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# Business model for a European interoperable road user charging system

## – Comparing EETS towards GSM and the payment card system

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# Abstract

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The transport of heavy goods vehicles across Europe is continuously increasing, causing problems as congestion, pollution and wear and tear of the infrastructure. In order to better internalise the costs of road usage, several independent road user charging systems have emerged on the continent. Most of these systems are so far not interoperable forcing drivers to have several different electronic devices present in their vehicles in order to be able to use the roads and become payment liable.

In unison with the thoughts of free mobility within Europe, the European commission has put forward a directive (the EFC-directive) stating that all member states' road using charging systems introduced after 2011 shall be interoperable, defined as the European Electronic Toll Service (EETS). This implies that one should be able to, with only one on board equipment, drive in all toll domains and get all payments liable on one single invoice. There are still many questions to be answered before the launching of EETS which is why comparisons to other systems are of great value. Since people within the road user charging industry often compare EETS to the systems GSM telephony and payment card system, a comparative study of these system have been carried out, focusing on the business model issues contractual relationships and information and money flows.

The study reveals several similarities and differences between the systems' business models and many of these disparities depend on differences in system structure, history and driving forces. In EETS there is, in contrast to the other two systems, no clearing function present which depends on structural system differences. Furthermore, bilateral agreements are the most common form of establishing contracts between the systems' actors, but both GSM and the payment card system contain elements of multilateral agreements which in the future can be an interesting contract alternative in EETS. Another central difference is the arbitration that is present in EETS, a function that is absent in both GSM and the payment card system. Additionally, there are in the development of EETS similarities in terms of evolutionary steps that are found in both GSM and the payment card system. Finally, there are both functional and historical similarities between the actors EETS Provider and Mobile Virtual Network Operator of GSM.

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# Populärvetenskaplig beskrivning

De transporter som lastbilar och andra tunga fordon utför på Europas vägar ökar ständigt, vilket orsakar problem som trängsel, föroreningar och slitage. För att bättre internalisera kostnaderna av vägtransporter har ett flertal vägavgiftssystem introducerats i Europa. De flesta av dessa vägavgiftssystem är inte interoperabla vilket gör att fordonen måste vara beskaffade med flera elektriska apparater, så kallade fordonsenheter, för att använda avgiftssystemens infrastruktur och bli betalningsskyldiga.

I strävan efter fri rörlighet inom Europa har Europakommissionen lanserat ett direktiv som deklarerar att alla vägavgiftssystem som introduceras efter 2011 ska vara interoperabla, definierats som den Europeiska Elektroniska Tull Tjänsten (EETS). Detta innebär att ett fordon ska kunna trafikera Europas samtliga tulldomäner och ta upp avgifter med endast en fordonsenhet samt få alla betalningar på en enda faktura. I dagsläget är fortfarande mycket oklart i tankarna kring införandet av EETS och därför är jämförelser med andra likartade system intressanta. Personer inom vägavgiftsindustrin brukar ofta likna EETS med GSM och betalkortsystemet men ännu har ingen grundligare jämförelse genomförts. Därför syftar detta examensarbete till att jämföra tankarna kring EETS mot dessa båda system, i avseende på affärsmodellperspektiven kontraktuella relationer samt informations- och pengaflöden.

Studien belyser både skillnader men också vissa likheter gällande systemens affärsmodeller. Många av dessa skillnader beror på olikheter i systemens struktur, historia och drivkrafter. EETS saknar i motsats till de andra två systemen en clearingfunktion, vilket beror på strukturella systemskillnader. Vidare är bilaterala överenskommelser det vanligaste sättet att ingå kontrakt i samtliga system, men både GSM och betalkortssystemet har inslag av multilaterala avtal vilket i framtiden kan vara intressant även inom EETS. En annan viktig skillnad är arbitrering som är planerat att ske inom EETS, något som saknas i både GSM och betalkortssystemet. Dessutom påträffas i EETS utveckling evolutionära stadier som återfinns i både GSM och betalkortssystemet utveckling. Slutligen kan man urskilja intresseväckande likheter mellan aktörerna EETS Provider och GSM:s virtuella operatör.

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# Introduction

Nobody can have escaped the everyday discussion in media about the influence that our way of living has on the world we live in. One important piece of puzzle in order to limit the greenhouse effect is to reduce the emissions of carbon dioxide. Several agreements to achieve this have been appointed, for example the Kyoto Protocol.

The Swedish Parliament's goal to, by the end of 2010, stabilize the emission of carbon dioxide to the levels of 1990, is about to fail. The most significant explanation is the increasing traffic of heavy vehicles, although traffic by regular cars has also increased. Several enquiries on European as well as Swedish levels show that the reason traffic of heavy vehicles increase is because it in a sense is subsidised. Taxes that for example are levied on trucks are not large enough to cover the costs that emissions, accidents, congestion, noise and wear and tear of the roads bring. Furthermore, the competition on the transport market is distorted, since foreign transport vehicles are allowed to operate on our road network almost without paying any tax at all. An introduction of a distance based taxation system, a kilometre tax, will give policy makers a tool to reduce the problems. (SNF 2006)

At present there are a number of distance based road charging systems running and even more are expected to come forward. Traditionally, road charging systems can be viewed as isolated administrative and technical islands where each system issues their own technological communication device, every system works independently and often differently from how the others are running. Hence, heavy vehicles that travel across the borders of Europe need a set of several different communication devices, so called OBE[1], in order to be able to pay kilometre tax in every country that is visited. This phenomenon has kept the improvements on hold and is also a waste of resources. (Sundberg 2007b)

Consequently, the requirements of interoperability[2] among these different road charging systems are coming from several concerned parties. The European Commission has identified interoperability between different road charging systems as a prerequisite of improving mobility within Europe. Therefore, the commission has put forward a legislative suggestion in the so called EFC-directive ("DIRECTIVE 2004/52/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004 on the interoperability of electronic road toll systems in the Community"). The EFC-directive is the first step towards the European Electronic Toll Service (EETS), promoting the principle that only one contract and one on board equipment should be needed as a valid payment method in all European road charging systems. This includes all systems that are initiated after year 2011 but the hopes are that all systems introduced after 2007 are to cope with the directive. A Swedish system is to be introduced at earliest in 2011 and so it shall be adapted to EETS. (Sundberg 2007b)

[1] The OBE, acronym for On Board Equipment, is a communication device that is placed in the vehicle which records information about the driven distance, either via GPS technology or DSCR, or both. The recorded information usually includes coordinates in combination with a time stamp indication where and at what time a vehicle has been. The OBE also transmits the information to a receiver using GNSS/CN networks.

[2] Interoperability is referred to the ability of diverse systems to work together (interoperate). In EETS, the term means that one should be able to drive in any of Europe's toll domains and being charged for the services, using one single OBE inside the vehicle and getting all fees on one invoice.

Practically, this means that when a foreign heavy vehicle enters Sweden it shall be possible to pay the taxes that are imposed upon it from the equipment that is already installed in the vehicle. All the vehicle owner needs is one contractual relationship with a third party called an EETS Provider that, in turn, is liable for the payments to the Swedish taxation authority. This is an arrangement that is usually not applied in Swedish taxation law, neither from a technical nor a contractual point of view. (Sundberg 2007b)

## Problem formulation

The technical standards necessary for achieving interoperability is currently not the biggest issue, even though a few questions are still to be answered. Instead, other matters such as how the business model issues concerning what actors are to enter and agree on contracts with each other, how the procedures for exchanging of information and money are to be designed, are among a few difficult problems to be solved in order to get a European interoperable road user charging system. Presently, there are several projects underway, aiming at developing a functioning and effective business model for EETS, for example RCI[3] and CESARE[4]. Within these programs, foundations for information and money flows are being developed, as well as how contractual agreements are to be made. However, since EETS is about to be introduced comparisons between the thoughts and ideas of EETS and other systems of similar characteristics are considered an important piece of the puzzle, and are something that has not been carried out yet. The systems for payment cards and GSM telephony are both interesting from a road charging system perspective, since they are both examples of successful interoperable systems with large adoption, which makes them interesting as comparisons and benchmarks to a European interoperable road user charging system. (Sundberg 2007a)

## Purpose

This thesis project aims at comparing the suggested business model for EETS to business models of two interoperable and established systems; the systems for payment cards and GSM mobile telephony. More precisely the paper shall analyse the foundations of the contractual relationships as well as information- and money flows of both GSM and payment card system, and compare the findings and shedding light on similarities and differences towards how it is thought about for EETS. Also, in order not only to study the details in regards to the systems' business models, general system differences and similarities are to be laid down. Thus, to allow answering why the business models differ, the systems' Meta Actors, the incentives of the different actors, the driving forces and conditions for introduction of the three systems are to be analysed. Finally, the aim is to stress some crucial issues to be solved for a successful introduction of EETS.

## Why comparisons with GSM and payment card system?

From an interoperability point of view the infrastructural systems supporting GSM telephone and payment cards resemble a future interoperable kilometre tax system. When a person is visiting most other countries, the mobile phone automatically changes to a "new foreign

[3] RCI is the acronym for the project Road Charging Interoperability.
[4] CESARE is the acronym for the project Common Electronic fee collection System for an Asecap Road tolling European service.

network" enabling continuous communication; neither a new phone nor a new SIM card is required. This automatic shift of Mobile Network Operators is made possible through roaming agreements between operators from different countries, allowing foreign visitors to borrow network capacity. This interoperable system is a service that is being charged for, which is one of the reasons international calls are more expensive than domestic. Roaming is made possible through the successful mobile telephone communication standards. The most common standard set is called GSM (Global System for Mobile communication) and was born during the 1980s as a means of facilitating international phone calls.

The system enabling payment card reimbursements can also be said to be interoperable. For instance with a VISA card, cash machine withdrawals and card payments are feasible in most countries of the world, without the need of swapping to another card supporting the visited country's standards.

The introduction of a European interoperable road user charging system faces many of the same challenges and development that the early days of the interoperable GSM and payment card systems saw. By looking at between which actors the contractual relationships were formed and how information and money flows were designed, important parallels can be drawn.

# Method

The reasons for analysing and comparing EETS against the system for payment cards and GSM telephony are that people in the EFC-industry, often compare and benchmark the European Service against the two system mentioned. The system for payment cards and GSM telephony are being considered role models on how to achieve and implement interoperability of large sociotechnical systems and thus, these two systems have been chosen. The choice of comparing the two subject areas, contractual relationships as well as information and money flow, stems from the fact that these areas are very interesting since, it is one of the most urgent issues to be solved in order to accomplish interoperability (Sundberg 2007a). In order to better understand the differences and similarities of the systems' business models, comparisons of general system characteristics such as the systems' Meta Actors, conditions for introduction, the driving forces and incentives of the systems have also been undertaken.

After having formulated the purpose and questions of issue, the choice of scientific method was pretty obvious. Since the paper deals with comparisons of different systems, a qualitative method is best suited to approach the problems. Hence, the method used can be described as from the understanding of two different systems being able to say something about a third. The course of action has been to gather the required information about the three systems, mostly collected from literature and Internet sources covering the current topics. Three interviews have been carried out in order to fill in the information gaps that literature and electronic sources could not cover; two with road user charging specialist Jonas Sundberg and one with system standardisation expert Johan Hedin. The interviews have lasted for approximately two hours each. Questions were prepared in advance and notes were taken in order to facilitate memorising of the answers. Also, a briefer telephone interview has been made with Björn Lindberg, project leader of Swedish mobile network operator Tele2.

The analyses and discussions of chosen topics have been performed in various ways. Comparisons of contracts as well as information and money flows are carried out a bit differently than comparisons of the introduction and incentives. Since this part of the comparisons is very technical with numerous abbreviations and a lot of details to bear in mind, the comparisons of EETS's contracts and information and money flows have been made separately, first towards the payment card system and then towards GSM, in order to better facilitate understanding for the reader. These more detailed comparisons are followed by a mutual analysis of EETS's differences and similarities towards both GSM and payment card system, concerning the systems' structure and incentives for introduction.

# Scope

Since the focal point of the thesis project is to examine the information- and money flows as well as contractual agreements of GSM and payment card systems as well as EETS from a Swedish perspective, other interesting areas of this system will not be studied. Neither attention-grabbing study fields as privacy issues, nor the technological nor environmental impact will be discussed any deeper.

The analyses of GSM system will mainly cover the business model and information flows for regular phone calls. Even though the information flows for other wireless services as SMS

and MMS are interesting, it is too large a topic for this thesis to cover. When it comes to the payment card system, the focus of description and comparison will be on the so called open payment card system. This is because this system is more complex. Thus, from understanding the features of the open payment card system, it is easy to comprehend the characteristics of the closed payment card system.

**Remarks**

This is a descriptive paper, demonstrating certain characteristics of three different systems. In the chapter concerning EETS, payment card system and GSM, information for example covering contractual relationships can sometimes be found under the headline “Actors of the system”, or under another headline than the heading “Contractual relationships”. This is not done deliberately to confuse the reader. Instead, sometimes presentation of certain information is just better suited in the context of other information just being presented.

# Presentation of important concepts

When comparing and analysing the systems, a few concepts will be used. These concepts will primarily be used in the chapter concerning comparisons of the systems and in case the reader is not familiar with them, they are briefly presented below.

**Interoperability**

Since this expression is central for the project, a definition of the term is motivated. Wikipedia defines it as:

> *Interoperability is a property referring to the ability of diverse systems and organizations to work together (inter-operate). The term is often used in a technical systems engineering sense, or alternatively in a broad sense, taking into account social, political, and organizational factors that impact system to system performance.* (http://wikipedia.org, search: interoperability, 071210)

**Consumer demanded technology**

Consumer technology is a product or service that is demanded by a consumer. Many products or services can be refered to as consumer technologies, since it is the demand from the customer that drives the industry. This is in contrast to products or services that are demanded by other organisations, for example authorities. (Hedin 2008)

**Network externalities**

Network externalities concern the differences in value that a product or service get, when the number of users of the service or product change. For instance, a system possessing network externalities is characterised by the fact that the products or services of it is more valuable for the system's actors, the more actors using it. (Hunt 2003; Besen 2008) Also, when a system possesses network externalities, there are strong incentives for all involved parties and one can expect an increasing adoptability in terms of the number of users (Kaijser 080717).

**Business model**

There are many ways in how to define and use a business model depending on focus, function and goal. For example, business models can vary in scope, some illustrating the business activities of a group of companies, others describing the roles different actors have in a business process and some are concentrating on describing the value adding steps that one explicit product or service experience. (Ballon et al. 2001)

However, generally a business model describes the external organisation of commercial contacts between different business entities. The commercial contacts described in a business model can for instance include the exchange of information, money, contractual relationships, services, goods and knowledge. (Ballon et al. 2001) Within the framework of this paper, only the business model issues contractual relationships as well as information and money flows will be studied.

#### Standardisation

Standardisation involves the procedures of building up and agreeing on standards. There are many incentives for agreeing on a certain standard. Basically, standardisation benefits both suppliers and consumers – the supplier can benefit from economies of scale in the production lines, since the potential consumers come from a very large population. The consumer benefits from lower prices and possibilities of choosing the supplier that has the best offer at the moment. Therefore, standardisation often facilitates introduction of larger systems. Yet, creating a standard is a complex process that takes a lot of time. (Nyqvist 2004)

## Meta Actors

I have also defined a few concepts myself, being four Meta Actors. These Meta Actors are working as classification of the systems' different actors, in order to facilitate comparisons between the systems. A more detailed motivation of the classification of actors will follow in later chapters.

#### Buyer

This term refers to the actors Service User (of EETS), Caller (of GSM) and Cardholder. The Buyer of the system is the actor that can be seen as the consumer of the service and is characterised by entering agreements only with the Intermediary.

#### Intermediary

This term refers to the actors EETS Provider (of EETS), Service Provider (of GSM) as well as Issuer and Acquirer (of the payment card system), even though they, in the paper, are often referenced to their real names. The Intermediaries' common denominator is that they enter agreements with both the Buyers and the Sellers of the systems, manages billing and customer contact and act as their agent towards the Seller of the service. Note that the Intermediary function of the payment card system can be seen as carried out by two actors.

#### Seller

This term refers to the actors Toll Charger (of EETS), Mobile Network Operator (of GSM) and Merchant (of the payment card system). The characteristics of the Seller are that it is the producer or owner of the service or product being sold and it enters agreements with the Intermediary.

#### Association

This term refers to the organisations Interoperability Manager, GSM Association and Payment Card Association, even though they, in the paper, are often referenced to their real name as well. Basically, what these actors have in common is that they work as rule making bodies for and sometimes coordinator of respective system.

# EETS and distance based road user charging

## Distance based road user charging in Sweden

After the Swedish government in a proposition to the Parliament put forward a suggestion concerning an introduction of a distance based road user charge, the Parliament voted in favour for it, under the condition that neither certain regions (for example northern Sweden) nor some businesses (as the forest industry) are disadvantaged. (Sundberg 2007b) This was in May 2006 and the proposal has been ratified by the new government that started ruling after the election of autumn 2006. (Arena 2007) In Europe there are already several different road user charging systems in operation and even more are to expect. Switzerland, Austria, Germany and the Check Republic have already introduced distance based road user charges on all or parts of their road networks, and Sweden, Slovakia, Slovenia, the Netherlands and the UK are probably to follow. (Hamilton 2007)

### The Arena Project

Within the Arena Project a concept for a Swedish distance based road user charging system, a so called kilometre tax system, is being developed describing how such a system is to be designed functionally and technically. Furthermore, the concept also includes solutions concerning security and organisation. The project is financed by the Swedish Road Administration (Vägverket) and Vinnova and is implemented as a partnership between local actors in southern Sweden (Blekinge Technical University (BTH), Netport Karlshamn, Vägverket region Skåne and Sydost) and Sweco Infrastructure. The Arena Project was started in April 2006 with a first stage finished in February 2008. The second stage started in March 2008 and is still in progress. (Sundberg 2007b)

As a result of the Arena Project, a network constituting the transport industry, systems suppliers and future users is established. An important purpose of the second stage is to launch trial activities on the basis of the concept being suggested and let the network try out different technical and functional solutions. An intention of the activities within the BTH framework is to develop a national centre of competence in regards to electronic payments from a kilometre tax system. (Sundberg 2007b)

### The extent of a kilometre tax in Sweden

Technological development, especially within IT, has made it possible to launch a kilometre tax system with a design that simplifies the managing of operations. Progress within IT also facilitates differentiation of charging levels depending on what kind of road and at what time the journey is being done. Since there has been discussions regarding the negative impact on mining and forest industries as well as the widespread northern parts of Sweden, special solutions that offset these impacts can also be facilitated by IT. (Sundberg 2007b)

A Swedish kilometre tax system is about to cover almost the whole road network, including private as well as public roads. Furthermore, all domestic or foreign vehicles with a maximum laden weight over 3.5 tonnes will be subject to the tax. Differentiation on vehicle characteristics (how environmentally friendly they are) is to be included in the specifications.

There are at present around 80.000 vehicles subject to the tax driving the Swedish road network. Among these 80.000, about 14.000 have already installed an On Board Equipment (OBE) compatible with any of the other distance based road tax systems in Europe. Of these 14.000 about 8.000 are estimated to be foreign vehicles and 6.000 are registered as Swedish hauling company vehicles. An OBE is a device inside the vehicle that continuously registers information about position and time in a protected memory within it. Registration is registered and transmitted via so called GNSS[5]/CN[6] technology, that is, the route is registered by GNSS technology and the information is sent further through the air interface with CN technologies. (Rydmell 2006)

### Important differences from the Stockholm congestion tax

In the Stockholm congestion tax example it is the tax authorities that operate and control the passageways in and out the city, registering the amount of tax that is to be paid. In the Swedish kilometre tax system, the approach has to be different, since the road network is too large and complex to control. It is too expensive to build up a system of cameras controlling vehicles passages. Instead, tax liability in a kilometre tax system appears when a heavy vehicle drives on a road that has tax obligation. Accordingly, it is the vehicle owner's responsibility to report to the tax authorities how far, on what roads and at what time it has been travelling. It shall occur on the vehicle owner's own initiative and be supported by a technical system irrespective if the tax authority has "seen" you or not. Heavy fines will be charged to vehicle owners who are cheating. (Sundberg 2007b)

## European history of EFC and interoperability

The history of Electronic Fee Collection (EFC) and interoperability in Europe started in the 1980s when several new DSRC-systems (Dedicated Short Range Communication) were launched within Europe. Most of these systems were installed to facilitate payments of toll-highways with the A1 in Italy being the first. However, congestions charging or urban tolling was also on the agenda, for example in Norwegian cities. It did not take long from that several systems being launched to the thoughts of cooperation and interoperability among the systems. From these thoughts followed several EU research projects regarding EFC[7]. In 1992, the thoughts of standardisation became reality, foremost regarding the DSRC interface. One year later, EU initiated the CARDME project attempting to tackle interoperability within EFC. Interoperability was at this stage defined as three different levels; technical, procedural and contractual, a way of thinking that still applies. Within five years (1998) technical interoperability (within the DSRC technique) was accomplished. Nonetheless, there were substantial disputes regarding the standardisation of DSRC technology, primary among national monopolies and suppliers. Norway and Italy who already had initiated their systems were not very enthusiastic to agree on a new standard. Nevertheless, following heated discussions a compromise was eventually reached. (Hedin 2008)

At the same time ideas about using GNSS (Global Navigation Satellite Systems) for EFC interoperability emerged within several standardisation research projects. In 1999 the

[5] Global Navigation Satellite System is a mutual name for positioning technologies such as GPS, Galileo and GLONASS.
[6] Cellular Network technologies, such as GSM, GPRS or UMTS (3G)
[7] For example ADEPT, GAUDI or PROGRESS.

CESARE project was initiated, focusing on accomplishing interoperability from a procedural and organisational point of view, something that earlier projects were missing. One year later (2000) The Swiss road user charging system was launched. The Swiss system featured a thick client[8] consisting of a tachograph supported by GNSS. In the meantime several European countries were planning to introduce EFC systems, but the thoughts of interoperability were scarcely included in the plans. As a reaction against this, the European commission stated in 2001 that they will launch a directive, forcing EFC interoperability on the member states. EFC actors within Europe were a bit surprised by this reaction, but the directive characteristics were so far unclear. While EU was preparing the characteristics of the directive, Germany launched, after an expensive one year delay, their road user charging system during 2003, the first solely GNSS based EFC system in the world. The German system, named Toll Collect, featured a relatively closed system design with very few thoughts of interoperability. (Hedin 2008)

In 2004 the EFC-directive was put forward by the European Council and the European Commission, stating that one should be able to drive a vehicle throughout Europe having only one contract and one OBE to be used for all European toll system implemented after 2011. Since the EFC-directive, road user charging systems have been launched in Austria as well as in the Czech Republic, but neither of these has met the demands of interoperability. However, Europe has agreed on a well functioning compromise for technical interoperability for DSRC communication. On the other hand, interoperability standards for the GNSS technology are unfortunately still yet to be found, due to lack of resources and the countries' urge to keep their freedom of action while still deploying their systems. (Hedin 2008)

There are several reasons behind the delay of interoperability and the EETS. There is and has always been substantial time pressure during procurements, making the thoughts of interoperability secondary. There is also a lot of money already tied to the systems as well as national prestige. Each country wants to keep their freedom of action while designing their systems that they do not want to adhere to rules and standards put forward from outside organisations. Also, there is little willingness to be the first interoperable EFC system; just as there is little willingness of being the owner of the first fax machine, with nobody to send or receive faxes from. (Hedin 2008)

## General roles and actors in road charging systems

In a road based tax collection system there are a few roles that are important to present in order to facilitate the understanding of the report. The traditional mindset of road tax systems is that there are two roles setting up the network of services and payments; the road user and the road owner, as Figure 1 illustrates. The user is typically a motorist or a transport- or logistics company. The road owner provides service for the user which the owner gets paid for. (Sundberg 2007a)

[8] A thick client transforms and manages processing of data before transmitting it to toll collector. In contradiction to the thin client that collects time stamped positioning information and transmits it for further processing.

