue has been control: if the MNO issues the UICC, they are in control of the platform where the secure applications are placed, whereas in the past, the financial institutions have been able to issue their own payment cards. In

addition, there have been questions about the security of the UICC. While UICCs and banking smart cards have the same underlying technology, banks face much stricter certification standards than MNOs with UICC. Moreover, the issuing cycles are different between the financial industry and MNOs, as merely the certification of new banking applications can take more than a year, whereas MNOs can issue UICCs in months [35]. Nevertheless, co-operation between the two industries should ensure that the UICCs issued by the MNOs are sufficiently secure.

While the UICC is currently the preferred secure element, embedded chips and secure memory cards are still considered as future options. Assuming the sufficient standards emerge, there could be multiple secure elements present in the same handset in the future. This could enable multiple business models, the most suitable of which could be chosen for a given market situation. For example, if the MNO subsidizes the handset, it could select the UICC to be used as the secure element. In other situations, the service providers might be able to choose their preferred secure element based on security reasons or financial considerations, for example. Additionally, the end users could be the ones to select the secure element used, based on their convenience or pricing considerations. [38]

However, while MNOs promote the use of the UICC as a secure element, they would also like to control other separate secure elements included in handsets as well. A point of contention has been the Host Controller Interface (HCI), which deals with the upper communication layers between the NFC chip, UICC, and other handset elements. Gemalto, with backing from large MNOs, has been pushing for the UICC to have a say in all communication between the NFC chips and other elements in the phone or even have the UICC control what applications can be installed on the other secure elements [39]. Nokia, on the other hand, has opposed this vision and has insisted that the HCI protocol only apply to the connection between the UICC and NFC chip and not the other secure elements in the phone [39]. The HCI standard was finished in ETSI in February 2008, and was applauded by GSMA as “routing all secure applications … through the SIM card” [40]. However, while the standard goes technically beyond mere communication between the UICC and the NFC chip, the true scope of the standard is still somewhat unclear and may only determined in the implementation phase. In any case, the roles and responsibilities of multiple secure elements are yet to be fully determined.

4.2.4 Security and privacy

Contactless, RFID-based devices have drawn criticism concerning privacy from customer activist groups for some time now. Fears of Benetton introducing RFID tags to its clothing caused a consumer group to call for a boycott of Benetton clothing [41]. Likewise, the German Metro Extra Future Store had to cancel its trial, where it included an RFID tag in the store’s loyalty card. Customers feared that the store could track the customers’ passage through the stores and what items they bought, despite the company’s assurance that this was not the case [42].

Adding NFC technology into a mobile phone is likely to raise privacy and security issues as well. A NFC-enabled mobile phone may combine multiple smart card applications and communicates using both short-range and long-range technologies. Attacks against the device could happen without the user noticing it, and the benefits of taking over a NFC mobile phone are likely to be high. However, the short range of NFC connections reduces some of these threats, together with a hardware-based secure element used to store confidential information.

Smart posters or any NFC tags located in public places could prove to be especially vulnerable to security threats. The tags could be vandalized or they could be replaced with tags that are used in phishing attacks. Several threats are examined in [43]. However, using digital certificates can eliminate some of these issues.

In addition to technical solutions to security, managing public perception of the security and privacy issues of NFC is going to be a key concern when aiming for a commercial deployment of NFC services. Also, any security or privacy related problems in the early rollout phase of a service could have a substantial negative influence on the NFC ecosystem. For example, a few widely-published attacks against NFC tags might undermine the public's confidence in them, even if these vulnerabilities are later corrected.

4.2.5 Application development

While the core application that handles confidential information and electronic tickets resides on the secure element, the user interface of the application can also be placed elsewhere. For example, the user interface could be implemented using J2ME and stored on the handset. This allows displaying rich graphics for the logos, coupons, and tickets related to the different services. On the other hand, the UI implementation is dependent on the handsets, which can have differences in Java Virtual Machine implementation. This also means that the applications have to be tested for all NFC handsets. In addition, storing the UI on the handset requires reinstalling the UI in case the handset is changed, and the OTA process for the application is more complex [44].

The other option is to store the UI on the UICC, a solution which is favored by the SIM manufacturers and some mobile network operators such as Orange [28, 45]. This option could currently be accomplished with the SIM Tool Kit (STK), which allows creating applications that work very interoperably between different handsets. However, STK only allows creating a text-based user interface, which might not be acceptable to service providers which wish to display their logos and brands to the user. A newer technology, Smart Card Web Server, allows creating and storing HTML pages, which are rendered by the handset browser. This allows creating more elaborate graphics, although they can still be limited when compared to the J2ME-based solution. Moreover, the SCWS technology is still new and not widely supported, the developers have much more experience in Java, and updating the UI without the involvement of the MNO could be next to impossible. Nevertheless, the UICC-based solutions do offer some

advantages, such as the ability for the user to transfer both the application and the UI to a new handset by simply transferring the UICC, as well as easier integration of the UI and the application residing in the secure element, assuming the secure element used is the UICC.

As mentioned, J2ME-based UI solutions suffer from limited interoperability between different handsets. The StoLPaN project offered a solution to this in the form of a wallet application for NFC services. This wallet application, called the StoLPaN HOST, "provides a transparent environment for the simultaneous operation of various NFC-based service applications by neutralizing specifics of the handset design and taking care of resource, security, and communication management" [38]. In addition to the interoperability issue, by separating the security functions, this kind of solution may also allow more dynamic application development that is not slowed down by security concerns.

This kind of wallet application also helps mitigate a problem that the end users may face – while using and selecting a single application in the mobile phone is easy, it is more difficult to handle multiple applications, each of which may be different in look and usability. Even without a wallet application, application developers should harmonize the user interfaces of all different applications utilized by the service. For example, a ticketing service is likely to include both a payment application and a ticketing application which should be easy to use together.

However, another problem with multiple applications may persist, if the UICC is used as the secure element. Some NFC trials have used UICCs with 128KB and 256KB of memory, which only allows storing up to six or seven applications on the secure element [36]. While this is quite suitable early on, the limit could prove problematic, should the NFC ecosystem take off and the users wish to transfer all their smart cards into the mobile phone. This is especially true if the user interface is stored on the UICC, as the space available for the actual applications is more limited then.

4.2.6 Over the air (OTA) channels

Over the air channels make it possible to provision, personalize, and update applications in the mobile phone remotely. In a mobile ticketing context, an OTA system allows the user to download the application to his mobile, the service provider to personalize the application, and the user to purchase and download tickets to his handset.

Unfortunately, the OTA processes are currently fragmented in a large part. Ideally, service providers could provision their applications to all handsets, secure elements, and secure element issuers using one standardized process [27]. In addition, downloading an application via the OTA channel may be slow. While the download depends on the application, its security level, and the connection used, download times of several minutes are not unheard of [27].

4.3 Organization Domain

While there have been numerous NFC trials worldwide in the past several years, they have mostly included a very limited number of participants. The trials have generally incorporated a single Mobile Network Operator (MNO), Service Provider (SP), and Trusted Service Manager (TSM). However, when NFC services will be fully rolled out, the ecosystem of different actors will be much more complicated. NFC services are likely to include multiple MNOs, SPs, and TSMs, supported by several other players. A functioning NFC ecosystem will require these different players to work together in order to create a win-win situation for every actor in the value network.

This chapter will examine the NFC ecosystem. First, an example value network is provided and the different roles (functions to be performed) therein are briefly explained in chapter 4.3.1. Second, the actors that are likely to fulfill these roles are introduced, and another value network with specific actors is provided. The most important actors of the NFC ecosystem and their goals are examined in more detail in chapter 4.3.2.

