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Analysis of roles and position of mobile network operators in mobile payment infrastructure

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Analysis of roles and position of mobile network operators in mobile payment infrastructure

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Abstract

A number of different mobile payment solutions have been presented the last decade. The phone subscription with its security mechanisms are used for user identification and payments. This is the case for SMS based payment and ticketing systems that are getting more and more popular. However, there are other ways to implement a Trusted Element (TE) , where a SIM card architecture is only one. It can be in the mobile phone, as a separate integrated circuit, as an optional customer deployed plug-in device (e.g., microSD) or be running as an application on a server existing entirely as software.

In this paper we analyze what roles and responsibilities different actors have in different types of mobile payments solutions. The main focus is on the implications for the mobile operator business. It turns out that new types of intermediary actors in most cases play an important role. Sometimes mobile operators are not even involved. The emergence of new payment together with other non-SIM card based TE solutions opens up for many different market scenarios for mobile payment services.

Analysis of roles and position of mobile network operators in mobile payment infrastructure

1. Introduction

1.1. Background

A number of different mobile payment solutions have been presented the last decade. The mobile phone can be used in a multitude of ways in addition to be a communication device. It can be used to: order a service or product, to receive "the product", e.g. a song or ring tone, to receive a receipt of the transaction, to "be a ticket itself". The phone subscription with its security mechanisms are used for user identification and payments. This is the case for SMS based payment and ticketing systems that are getting more and more popular in many countries.

Mobile wallet applications based on Near Field Technology (NFC) has been discussed. With a NFC enabled phone the user can store credit cards, loyalty cards and access cards e.g. for the office and for public transportation as an application running in the phone. Identity and security is handled by a Trusted Element (TE) that could be realized in many different ways including as a special type of SIM card. A SIM card based solution can allow mobile operators to take a role in the value network as described by organizations like GSM association (GSMA), NFC Forum and MobeyForum[1]. Figure 1 illustrates the GSM Association view on the actors involved in a traditional payment system based on credit cards and how it can be extended to a so called "pay-buy-mobile" payment system[2]. The management of service applications is handled by a role called Trusted Service Manager (TSM).

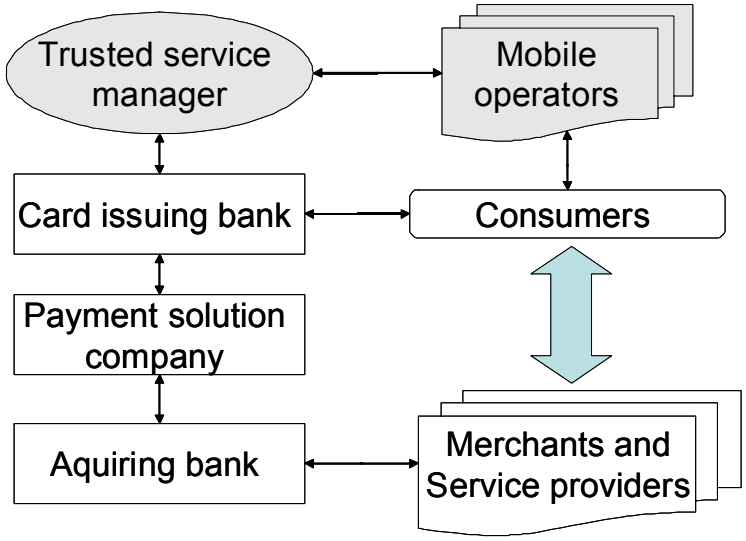

Figure 1 Actors and relations fo r traditional credit card based and a pay-buy-mobile payment system, the grey parts represent additions leading to a pay-buy-mobile ecosystem according to a GSMA white paper [2] (our modifications of figures 5 and 6 in the white paper [2])

[1] http://www.gsmworld.com/, http://www.nfc-forum.org/home, http://www.mobeyforum.org/
[2] "Pay-Buy-Mobile, Business opportunity Analysis", White paper by GSM association, 2007

1.2. The problem area and research questions

When we consider purchasing and payments of goods, services and tickets using the mobile phone, a broader business landscape can be seen for mobile operators. The operators traditionally act within a connectivity business with a strong focus on the consumer segment. Also in the business segment the end-users are seen as a group of consumers of connectivity services, although value added services are developed for and used by companies and organizations with a mobile work force e.g. craftsmen, for healthcare in the home etc. For mobile payments the main focus is not the traditional connectivity business of the operators. The main operator objective for mobile payment services is to support the core business of the merchants and non-telecom service providers, and their relation to the end-user. The end-users are customers of the both the operators and that merchants/service providers. Hence, the operators have two types of customers, both the end-users of "other" non-telecom services and the provider of these services. We have a situation with business to business to consumer ("B2B2C") services. In the same way as mobile operators can be involved in mobile payment and ticketing services, financial institutes and "other actors" can be involved, see figure 2.

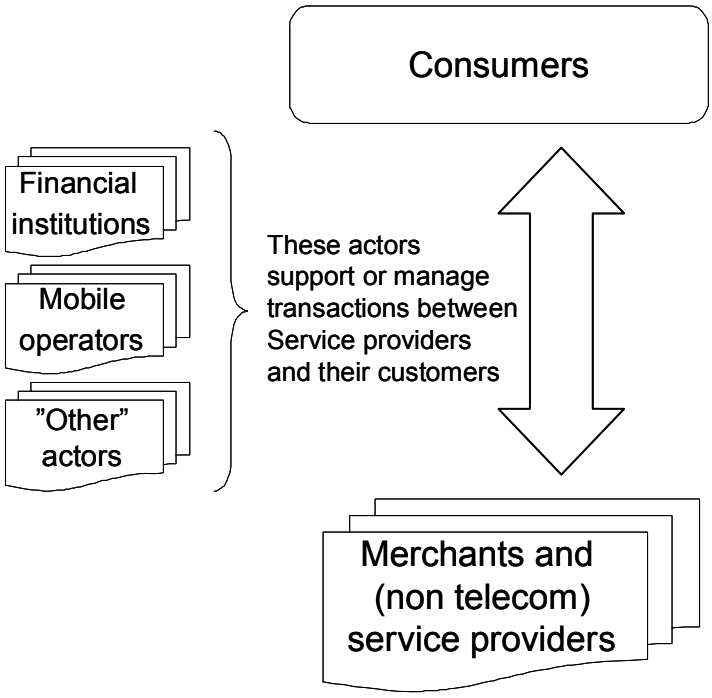

Figure2. Actors supporting the business relation between customers and merchants/service providers

In our analysis we will describe different cases of how financial institutions, mobile operators and "other" actors can support the business relation between merchants /service providers and their customers. The "other" actors can support the financial institutes or mobile operators or provide enabling technology. However, in many cases these "other" actors turn out to take a leading role in the mobile payment system. This seems to be in contradiction to the intensions outlined in figure 1 where the financial institutes and mobile operators are the key actors. Hence, it is interesting to study existing and emerging payment systems and see what lessons that can be learned when it comes to the roles that different actors take and what position that different actors have in a mobile payment system.

For the analysis of the market position of mobile operators within mobile payment and ticketing services we will discuss the following research questions related to business roles and the configuration of value networks:

RQ1. What kind of business roles can be identified for the mobile payment value network?

RQ2. How the roles and responsibilities are distributed among actors in the value network and are there any differences in the set of roles for different mobile payment solutions?

RQ3. What characteristics are essential for actors that want to take a key role?

