Master Thesis in Informatics

Nomadic Computing

Towards Secure Cargo Transports

Jesper Bonander & Mikael Wang

Göteborg, Sweden 2004

IT University of Göteborg

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REPORT NO. 2004:53

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SUMMARY

Cargo crimes, most of it taking place in the supply chain between production and delivery, is today a major problem for the global transport industry. Today, the security around physical plants such as manufacturer plants, distribution centres, warehouses, etc., has been so well improved that cargo crimes within those plants have been very difficult to conduct. This circumstance has made that cargo thieves now have started to concentrate on cargo transports in transit to conduct their criminal activities.

Our research objective has been to investigate in how Nomadic Computing can support and increase the security of cargo transports in transit. We have defined nomadic computing as the ability to perform computing services from anywhere, anytime, and with an unlimited number of different mobile devices.

Furthermore, we have in cooperation with Schenker started to realize their vision of a mobility platform. Schenker's goal with the platform is to provide more customer business value and strengthen their competitiveness. As an initial step towards this platform, has a system for trailer tracking been designed and developed. This system was aimed to increase the security level around trailers in transit. We have therefore performed an action case study in order to support Schenker with knowledge and practical work.

Our work has resulted into a conceptual architecture of the mobility platform with a strong focus in security services. We discovered that these services can generate benefits for security as well as increased productivity in the supply chain. We have also concluded that nomadic computing have the possibility to make significant improvements to the transportation process.

The report is written in English.

Keywords: Nomadic Computing, Mobile Services, Supply Chain Management, Logistics, Security.

Acknowledgement

We would like to thank all people that have helped us during this thesis work. Especially, we will express our thanks to our supervisors Steen König at Schenker AG and Rikard Lindgren at Viktoria Institute for their support and engagement. Moreover, we send our gratitude to all people at the department of Customer & Business Solutions at Schenker AG for making our time there very enjoyable and fulfilling.

Gothenburg June 4, 2004

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1 Introduction

In this section we introduce the topic of the thesis. This section begins with a brief background to the topic, followed by the scope of this thesis, purpose and the problem statement. The section ends with delimitation of the thesis.

1.1 Background

The world of logistics is facing great changes. The network between suppliers, distributors, haulers, customers etc. are growing more complex as each day passes and new emerging technologies are standing in the doorway, eager to offer new exciting and groundbreaking possibilities to the industry. These new technologies have potential to reshape this industry all together and could make significant improvements in all areas of the logistic world (O'Driscoll & Shankar, 2002).

Supply Chain Management (SCM) is about the coordination of logistics processes between different facilities, both within a firm as well as encompassing more than one firm. From a historical view the supply chain has been a set of linear, individualized processes that linked all involved parties together. Communication between collaborating companies was carried through manually by paper forms or by telephone conversation. This course of action for communicating and information exchange was time consuming and created often misunderstandings that slowed down the physical flow of goods within a supply chain. The industry is naturally welcoming more automated processes by taking advantage of the information technology (Mayer, 2001).

Recent and past research regarding SCM has focused primary on productivity and efficiency across the whole supply chain. Previously, all involved parties in a supply chain had concentrated on to make their own internal processes more effective. Today, many SCM research papers (Fink, 2004; Yan & Woo, 2004 and others) have illuminated the importance of supply chain integration. This means that all involved parties within a supply chain must cooperate to achieve as high productivity and efficiency as possible. Smeltzer (2001) claims that the battle for market supremacy will not be between enterprises but between supply chains.

One way to integrate companies together is to utilize different B2B solutions where collaborating companies exchange information electronically. This has made it possible to improve the quality and speed of data exchange, which in the long run will give a more effective supply chain (Smeltzer, 2001). The introduction of Information Technology (IT) has made supply chain integration to a reality and researchers claims that IT is the key to supply chain success.

Wireless networks and technologies are today in vogue. A wireless network can improve supply chain efficiency and productivity by providing real-time information about assets, equipment, and people within the supply chain. Wireless technology has now made it possible to exchange real-time information from any mobile unit in the field from everywhere in the world. Moreover, this technology has the capability to address another important challenge in this industry – increase the security of the physical flow during road transportation (O'Driscoll & Shankar, 2002; Bowman, 2003; Reese, 2003).

Cargo crimes, most of it taking place in the supply chain between production and delivery, is today a major problem for European transport industry and cost the European economy billions of euros per year (European Commission [EC], 2003). Today has the security around the physical plants such as manufacturer plants, distribution centres, warehouses, etc., become so well improved that cargo crimes within those plants have been very difficult to conduct. This circumstance has made that cargo thieves now have started to concentrate on cargo transports in transit to conduct their criminal activities. To counteract these kinds of crimes, the logistics industry has begun to investigate in various *telematics* solutions to increase the security level of the physical flow during road transports.

Rapid development in telematics, which is the combination of information and telecommunication technology, has made it possible to access, manipulate, and share information from mobile units that are on the move. This will create an increased visibility over your mobile units and an opportunity to monitor and control them in a more effective manner by integrating them into your other, stationary located, logistics information systems. In this way transport and logistics companies have the possibility to offer their customers real-time information directly from vehicles regarding their transports status. This kind of computing services has created an enhanced information environment – a *nomadic information environment*.

The nomadic information environment will differ from traditionally information environments in many ways. The most remarkable is the flexibility and the independence of environment; in a traditionally information environment you have been forced to come to a specific place, such as a desk with a stationary PC, to perform your computing services. In a nomadic information environment you can perform your computing services from anywhere, anytime, and with an unlimited number of different mobile devices. This will lead to new challenges to create, integrate, and maintain heterogeneous, geographically distributed computing resources in the fixed already existing infrastructure. But when overcome these critical challenges nomadic computing services will raise unprecedented concerns with regards to security, surveillance, monitoring, privacy, and new time regimes of work (Kleinrock, 1996; La Porta, Sabnani & Gitlin (1996); Lyytinen & Yoo, 2002).

We will in this report investigate in how nomadic computing could support and increase the security level of cargo transports in transit. We see several possibilities to increase the security with nomadic computing services and the most important is an increased visibility of your mobile units (nomads), in our case the vehicles or more correctly the trailers. Utilizing nomadic computing make it possible to monitor and control your trailers from a remotely transport management central and the ability to exchange real-time information with your vehicles. This makes it possible to react more quickly when a deviation occurs in the transportation process,which could be a potential criminal activity, and if so take measures for avoiding crimes.

Moreover, we have found a lack in research in the logistics sector – the transportation part. Research has mostly targeted streamlining and optimization of processes within physical plants. But transportation is a critical part in todays complex supply chains and needs our attention. We must, as de Palacio (2001) argues, avoid that transportation becomes the weakest link in the chain, and threatens the efficiency of conception, production, and distribution of our products. We will therefore contribute to this research field by focusing our work in road transport security in conjunction with nomadic computing.

1.2 Schenker Mobility

As many other companies within the transport and logistics industry, Schenker has realized that mobile and wireless technology will be a powerful tool to utilize for receiving real-time information from mobile units. This and the fact that customers require more visibility and control over their cargo transports, which are a vital part of customers total supply chain, have made that Schenker have begun to draft upon a mobility platform to fulfil customer requirements and increase their competitiveness against competitors.

Schenker have started to plan their mobility platform and have decided to realize it in small stages. There is a customer that requires a high security level over their cargo transports, due to their valuable and theft attractive goods. Therefore, Schenker with this customer as sponsor has started to implement services that will have a main focus on security. Moreover, this customer requires tracking of solely the trailer and not the whole vehicle. This creates some critical difficulties that we must overcome before we can build a satisfactory solution. This case will work as an initial step for the Schenker mobility concept and lay the foundation for the upcoming mobility platform. Another goal is to integrate the mobility platform into Schenker's current system environment and enable easy exchange of information with other information systems.

We have been involved throughout our work in the process to plan and realize Schenker's mobility platform. Our task has been to actively contribute and assist with our knowledge in mobile and wireless technologies, and provided information supported for decision making. This work has been very instructive and given us new interesting knowledge within this area.

1.2.1 Trailer Tracking

Vehicle tracking is possible by mounting a telematics computer that will include a communication unit and a positioning unit on the vehicle. This device make it possible to monitor and control the vehicle from a remotely place. Today there exist a lot of systems for vehicle tracking on the market but in our case one special circumstance have being prevailed, namely the ability to track solely the trailer. This means that the trailer is in focus and always must be possible to track. In today's solutions there has been a focus on positioning the whole vehicle, which means the tractor and the trailer. In these cases the devices, mentioned as black box throughout this report, have been in-cabin mounted in the tractor and you will be able to track the complete vehicle, i.e. tractor and trailer. We have during our work benchmarked the market for solutions including trailer tracking but it has showed that there is a lack of solutions for this purpose. Many of the companies we talked to say that many ask for this solution but they do not have any solution for this yet. They told us that they were drafting on a solution but there were some difficulties that must be solved before they could offer a stable and reliable solution. Problems they mentioned were for example problem with power supply to the black box mounted on the trailer when disconnected from the tractor.

1.3 Scope

Our research objective has been to investigate how nomadic computing could be utilized to increase the security of cargo transports in transit. Further, we have concentrated on to find a solution for solely tracking the trailer and not the whole vehicle (truck and trailer).

Our work has also been to design and analyze the Schenker mobility platform. We have investigated in various sections of this platform and how these can be utilized to increase security and productivity of a supply chain.

We have also performed a thorough review of the latest mobile and wireless technologies in order to get a comprehensive knowledge of this domain and how to utilize these technologies, and the services to its maximal extent, today and in the nearby future.

1.4 Purpose

We will in this thesis investigate how nomadic computing could support and increase the security level of cargo transports in transit.

Further, we will in cooperation with Schenker find a solution for trailer tracking.

1.5 Problem Statement

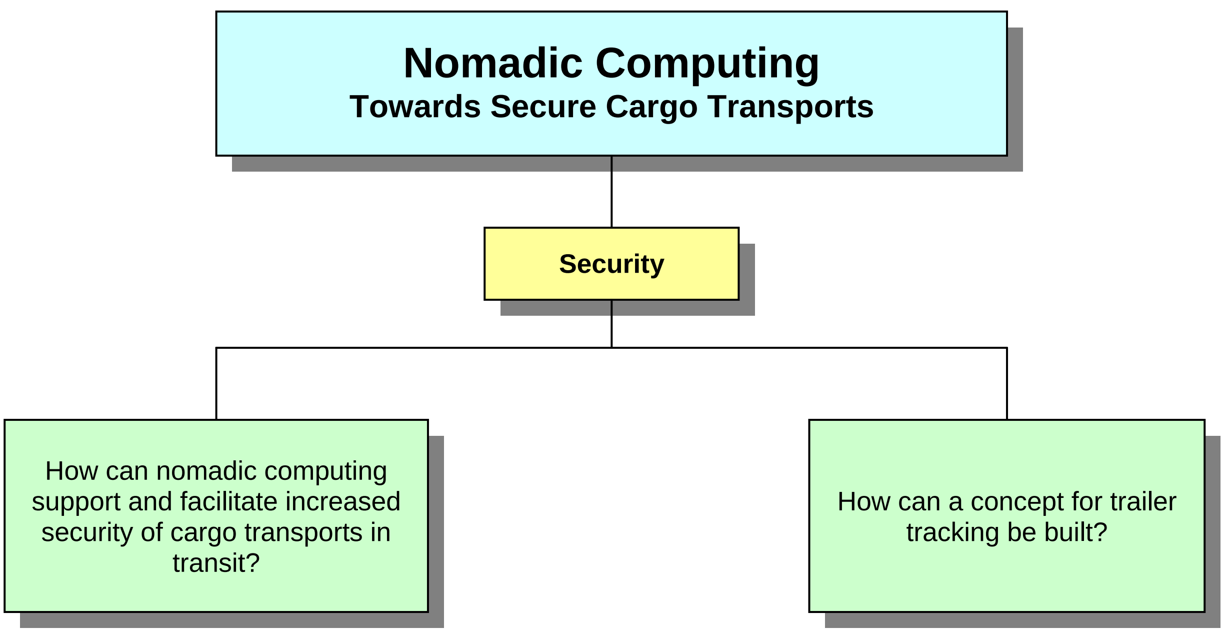

Fig. 1.1 This reports problem statements.

Our research objective has been to examine how Nomadic Computing can support an increased security of cargo transports in transit. We will define nomadic computing as performing computing services from anywhere, anytime, and with an unlimited number of different mobile devices. Further, we have in cooperation with Schenker investigated in how a solution for trailer tracking should be designed and constructed.

1.6 Delimitation

Our title; *Nomadic computing – Towards Secure Cargo Transports*, will hint that our work is to investigate in how nomadic computing could support and increase the security of all transportation modes. We will, however, elucidate that we only deal with road transportation in this work.

2 Theoretical Background

This section aims to give an introduction to the field of supply chain management and the research that has been conducted within this area. Our own field of research will also be explained and motivated later in this chapter.

2.1 Supply Chain Management

Supply Chain Management (SCM) is the planning and execution of supply chain activities, ensuring a coordinated flow within the enterprise and among integrated companies. These activities include the sourcing of raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels and, ultimately, delivery to the customer. The primary objectives of SCM are to reduce supply costs, improve product margins, increase manufacturing throughput, and improve return on investment (Gormly, 2002).

Robinson (2002) argues that to fully understand the term "Supply Chain Management" it is necessary to break the phrase down:

Supply -	Providing goods, services and knowledge
Chain -	Across several entities that are linked; encompassing the cliché that the chain is only as strong as it's weakest link.
Management -	"Management" is a verb – a doing word. This infers pro-activity.

Further, Robinson defines the SCM as:

> "*The proactive act of improving the efficiency and effectiveness of the flow of goods, services and knowledge across all stakeholders within a particular distribution channel with the goal of reducing total cost and obtaining a competitive for all parties*".

From a historical view the supply chain was a set of linear, individualized processes that linked manufacturers, warehouses, wholesalers, retailers and consumers together. Communication between collaborating companies was carried through manually by paper forms or by telephone conversation man-to-man. This course of action (procedure) for communicating and information exchange is time-consuming and creates often misunderstandings that will slow down the physical flow of goods within a supply chain (Mayer, 2001).