4.3.1 Roles

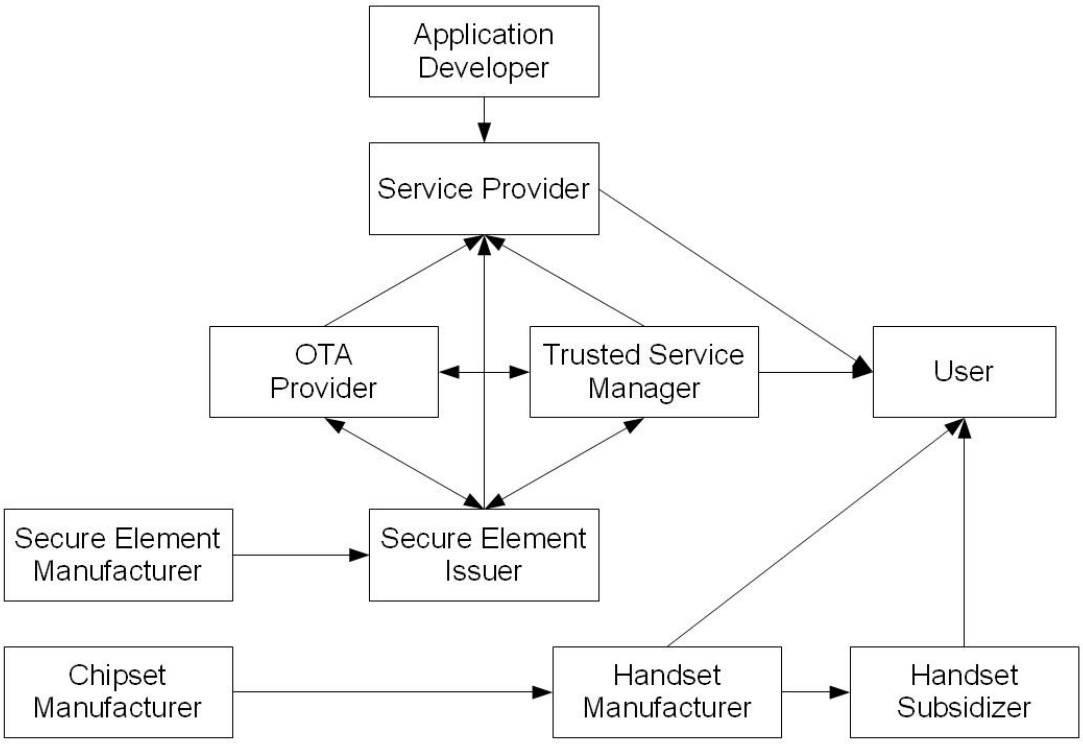

Figure 4.1. Roles in a generic NFC service value network.

Figure 4.1 displays the different roles in a generic NFC service value network. This figure is a simplification of a real-world value network, which would include multiple actors fulfilling the different roles. In particular, implementing a single NFC service is likely to include numerous Secure Element Issuers, Trusted Service Managers, and Handset Manufacturers.

4.3.1.1 User

This is the user of the NFC service. The role of the user is examined in more detail in the Service Domain, chapter 4.1.

4.3.1.2 Service Provider

A Service Provider is an actor who wishes to provide an NFC service to the end users. This actor deploys an application to the Secure Element of the handset and manages it after deployment by personalizing and updating the application. Alternatively, the Service Provider can subcontract this activity to another actor, such as a Trusted Service Manager.

Essentially anyone can be a Service Provider in the NFC ecosystem, but likely candidates for first large-scale NFC services include public transport operators, banks, and credit card companies.

4.3.1.3 Secure Element Issuer

The Secure Element Issuer (SEI) is the actor who issues and controls the secure element. This actor is responsible for loading, installing, deleting, extraditing, and personalizing the applications on the secure element. Alternatively, these tasks may be delegated to another actor such as a Service Provider or Trusted Service Manager. The Secure Element Issuer is responsible for managing the pre-issuance production processes of the secure element as well as many of the post-issuance processes including final decommissioning of a card. [46]

4.3.1.4 Trusted Service Manager

The Trusted Service Manager (TSM) is a support role for both Secure Element Issuers and Service Providers. According to GlobalPlatform, a TSM provides the technical capability to allow both the SEI and the SP to send messages to each other and to allow them to perform NFC services management [46].

Trusted Service Managers also help in scaling up the NFC ecosystem by managing complexity between multiple Service Providers and Secure Element Issuers. A TSM can manage not only the technical aspects of these relationships, but also the contractual side as well. Figure 4.2 illustrates the role of TSM in this regard.

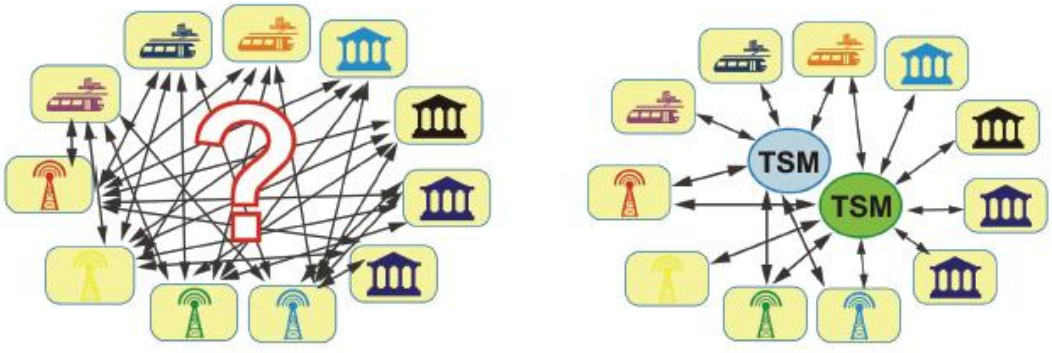

Figure 4.2. The role of a TSM in managing complexity. [46]

GlobalPlatform also defines three different business models that a SEI (in this example a MNO) can use to manage the applications on the SE. In Simple Mode, only the SEI performs content management, but the TSM can monitor this. In Delegated Mode, the content management is delegated to a TSM, but it always has to ask for authorization from a SEI to perform this management. Finally, in the Authorized Mode, content management is fully delegated to a TSM for a sub area of the SE. The different modes are illustrated in Figure 4.3. [46]

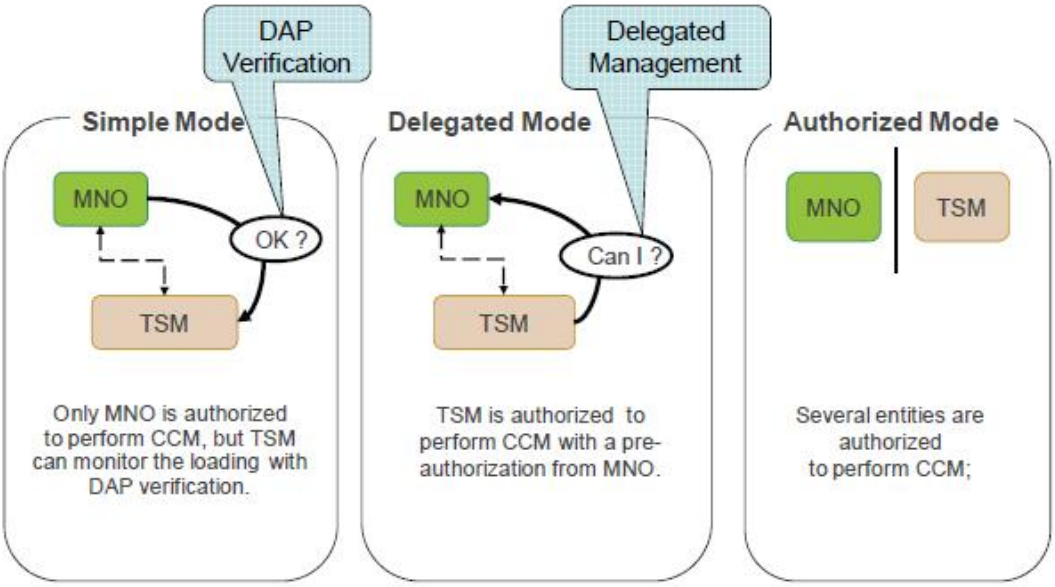

Figure 4.3. Different business models for application management. [46]

First Data, an American payment processing company, divides the tasks of a TSM into four areas of interdependent activities: MNO Management, OTA Provisioning / Handset Wallet Management, Service Provider Application Management, and Service Provider Management [47]. The tasks are shown in Figure 4.4.