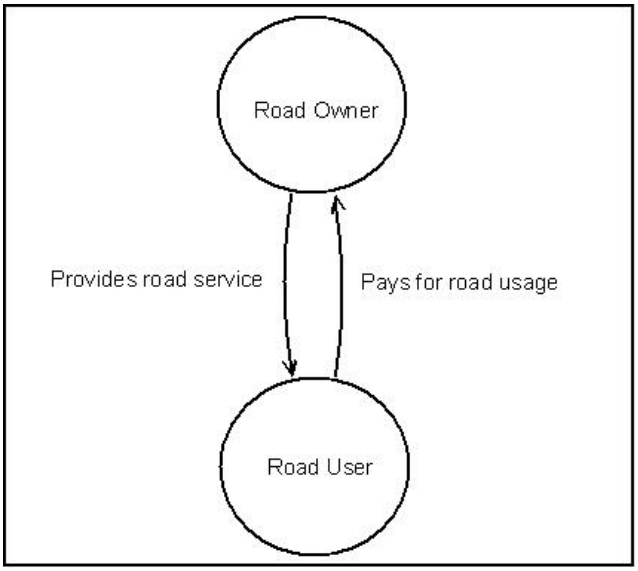


Figure 1 - The traditional mindset of a road user charging system.
(Sundberg 2007a)

The EFC directive specifies that only one contract and one OBE should be needed in all European road charging systems. This includes all systems that are initiated after year 2011 but the hopes are that all systems introduced after 2007 are to cope with the directive. (EFC-directive 2004) In the aftermath of the EFC-directive, a model describing the required roles has been developed. This is in order to fulfil the requirements of achieving interoperability. Compared to the traditional mindset described above, there are, as Figure 2 illustrates, two additional roles that, together with road owner and user, make up the EFC network. Firstly, it is within the EFC industry common that a road owner, usually a governmental institution, outsources all activities to a Toll Charger (TC). The area that a Toll Charger is responsible for is called a toll domain, which can be an entire country, a city centre or a bridge. The Toll Charger thus takes on the role as owner and manager of the systems needed to collect tax from road users. Secondly, the last role of the system is the Toll Service Provider (TSP), which is the role that the user subscribes a contract with. The TSP role provides the user with an OBE, enters contract with and makes sure toll is collected from the user. The TSP forwards the collected toll payments to the Toll Charger. (Hamilton 2007)

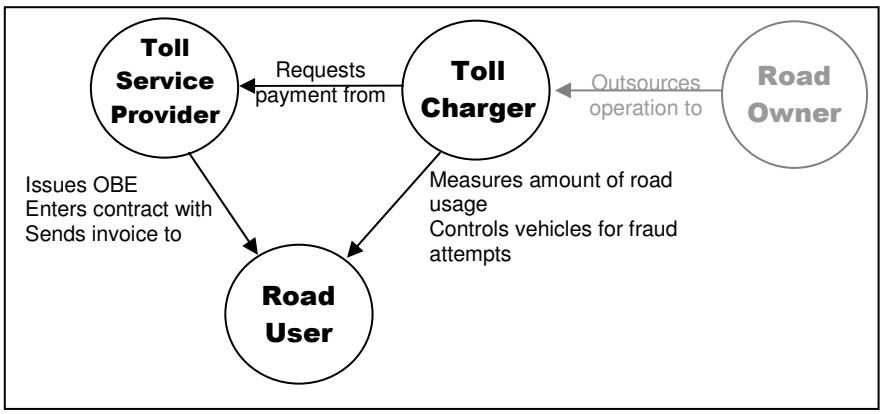


Figure 2 - The different roles and responsibilities of a road user charging system.
(Hamilton 2007)

However, in most current road charging systems, an actor who is trusted to act as TC in a toll domain is in many toll systems assigned the TSP role as well. This means that the actor receiving toll payments and taking on the responsibility for conducting control activities is also responsible for distributing OBEs and collecting toll from the users. So by looking at the system from an actor more than a role point of view, the network is limited to a TC/TSP actor and a user, as depicted in the Figure 3 below. (Hamilton 2007)

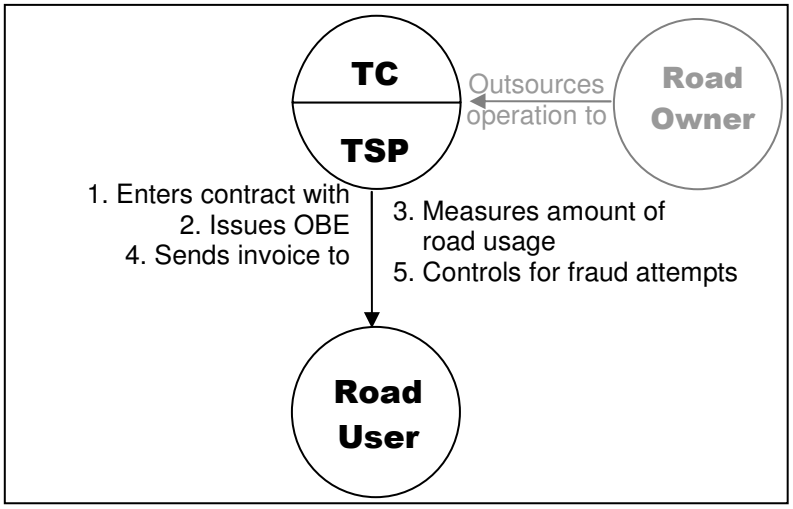


Figure 3 - One actor taking on both the TC and TSP roles. (Hamilton 2007)

It could for example be fairly easy for the Swedish tax authority to collect tax from a Swedish vehicle owner. Standards and routines for such businesses could be pretty straightforward and it is also well known and tested from the Stockholm congestion tax. Though, the complexity increases if the owner of the vehicle is from another country. In such a situation the collection of money may become more difficult, since the foreign vehicle owner is not "known" to the same extent as the vehicle from Sweden. Furthermore, when a user employs a service in another toll domain, that is when it drives its vehicle overseas, it needs to sign up with a TC/TSP in the new toll domain and get an OBE. It is not in line with the EFC-Directive to have several subscriptions and OBEs, nor is it very practical for the user. When visiting another toll domain, it is the TC in the visited toll domain that is supposed to receive the tax. On the other hand, it is not the TSP in the visited toll domain that the vehicle has a subscription with and an OBE from. Therefore, a situation illustrated in Figure 4 occurs. Hence, the need for a distinction between the actors TC and TSP starts to become obvious since the set up with an actor working as both TC and TSP starts to cause problems. (Hamilton 2007)

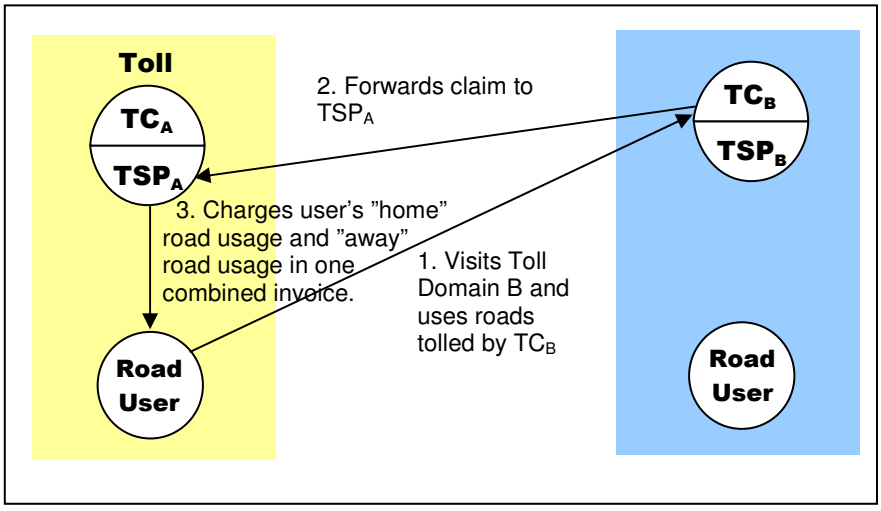

Figure 4 - Procedures when visiting a new toll domain. (Hamilton 2007)

Many voices from EFC-Europe propose that to solve this situation, a separation between the TC and TSP actors is necessary, just as Figure 2 describes. The idea is that each user signs a contract with a TSP, who issues OBEs to and claims payments from the user. The TSP then has a payment responsibility towards the TC for the amount that the TSP collects from the user. A system like this could be formed through bilateral agreements between TSP and TC. (Rydmell 2006) How the relationship between TSP and TC looks like, if the TSP is an ordinary company taking on commercial activities or works as a part of any tax authority is not yet decided. Furthermore, it is declared that a market based approach would be preferred. If the TSP operates as a competitive actor on the market, it will be able to compete with other firms to get user subscriptions and distribute OBEs and the competition may also stimulate technological development. For the fact that the TSPs involve themselves in risk taking activities when they act as payment responsible, the TSP will be given some economical compensation. This can be arranged by allocating a certain percentage of the tax being collected to the TSP. (Sundberg 2007b)

## The EFC-Directive and EETS

The EFC-Directive was put forward in April 2004 and defines the EETS as that only one contract and one OBE should be needed for usage in all European road charging systems. The approach of the introduction can be view as a Big Bang[9] strategy; by the beginning of 2012, all systems are forced to comply with the EFC-Directive. But the hopes are that all systems introduced after 2007 are to cope with the directive. (Sundberg 2008)

The EFC-Directive is rather vague and unclear stating that any actor taking part providing the EETS is not entitled to make profits on the services. Nevertheless, they are obliged to a fair compensation. What a fair compensation means is subject to interpretation leaving possible actors insecure whether to venture or not. This uncertainty has however been calmed to a certain degree by the decision of the EFC-directive, where it is explicitly stated that the actors

[9] Big Bang strategy means that the system is introduced at once and not gradually.

are allowed to levy a charge from the customer as a compensation for providing the EETS service. (Sundberg 2008)

## Actors of EETS

Figure 5 below displays the actors that constitute the EETS network; their roles are in some cases somewhat different from the general roles and actors of road user charging systems. Note that the actor Road Owner has been deleted from the model and the role Interoperability Manager has been added:

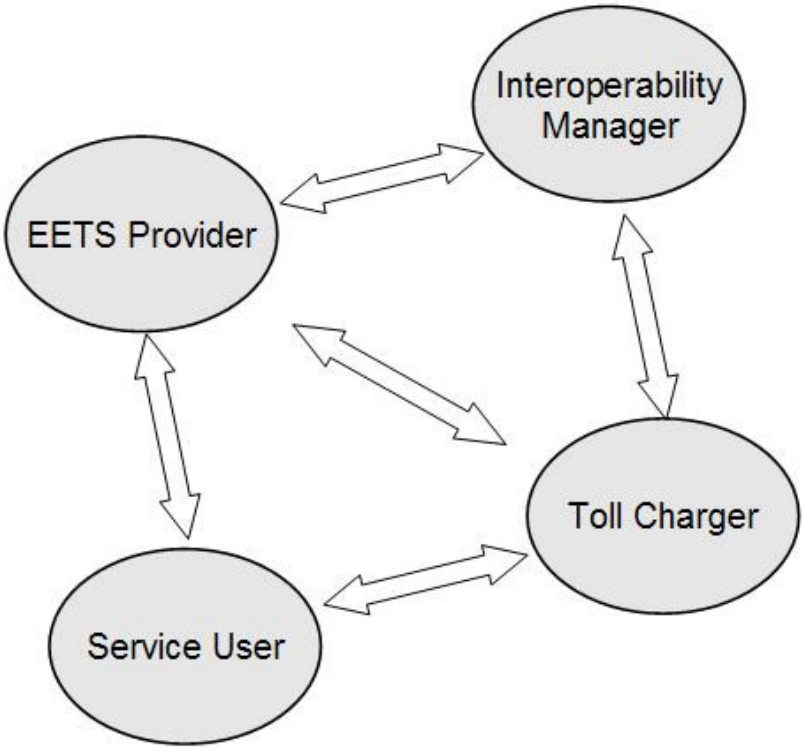


Figure 5 - The actors of EETS.
(CESARE III Project 2006)

### Service User

The Service User (SU) is for example a vehicle owner, a hauling company or a motorist who takes advantage of the EETS. The Service User is the system's consumer of the service and can therefore be categorised as the Meta Actor Buyer. The SU signs a contractual relationship with an EETS Provider who in turn provides the Service User with an OBE. The Service User agrees to pay the EETS Provider for the tolls levied upon him when driving in Toll Domains. (RCI 2006; CESARE III Project 2006)

### EETS Provider

The EETS Provider (EP) contributes to EETS by signing contracts with and claiming money from Service Users as well as issuing and installing OBEs in the vehicle. Hence, the EETS Provider can therefore be categorised as the Meta Actor Intermediary. The EETS Provider

also enters contracts with Toll Chargers, to whom they guarantee payments for their clients, the SUs, whether they get paid or not. (RCI 2006; CESARE III Project 2006)
The EETS Providers are appointed by national bodies (EFC-directive 2004). Furthermore, in order for a TSP to entitle itself as an EETS Provider (and hence offer the European Service (EETS)) it needs to enter contractual agreements with all existing TCs. (Sundberg 2008; RCI 2006; CESARE III Project 2006) In a way to ensure and enhance quality of the services provided, the idea is that the EETS Providers are to compete against each other in getting customer to enter contractual relationships with them (Sundberg 2008). Today, there are no EETS Providers present on the market why any examples of the actor can not be mentioned.

### Toll Charger

The Toll Charger (TC) is the producer or owner of the service being sold. The Toll Charger is collecting toll and entering relationship with the Intermediary. Hence, the Toll Charger is categorised under the Meta Actor Seller. For instance, a Toll Charger can for example be a national road administrator such as Swedish Vägverket (who is to be responsible for collecting the Swedish kilometre tax), a bridge such as Öresundsbron between Sweden and Denmark or a privately owned motorway. Though, the TC does not receive toll directly from the Buyer, instead the payments are claimed from the EETS Provider (EP), who has a payment guarantee for its clients. The Toll Charger operates the DSRC beacons placed on the roadside as a complement to the OBE of collecting charging data. (Sundberg 2008)

What TCs that are included in EETS are identified in the EFC-directive. Currently there are over 400 Toll Chargers in Europe subject to EETS, including distance based road user charges, city centre congestion charges, bridges, tunnels etc. and more are to follow. Besides, a prerequisite is that a Toll Charger needs to have a contractual agreement with at least one EETS Provider to be able to call itself a Toll Charger of the European Service. (RCI 2006; CESARE III Project 2006; Sundberg 2008)

### Interoperability Manager

The Interoperability Manager (IM) is the regulatory body of the interoperability scheme and is therefore considered being the Association of EETS. The Interoperability Manager is not expected to have a specific role of the everyday operation of a road user charging system. Instead, it focuses on interoperability aspects, supporting the setup of the system, acting as rule-making body taking into account existing and yet to come standards. Thus, the Interoperability Manager is to provide a framework for the other actors to operate within. The IM will also be arbitrators for EETS, responsible for supporting and solving possible disputes within the system, especially the ones expected between TC and EETS Provider. It is not clear under what organisation the IM should be placed or how the members of the organisation are to be elected. (RCI 2006; CESARE III Project 2006)

## Information and money flows in EETS

The current thoughts about the functions and everyday procedures of a Swedish kilometre based taxation system according to EETS are described in Figure 6. Put simply, four basic functions are needed:

- Registration of travelled route by the OBE

- Calculation of tax
- Payment of tax, from Service User to EETS Provider to Toll Charger
- Compliance check of tax paid

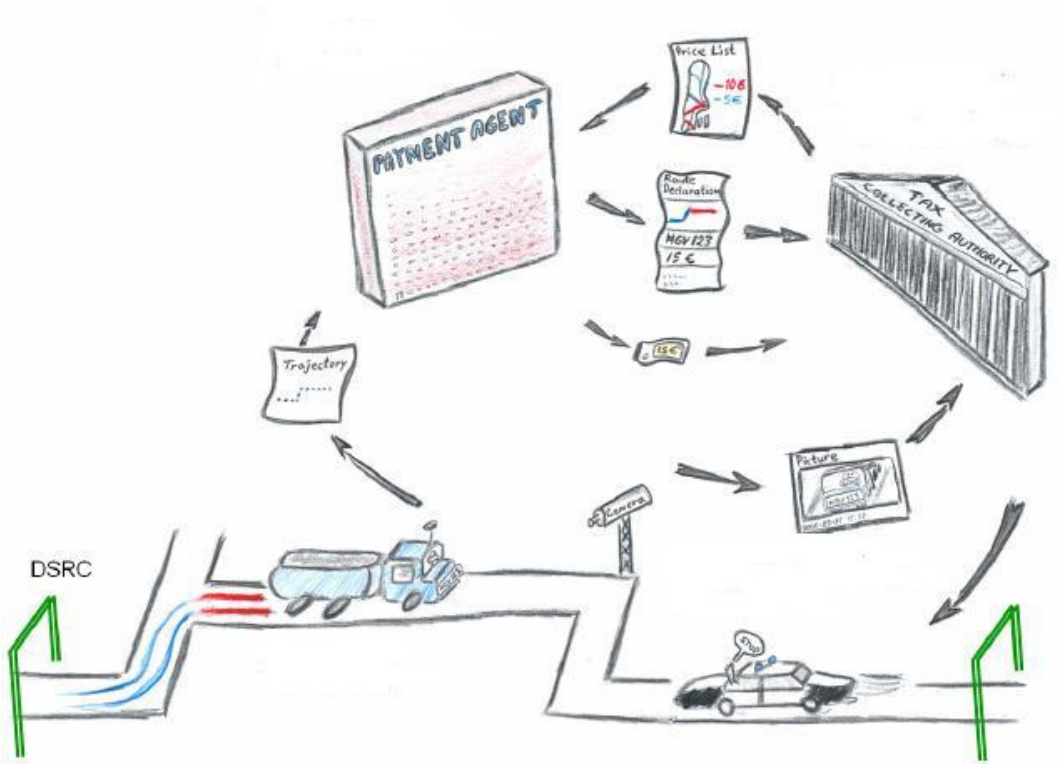


Figure 6 - Functions and daily procedures of EETS.
(Hallberg & Westerberg 2008)

Every tax liable vehicle is equipped with an OBE that registers the route travelled using satellite positioning techniques. The OBE is also able to communicate with DSRC beacons positioned along the road side, used for sensing passages and working as fixed references points also contributing to determine the route travelled. The communication with the EETS Provider is being transmitted over the cellular network, for example using GSM, UMTS or GPRS technology. The OBE and EETS Provider together provide the necessary data to translate the distance driven to into the fees payable. (Skatt på väg (SOU 2004:63); Hallberg & Westerberg 2008; Sundberg 2007b)

The Buyer gets tax liable when the Toll Charger makes a tax claim based on the information received from the EETS Provider. The EETS Provider has payment guarantee towards the Toll Charger, afterwards collecting the payments from the Service User. Compliance control of the Buyer can for example be made in combination with roadside speed cameras registering the vehicle along the road network, creating a foundation for comparisons with the registered route trajectory. Another possibility is that the police authority performs spot checks, controlling the OBEs' functionality. (Skatt på väg (SOU 2004:63); Hallberg & Westerberg 2008; Sundberg 2007b)

Another way of presenting the ideas of information and money flows of EETS is Figure 7 that illustrates these flows across certain interfaces. Note that since the Interoperability Manager is not involved in the daily operational information and money flows, it is not represented in the figure.