Before 1990s, very little was said about the impact of efficient and effective supply chains. However, this has changed; by the late 1990s the competitive importance of supply chain integration was well recognized. As businesses enter the 2000s, the importance of supply chain integration is well recognized. One way to integrate companies together is to utilize different B2B solutions where collaborating companies exchange information. This manner have made it possible to improve the quality and speed of data exchange, which in the long run will give a more effective supply chain (Smeltzer, 2001). There is a well-known expression that appears in many SCM research papers today that will illuminate the importance of an effective supply chain, that is: "The battle for market supremacy will not be between enterprises but between supply chains" (Smeltzer, 2001; Aronsson, Ekdahl & Oskarsson, 2003; Mattsson, 2002; and others).

2.1.1 Past and current research

The past research in supply chain management has almost exclusively been conducted in the fields of efficiency and optimization. This is however not surprisingly since the definition of supply chain management speaks of efficient integration of suppliers, manufacturers, warehouses, wholesalers, retailers, consumers, etc. The supply chain of today has become very complex and dynamic in terms of more actors, more optimization, more goods and not least more global. These factors have made it almost impossible to handle all the coordination manually. The penetration of Information Technology in supply chain management has generated a range of different research areas where different researchers tries to apply modern technologies into the supply chain.

> "*Information Technology is a prerequisite for successful Supply Chain Management) today and will become even more so in the near future*." (Sebastian &Voβ, 2004)

The statement above is not exaggerated and is a common understanding shared by majority of the people in the industry. The terms e-Logistics, e-Commerce, anything with "e" are frequent words that are often popped up in discussions. They are of course referring to different kinds of IT-based solutions aimed to improve efficiency.

We see that the research moves towards more automated processes (Fink, 2004) and more intelligent decision support systems (Sebastian & Voβ, 2004). It was after all with the introduction of Electronic Data Interchange (EDI) between corporations that the supply chain efficiency began to improve tremendously. The birth of computerized transmissions (information exchange) made the old manual paper handling obsolete and prepared the way for even more IT-supported systems. The power of Internet has also begun to be realized and utilized by people in the supply chain management. It is now where true global connectivity is a reality and has the power to improve the supply chain efficiency even further. Yan and Woo (2004) have for instance examined the Information sharing strategies (ISS) in a supply chain with dynamic consumer demand pattern. According to Yan & Woo (2004) has ISS long been a suggested solution to problems in the SCM such as bullwhip effect. This is one of the most well known problem and refers to the amplification of demand variability resulted from the information distortion in a supply chain. Simply put, companies upstreams in the chain do not have information on the actual consumer demand. The effect of bullwhip includes: large inventory costs, large safety stock, and inefficient resource use. Their work shows that by utilizing different ISS according to changes in demand pattern can improve the supply chain performance. As the IT enables the information to be shared among supply chain partners, it is important to structure all the information and distribute right information, to right partner, at right time flowing both upstream and downstream in the supply chain. Good ISS is a vital part of efficient supply chain management.

There have been huge increases in electronic information exchange with the introduction of EDI in SCM. Electronic information sends and receives almost instantly and is easily stored for further analysis. The Internet has been a perfect platform to share and communicate information between business associates and other involved parties. When operating in a global arena as we are today, will standardization of systems and transmissions play a very important part in an optimal SCM. A unified format where the entire world has agreed to follow will eliminate errors in interpretations and conversions. An example of such standard in the world of Internet is eXtensible Markup Language[1] (XML), designed to describe data with plain text. XML is not only useful to structure and store data and information but can also be utilized in Supply Chain Process Management (SCPM). Design and control of production, logistics and information processes on an operational level is the practical execution of SCPM. The latest research conducted by von Mevious and Pibernik (2004) shows an innovative way in process modelling based on new type of high-level object representation, so-called XML-nets. They claim several advantages with their approach and promises better simulation, better workflows and simpler connectivity and exchange of data with different transactions systems, both intra- and inter-organizational, simply due to the XML integration. Standardization is a necessary condition to a successful global co-operation where everybody has the possibility to know the exact "rules"; this will hopefully eliminate any ambiguity among the parties and maximize the efficiency in the supply chain.

Another vital efficiency and profit factor in SCM have Smeltzer (2001), professor in supply chain management at Arizona State University, identified in his report "The Five Immutable Laws of Universal Supply Chain Connectivity". He claims that the major impact in savings doesn't lies in large enterprises with well-developed SCM systems and full electronic connectivity between each other. The key is also to incorporate all the small and medium sized enterprises (SMEs) into the supply chain electronically. According to Smeltzer, up to 80 percent of the supply chain members are small and medium sized enterprises in most supply chains. The problem lies in that the SMEs don't have the resources (economical, software, hardware, technical staff, etc.) and/or the ability to convert to EDI systems like the large enterprises. Another factor is that SMEs is simply different from large enterprises and must be approached different to become integrated in the supply chain. Further, Smeltzer propose a solution where large enterprise could outsource a supply chain integration service to the SMEs. He has made clear that there will not be a total efficiency and effectiveness unless the SMEs are fully integrated and connected within the supply chain.

2.2 The wireless supply chain

The next big hype in supply chain management is the integration of the wireless supply chain. Wireless supply chain includes mobile technology in conjunction with wireless devices to support and optimize the various parts of a supply chain. Tony O'Driscoll, executive consultant with IBM Global Services' e-Business Strategy and Design Consulting Practice, is very optimistic in this area and states as follow:

> "*Wireless devices and mobile business solutions have the power to make significant changes in supply chain management.*"

[1] http://www.w3.org/XML/

These new technologies will allow the supply chain to instantly sense requirements, problem, or changes throughout the network and react faster to disturbances and adapt to it accordingly. As result, provide real-time information that will enable faster decision-making and better communication among the involved parties in the supply chain. With help of mobile services will a supply chain transform from a reactive linear process to a more proactive, wireless supply web (O'Driscoll & Shankar, 2002). Wireless networks can link together all the elements and entities of the supply chain, such as peoples, vehicles, processes etc. The different elements and assets in the network can then be tracked and monitored as they move through the supply web. There are three unique properties of the mobile network that can make the supply chain more efficient:

- Visibility and Presence
- Immediacy
- Location

Tags, sensors, positioning devices enable full visibility throughout the network and can signal and communicate the presence of people, parts and processes in the supply chain. The wireless technology allows mobile devices to respond instantly to request of information and status whenever it is needed in the supply chain. Any user can get exact location of any object throughout the supply network and thus allow proactive measures if needed. Our confidence regarding how mobile technology can greatly improve supply chain efficiencies productivity, is obviously also shared by Shankar and O'Discoll. It is in the pivot processes in the supply chain that should be targeted for maximum results. Pivot processes are those processes in the supply chain where improvements can enhance the efficiency of the entire supply chain. Furthermore, reduce the costs and/or increase customer value greatly. Some example of key pivot activities where wireless technology can have a significant impact is:

- Materials handling
- Inventory handling and tracking
- Customer information management
- Asset tracking
- Warehousing
- Transport security

All these activities have more or less focus on efficiency, except the one regarding transport security. This particular pivot process is, as we feel, underrated but has great potential to make very significant improvements of the entire supply chain. Increased security in cargo transportation will most certainly benefit all actors within the supply chain. It has for long time been a troublesome and inefficient procedure to secure valuable cargo in transit, e.g. the lead vehicle is escorted by one or more vehicles. The advancement of current technological progress has now made it possible to implement intelligent systems in mobile units, such as a truck or trailer. These devices will open up a whole new world of smart services and business values. The domain of *Nomadic Computing* will, as we believe, become the key for a successful logistics in the future.

2.3 Lack in research in the logistics sector

The research we have found and investigated in has mostly consisted of optimization in supply chain nodes: warehouses, distributions centres, customer plant etc. Another hot topic is electronic information and data interchange processes. There is however one specific area where we see an evident lack in research – the physical links between the nodes, which is the transportation of goods between plants. The supply chain management of today has become very slim and relies heavily on just-in-time scenarios in order to minimize large inventories. Because of the fact with minimal inventory focus will production industries (e.g. vehicles, computers etc.) hit severe economical consequences if one or more deliveries fail to arrive in time (i.e. when they are needed). Their whole production process would halt and as result waste a lot of resources, manpower, and even worse economical loses. We will argue that reliable transportation of goods is one of the most important factors for successful supply chain management. The very essence of supply chain is to transport one item from one place to another, and it is critical that the item doesn't get lost during the way.

By having complete control and supervision over the physical flow in the supply chain will naturally allow better measures against unexpected disturbance in the transports and hopefully mitigate the consequences. The disturbances within the links could e.g. be accidents, traffic jam, hi-jacking and other criminal activities. These kinds of events are not uncommon and happens probably everyday. The traditional supply chain is facing great changes and is today standing at the doorway of a completely new era – the world of mobile and wireless technology.

2.4 Nomadic Computing

Rapid developments in information technology (IT), particularly in communication and collaboration technologies, are substantially changing the landscape of organizational computing. Dramatic developments in mobile and wireless communication technologies and the continued miniaturization of chips and computing devices suggest radically new types of computing based on users' nomadic behaviours (Lyytinen & Yoo, 2001). Nomadic computing addresses problems in a new computing paradigm called nomadicity. Nomadicity means the use of software application services independent of location, motion, time, and application platform (Helin & Laamanen, 2002). Kleinrock (2001) identifies nomadicity as the way systems can support a rich set of computing and communication capabilities and services for nomads as they move in a transparent, integrated, convenient, and adaptive manner.

Wireless and handheld computing devices will also lead to a more encompassing digitalization, miniaturization, and integration of diverse sets of information (personal, organizational, public) and offer unprecedented possibilities to access, manipulate, and share information on the move. The most important feature of these devices is their nomadic nature: they move with us all the time, and accompany us in many types of services. This raises the need to integrate them with other resources while we move around (Lyytinen & Yoo, 2001). Lyytinen & Yoo (2002) mean the resulting is a *nomadic information environment* being composed of a heterogeneous assemblage of interconnected technological and organizational elements, which enables the physical and social mobility of computing and communication services between organizational actors both within and across organizational borders.

2.4.1 Nomadic Information Environments

The essential features of a nomadic information environment are high levels of mobility, consequently large scale services and infrastructures, and the diverse ways in which data are processed and transmitted – often called digital convergence (see figure 2.1). These three key drivers – *mobility, digital convergence, and mass scale* – influence and enable developments in both *infrastructure* and *services*.

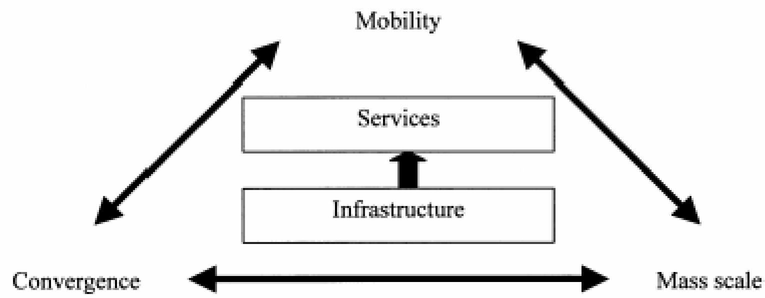

Fig. 2.1 A framework of nomadic information environments, adapted from Lyytinen & Yoo (2002).

The infrastructure is defined as the whole set of technological specifications, standards, and protocols and their technical implementations necessary to support mobility, large scale, and digital convergence, and the associated family of institutions and communities needed to develop and sustain such standards and technical implementations. The services cover any functional application of the infrastructure resources to provide a computational solution to a client's needs (Lyytinen & Yoo, 2002).

Further, Lyytinen & Yoo (2002) see these three drivers as distinct in the sense that you can achieve, for example, a high degree of mobility without extensive digital convergence (e.g., current cellular services or low-level mobile data services), or you can provide a high level of digital convergence without a high level of mobility (e.g., current CD-ROM based multimedia applications). Yet, when these three drivers are combined, they reciprocally influence and shape the future computing.

2.4.1.1 Fundamental Drivers towards Nomadic Information Environments

This section intends to explain each driver in a nomadic information environment in more detail. The section is mainly influenced by Lyytinen & Yoo's research paper, *The Next Wave of Nomadic Computing: A Research Agenda for Information Systems Research (2001)*, but in an adapted and abbreviated form.

Mobility – In the past, computing services were always provided in a stationary location. Accordingly, users had to come to the physical site to receive the service. For example, a user of a desktop computer needs to come to his or her office to use it. In a nomadic information environment, however, all this will change: services will come to the users whenever and wherever they are needed. Furthermore, identical or similar services will be provided through multiple devices at different sites, and on the move services will move across and between devices even during the delivery. Accordingly, the infrastructure will have capability to recognize differences in the deployed devices and will thus adjust the content and rendering mechanisms to fit the device.

The need to support all forms of mobility will lead to important changes in input/output terminals. Their size (smaller), shape (more diverse, ergonomic, and stylistic), and functional diversity (from simple mobile phones to portable laptops offering complex virtual reality environments or embedded chips in our body) will be increasingly varied in the future. Moreover, our capability to configure them into varied service platforms will have to grove rapidly.

Digital Convergence – The evolution of computing has made the computer to a universal media machine due to an increasingly low-cost digitization and open standards. Digital processing of all forms of data (text, audio, video, etc.) across different carriers (radio waves, electromagnetic phenomena, optical phenomena) with multiple devices (PC's, mobile terminals, or consumer electronic devices like digital TV's) becomes the fundamental enabler of all emerging communication and computing tools. It will also integrate multiple types of data that are displayed on the same device. At the same time, emerging open standards, such as WLAN (IEEE 802.11 standards), Bluetooth, TCP/IP, and WAP, are critical to digital convergence and the support of physical mobility. Finally, digital convergence requires that various devices share information and interoperate seamlessly while providing services across heterogeneous computing networks. Such seamless data sharing will depend on the availability of data communication and service protocols between mobile tools and other computing resources embedded in physical environments such as walls, furniture, or desktop computers.