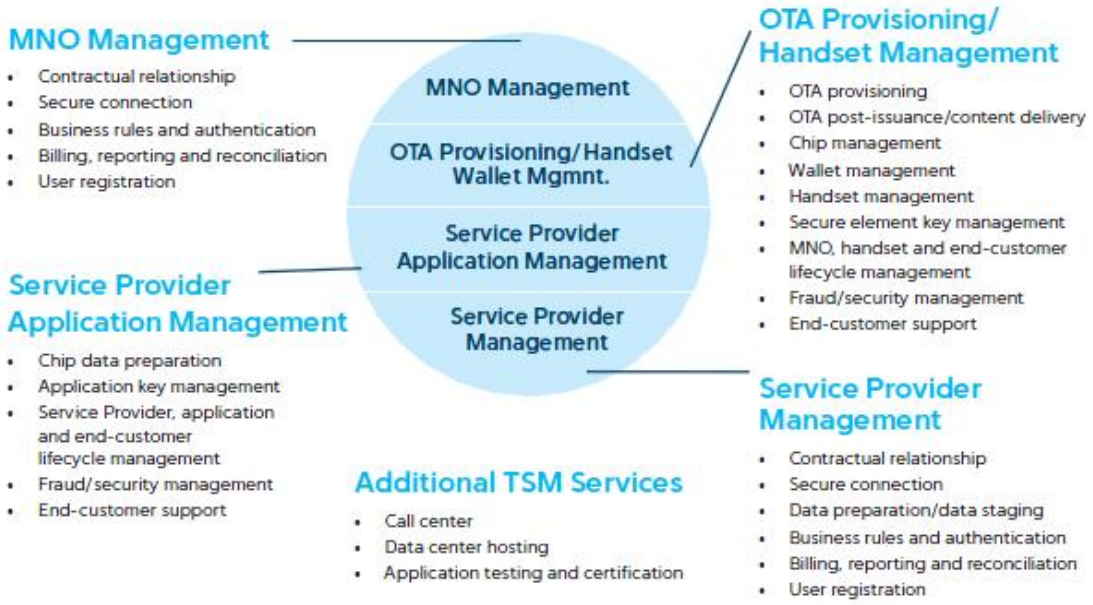

Figure 4.4. Essential tasks of a TSM. [47]

4.3.1.5 Handset Manufacturer

The Handset Manufacturer is responsible for producing NFC-enabled handsets that include or can support a secure element. The Handset Manufacturer may sell the handsets directly to the end users, or it may sell them to a handset subsidizer, who leases them to the end users.

4.3.1.6 Secure Element Manufacturer

The Secure Element Manufacturer is the actor that produces the secure elements according to the specifications of the Secure Element Issuer.

4.3.1.7 Chipset Manufacturer

The Chipset Manufacturer fabricates the required chips, such as NFC chips, as needed by the Handset Manufacturer.

4.3.1.8 Application Developer

The Application Developer provides the application which fulfills the requirements of the Service Provider. This can include the application that is stored on the secure element as well as the graphical user interface, which can be stored elsewhere on the handset.

4.3.1.9 Handset Subsidizer

Handset Subsidizer, in most markets, denotes a MNO that subsidizes the handset to its customers. In effect, the MNO is a customer of the handset manufacturer in this role and owns the handset in question as long as the subsidy is in effect.

4.3.1.10 OTA Provider

The OTA Provider owns the OTA platform that can be used to manage the secure element as well as personalize and update the applications stored in the secure element. Typically, the OTA Provider is a MNO or TSM and has other roles in the value network as well.

4.3.1.11 Other Roles

In addition to the roles pictured in Figure 4.1, other roles can also be identified. First, there is likely to be a system integrator that offers a complete service platform for the end user and ensures that the service doesn’t become fragmented. Second, there are roles outside the direct value network. For example, standard bodies such as ETSI and 3GPP are responsible for designing standards required for homogenous NFC services. In addition, there are industry forums such as NFC Forum and trade associations such the GSM Association and Smart Card Alliance, who make recommendations or publish white papers in order to have an impact on the NFC technology and ecosystem.

4.3.2 Actors

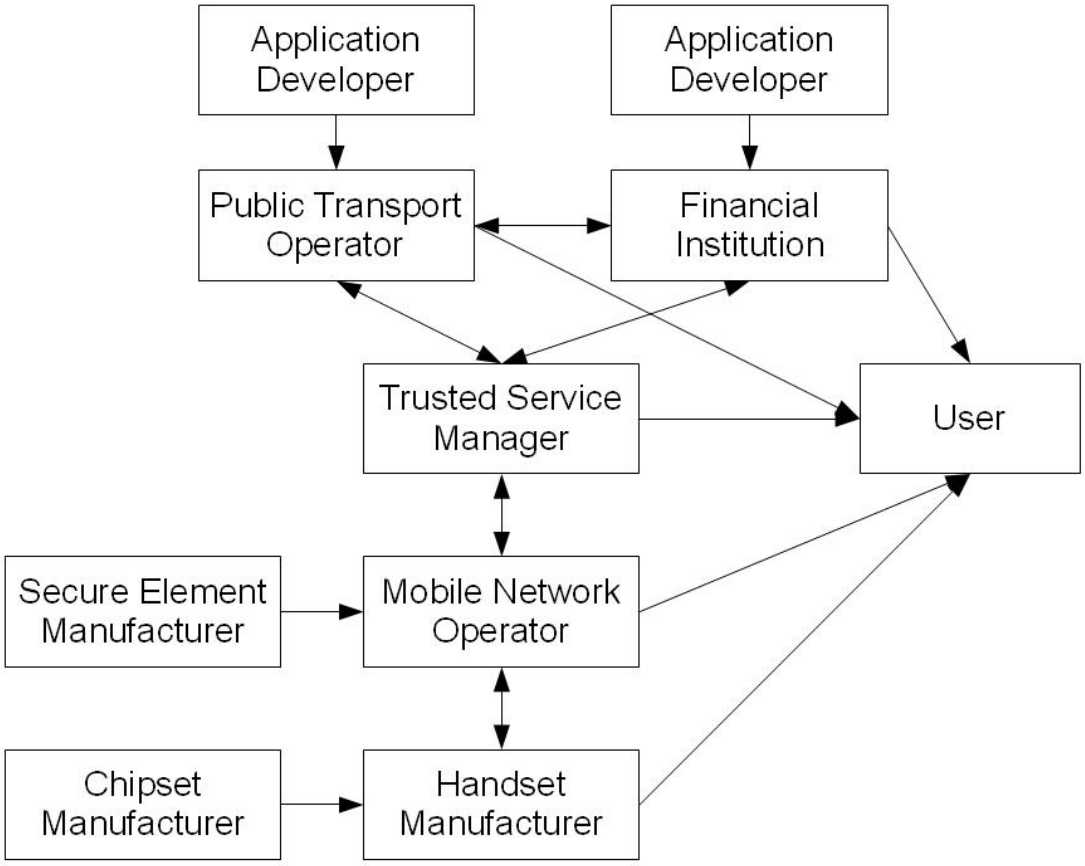

Figure 4.5. An example Mobile Ticketing value network.

4.3.2.1 Mobile Network Operator

A Mobile Network Operator (MNO) is likely to have numerous roles in the NFC ecosystem. At a minimum, a MNO is responsible for transferring data in the mobile network between the end user and the Service Provider. In addition to this, the MNO is expected to have an OTA platform that can be used to manage the applications in the secure element remotely. Additionally, if the secure element is the UICC, the MNO functions as a Secure Element Issuer. Finally, the MNO subsidizes handsets for the end users and is thus a customer of the Handset Manufacturers.