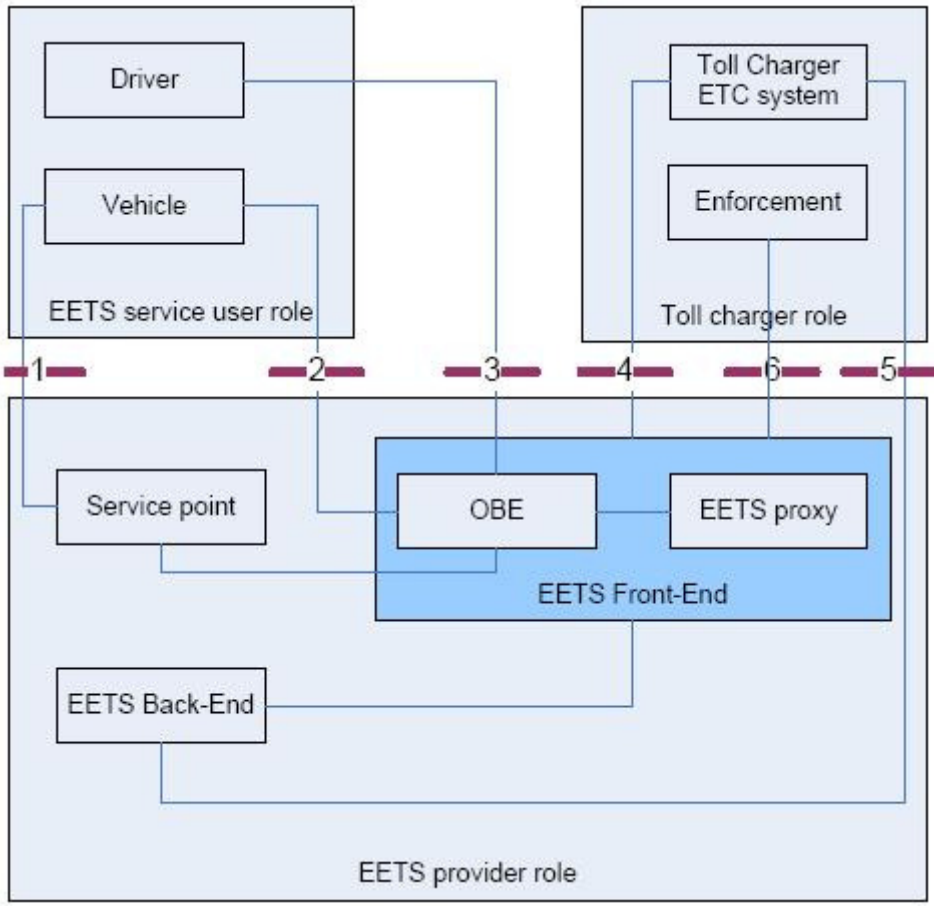


Figure 7 - Information and money flows of EETS.
(RCI 2008)

As stated earlier, a prerequisite for the system to work is that all tax liable vehicles are equipped with an On Board Equipment (OBE) which is located inside the vehicle. The OBE is issued and managed by the EETS Provider (which is why the OBE is illustrated as belonging to the EETS Provider) and it is installed at the Service Point over interface 1 and connected to the vehicle over interface 2 by an organisation responsible for the proper installation and initial functioning of it. (RCI 2006) Certain tax characteristics of the vehicle, for instance max laden, number of axles etc. are registered in the OBE by the driver, over interface 3. The OBE is equipped with GNSS- as well as cellular network-based technologies sensing the vehicle's route and sending information further to the EETS proxy. The OBE continuously registers information about position and time in a protected memory within it (Sundberg 2007b). The road usage information is sent, together with data about the vehicle, over the cellular network to the EETS proxy, a central processing unit of the EETS Provider, which together with the OBE constitutes the technical EETS Front-End, according to the RCI-model. The EETS Front-End together provide the information necessary for translating the road usage into a fee or tax payable. The information concerning charging data is sent to the

Toll Charger over interface 4 from the EETS Front-End. (RCI 2008; RCI 2006; Sundberg 2007b)

Furthermore, the TCs will perform compliance checks, enabled since OBEs will have built in receivers sensing important spot checks in the road network. The roadside spot check equipment, DSRC beacons, are owned and managed by the Toll Charger, and work as an enforcement tool controlling that position- and time information generated by the OBE is correct. The checks are illustrated as information flows over interface 6. (RCI 2008; Hallberg & Westerberg 2008) The EETS Provider pays the tax over interface 5, from EETS Provider's more administrative back-end function to the Toll Charger. Finally, the EETS Provider bills the Service User, who gets one single bill for all fees being charged upon him. (RCI 2008; Sundberg 2008)

Blacklisting of vehicles is also to be made over interface 5, which can occur if the Service User for some reason fails to provide payments on time, is caught manipulating the OBE or in other ways fails to follow the contractual obligations. The EETS Provider will then suspend or cancel the contract and thus it no longer has to provide payment guarantee to the Toll Charger for its client. (Sundberg 2008)

## Contractual relationships within EETS

Essentially, the relationship between the Toll Charger, The EETS Provider and the Service User can be seen as resembling a reselling relationship; the EETS Provider buys toll passages from the Toll Charger and then resells the right to use the roads to the Service User as Figure 8 illustrates. In this model the EETS Provider is to operate in its own name and assume all toll service risk and other possible service risks involved with it. The EETS Provider's main duty towards the Toll Charger is the payment guarantee for its clients. In addition to being responsible to pay the Service Users' debts, this also means that when a Service User drives in a toll domain, the EETS Provider's customer has duties towards the Toll Charger to provide financial accounts from its interaction with the Service User. This includes providing customer data when necessary, assist in the collection of toll, perform credit checks of the Service User and provide information of black-listing of customers not paying the bills. The EETS Provider also has duties towards the Service User, for example providing access to the toll domain on behalf of the Toll Charger and forwarding the toll received to the Toll Charger. (CESARE III Project 2006) The EETS Providers are to compete on entering contractual relationships with Service Users, contracts that are to be agreed on bilaterally. (Sundberg 2008)

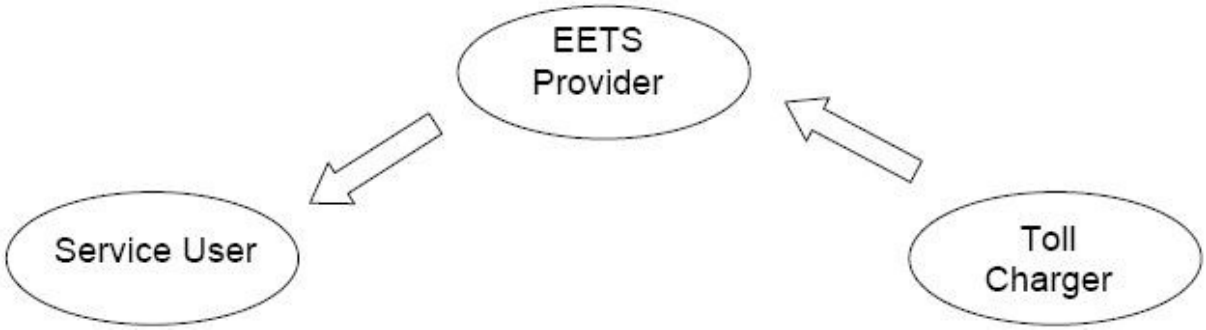

Figure 8 - The reselling relationship between the Toll Charger and the EETS Provider. (CESARE III Project 2006)

From a contractual point of view, the EFC-directive's launch of the European Service makes two important statements that influence the contractual relationships within EETS. First of all, it is decided that in order for a TSP to become an EETS Provider, it needs to have a contractual relationships with all existing Toll Chargers. Secondly, a Toll Charger needs to have a contractual agreement with at least one EETS Provider to be able to call itself a Toll Charger of the European Service. (Sundberg 2008) The contractual agreements between the EETS Provider and the Toll Charger are to be made up bilaterally. Thus, together the EETS Provider and the Toll Charger are to arrange the scope and all details of the contractual agreement between themselves. (CESARE III Project 2006)

**Arbitration**

However, the legislation stating that an EETS Provider needs to reach a contractual agreement with all Toll Chargers and that every Toll Charger needs at least one EETS Provider to entitle themselves as providing the European Service can be problematic. Consider a situation with an EETS Provider who has contractual agreements with all Toll Chargers, and a TSP having contracts with all Toll Chargers except one. If the EETS Provider for some reason fails to enter a contractual agreement with one of the Toll Chargers (that the TSP has an agreement with), other actors will be influenced, see Figure 9. First of all, this implies that the Service Provider of interest no longer fulfils the requirements of an EETS Provider (since it does not have contractual agreements with all present Toll Chargers); instead it becomes a TSP. This in turn will affect the Service Users since they will not get access to all toll domains. Furthermore, the Toll Charger who only had a contractual agreement with the former EETS Provider (now TSP) is now not considered a Toll Charger according to EETS (since it does not have a contract with an EP).

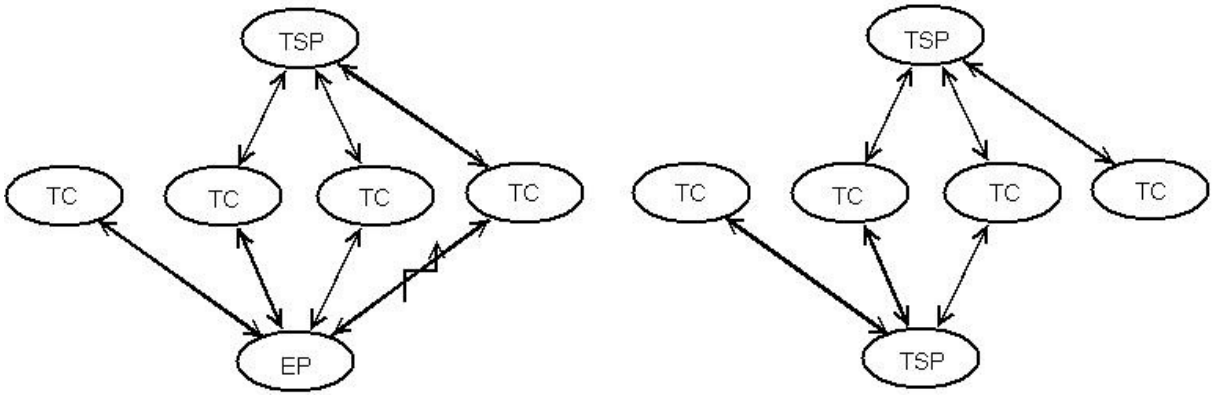


Figure 9 - Failure of agreement between EETS Provider (EP) and Toll Charger (TC). (Sundberg 2008)

The possible disputes between Toll Chargers and EETS Providers are an uncertainty factor for the implementation of EETS. Though, EETS Providers who are not able to reach bilateral agreements with all but with some Toll Chargers, can start acting as TSPs, or sub-EETS Providers as they are also called. This means that they can not provide EETS, which is a

competitive disadvantage, but they can provide access to some toll domains, which may be enough for some Service Users. (CESARE III Project 2006)

However, a scenario like the one in Figure 9 is of course not acceptable. In order to prevent such cases when two actors fail to reach an agreement, the EFC-Directive has legislated for a fallback solution meaning that an arbitrator solves the disagreement by enforcing a standard contract upon the EETS Provider and Toll Charger. This is because EETS requires that all actors agree. The dispute resolution will be processed under the Interoperability Manager and it will require some form of guidelines in order to render a decision. Such guidelines are yet to be formulated. (CESARE III Project 2006)

The idea with an arbitrating body puts the contractual agreements in a new light; when two parties disagree, a third party will come up with a contract proposal that they are forced to agree upon. There will be little incentives for negotiations if there is a standard contract waiting for the parties in case they cannot come up with a mutual agreement. Therefore, in order to prevent this, there is a suggestion of a walk-away[10] within the Arena Project, enabling two parties (EETS Provider an TC) to not enter a contractual agreement without losing their status as EETS Providers or Toll Chargers. (Sundberg 2008)

The contracts between Toll Charger and EETS Provider only deal with the conditions the two actors have agreed upon. Thus, the EETS contract neither takes into account vehicles missing an OBE, nor vehicles equipped with OBEs issued by non-EETS Providers. Normally, a correct and valid toll declaration, submitted by the OBE to the Toll Charger via the EETS Provider, gives the Toll Charger a valid claim for the fee from the EETS Provider. In this case there are two sub cases: If the data in the toll declaration is showed to be correct the Toll Charger charges the EETS Provider under the provisions of the EETS contractual framework. But if the data in the toll declaration for some reason is shown to be incorrect, for example if the vehicle's number of axles is wrong, the Toll Charger will charge the EETS Provider with the correct fee plus any additional penalties according to the EETS contractual framework. The EETS Provider will be burdened the fee but the EETS Provider later passes the additional costs on to the Service User. (CESARE III Project 2006)

If there is no toll received, for example because the vehicle does not carry an OBE, the OBE is defect or sabotaged or the toll system is not functioning, the Toll Charger recovers the fee by holding the EETS Provider responsible according to the payment guarantee agreement. The EETS Provider then recovers the costs by billing the actors responsible for the defect, for example the Service User, the hauling company, the OBE manufacturer or the OBE installer or maintenance organisation. (CESARE III Project 2006)

[10] Walk-Away means that there is a possibility to refuse entering a contractual agreement with another party.

# The payment card system

Visa, MasterCard and American Express are all examples of internationally renowned payment card brands that process payments to the extent of billions of euros all across the world every day. Each second brings new transactions that at the end of the day constitute millions of closed deals. In locations where cash is still the most prevalent form of payments, it is often obtained from a cash machine using a payment card. The wide adoption and success of this service lies not only in the convenience it brings their cardholders (that cardholders do not have to bring cash wherever they are going) but also in the fact that payment cards enable retailers to sell their services and products without credit risk. Furthermore, payment cards and especially credit cards are an important source of consumer credit and therefore work as a driving force for the economy. (Slawsky & Zafar 2005)

## Different kinds of payment cards

Basically, there are two kinds of payment card technologies. The most common is the magnetic stripe at the back of the card, which stores the needed information required to process a transaction. There are also chip cards or smart cards, two names for the same kind of technology that represent the next generation among payment card technologies. Instead of a magnetic stripe, these payment cards contain a small electronic microprocessor (a chip) that can contain more information and it is also much more difficult to counterfeit. (Slawsky & Zafar 2005)

A payment card can be used at any Merchant that accepts it. Merchants display the card types they do accept, Visa and MasterCard are the two most widely accepted card brands with American Express, Diners Club also being widely adopted card brands. In contrast to these general payment cards, there are also store cards. These cards differ to the above mentioned in the way that they can only be used at one or several specific stores and sometimes even regions. Store cards are prevalent in the gas station industry as well as some retail businesses and they often tie in promotional events and discounts in order to retain customer loyalty. The word payment card is a mutual name of several different types of card-based payment products, irrespective of which organisation that issues, markets or processes them. The most common types of payment cards are credit cards, debit cards and charge cards. (Slawsky & Zafar 2005; Kellagher et al. 2002)

### Credit cards

A credit card has a revolving credit that is charged when being used. It enables the customers to be billed for the purchases afterwards, commonly by the end of the month. On a credit card there is always a predetermined amount of credit, and the Cardholder can use the card up to that credit. All purchases are stated on one invoice and the Cardholder can thereafter choose to reimburse the whole sum on the due date, or parts of it. Usually a certain percentage of the debt is to be paid each month, for instance a tenth of the full amount. The rest of the amount due can be borrowed with an interest fee as the financial institution’s return. (Slawsky & Zafar 2005; Kellagher et al. 2002)

### Charge cards

American Express and Diner's Club are two renowned examples of charge cards. These payment cards usually have no upper credit limit. Charge cards are similar to credit cards as they offer a handy way of getting interest free credit period. Yet, the issuing institution requires that the full balance is paid back on the due date, which is normally 30-45 days after the purchases are done. (Slawsky & Zafar 2005; Kellagher et al. 2002)

### Debit cards

Purchases made with debit card are deducted from funds on an account belonging to the Cardholder. Since debit cards almost always are linked to a bank account, these types of cards are often referred to as bank cards, indicating that banks are the most common Issuer of these cards. Debit card transactions are generally processed the same way as credit- and charge cards in terms of authorisation, clearing and settlement. (Slawsky & Zafar 2005; Kellagher et al. 2002)

## History of the payment card system

The practise of buying things on credit is no news. In fact, it is more than thousand years ago since sellers first started to sell their goods or services on credit, keeping the customer accounts in their books, not seldom without a collateral. (Slawsky & Zafar 2005) Today's payment cards date back to the late 1800s, when Merchants and consumers exchanged goods and services using charge plates and credit coins as currency. (Starbuck Gerson & Woolsey 2008) The basic idea is that a Merchant should not have to lose a sale just because the customer does not have any money at the moment. Instead the customer can pay when it has the economical means to it. Naturally, sellers are more likely to extend credit to people who have a regular source of income and a decent history of paying their debts on time. Nonetheless, payment cards developed not only because people did not have any money to pay for their purchases. The convenience of not needing to bring cash around was an even more important reason for the expansion of payment cards. Also it was a lot safer to bring a payment card than carrying cash in your pocket. Still, convenience is the primary value of payment cards and the main benefit that facilitated its success, expansion and wide adoption. (Slawsky & Zafar 2005)

Understanding the convenience for the customers of not needing to carry cash, some establishments began issuing payment cards to a few trusted customers in the early twentieth century. This occurrence was particularly common among companies that had several dispersed outlets, for example oil companies and department store chains. (Electronic Transfer Inc. 2005) In 1914, The General Petroleum Corporation of California, later renamed Mobil Oil, started issuing payment cards to employees and customers. This card was only to be used at the sales outlets belonging to the company – the first store card (or company issued card) was a fact. (Slawsky & Zafar 2005) The objectives of issuing these charge cards were to create loyalty to the specific organisation and to improve customer service. The cards were only accepted at selling locations associated with the Issuer of the card and it was not rare that the card had a limited geographic area of functionality. Hence, a Cardholder travelling to other states or even cities had no use of it, and doing a day of shopping required the customer to bring several cards along. (Sienkiewicz 2001)

In the middle of the twentieth century, until the outbreak of World War II travel corporations and communication companies had also started giving out store cards to their preferred clientele. All processing of transactions, issuing of cards and collection of debts were managed by the specific company. During World War II usage of payment cards was prohibited. (Electronic Transfer Inc. 2005)

After the war followed a rapid increase in spending among those who possessed a payment card, which is the reason why some big US banks started discussing new ways to tap this growing market. (Electronic Transfer Inc. 2005) The Flatbush National Bank of New York was first to introduce their Charge It card in 1947 and Franklin National Bank was first to issue credit cards. (Slawsky & Zafar 2005) These card systems were very similar to how the system works today; the consumer made a purchase using the card, the Merchant obtained authorisation from the bank and closed the sale. The bank reimbursed the Merchant and charged the Cardholder at a later date. Though, they were only issuing cards to local consumers. (Electronic Transfer Inc. 2005) Despite long experience of lending people money, the bank segment was slow in developing the new product. Instead, other companies were faster in understanding the huge opportunities of reaching the market. (Slawsky & Zafar 2005)

When Frank McNamara, a New York businessman, was dining at a New York restaurant, it suddenly and unfortunately came to his mind that he had forgotten his wallet. The embarrassment made a lasting impression and he saw an imminent demand for a payment card that could be used for all purchases no matter the location. Later that year, still in 1950, Diners Club was formed. It started as a selected group of hotels and restaurants, but new members joined and the network of Merchants grew. (Slawsky & Zafar 2005) The Diners Club provided its Cardholders 60 days to make the payment. (Electronic Transfer Inc. 2005) In the meantime Diners Club expanded, a travel company named American Express wanted to ripe profits of the growing market that it introduced its own credit card with a Merchant base consisting mainly of travel companies, hotels and restaurants. Eventually, American Express outstripped Diners Club and laid a foundation of a multinational business that still flourishes. (Slawsky & Zafar 2005)

Meanwhile, the US banks were steadily building up payment card businesses on the same concept as Diners Club and American Express and by the end of the 1950s there were almost one million bank cards in circulation. Merchants paid a fee for the service of being offered a card based payment alternative. The fee, called Merchant discount, generated good profits for the card companies. The fees Merchants paid the card companies in order to be able to accept a card were pretty large, but they found it worth it. The high fees eventually came to slow down the growth and expansion of the payment card business. (Slawsky & Zafar 2005)

In the late 1950s, California based Bank of America started issuing its BankAmericard, which in the early 1960s reached its millionth bank card to be issued. The success of BankAmericard was to find in the fact that it gave the Cardholder an option on how the purchase was to be paid. Either by letting the consumer pay the debt in whole or letting him make minimum payments each month and while the issuing bank charges interest on the remaining balance, the revolving credit principle. (Electronic Transfer Inc. 2005) BankAmericard started licensing its bank card to other banks in the US that did not have the resources (the set-up

costs of developing a network of Cardholders and Merchants are substantial) to issue a bank card of their own. The development went slowly and the difficulties of convincing member banks to sign in were substantial. They were reluctant since the new situation of joining a network meant too little self-determination. However, when a few banks started to join, the other ones could simply not stand aside watching and by the end of 1960s over three thousand US banks had signed up to join the BankAmericard network. This step led rivals to develop similar schemes; in 1966 The Interbank Card Association launched their Master Charge card, which thirteen years later was renamed to MasterCard, in the year 1979. (Hock 1999; Slawsky & Zafar 2005) By 1969, most independent bank cards had been converted to either BankAmericard or MasterCharge. (Electronic Transfer Inc. 2005) During the late 1960s the BankAmericard developed further and under their new name, Visa, it became one of the most renowned and widespread brands of the world. (Slawsky & Zafar 2005)

In the meantime the European market introduced several similar payment systems with Eurocard and Eurocheque from 1969 being the two largest systems. The two brands merged in 1990 under the name Europay, which was acquired by MasterCard in 2002. In the mid 1960s of the UK, Barcleys Bank bought a license to market the BankAmericard and became an important European Visa promotion actor. (Slawsky & Zafar 2005)

One major change in the payment card industry was the streamlining of the transaction processing. Before 1970 authorisation was made over telephone, but thanks to innovations such as electronic authorisation, it was after this date available for retailers 24 hours every day. This innovation also reduced payment card fraud. By 1979 electronic processing was improving with electronic dial-up terminals and magnetic stripes on the back of every card. This quickened the processing of information dramatically and it gave processing of authorisations and settlement agreements in just one or two minutes. The first automatic teller machine (ATM) came in the early 1980s and eased the managing of cash withdrawals, enabling credit card holders to withdraw cash in different currencies. (Electronic Transfer Inc. 2005) There are three dominant global brand names on the world market today: Visa, MasterCard and American Express. Other large, prevalent payment card organisations are Discover, JCB and Diners Club. Usually the dominant local brands in domestic markets are linked to either MasterCard or Visa. At present a bank can be a member of both MasterCard and Visa, but it was not until 1976 this was accepted. (Slawsky & Zafar 2005) Visa has, since its formation, been the leader of technological and organisational innovation and has emerged as the world's largest credit card association reaching over one billion cards issued, processing over 50 percent of all transactions world wide. Visa is a 'not for profit' organisation comprising over 40000 member banks. MasterCard and American Express are 'for profit' companies. (Electronic Transfer Inc. 2005)

## Actors of the payment card system

### Cardholder

The Cardholder is a person that has been issued a payment card. The Cardholder is the consumer of the system and can therefore be categorised as the Meta Actor Buyer. The card is received from an Issuer which is a mutual name for all financial institutions that issue payment cards to Cardholders, for instance banks, gas stations etc. (Kellagher et al. 2002)

### Issuer

The Issuer enters agreements with the system's Buyer, the Cardholder, to whom it also manages billing and other customer contact related issues. The Issuer is financially liable for their Cardholder's actions, which is the reason why Issuers perform credit information checks of potential Cardholders. Also, the Issuers determine credit worthiness, set interest rates and assign credit lines. (Cornish et al. 2004) The Issuer recovers its costs with annual fees and interchange fees. The annual fee is the amount that the Cardholder needs to pay in order to be able to use the card, usually between 15-30 euros a year. The interchange fee is a kind of discount or beneficial concession that that the Issuer has at its disposal, meaning that the Acquirer is paying the Issuer a certain percentage of the total purchase amount, as shown in Figure 10. (Kellagher et al. 2002)

### Acquirer

The Acquirer is a financial institution, for example a bank, which is the Merchant's representative. The Acquirer accepts the Merchant's deposits for card transactions and reimburses the Merchant for the amount, with any possible fees deducted. Acquirers enter agreements with the Seller of the system (the Merchant) and are financially liable for their Merchants' actions, which makes screening and control of Merchants' legitimacy important. Besides processing the Merchants' transactions, the Acquirers also install card processing terminals, record transactions, provide reports and handle problems regarding processing. Some Acquirers also provide more advanced services as analyses of purchasing patterns. Basically, Acquirers get their revenue from sales provisions or Merchant discounts, see Figure 10. (Cornish et al. 2004) Thus, in the payment card system the Issuer and the Acquirer together constitute the Intermediary; together these two actors enter contractual agreements both with Buyers and Sellers of the system, managing billing and acting as the Buyer's agent as well as providing payment guarantee for the Seller.