Mass Scale – Mobility and convergence will make it necessary for nomadic information environments to be available, in principle, at a global level, resulting in an unforeseen increase in service volume, service types, and the number of users. An increasing number of Internet-capable mobile devices lead to an increased amount of data transfer via wireless connections. This change will not be an easy one because issues of scale, reliability, the integration of services, and new interfaces to the existing infrastructure will have to be successfully addressed.

2.4.1.2 Infrastructure and Services

As showed in figure 2.1, nomadic information environments will become organized into two layers. The lower layer encompasses the emerging global information infrastructure for nomadic services, which covers both telecommunication services, wired and wireless, and multimedia-based computing and representation services. Such an infrastructure will be technically heterogeneous, geographically dispersed, and institutionally complex without any centralized coordination mechanism. This infrastructure must be based on a common platform of protocols and data standards to ensure interoperability, stability, reliability and persistence.

The higher level includes all types of digital services, which can be accessed by the mobile users through different channels. Accordingly, services will be configured dynamically and they will be obtained from many sources. This will require novel means of the creation, configuration and distribution of services for dynamic service discovery, assembly and purging. In addition, nomadic services will require personalization, dynamic mobility for services and users, and associated channel adaptation; services must be dynamically configured, modified and combined to meet the personal needs of the mobile users. Services provided by a specific infrastructure element, such as an enterprise-planning system or a customer-relationship management system, have to be customized accordingly and combined with personal and public services that are needed by the particular user.

3 Method

This section will describe the method we have been using in this research study. The focus of this research project was to gain knowledge and understanding in how nomadic computing, can be exploited in the field of logistics and in particularly increase the security of cargo transports in transit. The chapter begins with descriptions of general research methods and narrows later down to our specific choice of method.

3.1 Two different research approaches

Two of the fundamental research approaches in conducting research work are, as Backman (1998) calls them, the traditional and the qualitative way.

The traditional way of research is when you behold the world around us in an objective scientific way. Usually it is based on different measurements and other statistical approaches in order to gather data. The data consist often of numerical number and are extracted from e.g. surveys, experiments and tests. This is a great way if you want to find out any average tendencies in a population assuming that the test subjects are heterogeneous and many enough.

In contrast to the traditional method where objectivity was focused is now subjectivity the important factor. In the qualitative perspective lies the interest in how the reality looks from an *individual*, *social* and *cultural* way. The reality is interpreted from an individual and is therefore shaped from his or hers experiences and perception. *Significance*, *context* and *process* are the keywords in this perspective. The aim is to learn how an individual experience and interpret the surrounding reality in relation to his or hers previous knowledge and experiences. How can the life and surrounding world get a meaning? The context refer to that it is important to study the person in the "real-life", right in his natural working environment. The course of event or in other word the process is equally important in the qualitative methodology.

These two opposite perspectives are illustrated below. The left shows how an individual beholds the world from an objective type of way. The right figure places the individual right in the center of the world in order to receive his subjective point of view.

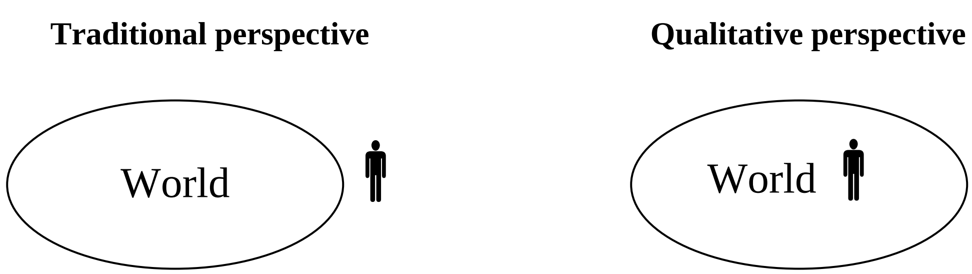

Fig 3.1 Adapted from Backman (1998).

The data gathering process in the qualitative perspective is suited if your need is to go in depth and reveal the underlying cause of the problem. This approach focuses much on interviews with key personals. One of the strength of this approach is the ability to really reveal the reality of the research subject and on the basis of that design and support new IT tools.

When it comes to research targeted to design in the industry, it is difficult to apply the traditional research methods derived from physics and social science. Industrial design has its own purposes, values, measures and procedures (Owen, 1994). It is possible to conclude that design knowledge is gained through both research and practice. This perspective will require a more extended view of the traditional case studies, which is the favoured and is the traditional approach to the study of design practice (Svengren 1993, Hinells 1993).

The two main types of research methods that are commonly applied in the study of design practices are action research and case study. (Yen, Woolley & Hsien, 2002)

3.2 Action research

As the title describes it is a research method that emphasis on direct action in order to generate and accumulate knowledge. Action research is attractive to those practitioners or researchers that have identified a problem during the course of their work and sees potential of improvement in the practice. The natural process of action research is by alternating action with critical reflections as it moves forward. Each action is reviewed and examined; the conclusion and understanding drawn from the previous reflection will be tested in a new action. The critical reflections in each cycle provided many chances to correct errors. This method is well suited for situations when you wish to achieve change (action) and understanding (research) at the same time.

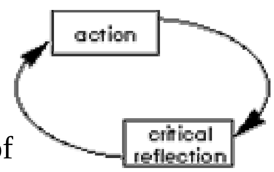

Fig 3.2
Cycle of action research.

3.3 Case studies

One of the recurrent methods in the design practice approach is the use of case studies. Yin (1989) has defined a case study in following manner:

"*investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used*."

Yin emphasizes that a case study is conducted in a realistic environment and it is difficult to separate phenomenon and context. The case study looks intensely on a small participant pool and all conclusions and results gathered during the research work are only applicable on that type of group in that specific context. A case study can also be conducted with different intentions. The *descriptive* approach is when the researcher wishes to describe the phenomenon and *explorative* is when you need to investigate and explain in more depth. Case studies are especially suited for evaluation of complex environment e.g. organizations and systems.

3.4 Our choice of method

Our goal in this project was not simply an observation study of any existing process or supply chain. We had to take a more active role and collaborate closely with Schenker in order to discover and evaluate appropriate technologies and services for the mobility platform. In order to design this mobility platform, was therefore a thorough investigation of Schenker's current situation necessary. We also wanted to learn as much as possible of the latest technology and how to utilize them in the best way. Our participation in the initial stage of the mobility platform project required a great deal of effort from our part and gave us the possibility to shape it actively. Therefore, our method differs from traditional case studies where the researcher observes and interprets strictly from an objective point of view. We had to conduct a case study of Schenker and at same design the mobility platform adapted for Schenker. The combination of these two disciplines, action research and case study, can possible fill the gap between these two methods and get the best of the two worlds, which in scientific terms is called - Action Case Research.

3.4.1 Action case research

This research method was developed by, Barr and Vidgren (1995), for information system design as a response to the dilemma of interpretation and intervention.

"A research method for design is therefore required as the aim of the study is therefore not only the desire to observe and understand the use of theory in practice but also to intervene in and change the process under the theory" (Yen, Wolley and Hsien)

As the figure show it is a mixture of action research and case studies. The term action research reflects that it contains elements from both the mentioned disciplines that blend to a hybrid of understanding of the theory and its change to practice. In this case will the researcher operate or collaborate with the practitioners in studying and transforming knowledge generated from design theory into practice. An action case study is goal-oriented problem solving case study and attempts to draw general conclusions from specific cases.

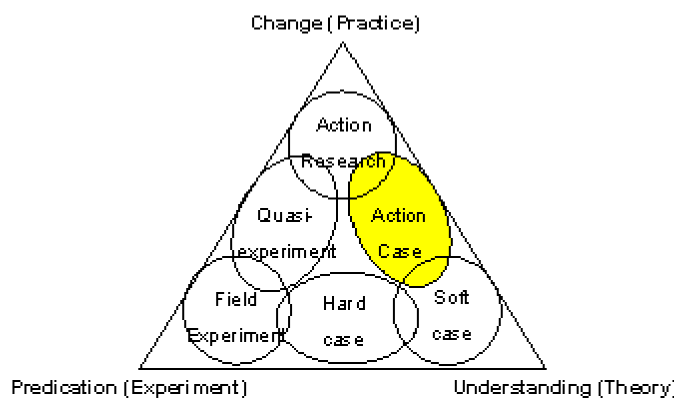

Fig 3.3 Method location for action case
Adapted from Vidgen & Braa (1997).

A comparison in terms of research focus between the three methods mentioned above is demonstrated in Fig. 3.4

	Action research	Case study	Action case study
Researchers	Participation	Third-party	Participation
Research inquiry	Problem-oriented, might change during the process	Goal-oriented	Goal-oriented, problem-solving
Research process	Flexible, solution-oriented	Preplanned, some flexibility	Preplanned, flexible, goal-oriented
Dependency on the case	High	Low	High
Research objectives	Knowledge and understandings: focus on intended changes	Knowledge and understandings: focus on establish a new knowledge (know how)	Knowledge can be applied to all instances of the same type. It contains mainly general rules.
Area of validity	Pieces of knowledge are detached and valid only in one case	Knowledge can be applied in several instances	Knowledge can be applied in several instances of the same type. It contains mainly general rules.
Reliability	Difficult	Possible	Difficult
Intervention by researchers	Allowed and desirable	Not allowed	Allowed and desirable
Analysis concern (pragmatic criterion)	Credibility/consistency and workable for client	Credibility/consistency	Credibility/consistency and workable for other instances
Mode of presentation	The essential sense of 'tacit' knowledge cannot be explained verbally	Tradition. Exemplar. Skill of trade. Many important points of these cannot be presented verbally.	The knowledge can be explained as a design models

Fig 3.4 Source: Adapted from Yen et al.

The combined guidelines of action case study have suited our work very well. We have in close co-operation with Schenker been selecting and evaluated the technologies and systems for use in the pilot case. This project had a clear goal and our task was to reach that goal with the best solution possible. Our final result has generated in a list of design implications of the mobility platform. However, these design suggestions are not limited to this case alone, since they are fully applicable on other similar projects. The methodology of action case study has therefore suited our work very well.

3.5 Work processes

We have during this project been involved in many different processes in order to carry out our work. Schenker had a theoretical concept of a mobility platform that was aimed to support various business cases with different services. It was necessary for us to understand the background and the underlying forces of why this platform was required in the first place. We needed an overall view of Schenker's current situation and their visions with the mobility platform. That information was gathered by studying previous presentation and other related materials within Schenker's intranet and discussions with the project leader and our supervisor, Steen König. We learned that one of the strongest drivers to this project was simply the competition factor. Schenker sense, in order to keep their leading position in this industry it is crucial to begin and explore the latest mobile services before the competitors will get too far ahead.

We were therefore given the task to investigate and design this mobility platform together in close cooperation with Schenker. We needed to evaluate each component in this mobility platform and find the best solution possible. That includes everything from choice of telematics devices to the overall system architecture of the platform. In order to organise this work, we have divided this work in eight phases. Each step is described below.

3.5.1 Phase I - Literature studies

The activity of reading literature and other relevant information has been a recurring moment throughout the whole thesis work. We began this work with very little experience and knowledge about the world of logistics. It was apparent that we needed go through a couple of books regarding logistic, supply chain management, transport management etc, in order to get a overall knowledge of some of the basic aspects in this industry. This initial review lead eventually towards more research oriented fields and allowed us to get a comprehension of the scientific sides of the subject.

The theoretical information search was conducted in the fields of mobility, mobile services, nomadic computing, transport security and supply chain management. Search engines e.g. Google was extensively used since it returned a broad range of related material. It allowed us to get good overview of research, reports and other information of these areas. We utilized the archive of Hawaii International Conference on System Science (HICSS)[2] a great deal when finding recent research papers about supply chain management and mobility systems.

3.5.2 Phase II – Benchmark & data collection

The intension of this phase was to explore the current market for existing technologies to support positioning and other mobile services. Those technologies have been evaluated in terms of advantages, disadvantages and future compatibility issues. The benchmark process was an

[2] http://www.hicss.hawaii.edu/

efficient way to sweep the market of all relevant systems, both hardware and software. The process of finding relevant companies in this area were a mixture of Internet surfing, transport magazines and recommendations from people in the industry. The process of information gathering was first concentrated in the section of telematics devices, because we realized early in the project that this was an important element in the final mobility platform. The Internet enabled us to conduct a rather comprehensive survey of available devices in the market today, from domestic as well as from foreign manufacturers. The websites of each company gave us for most part sufficient information of their products and allowed us to decide if further actions were necessary. We set down two basic requirements of the device in order to screen out the most flawed devices. The device we were looking for had to contain a positioning unit and a communication unit. When a device passed our initial screening process was a first contact initiated, usually by phone but e-mail was also used when needed. We usually asked them to describe their product in more detail and allowed them to present the strength and uniqueness of their device. The discussion progressed gradually to the field of security around a trailer. We stressed the fact that it was the trailer in focus and many manufacturers realized eventually the increased difficulties of tracking only a trailer, since most of the systems are primary used and installed in the truck cabin with the driver. More information about challenges and difficulties in trailer tracking, refer to chapter 4.4.3. After each conversation, was a summary written down for future reference. Those companies that passed this second screening process were naturally found interesting and had potentials to contribute to our case was invited to Schenker AG for further discussions.

The benchmark phase allowed us to understand current level of technology advancement. The limitations and possibilities of technology were discussed extensively. The goal of this phase was to select one or more communication boxes that were suited to install in a trailer.

3.5.3 Phase III – Compilation of data

The benchmark process generated a long list of various companies in different specializations; all of them were working with positioning services of some kind. We listed all these companies in an excel-sheet in order to organize and get a better overview of them. The sheet was composed with comprehensive data like contact person, head office, live demo etc. At the end of this process was another sheet formed including only the hardware devices, about 10 different models. This sheet gave a very good overview of each device and showed their complete hardware specifications. This allowed us to compare the devices against each other and made it possible for us to rate them.