A key issue is the control and management of the solutions for user identification and security, often called the Trusted Element (TE) or the Security Element (SE). For SMS payments the SIM card is used as TE and for the proposed NFC pay-buy-mobile solutions the services are proposed to be stored at a new type of SIM card (UICC)[3]. The UICC is provided by a mobile operator but the payment applications can be managed and maintained by one or more other parties[4]. However, there are many other options to implement the TE, the SIM card architecture is only one. It can be in the mobile phone, as a separate integrated circuit, as an optional customer deployed plug-in device (e.g., microSD) or be running as an application on a server existing entirely as software. Hence, we this as a background we can identify a fourth research question:

RQ4. What are the implications in the business domain of different Trusted element (TE) solutions?

1.3. Outline of the paper

The paper is outlined as follows. Chapter 2 describes related work in the areas mobile payments, business modeling & analysis and actor relations and networks. The data collection and the analysis framework are described in chapter 3. In chapter 4 findings from the empirical data is presented in the form of "maps" of actors and their relations. In chapter 5 we describe options for implementing the Trusted Element (TE) and implications in the business domain. Next, we present an analysis of business roles and company position. In chapter 7 we summarize our observations and look into different types of future business scenarios. In chapter 8 we conclude the paper by providing short answers to the research questions.

[3] UICC Universal Integrated Circuit Card

[4] Trusted Service Manager, Service Management Requirements and Specifications", EPC – GSMA, Doc: EPC 220-08, Version 1.0, January 2010

2. Related work and areas of contribution

An introduction to the possibilities when using NFC for mobile payments is given in (Ondrus & Pignuer, 2009). A few comparisons of NFC based and other types of (mobile) payments have been presented (Ondrus & Pignuer, 2009), (Massoth & Bingel, 2009). These papers focus on technical and usability aspects, the market or business related issues are not included. However, the discussion in (Massoth & Bingel, 2009) provides good insights on authentication mechanisms categorized in groups related to "something you have", "something you are", and "something you know".

Most literature on NFC payments either are research papers describing functionality and mechanisms or are specifications or "white papers" from organizations like MobeyForum, GSM Association, NFC Forum, etc. Some white papers and specifications discuss "business opportunities" and the need for new business roles. The need for someone being a Trusted Service Manager (TSM) is mentioned in many white papers. GSMA also outlines a "NFC service process" including NFC enablement, TSM activities and service provisioning (applications).

An overview of contributions to mobile payments is presented by Dahlberg et al (2008). In this literature review it is stated that research papers on mobile payments are dominated by topics related to either consumer factors (user attitudes, behavior, adoption) (Dahlberg & Öörni, 2006), (Pousttchi & Widemann, 2007) or on technology factors (m-payment system, mechanisms or protocols). A number of papers on m-payment market and provider factors listed in (Dahlberg et al, 2008) describe to analyze mobile payment and descriptions of scenarios, business model and analysis frameworks. Analysis of business models and value networks for mobile payments can be found in (Panis et al, 2002), (Methlie & Gressgård, 2006). Analysis of different types of "market failures" for mobile payments can be found in (Rouibah, 2009),(Ondrus, Lyttinen & Pigneur, 2009).

For our analysis the modeling and grouping of actor networks and relations presented in (van Bossuyt & van Hove, 2007) is very useful with two main types of payment models are described; operator-centric and payment service provider (PSP)-centric. The operator-centric models are different forms of walled garden approaches and the PSP models include different forms of cooperation between operators, merchants/service providers and also intermediaries.

Mobile payment ecosystem has been analyzed by Pau (2009) within a context of mobile and internet banking where also "operators as banks" and "banks as operators" were discussed. The overall picture by Pau included many actors that are believed to be either passive (regulators, central banks, terminal vendors) or against mobile payments (banks). Whereas operators in developed countries view mobile payments mostly as a technology project, operators in developing countries see it as a key service. The latter statement is supported by examples from the Philippines (Mendes S et al, 2007). Mobile payment services are important in countries where there is no or limited banking and payment infrastructure. The SMS based banking is dominating or in some areas even the only one used (Neville W, 2006), (Bångens & Söderberg, 2008). This is quite different to the situation in Western Europe where the financial institutions and infrastructure are well established and most people have bank accounts and regularly use credit cards.

A number of research papers and reports have been published by the EU project "SToLPAN" focusing on NFC services. The project focuses on technology aspects but include business related

work items. Examples are evaluation of how NFC services may affect the existing value chain (Benyo B, et al 2007) and different tasks for a trusted 3rd party (Parkanyi , 2008). One key aspect mentioned by many authors is the "Life cycle management of NFC applications" (StoLPAN deliverable 7). Here also a number of challenges for Service Providers (SP) are mentioned: the SP does not control the (SIM) card where the application is to be stored or the other applications at the card. In addition, the customers may not be known. In this document primary and secondary roles for NFC services are listed. Primary roles include the user, the issues of the Secure Element (SE) and the Service Provider (SP) that deploys the NFC application to end users. Some secondary roles are Over The Air (OTA) provisioning, usually a mobile operator and the TSM. Here it is claimed that the secondary roles can be performed by the service provider or the issuer of the SE.

Actors and roles for platform management and life cycle management of the SE are discussed in (MadlMeyr & Langer, 2008). In this paper the role of the Platform Manager (PM) that controls the SE is introduced. The PM operates in parallel with a Platform Provider (PP), usually the Mobile Operator, with the main role to offer the OTA provisioning services for applications. The PM acts as mediator between the service provider and the PP. With a PM the end-user can freely change the mobile network operator (MNO) as well as the provisioned application. The paper also describes different approaches for control of NFC applications including MNO-centric, handset manufacturer-centric and service provider-centric approaches and a "neutral" approach using an independent TSM.

In our analysis we adopt the approach of "Markets as networks" with a focus on relationships between different actors building upon the so called ARA model with Actors, Resources and Activities (Håkansson, 1987), (Håkansson & Snehota, 1989). Actor networks and interaction between market players have been studied by business and market researchers since the 1980´s (Johansson & Mattsson, 1985), (Ford et al, 2007). Many studies analyze the interaction within a network of suppliers and the relationships between suppliers and customers in the manufacturing industry (Andersson, 1994), (Gadde & Snehota, 2000), (Grönroos, 2004), (Ulaga & Eggert, 2006).

Actor interaction is also described in (Normann & Ramirez, 1993), (Peppard & Rylander, 2006) where actors create value in networks or constellations rather that in a "value chain". The analysis in these references focus on Business to Consumer (B2C) relations whereas the supplier network analysis mentioned above focus on Business to Business (B2B) relations. In our paper mobile payments will be analyzed in Business to Business to Consumer context (B2B2C).

In our analysis of actors and distribution of roles and responsibilities within value networks we use a modified form of the ARA model influenced by the business model definition proposed and used by Chesbrough & Rosenbloom (2002). The definition contains the following elements: value proposition, market segment, cost structure and profit potential, firm organization and value chain, competitive strategy, firm in the value network. The key issues in our analysis are those related to the value network; i.e. "the firm organization and value chain" and "firm in the value network.

3. Research approach and methodology

The results in this paper are based on interviews and analysis performed in a Swedish research project focusing on mobile payments, NFC services and SMS based ticketing services. In this section we will describe the collection of primary and secondary data and outline the analysis approach.

3.1. Collection of primary data

A number of interviews were made November 2009 to June 2010 with representatives for the companies according to table I. The starting point was discussions within a research project together with the Swedish Mobile Operator where we identified a number of companies with interest in contactless services for payments, ticketing and electronic locks. These companies were interviewed together with actors involved in commercial launches and trails that were announced in Sweden 2009 and early 2010 respectively. Additional data from the Japanese market and the view from some Japanese companies were collected during a study trip in Japan 2010.