The MNO can benefit from increased data traffic in its networks due to NFC services. However, this increased traffic will be less beneficial if the operator offers flat-rate data transfers to its customers. Instead, the real benefits for the MNO are likely to be found in managing the applications on the secure element. First, the MNO controls an OTA platform, which means that it can either lease out this capability to another actor or function as a TSM and offer secure element management as a service. Second, and more importantly, if the UICC is used as a secure element, the MNO can benefit from controlling the secure element. In this case, the operator can rent the space on the secure element to the Service Providers who wish to place their applications there. Alternatively, the MNO may allow another actor, such as a TSM, to manage the secure element on its behalf.

With the UICC used a secure element, MNOs also benefit in another way. When a subscriber wishes to switch to another MNO, he has to change the UICC to a new one. Using the UICC as a secure element means that all the applications on the old UICC have to be transferred to the new one. Unless this can be done in a very convenient manner, the end result is that users find it less attractive to change operators, which reduces churn for the MNOs.

As controlling the secure element can be very beneficial for the secure element issuer, the MNOs seek to ensure the role of the UICC as a secure element. Because the alternative secure element solutions to UICC such as secure memory cards or embedded chips are not fully standardized or widely available [27], the UICC is currently the best choice for a secure element, as recommended by GSMA [48]. However, these alternative secure elements options might become more realistic in the future, in which case the importance of the UICC and thus the importance of the MNOs might decrease. Thus, the MNOs have pushed for the UICC to be able to control other secure elements and have this vision cemented in the HCI standard, as described in chapter 4.2.3. However, the multiple secure element architecture is currently still unresolved.

The MNOs have an important role as the customers of the handsets manufacturers because in many markets they subsidize the mobile phones and bundle them together with subscriptions for their customers. As the MNOs pay for the subsidized handsets, they are reluctant to order mobile phones with capabilities such as NFC, without ensuring that it is financially beneficial to them. This means that the MNOs have considerable choice in deciding what kind of handsets they order from the manufacturers and they can have a substantial effect on which handset features their customers use. This is especially true at the early stages of NFC evolution, as the end users are not very familiar with the technology, and the demand is driven by the MNOs ordering the phones. However, some analysts note that the end-user demand is rising [33], which could mean that the importance of the MNOs in pushing the technology will slightly decline, at least if the end users find the NFC services as desirable in roll-outs as they have done in pilots. In addition, the MNOs' situation will be different if NFC technology does break through and become a standard part of new handsets. In that situation, the MNOs' role as handset manufacturers' customers will give them less bargaining power than now.

A MNO can have a role in mobile payments, if a post-paid scheme is used. In this way, the NFC service is charged from the MNO subscriber in his monthly phone bill. The benefits of this method are that MNOs have a lot of experience with micropayments and already have a billing relationship with their customers. On the negative side, this method ties the payments to the MNO subscribers and the MNOs have to bear the credit card risk of the customers. Nevertheless, some customers may prefer this billing method, and thus it could be prudent to provide it as an option.

MNOs can also be prominent in providing customer service to the users of NFC services. The MNO customer service personnel have the technical experience needed to help users with issues related to the handset or the UICC. In addition, MNOs know the types of handsets and SIM cards their customers are currently using and can help them with upgrading to a NFC-enabled handset model and an appropriate UICC. However, the MNO customer service personnel are unlikely to be familiar with the specifics of the actual NFC services.

It's worth mentioning that a single MNO is unlikely to be enough to launch successful NFC services. Instead, all, or at least the major MNOs, should participate in the NFC value network in order to serve a large enough subscriber base. The service providers will be hesitant to bring out mobile services that don't work with all MNOs.

4.3.2.2 Public Transport Operator

The Public Transport Operators (PTOs) are in many ways the true customers of a mobile ticketing service. They issue the tickets and control the ticketing service, and they need to see tangible benefits in order to roll out a mobile version of the ticketing service.

Thankfully, a NFC-based mobile ticketing service offers PTOs many benefits compared to a smart card - based system. First, mobile ticketing reduces cash handling, as single tickets that were purchased with cash in the transports can now be purchased with the mobile phone. Payment with cash in the vehicles is slow and cash handling is expensive and labor intensive. In a 2008 global expert survey, 87% of the respondents saw reduced cash handling as the most important driver for NFC adoption in the public transport industry [30]. Second, NFC-based ticketing allows the users to purchase their tickets remotely using the OTA channel, which reduces costs in ticket sales and distribution. This was considered important by 78% of survey respondents, the same percentage that saw the closely related issue of increased customer self-service as important [30]. In addition, delivering the tickets to a mobile phone saves PTOs the cost of issuing smart cards.

Additionally, PTOs can benefit from increased customer convenience and experience, which was found important by 84% of respondents [30]. NFC-based mobile ticketing offers customers more choices in how and when to purchase tickets and generally makes ticketing easier. This can make public transportation more attractive to travelers and increase customer satisfaction as well as the number of customers of the PTO.

Another big advantage of NFC for PTOs is that it is compatible with the existing (ISO/IEC 14443 compliant) ticketing systems, a fact which was considered important by 80% of survey respondents [30]. Thus, the installed base of smart card readers in transports can be used together with the NFC technology in mobile phones and no major investments in this regard are needed. In fact, NFC can be taken into widespread use by investing in smart posters containing NFC tags. The end users can purchase their tickets by reading these tags with their handsets, which minimizes the need for more

expensive solutions such as ticketing machines. The smart posters and the NFC tags can be manufactured cheaply, and a large area, such a city, can be covered with the posters. This was the tactic used by Rhein-Main-Verkehrsverbund (RMV), when it equipped all bus and tram/train spots in Frankfurt with NFC tags [12].

Some of the benefits of NFC-based mobile ticketing can be realized with existing mobile ticketing systems such as SMS-based ticketing. However, compared to SMS-ticketing, a NFC service offers certain benefits to PTOs. First, the tickets are easier and faster to validate as well as being much more resistant to fraud. Second, NFC ticketing offers more choices for payment than just charging the user on his mobile phone bill. This method places the credit risk on the MNO, which increases the cost of the service for the PTO.

4.3.2.3 Financial Institutions

Financial institutions (FIs) and credit card associations are among the Service Providers in the NFC value network. However, they represent a more concentrated power than the other Service Providers, even the large transport companies, making them very important actors in the NFC value chain.

As Service Providers, Financial Institutions can have their own applications on the secure element and provide end users with mobile services such as mobile banking. However, FIs can also play a role in other SPs' services by providing them with payment options. In fact, FIs are essentially guaranteed a role in services that use electronic money (value accepted as means of payment by undertakings other than the issuer), because of government regulation, such as the electronic money directive in EU (Directive 2000/46/EC).

One area that holds significant promise for financial institutions is retail payment, where NFC-enabled mobile phones could replace contactless credit cards. In this service scenario, the significant benefit of NFC is that it is compatible with the existing contactless reader infrastructure, which is most extensive in North America.

In general, providing services on the mobile phones for their customers is one way for the financial institutions to increase customer convenience, differentiate their services from the competitors, extend their brands, increase transaction volumes, and deliver promotional content to the customers. In addition, if mobile payment is going to increasingly replace cash, it gives the FIs the opportunity to tap into cash transactions. In fact, the customers may spend more money at checkout, as they are not limited by the amount of cash they carry.

However, one significant issue for the financial institutions is their control of the customers. With traditional credit/debit cards, the FIs issue the cards and are thus in control of the customers. However, bringing the financial applications into the mobile phone means that the users are simultaneously

customers of both the Financial Institution and the MNO. This is especially relevant if the secure element used is the UICC and the MNO acts as the SEI(card issuer). This is why the financial industry -driven Mobey Forum recommended in its white paper that other alternatives to the UICC as the secure element be further developed in the future and that the financial institutions should be able to act as co-issuers of the secure element together with the MNOs [27]. Mobey Forum also feels that the FIs should be involved when the MNOs update their UICCs, so that they can ensure the new UICCs are suitable for their applications.