### Merchant

The Merchant is an organisation, for example a store that accepts payment cards as a form of imbursement for goods or services. If a Merchant wants to accept a payment card as payment, it needs to sign an agreement with an Acquirer. There are no regulations in regards to which Acquirer a Merchant is to form an agreement with; instead there is competition on the payment card market comprising several acquiring institutions. (Kellagher et al. 2002) Since the Merchant is the owner of the services or goods being sold and it enters contractual relationships with the Acquirer (Intermediary), it can be seen as the Seller of the payment card system.

### Payment Card Association

There are thousands of banks and other companies that allow for card-based payments and there are a billion Cardholders who use them and millions of Merchants that accept the cards. This extensive network of Intermediaries calls for some kind of coordination, which is being managed by the Payment Card Association. The Payment Card Association organises and manages the actions and behaviours of Merchants, banks and Cardholders by acting as coordinator and rule making body, for instance deciding interchange fees. Thus, the Payment Card Association can be viewed as the Association of the payment card system. The interchange fee is paid by the Acquirer which is one way to make sure the network

participants (in this case the Issuer) recover its processing costs. The Payment Card Association also provides much of the infrastructure, for example switches, required to route transaction information between acquiring and issuing banks. The two most common Payment Card Associations are VISA and MasterCard who together, during 2004, processed more than 45 billion card. (Large 2005) The financial institutions, Issuers and Acquirers, pay annual fees and commissions to be affiliated to the Payment Card Association, with varying prices for instance depending on association and banks' transaction volumes. (Ghosh 2008)

#### Examples of rules

As stated above, the Payment Card Association acts as rule-making body of the system and some rules set by them have recently received attention. For example, the no-surcharge rule states that Merchants are not allowed to charge customer more for a transaction using one payment card than for a transaction using any other payment card. The honour-all-cards rule states that Merchants who wish to accept a card brand must accept all cards issued under that card brand. For example must a Merchant that accepts Visa cards issued by ABC Bank also accept Visa cards from DEF Bank. Furthermore, a Merchant can not only accept American Express Gold cards and not American Express Centurion. Put together, these rules force Merchants to treat all cards issued under one brand equally. (Hunt 2003)

## Open payment card system

In an open payment card system there are five entities that together make up the main actors of the payment system; the Payment Card Association, the Cardholder, the Merchant, the Issuer and the Acquirer. (Kellagher et al. 2002) An important feature of the open payment card system is that it requires cooperation of all parties for the transactions to be successful. Without the Payment Card Association, Merchant, Acquirer, Issuer and Cardholder accepting the transaction would not occur. (Sienkiewicz 2001) The basics of the open payment card system are illustrated in Figure 10 where a cardholder is purchasing something from a Merchant with a payment card. Basically, if a cardholder makes a $1 purchase, the cardholder pays its Issuer the whole amount, in case there is not any deal between Cardholder and Issuer that entitles him to any discounts. The Issuer in turn pays the Acquirer 98,5 cent after deduction of a 1,5 percent interchange fee. Thereafter the Acquirer pays the Merchant 98 cents after a merchant discount of 2 percent is deducted. (Hunt 2003)

A bank can engage itself in both the actions taken by an Issuer and an Acquirer; it can be seen as an Acquirer given that it is assigned to process payments on the behalf of a Merchant. The very same bank can also be acting as an Issuer if it has Cardholders that use payment cards handed out by them. (Hunt 2003)

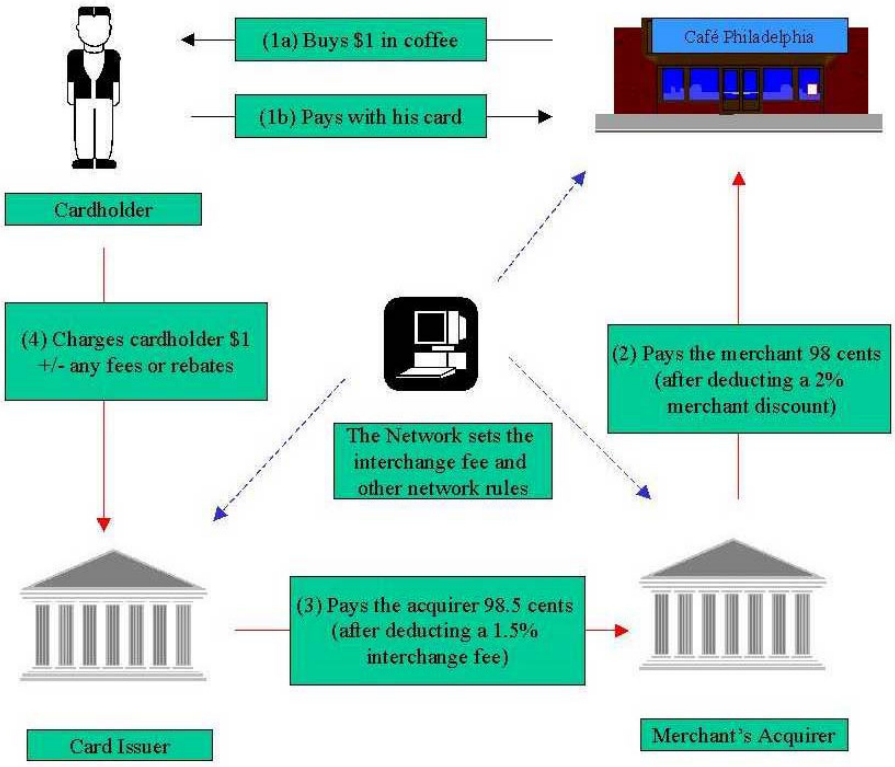


Figure 10 - The open payment card system.
(Hunt 2003, p. 82)

## Closed payment card system

The closed payment card system's major difference from the open payment card system is that the Issuer and the Acquirer is the very same actor, as Figure 11 illustrates. This Intermediary performs both issuing of cards as well as facilitating the card acceptance at Merchants. Thus, no coordination is needed. Therefore, the closed payment card system does not need an explicit Payment Card Association in the same sense as open payment card systems do. Instead, the setting of rules is carried out by the financial institution acting as Intermediary. The Payment Card Association in open systems is, as earlier mentioned, coordinating and supporting the member banks, which in turn can bee seen as sharing the network. This is in contrast to the financial institution in the closed payment card system, who can be said to own their network. Most payment cards in closed payment card systems are non-bank cards, with examples varying in scope from house brands such as gas station cards (only valid at a certain gas station chain) to global charge cards as American Express. Still, the structural differences between open and closed payment card systems are almost always unimportant for the Cardholder. (DeGennaro 2006; Cornish et al 2004)

Closed payment card systems apply Merchant discount but no interchange fee. Hence the financial institution of the closed payment card system makes a larger profit on each transaction, but on the other hand the very same institution also has larger processing and infrastructural costs. (Hunt 2003)

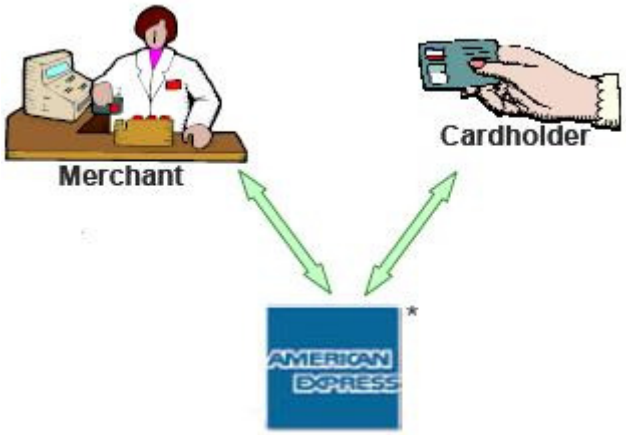

Figure 11 - The closed payment card system.
(Cornish et al 2004)

## Information and money flows of payment card system

The scheme of the open payment card transaction in Figure 10 is relatively simplified; it merely describes how the participating financial institutions receive their revenues. More precisely, the information and money flows in an open payment card system can be viewed as divided into three steps; authorisation, clearing and settlement. (Large 2005) In order to illustrate the information- and money flows of the transaction process, these three transaction steps of the open payment card system will be studied.

### Authorisation

Authorisation is a procedure carried out in order to get permission from the Issuer that the buyer's card is accepted as a means of payment and the authorisation process is illustrated in Figure 12. The first thing that happens in the authorisation process is that transaction information is transmitted from the Merchant to the Acquirer. For instance, the information sent contains payment card number, transaction amount and currency, time and date, Merchant ID, name, location, Merchant type and Issuer ID as well as different card security information. A processing unit at the Acquirer reads the information and forwards it, via the Association to the issuing bank. The Issuer either approves or denies the authorisation, depending whether the Cardholder's funds or credit line is sufficient to cover the purchase. The Issuer then returns, via the Association, either a positive or negative response to the Acquirer who forwards it to the Merchant, who in turn approves or denies the purchase. (DeGennaro 2006; Large 2005) During authorisation a black-listing check is being processed, where the card is matched against the issuing bank's database containing all cards being reported as lost, stolen or counterfeited. Any authorisation request for a restricted account will receive a "pick up card" response, meaning that the card should be confiscated. (Cornish et al 2004) If the Acquirer also is the Issuer the authorisations is handled within that actor, not involving the Payment Card Association. (Sienkiewicz 2001)

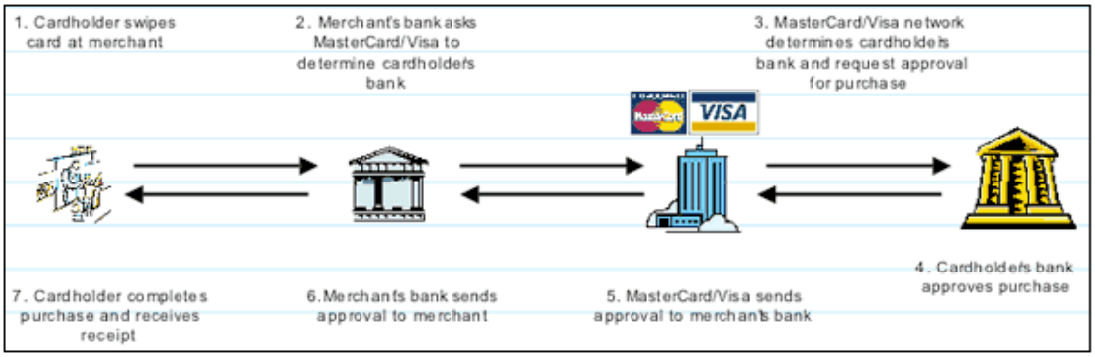

Figure 12 - Authorisation process in the open payment card system. (Large 2005)

Note that all contact between the Issuer and the Merchant is transferred through the Payment Card Association, a procedure that applies for the clearing and settlement processes as well. Most commonly, the authorisation is being done electronically at the point of sale after the Cardholder has swiped the payment card through a terminal. A typical authorisation process takes normally a few seconds, although the issuing bank can be located anywhere in the world. A so called voice authorisation is common for larger transaction amounts, where the Merchant calls an authorisation centre to obtain permission to accept the card. (DeGennaro 2006; Large 2005)

### Clearing

After authorisation is complete clearing begins. Clearing of a transaction involves the series of activities from that a transaction has been successfully authorised until the financial settlement commences. Clearing comprises exchange of information rather than financial assets and can be seen as facilitating the settlement. It can easiest be viewed as a process including calculation and reconciliation of who owes what to whom. Clearing is being accomplished between several actors in open the payment system. For instance the transfer of transaction information from the Merchant to the Acquirer is a type of clearing facilitating that instead of several transactions per day, all transactions are summed up so that only one single transaction is needed. Thus, clearing includes summarizing several trades between two banks, for example concluding how much bank A owes bank B. Since the same bank can act both as an Issuer and Acquirer, clearing aims at limiting the transactions and financial deliveries being processed through the Association by levelling out the liabilities between the banks. (DeGennaro 2006; Large 2005)

The first thing happening in the clearing process is that, as Figure 13 depicts, the Acquirer brings together the full transaction information, stemming from the authorisation details already sent to the Issuer. Along with a certain authorisation code plus any local tax details, this information is transmitted to the Association that collects the data on the morning of the day after the purchase. The Association then prepares files to transmit both to the Issuer and the Acquirer, with the purpose to merge the debit transactions from several Acquirers into one file for each issuing bank. The basic idea is to calculate the net balance to be paid or received, by every member bank. A fully reconciled clearing file is arranged daily by every bank that is a member of the Association. The clearing file is sent to all other member banks, approximately three to six hours after the data collection has taken place. (Large 2005)

The member banks decide by themselves which currency to settle in, but it is usually the domestic. Hence, the clearing files state the net balance in chosen currency that each member bank will receive or pay. Therefore, since the Payment Card Associations have huge volumes of foreign exchange they often get quite beneficial exchange rates from the banks they use. Yet, for some currency conversions both VISA and MasterCard apply a mark-up margin consisting of the wholesale rate plus a percent or so. Nevertheless, this does not apply for inter-European currency conversions. (Large 2005)

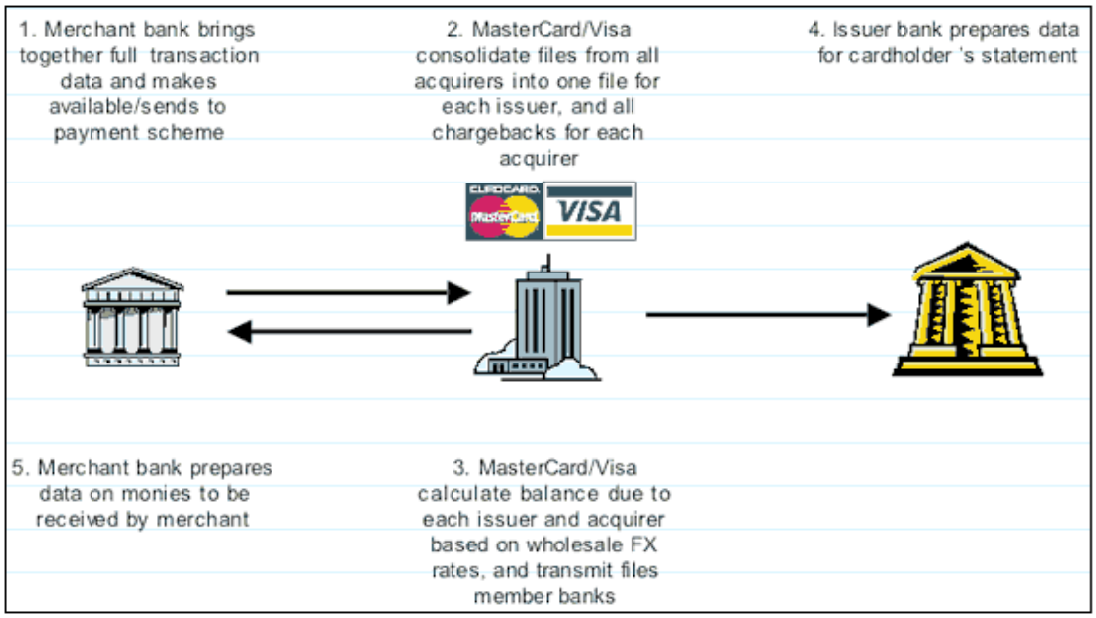


Figure 13 - The clearing process in the open payment card system. (Large 2005)

### Settlement

The last step in the transaction process is the settlement, which is when the actors pay their remaining debts to each other. At what time the Cardholder's account is debited and the Merchant's account is credited depends on the preferences and decisions of the member banks, what kind of card is being used and the size of the Merchant. (Large 2005) The different steps of the settlement usually follow a typical order, described in Figure 14. Normally, the first thing happening is that the Issuer commences the reconciliation by sending the payment to the Acquirer with any possible interchange fees deducted. As earlier stated, this transfer is being done via the Payment Card Association. Later on the Acquirer reimburses the Merchant with possible Merchant discount deducted. The settlement is finished when the Issuer bills the Cardholder. (Large 2005)

Usually crediting of the Merchants' account occurs on the same day the funds are received from the payment system, but some differences exist depending on the size of the participating banks. For example, if the Merchant is somewhat large and considered important, or possess substantial bargaining power in some state of affairs, the acquiring bank will credit the Merchant the day the transaction is being processes (day 1), even though the Acquirer has not received payment from the issuing bank until day 2. Hence, issues like these

are decided in the contractual agreement between the Merchant and the Acquirer. (Large 2005)

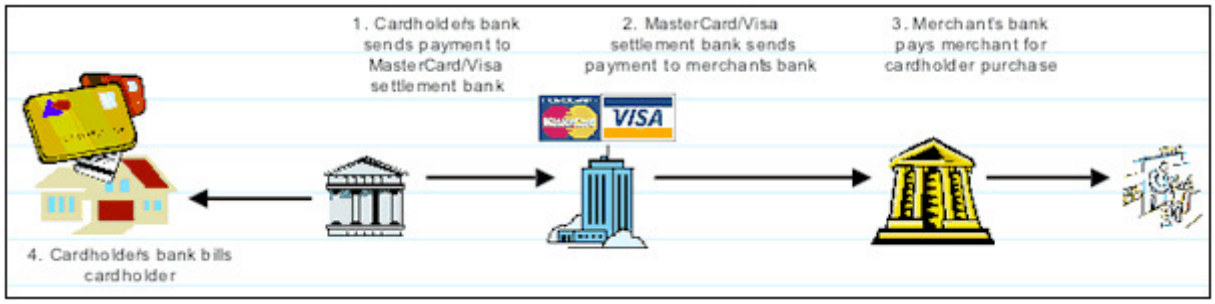


Figure 14 - The settlement process in the open payment card system. (Large 2005)

## Contractual relationships within the payment card system

The contractual relationship between Cardholder and Issuer is made up bilaterally, often in accordance with fairly standardised templates, for instance based on income factors, containing few negotiable parameters. A common denominator is that, since the Issuer has payment guarantee towards the Cardholder, credit checks are performed before entering agreements and issuing card. (Cornish et al. 2004) Acquirers also perform credit checks of the Merchants that they service. This is done annually, before the Merchant's account is renewed. The Acquirer indemnifies the card Issuer and the Issuer in turn indemnifies the Cardholder. When evaluating the Merchants' accounts, the Acquirer considers industry effects, firm specific effects and the characteristics of individual transactions, later described in this chapter. While the contracts between Merchant and Acquirers are negotiated bilaterally, for example containing the size of the Merchant discounts, the interchange fee is determined by respective Payment Card Association. (DeGennaro 2006)

The banks (Issuer and Acquirer) enter contractual relationship with the Payment Card Association. These contracts resemble multilateral contracts, where the bank, through the Payment Card Association gets affiliated to thousands of other banks linked to that particular Association. The negotiable parameters of the agreements vary, depending on many factors such as banks' sales volumes etc. (Sienkiewicz 2001) Normally, within the Visa and MasterCard networks, Acquirers pay Issuers around 1,3 percent of the transaction amount in interchange. This interchange fee is established to facilitate cost allocation and provide an incentive for Intermediaries to issue more cards and affiliate more Merchants to expand the payment card system. It can be seen as a compensation tool, promoting cooperation and participation between network parties by balancing the incentives to increase both Cardholders and Merchants. (Sienkiewicz 2001)

### Chargebacks

A chargeback is a credit transaction that is disputed by the Cardholder. It usually occurs because the customer is not satisfied with the purchased product or service. Cardholders always have a period of time to claim a chargeback, between 30 and 90 days, depending on credit card being used, the time of the purchase, the product or the service. Cash transactions

are final when a product or service is exchanged for cash. But credit card transactions are, because of Visa and MasterCard chargeback rules, not final until three months after date of purchase or delivery. This lack o finality is the key determinant of the Acquirers risk; until a transaction is final, the Acquirer bears the risk that a Merchant cannot cover a chargeback. Hence, all risk affecting the Merchant also affects the Acquirer. The initial presumption is in favour of the Cardholder, meaning that the chargeback amount is instantly deducted from the Merchant's account while pending the result of the dispute. If the dispute is resolved in favour of the Merchant, the amount will again be credited the Merchant's account. But if the chargeback is granted, the Merchant will, naturally, not receive the funds. Hence, the prevalence of chargebacks puts the Merchant at risk. Likewise, if the Cardholder is unable to pay, the Issuer is liable to recover the payments. Of course, Issuers and Acquirers include the cost of risk bearing in the annual service fees that Merchants pay their Acquirers. (DeGennaro 2006)

## Fraud

Fraud risk is the risk that a claim cannot be collected since the identity of the person incurring the debt cannot be established. Basically there are tree distinct types of fraud: stolen account information, identity theft, and "friendly fraud". Te first kind of fraud, stolen account information, usually occurs when a thief steals a payment card and uses it for purchasing merchandise. In the identity theft fraud case, or new account fraud as it is also called, a thief uses information about another person to open an account and then incur debts in that name. Purchasing product legitimately and regularly, followed by denying the purchases is called friendly fraud. The risk of fraud is especially high in payment situations where the card is not present. States of affairs like these are common if a Merchant takes orders over the Internet, by mail or over telephone. In card not present situations the Cardholder is not responsible for any fraudulent activities, shifting the responsibility to the Merchant and in turn creating a larger contingent liability for the Acquirer. (DeGennaro 2006)

#### Industry risk factors

Some industries are considered more risky. Commerce that is susceptible to buyers' remorse involves higher risks for an Acquirer because of the three month until a credit card transaction is final. Consider a health club business, often selling annual memberships on a mark down price relative to the monthly membership fees. The dilemma is that customers sometimes regret the commitment after a while, claiming the money back. Of course, the remorse of the buyer is not enough to win a chargeback dispute, but it might give the customer incentives at least to try. He can for example claim that the premises are unsanitary or that the equipment is often broken. Since such words as often and unsanitary are matters of degree, the Acquirer is put at risk because the customer has a chance to win the chargeback dispute. Other businesses that are prone to chargeback disputes are Merchants selling things of uncertain value, for example rare coins, artwork, collectibles etc. Businesses like these are also susceptible to fraud, since the condition of the goods being sold are note seldom exaggerated. For these reasons, Merchants selling products or services prone to chargeback disputes are seldom authorized to accept credit cards, since Acquirers are a bit unwilling to service them. (DeGennaro 2006)

**Firm specific risk factors**

Acquirers determine Merchants' risk susceptibility by looking at their financial ratios, business tax returns and viewing owners' economy to gauge risk, especially for unincorporated firms. Prevalent routines are usage of credit history and processing history if the Merchant has been served by another Acquirer, as well as taking into account how many years the business has been running. Generally, Acquirers look closely on information that others have already generated. If the Merchant's economical condition is weak, the Acquirer might force the Merchant to offer a personal guarantee or other forms of covenants. For example, the Merchants can get processing limits imposed on them, or they can be forced to provide collateral in the form of cash deposits. If the Merchant cannot provide such collaterals the Acquirer may suggest a delayed-payment arrangement, meaning that the Acquirer withholds the payment for a predetermined length of time after transaction processing. Hence the step in the settlement process, when the Acquirer reconciles the Merchant, is delayed. (DeGennaro 2006)