TABLE I. INTERVIEWED COMPANIES

Type of actor	Company	Position or Unit
Non-telecom service providers		
Public transportation	Storstockholms Lokaltrafik	Payment solution manager
Public transportation	Upplands Lokaltrafik	Marketing manager
Public transportation	Västtrafik	Project manager
Parking operator	Municipality of Västerås	Municipality traffic office
Mobile operators		
Mobile Network Operator	Tele 2 Sweden	Mobile Product Marketing
Mobile Network Operator	TeliaSonera AB	Head of 3rd party content services
Mobile Network Operator	TeliaSonera AB	Research & innovation
Mobile Network Operator	KDDI (Japan)	Foreign Market & Policy Group Industry Research & Standards
Mobile Service or ticket providers		
Payment solution provider	Sergel	Content Billing and clearing
Mobile parking payment provider	Tele-P	CEO
Mobile parking payment provider	EasyPark group	Marketing manager
Mobile parking payment provider	Mobill	CEO
SMS ticket provider, Aggregator	UNWIRE	Country Manager
Aggregator	Ericsson IPX	Global Solutions Manager
Technology providers		
Security solution provider	Accumulate	CEO
Security solutiosn for digital locks	Assa Abloy	Product Manager Digital Sesamy
Service platform solutions	Ericsson IPX	TSM products
Payment and ticketing solutions	Modul-System AB	Marketing manager
Security solution provider	Payair AB	CEO
SIM card solutions	Smarttrust	Director Product Management
NFC chip sets	Sony Felica	Global Standards and Industry Relations Department .

In addition to questions related to the start up of the payment related services or activities and even the company itself the interviews included questions around future services. The main questions were: What are the target application areas? What market segment do you address? What kind of resources have you developed or do you need to develop? Who are you partners and business customers?

The questions, answers and discussions around future NFC enabled services were quite different to the similar interviews done for the existing SMS based payment and ticketing services. The description of the SMS cases to a large extent is focused on what did happen, how the services emerged and how the situation is today. The interviews about NFC services typically resulted in descriptions on "how it will work" and "how it can be" at a future service market. Whereas the SMS cases is about "how it is" the NFC related interviews provide information on what people believe "may happen".

3.2. Collection of secondary data

Background material has been collected from web sites and from white papers and specifications presented by industry associations and organizations like MobeyForum, NFC Forum, GlobalPlatform, GSM association (GSMA) and European Payment Council (EPC). We have also collected information on ongoing NFC projects and trials with NFC services. By searching and compiling research papers on NFC technology, security and trust in the Force project we have got an overview of the State of the Art within the area. Although most work is on technology aspects, i.e. functionality and interfaces, some contributions address market aspects and the need for new roles. Information on payments solutions outside Scandinavia, e.g. Verrus and m-pass, were collected from the company web sites.

3.3. Analysis approach

The first step is to look into what the industry and standardization organizations say about interaction between actors at future mobile payment markets, resulting in an initial map of roles, actors and relations. Next, two similar maps are compiled based on two types of input;

- What is happening within recent initiatives in mobile contactless payments in Sweden
- Findings from existing mobile services for mobile payments, ticketing and parking

The third analysis step includes a comparison between these different types of market descriptions (the maps) where the focus is on the distribution of business roles. The types of questions to be answered in this comparison are: What kinds of business roles are identified? Are they the some or are some roles missing? What new roles are identified? Are all new roles of the type intermediary? What actors are candidates to take different roles?

The next analysis step is to compile an overall picture of mobile contactless payment ecosystems. This includes identifying patterns of and main differences between different types of markets depending on how the involved actors build their relations and configure the value network. In all these steps the key "analysis tool" is to identify and describe the type of interaction between financial institutes, the (non-telecom) service providers, mobile operators, mobile service providers and different intermediaries taking existing or new roles in the value network.

Finally, we look into how different types of implementations of the TE influence the distribution of roles within the value network and the position of the involved actors.

4. Actors and relations for different payments solutions

This chapter starts with a grouping of the different analyzed payments solutions. One group is SMS based payment and ticketing services, i.e. solutions where mobile operators have a natural role. Next, we will provide examples of existing mobile payments that do not involve mobile operators.

4.1. Grouping of payment solutions

When we study different payment solutions we can recognize some similarities and differences. One aspect is the one of proximity, i.e. whether the transaction is done "close to" a point of sales terminal or not. A second aspect is whether the security and/or payment solution will be directly connected with the SIM card or whether it will be connected with a server or the mobile phone in itself. The combination of these two factors leads to four different scenarios that will guide our discussion and analysis, see Figure 3.

SMS payments use the mobile subscription for identification and charging but do not include any proximity features. NFC services can make use of SIM cards for storage of the TE for a specific service in combination with proximity features where you need to "touch or swipe the phone". With this kind of "proximity feature" the personal device (e.g. a phone) touch or is moved across an infrastructure device such as a reader in a shop, a subway gate, or a hotel door lock.

However, there are payment solutions with proximity features where the mobile operators are not involved in the security or payment mechanisms. Commercial services and trails have been launched with security mechanisms combining server based TE and some type of proximity feature; one-way (Mayfair card) or with some delay (using Bluetooth). Finally, we have server based payments using mobile phone without any proximity features. Existing solutions for this separate charging include both dedicated mobile parking payments and more general payment services. The grouping is shown in Figure 3. The actors and relations for different solutions will be discussed in more detail in the coming subsections, except for the NFC based services which is described in Figure 1.

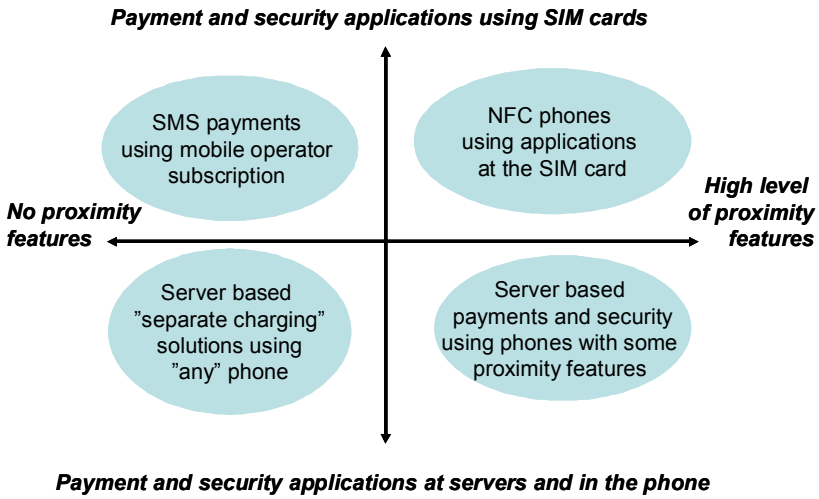

Figure 3 Grouping of mobile payment solutions

4.2. Existing SMS payment and ticketing services

Businesses that want to use SMS messages for any kind of service; advertising, voting, collection of money, ticketing or payment, are faced with an eco-system for SMS services consisting of a number of actors with different types of relations. On one side we have the end-users who have subscriptions with a specific Mobile Network Operator (MNO) and on the other side we have the businesses that want to use SMS services. In between, in addition to MNOs, there are so called "aggregators" that aggregates SMS traffic from all operators, unless you want the SMS service to be offered to subscribers of a specific MNO. An aggregator has two types of relations with a MNO. First, there is a technical part consisting of connections to carry the traffic. Secondly, there is a business related part where the partners have agreed on prices for a specific amount of SMS traffic and, for the case that the mobile phone subscription will be used for payment, the size of service fee (per cent) that the MNO puts on top of the amount of money that is charged to the end-user mobile subscription.