3.5.4 Phase IV - Analysis

All the information about the different devices we gathered was analysed in great detail. Every single component of the box was investigated and analysed. We wanted to compare all the devices against each other, and constructed therefore a matrix. This matrix contained all the relevant data and specification of the device and provided an excellent overview of all the devices that we had collected. We formed a rating system, where we rated each component or functionality of the device. The grades were:

- non-existing 0 component or function not available
- bad support 1 limited or bad functionality

- good support 2 average functionality, sufficient in most cases
- excellent support 3 full utilization of functionality

Each rating was transformed into a numeric value; these numbers was then summarized at the end in order to get a total score of each device. The total score was then compared and made it easy to judge the overall capabilities of each device. The summary does, however, not take the price of each unit into consideration. It is therefore not certain that the highest scored device is best suited for this business case. There are plenty of other factors that are also important to take into consideration. It is sometimes better to choose a simpler device and upgrade later when needed, especially if the device have high initial cost.

3.5.5 Phase V – Business meetings

Throughout the whole project was a series of meetings with various companies representatives conducted. We participated in most of these meeting, observed and questioned the attendants. This gave us a very good ground for what is possible and realistic with the current level technology in regard of trailer tracking. The opportunity to get in touch with the leading companies in the industry of positioning and tracking was most valuable for our case. We contacted companies that operate in different areas. Some were pure hardware manufacturers while other focus on developing system platforms. It was interesting to see how they approached the same problem from their own background and expertise.

3.5.6 Phase VI – Workshops

When we approached the deadline of making a final decision for which of the communication boxes that we would initiate a pilot case with, was it therefore appropriate to invite the affected parties to a workshop. The goal of these workshops was to openly discuss the reliability and possibilities of the various technologies surrounding positioning and communication. Even if this project was directed for one specific case, security concept, was however the intention completely the opposite. The mobility platform must be build for future expansion and upgrades. So the architectural design of the platform was also under serious discussions.

3.5.7 Phase VII - Interviews

In all types of scientific research work is interviews necessary component to go through, especially in our case when our approach is based on qualitative information.
There are a few interview techniques and guidelines that we have utilized. Davidson & Patel (1994) defines 2 aspects of an interview: standardization and structure. A high level of standardization incorporates a strict order of questions and the formulation of each question. This technique suits well when seeking general conclusions about a larger group of people. The aspect of structure involves how much freedom the interview person is able to interpret and express his or hers answer. The level of structure in interviews is dependent on the variety of answer each question can generate, consequently will “yes” and “no” question considered high level of structure. Interviews with low level of both standardization and structure will generate qualitative aspects and analysis of the result (Davidson & Patel, 1994), which is well in line with our goals and intentions.

We have chosen a selection of key persons involved in this project for interviews and in-depth discussions. This focus group represents people inside Schenker and external experts with deep knowledge in technical areas. The interviews were often semi-structured since we valued open answers with room for discussions.

We got in contact with many different people in this industry during meetings, workshops, etc. Those discussions were a rewarding because it was a relaxed atmosphere and we could discuss the situation openly. Semi-structured interviews were carried out with key persons, the project leader, Schenker Chief Security Officer and represents from mobile operators: TeliaSonera, Vodafone and Wireless Maingate. Those interviews were conducted either by “face to face”, telephone and e-mails, depending on the circumstance. The interview with project leader and CEO resulted in very interesting conclusion of Schenker’s current situation and more importantly their future vision of Schenker as a logistics company. One important goal of Schenker was to be able to increase their portfolio of added services for their key customers. Improvement of customer relationship is a critical aspect of any organisation and corporation.

3.5.8 Phase VIII - Review of Technology

Our work required us to fully understand the broad variety of the technologies that exists in the field of nomadic computing. It was necessary for us to know in great detail what the advantages, possibilities and limitations of each technology in order to design an accurate and realistic mobility platform with optimal performance. Our findings, extracted from people and websites in the industry has been documented and composed in chapter 5. This will hopefully allow the reader to understand the potential possibilities of what these technologies can offer today and in the near future.

4 Research Context

We will in this chapter describe the empirical research environment that we have investigated in. There is also a description of the business case that we will support with mobile and wireless security solutions.

4.1 Schenker Background

Schenker, a subsidiary to Stinnes AG, is one of the leading international providers of integrated logistics services.

Schenker provide support to trade and industry in the global exchange of goods - in land operations, in worldwide air and sea freight, and in all the associated logistics services. About 36,000 employees at 1,100 locations throughout the world achieve a turnover of roughly Euro 6.5 billion per year[3].

Schenker provides its customers with all the main services from a single source.

Services

- Integrated logistics services from a single source in the areas of land, sea and air transport
- Global supply chain management
- All associated logistics services like warehousing or value added services
- Special services like project logistics, trade fair and Olympic logistics[4]

This business principle has proved its worth ever since Gottfried Schenker in Vienna founded the company for more than 130 years ago. The Stinnes subsidiary Schenker is a Deutsche Bahn AG company.

4.2 Schenker business strategy

Schenker today offers two kinds of land transport services. First they have their standard product, which stands for 85 percentage of the total sale. This implies that a customer book a transport service that can take their goods from one place to another. This service has production focus, which means that the customer bought a standard service that includes no more than the physical transport[5]. Remaining 15 percentage of the sale is customized services that have more focus on the customer. Customer focus means that Schenker and the customer works together to find a

[3] www.schenker.com
[4] Schenker is an official supplier to the IOC for freight forwarding and customs clearance for the Olympic Games. Schenker will cooperate with the IOC and the Organization Committees for the 2004 Games in Athens (ATHOC), the 2006 Winter Olympics in Turin (TOROC) and the Summer Games in Peking in 2008 (BOCOG).
[5] There is a tracking service included where you have the possibility to track your shipment either by phone, Internet or your WAP telephone. This is not real-time information; just last known position is presented.

solution that satisfy the customer's requirements. The segment of added customer value has lately increased in importance and plays today a vital role in future customer relations. 4ROOMS is a group within Schenker that is dedicated to work together with the customer to find additional business solutions that satisfies the customers' needs and requirements. The emerging mobility platform is of course a step towards the policy of increased customer services and business values.

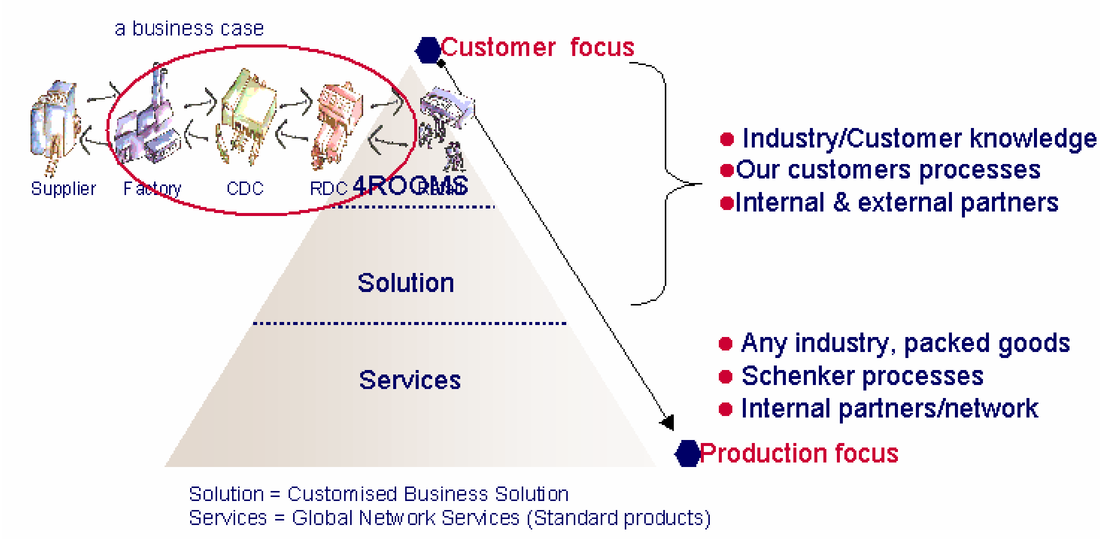

Fig. 4.1 Schenker business Strategy.

4.3 Schenker Mobility Platform

To provide more customer value and stand out in the competition Schenker has realized that an introduction of mobile services is inevitable. Therefore Schenker has begun to draft upon a mobility platform. The main idea is to realize this mobility platform that easily can be integrated into Schenker's current system environment. The cause for this is that in this way they have the possibility to provide real-time information from vehicles to other logistics information systems within Schenker. This will speed up the information flow and the possibility to give more exact and dynamic information both to customers and themselves.

This platform will work as "mobility broker" (see section 4.3.2) that can interface a range of available systems and devices. It should be a generic (non platform or system specific) and modular in its design so it could be applied in many different business cases. The requirement of the platform will vary from case to case; some may have security as a focus, while other just needs general tracking service for increased visibility. The final mobility platform should be practicable to handle all current and future demands of mobile services.

We will point out that Schenker's overall goal with the mobility platform is to create new, and to improve already existing services through acquire real-time information from the vehicles to their customers.

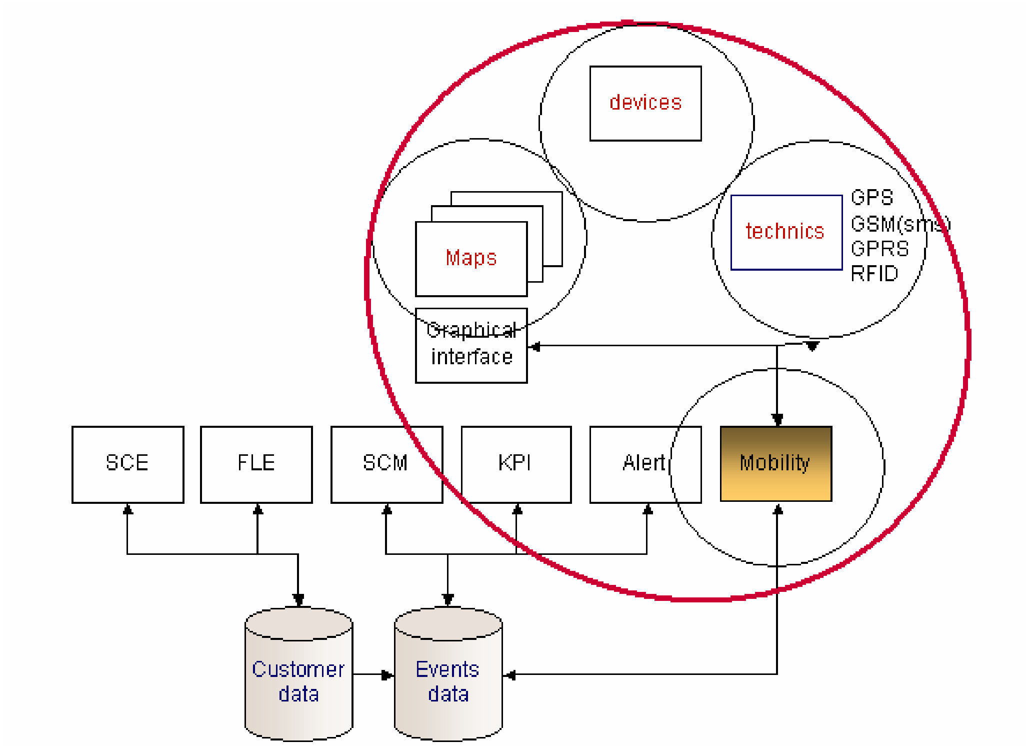

Fig. 4.2 Schenker's future planned system environment, where a mobility platform is integrated.

4.3.1 Supply chain vision

Schenker's vision with a mobility platform is to give their customers more dynamic and real-time information. Mobile services are a great tool to use for receiving real-time information directly from vehicles about a transports status. This real-time information will give increased visibility and the opportunity to inform about deviations in the transportation, which can help the customer to optimize their supply chain and use their resources in the most effective way. Further there is possible to improve the security over the physical flow during road transportation with an increased visibility.

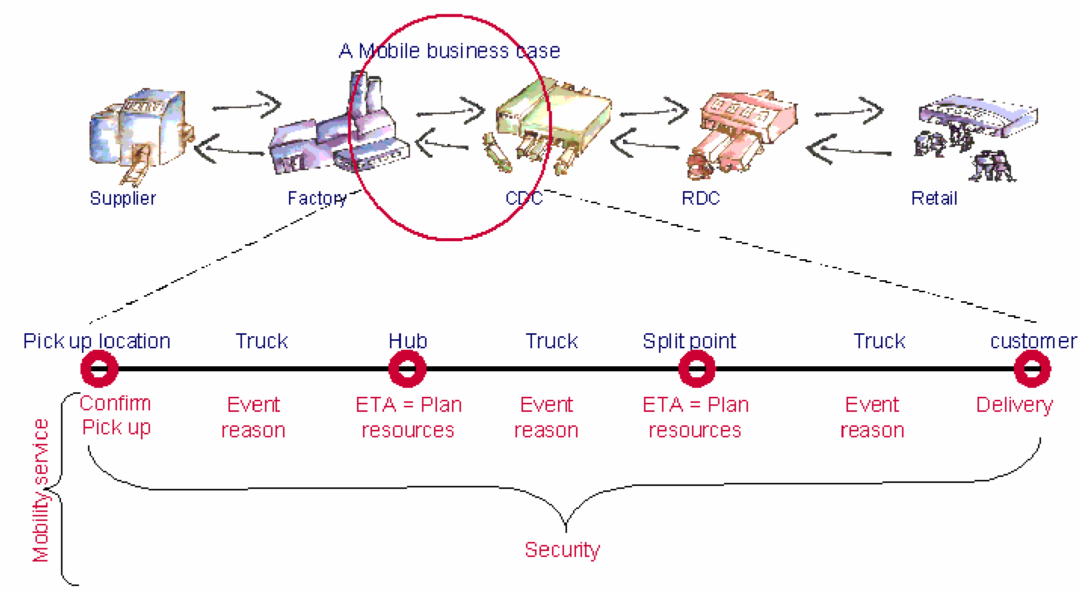

Fig. 4.3 Schenker supply chain vision.

4.3.2 Mobility broker

One of the main goal for Schenker is that the mobility platform will work as a "mobility broker". This means that information from vehicles can be transferred into Schenker's logistics information systems in real-time and speed up the overall information flow. The speed of information between Schenker and their customers are important out of several aspects.