**Transaction related risk factors**

Payment cards were originally designed to be physically present at the point of sale. If they were, and Merchants followed the appropriate procedures, almost all risks, except fraud and delayed delivery, would decline. Today a growing number of transactions occur over the Internet, by mail or over telephone, making neither the Cardholder nor the card visible for the Merchant. These more recent forms of managing payments present problems for the Payment Card Associations. The most common way to deal with the problem has been to provide the Merchant with secret bits of information during authorisation. Usually these pieces of information help confirming that the customer has got the payment card in his hand at the point of sale and not only the card number. One example of these bits of information is the Card Verification Value (CVV), a digital code programmed in the magnetic stripe that is read during the swipe confirming the authorisation. (DeGennaro 2006)

For mail, telephone or Internet orders, the Payment Card Associations have had to come up with other ways to confirm that the Buyer has the card in his hand at the point of sale. The solution is CVV2, a three digit number printed on the back of the card, to the right of the signature area. Since the CVV2 is not embossed on front side the card, instead printed on the back of it, it does not appear on the paper sales slip, an also making it harder for a camera holder with bad intentions to get it. The Address Verification Service (AVS) is another obstacle that is makes it harder for a thief to have the necessary information. AVS is mainly used in card not present situation, asking the Cardholder to give the address where the Cardholder lives. If the right address is not given, the transaction is not authorised, and will be cancelled. CVV2 and AVS are only partially effective, it can for example easily be stolen from a dishonest waiter while clearing the table and address information can easily be found. More recent innovation are Verified by Visa and MasterCard Secure Code, two systems using passwords for Internet purchases. (DeGennaro 2006)

Acquirers use Merchant discounts as a means to give Merchants economical incentives to follow procedures to prevent transactions involving higher risk. These incentives can be viewed as qualification levels where the Merchants pay a smaller discount the higher qualification level that the transaction meets. The more hurdles for the transaction, the higher is the qualification level and the lower is the discount fee. A three-tiered layer is not rare,

starting with the non-qualification rate (the lowest acceptable category with the highest fee). The second step is called the partially qualified rate and last the qualified rate (the highest category). For instance, entering the card number without AVS gives the transaction the non-qualified rate, hand keying the card number including an AVS request moves the transaction to the partially qualified rate and swiping the card gives the transaction the qualified rate. (DeGennaro 2006)

Some industries can have different qualification measures. Businesses where tipping is common are treated specially, depending on how large the tip is. This is because the amount of the tip is unknown until after the card has been swiped or the number hand-keyed. Hence, the amount approved by the customer is lower than the final amount to be charged. If the total amount including tip is much more than the approved amount, the transaction may drop from a qualified rate until a partially qualified rate, forcing the Merchant to pay a percentage wise larger Merchant discount. (DeGennaro 2006)

Acquirers may impose rules that Merchants have to follow, apart from the procedures to follow when the payment is managed. This is especially common when items are sent to the customer. Just before shipping an ordered item, a Merchant can be forced to contact the customer in order to verify the telephone number, shipping- or e-mail address. Another procedure to prevent fraud is to only ship items to the payment card's billing address, refusing delivery to other destination. (DeGennaro 2006)

Payment Card Associations have set up rules that force Acquirers to cooperation and strive to improve network efficiency. One example is the Visa and MasterCard managed MATCH list (Members Alert To Control High risk Merchants) that highlight problem companies. If an Acquirer denies serving a particular Merchant because of adverse processing procedures, that Acquirer is forced to add the Merchant to the MATCH list. If the Acquirer does not, it can be held liable to any later losses that another Acquirer might suffer from that Merchant. (DeGennaro 2006)

### Information and money flows and contractual relationships in closed systems

As stated earlier, there is no split between the Issuer and the Acquirer in the closed payment card system. Instead these actors' assignments are managed by on specific Intermediary, but apart from that the structure is similar to the open payment card system. Figure 11 illustrates how the Merchants enter bilateral contractual agreements directly with the Issuer/Acquirer, who in turn issues cards to the Cardholder. This Intermediary performs all transaction related information- and money flow activities and it also provides all technological infrastructures needed. The contractual relationship between Cardholder and Issuer/Acquirer, see Figure 11, is also made up bilaterally. These contract are somewhat standardised and a common denominator is that, since the Issuer/Acquirer has payment guarantee for the Cardholder, credit checks are performed before entering agreements and issuing card. (Cornish et al. 2004)

The information and money flows are similar to the open payment card system, also with the difference that the Issuer/Acquirer is the same actor. The Merchant initiates an authorisation request from the Point Of Sale (POS) terminal, which flows directly to Intermediary who makes a credit decision and then returns either an approved or a denied response in return. If the authorisation is approved the sale is completed and at the end of the day the Merchant

submits the completed transaction data, batch wise, to the Intermediary. Then, the Issuer/Acquirer reimburses the Merchant by depositing the accumulated value of the batch of transactions, with any Merchant fees deducted. The Issuer/Acquirer then posts the transaction to the Cardholder's account. The Issuer/Acquirer produces monthly statements that are sent to the Cardholder, who in turn makes payment against their credit account. Since there is only one single Issuer/Acquirer there is no clearing present. (Cornish et al 2004)

# GSM

GSM is the acronym for Global System for Mobile Communication and is the world's largest mobile communication system. The GSM telephony is used by over a quarter of the world's population, reaching over 2.5 billion subscribers by the end of 2007, representing over 85 percent of world's mobile communication market. (GSMA 2007)

## History of GSM

At the beginning of the 1980s, the mobile telephony systems were experiencing rapid expansion. These early analogue systems of mobile communication stem from the middle of the twentieth century, where it was brainstormed in 1947 intended to be used for military purposes. From the middle of the century to the beginning of the 1980s, many different broadcasting technologies came forward, for example the American AMPS (Advanced Mobile Phone Service) and the Scandinavian NMT (Nordic Mobile Telephone). However, these analogue systems were not interoperable, making international calls a utopia. Also, by current standards they were characterised by low capacity, limited coverage, high user tariffs and expensive, large and power-consuming user equipments that kept the number of users down. (Bekkers 2001) Still in the 1980s, there was no existing European standard for mobile telephony. Rather, there were several different system standards with no particular market leader, which together made the mobile telephony map quite fragmented. The possibilities for using a mobile phone abroad were small. Some initiatives towards interoperability were the Nordic countries, where the NMT allowed usage of the same mobile phone throughout the region. The costs of setting up and maintaining several systems like these were substantial. Economies of scale were an impossible vision since different standards demanded different technologies and the costs for developing and purchasing a telephone followed the pattern. (Mölleryd 1999)

In the early 1980s, the European Commission together with Mobile Network Operators started urging for a pan European mobile telephone standard. The main motives were lack of capacity, high costs and lacking roaming possibilities. (Bekkers 2001) The hopes and intentions with a pan European network were that it would contribute to a positive economic development in many ways; better communication opportunities on inter-person and inter-country levels would bring positive effects on business life. (Mölleryd 1999)
Basically, GSM was founded on the concept of roaming, meaning that Callers are allowed to use their mobile phones when visiting other countries or networks. (Gullstrand 2008)
Furthermore, a single market for mobile telephone systems and phones would strengthen a European telecommunication industry, something that was essential. (Mölleryd 1999)

The idea of a standardised mobile telephone market was not new; in the early 1970s members of the NMT group had it on the agenda. Although, there were difficulties in agreeing that a mutual standard was to be beneficial, but the NMT-group did not give in and they were instrumental in promoting the first step towards a standardization process in 1982. This resulted in a working group named GSM (acronym for Groupe Spéciale Mobile), commissioned to develop a mobile telephone standard. The initiative behind this directive came from the Conference of European Posts and Telecommunications (CEPT), consisting of

national telecommunication administrations of 26 member states. In the 1990s the acronym GSM was changed to Global System for Mobile communication (still GSM though). (Mölleryd 1999)

Frequency spectrums had already been allocated for increased mobile telephone communication. It was decided that that the new GSM system was to be based on digital transmission, in contradiction to the earlier analogue communication systems. The objectives behind this decision was improved speech quality, higher capacity, increased security through encryption and more combined services to offer. The following years, different alternatives of handling the radio transmission were being discussed. Briefly, Time Division Multiple Access (TDMA), a technique of dividing the frequency spectrum into several time slots was after long negotiations finally decided to be implemented. (Mölleryd 1999)

### Memorandum of Understanding

In the latter part of the 1980s, after the projections of the new GSM system still being modest and analogue networks concurrently expanding across Europe, the Commission found it necessary that the European Mobile Network Operators made a special commitment to implement a GSM-network. The objective was to speed up the introduction by creating a sufficient market to convince the industry to make investments in R&D for a pan-European standardisation of GSM. The consequence of these thoughts resulted in a formation of agreements between Mobile Network Operators formalised in a Memorandum of Understanding (MoU). The idea took place in May 1987 by representatives from France, Italy, West-Germany and the United Kingdom and was signed by 15 network operators from 13 European states in September 1987. The memorandum stated that the organisations ratifying the agreement were committed to introduce GSM networks no later than January 1991. (Mölleryd 1999) The signatories of the MoU also established a number of working groups studying the problem of building and administering a worldwide interoperable system based on independent networks. (Gullstrand 2008) The MoU laid the foundation of the pan-European mobile system, triggered technological development and bringing economies of scale, contributing into making usage of mobile phones an affordable activity, reaching out to the wide public. (GSM Twenty 2007) The different working groups stemming from the MoU, later became the GSM Association (GSMA), today's largest wireless industry body, initially working hard to enable cross border roaming and the complex billing procedure that follows from it. (Gullstrand 2008)

Other instructions were put forward in the aftermath of the MoU, contributing in shaping the development of mobile telephony. The most important was formed the year after, 1988, and concerned competition in the telecommunication equipment market, ensuring liberalisation of it. From this followed that it was not a good idea to develop GSM within the CEPT organisation. Since an organisation only open for national telecom administrations, CEPT would not be optimal for this liberalisation and instead the responsibility for the development of GSM was given to the newly founded European Telecommunications Standards Institute (ETSI) in 1989. ETSI was, in contrast to CEPT, open for any European organisation in the telecom industry, facilitating suppliers and other participants to take an active interest in the standardisation process. This way, the industry got official access to the specification work on equal terms. (Mölleryd 1999)

The MoU was a multilateral agreement and not a legal agreement, declaring the intentions of the signatories to the outside world. It was initially open to licensed Mobile Network Operators in all CEPT countries which gave it a wider geographical reach than the EC. The agreement contained a voting mechanism, which made it possible to take decisive measures and the members were obliged to support the result of the vote. The MoU was drawn up under initiatives from the manufacturing industry with the intentions of securing that network operators would place orders on GSM networks. Its development gained momentum by reducing uncertainties for all actors. When the MoU was formed it was expected to be a one-time action. However, when the agreement expired in 1991, there was still a need for continuous coordination between operators in the areas of billing, routing and accounting among other things. For this reason GSMA was founded, presented later in this chapter. (Bekkers 2001)

## GSM architecture

The GSM network consists of several different entities, each serving a specific function using a particular interface. Figure 15 gives a brief illustration of how a GSM network is built up. Basically, the net constitute three different subsystems: the Mobile entity, the Base Station Subsystem and the Network Subsystem.

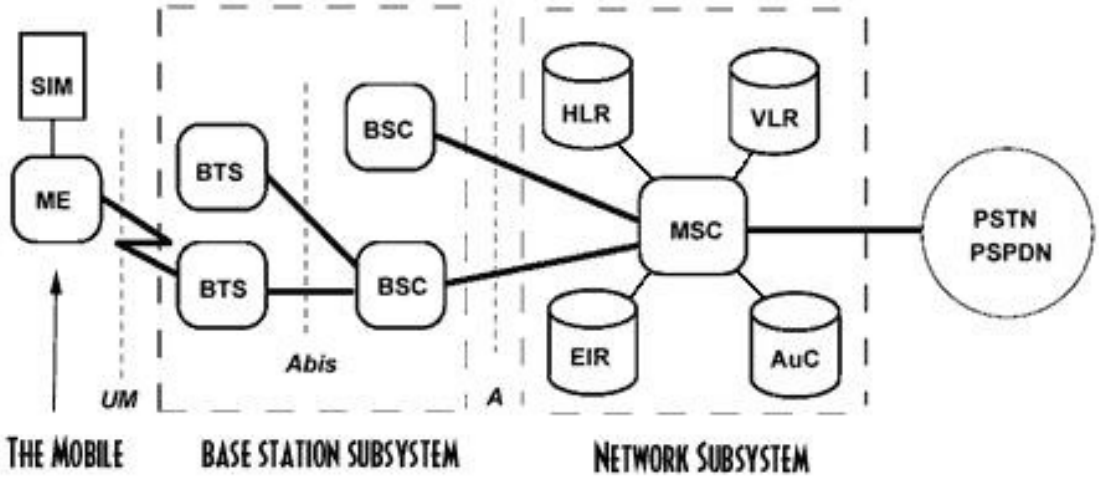


Figure 15 - General architecture of the GSM network.
(Scourias 2008)

### The Mobile entity

The Mobile entity contains the Mobile Equipment (the cellular phone) and a smart card named the Subscriber Identity Module (SIM). The subscriber is in the mobile network identified by a system called International Mobile Subscriber Identity (IMSI), with the required identification information is located within the SIM. Thus, the SIM enables mobility since the Caller can use mobile phone services no matter of the cellular phone. In addition there is also identification for the mobile equipment called the International Mobile Equipment Identity (IMEI) enabling blocking of for example stolen mobile phones. GSM is the first mobile telephone system employing a SIM, facilitating more flexibility for the Caller. For example, a subscriber can with a GSM subscription easier buy a new phone while still keeping the same number, something that was harder with earlier systems because the

identification of these systems consisted of a burned in serial number permanently connected to the phone.

### The Base Station Subsystem

The Mobile entity communicates with the Base Station Subsystem through an air interface called the UM. This subsystem consists of two parts, The Base Transceiver Station (BTS) and the Base Station Controller (BSC). The BTS contains the radio transceivers, enabling communication with the mobile equipment. Hence, in order for a mobile phone to have reception, a BTS is needed in the phone's vicinity. It can be viewed as each BTS transmission creates a cell and within each cell the BTS senses the mobile entities located in that cell. In urban areas there are numerous BTSs installed for capacity and redundancy reasons. (Scourias 2008)

The Base Transceiver Station is managed by a Base Station Controller, gathering calls from the BTSs and forwards them to the Network Subsystem. These entities communicate with each other through the Abis interface. The BSCs also manages functions as handovers between BTSs (which is required when a Caller moves from one cell to another), radio channel setup and is the connection between the mobile equipment and the Network Subsystem. (Scourias 2008)

### The Network Subsystem

The main component of the Network Subsystem is the Mobile Switching Centre (MCS), which is the switching mode for all calls going in and out the network. The MSC provides many functions necessary for mobile communication; the connections to other mobile and fixed networks (PSTN and ISDN), registration, verification, location updating and it also manage roaming subscribers. These services are made available in combination with a few functional entities, together making up the Network Subsystem; Home Location Register (HLR), Visiting Location Register (VLR), Authentication Centre (AuC) and the Equipment Identity Register (EIR). The MSC communicates with the Base Station Subsystem through the A interface. The HLR and VLR are large databases maintained on servers. The HLR contains information about all subscribers presently located in corresponding GSM network, along with position information (what cell the subscriber is to be found in). There is typically only one HLR in each GSM network, but for redundancy reasons the same register is distributed on several servers. The VLR contains information about visitors in the network (Callers that are not subscribed) and information needed for roaming purposes. When a non-subscribed mobile entity is detected within a network, the VLR queries the subscriber's HLR if it is allowed to connect to the network, followed by a positive or negative response. (Scourias 2008) The EIR and AuC are registers used for authentication and security purposes. Each time a mobile phone is turned on an identity and authority control is matched against EIR and AuC (Ademar & Nyström 2003). The EIR database holds a list of all valid mobile equipments in the network, identifying the mobile equipment by its IMEI; if a cellular phone is reported stolen its gets blacklisted through the IMEI and the phone will be marked invalid in the EIR. AuC is a protected database containing copies of secret keys stored in every subscriber's SIM. This key is then being used for encryption and authentication. (Scourias 2008)

# Actors of GSM

## Caller

The Caller is the consumer of the service being produced and can therefore be categorised as the Meta Actor Buyer. The Caller only has contractual relationship with a Service Provider.

## Mobile Network Operator

The main actor of the GSM network is the Mobile Network Operator (MNO). The MNO is the telephone company that is providing network connection. Examples of MNOs are the Swedish companies Tele2, British Vodafone or German T-Mobile. The MNO has its own GSM network containing operations of base stations, mobile switches, databases and so on, see Figure 15. The MNO also uses their own frequency spectrum, usually allocated and leased from the government. Since the MNO is the owner of the service being sold and enters contractual relationships with the Intermediary (the Service Provider) it is categorised as the Seller of the system. (Ballon et al. 2001)

## Service Provider

The Service Provider (SP) is the Intermediary of GSM, entering contractual agreements with the Caller and manages billing and customer contact. The Service Provider buys bulk calls and services from an MNO for further reselling to the Buyer. The Service Provider can have several different MNOs and it can either be a part of the MNO or a detached company. In the early days of GSM, it was in fact common that the Service Provider and the MNO was the same actor – that is, the MNO was usually taking on activities as billing and other customer contact issues. As the GSM industry matured, the Service Provider roles have been outsourced to companies that specialise in managing this administrative business. The same way the MNO can have several different Service Providers, a Service Provider can buy calls from multiple MNOs. Roaming agreements are only made between MNOs and not between Service Providers. (Hedin 2008) Examples of Service Providers are Swedish-based Optimal Telecom, using the network of Tele2 to provide the services for its Callers. Often these actors specialise in signing up Buyers for mobile services within a specific area, it can be geographical or segmented in other ways; there are for example Service Providers concentrating on providing mobile services towards university students etc. (Lindberg 2008)

#### Mobile Virtual Network Operator

The last eight years a new type of Intermediary called Mobile Virtual Network Operators (MVNOs) have emerged on the market. Basically, the MVNO is a sort of Service Provider; it provides telecommunication services without having access to a complete network. The MVNO pays another network operator to provide them the necessary infrastructure for them and their customers and they can have contract with several Mobile Network Operators. However, the MVNOs often have some parts of the network, sometimes managing their own HLRs, MSCs and other infrastructural necessities. The never manage their own frequency spectrum though; instead they lease it from other Mobile Network Operators. In contrast to Service Providers, MVNOs issue their own SIMs to Callers and they also enter roaming agreements with other MNOs. (Buckley 2003; Telecommunications regulatory commission 2008; Duke-Woolley 2001; Ballon et al. 2001; Nyqvist 2004) Another distinguishing characteristic is that Service Providers merely manages the administrative parts of the

business, whereas the MVNOs also manage the more technical information flows. The first MVNO that entered the mobile telecommunications market was British Virgin Mobile. Swedish-based Glocalnet and British Tesco are two other examples of MVNOs. The MVNOs and Service Providers often reach the market with an idea of being able to make use of an already existing customer base. For instance, Virgin already had a customer-base from their operations within the flight industry and Tesco have a long history of being active in retail and finance. (Lindberg 2008)

### GSM Association

GSM Association (GSMA) is a global trade organisation representing over 700 GSM network operators across 200 countries. Also, over 200 manufacturers and suppliers support the association as members. The objectives of the organisation are to make mobile telephony easily accessible and work globally. (GSM World 2007b) GSMA works as a forum where industry associates come together, setting rules and standards and developing the GSM platform to the advantage of members, investors and customers. (GSM World 2008) Thus, the GSMA can be viewed as the Meta Actor Association, of GSM. Membership is open to any Mobile Network Operator, as governmental regulators and associate memberships are open to all actors within industry, such as application providers, handset manufacturers, infrastructure manufacturers etc. (Sexton 2001) The GSMA assists operators in agreeing on settings and conventions, for example regarding standardisation of interfaces and they lay down rules and guidelines facilitating interworking between different networks (Mangtani 2007). Furthermore, the organisation strives to support a competitive environment and create new business opportunities for its operators and suppliers. (GSM World 2007b)

Yet, this actor model is very simplified leaving many other GSM actors outside. For example, the infrastructure providers who build and deliver the network subsystems to the network operators are excluded in this model. Also there are no content providers, developing new services, in this simplified model and the retailers who sell mobile handsets to Buyers are also excluded, just to mention a few.