When a SMS is identified as a "Service SMS" it is transferred to an Aggregator that checks with the operator of the user that the user account (or pre-paid SIM) can be charged. If the account can be used the operator sends OK to the aggregator and then charges the user subscription the cost of the mobile service, the price of the SMS and a the service fee. For transportation and parking services a "SMS ticket" needs to be produced and delivered to the phone, for buses and subways you need to "show a ticket". In addition to the aggregation, use of SMS tickets requires support for ticket issue, delivery and validation features; see more in (Markendahl & Andersson, 2010).

Aggregators and companies issuing SMS tickets are denoted "mobile service provider" in Figure 4, names of specific companies can be found in table I. These companies are examples of actors that cooperate with both operators and service providers. The studied cases for SMS based services indicated a large number of variations in the type of interaction between these different actors The Figure 4 provides examples of this variation where we also can see that the mobile service provider (that issues the SMS ticket) can have the main relation with the end-user (parking case to the right) or be invisible to the end-user (transportation case to the left). The cost for the SMS tickets is charged to the end-user using the subscription with the mobile operator.

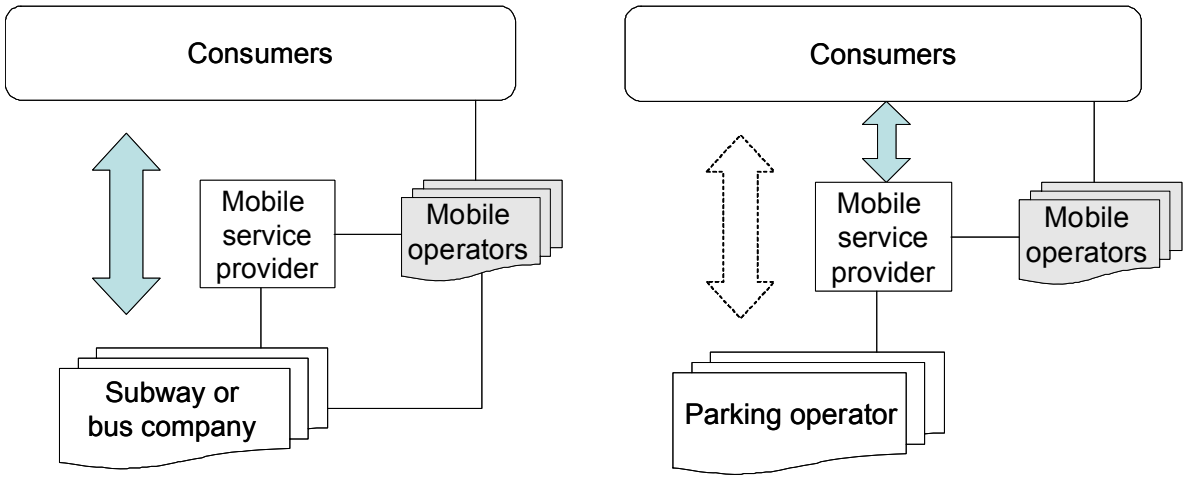

Figure 4 Actors and relations for two cases with SMS tickets. The arrows indicate "main customer relation for the transaction" and the lines indicate some other type of business relation or agreement.

4.3. *Mobile parking subscriptions and separate charging solutions*

Mobile parking subscriptions and separate charging solutions allow users to order and pay with the mobile phone without charging of the phone subscription. The identification is based on the mobile phone number and the charging is based on use of a credit card or sending an invoice to a billing address. The services have no proximity features, i.e. they can in principle be used from any location.

There are a number of challenges for mobile operators related to SMS payments. One challenge is the size of the "transaction fee" that operators use in order to compensate for their costs and risks. Operators typically keep 20-30% of a SMS transaction when an aggregator is used for distribution of payments. Another challenge is the limit on SMS transactions that prevents use of more expensive tickets e.g. for concerts, train travels and airline flights. This leads to an interest from operators to also offer "separate charging" to the customers. One example is m-pass (www.mpass.de) where the users get a monthly bill with aggregated purchases, tickets, etc. Year 2008 the two German operators, O2 and Vodafone announced the m-pass mobile payment service. M-pass is automatically available to all Vodafone and O2 postpaid subscribers in Germany. Prepaid subscribers, business users and subscribers of other German operators can use the service after an online registration. The m-pass service combines a direct debiting scheme with a SMS confirmation on the mobile phone. This kind of concept is growing in Germany and Austria. Late 2009 it was announced that the payment service company Easycash has been selected as a payments partner for the m-pass system.

Although there currently is an increasing interest for separate charging solutions, mobile phone based payment solutions for parking services have existed for almost 10 years in Sweden (companies Tele-P and EasyPark). These services replace cash and card payments by using a login-logout procedure when parking. The user needs to register the mobile phone number, registration number of the car(s) and credit card number or a billing address for monthly payments. There also exists similar payment services that can be used for both parking and taxi travels (www.verrus.com)

These solutions are illustrated in Figure 5 where the monthly bill is assumed to be paid by credit card. The provider of the mobile parking subscription or the separate charging service has the main billing relation with the end-users and also with the merchants etc. For example, for specific parking events, the mobile operators or banks are not involved at all in the payments.

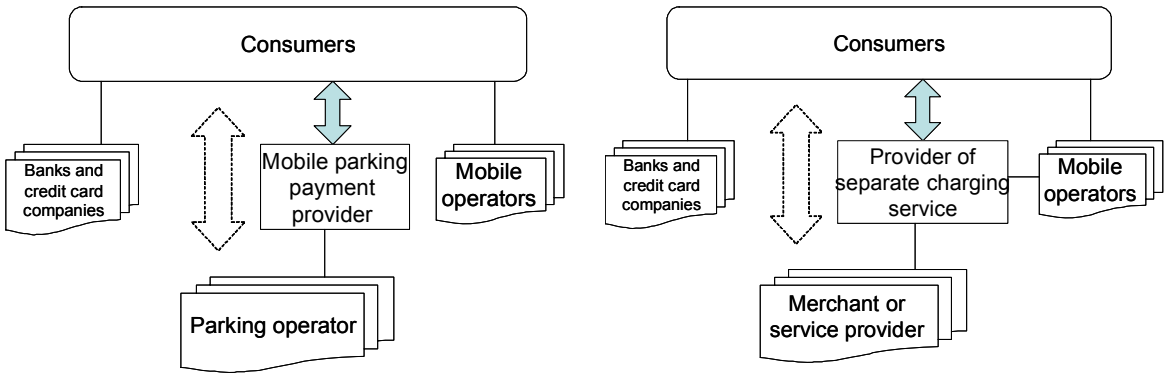

Figure 5 Actors and relations for mobile parking subscriptions and separate charging services. The blue arrow indicates "billing relation" and the lines indicate other types of business relations

4.4. Payment providers offering contactless mobile payments

In Sweden the service "Payex Mobil" with contactless mobile payments was launched mid 2009 by Payex[5]. The company Payair[6] announced trails with contactless mobile payments March 2010. The security and payment solution used by Payex is developed by the company Accumulate[7] that also is acting as a payment service provider supporting the customers of Payex.

Both Payair and Accumulate provides secure login, authentication and payment solutions. The mobile solutions are different but both use two-way communication with a security server; one way is through the mobile network and the mobile phone and the other way is through internet and the reader in the shop, restaurant etc. Both solutions have proximity features, one based on a NFC sticker and the other one on a Bluetooth connection. Note that the proximity features are both related to ease of use for the consumers and to be a part of the "two-way" security solution.

One advantage is that there is no need for NFC enabled phones, and the payment service works today. The solutions can be adapted for use by NFC mobile phones when these become available. Another main characteristic is that the solution is operator and network independent. Mobile operators (or SIM cards) are not involved in storing or management of the payment application and the mobile operators are not involved in the transactions made by the end-users.