For example, if Schenker can offer their customers real-time information from vehicles on the move they can provide information about deviations during the transportation process. This creates opportunities for customers to react and optimize their resources and processes in the most effective manner during the prevailing circumstance. From Schenker's point of view, there is possible to quickly inform their logistics information systems about performed operations. One example for this is that customers often not will pay for their transports until they have been noticed that their cargo is in the right place. When information can be sent directly as soon a delivery is complete it will increase the cash flow for Schenker.

4.3.3 Integrate customer's

The integration of IT must be a joint venture among the various actors in the industry and requires a great deal of efforts and determination from everybody. Manufactures, customers, haulers, they all have to see the long-term perspective and must work towards a common goal. Those who don't see it might loose their competitive strength. The industry is facing even more interconnected networks of global magnitude and thus creating more and more complex systems that need to be integrated with each other. A system may want to be viewed and accessed by partners, customers, customers' customer, end users, and the list goes on. This opens up a variety of different scenarios that need to be prepared with good planning and smart integrations. Because of the fact that the variety of different users needs to have access to these systems, must a defined set of security/access levels be strictly implemented.

4.3.4 Mobility platform – Business values

Schenker's goal with the mobility platform is to increase the customer business value. There is out of several aspects that Schenker sees opportunities for added customer business value.

- Improve customer satisfaction
  - Meet delivery promises
  - More visibility
  - Real-time status
- Improve productivity
  - Better use of trucking fleet
  - Automatize & Simplify processes
- Lower cost
  - Inventory cost
  - Administration costs
  - Freight costs

4.4 Description of Business Case – Security Concept

Schenker AG has a frame contract with a customer that requires a high security level over their transports. To fulfil the requirements of this contract Schenker has decided to implement a security system that monitors the physical flows from customer plants in Finland and Hungary to distribution centres throughout Europe. The reason for the customer wants an increased security level is, of course, to avoid loss of goods during transportation. Hi-jacking and theft of goods in transit is a major problem for the transport industry today. Especially, there is a problem when the goods are valuable and theft attractive, which is a reality for this customer.

To improve the security over the physical flow, we have been asked to help Schenker to decide with how to implement a security system that will utilize the latest information technology (IT). With today's information and telecommunication technology you can receive a total control over your vehicles from a centralized transport management central. To have this opportunity you must equip the vehicles with a vehicle computer that will make it possible to exchange real-time information directly with the vehicle. This device, that we will call black-box, will include a positioning unit and a communication unit. From this device we have the possibility to receive a vehicles position with accuracy down in a level of metres, along with speed, direction, etc., and send this to the Transport Management Central. Further we can receive information about status of the cargo doors; we will even have the possibility to lock/unlock the doors from the service central. We will also been able to connect additional peripherals and control those remotely from our service central. Examples of this kind will be surveillance cameras, freeze aggregates, etc.

Today's situation for this customer, mentioned above, transports is that there is a lot of manual actions in form of mobile telephone calls between the service central and the driver about the transports status. With modern IT support you can automatize many of these information exchanges and communicate with the vehicles through the black-box. This opportunity is a must in this case while solely tracking of the trailer is required.

This project focuses on cargo security, which means that only the trailer will be monitored and secured. Personal security, that is the driver, will not be prioritised in this case. Personal security is of course also an important aspect of a total security solution but falls out of scope for this business case. In a later phase, this aspect also will be built in into the security system.

4.4.1 Increased need for security

There is a common understanding of the increasing security problems regarding crimes during road transportation. According to the Chief Security Office (CSO) of Schenker North, Alexander Wallsten, is this a matter that needs immediate action. He states that the security policies around the physical transports are in need of serious upgrade but at the same time very tough to accomplish. He has initiated discussions with various security organisations with aim to address this issue. However, little progress has been made; it has been difficult to come to good solutions because many of the involved actors find the increased security measures of the physical flow very complex in many aspects.

4.4.2 Transportation (Distribution) process

This customer physical flow will consist of transportation of their products from their plants in Finland and Hungary, to distribution centres throughout Europe – in total 22 countries and 80 to 100 distribution centres.

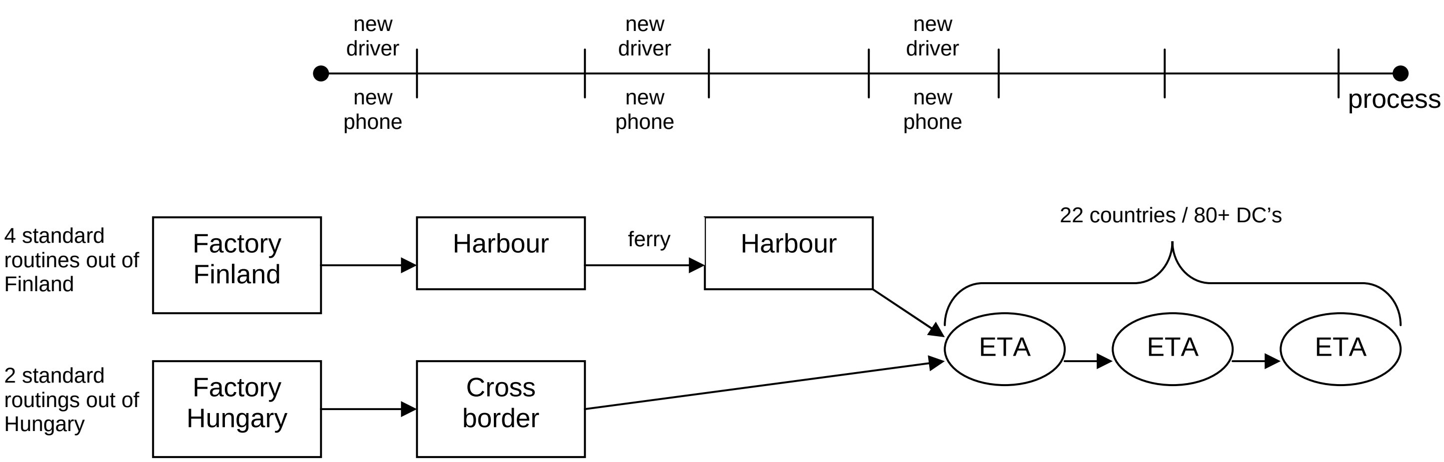

Fig. 4.4 Overview of the distributions process.

From Hungary there are different types of vehicles that leave their plants with products for delivery to distribution centres throughout Europe. All vehicles are equipped with some kind of black-box, from different manufacturers, and are today possible to monitor and control through a system that Schenker Hungary has implemented. The goal is to re-use these black-boxes and therefore these must be possible to communicate and integrate into the new system solution.

The distribution from Finland will have some special circumstances to have in mind. Some routes from Finland involve that just the trailer will be moved to the harbour and leaved off there. Then it will be transported by ferry to the continent of Europe and be picked up by another truck. This truck will in most of the cases be a hired truck that has no connection to Schenker. In most of the cases Schenker will not be using the same truck again.

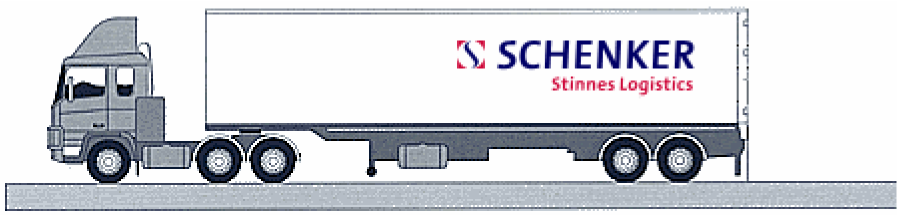

Fig. 4.5 Trailer tracking implies that merely the trailer must be possible to track. The trailers out of Finland will consist of box-trailers that must have the possibility to be tracked alone.

Trailer tracking will differ in many ways from that of tracking the whole vehicle, as was the case in Hungary.

4.4.3 Trailer vs. vehicle tracking

Today there is no problem to receive a mobile unit's position anywhere in the world. All you need is some kind of device that includes a communication module and a positioning module. Often this device, so-called black box, is in-cabin mounted and has their power source directly from the truck/vehicle power system. The black box is also placed in an environment that is well protected which will eliminate damages from a roughly external environment. You will also have the possibility to have the black box connected to a monitor that can give the driver real-time information. The driver will also have the possibility to have contact with and communicate with the transportation/service central by voice communication or some kind of electronic text-based message.

There will be some remarkable differences when you just want to have the possibility to track a trailer. First of all you must mount the black box directly on the trailer. In our case where the security is highly prioritised you must try to hide it so it not will be easy to put the black box out of function or in some way make it not usable. One further thing to have in mind is that you are not allowed to take up place in the trailers cargo area because this will reduce valuable area for cargo. Therefore we are forced to mount it outside the trailer in an environment that could be very rough. This will require a very robust device that will handle this environment. One further problem to solve is how the driver should receive information from the black box without some kind of device that will inform the driver in the cabin. One way to solve this problem is to have a communication device that belongs to each trailer, and that the haulier will bring into the cabin when driving. But this is not a satisfactory solution since it is widely known within the transport industry that portable devices like this are very often lost. Further there is a difficulty with the power supply to the black box when the trailer is disconnected from the truck. There must be a back-up battery that provides the black box when it's being without external power supply.

4.4.4 Pilot Project

We will after our benchmarking of the market introduce a pilot project where we will test some of the black-boxes we have encountered. The pilot project has been carried out together with some potential partners that have good experience in some of the areas that will be of interest for this case. This can be partners that have good knowledge and experience to present positioning data in digital maps etc. The main purpose with the pilot project is to see how those black-boxes that will be tested is working in the future planned operational area. Critical aspects as how the communication with the black-boxes works is important to have knowledge about since we want to have the position for the trailer reported regularly to a service central. The communication technology reliability is here very critical and there will not be allowed to have disruptions in the communication with the trailer. Communication technologies that will be of interest to test are GSM and GPRS, UMTS (3G) will not be of interest in this moment but will of course be of interest in future when it is more developed and improved. GSM is a communication technology that is well widespread and established in Europe today. A drawback with GSM is that is expensive to send data with SMS that will work as the carrier of data in the case of using GSM/SMS technology. Using GPRS, which is an extension of the GSM technology/network, as the carrier of data will decrease the running cost considerably for the transferring of data between trailer and the service central. The reason for this is that you in this case always are connected to the network and only will pay for the data that is transferred. The drawback with GPRS is that it is not so well established as GSM so one important thing to test is to see how well GPRS is working in the operational area.

Further, the aim with the pilot project is to watch and learn about the reception of the input data from the black-box. One important thing to consider here is if we shall build our own software for dealing with the input data, or if we shall use an external partner for this purpose, or a combination of both?

4.5 The Project Timeline

As any project it is important to set up deadlines along the different phase of the project. The mobility project is an ongoing process that will evolve as the time goes. The following timeline is outlined only for the pilot case.

October 2003 - Project start
The birth of this pilot case began in October 2003; it was a request from one of Schenker's customer to tighten up a route with higher security measures. This was a perfect opportunity since Schenker had already begun to think of a mobility platform for a period of time. This pilot case would make a perfect start to build this platform.

October 2003 – December 2003 Benchmark process
The work of sweeping the market for suitable devices, maps and other systems was in its most intense phase. Every system was carefully investigated to see its potential.

January 2004 – Decision of communication box
After the benchmark process was a decision been made regarding the choice of communication boxes. The involving companies were given the opportunity to initiate a cooperation with Schenker AG in order to run the pilot case. They were later invited for a workshop where the architecture of the systems was discussed along with the specifications of all the requirements for the communication box. One significant criteria of this emerging mobility system was that it had to integrate into Schenker's internal systems to introduce other synergies.

The benchmark process resulted in two different communications boxes; one from Fält Communication and the other was from Haldex. A software company named B&M Systems was also chosen to be charge of the software platform, including maps presentation and communication specification.

April 2004 – Implementation of pilot case

The actual implementation of the mobility system has been started up. This involved installation of all the communications boxes in the trailers along with sensors and other peripherals. It was also decided that it was wisest to customize on of the partners software system in this first pilot case or else would the development time prolong the project considerably.

5 Technological review

This section intends to give an overview of those wireless technologies that could be utilized in a nomadic information environment.

The mobility platform of Schenker will utilize the latest technologies to date. This should assure a lasting platform that has potential to evolve as time goes on. There exist at multitude of various wireless technologies today; each has their own special purpose and usability. Wireless technologies can be divided into two main sections: the positioning technologies and the communication technologies. Many of these sections has been reviewed in full and their unique characteristics have been covered in great detail.

5.1 Positioning Technologies

In all times, mankind have been trying getting to places and finding locations where they have not been before. The current state of technological advances allows you to position and track a moving object and peoples with an accuracy of a few meters all over the globe. There are two main approaches in order to position an object, GSM or satellite positioning. Each of these has both strong and weak sides but if utilized correctly they can complement each other.

5.1.1 Satellite Navigation

The latest hype in positioning technologies is, without doubt, using satellites in the sky to positioning an object on earth. The thoughts of using satellites for navigation and positioning have existed for over three decades and are still under constant research. But it is now the technology is mature and ready for big scale use in the industry sector. The most known navigation system is called GPS.

5.1.1.1 GPS – Global Position System

The GPS is developed by U.S Department of Defence, initially only for the US military. Their goal was to create a worldwide position system with a super precise accuracy. It must function in any weather condition, anywhere in the world, 24 hours a day. They succeeded and the final bill ended at $12 billion. They launched the first GPS satellite in 1978 and reached the full constellation of 24 satellites in 1994.

At first this system was only intended for the U.S. military applications like troop deployment, artillery fire etc. Luckily in the 1980s the government made the system available for civilian use too and removed the interference signal so that an accuracy of 5-10 meter was possible for everybody. There are also no subscription fees or setup charges to use GPS.