In essence, the negotiations between FIs and MNOs have been one of the key uncertainties with financial NFC services and have helped push back NFC deployment. It has been quite clear that both parties are needed in developing NFC payment services, but points of contentions have included revenue flows between the two parties, the security requirements and certifications processes of the UICCs [35], and control of the applications and customers. In the end, though, the back-and-forth between financial institutions and operators is necessary in the creation of a complex value network [19].

4.3.2.4 Trusted Service Manager

The role of a Trusted Service Manager could be played by many different actors. GSMA proposes that the TSM could be a MNO, a service provider such as a bank, a trusted independent entity, or a combination of the three [48]. However, it has been suggested that an independent, neutral TSM would provide the largest benefits in enabling an open NFC ecosystem [47].

The role of a TSM requires a significant technical capability as well as certified security processes for handling confidential data. The provisioning of a mobile phone is a more difficult task than provisioning smart cards for numerous reasons: the mobile phones hold multiple accounts, the users have to be able to manage their accounts in real time, and the provisioning has to happen over the air and in real time [47]. Consequently, there are currently not many actors that can fulfill the requirements of the TSM role.

In any case, standardization of the role and responsibilities of a TSM is required. An established network of TSMs is necessary for a mass-market launch of NFC services [27]. However, a TSM may be unneeded for the first NFC services, where the value added by this role might be relatively small and not worth the cost of having an extra player in the value network.

4.3.2.5 Handset Manufacturer

Handset manufacturers provide the mobile phones used in the NFC Services. The manufacturers can sell the handsets directly to end users, or they can sell them to MNOs, who subsidize the handsets and sell them as a bundle together with a subscription to their customers. These subsidies by the MNOs are a common practice in most major markets, and thus the MNOs are important customers of the handset manufacturers.

Besides their close relationship to MNOs, handset manufacturers try to create a mutually-beneficial relationship to another actor in the NFC ecosystem – the Financial Institutions [49]. In many ways, the handset manufacturers engage in a balancing act between the financial industry and the MNOs and try to collaborate with both parties. The handset manufacturers are also a part of numerous consortia, which allows them to influence the standardization process. It is in the handset manufacturers' interest to not have technical standards that limit the business models that can be used in NFC services. Instead, the manufacturers promote standards which allow the production of flexible handsets, which can be used in different ways in different markets, based on the business needs of the specific situation. Thus, the handset manufacturers tend to favor, for example, having multiple choices for a secure element, from which a specific one, such as the UICC, can be used in a particular market.

Integrating NFC technology into the handsets is a way for the manufacturers to increase the value of mobile phones. While the mobile phone is already a key accessory for most people in the developed countries, NFC technology holds the promise of cementing the mobile phone's status as the most important asset for end users by replacing and supplementing cash, smart cards, tickets, keys, and so on [50]. In the short term, NFC technology is also a way for manufacturers to differentiate their devices and hopefully increase their margins. In the long term, if the technology becomes a standard feature of new handsets, having more experience with the technology becomes a competitive advantage [51].

4.3.2.6 Chipset Manufacturers (NFC & UICC)

For NFC Controller chip manufacturers, there's a large potential market in mobile phones, which are the common consumer electronic products. In addition, NFC technology can be integrated into many other devices, such as televisions, radios, posters (as NFC tags), etc. However, the value of being a mere silicon provider may be limited. Heikki Huomo, general manager for the NFC segment at NXP said, "We are already the biggest supplier of chips for the NFC business, but in reality, it is not a huge business, even in the future. 100 million units at, say, $1 each and dropping is not that big a revenue earner. For us, it is an enabler into secured elements and services — that's where the pot of gold lies, not just in the silicon itself." [52]

UICC manufacturers, on the other hand, will benefit if the UICC will be commonly used as the secure element in the mobile phones. SIM card prices have been falling quite sharply (30-40% drop in Europe in 2006 [53]), but new UICCs that would function as a secure element could change this trend. Instead of being commodities, UICCs could become the first real multiapplication smart cards on the market. Furthermore, UICC manufacturers could then play a role in pre-installing certain applications into the UICCs. Especially with backing from the MNOs, it seems that the value of UICCs is going to increase, possibly along with their manufacturers' margins.

4.4 Finance Domain

Public transportation is a very large industry worldwide, worth over $48 billion in the United States alone [54]. There is a substantial existing revenue stream, which originates mostly from travelers paying for their tickets. Thus, assuming a significant portion of these travelers can be converted to mobile ticketing users, and mobile ticketing provides large enough savings, the source of revenues is not in question. What is still unclear, however, is how those revenues will be divided among the different actors mentioned in the previous chapter.

Perhaps the most significant issue in the NFC ecosystem has been the revenues the operators should receive. It has been reported that the operators will consent to not receiving any transaction-based revenues from the service providers such as banks and transport service providers [35]. The exception to this is Japan, where looser banking regulations have allowed the leading operator NTT DoCoMo to start its own credit brand and South Korea, where the operators went after a share of the merchant transaction fees collected by credit card companies [55]. However, what the operators, led by their trade association GSMA, have insisted on, is that the UICC ("SIM" card) function as the secure element in the handset. As the operators issue UICCs to their customers and thus control the smart card, they can also decide which applications can be installed there. The operators envision that they can rent the space on the secure element on the UICC to service providers such as banks. The magnitude of the rent has not been negotiated yet, but some reports put the opening offer of the operators at about 1€ / subscriber / application / month [34]. In addition, operators could charge fees for updating the applications or for more regular downloads over the air such as tickets or coupons, although these could also be included in the rental fee [55]. Furthermore, operators can receive extra income through increased data traffic in their networks, although this effect is likely to be smaller if they offer a flat-rate data package to their subscribers. Finally, operators could also profit from premium services like ringtones or video clips by promoting them using NFC technology such as smart posters [55].

An important thing to note when considering the revenues of operators, is that they can potentially charge for every application residing on the UICC cards. Thus, pricing their UICC rents so high that they will recoup their investments with just one application, such as a mobile ticketing application, may not be needed. In fact, lower rents may encourage more service providers to develop NFC applications stored on the UICC and thus provide larger revenues for the operators in the long run. Prohibitively high rents, on the other hand, may make the NFC platform unattractive to service providers in the first place, in which case they may decide to forgo the technology altogether. Consequently, the operators may need to try and balance their immediate revenues with the health of the entire NFC ecosystem. As an example, some of the success of Osaifu-Keitai is attributed to NTT DoCoMo striking reasonable deals with other players [56].

Flexible Services

As mentioned in Chapter 4.3.2.3, Mobey Forum published a white paper in which it presented a more active role for financial organizations in managing the UICC card as a secure element. The paper recommends an option for service providers such as banks to not only rent space on the UICCs but also become co-owners and co-issuers of the UICC. This could, conceivably, be also an option for transport service providers, although their security needs are not likely to be as great as those of banks. In this kind of revenue model, the service provider does not pay monthly fees to the operator, but it would have to make a larger upfront investment. [27]

The reason why the operators' revenue is such a key issue is that the operators are likely the ones to make the biggest investments needed to realize NFC services. First, operators heavily subsidize the handsets in numerous significant markets around the world and they will bear the costs of adding NFC chips and other required technology to the handsets. This added cost could be as much as $10 to $30 per handset in the very early rollouts [34] and $4 to $9 later on [20, 55, 6], although the cost should drop with increased production of the chips and handsets. Nevertheless, the operators need to decide whether to introduce the handsets to their customers, and the investment required to do that for a large customer base is substantial. As a representative of German's Vodafone remarked of the $150 million investment for their 30 million customers: "We don't do that for reducing churn or introducing gimmicks; we need to see some real revenue." Second, the operators need to invest in new UICC cards, as the existing installed base is not suitable to function as a secure element supporting the new SWP and HCI protocols.