The interaction between actors is illustrated in Figure 6. In one case Payex is the payment provider where Accumulate as "subcontractor" acts as service provider of the security and payment solutions. In the other case Payair is the payment provider. The payment provider has relations with both the consumer and the merchant/service provider. In the Payair case the money of the end-user is linked to a credit card or bank account. Payex uses a solution with a mobile wallet that need to be "filled" with money before usage

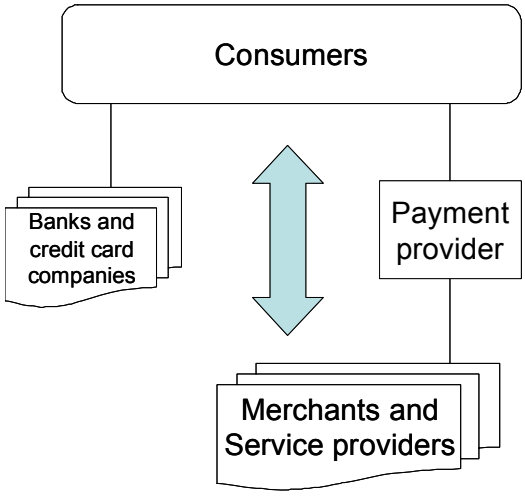

Figure 6. Actor and relations using a payment provider, the arrow indicates "main customer relation for the transaction" and the line indicates some other type of business relation or agreement.

[5] http://payex.com/about/news?articleId=922
[6] http://www.payair.com/
[7] http://www.accumulategroup.com/webb/

5. Business implications of options for implementation of the Trusted Element

5.1. Trusted Element Definition and Functionality

A Trusted Element or TE is a functional unit that can exist alone or in an information terminal, and allows for the storage and exchange of data in such a way that makes a secure transaction possible. A secure transaction is one that needs to preserve the integrity or secrecy of data in various ways. TEs can be realized in a number of different ways, but there are common aspects of functionality that make it possible to compare them and evaluate their suitability for different methods of deployment, and for different tasks such as electronic payment. With respect to electronic payment, functionality revolves around three areas; data exclusivity, platform exclusivity and device interoperability.

The trust aspect is concerned with integrity and possibly secrecy of data necessary to conduct a transaction. This data typically represents items such as customer identity, account numbers, available balances and time stamps, although the data could represent anything. It is important that the data represents exactly what it claims to, and so can be completely trusted by a merchant. A TE accomplishes this by insuring exclusivity to the data resources that it contains. This data exclusivity is accomplished by restricting the ability to read, write or process data that exists in the TE to a limited number of actors, often just one. The SIM card in a mobile phone is a example of a TE that provides excellent data exclusivity by providing a single locked interface to the card contents which only the subscribed network operator has the keys to access and modify.

Platform exclusivity refers to how a TE will allow the information terminal to use it and especially how many TEs can exist simultaneously in the information terminal. If multiple TEs can exist in an information terminal such as a mobile phone then this means that multiple merchants can have their own exclusively trusted data spaces. There are many conceivable ways to have multiple TEs in a terminal, for example by having multiple SIM cards, by having TE hardware that can support several simultaneous secure connections, or through virtualization using software. Regardless of how it is done, there are significant functional and usability differences related to platform exclusivity. For example, in platforms having only a single TE using a single interface such as a current SIM card, then anyone other than the network operator will need to have access to the data in the TE mediated for them. This can mean that a merchant will need to have relationships with a lot of different operators, or will need to find a trusted third party (TTP) who can provide these mediated services across multiple operators. Conversely, the ability to host multiple TEs in a terminal may remove the need for mediated data services, but may in turn create unintentional side effects such as the ability to do on the spot bargaining across multiple merchants.

Device interoperability refers to the ability of the TE to be used in a number of different information terminals without the need to redesign or customize the TE. This reflects the word “Element” in the term “Trusted Element”, and implies that the TE is a separable entity from the rest of the information terminal’s circuits and software. The ability to use a TE without modification across different information devices is possible if the TE has its own dedicated hardware and/or software. Using the SIM card again as an example, this functionality gives the network operator control in a manner independent of the mobile device technology and who made it.

5.2. Trusted Element Types

Trusted Elements can be realized in a number of different ways, and how they are realized will have an impact on the degree to which they exhibit data access exclusivity, platform exclusivity and device interoperability. Existing options for trusted elements that have been described are related to Smart Cards[8]. The most common choices are derivations of existing SIM or UICC cards, user installable option cards such as trusted element hardware in a standardized package format such as a Secure Digital Card, and non-user installed hardware such as a trusted element chip that has been designed directly into the mobile terminal. In addition to these options, it is technologically possible to deploy a software only solution and form a virtual trusted element that runs directly on the computing resources native to the mobile terminal. In addition to the form factor, amount of special hardware used and other technology factors, the differentiators between these trusted element architectures are mostly reflected in how they can be used.

SIM or UICC cards and their use as TEs in mobile payment solutions based on NFC have been described[9]. In this environment a single direct connection between the NFC hardware and the SIM or UICC card is formed, with the payment transaction taking place over this connection following a "Single Wire Protocol". This results in a mobile payment platform where the operator has exclusive access to both the contents of the TE, and to the platform that the TE is installed in. There is only one interface to the NFC hardware used to perform the payment transaction, and that interface is exclusively given to the SIM card making the mobile platform as a payment device only accessible to the operator. Because the operator is the owner of the SIM card and the only one who can grant access to the data it contains, the operator maintains control over the data as well. Any other merchant wanting to use the TE for payment services will need to rely on the operator for data access. Because the TE is a separate hardware element that shares no part of the mobile terminal itself, TEs using SIM or UICC cards are very interoperable across mobile platforms.

Smart card hardware can be designed in ways that do not restrict the number of data connections that can be made between the TE and the mobile terminal to only one. TE options based on user installable hardware in a standardized package format can be realized this way. TE hardware realized as a separate chip that is directly installed into the mobile terminal during manufacture is another possible example. In these cases, there is no reason that the TE hardware has only a single access interface or protocol. The resources in the TE instead could be shared among merchants who want to support mobile payment applications by provisioning the applications to use part of the storage and computing resources available in the TE. In this case not only is the access to data in the TE not exclusive to a single entity, the platform is not necessarily exclusive to a single TE. Multiple TE devices could be plugged in, or installed in the mobile terminal limited only by cost and space. A payment application could be provisioned with access over the air from a provisioning authority that provides keys or other tokens necessary to gain access to TE resources. As in the case with SIM cards, because these TEs are separate hardware elements that share no part of the mobile terminal, they also are very interoperable across mobile platforms.

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[8] Proximity Mobile Payments: Leveraging NFC and the Contactless Financial Payments Infrastructure, Publication number CPC-07002, September 2007, Smart Card Alliance, 191 Clarksville Rd., Princeton Junction, New Jersey, 08550, USA

[9] Ericsson, D., The Role of SIM OTA and the Mobile Operator in the NFC Environment, White Paper, August 2009, SmartTrust, Fredsborgsgatan 24, Box 47152, SE-100 74 Stockholm, Sweden

Software based virtual TEs are also possible. These can be installed and provisioned over the air, and because there is no shared TE, merchants could perform the provisioning without resorting to a third party provisioning authority. The number of virtual TEs a mobile terminal can support is only limited by the available memory and computing resources in the device. Because such TEs do not represent hardware that is separate from the mobile terminal, interoperability across many different types of mobile terminals will be more of a concern. Transaction security may also be a concern although there is precedent for customers routinely performing payment transactions on personal computers containing no special hardware to support secure transactions.