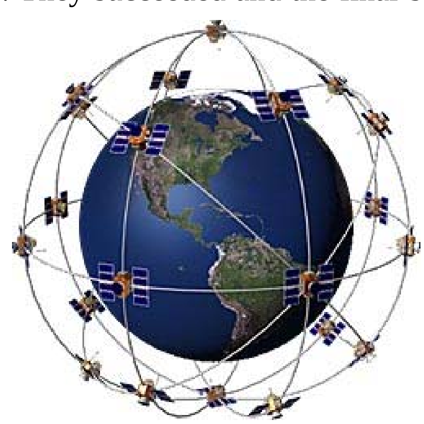

Fig. 5.1 GPS satellites orbiting the globe.

GPS is divided into three segments.

1. Space segment (the satellites)
2. Control segment (the ground stations)
3. User segment (you and your GPS receiver)

- The space segment

The space segment is composed of a constellation of 24 satellites; they are constantly orbiting the earth about 28.000 km above us. At this altitude it allows the signals to cover a greater area. The arrangement of the orbiting satellites has made it possible for any GPS receiver on earth to always receive signals from at least 4 satellites at any given time. Each satellite can manage to complete 2 orbits in less than 24h.

The satellites are equipped with solar panels to meet their power consumption, but they do also have backup batteries onboard to keep them running in the event of solar eclipse. The transmitting power of a GPS satellite is only 50 watts or less, compared to a local radio station that transmits at around 100.000 watts.

Each of these satellites transmits several radio frequencies, L1, L2 etc. All civilian GPS receivers "listen" on the L1 frequency of 1575.42 MHz in the UHF band. The signal can only travel in a "line of sight", meaning it will go through clouds, glass etc, but not solid objects like buildings and mountains. Each satellite signal contains a "random pseudo code" (RPC), this is a very fundamental part of GPS. The code is basically a complex pattern of digital code or in other words a sequence of ON and OFF pulses. The signal is so complicated that it almost looks like random electrical noise, hence the name "Pseudo random".

It is not a coincidence that the code is so complex. It will help the receiver not to accidentally sync up to other satellites and stray signals. Since each satellite has its own pseudo random code they can all use the same frequency without jamming each other. It will also make it difficult for a hostile force to jam the system. Another significant aspect of pseudo random code is it makes GPS economical. The code makes it possible to use "information theory" to amplify the weak GPS signal. This is the reason behind why GPS receivers don't need big satellite dishes to receive the GPS signal. This is a huge economical benefit.

The main purpose of the pseudo random code is to allow for calculating of the travel time from the satellite to the GPS receivers on the Earth. This simple equation is used to calculate the distance to the satellite.

Velocity (speed of light) × *travel time = distance*

How do you calculate the time it takes from a satellite to a GPS receiver on earth? Suppose both satellite and the receiver start the RPC sequence at the same time. Naturally the sequence from the satellite will be delayed due to the distance the signal has to travel. Let's then see how delayed the satellite's version was by delaying the receivers version until they both are in perfect sync. Consequently, the amount we have to shift back the receiver's signal is equal to the travel time of the satellite's version. Now we have both velocity and time and can easily calculate distance to the satellite. The satellites have a highly accurate atomic clock to time the signals.

The basis of GPS to get a position is trilateration and not triangulation. With 3 satellites it's possible to get a 2D position; hence you need a fourth satellite to provide a 3D position (longitude, latitude and altitude).

- Control segment
This segment controls the GPS satellites by tracking them and providing them with corrected orbital and clock information. There are a total of five control stations around the world. One is the master station and the remaining are four unmanned receiving stations. These stations collect data from the satellites and send the data to the master station. The master station processes the information and sends the "corrected" data back to the GPS satellites.

- The user segment
This segment is simply all who uses the GPS system. It can consist of boaters, hikers, military, trucks, drivers etc.

5.1.1.2 GLONASS

The not so well-known satellite system named Global Navigation Satellite System is the Russians equivalent to America's GPS. Just like GPS, the constellation is based on 24 satellites orbiting the globe. The first GLONASS satellite was launched in October 1982 and the system is today managed by the Russian space forces. The system provides two types of navigation signal:

- SP (Standard Precision)
- HP (High Precision)

SP positioning and timing services are free of use for all civilian users. The accuracy capability of SP is further divided into horizontal and vertical. The system can guarantee an accuracy with 99.7% probability at 57-70 meters (H) and 70 meters (V) and a timing accuracy of 1µs.[6] These characteristics can of course increase significantly by using differential mode and other special methods.

5.1.1.3 Galileo

A new global satellite navigation system is on its way to break the monopoly of GPS. The "Galileo" is planned to go in operation in the year 2008 and will consist of 30 manmade celestial bodies orbiting our planet at an altitude of exactly 23,616 km.
This next generation satellite system is the most expensive EU project ever; a joint venture of European Commission and European Space Agency (ESA). The first satellite is expected to be launched into orbit as early as September 2005.

Why use Galileo
This system will work with in same principle as GPS, but it will be more accurate and more reliable. A very precise atomic clock that is able to tick away at precisely a billionth of a second will control the 30 observers. The distance is measured in same fashion as GPS and to determine a position in space, a total of four satellites are required. A group of nine satellites evenly spaced will revolve in three different orbits. Each group will also have a spare satellite as backup if one of the main satellites breaks down.

The system will be able to interoperate with both GPS (American military) and Glonass (Russian military), the other two global satellite navigation systems. This means that a user will be able to

[6] http://gibs.leipzig.ifag.de/cgi-bin/glo_intro.cgi?en

take a position with the same receiver from any of the satellites in any combination. This is obtained by implementing dual frequencies as standard. The Galileo satellite navigations system will offer position accuracy down to metre range for the public sector. In fact Galileo is prohibited for use in military applications in contrast to GPS. The military operators of GPS and Glonass give no guarantee to maintain an uninterrupted service and if they ever decide to shutdown the whole system there would be instantly chaos among many users, especially in the seas. One of the head reasons of why Galileo was built in the first place is the need of an independent satellite navigation system under civilian control which will guarantee to operate at all times.

The price tag

This huge project will of course cost some serious amount of time, commitment and money. A rough predicament of the final bill will land around 3.5 billion euro including the two powerful ground control centres. EU and the 15 ESA member states will pay this, and it's considered to be worth every cent. From their point of view it is a long-term investment and will eventually boost their national economy significantly.

5.1.2 GSM positioning

The initial GSM stands for Global Systems for Mobile Communications. The GSM network was first introduced in 1991 and is today one of the leading technology for digital mobile phone system. GSM world[7] estimates over 1 billion GSM subscribers by end of January 2004 in over 200 countries. The international roaming capabilities of GSM allow the consumer to use their cell-phones roughly anywhere in the world. The coverage of the GSM network is constantly growing and evolving thus making it very interesting for the future.

A GSM network has a structure of hierarchy. Following components are parts of the structure; cell, location area (LA), MSC service area, PLMN Service area and GSM service area.

The cell

A cell is simply an area from a radio transmitter to anywhere the signal can reach. The size of the cell depends heavily on signal strength, angle and obstacles. It can range from 100 meters up to 35 kilometres. Each cell is identified with Cell Global Identity (CGI) that is e.g. used in positioning. CGI is composed of four parts: MCC, MNC, LAC and CI.

Acronym	Full	Explanation
MCC	Mobile Country Code	Identifies which country the user is registrated in
MNC	Mobile Network Code	Identifies which network the cell phone is connected to in current country
LAC	Location Area Code	Identifies which Location Area the cell phone is in
CI	Cell Identity	Specifies which cell the cell phone belongs to

Fig. 5.2 the four parts of a cell.

[7] http://www.gsmworld.com

Location Area
A group of corresponding cells is called LA. The LA of each cell phone is stored in a database called Visitor Location Register (VLR).

MSC Service area
The complete area of all the LA that uses the same Mobile services Switching Centre (MSC) is called MSC Service area. The MSC service area of each cell phone is stored in a database called Home Location Register (HLR).

PLMN Service area
Public Land Mobile Network (PLMN) service area is the complete GSM coverage of a single operator.

System component of GMS network
The GSM net is divided in two parts; Switching System (SS) and Base Station System (BSS). The SS handles mostly connection and user related functions and BSS handles radio related functions.

MSC takes care of all the connections between the calls. The MSC is also connected to other data networks, private networks and mobile networks.
The Gateway MSC stands as an interface to other GSM networks.
In the HLR database is all the user information stored. The record consist of identity, service and the last know position (cell id). VLR is a copy of HLR but also stores user information from other networks. This information is used in case of when user moves from one network to another, in other words roaming.

The GSM network enables positioning and localization capabilities of any user in the network. The basics and requirements of such use are just a device with a sim-card and a base station. Two types of positioning bases on GSM network exist today: sim-card positioning and network-positioning.

5.1.2.1 Sim-card positioning

The sim-card solution is becoming obsolete which is based on sending a data-sms to the terminal that is being positioned. The terminal then sends back a sms containing the Cell-Id to a system that converts the Cell-Id to a usable coordinate. The main drawback of this system is that both the terminal (sim-card) and the base-station must have support for this technology. The overall response time of each positioning is also rather slow compared to network positioning.

5.1.2.2 Network positioning

Network positioning can currently be obtained in two ways, either by requesting information from HLR/VLR or going through. By BSS it is possible to acquire additional information besides Cell-Id to improve the positioning accuracy. These are e.g. field strength and Timing Advance. The big advantage in network positioning is that you can theoretically position any sim-card without having to upgrade of the terminal, only the base-stations.

Accuracy

The positioning accuracy of a GSM network is variable depending on your location and number of base-stations surrounding you. As long as you have GSM coverage you can be positioned. All the nearby BS that receives your signal can calculate your signal strength to them and by combining all the data and put the terminal in relation to each of the BS it is possible to get a rough estimate of your position. This technique is called triangulating. The environmental settings are also an important factor to consider with GSM positioning. A clear open landscape with no obstacles will of course provide better positioning compared to an urban area with plenty of tall buildings that reflect the radio waves.

5.2 Wireless Communication Technologies

It is great if you can acquire an exact position of where you are in the world but if you can’t send the data to others then it would not be much worth. That is why the next important step is to decide the communications carrier for your transmissions. First of all you must decide what area you will be using the service. Perhaps just within a city or even around the whole world. Each technology has its limits and depending on where and what you want to transmit one of them is better suited than the other. All of the following alternatives we present here are wireless technologies and that is prerequisite for mobile services.

We will group these technologies in two main categories; Local Wireless and Distant Wireless. In local wireless technologies will all the transmission be limited within a radios originated from the device. The distant wireless setting is all the transmissions with no limits of physical distant between sender and receiver, only the coverage.

Distant wireless technologies

- SMS
- GPRS
- GSM data
- 3G
- Satellite (Inmarsat)
- Mobitex

Local wireless technologies

- Bluetooth
- WLAN
- RFID

5.2.1 GSM / SMS – Simple Message Service

This is simply text-based messages that you send away in plan number and alphanumerical characters. Each message can consist of 160 characters in length but only if Latin alphabets are used. One of its capabilities is that the message will be temporary stored if the receiver was unavailable at the time of transmission.

5.2.2 GSM / GPRS – General Packet Radio Service

With GPRS possible to always stay connected to the mobile network. As the name points out it is a packet switched network and allows information to be sent and received both faster and quicker. The maximum theoretical speed of GPRS is up to 171.2 kb/s and is about 3 times as fast as the data transmission over the fixed telecommunications networks[8]. It is fully compatible with all internet applications and thus makes it a very interesting technology for the mobile network.

5.2.3 GSM data

With the GSM network it is also possible to have data and fax services. This data transfer facility can be compared to a modem at a speed up to 9.600 bits per second, also known as data streaming. Unlike the packet switched approach of GPRS a connection must be made prior to the transmission and this is referred as circuit-switched network. Each connection must have a modem at the receiving end and the amount of simultaneous connections will thereby be limited to the amount of modems at the communication centre.

A newer standard for data transfer in the GSM network is also available called HSCSD (High Speed Circuit Switched). It will offer a considerable higher data rates than the present. At a rate of 38.4 kilobits per seconds it is comparable to the transmission rates of usual modems via fixed telephone network. This transmission rates over wireless networks will perhaps open up new services that require and use this bandwidth.

5.2.4 UMTS / 3G

The term 3G is just a term for the third generation mobile system. The technical standard is called UMTS (Universal Mobile Telephone Service) and allows a theoretical transmission rate of up to 2 Mbps downstream and 384 kbps upstream[9]. This kind of bandwidth in conjunction with the IP support will make services like video telephony and videoconference over mobile networks a reality. UMTS is able to combine both packet and circuit switched data transmission in order to achieve high compatibility with other systems and networks. The system will also offer “data rate on demand” which in combination with packet data will optimise the operation of the system and perhaps in the long run save money.

The UMTS has been from the very beginning designed to become a global system with both earthly and satellite components. A user should be able to roam from any micro-cellular all the way to macro-cellular networks like GSM and even satellite support, all with minimal break in communication.

5.2.5 Inmarsat

This system was the world’s first global satellite communications operator and offers today many communications services to maritime, land-mobile, aeronautical users. Inmarsat was formed over 20 years ago as an intergovernmental organization with a focus on maritime. The system has grown from serving a user base of 900 ships in the early 1980s to more than 250,000 ships, airplanes and other vehicles (source: www.inmarsat.org). These users will have a data rate up to 64 kbit/s at their disposal, for use in phone, fax and data transmissions.

The current constellations of satellites consist of four Inmarsat-3 in geostationary orbit. They are all positioned around the equator at a height of 35,600 km and cover most the globe thanks to the high altitude. These satellites are backed up by one more Inmarsat-3 and four Inmarsat-2 generation satellites. The generation 3 satellites have one big advantage to its predecessor

[8] http://www.gsmworld.com/technology/gprs/index.shtml
[9] http://www.cellular.co.za/technologies/3g/umts_technical.htm

Inmarsat-2, the spot beam capability. In case of a high usage in a particular area the Inmarsat-3 can direct a beam which will allow extra communications capacity when needed. A new generation of satellites is under development. The generation four Inmarsat-4 will support the Inmarsat Broadband Global Area Network (B-GAN). This network will offer a mobile data communication at data rate up to 432 kbit/s for Internet access and other multimedia services. These satellites will be 100 times more powerful than the present one and can provide at least 10 times as much communications capacity as today's Inmarsat network. The B-GAN will also be compatible with the third generation cellular network (3G).