Certain other actors can avoid making significant investments to adopt NFC technology. In particular, numerous public transport operators all over the world have an existing infrastructure of ISO/IEC 14443 -compatible smart card readers. As the NFC chips in the mobile handsets can emulate the ISO/IEC 14443 smart cards, these readers require no upgrades to function together with NFC technology. Likewise, should NFC technology be used for contactless retail payment, the existing contactless credit card reader infrastructure is also compatible with NFC technology. It should be noted that contactless credit cards are more popular in the United States and Asia than in Europe, and subsequently their installed base is lacking in Europe. On the other hand, American cities have not adopted contactless smart card -based ticketing systems as quickly as European cities, suggesting that mobile retail payment could function as the lead NFC service in the United States, while mobile ticketing could be the first major NFC service for Europeans. As for other actors, application developers can make substantial investments by developing the application and the backend system needed by the service. They could be paid back for this on a transaction-fee basis.

In addition to up-front investments, NFC services also generate operating costs that must be covered by the revenues. Running the OTA platform is a source of costs for the operator, as is customer service, which can be provided by the operator, service provider, or a third party. In addition, maintaining the application and the system backend generates costs.

Another potentially significant cost, especially from the end user point of view, is the data transfers in the mobile network resulting from the Mobile Ticketing service. This might not be a significant issue for the user if he has an unlimited, flat-rate mobile data subscription, but otherwise, the data transfer costs could become significant when compared to the rather low prices of public transport tickets. This issue is especially significant with international roaming, in which case the data transfer prices may be prohibitively high. In essence, these costs may limit the user base of the service extensively by effectively preventing foreign tourists from using the service. Even domestic users might opt not to use the service, if their data transfer prices are too high.

It should be noted that there is little financial research and hard numbers available on what the different revenues and costs for the numerous actors from the NFC technology are. All available reports tend to present their results toward a certain group of actors, while neutral reports remain hard to find. As noted in the 2008 survey [30], a lack of understanding of the costs and benefits remains an inhibitor for NFC services. As one respondent stated: "Happily written advertising articles are not useful; we are interested in concrete examples how and what did you do to make it work." Thus, more work should be done in determining the concrete benefits that NFC services can provide to the different actors.

4.5 STOF analysis summary

This chapter provides a summary of the key issues examined in chapter 4.1–4.5, as illustrated in Figure 4.6.

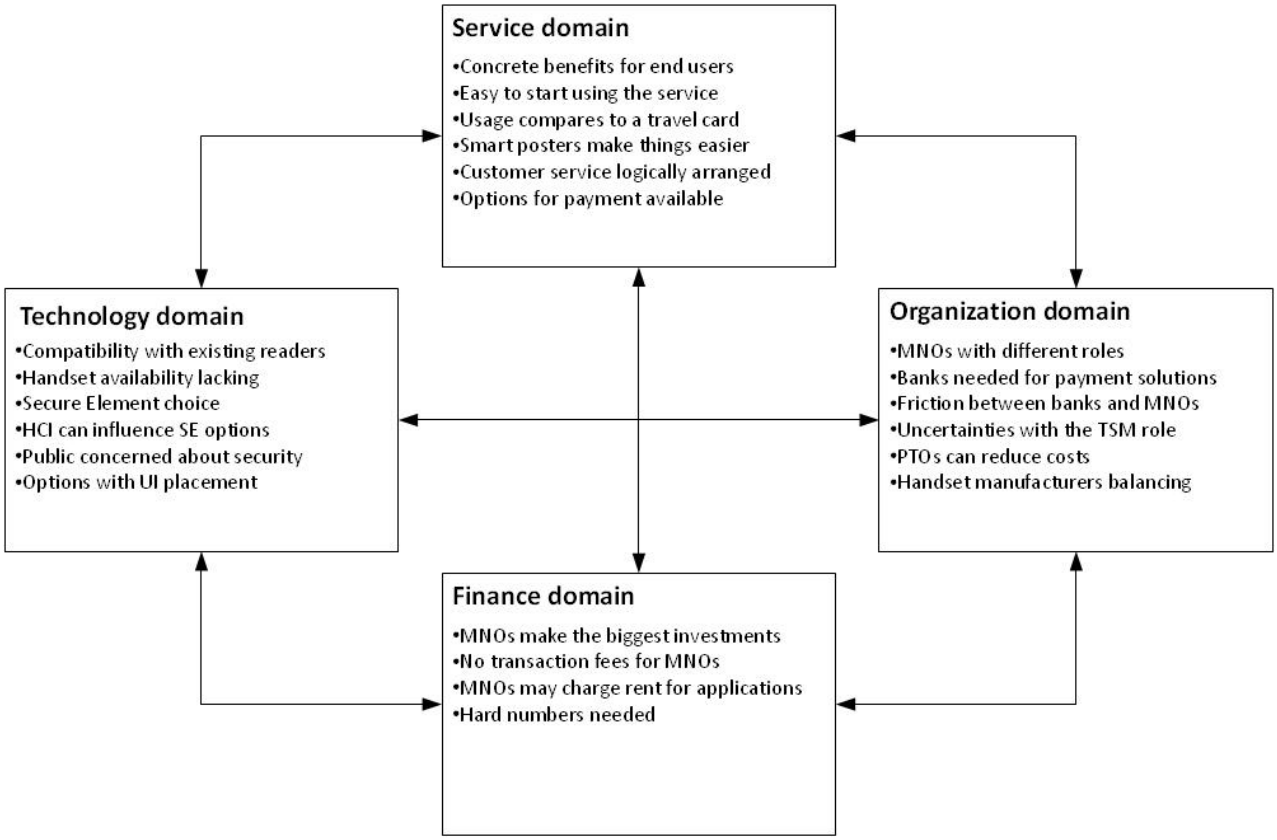

Figure 4.6. STOF analysis summary.

4.5.1 Service Domain summary

- The crucial success factor of mobile services is the value they bring to the end users. In the case of NFC mobile ticketing, the benefits are concrete and provide the users with more options, a more convenient way to purchase and use tickets, and value-added services.
- A key issue is how easy it is for the travelers to start using the service. Thus, everything should be done to ensure that getting the ticketing application into the mobile phone and purchasing the first ticket is as straightforward as possible.
- Smart posters can make it simpler for users to download the application or purchase tickets.
- Using the tickets purchased should be no more complicated than using a travel card and it should be possible to make phone calls or send text messages when validating a ticket by showing the mobile phone to a reader.
- There should be multiple payment options available for the users, so that they can select the one suiting their preference and their current situation.
- The customer service arrangement for the mobile ticketing service should be clearly defined, so the users know who to contact in case they have issues with the service.

4.5.2 Technology Domain summary

- The most important technical factor of NFC technology that favors its use in mobile ticketing is that it is compatible with the majority of existing contactless ticketing systems. This means that the current travel card reader infrastructure does not have to be updated for the mobile ticketing service.
- The lack of NFC handsets, which are not expected to become widely available for the next few years, is concerning. However, this shortage is a symptom of other underlying issues, such as unclear revenue sharing between the different players.
- Also worrisome can be the public's perception of the level of security and privacy provided by NFC technology. Contactless technology has received criticism from consumer advocate groups before, and combining several smart cards in one device may raise security concerns as well.
- The choice of a secure element has many repercussions to the design of a service that needs to store confidential data. Currently, the UICC is the most mature choice technologically and is likely to be used at the start of NFC deployment.
- The other secure element solutions might be a more realistic choice in the future, although it remains to be seen if they will be equal to the UICC or if the UICC can control the use of the other secure

elements. This issue might even be decided on the level of standards, as debate over the Host Controller Interface standard has shown.
- There are several technical solutions available for designing an UI, which gives freedom for the developers but may ultimately prove confusing for the user, if the NFC applications differ greatly from each other.