TABLE II. TAXONOMY OF DIFFERENT TYPES OF TRUSTED ELEMENTS

Type of TE	***Data Access***	***Platform Access***	***Inter Operability***	***Provisioning***
SIM card or UICC card	Exclusive	Single TE	Yes	May need Trusted Third Party (TTP)
Module in standard interface	Shared	Multiple TEs possible	Yes	Need provisioning authority
Custom chip installed in terminal	Shared	Multiple TEs possible	Yes	Need provisioning authority
Software or Virtual TE	Exclusive for each TE	Multiple TEs possible	No	Can be provided by merchant

Interoperability for SW TEs running on handsets is a big problem because of differences across the handset vendors, both for hardware and software. A software TE is different from a HW TE in that the software TE just runs on the hardware already in the phone. They all construct their handsets differently, so buttons are not all in the same place. They use different operating systems, so that code does not port well across them all. In some cases, they lock developers out of their handsets, for example Apple does that. Another example of interoperability problems can be seen with Android. Different handsets can have such different versions of Android running in them that software developed for one will not run on the other**.** Even among one manufacturer there can be completely different operating systems used in their handsets. These differences can result in the need to support many different versions of software in order to support a large number of different handsets, which does not seem economically advantageous.

When it comes to the provisioning of services where the TE solution is based on SIM cards a trusted third party (TTP) is needed if multiple (many) operators are involved. It is not the technical solution of the SIM card itself that requires the TTP but the operator control. It is technically possible to do mobile transactions using a SIM or UICC card as the TE without using a TTP, For example, the TTP is not needed if all of your customers are connected by only a single operator. In order to make the service available for customers of many operators the involved operators need to have a general and agreed solution. If few operators are involved they can have mutual agreements but if many actors are involved the agreements can be handled through a third party.

5.3. Business implications

The different solutions for implementation of the TE have implications for what actors that will be involved in the service provisioning. A general implication is the one that results from the "multitude of multitudes" meaning that the mobile payment service should be offered by many merchants and service providers to customers that have different mobile operators, banks and credit card companies.

SIM card solutions

The multitude of multitudes is one reason why trusted third parties are discussed for NFC payments. The different NFC services, that may have own "TEs", are stored at the UICC card and managed by a role usually called the TSM (Trusted Service Manager). The actor taking the TSM role will have agreements with "many" merchants/service providers and manage their services, hence each mobile operators do not need to have own agreements with "many" merchants/service providers.

But, as the TSM role for NFC services is defined, the TSM will not be involved in the actual service provisioning. E.g. if a credit card company implements a contactless credit card, including a TE, in a NFC phone, then it is the credit card company that controls the TE, not the TSM or the mobile operator of the user.

Different approaches are discussed for what actor that may take the TSM role, e.g. bank-centric, operator-centric or neutral actors. Neutral actors are found for existing SMS payment and ticketing services. However, in this case the TE stored at the SIM card is controlled by each mobile operator. The third party, the SMS aggregator, in this case ensures that the SMS service is available to the customers of all operators and also distributes payments from mobile operators the service provider.

To summarize we can say that solutions based on SIM or UICC cards lead to business solutions with third parties that will play one or more intermediary role; management of the services at the SIM card, maintaining business relations with merchants/service providers and distribution of payments. The mobile operators are absolutely "within the loop" but other actors, third parties, are required and play important roles. For the mobile payment service itself it can be questioned if the mobile operator subscription can be used as a general payment solution. However, charging using the "mobile phone bill" seems to be feasible solution for small payments and for mobile ticketing

Custom chip installed in the terminal

Although there are no examples of this solution yet it may just be that we will only have to wait until a solution wins the market. It would be an opportunity for handset manufacturers to get a stronger position for mobile services, especially companies like Nokia and Apple.

We can compare what happened to WiFi.technology. Even less than 10 years ago it was hard to find a laptop computer with WiFi built in. Businesses and individuals were worried about claims that it wouldn't work well and that it was not secure. However, at that time you could buy lots of WiFi add in cards. Now that WiFi is completely accepted it is hard to find a laptop that does not have all the required hardware integrated in. It is not unlikely that TE hardware will follow the same path and eventually be integrated right into the handset.

TE module inserted in the handset

The "module" in this case is a micro SD card that acts as the TE, and software to use it is added to the phone. This kind of solution has been presented by major credit card companies. E.g. VISA offers contactless payments that can be used with an Iphone[10].

The same kind of solution, where a mobile phone is enabled for contactless mobile payments by inserting a card in a memory slot, was recently announced in the US[11]. In this case three competing mobile operators in the US are exploring a joint venture to develop a mobile payment service. The operators AT&T, Verizon Wireless and T-Mobile will form a team with Barclays as bank partner and they will use Discovery Financial services for processing of payments. As commented by the Wall Street Journal the mobile operators have billing relations and billing platforms but

> *" they need to team up with payment processors which manage large networks of merchants and banks which provide credit and handle accounts "*

Here we can see that the very same technical solution leads to totally different roles and positions for the mobile operators. In the VISA case the mobile operator is not involved at all. In the mentioned "US case" the three operators team up with financial institutions. The operators offer the service to there own customers but that partners handle the payments and credits. Hence, they are still in the mobile payment business.

Software TE or a Virtual TE

Here the TE solution is a combination of SW at a server, SW in the phone, a link to phone number and passwords. It is kind of combination of authentication methods as discussed by (Massoth & Bingel, 2009) where you both "something you have" (i.e. the phone) and "something you know" (a password "that only you know" or "that you get from a server").

This type of TE solutions were described in chapter 4. The M-pass solution and the parking subscriptions have no proximity features while the Payair and Payex solutions have. Payair and Payex solutions can be considered to have a high level of security while the parking subscriptions have a lower level of security and also only can be used for payment of parking services.

In the M-pass case the mobile operators offer this service to there own customers in order to enable charging not using the phone bill. The service is automatically offered to Vodafone and O2 customers in Germany but customers of other operators can register for the services. For the Payair and Payex solutions and the parking subscriptions the operators are not involved at all. In principle "anyone" can offer this kind of mobile payment service without any operator being involved or aware. One challenge is to get good "service coverage". For the payment solutions like Payair and Payex many merchants need to install readers. It is the same situation as the "three US operators" mentioned above; you need "a *large network of merchants"*. The same applies for the companies offering parking subscriptions. They also need to have agreements with "many" parking garages, parking operators, municipalities, etc in order to provide "wide area coverage" for their customers.

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[10] http://www.readwriteweb.com/archives/visa_to_launch_contactless_mobile payments_for_iphone.php

[11] Wall Street Journal reprint August 4, 2010, "Telco rivals plan mobile payment service"

6. Analysis of business roles and company position

In this section we discuss the business roles typically found for mobile payment services and how they are distributed among actors for different types of mobile payment systems.

6.1. What business roles can be identified?

From the cases described in section 4 and 5 and based on the findings from the references in the related work section and we have identified three main groups of business roles:

1. Roles related to the services and service provisioning in order to:
    - develop the service or applications
    - manage services, service platforms and trusted elements for end users and service providers
    - provide the service (e.g. a SMS ticket) to end-users (on behalf of the service provider)
2. Roles related to business relations that handle
    - the interface towards end-user when it comes to the service provisioning
    - the relations with the business customers, i.e. "non-telecom service providers"
    - exchange and relations with partners, i.e. other actors in the supply network
3. Roles related to charging, billing and payments that
    - initiate and send request for end-user charging
    - charge end-users, send bills to end-users or to send charging requests to a partners
    - manage payments streams and to distribute payments

Are these roles new? All of these business roles can be identified in existing markets and for existing services. The role of acquiring customers and manage the relations with end-users exists in many forms. Operators and banks take this role for their existing services but for mobile payments we can observe multiple ways to establish a relation with the end-users; through the service provider (e.g. SMS tickets), through the mobile operator (the example m-pass) or through a new payment provider (e.g. Payex, Tele-P or Easypark).