5.2.6 Wireless LAN

Wireless Local Area Network has its primary use in business offices and homes where you can replace the physical cables with a wireless substitute. It offers a great flexibility and mobility to the working environment. The 802.11b standard which specifies a maximum data rate of 11 Mbps is being replaced by its bigger brother 802.11g with a theoretical bandwidth of 54 Mbps. The maximum radius of a WLAN network is about 100 meter in open space.

5.2.7 Bluetooth

The birth of Bluetooth was seen 1998 and the same year was also the Bluetooth SIG[10] (Special Interest Group) formed to develop the concept to a technological standard. The technology is based on a short-range radio link to exchange information between two or more Bluetooth capable devices. It is seen as a cable-replacement technology to effortless and quickly offers wireless connectivity between mobile devices. The specifications allow a seamless voice and data secured transmission which can be utilized in many areas where mobility is required. The signal strength of each device is possible to reach a range of 10 to 100 meter. It operates in the 2.4 GHz ISM (Industrial Scientific Medical) band, which is globally available and will allow international travellers to use their Bluetooth devices worldwide.

5.2.8 RFID – Radio frequency identification

Radio frequency identification appeared first in tracking and access applications during the 1980s as a complement to bar code labels[11]. It has naturally evolved into better and cheaper as the year passed. A basic RFID system consists of three components:

- An antenna or coil
- A transceiver (with decoder)
- A transponder (RF tag) electronically programmed with unique information.

It is the antenna that emits radio signals and activates the tag and read and writes data to it; it controls the system's data communication. An antenna can have variety of different shapes and sized and is highly adaptable to suit different settings, e.g. doorways, pass-through gates etc. The electromagnetic field produced by the antenna can be constantly present in case you want to monitor a constant flow of tags, but can also be turned off when not needed.

[10] www.bluetooth.com
[11] http://www.rfid.org

It is often the antenna is assembled with both the transceiver and decoder to become a reader, also called an interrogator, which can be configured either as a handheld or a fixed-mount device. Depending on the emitting power output of the reader it is possible to reach a tag within 30 metres or perhaps more. When a RFID tag passes through the electromagnetic zone, it detects the reader's activation signal and decodes the data encoded in the tag's integrated circuit.

The RFID tags can also be manufactured in a variety of shapes and sizes, ranging from tens of millimetre to a couple of centimetre. The smallest versions can e.g. be utilized in animal tracking and inserted beneath the skin. The RFID tags can be categorized as either active or passive.

Active tags are powered a by an internal battery and are typically enabled for both read and write operations. These kinds of tags could store a history of all past activities, which can be very useful when you want to back-trace an item or cargo. Thanks to the battery-supplied power will an active tag generally give a longer read range, but must be considered relative to the trade-offs of bigger size, greater cost and limited operation life. An active tag may yield a maximum of 10 years depending on surrounding environment and battery type.

Passive tags operate completely without internal power source; it obtains operating power generated from the reader. They are therefore much lighter, less expensive and offer virtually unlimited operation lifetime. The disadvantage is that they require shorter read range and a more high-powered reader. These tags are usually read-only and are only programmed once with a unique set of data (usually 32 to 128 bits). Read-only tags operate very much like the bar codes that are used today.

The RFID system is also distinguished by three main carrier frequencies ranges: low, intermediate, and high. The following table summarises these three ranges along with the typical system characteristics and examples of applications.

Frequency Band	Characteristics	Typical Applications
Low 100-500 kHz	Short to medium read range Inexpensive low reading speed	Access control Animal identification Inventory control Car immobilizer
Intermediate 10-15 MHz	Short to medium read range potentially inexpensive medium reading speed	Access control Smart cards
High 850-950 MHz 2.4-5.8 GHz	Long read range High reading speed Line of sight required Expensive	Railroad car monitoring Toll collection systems

Fig 5.3 Overview of RFID frequency bands.

The most significant advantage of all the RFID systems is the non-contact, non-line-of-sight nature of the technology. The tags can be read through all kinds of weather conditions and a huge variety of other obstacles. RFID tags can also be read at remarkable speeds, since the response time is less than 100 milliseconds in most cases. The read-write function of RFID makes it even more superior to the barcode label. However, this technology is still very costly, at least compared to barcodes, but has come to be indispensable for a range of data collection and identification applications that would not be possible otherwise. The RFID will certainly continue to develop further and the market of RFID will most likely grow exponentially the next 5 years.

5.3 Summary

Those technologies listed above are overview of what kind of possibilities that is available to support a nomadic information environment today. It is important to separate those technologies that are used for positioning purposes from the communications technologies that are used for the actual data transmissions. Satellite positioning is superior when it to comes to coverage and is often the natural choice when selecting a positioning service. There is however a requirement of "line in sight" in order to get an accurate reading. This may not always be the case when operating in dense cities with many tall buildings and other obstacles. In cities is perhaps GSM positioning more preferable due to the possibility to position objects inside buildings and tunnels. One big huge advantage with GSM positioning is there is no hardware requirement to position an object. Everybody that has a cell-phone with an ordinary sim-card is possible to position. The GSM network is also fully capable of transmitting information, both text and data. SMS and GPRS are the most used approach to transmit information and works pretty well in most circumstances. The only limitation is to be inside the coverage of the GSM network, which is different from country to country.

Wireless communications technologies can be separated into two classes: local and distant. Local wireless is limited in the range of which the transmission can reach and suits well for local mobility applications such as driver and vehicle interaction. The other class, distant wireless technologies are utilized whenever there is a need to transmit information from an arbitrary location. By combine these various technologies it is possible to generate mobile services that can increase the efficiency of the logistic industry in unlimited ways.

6 Result

This section intends to present the Schenker trailer tracking system. We will review and analyze the different components in our suggested solution. Furthermore, we will describe those services that enable an increased security of cargo transports in transit.

6.1 Schenker Trailer Tracking Concept

Our work with to find a solution for tracking of trailers has resulted in a conceptual architecture presented in figure 6.1. The proposed architecture will be realized and tested in a pilot project that will be in progress during a three-month period starting April 2004. The pilot project will be a perfect opportunity to test and evaluate the trailer tracking system in a real operational environment. Furthermore, this proposed architecture will lay the foundation to the future Schenker mobility platform.

Schenker trailer tracking concept for an increased security of cargo transports in transit will consist of a number of components that you could divide into two parts – trailer components and platform components. First, the trailer must be equipped with a black box, including a communication unit and a positioning unit, that make it possible to monitor and control the trailer from a remotely transport central. Besides the black box the trailer will be equipped with some other peripheral equipment, such as door sensors, cables, and surveillance camera.

Secondly, you need a platform where you can monitor and control the trailer from a remotely transport central. This platform will consist of several components, such as a communication server, databases to store input data from trailers, a gateway for communicating with both internal and external systems among other components. Below we will review and reflect the different components further and give details about how the trailer tracking system is constructed.

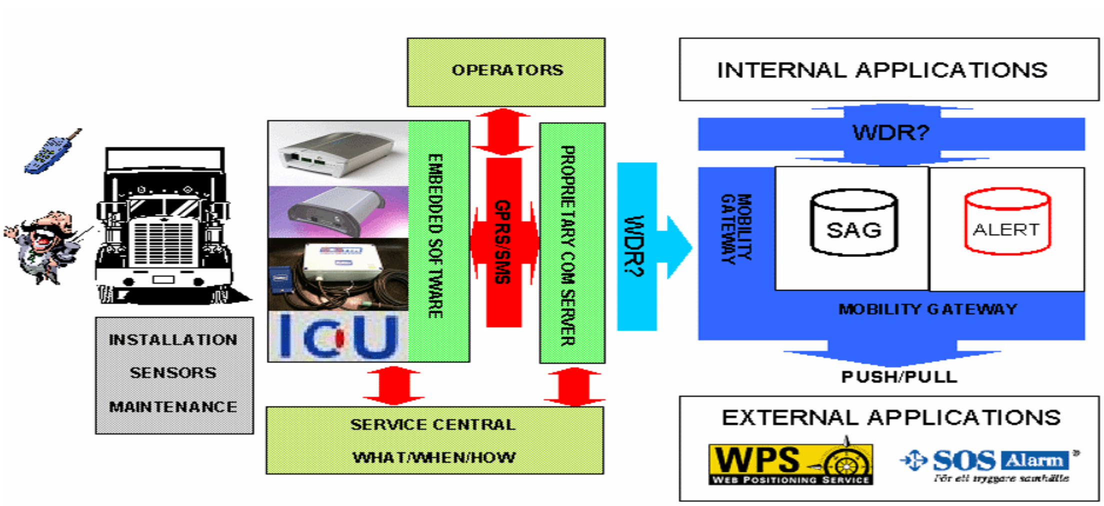

Fig. 6.1 Proposed system architecture for Schenker trailer tracking system.

6.1.1 Trailer equipment

The trailer will be equipped with a number of devices and peripheral equipment. The most important is a black bix that make it possible to transmit information between a trailer and a remotely transport central. Other equipment mounted on the trailer will for example be sensors, surveillance cameras and cables. Furthermore, this section concentrates on equipment that will support an increased security around a cargo trailer.

6.1.1.1 Black box

The black box is an important component in the trailer tracking system. During our benchmark it became clear to us that a wide range of devices exists on the market today, often designed for a specific purpose. We have during this process learned a lot of details about how these kinds of black boxes are constructed and what properties and features are important to consider. As result, we have identified several factors that must be considered before making a decision. The various characteristics of a black box are described below.

Main processor

The computing power of the device is highly dependent of the processor in the device. The more intelligence you can add to the device the more sophisticated functions will the box be able to perform. With a good processor unit it is possible to compress outgoing messages in order to minimize transmission costs. The encryption is useful to add extra security but at expense on increased transmission costs due to more information to be transmitted. A powerful processor could also have the capability to calculate, e.g. ETA (Estimated Time of Arrival) at runtime and route deviation in real-time.

Memory

The memory unit is another important component in the communication box. The embedded software that is used to control the device lies in a non-volatile memory that will keep the information when the power is off. There are many types of memories, ranges from PROM (writes ones) to FLASH (write/erase many). There is also a third type RAM, which is volatile and loses its contents when the device is shut down. The control software plays an important role to the overall device capability. It could be a disadvantage if the control software has been burnt into a PROM-chip already from factory assembling. Consequently, prevents us from update this software in the future and we lose the flexibility of controlling and adapt the device for different situation and user cases. A FLASH-chip will always have the possibility to be updated later, even wirelessly/remotely if the device supports it. This is a powerful characteristic that could save time and resources in the future.

Programmability

Like the memory section, it is also important that the control software is flexible and highly customizable. Some devices are very customable and offer a development platform in e.g. C language. However, most devices only offer configuration abilities through various parameter settings. In some cases maybe that’s enough, but true power lies in to have complete control of the embedded software. This will allow us to adapt the device to a wide range of different user settings in the future.

Power consumption
This is critical area to consider with care. One of the main problems with installing a black box in a trailer is the uncertainty in the feed of constant electricity. In contrast to truck cabin where electricity always is available, there is no guarantee that a trailer is always powered. Some trailers are only powered while the backlights are lit; in many of the European countries it is perfectly legal to drive without backlights. However, every time the driver steps on the brakes will electricity flow to the trailer-part. Whenever the black box is lacking from direct power it must then rely on a backup battery. This is where an efficient power management plays an important role. The device should have a series of power modes ranging from fully operational to sleep mode where it basically stays alive as long as possible. A well-defined power management will not only prolong the life of the backup battery but possibly also decrease the size of the actual battery. Conversations with different device manufacturers have made it clear that the battery backup is the largest component of the whole communication box. A trailer in the field could at intervals be out of power for weeks or even month and this is an issue that must be thoroughly investigated if security is prioritized.

Temperature tolerance
Advanced piece of electronic devices such as these must be able to function in heavy temperature fluctuations, or they become useless for the transportation industry. A transport could take place anywhere in the world and travel from extreme cold to burning heat. Humidity is also important factor to consider since there could be extensive variations from country to country.

Positioning module
This component determines how a position is received and processed. Two possibilities exist today: GPS and GSM positioning. A considerable majority of the black boxes on the market have GPS capabilities. Its advantages over GSM positioning are many: coverage, accuracy, flexibility etc. However, GSM is able to position objects inside buildings and other confined spaces unlike GPS that requires “free” sight directly to the sky in order to function. The most significant attribute of GPS is its ability to position an object anywhere in the world, while GSM positioning only works within the coverage of a GSM network.

Communication module
The communication module is perhaps one of the most important components in a black box. There are several ways to transmit information from and to the unit: SMS, GPRS, Inmarsat etc. The most common way to transmit data wireless is SMS and GPRS through the GSM network. The GSM coverage is relatively well spread around the world, all major cities, and suits well for communication purposes. The price per SMS is still at high cost and will not be very cost effective in the long run with thousands of vehicle sending continuous messages daily. GPRS on the other hand isn’t charged per message but instead for the amount of traffic that you use; this will result in a much lower communication cost compared to SMS.

Ports
The device should also support a series of ports for input and output in order to connect external accessories like sensors and triggers. Analogue ports are useful to measure temperatures while digital ports can detect door openings and other forms of breaches. Other neat features could be support of CAN-bus (Controller Area Network), which is an industry standard for vehicle

diagnostic. Ethernet-port is another well-known standard for connection with computer related devices.

Summary of the Black Box

As we can see does a black box consist of a great deal of different components and modules. It is how you combine these components that will define the capabilities of the device. We have come cross a wide range of different devices; some are simple and others are highly advanced.

The choice of the black box must be based on a list of criteria. Different cases will of course generate different criteria. The optimal solution is to have a modular architecture where you could just add or remove different modules depending on price, usability, need and so forth. Additional modules such as Bluetooth, WLAN, and Ethernet-port can add extra values but must be compared relative to the additional cost that comes for theses modules. Some more sophisticated black boxes offer the ability to remotely update their software/configurations settings. This would add more value to the device since it could be customized to suit different user settings over time.