## Roaming

One of the strengths of the GSM system is its interoperability. This is accomplished through the international roaming capability that facilitates customers to use their phone wherever they travel. (GSMA 2003) This concept offers the customer the convenience of having one single number, one bill and one phone and still having mobile access in over 200 countries. (GSM World 2007a) Roaming allows a Caller to use services of another Mobile Network Operator when the customer is within its coverage area, which has been possible through so called roaming agreements. Operators have signed over 20.000 roaming agreements until the end of 2001. Roaming over GSM networks has become a key service, generating large revenues for Mobile Network Operators, since roaming increases the number of subscribers that are reachable. (Pohjola, Kumar & Hämmäinen 2001) The roaming agreements within GSM have typically been made bilaterally between network operators concerning general terms and tariffs, who have agreed on procedures developed by the GSMA. (Pohjola, Kumar & Hämmäinen 2001)

There are basically four types of roaming:

- International roaming – as earlier mentioned this is the ability to use services of a foreign operator while the Buyer is abroad.
- National roaming – ability to use services of a competing operator from the same country, where the network operators have the same service area.
- Inter-regional roaming – ability to use services from an operator in the same country, where the operators have non-overlapping service areas.
- Inter-technology roaming – ability to roam between different technologies, for example GSM and 3G. (Pohjola, Kumar & Hämmäinen 2001)

## Information and money flows of GSM

The concept of roaming sounds simple. However, with some 700 networks in operation and estimating 20000 roaming agreements in place it is a pretty complex system. In order to accomplish the straightforward objective of global roaming lies a process that gathers information about each call and uses a standardised approach to the charges incurred during inter-operator and roaming calls. (Gullstrand 2008)

The Transferred Account Procedure (TAP) is the method that operators adhere to when exchanging billing information. Put simply, TAP is a standard process describing how roaming partners are able to charge each other for the use of networks and services. The TAP protocol was designed by GSMA, under a subgroup called Transfer Account Date Interchange Group (TADIG). TADIG was formed in May 1989 delivering the first TAP protocol later the same year. The first TAP standard was not launched until 1993 and implemented by GSM operators in September 1996. The first TAP rapidly progressed to TAP2, allowing billing for the new services developed. TAP3 is the name of the current standard which was launched in 2000 and it is still developing. (Gullstrand 2008)

But it is not just during roaming that TAP is used. Since a lot of the telephone traffic in the GSM mobile network either starts or ends in another network, so called inter-operator calls, TAP is a commonly used billing mechanism. For example, a fixed network operator charges the Mobile Network Operator for every call terminating at one of its fixed subscribers. Similarly, the Mobile Network Operator charges the fixed network operator for every call from the fixed network that ends in the mobile network. To facilitate and simplify these charging processes, the GSM network operators negotiate interconnect agreements, described in next section. Fixed network operators have also negotiated similar contracts. (Gullstrand 2008)

These interconnect agreements make inter-operator telephone traffic and roaming a lot easier to manage. For example, for a Swedish mobile subscriber to make a call from his Swedish Mobile Network Operator to a Spanish Mobile Network Operator, an interconnect agreement between these two organisations is not required. Instead, the Swedish Mobile Network Operator bilaterally negotiates a price with the Swedish fixed network operator and, in turn, the Swedish fixed network operator negotiates prices with the Spanish fixed Mobile Network Operator and the Spanish fixed operator negotiates a price for calls from that Spanish mobile operator. When the call passes through each network a call record is produced at every networks MCS. This record is forwarded to the billing system of each network, where every

network's cost of the call are registered. Then, the Spanish mobile operator charges the Spanish fixed mobile operator for the costs incurred by the call. The Spanish fixed network operator recoups its costs by billing the Swedish fixed network operator, who in turn passes its costs of the call to the Swedish Mobile Network Operator. The Swedish Mobile Network Operator then recoups its cost by billing the subscriber, either directly (retail billing) or via a Service Provider (wholesale billing) as Figure 16 illustrates. (Gullstrand 2008)

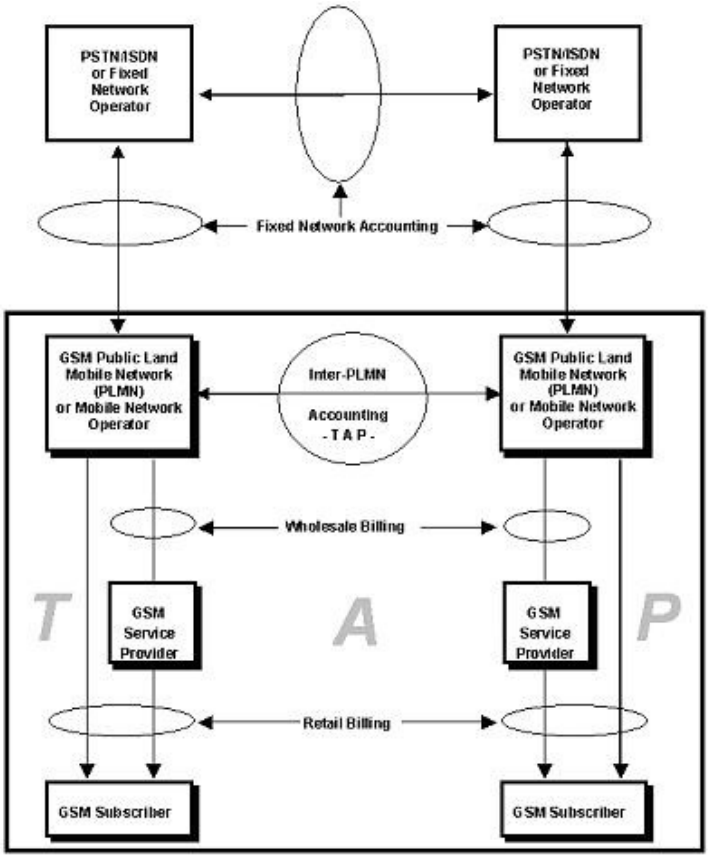


Figure 16 - Transfer Account Procedure (TAP).
(Gullstrand 2008)

This agreement based form of administrative accounting handles most allocation of costs and revenues between both fixed and mobile networks. Nevertheless, this model does not really cover the costs stemming from a foreign subscriber roaming in other networks. Think of a Danish subscriber making a phone call to a Spanish mobile network, from a Swedish MNO. Naturally, the Swedish fixed network operator will charge the Swedish Mobile Network Operator for the part of the call to the Spanish subscriber; the Swedish fixed network will charge the Spanish fixed network operator, and so on. But in this case, the Swedish Mobile Network Operator is not getting paid by its own subscriber. Instead it charges the customer's home Mobile Network Operator, in this case the Danish mobile MNO, to recoup the costs incurred by the call. (Gullstrand 2008)

In the example above, the information flow between the subscriber's Home Public Land Mobile Network (HPLMN) and the subscriber's Visiting Public Land Mobile Network (VPLMN) is illustrated in Figure 17. The call details are recorded by the Mobile Switching

Centre (MCS) in the network the call originates (the VPLMN). A call can generate one or many call records and there is a standard for these records defined as GSM 12.05. The records generated by the MSC are regularly sent to the billing system of the VPLMN, where pricing and rating takes place. Each call goes through the billing system and are finally resulting on the subscribers bill, but when the records are generated on behalf of a roaming subscriber, the call records are then converted, grouped and filed under the TAP format. (Gullstrand 2008)

The TAP records sent to the HPLMN may be transferred directly from VPLMN to HPLMN. However, if the Mobile Network Operators are connected via a roaming broker, this actor provides a data clearing house taking on this activity. The TAP records are generated and transmitted, at least 36 hours after the call has been made and mobile operators send several TAP files every day. The TAP files transmitted contain information about the call length and the call rate according to the roaming agreement's Inter Operator Tariff (IOT) as well as possible discounting schedules. Invoicing between the roaming partners then typically takes place once a month. (Gullstrand 2008)

When the HPLMN receives the TAP, the record is usually converted into an internal format and merged together with all other call records generated during that period of time, both from roaming and while being in the home network. Thus, the subscriber gets only one invoice, no matter how many countries the phone has been used from. The call records are then produced on an itemised bill which is being transmitted to the subscriber on a retail billing basis as Figure 16 illustrates. If a GSM Service Provider is serving the subscriber, the billing will be classified as wholesale billing. When the GSM Service Provider receives the information from HPLMN, the calls may be re-rated according to their own tariff schemes and produced on a bill sent to the subscriber. (Gullstrand 2008)

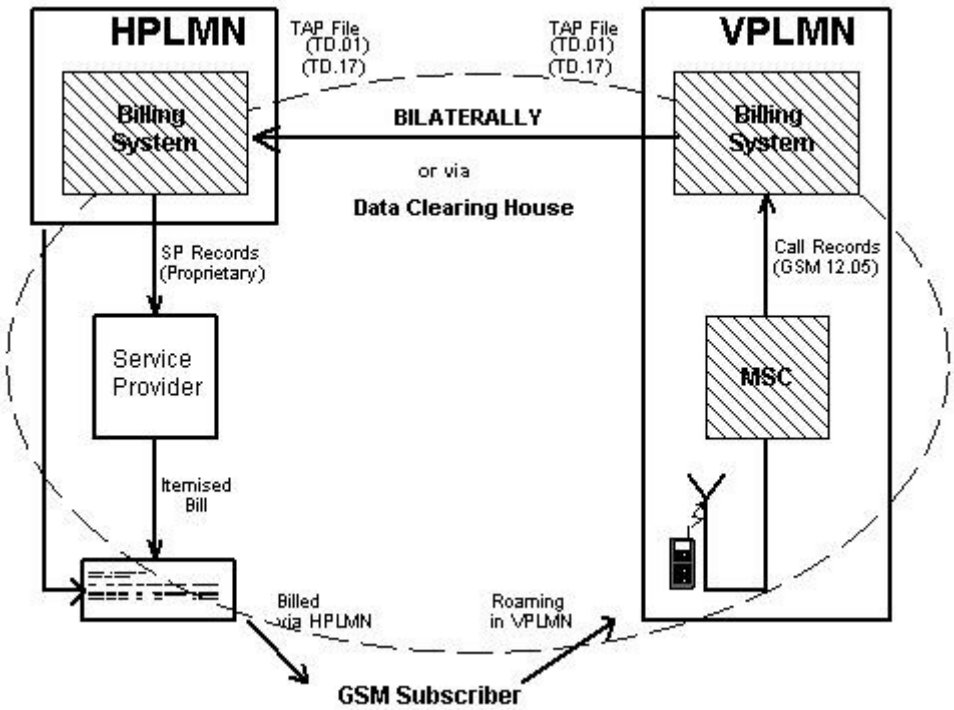


Figure 17 - Information flow for subscriber roaming in foreign mobile network. (Gullstrand 2008)

## Contractual relationships within GSM

The contractual relationship between Caller and the Service Provider is made up bilaterally, containing few negotiable parameters. The Service Provider in this relationship acts as an agent or representative, providing payment guarantee towards MVO, and the Caller agrees to pay the bills from the Service Provider on time. Also, since the Service Provider is the only actor that the Caller has contact with, a SIM is also received from the Service Provider. This is not the Service Provider's own SIMs but instead belonging to the MNO; the Service Provider is only responsible for deliverance of them. The Service Provider in turn, bilaterally enters contractual relationships with MNOs, resembling a reselling relationship where the Service Provider buys calls from the MNO and resells them to the Caller, providing payment guarantee towards the MNO. The contractual relationships between Caller and MVNO are very similar to the relationship between Caller and Service Provider, with the difference that the MVNOs issue their own SIMs. This also enables MVNO to enter roaming agreements with other MNOs. (Pohjola, Kumar & Hämmäinen 2001; Hedin 2008)

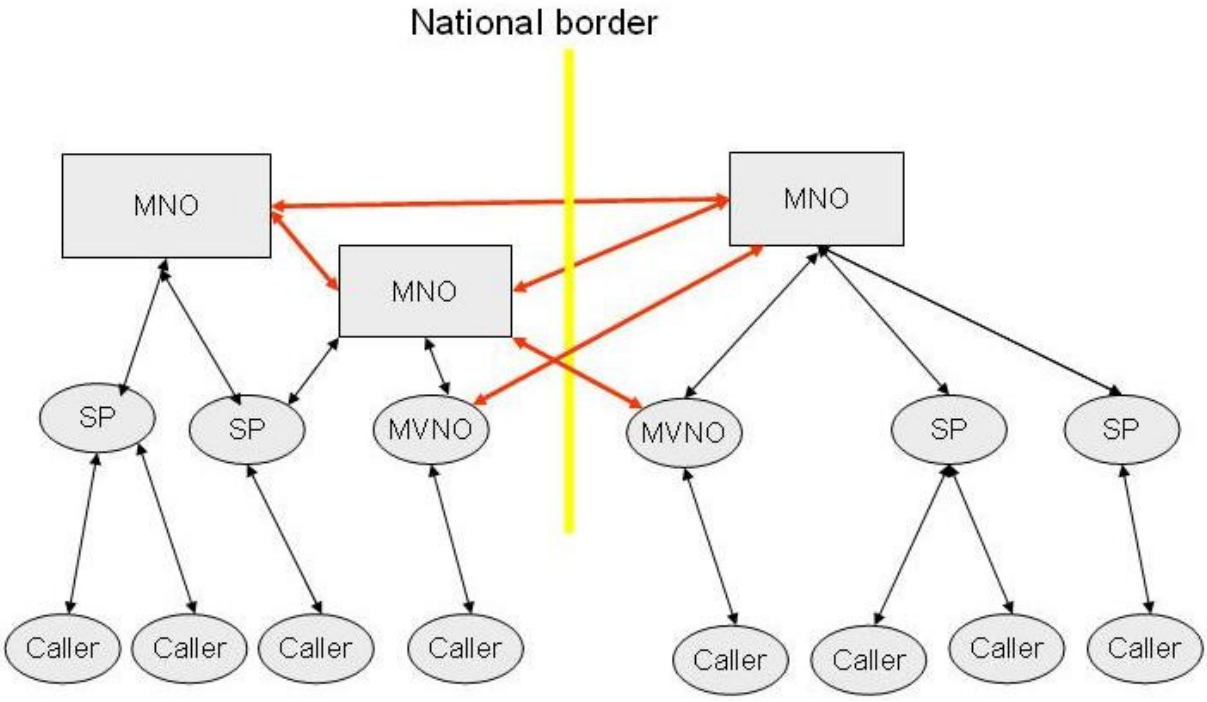


Figure 18 - Contractual relationships between actors of the GSM network.
(Hedin 2008)

In order to enable roaming, MNOs enter contractual relationships where they negotiate wholesale prices for the buying and selling of calls with foreign MNOs. In GSM, the roaming agreements are normally made bilaterally between operators. GSMA assists operators in agreeing on contracts by identifying topics of agreements, such as tariffs and responsibility areas and they also facilitate contractual agreements on services as SMS and data transfer services. (Pohjola, Kumar & Hämmäinen 2001)

When a Caller is roaming, the home Mobile Network Operator or (MVNO) can be seen as buying calls and services from the Visited Network Operator. In this way the MNO (or MVNO) buys network capacity from the Visited Network Operator, resells it to the Service

Provider, who in turn resells it to and bills the Buyer (MVNO do not resell to Service Provider but directly to the Caller. In these roaming agreements, the home MNO (or MVNO) provides payment guarantee towards the Visited MNO. The MNO then sells calls either to the Service Providers at a mutually agreed price (or directly to the customer if no Service Provider is used), and the Service Provider in turn resells it to the customer at retail price. The Service Provider has payment guarantee towards the MNO, meaning irrespective of the Service Provider gets paid by their customers for the calls they make, the Service Provider is forced to pay the MNO. (Hedin 2008)

### Roaming brokers

However, since then number of MNOs are steadily increasing, options to bilateral roaming agreements have recently been a reality. These new ways of committing with other MNOs are being offered from so called roaming brokers, who provide MNOs with bundle agreements that comprise roaming cooperation with several network operators. This way of finding roaming partners is an easy way for operators to get roaming access to several operators in different regions and countries. The main reasons to interact with a roaming broker is the costs of setting up and managing bilateral roaming agreements and in order to get good coverage, there is a need for at least 200 roaming partners. The roaming brokers do not have anything to do with the everyday information and money flows. Instead they are only active writing roaming agreements. (Pohjola, Kumar & Hämmäinen 2001; Performance technologies 2008)

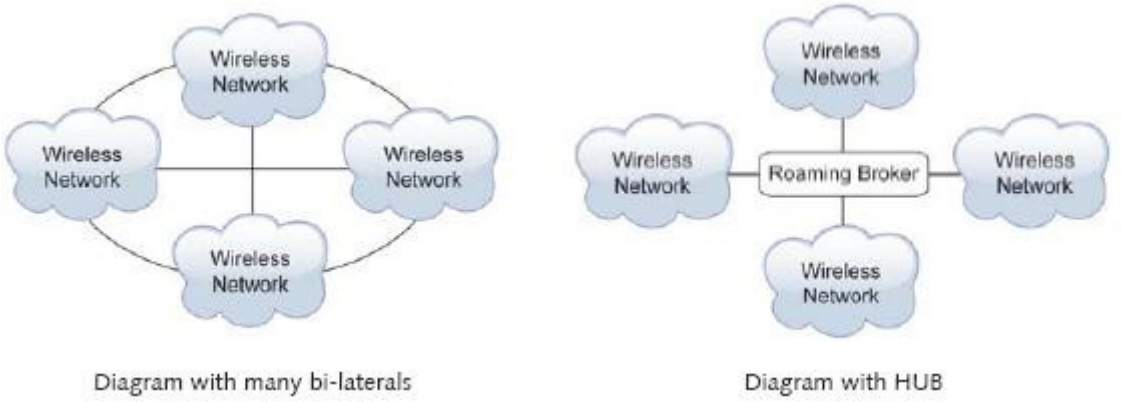


Figure 19 - Difference between bilateral roaming agreement and usage of roaming broker. (Performance technologies 2008)

### Fraud

Fraudulent activities within GSM telephony is basically subject to thefts of mobile devices, subscription fraud and cloning of phones. Each theft type renders severe economical losses for Mobile Network Operators and their Service Providers. The losses can be major since many services, such as roaming calls, still are very expensive. For example if a stolen phone is used for roaming calls, the criminal may cause the owner of the phone liabilities for hundreds of euros; just on a single day's calling. (Hynninen 2008) This is unfortunately possible since the subscriber is mobile and the payment system global; it takes too long time before the call records reaches the home Mobile Network Operator, making it difficult to prevent the behaviour on time. This puts the home network operator and Service Provider at risk, since they have payment guarantee towards the Visited network operator. (Svendsen

2007) In order to mitigate the losses caused by fraud, several programs have been and are expected to be launched. For instance, GSMA has decided an implementation of NRTRDE[11] compulsory, at latest by the 1 October 2008. (Allround 2008)

[11] NRTRDE is the acronym for Near Real Time Roaming Data Exchange.

# Comparisons of the systems

In the following chapter, comparisons concerning contractual relationships as well as information and money flows will be made between EETS and GSM as well as payment card network respectively. These comparison will first be carried out towards payment card system and then towards GSM. In order to facilitate understanding of the comparisons, the chapter starts with a summary of the Meta Actor classifications. Also, in order for the comparisons of the business models to be comprehendible, it is central to compare the general differences and similarities of the systems. Sometimes the answer to why parts of the business models are different can be found in these more general disparities of the systems. Therefore, it is also important to analyse and compare the history, the structure and the conditions and incentives for introduction of them. These comparisons will be carried out between EETS, GSM and payment card system mutually and follow the business model comparisons, providing a holistic view of the differences and similarities.

## Meta Actors of the systems

In order to facilitate the understanding of the comparisons, a concise display of the Meta Actors is presented in Figure 20.

| | **Buyer** | **Intermediary** | **Seller** | **Association** |
|---|---|---|---|---|
| **EETS** | Service User | EETS Provider | Toll Charger | Interoperability Manager |
| **Payment card system** | Cardholder | Issuer & Acquirer | Merchant | Payment Card Association |
| **GSM** | Caller | Service Provider or MVNO | MNO | GSMA |

Figure 20 - Meta Actors of the systems.

From a Meta Actor point of view, the structures of the systems are quiet similar. They all consist of a Buyer that, in each system being the Service User, Cardholder and Caller, is about to use a service that is subject to payment. The Buyer has to enter a contractual agreement with an Intermediary who, in turn, enters contracts with the Seller of the services and acts as a middleman responsible for billing, customer contact and providing payment guarantee towards the Seller. This Intermediary is in respective system EETS Provider, Issuer and Acquirer as well as Service Provider, since all can be viewed as an actor facilitating customer contact and billing. The Intermediary role is a bit different in the open payment card system since this Meta Actor role constitutes two actors. This becomes more obvious if it is thought of as both the Acquirer and Issuer together manage the Intermediary role. The Sellers of respective systems are naturally Toll Charger, Merchant and Mobile Network Operator. The Associations of the systems are Interoperability Manager, the Payment Card Association and the GSMA.

# Contracts and responsibilities between actors of the networks

## Comparing EETS contractual relationships with open payment card system

First the open payment system will be compared, followed by the closed system.

#### Cardholder and Issuer

The contractual relationship between the payment card system's Cardholder and Issuer is very similar to the Service User and EETS Provider relationship. Both Service Users and Cardholders are the Buyers of the system and they both interact with the system through one actor, the Intermediary, which is EETS Provider and Issuer respectively. Thus, they have only one contractual relationship. The agreements between the actors in respective system are pretty similar; both types of contracts are quite standardised and the negotiable parameters are limited. The Cardholder pays an annual fee, which is decided by the market, for the services that are provided by the Issuer, who in turn provides the Cardholder with a payment card. The fee the Service User pays the EETS Provider is somewhat regulated, since the EFC-Directive states pretty vaguely that only a fair compensation is to be received from providing EETS. Nonetheless, there are indications from EFC-Europe stating that competition among EETS Providers is to enhance the quality of services (Sundberg 2008). Both Service User and Cardholder are responsible for paying the debts that are caused by the usage of roads and payment card. Thus, both the EETS Provider and Issuer perform credit checks on their clients before entering agreements.

#### Acquirer and Merchant

The contractual relationship between the Acquirer and the Merchant resembles the situation in EETS where EETS Providers enter agreements with Toll Chargers. The agreements in both systems are entered bilaterally. Just as the agreements between the Toll Charger and EETS Provider, the Merchant pays the Acquirer for services as processing, transaction recording etc. In both systems the imbursement or compensation is supposed to be paid percentage wise as commissions. Another similarity is that in both systems, the Intermediary has payment guarantee towards the Seller, even though the Buyer cannot pay its debts. In the payment card system, the opposite also applies; the Acquirer has payment responsibility towards the Buyer (via the Issuer), in case the Merchant is unable to recover a chargeback. This scenario, that the EETS Provider should be payment responsible in case the Toll Charger has debts towards the Service Users that it cannot reimburse, is not considered within EETS. Another important difference is that in case the Intermediary and Seller in EETS do not agree during negotiations there is no walk away present. Instead, an arbitrating body (the Interoperability Manager) will impose a rather standardised contract upon them. In payment card system there is no counterpart to this, since the contracts are entirely based on negotiations.

#### Issuer and Acquirer (via the Payment Card Association)

As explained in the chapter Actors of the payment card system both the Acquirer and the Issuer can be classified as the Meta Actor Intermediary. However, there is no direct contractual relationship between the Intermediaries. Instead, the Issuer and the Acquirer are tied together via multilateral agreements entered with the Association since both the Issuer and the Acquirer are having contracts with at least one Payment Card Association. The Intermediaries pay the Association annual fees and sales commissions and in return they are

provided necessary infrastructure links to other banks, processing and clearing services, the right to issue payment cards under the Payment Card Association's name etc. The terms and conditions of the contracts vary depending on Association, the banks' transaction volumes etc. The Payment Card Association acts as decision making body determining interchange fees, making rules and stipulating policies. In that sense the relationships between the Payment Card Association and the Intermediaries resemble the Interoperability Manager's relationship with EETS Providers and Toll Chargers. But even though the Interoperability Manager of EETS also acts as rule-making body, it is merely coordinating the activities and contracts between Intermediary and Seller, not between Intermediaries. Nonetheless, indirectly the Issuer and Acquirer have a contractual agreement. For instance, the Issuer has payment guarantee towards the Acquirer, in case the Cardholder cannot pay the debts incurred. The same way the Acquirer is responsible for paying the Issuer (and in the end the Cardholder) for any chargebacks that the Merchants for some reason cannot cover. These rules are determined by the Payment Card Association and are seldom negotiable.

In EETS there are a few differences to this. First of all there is only one Intermediary present in EETS, a difference that is fundamental. The demand for two Intermediaries and thus the Associations role as coordinator in payment card system comes from the great extent of it. With a system constituting a billion Buyers and a million Sellers it is impossible that these two Meta Actors are to be linked together through one Intermediary. Instead they enter agreement with one or several of the 40000 Intermediaries, who then are linked together through an Association.