The role to manage services and platforms is not new. For NFC services the role of the TSM is usually described as life cycle management of the application stored at some kind of TE, e.g. a UICC. This role is new in the sense that the joint use of a TE for storage of applications from different service providers is a new way to exploit the features of SIM cards. If the applications were stored at an “own TE”, or at least at non SIM card based TE´s, the need for a dedicated neutral role would probably be lower. Otherwise the role to manage services and service platforms is not new or linked to secure elements or NFC applications only. Applications can be stored in different forms of TE´s, dedicated or for joint use. However, many applications use other solutions where both the “service” and the TE are located at a remote server. For SMS services and mobile parking subscriptions there is nothing that needs to be managed in the mobile phone. The security and authentication procedures needed for SMS payments are already in place using the mobile phone and subscription features.

The applications developed by Accumulate and Payair supporting contactless mobile payments are provided by the payment provider and downloaded in the phone. No access to any operator controlled TE is needed; the identification and security mechanisms are running at a remote server.

5.2 What business roles are taken by whom?

For different payments solutions we need to see how the business roles are distributed among the different actors. In table III this distribution of roles are shown for four existing types of payment services and our "best guess" for the solution with the three US operators mentioned in section 5.

TABLE III. DISTRIBUTION OF ROLES AMONG ACTORS FOR DIFFERENT TYPES OF MOBILE PAYMENT SERVICES

	Type of Mobile Eco-System				
Business role and the main area of responsibility	*SMS tickets*	*Parking subscription*	*Payex solution*	*Payair solution*	*Case"3US operators"*
Develop service (e.g. SMS ticket or secure payment)	SMS ticket provider or other	Mobile parking provider	Solution developer Accumulate	Mobile payment provider	Any solution developer TBD
To manage applications or service platforms	SMS ticket provider	Mobile parking provider	Mobile payment provider	Mobile payment provider	*?*
To provide the service (e.g. to issue a SMS ticket, to make transaction)	SMS ticket provider	Mobile parking provider	Mobile payment provider[12]	Mobile payment provider	Payment processor
To handle relations and the interfaces with end-users	SMS ticket or Service Provider	Mobile parking provider	Mobile payment provider	Mobile payment provider	Operators +Payment processor
To manage the relation with merchants/service providers	SMS ticket provider	Mobile parking provider	Mobile payment provider	Mobile payment provider	Payment processor
To manage relations and exchange with partners	SMS ticket provider or aggregator	-	Mobile payment provider	Mobile payment provider	Payment processor
Initiate and send request for end-user charging	SMS ticket provider	Mobile parking provider	The user (by loading mob wallet)	The user + merchant at point of sale	Payment Processor
Charge the end-user	Mobile operator	Mobile parking provider	Bank or credit card company	Bank or credit card company	Bank
Manage payment streams and distribute payments	SMS ticket provider	Mobile parking provider	Mobile payment provider	Mobile payment provider	Payment processor

[12] Solution developer Accumulate also provides the security solution

The content in table III together with the descriptions in sections 4 and 5 enable us to make some observations about what actor that takes different roles. Three main conclusions can be made:

- For all types of payment solutions some intermediary actor takes most of the roles. Other actors like banks, credit card companies and mobile operators are "less directly involved" in the mobile payments and ticketing services.
- We can however observe differences in the operator involvement and position. For the parking subscriptions and the Payair and Payex solutions the operators not involved at all. For SMS tickets the mobile operators are involved although other actors take most business roles. In the cases of M-pass and the "3 US operators" the operators take the initiative and include the payment service as an offer to their customer, i.e. they are "still in the loop" r
- The different intermediary roles are closely linked and often one actor takes many roles for a specific service. In the observed cases it is less common that an actor takes a "single role" for provisioning of a specific service.

Some companies that develop the technology or service also are the provider of the service; examples are Easypark and Tele-P for mobile parking subscriptions, and Accumulate and Payair for contactless and secure payment services. Other companies, like Mobill and Unwire for SMS tickets, develop and provide the payment or ticketing service on behalf of the provider of the non-telecom service provider. When services are developed and provided for other businesses the intermediary will develop a good knowledge of these non-telecom services and markets.

The main business relation is between the merchant or service provider and the end-user. For the mobile payments and ticketing services the intermediary can be more or less visible to the end-user. In some cases an intermediary is responsible for the payment and ticketing, e.g. for mobile and SMS parking services. In other cases the end-user is not aware that an intermediary is involved, e.g. for SMS bus tickets in Stockholm. When it comes to the contact with the non-telecom service providers the intermediaries have a very strong position. Companies like Easypark, Mobill, Payair, Payex, Tele-P and Unwire have relations with many merchants or service providers. For mobile payments and ticketing the financial institutes and operators in most case do not have any agreements with the services providers.

Companies like MBLOX and Ericsson IPX take the role of a neutral partner that aggregates traffic from many operators and distributes payments from SMS premium services. The intermediaries that provide SMS tickets often handle the distribution of payments to the service providers. For mobile parking services it is the intermediaries that collect parking fees from users and distribute to the parking operators. The payment providers naturally support payments.

For the pay-buy-mobile type of services it is unclear what actor that will take different roles, especially when it comes to development and provisioning of the mobile service. A lot of effort has been spent on the specification of tasks, responsibilities and interfaces for a TSM role with a focus on life cycle management of the secure element (the UICC). It is identified that someone needs to take the TSM role but the other roles and their inter-relations are unclear, it would be mostly question marks in table III. Hence, the position of mobile operators is unclear.

7. Discussion

In this chapter we will summarize our findings and look into different types of future scenarios. First, we list some observations on NFC technology and mobile payments from the Japanese market.

7.1. Some notes from the Japanese market

Contactless NFC technology is quite well spread in Japan and is implemented both in plastic cards and in mobile phones. The main actor is Sony that manufactures the FeliCa chipset. Until 2009 the estimateC is that 410 million FeliCa chips have been shipped, where 120 million of the chips are installed in mobile phones. Currently there are roughly 60-70 million handsets with NFC capability in Japan, the share that is being used is estimated to be 15-20%. Every year ~49 million NFC handsets are sold. The mobile operator NTT Docomo equips all their mobile handsets with NFC.

The services where the FeliCa technology is used include public transportation (pre-paid and season tickets), credit cards, pre-paid card (taxi, vending machines, convenience stores) and coupons and stamp cards (fast food restaurants) shopping

Sony FeliCa is a joint venture between Sony, the train operator JR East and the mobile operator NTT DoCoMo, The Sony FeliCa business revolves around all parts of the “NFC value chain”, complete solutions with chipsets, equipment, software etc. FeliCa Networks manufactures chipsets and also acts as a trusted 3rd party for the NFC system

NTT Docomo has been very active in the area of contactless services. In March 2005 a pilot was launched with JR East to test a contactless card integrated in a mobile phone, the “Mobile Suica“. In June the same year DoCoMo and JR East agreed to develop and manage a common reader/writer infrastructure for FeliCa smart card technology. In January 2006, JR East launched the “Mobile Suica“, available via DoCoMo, aU and other providers.