4.5.3 Organization Domain summary

- The Mobile Network Operators may fulfill multiple roles in the NFC mobile ticketing value network: they subsidize many NFC handsets, they provide an OTA channel to be used for installing or personalizing the applications, they issue an UICC, and they have a billing relationship with the end users.
- Also of importance are the financial institutions, which are likely to be needed to provide payment solutions for other services and will provide mobile services for their own customers.
- Bringing the banks and the MNOs together has been complicated at times, as the goals of the two players have not always aligned. Nevertheless, both parties are needed in the NFC value network to provide the most valuable services for the end users.
- Public Transport Operators are the customers of a mobile ticketing service. They anticipate cost reductions from mobile ticketing as well as increased customer satisfaction.
- Handset Manufacturers foresee that NFC technology could increase the role of the mobile phone as an important asset for users by including the wallet in the mobile phone. Handset Manufacturers tend to aim for a balance between the other parties such as MNOs and banks.
- The Trusted Service Manager is a new role in the NFC ecosystem. The exact responsibilities of a TSM are not firmly defined, and it is not clear which players will fulfill the role and even whether the role is needed for the first NFC services.

4.5.4 Finance Domain summary

- The MNOs make the largest investments in NFC services as they order the new handsets from the manufacturers and need to provide their subscribers with new UICCs.
- It has been reported that the MNOs will agree not to receive a fee from transactions made in the NFC services.
- However, the MNOs are likely to charge rent from the service providers for allowing them to place their applications on the UICC. The size of this rent and the conditions involved are still unclear.
- There has been little in the way of impartial reports presenting analysis on the costs and financial benefits involved with NFC services.

5 Conclusions

Incorporating NFC technology in mobile phones promises to offer numerous valuable new services to end users, while generating profits for the actors involved in providing these services. One possible killer application for NFC in mobile phones is considered to be mobile ticketing in public transportation. This service could fuel the growth of the NFC ecosystem and be profitable by itself. This report analyzed the business model of NFC-based mobile ticketing, and the most important drivers and restraints of the service are listed in chapters 5.1 and 5.2, respectively. Chapter 5.3 presents four possible scenarios for NFC services. Then, chapter 5.4 provides recommendations for a mobile ticketing pilot, while 5.5 provides recommendations for a service roll out. Finally, chapter 5.6 introduces possible related further research to be done in EDEN WP2.

5.1 NFC Mobile Ticketing drivers

- One of the stumbling blocks of mobile services has been the inadequate usability of the products. However, the touch-based interaction of NFC mobile phones has been found to be intuitive and convenient to use by the end users. Naturally, NFC technology alone can't solve all usability issues, as the mobile phone applications and interfaces have to be designed to be easy to use as well. Nevertheless, NFC technology provides ways to make NFC services, including mobile ticketing, more intuitive and usable for end users.
- NFC mobile ticketing is a service that adds real value to customers, not a solution looking for a problem. Current smart card -based ticketing solutions don't allow the travelers to check their ticketing information or the value stored on their cards whenever they want, nor can the users buy tickets wherever or whenever they want. Mobile ticketing solves these issues and makes it more likely that the traveler has the ticket with him, as most people are more likely to leave the travel card than the mobile phone at home.
- Compatibility with the legacy ticketing infrastructure is an important driver for the public transport operators, as they don't need to invest in new infrastructure to support NFC ticketing services. This also allows the PTOs to roll out mobile ticketing services gradually and keep the smart card based ticketing system working simultaneously for a long time.
- The PTOs also benefit from reduced costs in ticketing. Mobile ticketing forgoes the costs of issuing and distributing the physical smart cards, and selling tickets directly to customers is cheaper as well. In addition, mobile ticketing can reduce cash handling in transports, which is expensive and time-consuming.

5.2 NFC Mobile Ticketing restraints

- While the touch-based interaction of NFC has met with approval from end users, a complete mobile ticketing service may still turn out to be too difficult to use for the end users. The travelers are already

used to the smart card -based systems currently deployed, and expect similar simplicity from a mobile service. Thus, designing the user interface of the service in a way that makes the service easy and intuitive to use is of utmost importance. This is especially true in public transportation ticketing, where the user should be able to purchase the tickets quickly when needed. Purchasing the first ticket should be made especially easy for the user because if the user has problems at this stage, he is unlikely to use the service in the future. Thus, the question of how to issue the ticketing application to the user should be solved in as user-friendly a way as possible.

- The end users tend to have negative perceptions of the security and privacy levels of contactless, RFID-based solutions in general. This seems to be true of NFC as well, and people are also concerned about keeping much of their valuable information on a single device. They are also worried about what happens when they lose the mobile phone and whether others can abuse the cards stored in the mobile phone. While these fears are mostly exaggerated, it is important to communicate this to the end users, and handle the public opinion skillfully. Naturally, any actual problems must be quickly solved, or the image of NFC may be in danger. Specifically, the safety of NFC tags must be guaranteed in a user-friendly way, or a significant area of NFC functionality could end up unused if the end users cannot trust the tags. Early rollouts can be an especially vulnerable time, as any substantial negative experience then could be hard to overcome later.
- Uncertainties in the value network are one of the main things slowing down NFC deployment on the supply side. The different roles of the actors are not always clear, and perhaps more importantly, the revenue sharing is still an open issue. Bringing together many players always creates complexities, especially so with NFC services, in which industries with diverging goals have to work together.
- The limited availability of handsets is currently a very visible issue that delays the commercial launch of services. However, the lack of handsets is actually of symptoms of other issues, such as unclear business models, which prevent MNOs from ordering NFC handsets in substantial quantities. Also, the NFC ecosystem suffers currently from the classic chicken & egg problem: with too few handsets, there are essentially no NFC services, and with no services, there is no end user demand for handsets.

5.3 Scenarios for NFC services

Scenario planning is a way to offer plausible alternative views for the future development of the business environment of an organization, or in this instance, a technology. They typically use key drivers with the greatest uncertainty and construct different scenarios of the future. The point is not to predict which of the scenarios will occur or is the most likely to occur, but to highlight the important drivers, foster discussion, and help prevent people from closing their minds to alternatives. [57]

Flexible Services

In the case of NFC services, two key drivers for change are identified. The first is end user acceptance. This driver is influenced by issues such as the value of the service to end user, ease of use, perception of security / privacy, and handset selection. The second driver is ecosystem openness, which describes whether the NFC ecosystem is open to new players such as service providers or whether it is closed and thus controlled by certain key players. The reasons for a closed ecosystem could be business decisions by incumbents to actively prevent new players from entering the market or high barriers of entry caused by difficulties in developing services (because of heterogeneous devices) or difficulties in providing those services (because of having to negotiate with numerous players or having to pay too high fees). Simplifying the drivers so that each has only two possible outcomes, they define a matrix with four basic scenarios (illustrated in Figure 5.1):

	End user rejection	End user acceptance
Open ecosystem	**Niche Services** Virtually anyone can provide services, but the users find them inadequate. A few key services succeed, but substitutes are used more commonly. Factors: Poor usability, limited end user value, security problems, limited handset selection, easy to develop services, low fees for service providers, easy to negotiate agreements.	**Virtuous cycle** Users love the services and almost anyone can provide them. This results in a fierce competition for customers, but also very rapid growth in the market for NFC services. Factors: Good usability, high end user value, sufficient handset selection, easy to develop services, low fees for service providers, easy to negotiate agreements.
Closed ecosystem	**Vicious cycle** Key suppliers try to control the ecosystem but the users reject the services. No new entrants can try their luck and the technology is abandoned. Factors: Poor usability, limited end user value, security problems, limited handset selection, hard to develop services, high fees for service providers, hard to negotiate agreements.	**High demand, few service providers** The end users love NFC services, but there is only a limited selection available, as providing services is tightly controlled. Factors: Good usability, high end user value, sufficient handset selection, hard to develop services, high fees for service providers, hard to negotiate agreements.

Figure 5.1. Possible Scenarios for NFC Services.