## Comparing EETS contractual relationships with closed payment card system

#### Cardholder and Issuer/Acquirer

Since there is no distinction between Issuer and Acquirer in the closed payment card system, the contractual relationships are very similar to the open payment card system. Relationship between the Cardholder (Buyer) and Issuer/Acquirer (Intermediary) is similar to relationship between Service User and EETS Provider. The Cardholder has a range of different bank cards to choose from that all compete in issuing cards to Cardholders, not dissimilar to the Service User and EETS Provider case. The contract is made up bilaterally on standard terms, just as in EETS. The Issuer/Acquirer is responsible for the actions of the Cardholder, which is why credit checks are performed in prior to contracts. However, in EETS a Service User is forced to enter an agreement with an EETS Provider.

#### Merchant and Issuer/Acquirer

In the closed payment system, the relationship between Merchant and Issuer/Acquirer is similar to the relationships between Toll Charger and EETS Provider. The Merchant bilaterally enters agreements with the Issuer/Acquirer, who has payment guarantee towards the Merchant, in case the Cardholder fails to pay. Though, the closed payment card system does not feature arbitration in case the Intermediary and Seller fail in agreeing.

Since the closed payment card system has only one Meta Actor Intermediary, one can from a first glance visualise that the closed system resembles EETS more than the open payment card system. Yet, EETS is more similar to the open payment card system than to the closed payment card system. The idea with EETS is that many Intermediaries, that is many EETS

Providers, are present on the market competing against each other in entering contractual relationships with Buyers. In contrast, the closed payment card system has only one Intermediary that both Seller and Buyer have to enter agreements with. From this reasoning, EETS can be viewed as an open system.

Worth noticing is that the first payment card system, the store cards, also can be classified as closed systems. They contained many Sellers linked to the same Intermediary. When the ideas of interoperability took ground, the open systems were developed. Hence, the closed system maybe can be seen as an evolutionary step of system design. This is pretty similar to EETS, with a history of road user charging systems present in Europe today that resemble the closed payment card system. Similarly to the closed payment card system these road user charging systems have only one single Intermediary that is linked to several Sellers and Buyers (EasyGo 2008). Thus, the background of EETS and payment card system interoperability can be seen to resemble each other in these terms.

## Comparing EETS contractual relationships with GSM

#### Caller and Service Provider

The relationship between the Caller and Service Provider resemble the relationship between EETS Service User and the EETS Provider. Just as in the section concerning comparisons with payment card system, both EETS Service User and Caller are the Buyers of respective system and they have only one bilateral contractual relationship with and interacts only through one actor; the Intermediary. In both systems the Buyer signs a contract with the Intermediary agreeing that it is responsible for paying the debts that the use of telephone and roads causes. Also, both systems are similar in the contractual agreements that have few negotiable parameters. The Intermediaries of both systems hands out necessary equipment to the Buyer; the EETS Provider issues OBE and the Service Provider makes sure the Buyer receives a SIM. Although, if the GSM Intermediary is a regular Service Provider it does not issue its own SIMs, instead they make sure the Buyer receives the MNOs SIM. MVNOs on the other hand, issue their own SIMs. Thus the MVNO resembles the EETS Provider more than the Service Provider does. The Intermediaries of both systems have payment guarantee towards the Sellers, which is the reason they perform credit checks before accepting Buyers as their clients.

#### Service Provider and Mobile Network Operator

The contractual relationships between Service Provider and Mobile Network Operator do resemble the agreements between EETS Provider and Toll Charger. Both within EETS and GSM the relationship between Intermediary and Seller can be seen as a reselling one. The regular Service Provider, who in contrast to the MVNO does not have any infrastructure at all, buy bulk calls from the MNO and resells to the Caller. MVNOs on the other hand, can manage their own switches, registers and so on. Yet, they still resell the airtime that is bought from the MVO. The responsibilities between the actors are also similar; just as the EETS Provider has payment guarantee towards the Toll Charger, the same is true for Service Provider, who is liable to pay the MNO no matter the Caller can or not. The contractual agreements between Service Provider and MNOs are made up bilaterally, and the terms and conditions are negotiated bilaterally. However, if the Service Provider and MNO do not agree on a contract there will be no business between the two parties, the Service Provider will

loose the services that the specific MNO could provide and the MNO would loose a customer. This is somewhat different to the EETS. Although, the idea is that EETS Provider and Toll Charger are supposed to agree bilaterally, but if EETS Provider and Toll Charger will not agree, the foundation for EETS is put at risk (every Intermediary has to agree with every Seller in order to achieve interoperability), and an arbitrating body (the Interoperable Manager) will impose an agreement on the parties. Hence, there is no walk away present in EETS, the way it is in GSM. Still, as long as EETS Provider and Toll Charger do agree, the relationship is similar to the relationship between Service Provider and MNO. If they do not agree, there is a difference.

#### Contractual relationships for roaming

The roaming service is the foundation for GSM interoperability and the roaming agreements are a prerequisite for this. In order for a Caller to roam, the MNO needs roaming agreements with other MNOs, enabling use of the other MNO's network capacity. In order to provide good coverage in several countries, an MNO needs many roaming agreements. These roaming agreements are made up bilaterally between MNOs. Furthermore, MVNOs but not regular (Service Providers) enter roaming agreements with MNOs. This is possible since they issue their own SIMs to the Callers. Hence, the subscriber can be identified in the roaming area, making roaming possible. There is no good EETS counterpart to when MNOs enter contracts with other MNOs – Toll Chargers never enter contracts with other Toll Chargers. Instead, the ways EETS Providers enter contracts with Toll Chargers are very similarities to the ways the MVNOs are entering roaming agreements with other MNOs. It is both made between Intermediary and Seller. The "common" roaming agreement, between two MNOs, is a contract between two Sellers.

Since there are several roaming agreements that need to be made, it has lately become popular to enter a contractual agreement with roaming brokers. Through this actor, the MNO gets a bundle of roaming partners, saving time otherwise spent on setting up and maintaining bilateral roaming agreements. There is no counterpart to this kind of bundle agreements in EETS. Yet, it is a very interesting topic from an EETS perspective. A foundation for interoperability in EETS is that the EETS Provider has contractual agreements with all Toll Chargers. Since EETS requires that everybody has to agree with everybody, a future actor equivalent to the GSM roaming broker has potential of serving a purpose. Consider a scenario when all EETS Providers and all Toll Chargers, for some reason, refuse to negotiate bilateral contractual agreements. Logically, the arbitrator, the Interoperability Manager, will then take actions imposing standard agreements between all EETS Providers and Toll Chargers. It is a bit far-fetched, but such a situation can be seen as resembling the roaming broker scenario, since the EETS Provider gets all agreements from one actor, without needing to negotiate the agreements themselves.

#### GSMA and Service Provider and MNOs

GSMA and Interoperability Manager both work as rule-making bodies for respective system and are both classified as the Association. GSMA has strong ties to Network operators, Service Providers, suppliers and manufacturers, constituting the members base of GSMA. GSMA works as a forum, where industry partners as MNOs and Service Providers can meet and discuss setting of common rules, trying to work out interfaces and standards facilitating roaming and billing procedures. The association of EETS, the Interoperability Manager, is so

far only a planned actor and not realised and the responsibility areas for the Interoperability Manager is therefore somewhat uncertain, but it seems for sure that it is going to act as arbitrator and rule-making body. The Interoperability Manager does not have any direct contracts with neither Toll Charger nor EETS Provider, but they do have interaction. Hence the roles of the two actors are pretty similar, both work as standard and decision makers, but there are exceptions. Although, GSMA do not act as an arbitrator, instead it is a discussion forum. Arbitration is not needed from GSMA, mostly since in GSM there is no imposed prerequisite that everyone has to agree with everybody. Instead, the actors of GSM have the option to a walk away solution, just skipping entering a contractual relationship in case two parties disagree.

# Information- and money flows

## Open payment card system compared to EETS

#### Authorisation

In payment card system the authorisation process are performed before the transactions are granted to secure that the Buyer is credible and decrease the Intermediary's risk. In EETS, there is no control that there are sufficient funds on an account linked to the Buyer, before getting permission to use a toll domain's roads. Instead, the Buyer will later be invoiced the liabilities that are produced by driving on toll roads.

On the other hand, the idea of compliance checks, controlling that there is a functioning OBE on board every tax liable vehicle, performed at country borders as well as spot checks along the road, in a way works as a form of authorisation; "before driving the Swedish roads you need a functioning OBE". It also has a similar purpose, guaranteeing a compensation for the service being offered. Still, it is a bit far-fetched to compare it to the electronic authorisation being processed in payment card system.

#### Blacklisting

The blacklisting works similarly in the two systems. The payment card system's blacklisting function is linked to a blacklisting database of the issuing bank and if the card being used is present in it, the authorisation is not granted. The blacklisting of vehicles in EETS is being carried out by both EETS Provider (who is looking for abnormal patterns in the GNSS data registered by the OBE) and Toll Charger (who performs sample tests on the road). Within the payment card system, you cannot pay if the card is black-listed. Likewise you cannot pay road fees if your vehicle is blacklisted. Nevertheless, there is no excludability present in neither system. This principle is illustrated as a Service User who can continue driving the vehicle even though it is blacklisted resembling the option that a Cardholder can take the desired product and leave the store without paying.

#### Clearing

Clearing as it is being processed within the open payment card system is not carried out within EETS. The primary purpose of clearing in open payment card system is to reduce the amount of money flowing between two banks. If for example, at days end, bank A owes Bank B 100 thousand euros and, likewise, Bank B owes Bank A 40 thousand euros, the only

transaction being settled is Bank A crediting Bank B 60 thousand euros. Hence clearing is the term for evening out liabilities before paying. Though, within EETS there are no indirect inter-contractual relationships corresponding to the ones between banks in the payment card system. Every Toll Charger only has contractual relations with EETS Provider, who in turn only have to sign contractual agreements with Toll Chargers. Hence no clearing processes are being performed in EETS. Though, the total liabilities are summed up before billing and invoicing.

However, if the situation were to be as in Figure 3 and Figure 4**,** where Toll Chargers also takes on the activities of issuing OBEs, collecting toll data, billing etc, a clearing function between Toll Chargers would be worth considering. If the there were no Service Provider and the driver of the vehicle instead entered contractual relationships directly with Toll Chargers, these Toll Chargers would end up owing other Toll Chargers money when their client drive in other toll domains. These amounts could then be cleared before the settlement of payments takes place. Yet, the necessity of using clearing at all is a topic for discussion. Today, when transactions are being made electronically (and thus very quickly) there is perhaps no real demand for clearing out the liabilities before settlement.

#### Settlement

There is much similarity regarding settlement between the actors in the two systems. In both systems the Intermediary pays the Seller with any fees and commissions deducted, and then claims the money from the Buyer.

#### Closed payment card system compared to EETS

From an information and money flow point of view, the EETS information and money flows more resemble the closed payment card system than the open payment card system; even though the difference between the open and the closed is small (compare Figure 10 and Figure 11). In the closed payment card system, information is only transferred to and from one Intermediary. Hence, authorisation is quicker than in open payment card systems, with information only being transferred to one actor – then a decision is taken whether to grant the decision or not. There is, just like in EETS, no clearing before the transaction is settled. The settlement is made by the Intermediary who deposits the amount on the Seller's account, with any discounts deducted, and then bills the Buyer. Given this, the information and money flows are very similar; the systems' both Intermediaries act as information collectors registering records of purchases and distance travelled. Otherwise, blacklisting and fraud is dealt with the same way as in open systems with the difference that one single Intermediary carries all risks, just like in EETS.

### GSM compared to EETS

There are both differences and similarities in terms of information and money flows between GSM and EETS. Consider a subscriber making a call to a friend who has the same Mobile Network Operator. The dialled number is recognised in the Home Location Register (HLR) containing information where the subscriber being contacted is located. The call is then routed via the MSC, the BSC and the BTS (see Figure 15) to the friend's Mobile phone and the call is initiated. At the end of the call, a record of it is being produced in the network's MCS, which is being sent to the mobile network's billing system for pricing. Then, at the end of the

month, the subscriber gets invoiced the accumulated sum that these records make up, either through a Service Provider who has payment guarantee towards the Mobile Network Operator, or directly from the MNO. Furthermore, just as the Interoperability Manager is not involved in the information and money flows of EETS, neither is the GSMA involved in corresponding flows in GSM.

This, the least complicated scenario of billing in the mobile communication world, is quite similar to the information flows of EETS; In both systems, the Buyers activity is being registered, a record of the usage is being made, it is sent to another entity where calculation of the liabilities takes place, the Service Provider pays its liabilities to the actor above in the system and then claims the amount from the Buyer. Anyhow, there are a few differences. The majority of the information processing and flow in GSM are made by entities managed by the Seller (the MNO), while it in EETS is performed by the Intermediary (the entities that the EETS Provider is responsible for). It is the Mobile Network Operators that produce the call records, while it is the EETS Provider that mostly is responsible for registering trajectory information and calculation of tax. On the other hand, if the Service Provider is an MVNO, a lot of the technical information flows such as call records etc. all of a sudden are carried out by the Intermediary. Hence, this distinction/similarity towards EETS depends on if it is a regular Service Provider or an MVNO that service the Buyer of GSM.

The concept of inter-connect and roaming agreements make GSM's chains of information and money flow longer than in EETS. In EETS there are only three actors involved (Service User, EETS Provider and Toll Charger), while in GSM up to six different actors can be involved in managing and routing phone calls, producing call records and transferring money between accounts. This is for example the fact when a roaming customer makes a phone call to a mobile phone in another country. For any activity that borrows capacity from the GSM network, records are registered by the network's Mobile Switching Centres (MSCs); call records are generated for each call being made, SMS records are produced for every text message sent etc. This information gathering resembles the route information collected by the EETS Front-End (see Figure 7); both data sets make up the foundation for later information processing and payments. However, in GSM, call records are being made in the network that the call starts from, the networks that the call is routed via and from the network where the call is terminating. Hence, many call records are made for one single call. These records are then forwarded to the billing centre of each network, where call rates and call lengths generate a price for the service provided. The call rates are one of the parameters negotiated and decided in the bilateral agreements generated between network operators. Each network then bills the previous network (as explained in the chapter Information and money flows of GSM) and finally the Caller is billed. In EETS, records of distance travelled are only being documented by the EETS Front-End. Although, if the service is used by a subscriber currently roaming in the network, the call records are converted to a special TAP format and forwarded to the roaming subscriber's home network who takes care of customer billing and reconciliation towards the VPLMN.

#### Blacklisting

The blacklisting works differently in the two systems. Within GSM, a black-listed phone is excludable while a black-listed vehicle is not since it, illegally, can continue driving the toll roads. The GSM blacklisting function is linked to the EIR of the Mobile Network Operator.

When a Caller attempts to use his phone, a check towards the EIR will be made looking if the phone is blacklisted. The blacklisting of vehicles in EETS is being carried out of both EETS Provider (who is looking for abnormal patterns in the GNSS data registered by the OBE) and Toll Charger (who performs spot checks on the roads).

## General system similarities and differences

It is difficult and perhaps even pointless to compare a system's business model to other system's business models, if not knowing the general similarities and differences of the systems. Sometimes the answers or explanations of the business models' differences lie in the system's structure, their history or the incentives. Thus, the structure of the systems, the incentives of the different actors, the driving forces and conditions for introduction of the three systems are to be analysed and compared.

### History and obstacles to overcome

The ideas of GSM have its origins in the interoperability and capacity problems that the contemporary mobile communication systems were facing. The largest obstacle to overcome was the ambiguity that the industry felt for making new investments. This uncertainty slowed down and postponed the realisation of a pan-European mobile communication system. Nevertheless, the initiation of GSM started to gain momentum when the MoU was formed by industry partners during the 1980s, with the incentive to speed up the introduction of GSM. The MoU was formed as an agreement stating that GSM was to be implemented before 1991 and it was a commitment rather than legislation, made with intention promote competition, set standards as well as trigger infrastructural and technological investments.

The thoughts of today's payment card systems originates from the lack of interoperability that the contemporary store cards had, who were only valid as payments in a particular store and/or geographical area. The problems of convincing industry partners to join a network that decided the rules and regulations were substantial. Eventually, the banks saw the potential of it and after a few banks had joined, others could not stand by watching. The competition between rival payment card systems characterised and triggered the development of them.

The thoughts of EETS have its heritage in the EFC-Directive, which in turn stems from the difficulties to develop an interoperable road user charging system in Europe. The problems seem to be that a lot of money is tied to several already existing systems and that no road charging system wants to be the first interoperable. In GSM, the circumstances were similar. The situation was solved through the MoU that contributed to solve the deadlock. Yet, there is a big difference between the MoU and the EFC-directive, especially in terms of what actors being the source of it. The idea of an interoperable payment card system, on the other hand, was so attractive that the competition managed to speed up the development. In both GSM and payment card system there were prospering markets that waited, working as an incentive for industry partners to invest and venture.

### Incentives

There are perhaps also prospering markets waiting for the actors that dare venturing in EETS, also for the not yet existing EETS Providers. Still, there are a few differences. The EETS market is somewhat regulated, with the EFC-Directive both urging for regulation (in terms of

profit ceilings and arbitration) and market competition (that several EETS Providers are to compete for customers). This was prevalent in neither payment card system nor GSM. The EFC-directive implies less self-determination for the actors, since the absence of a walk away, and may mitigate their willingness of venturing in the industry. Also, the fact that EETS in some ways concern taxes makes the situation a bit different from the otherwise commercially driven GSM and payment card system. This implies that taxation policies of several countries have to be taken into account, contribution to postponing or slowing down the introduction. Besides, the idea to launch EETS at once, as a big bang, is also different from the other systems. It may leave venturing actors hesitating, since they do not really know what they are facing. In the case of the payment card system, interoperability gradually started to take shape, but within EETS everybody has to agree with everybody at latest 2012, leaving potential EETS Providers hesitating. In GSM, the MoU was formed as a commitment, where the operators promised to implement GSM networks at latest in 1991. However, this was on the initiative of the operators within the industry while the EFC-directive is on the initiative of the European Commission.

If taking a look at the incentives that the actors were and are facing at the introduction of the systems, some differences are found among them. In both GSM and payment card system, the incentives were fairly obvious for the involved actors. For GSM the MNOs could profit from roaming revenues and reach out to a wider public of Buyers if capacity increased. Callers would benefit from a cheaper mobile telephone that could be functioning in several countries and international calls were made possible. In payment card systems the incentives were also relatively evident. Merchants linked to a global system for payments were likely to miss out on fewer sales due to consumer lacking cash. Banks could offer their Cardholders the convenience of not having to carry cash by a payment card that could be used almost anywhere, making their services more appealing contributing to larger profits.

For Toll Chargers, EETS is an opportunity of simplifying revenue collection. If every vehicle that uses Toll Chargers service is linked to an EETS Provider who has payment guarantee for the vehicle, there is a lot of work that the Toll Charger do not have to do. The Toll charger is therefore probably about to cut in expenses caused by billing and customer contact. On the other hand, the Toll Charger will probably, cut in marginal revenue, since they will not get 100 percent of the fees collected from every vehicle (because the EETS Provider will get some commission for risk compensation). For Toll Chargers, the incentives for EETS is similar to the incentives the MNOs are facing when deciding whether to use a Service Provider or not. On the other hand EETS is not really a choice for the Toll Chargers – instead, EETS can be seen as being imposed upon them. The Toll Chargers that should be included in EETS are mentioned in the EFC-directive, and are hence forced to join.

The EETS Providers on the other hand, are not being forced upon EETS. Since this actor is barely present on the market today, their participation is most voluntary. The EETS Providers join on the same incentives as the GSM Service Provider, both being the Intermediary between the Seller and the Buyer. The EETS Provider is a necessary condition for interoperability as defined in the EFC-Directive. Still, they will need the right economical incentives to venture in the business. The incentives will be the commissions earned (the

percentage of the fees payable that the vehicles produces when using TCs services) and future additional services[12] linked to EETS (Sundberg 2008).

#### Asymmetries in incentives

The incentives for distance based road user systems are not equal for all countries. So called transit countries are probably more prone to invest in setting up these road user charging systems than more peripheral countries. Since a large percentage of the transit countries' vehicles travelling the roads are from overseas, they are to benefit most from these systems. That Germany, Austria, Switzerland and the Czech Republic have already launched distance based road user charging systems is an acknowledgement of this reasoning. With a similar way of thinking, EETS is probably most likely to be beneficial for transit countries. Since EETS is a way of facilitating the payments of distance based road user charging systems, it will in particular benefit the systems that have many foreign vehicles. Likewise, since interoperability is expensive to develop, the peripheral states are probably more willing to set up a simpler system being less expensive, since the benefits from an interoperable are smaller. This is a difference that can cause delays of introduction.

Asymmetries in incentives as in EETS can be seen in GSM and the payment card system as well. For example, it is probably more valuable for a Swedish businessman often travelling to London that his phone working there than in remote places not as frequently or never visited. The same is to some extent true for the payment card system; it is more important that a businessman's payment card is harmonised with the banks in London than place seldom visited. Anyhow, this may not have caused delays of introduction in the same way as in EETS, as these telephone systems could be built out more gradually.

#### Consumer demanded technology

There are also differences in terms of what kinds of demand drive the industries. Both GSM and payment card system are examples of consumer demanded technology systems, simply meaning that the Buyers of the systems are taking advantage of and benefiting from the products developed. Hence, the development of the products is demanded by the customer; mobile phone users find it handy when roaming is an available service and Cardholders find it practical when their card can be used in many different stores instead of not only one chain of stores. In EETS, this cannot be said to be true. Although Service Users do benefit from needing only one OBE in their vehicle's windshield, the Buyer would probably be much happier if they needed no OBE at all, and the service was free of charge. There are of course already toll roads, but when EETS is realised, more toll roads are perhaps to be expected. Therefore, initially EETS cannot be said to be a consumer demanded industry. Also, EETS is an imposed way of internalising the costs of road usage, or method of control, that is demanded from politicians within the European Union.

#### Network externalities

In terms of network externalities there are similarities between the systems. It is sometimes, somewhat negligently said that systems that possess network externalities will expand and be successful. Both GSM and payment card system can be viewed as possessing network

[12] An additional service can for example be new route suggestions. These kinds of additional services are increasing the profits of GSM MNOs, for example the downloading of ring tunes.

externalities. A GSM phone is more prone to be valuable for a Caller, the more people that has a phone. Likewise, a Cardholder benefits more from his payment card the more Merchants that accepts it, and vice versa. Similarly, EETS can be said to possess these network externalities. One can say that for a Buyer, an interoperable OBE (that follows from a contract with an EETS Provider) is prone to be more useful the more Toll Chargers that accept them. Vice versa also applies – the more Buyers carrying an interoperable OBE, the more are the incentives to join EETS. Thus, the more Toll Chargers and Service Users that are linked together, the more do they benefit. Buyers take advantage of easier ways to pay, and Toll Chargers benefit from easier ways to get paid for their services. On the other hand, the Buyers' incentives just being mentioned are probably not valid at an introductions stage; Buyers probably do not want EETS since it is likely to increase the amount of road user charging systems having a negative effect on their economical situation.