2005 DoCoMo also founded a strategic alliance with a number of financial institutions in order to launch a credit-payment service using DoCoMo´s “mobile wallet“ phones. DoCoMo also acquired 34% of the common shares of one of the partners (Sumitomo Mitsui Card's). This strategic alliance resulted in the launch of the DoCoMo´s credit card brand called “iD“ in December 2005. “iD“ enable companies to link credit cards to DoCoMo wallet phones and to offer contact-less mobile payment services. It was developed as an open system and firstly was promoted by Credit Saison, Mizuho Bank and UC Card in February 2006.

The knowledge and experience with “iD“ in the credit card business led DoCoMo to launch its own credit card service „DCMX“, in April 2006. Now DoCoMo reached the credit service market and put a lot of expectations into it. Every new customer, purchasing an “Osaifu-Keitai“ phone is automatically enabled as a DCMX customer. In August 2009, DCMX gained over more than 10 million subscribers. (Bockisch & Cantú Alejandro, 2010)

Other operators like KDDI have developed NFC cell phones and conducted own trails. A problem for all operators is that the current business model of the NFC services does not generate any revenues. NTT Docomo has promoted NFC applications but has not taken any margins for the payment handling for example the train companies. It has been regarded as an added customer value, as a way to improve customer loyalty and to reduce churn and making the mobile terminal to a general payment device.

7.2. Summary of observations

When we study our own "Swedish" cases and some initiatives at other markets we can identify same common patterns how mobile operators and other actors act and also re-act when it comes to mobile payments and ticketing.

- *Mobile operators join forces.* In many cases the mobile operators start to cooperate with their competitors in order to provide a common solution. Examples are M-pass in Germany and Austria and the AT&T, Verizon Wireless and T-Mobile initiative in the US. The same is true for Felica in Japan and when it comes to SMS ticketing.
- *It is essential to have financial institutions as partners.* NTT Docomo established close cooperation with a bank and a credit card company and later launched an own credit card brand. The Payair trails include a bank as a key partner. The "three US operators" cooperate with a bank and a payment provider. Also the M-pass solution means that "someone else" will charge the customer of the mobile operator although the mobile phone is used.
- M*obile payment and ticketing service can be offered without any operator involvement*. We have the Payair and Payex examples and the parking payment subscriptions. These solutions use server based security. Any large actor could do the same
- *Mobile ticketing will happen if there are strong incentives from service providers*. Public transportation companies all over the world now use contactless pre-paid tickets, season or monthly card. Problems with paper tickets and costs for ticket machines and gates are drivers for this change. The use of SMS ticket is growing, driven by user convenience or cost or safety issues with cash handling.

If we look at the Japanese "Mobile Suica" case we note some interesting issues, especially when we compare with Europe. In Europe there have been many trails with NFC services. The common view is that the NFC technology will work but feasible business models are lacking. In Japan three partners were committed to start a contactless service. There is one actor taking the role as trusted service manager. In addition, NTT Docomo does not charge for the contactless service, it is seen as added value for their customers. This can be compared to the SMS payments and services where the operators can take around 20 % of amount charged to the end-user. If the same kind of reasoning is applied to NFC services it will be difficult for these services to take off.

If we look into the different technical solutions to implement a TE it seems like solutions based on plug-in modules in memory slots in the handset and SW based solutions running at some server are at least as feasible as SIM card based solutions. But what is really the key issue? Is it the content of the SIM card? Is it the control of the SIM card? Or is it something else?

The role of the SIM card as being the TE for the transaction or the end-user charging can be questioned. However, common for all solutions that we have discussed in this paper is that the mobile phone as a device and/or the mobile phone number is used for identification. It is the control of the mobile phone (with some associated identification mechanism) that enables all of the mobile payments we have discussed. Hence, the SIM card and its security mechanism is a tool to identify the phone itself. Additional features are needed to ensure that the user of the mobile phone is the correct one.

7.3. Possible future scenarios

Based on different initiatives and on existing solutions we can identify a number of future business scenarios for mobile payments.

- The “pay-buy-mobile” ecosystem e.g. as proposed by GSMA and EPC
- A mobile payment system dominated by one or several financial institutions, an example is the VISA “paywave” solution with both contactless cards and phone implementations
- Multi-operator solutions for “all users” in the country, e.g. m-pass initiated by O2 and Vodafone in Germany and the initiative by AT&T, Verizon Wireless and T-Mobile in the US.
- A few big companies from different sectors, e.g. one mobile operator, one band and some merchants or service providers, form a strong team and offer services for their customers only

We can also identify other business scenarios driven by actors that want to enter (mobile) payments or want strengthen their market position for the current business. Contactless payment services’ using the mobile phone is one way to establish stronger relations with the customers. As we have seen in section 5 security and payment solutions can be used without any involvement of mobile operators. Solutions based on plug-in modules and/or served based software can in principle be by “any” actor. However, for the mobile operators it would be challenging if (when) the following actors enter mobile payments on a large scale and offer services for their customers:

- Handset manufactures may offer “NokiaPay”, “Mobile I-tune”, “GooglePay”.
  These actors already look into mobile payments
- Retail chains, oil companies, transportation companies and other companies with a large customer base. If mobile payments will be popular there can be “mobile phone versions” of loyalty cards and branded credit cards from shops / gas stations /retail chains.

Drivers can be from the supply side, e.g. in order to ensure market position, or from the demand side, e.g. the cases from public transportation. In Japan the pre-paid subway and bus tickets can be used as ”money” in convenience stores, in vending machines an even in the airport tax free shops.

8. Conclusions

We conclude this paper by answering the four research questions defined in the introduction.

For the ***first question*** about what business roles that can be identified, the answer for existing mobile payments services is that "many" roles and groups of roles can be found. Our cases indicate that are multiple roles and responsibilities that can be related to the following groups:

- Service development, service and platform management and service provisioning
- Management of business relations with end-users, business customers
- Charging, end-user billing and distribution of payments

The ***second research question*** deals with if there are any differences in the distribution of roles for different types of mobile payment solutions. For the existing solutions there are a lot of roles configured in different ways depending on the specific service concept. In all of the studied cases an intermediary actor like a mobile ticket providers or a payment provider take most roles and hence can be seen as the dominating actor. There are examples of mobile payments where mobile operators are not involved at all. Other examples exist where operators take the initiative and form joint ventures for mobile payment solutions but the partners take most roles.

The ***third research question*** address key characteristics that are essential for actors that want to take a key role. The studied cases show that the intermediaries the provide services have good relations with service providers and knowledge about their business. Relations with partners and with end-users are beneficial and, if that is not applicable, know-how about operation in B2B2C environment is good. For mobile operators it is interesting to note that key asset is the customer base and relations. The SIM card payments schemes seems to most suitable for small payments and SMS tickets.

The ***fourth research question*** deals with what kind of business implications that can be found for different ways to implement the Trusted element (TE). SIM card solutions have a potential for NFC services provided that clear business incentives can be found for all actors. With non-SIM card based solution, plug-in modules in the mobile phone and server based software solutions, other actors can offer mobile payments without any mobile operator involved.

The non-SIM card based solutions would be attractive for other types of actors within the mobile telecom business, especially handset manufacturers that also want to offer mobile services and to establish direct relations with the end-users. Another type of actor is companies with large customer bases, e.g. IKEA, Tesco, ICA, Shell, Statoil, OnOff, H&M, etc. These kinds of companies today offer different forms of payments solutions, loyalty cards and company specific credit cards. If mobile payments will be popular these kinds of companies would be interested to also offer a "mobile phone version" of the loyalty card or branded credit card.

The mobile operators need to look carefully into what kind of strategies that can be successful. Hence, we will end with a number of questions for mobile operators: Is it best to compete with financial institutions or form partnerships with them? Can partnerships be formed handset manufacturers? Should payments solutions and partnerships be formed for each national market?

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