1. The “Niche services” scenario involves a situation in which numerous players can enter the NFC services market and the end users can choose freely from different services. However, the usability of these services leaves a lot to be desired, and the users find them inconvenient compared to other alternatives. This inconvenience could even stem from the multitude of available options, as the users might find it difficult to manage their numerous services. In addition,

the services might not be all that valuable compared to traditional solutions or the security and privacy issues could cause concern. The end result is that the users generally prefer the substitutes of NFC services, such as smart cards, but might end up using a few key NFC services, which offer superior value to their alternatives. Such niche services could well include mobile ticketing or industry services such as workflow management. However, if the ecosystem stays open for service providers, offering a valuable, well-executed service could still gain them customers or even accomplish a breakthrough on a larger scale.

2. The "Vicious cycle" scenario describes a situation in which the NFC ecosystem is controlled by certain key players and entry into the market is difficult. The end users have few choices with NFC services, but they also don't find the services very valuable or convenient to use. As before, this could originate from problems with the NFC technology, a lack of suitable handsets, poorly designed user interfaces, or security issues. With no new entrants coming in to offer competing services, diminishing enthusiasm from the end users, and a tarnished reputation for the technology, a vicious cycle could be reached where the costs of supporting NFC or adding it into the new handsets are not justified.
3. In the "High demand, few service providers" scenario, the users are enthusiastic about the NFC services and find them convenient and valuable. This requires clear added value provided by the services, as well as good usability and sufficient choices in NFC handsets. However, tight control of the ecosystem by key players means that the users have limited choices for the services they use. This control could stem from key players actively trying to keep their competitors away or from high barriers of entry caused by the difficulties new players have in developing or providing services. The result is a bigger market share for certain players, but a much smaller overall NFC services market than in the "Virtuous cycle" scenario.
4. The "Virtuous cycle" scenario sees the users embrace NFC services finding them convenient and invaluable. They can choose their favorites from a multitude of services and new entrants can easily enter the market and provide these services. Thus, the competition for customers is intensive, but the overall market grows rapidly. The technology benefits from a virtuous cycle, where the valuable services attract customers and increase the installed base of NFC devices, which further attracts developers of NFC services and complementary goods. The mobile phone becomes the single most valuable asset to consumers by replacing, to a large extent, wallets, keys, and tickets. In addition, NFC tags become a common sight and the mobile phones are increasingly utilized as tag readers.

5.4 NFC Mobile Ticketing service evolution

A NFC Mobile Ticketing service is not expected to be static in time. Instead, the value offering of the service is likely to change over time and the service may incorporate additional features or options that were not presented during the roll-out. Figure 5.2 presents one possible service

evolution path for NFC Mobile Ticketing. Note that the order of the different phases is not fixed and that phases can be skipped and combined into one.

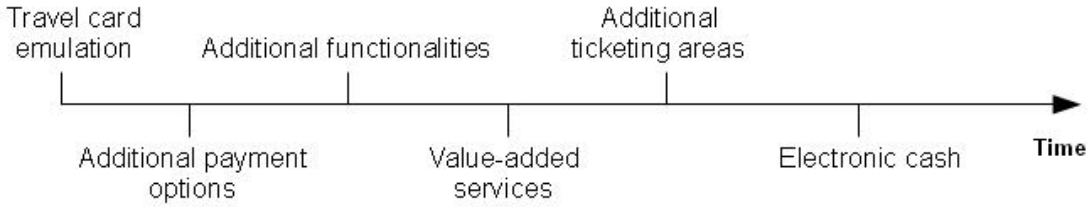

Figure 5.2. Possible service evolution of NFC Mobile Ticketing.

At first, the service provides the basic functionality expected by the users. That is, the users can replace their travel cards with a mobile phone. The second phase may provide the users with enhanced payment possibilities, most notably with the possibility of paying for the tickets using the mobile phone. Depending on the user preferences, this option could be a requirement and already included in the roll-out phase of the service.

Next, the service may include additional functionalities that enhance the existing service. For example, the service may allow the users to automate topping up their cards based on predetermined limits. In addition to this increased functionality, the service may include other, value-adding services. For example, combining a personal journey planner with location information from the mobile phone together with the ticketing service could be seen as a value-added service.

At the next phases, the service could be extended to new business areas. For example, the service could then encompass other kinds of tickets instead of just public transportation tickets. Most notably, the service could provide tickets for events such as concerts or sporting events. The upside of extending the service like this is that the existing application is likely to be expandable for these new business areas as well and that the users would probably find it useful to be able to purchase multiple kinds of tickets at the same place. However, it is important that the usability of the basic public transportation ticketing service remain unaffected by the addition of these new business areas.

Finally, the service can be extended by allowing the users to spend the electronic value they use for purchasing tickets for other kinds of purchases as well. These could include point-of-sale purchases as well as remote purchases. Essentially, in this phase the customers may purchase tickets with electronic money that they can use to make all kinds of purchases and effectively replace their cash with. This phase requires a financial institution as the issuer of money and is unlikely to take place in the short term.

5.5 Recommendations for a pilot

- Try to include a wide selection of testers in the pilot, so that they can represent multiple user groups of the actual service. An opt-in

method might normally result in testers that are more interested in technology and predisposed to like a service such as mobile ticketing. However, if such a bias exists among the testers, it should be taken into account when analyzing the results.

- Try to evaluate how the users would like customer service to be handled. Should it be the PTO's or the MNOs' responsibility, or should there be a centralized contact point for all mobile ticketing related issues?
- Be prepared to collect and analyze data relevant to evaluating the benefits and costs of NFC mobile ticketing. Concrete numbers would be the most useful when making decisions about roll outs.
- Try to analyze what types of payment solutions different kinds of customers prefer.
- Test the best method of issuing the ticketing application to the customer's handset. Is pre-installing more efficient than an OTA transfer? How quickly are the testers able to get the service into use?
- Find out how the testers feel about using the mobile phone to read NFC tags in different situations.
- Have the testers compare NFC mobile ticketing to other, alternative ticketing choices such as travel cards, single tickets purchased with cash, SMS mobile tickets, and a travel card that can be topped up from a web portal. In which situations do the testers prefer NFC mobile ticketing?

5.6 Recommendations for a roll out

- Mobile ticketing has previously been used in situations where other options aren't available or are inconvenient. These include circumstances where the user is in a hurry, he doesn't have a travel card with him, or doesn't have any cash with him. To be able to serve these kinds of customers, a NFC mobile ticketing service should try to make purchasing the first ticket as easy as possible. This means that the ticketing application installation should be painless, choosing the right ticket is intuitive, and buying the ticket should be fast. The user should also be able to purchase an anonymous ticket without needing to provide his personal information.
- Arrange the customer service in a convenient way for the user. Having multiple points of contact is likely to be confusing for the customer, although this might be unavoidable in the early phase of NFC adoption, when the users have to change their handsets and UICCs.
- Take extra care to dispel the public's fears of possible security and privacy issues. Ensure that no personal information is saved without the users' consent and that the ticketing application on the users' mobile phones can be easily disabled in case the phone is stolen.
- If a nation-wide ticketing system could be created instead of the typical city-centered solutions, the people traveling between different cities could benefit significantly. However, the benefits of such a solution are greatly dependent on how common inter-city travel is. For example, Germany is a country with a significant

amount of people traveling between cities managed by different public transport operators. Thus, interoperability between different ticketing systems is more common.

5.7 Further Research

Analyzing the NFC mobile ticketing service from the end user point of view revealed the availability of payment options to be an important issue. A mobile ticketing service is unlikely to be very valuable for users if they cannot pay the tickets using the mobile phone. Likewise, mobile payment is likely to be important for numerous other services and a convenient payment service may be required for the NFC ecosystem to take off. Thus, follow-up research concerning the different payment solutions for mobile ticketing and NFC services in general, as well as the related business models should be considered. Additionally, the MoFS mobile ticketing pilot in early 2010 can provide important data concerning the business model of the service.

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