#### What service is actually being sold?

There are also system differences in terms of what service is actually being sold. EETS is not similar to GSM where it is the service, to call, that is being sold. In EETS it is not the trip, journey or passage that is being sold, but the right to do the trip or passage. Intuitively, one can say that there is a difference in terms of what the Buyer demands and what service the Seller offers between the systems. In GSM the Caller wants to call, which is the service that is being provided by the MNO. In EETS the Service User wants to drive, but the service offered by the Toll Charger is not to drive, instead it is the right to drive. In this sense, EETS is a bit similar to the payment card system, where the bank is not selling the product you want, but they are selling the right to get the product you want (by providing efficient payment means). Though, it is probably more widespread and rooted that you are not allowed to steal a product without paying, than it is to drive without paying. Therefore, Buyers may initially have problems facing the benefits of EETS and be somewhat reluctant to distance based road user charges, since it is a fairly new phenomenon.

### Extent

The extent of the systems also varies. GSM has for instance around 700 Mobile Network Operators, VISA alone has 40000 member banks linked to their network and there are approximately 400 Toll Chargers subject to EETS. These differences in system size affect the way the actors of the systems have to form contracts, in order to establish interoperability. For example, the very large extent of the open payment card system, with thousands of banks, a million Merchants and a billion Cardholders makes the system a bit different from EETS and GSM. The great extent of the open payment card system contributes to shaping the way the parties enter contracts. It is impossible for the payment card system to be run as GSM, where bilateral agreements between the Sellers are the most common way to establish roaming contracts. It is not feasible for a bank to enter and maintain 40000 bilateral relationships with other banks in order to provide good coverage for their Cardholders' payment cards. Instead, the payment card system has a multilateral contract form, where Intermediaries join a Payment Card Association and through that get access to the other banks.

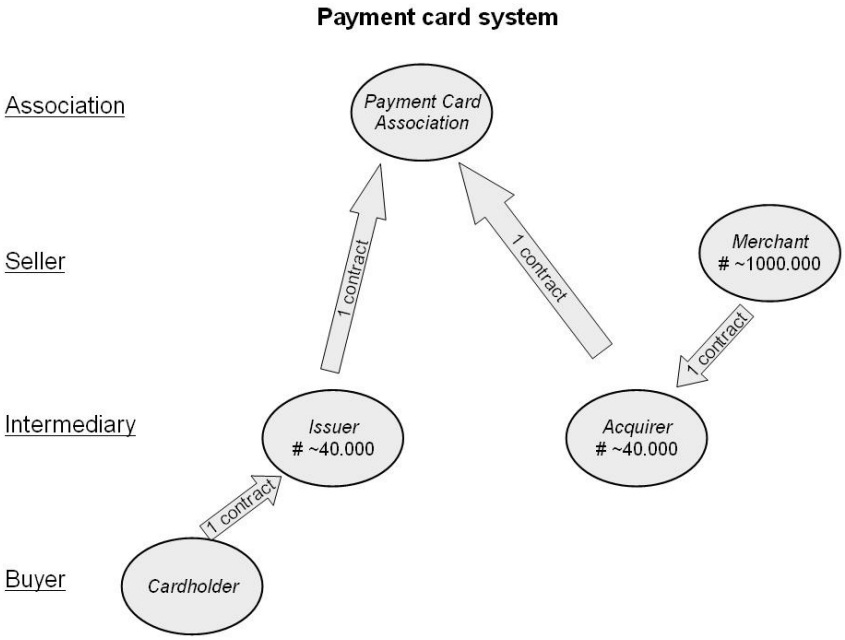


Figure 21 - Actors and contracts in the open payment card system.

In order for a GSM Mobile Network Operator to provide decent coverage, approximately 200 roaming contracts are needed. But as GSM continuous to grow and more Mobile Network Operators are emerging, especially in third world countries, the market experiences a new method of establishing interoperability. This is done through roaming brokers who are entering the GSM market offering interoperability in a similar way as the multilateral contracts in the payment card system, where MNOs get linked to other MNOs through one multilateral agreement. However, worth noticing is that the GSM roaming broker is linking Sellers together while the multilateral agreements present in the payment card system are linking Intermediaries together through the Payment Card Association.

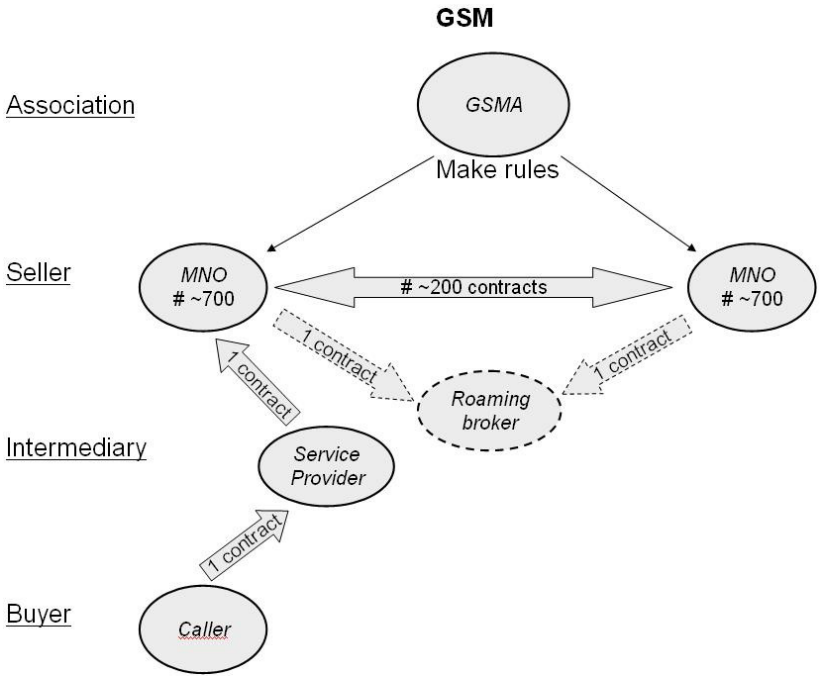


Figure 22 - Actors and contracts in GSM.

As Figure 23 illustrates it is in EETS necessary that each EETS Provider enters 400 bilateral agreements, one for every Toll Charger, in order to accomplish interoperability according to the EFC-directive. If GSM, with approximately 700 MNOs, has managed to set up an interoperable system via bilateral roaming agreements, one can argue that bilateral negotiations should be the method of entering contracts in EETS. Although, one have to keep in mind that for an MNO it is not necessary to enter agreements with all 700 MNOs available, to keep good roaming coverage since some networks overlap in terms of coverage. Hence, the number of roaming agreements entered is being less than 700, rather around 200. Therefore, since the GSM market with approximately the same number of Sellers has found it functional with a roaming broker, maybe an actor corresponding to the roaming broker would be useful in EETS, linking EETS Providers and Toll Chargers together through one multilateral contract. Although, one could argue for that the Interoperability Manager already has this role, when arbitrating in case EETS Providers and Toll Chargers do not agree. If no EETS Provider succeeds in agreeing bilaterally with any Toll Charger, the Interoperability Manager will, as arbitrator, impose a standard contract upon them.

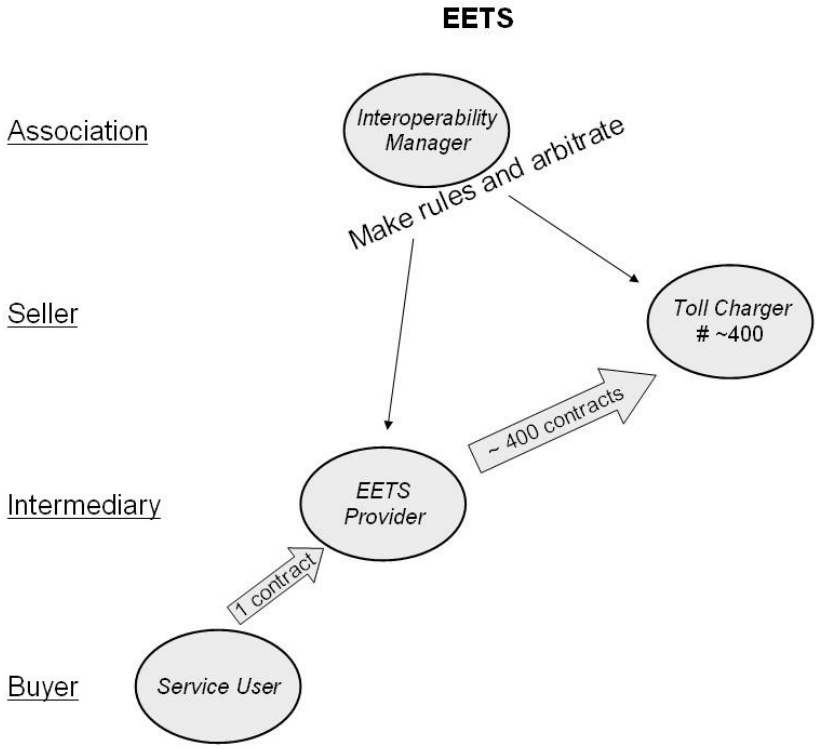


Figure 23 - Actors and contracts in EETS.

**Fraud**

In payment card system it is clearly stated how fraud is to be managed and how losses are to be allocated. These rules are determined by the association in the payment system. The network of banks is so large (over 40000 member banks linked to VISA alone) that it is impossible with a network based on bilateral agreements between the banks. Instead they are linked to an association by multilateral contracts. The reason why GSMA do not have any similar rules when it comes to fraud in GSM probably depends on a two factors. Firstly, GSMA is not the rule making body or link between network operators, to the same extent as

the association is in the payment card systems. Instead, MNOs negotiate their contracts bilaterally, and loss allocation rules due to fraud are included in them. Secondly, GSM is not as prone to fraud as payment card system is. Of course phones are stolen, but so far it is the Buyer that pays for the calls made by the thief. However, if a roaming broker is used, this actor has already determined the conditions of responsibility areas in terms of who is paying in case a phone is stolen and used. EETS is probably more similar to GSM in this case. At the moment there are around 400 Toll Chargers subject to EETS, around the same approximate size as GSM's 700 MNOs. In EETS fraud is to be managed by the local Toll Charger in cooperation with the EETS Provider and fraud responsibility areas are to be negotiated bilaterally, just as in GSM. Anyhow, there are already a few rules being proposed by CESARE III, stating who bears the risk in different fraudulent scenarios (see chapter Contractual relationships within EETS). Generally, the EETS Provider is responsible for its client, with payment guarantee towards Toll Charger applying here as well.

# Conclusion

Since the systems for payment cards and GSM work as role models for EETS and the EFC industry, the aim of this paper has been to compare EETS against the payment card system and GSM. The study has showed both differences and similarities between the systems' business models. In some cases, it has been possible to understand these differences by studying how EETS differs to GSM and payment card system in terms of their structure, incentives, what service is being sold, network externalities and history. This final conclusive chapter is supposed to summarize the comparisons, explain why some differences exist and recommend what can be done in order to facilitate the launch of EETS.

Information and money flows are a bit different between the three systems. In GSM and payment card system, a clearing between MNOs and banks are prevalent, while in EETS, there is no real demand for that, first and foremost because of contractual and structural differences. Furthermore, the disparities in terms of what service is in fact being sold, affects the role of authorisation of the systems. In GSM it is the service, to call, that is actually being sold. Hence the authorisation in GSM can exclude a Caller from using the network capacity. This is in contrast to EETS and payment card system; the Issuer is not selling the product you want but the right to get the product you want by offering efficient payment means. Neither is the EETS Provider selling a journey or a passage, but the right to do it. The authorisations in these systems can exclude the Buyer from consuming the services, only from legally obtaining it. The settlements of the payments are similar in the three systems. It is based on reselling, where the Intermediary reimburses the Seller and then claims payments from the Buyer.

Also, GSM is different to EETS in terms of that the chains of information flow are longer than in EETS and payment card system. This is in particular true for GSM inter-connect and roaming calls, where each network generates call records that are to be sent further. This is because GSM differs in structure to EETS and payment card system. The payment card system is distinguished in the sense that the association is active in the systems' information and money flows, working as an actor carrying out information processing.

The way contractual relationships are to be entered in EETS is fairly similar to how agreements are entered in both GSM and payment card system. The Buyers enter bilateral contractual relationships with the Intermediary who manages billing and customer contact. In EETS and payment card system, the Intermediary issues the necessary equipment (OBE and payment card). This can be the same in GSM, depending on if it is an MVNO or a regular Service Provider that the Caller has a contract with. The Intermediaries' payment guarantee towards the Seller is present in all systems and in both GSM and payment card systems, the contractual agreements are negotiated bilaterally between the concerned parties, (with exception for the multilateral agreement between the Intermediaries and the Payment Card Association as well as MNOs' agreements with roaming brokers). In EETS, this model based on bilateral relationships is suggested and strived for, but in case the negotiating parties fails to agree, arbitration from the Interoperability Manager will solve the dispute.

A walk-away solution is being suggested within the ARENA Project which implies that there will be no arbitration if EETS Provider and Toll Charger disagree and hence no contract

between the parties involved. Yet, this undermines the European Service since it, as it is defined, is not being accomplished; it is not possible to drive in all toll domains and get one invoice if the EETS Provider does not have contracts with all Toll Chargers. The presence of walk away, or absence of arbitration, is implicitly a fact in both GSM and payment card system. These two systems contractual agreements depend entirely on that the Intermediaries and Sellers negotiate on terms and conditions bilaterally and there is no organisational body imposing a contract upon them in case they do not agree. In EETS this is different, which has its explanation in EETS's heritage as an imposed service demanded by a central authority. As EETS is defined in the EFC-directive, all Intermediaries have to agree with all Sellers; a walk away therefore affects many actors as shown in the chapter Contractual relationships within EETS. Given this definition, arbitration is a necessity. GSM and payment card system were not imposed by an outside organisation, instead the incentives for the development of these systems came from within the industry, while in EETS it is not. This difference can depend on that EETS, in contrast to GSM and payment card system, is not based on consumer demanded technology.

Other similarities are found in the systems' early development in terms of evolutionary steps of the system design. In both GSM and EETS, the history of system structure is somewhat similar where both the Intermediary and the Seller used to be one merged actor. In early GSM, the MNO handled all billing and consumer contact and the detached Service Provider actor were not invented. Today it is more prevalent with a detached Service Provider, even though the set-up with a merged Service Provider and MNO still exist. Likewise, the early road user charging systems had and still have the same architecture, with the Toll Charger managing billing, issuing OBEs etc. Yet, the reason of the systems' evolution differs; In EETS the split of Intermediary and Seller is a necessity for accomplishing interoperability, while in GSM the rationale is probably business ideas based on outsourcing and focusing on a company's core competencies. There are also similarities of evolutionary stadiums in system design between EETS and the payment card system. In Europe there are currently road user charging systems that resemble the closed payment card system, in the sense that they only have one single Intermediary actor managing the operations. These road user charging systems are characterised by having only one single TSP that have contracts with several different Toll Chargers, enabling interoperability in smaller regions, for example the EasyGo system (EasyGo 2008). Thus, the same way that the open payment card system can be seen as having evolved from closed payment card system and expanding interoperability, EETS can be classified as the next evolutionary stadium within road user charging.

The foundations for interoperability are fairly similar in all three systems. GSM interoperability from the Buyer's point of view is based on that the Mobile Network Operator (or MVNO) is having bilateral roaming agreements with many other operators or one multilateral contract with a roaming broker. In payment card system it is dependent on that the card issued is accepted, through Intermediaries linked to a Payment Card Association, at many Merchants. In EETS the interoperability is based on that the EETS Provider has contracts with all Toll Chargers. Since all EETS Providers need contractual relationships with all Toll Chargers, the GSM actor roaming broker is an interesting actor for EETS. Just as the Association in the payment card system links banks (Intermediaries) together through multilateral contracts, the roaming broker links MNOs (Sellers) together. This means that instead of each bank needing to agree with all banks to accomplish interoperability; they only

enter one contractual relationship. The same goes for MNOs; instead of entering several roaming agreements with hundreds of other MNOs to provide good coverage, it only has to enter one agreement. Since the foundation of EETS is that all Intermediaries agree with all Sellers, this way of creating contracts is very exciting from an EETS viewpoint and a similar function could be needed. Maybe in the future, EETS will face an actor doing just this – offering EETS through one multilateral contract that links all Intermediaries to all Sellers. In the open payment card systems this function is managed by the Association and in GSM it is a commercial actor handling it. In EETS it is difficult to tell what kind of an actor that could take on activities like these. It is possible that a commercial actor will take on this activity in the future, but it may also be provided by the Interoperability manager. However, this is a bit what the Interoperability Manager is doing when, in case EETS Providers and Toll Chargers fail to agree, solving disputes through arbitrating.

Another interesting difference between the systems is that the open payment card system has two Intermediaries in contrast to EETS and GSM only having one. The reason for the two Intermediaries is the great extent of it, with over one million sellers. Presently, there are within the member states of the European Union approximately 400 Toll Chargers subject to EETS. Though, EETS is a system that easily could expand by merely linking other service to it. If for example parking houses, car ferries and other businesses also collecting payments from vehicles decided to join the system, the number of Toll Chargers could easily exceed several thousands. The complexity of such a large system would increase, which could cause a demand for a second Intermediary. This is since the EETS Providers may face more challenges coordinating such a network. This would of course demand some kind of coordination, something that could be managed by the Interoperability Manager.

## Issues to be solved

Mutual for all three systems is that they all experienced some difficulties in the introduction phase. Common for interoperable systems is that nobody wants to be the first entering it. In GSM the MoU was fundamental in solving the deadlock while the payment card system started facing rapid growth once some banks joined. Still, once the three systems are introduced, they all possess network externalities. Nevertheless, the question remains; how shall this catch 22 in EETS be overcome. At the moment one of the biggest issues to solve is how to attract EETS Providers to the industry. At the moment it seems that the thresholds are too high with the EFC-directive leaving EETS Providers too little self-determination in regards to entering contractual relationships, since all Intermediaries have to agree with all Sellers. As it is now, EETS Providers have to enter unprofitable contractual relationships with all Toll Chargers, even the ones where their potential customer rarely will travel. Perhaps it is time for the European Commission to use the carrot rather than the whip, providing some motivations for EETS Providers to enter agreements with such Toll Chargers. For example, a classification of Toll Domains into profitable and unprofitable ones could be made, assumed from the EETS Provider's perspective. Then, economical incentives as interoperability bonuses could be provided to enter contracts with unprofitable Toll Chargers, for instance in terms of tax relieves. Perhaps economical incentives, similar to the one described above, together with standardisation of interfaces driven by the Interoperability Manager, as GSMA did in the GSM case, could help solve the deadlock.

In terms of new actors entering markets, the EETS Provider can be seen as having several similarities with the MVNO, which it resembles more than the regular Service Provider. This is since the EETS Provider, just as the MVNO, manages not only administrative but also technical information flows as well as entering contracts with Sellers and issuing necessary equipments to Buyers (OBE and SIM). So far, the MVNO does not have any regular Service Provider beneath them in the hierarchy managing strictly administrative information flows, just as the EETS does not. Anyhow, in the future it is not impossible that a relationship like this will occur on same incentives as the split between MVO and Service Provider. However, another historical point of interest is that many MVNOs have their heritage in companies that have had earlier business projects running, from where they got their initial customer base. Thus, if a suggestion of a potential EETS Provider is to be come up with, it is not far fetched to think that a future EETS Provider is a company or organisation that already has contacts with potential Buyers of EETS. Therefore, an example of a potential EETS Provider could be a petrol company, since they already issue payment and bonus cards for their loyal customers. It could also be viewed the other way around; EETS could for an EETS Provider be an opportunity of affiliating certain customers that later on could be targeted for other services provided by the EETS Provider. For example, many banks today issue cards to cardholders with the ambitions and expectations of later on being able to sell them investments funds. Not only the commissions from interchange fees and merchant discounts drive banks to issuing cards, there are other benefits as well. Similarly, a future EETS Provider could profit from other additional services provided to the Service Users, for instance selling travel route information also comprising expected time of arrival. Therefore, a future EETS Provider could be a company that is developing services based on GNSS technologies, that they hope to be able to sell to a wider EETS Service User customer base.

## Further studies

This study has revealed similarities and differences between EETS and GSM as well as the payment card system, both on business model as well as on general system level. Though, there are still questions to be answered and since EETS is not introduced yet, there is still time for changes in the design of business model issues. For instance, in order to get a foundation for how to determine the EETS Providers' commissions, an interesting topic of study would be an evaluation of the risks carried by the EETS Provider, when guaranteeing payments to the Toll Charger. Comparisons could once again be performed towards GSM and payment card system focusing on the risks that the Intermediaries bear and what they get paid in percentage on sales to compensate for that risk. Such a study could take into account the assumptions of what economic risk that each system's Intermediary carries and compare the findings to the economic risk that the EETS Provider is exposed for. Furthermore, a comparative study between EETS and other systems with similar history of both free market powers and regulation could show to be very exciting, with interesting focal points as how to launch a commercial service by legislation.

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# Appendix

## Abbreviations and expressions

**CN:** Cellular Network technologies, such as GSM, GPRS or UMTS (3G).

**DSRC:** Dedicated Short Range Communications is a protocol for transferring information between two devices. In road pricing it is used to detect vehicles passing under gateways.

**EETS:** European Electronic Toll Service, or just the European Service, meaning that one should only need one OBE and with that be able to collect toll in all Europe's toll domain and get the tax claims on one single invoice. EETS and European Service will be used synonymously in the paper.

**EFC:** Acronym for Electronic Fee Collection, used within road user charging systems.

**EP:** EETS Provider

**European Service:** See EETS

**Galileo**: The European satellite positioning system.

**GNSS:** Global Navigation Satellite System is a mutual name for positioning technologies such as GPS, Galileo and GLONASS.

**Interoperability** is referred to the ability of diverse systems to work together (interoperate). In EETS, the term means that one should be able to drive in any of Europe's toll domains and being charged for the services, using one single OBE inside the vehicle and getting all fees on one invoice.

**Kilometre tax:** Distance based road user charging system.

**MNO:** Mobile Network Operator, the actor within the telephone industry that owns the network that facilitate communication.

**MVNO:** Mobile Virtual Network Operator, an Intermediary issuing SIMs and sometimes owning part of it own infrastructure.

**OBE**: The On Board Equipment is a piece of equipment that is placed in the vehicle and takes up information about the driven distance, either via GPS technology or DSCR or both. The information usually includes coordinates and a time stamp indication where and at what time a vehicle has been. The OBE also transmits the information to a receiver using the GSM network.

**Roaming subscriber:** A GSM customer that uses its mobile phone from another network than its home mobile network.

**TSP:** Toll Service Provider, an actor who is responsible for issuing OBEs, billing and customer contact. An EETS Provider is a type of TSP, with some additional criteria.

**Walk Away:** The ability to refuse entering a contractual agreement with another party.

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