The operational lifetime of these devices is also an uncertain factor to consider. If the price for each device becomes cheap enough, then you may consider them as expendable. Technology advances, in this industry, moves at rapid speed and new and better devices are constantly emerging. Is it really necessary to have a device of latest technology? It may after all be sufficient with the simplest device only capable of receiving a position and transmit the data to the service/transport central. All logic is then processed at one central place. The downside of this approach is that it will generate more traffic since the server needs to have constant status check of the devices.

The most important criteria to consider should be the reliability and durability of the device. According to Per Bergström from the company B&M Systemutveckling, he has over 10 years of experience in positioning systems and claims that “simplicity often is the best solution”. The equipment must be easy to hide and tamper-proof which is another challenge to overcome.

Since the black box will be mounted on the trailer we will encapsulate it in a weatherproof box, together with a backup-battery. The weatherproof box will then be mounted under the trailer in some suitable place. It would be preferable to integrate it with the trailer chassis in some way, this will make it more difficult for criminals to find and set the black box out of function.

6.1.1.2 Black Boxes Chosen for the Pilot Project

We have chosen two black boxes that we will test in the pilot project. The most important characteristics have been, price, functionality, reliability, stability, flexibility and possibilities for adaptations. We have narrowed down to two candidates; one simple box from Haldex and the other is more sophisticated from Fält Communication.

	Positioning	Communication	Other	Type
Fält Communication	GPS	GSM / GPRS	MLAN (Mobile Lan)	Advanced
Haldex	GPS	GSM / SMS		Simple

Fig. 6.2 Characteristics of chosen black boxes.

The process of selecting these two was based on several factors. Most of the devices contained similar functionality and differed only in size and ports. In the end, the determining factor was the cost issue. It turned out that the final two devices were agreed to be sponsored from the manufacturers for use in this pilot case.

Both devices offer GPS as positioning technology and GSM as communication carrier. The device from Fält Communication has GPRS as primary communication mode (Data carrier) while Haldex use SMS as primary. The device from Fält has a unique feature called MLAN, it uses Ethernet interface and GPRS interface as an access-point to Internet. It is therefore possible to connect various peripherals such as camera, printer, laptops etc. into the device and get Internet access through the GPRS connection.

The pilot project has focus on security and tracking of the goods. Our goal is to find appropriate tools and services to support these demands. It is evident that we need mobile technology for this purpose.

6.1.1.3 Sensors

We will equip all trailers with door sensors to have the ability to see if a door is closed or open. This sensor will be connected to the black box via a digital port.

6.1.1.4 Cables

Since we will have focus on security trailers must be equipped with armoured cables that will make it more difficult for cargo thieves to snip of the cables and set the equipment out of function. Furthermore, of the same reason there is important to hide the cables as good as possible to make it even more difficult to snip of the cables.

6.1.1.5 Surveillance cameras

We will also test to equip trailers with surveillance cameras. The pilot project will include one camera that is mounted on one of those trailers used in the pilot project. The size of the camera must be minimized since the camera will be mounted within the trailers cargo area, and is not allowed to allocate valuable cargo area. Moreover, the camera must have a high durability.

6.1.2 Schenker mobility platform

The mobility platform is not a simple task to construct; it requires a great deal of different components that must coexist and even interact with both internal and external systems. The platform will evolve over time whenever new services become available and needed. One of the visions of the mobility platform is to be able to support a range of different business cases, which means possibilities to adapt the utilization of the platform for various customer needs and requirements. The complexity of this platform makes the architectural design a very critical step to overcome. One recurring attitude throughout the project was not to build something that eventually would become too specific and useless in other cases. We have therefore come to the conclusion that a modular system design is a must that communicates with open standards across all levels in the platform.

Below we introduce those components that Schenker mobility platform will consist of during the pilot project. This architecture proposal is the result of our practical work, in cooperation with some external professionals[12], and will probably lay the foundation for Schenker mobility platform. Initially, the pilot project will just include the trailer equipment; platform components will gradually be integrated during the pilot projects progress. But at first all information from trailers will be transmitted to our cooperating partner, B&M Systemutveckling, and their databases. Moreover, we will use their system WPS (see section 6.1.2.7) to display our trailers in digital maps.

6.1.2.1 Communication server

The communication server will be a very crucial component since all information between the trailer and service central will be transmitted through this. Therefore, it is very important that it will be reliable and stable for to avoid disruptions in the information transmission.

Schenker have plans for buying their own communication server. Advantages with to have a proprietary communication server is that you have control of the traffic and not is dependent on external management. During the pilot project we will use a communication server placed at our cooperating partner B&M Systemutveckling (see section 6.1.2.7).

6.1.2.2 WDR – Web Development Rules

Web Development Rules is a set of rules of how web-applications will be implemented within Schenker information system environment. WDR is a way to describe data very much like XML, and is in this case used if other applications within Schenker are interested to use data from the database (SAG), where all data from the trailers is stored.

6.1.2.3 Mobility Gateway

Mobility gateway is an application that will take care of all data transmitted from trailers and put it into the SAG database in proper format. Moreover, mobility gateway secures that Schenker own all data that is transmitted from the trailers.

6.1.2.4 SAG – Schenker AG Database

SAG is the database where all data transmitted from trailers will be stored. However, initially in the pilot project we will store all data from trailers to a database owned by B&M systemutveckling. The goal is then to build the SAG database and during the pilot project gradually supply it with input data from trailers.

6.1.2.5 ALERT

ALERT is an existing Schenker application that will be responsible for creating alarm around different parameters.

6.1.2.6 Internal Applications

The pilot project will not include any internal applications. But when the mobility is in production the goal is to integrate the mobility platform into other Schenker information systems.

6.1.2.7 External Applications

The pilot project will include an external application, WPS, from our cooperating partner B&M Systemutveckling. WPS offer positioning and fleet management services over Internet. With a

[12] Surikat AB, www.surikat.se

standard web browser application you will have full access to the positioning and fleet management services.

WPS Fleet Management is an advanced service including real time display of all mobile objects on a digital map, zoom in/out, replay/trace of positions, status and alarm display, dispatch and messaging functionality[13].

The pilot project will not include any external applications from security companies.

6.2 Schenker Security Concept

Schenker security concept will consist of a number of services for to increase the security of cargo transports in transit. There are mainly two aspects that will increase the security. First of all there is always possible to transmit real-time information between a trailer (black box) and a remotely service central. Secondly there is always possible to have the exactly position for a specific trailer via GPS. With these two possibilities you can create several services that will prevent cargo crimes during road transports. Below we will present those services in more detail.

6.2.1 Build Routes and Schedules

There will be a number of predetermined routes out from customer plants in Finland and Hungary that will be used to transport products to various distribution centers throughout Europe. This is made by geo-fence the route, which means that you will specify that area where it is allowed to drive. More exactly it means that you mark out a polygonal area around the route by specifying longitude and latitude for the safe area. Simply you put a fence around the actual route and the safe area is within this enclosure. Then by having the position for the trailer (longitude and latitude) you can see if the trailer is inside a safe/allowed area, if not it will trigger an alarm to the service central. Moreover, there is possible to make a schedule that your transports must follow. This is made by divide the route in different zones and put time intervals of when the trailer should be found to be in a specific zone. It is also possible to predetermine allowed places to have stops, such as customer plants, Schenker plants, harbors, receivers and resting places.

6.2.2 Door Sensors and Surveillance Camera

The possibility to see if cargo doors are open or closed could also support an increased security. Especially in combination with utilization of routing and scheduling mentioned above. In this way you can predetermine places where it is allowed to open the cargo doors. This is made by define special zones such as customer plants, Schenker plants, and receiver plants. Moreover, if needed, it is possible to lock/unlock cargo doors from a remotely service central.

A camera makes it possible to monitor the area around the trailer. This could be used in many ways and is highly independent on the communication technology used as data carrier. Transmission of pictures to a remotely service central, either in still picture or streaming real-time pictures, is desirable but require huge bandwidth and will probably not function with todays wireless communication technology. The goal is to have streamed real-time pictures as soon an

[13] For more information about WPS, see B&M Systemutvecklings website http://www.bmsystem.se.

alarm will be triggered. As said above a camera will be tested in the pilot project and result from this will be interesting. An alternative is to save pictures in the black box and take part of these afterwards when needed, such as when an alarm has been triggered.

6.2.3 Communication with the Driver

As we mentioned in the research context trailer tracking have some problems to overcome. One problem was how the service central will communicate with the driver. We will solve this problem by perform all communication through a simple mobile phone. We expect that every haulier dispose of a mobile phone in some way. Moreover, we will use the drivers mobile phone number as a kind of password. This password (mobile phone number) must be typed in to our monitoring system before it is allowed to move the trailer out of a safe area. If not, it will trigger an alarm to the service central.

6.2.4 Alarm Levels

We will use three different alarm levels. Which one is triggered depends on the reason for a deviation to planned schedule and/or route has occurred. The first two levels means that the service central communicating with the driver, by phone or automated SMS, and find out reason for deviation. If there in some reason is an indication of a criminal activity the alarm will be increased to level 3. A level 3 alarm will directly be forwarded to Securitas, SOS or Falck.

Level	Colour	Action
1	Green	SMS communication with the driver
2	Yellow	Service central communicates with the driver by telephone conversation.
3	Red	Securitas, SOS or Falck is alarmed and take agreed action.

Fig. 6.2 Table of security levels and actions.

6.2.5 Summary of Schenker Security Concept

Schenker security concept gives an increased visibility of Schenker cargo transports and makes it possible to monitor and control the whole transportation process, from customer plants in Finland and Hungary to distribution centers throughout Europe. Schenker security concept will in this manner make it possible for the monitoring service central to quickly react when a deviation in the transportation occurs, and take action for to prevent a possible crime.

The most critical section in Schenker security concept is the communication part. We will be highly dependent on a reliable and stable connection from the black box to the service central to handle the requirement of having the trailers position every ten second. Moreover, it is of highest importance that the final black boxes we choose will have a high reliability and durability.

7 Analysis & Discussion

We will in this chapter reflect and discuss some of our findings we have discovered during our thesis work. The chapter ends with a couple of suggestions to future work and research.

7.1 The Future is Wireless

Our thoughts have been confirmed during our work – mobile and wireless technologies are of highest importance for the transport and logistics industry. We are convinced of that a real competitive differentiator today is in how well a company utilizes wireless technology.

Our aim with this work was mainly to find out how mobile and wireless technologies could be utilized to increase the security level during cargo transports on the road. Cargo crime during road transports is a fast growing problem and it is up to transport providers to protect the flow of goods around the world. The reason for increasing cargo crimes during road transports is an increased security level around the physical plants, i.e. manufacturer plants, distribution centres, warehouses, etc., which makes it almost impossible for cargo thieves to conduct their breaches within those plants.

We have found that services built upon mobile and wireless technologies make it possible to strengthen the security of cargo transports. First of all it is possible to receive the exact position for a vehicle anywhere in the world by means of different positioning technologies. Secondly, modern telecommunication technologies make it possible to exchange real-time information between a vehicle in transit and a remotely service central anywhere in the world. This gives an increased visibility of your vehicle fleet, which creates opportunities for both an increased security and productivity of road transports.

Transportation of goods within a supply chain is a very crucial part and it is of highest importance that these will be conducted in an efficient manner and not creates disruptions in the total supply chain. Despite this fact we have found a lack in research regarding how mobile technologies could increase the transportation efficiency and security of goods between physical plants. Most of the research within the logistic sector is about how to optimize the flow of goods within the physical plants. The transportation process is just mentioned as a process that everybody is expecting to be conducted in a desirable manner. This is a major weakness considering the total time goods are in motion and what influence the transportation process will have on the total supply chain efficiency.

Companies today work for a centralization of their physical distribution flows and activities. The trend goes towards a few numbers of distribution centres and a close down of local warehouses. This change has result in a considerably efficiency profit within the distribution structure, but also in changes about how companies are organizing their business. This will be true both for them who performs their logistics activities themselves, and those that are utilizing a logistics service provider, so-called third-party logistics provider. This change in structure affects the need of logistics and transport services in a manner that the need shifts geographically, increased time requirements and that the purchasing process will change.

Transport and logistics industry see the mobile and wireless technologies as a tool that can make their processes more efficient and there are many providers who offer different solutions for transport information systems. Most of the information about how these technologies could support this industry was gotten from system providers of these kinds of systems and from research papers regarding supply chain management, where transportation is a crucial part. We have found it obvious that mobile and wireless technologies could support the transport process and make it more efficient out of several aspects.

The logistic industry is under constant development; especially in the recent years have telematics and nomadic computing have progressed in a rapidly tempo. These new technologies will allow new services to increase efficiency and improve the supply chain in many levels. This is however not an easy task to implement all the technologies and services; it requires a great deal of effort, time, resources and not least cooperation between parties. The whole logistic industry is made of a global network of various companies that make the world go around. This cannot be done over a night and must be implemented in small steps. Today, we are able to track and trace a vehicle anywhere in the world. This alone is a big step enabling full visibility throughout the whole physical flow. Tomorrow is the ambition to be able to track a single parcel or even an item throughout its life cycle. This is a near reality with the integration and implementation of RFID. However, this is not a project that a few can fulfil but the whole industry must realize its potential and benefits, and together strive for a common goal. One way in the right direction is the announcement of Wal-Mart, the biggest low-price chain store in America; they will begin to roll out RFID scanning technology in full scale beginning as early as January 2005[14]. The estimated cost of this project is calculated up to 2 billion US dollars. Many analytics in the business predict dramatic impact on the operation of global supply chain over the next 10 years. According to the chief scientist of Accenture, Glover Ferguson, at the Comdex Scandinavia 2004, is RFID the next big thing in the IT era.

The wireless technologically progress has matured enough and is ready to be fully exploited for the transport and logistics industry. We are still at the doorstep of what mobile services can do for this industry and the possibilities are limitless – The Future is Wireless.

7.2 Schenker Mobility

We believe that Schenker’s investment in the mobility platform as the right path to take. This is not only good for Schenker’s sake, their size and global position will probably influence other actors in this industry too. Schenker’s role as a transport and logistics provider is very important for customer’s total supply chain. If Schenker fails in their part of the supply chain, this will create disruptions in the total supply chain, which could cause great damages and huge economical losses for both customers and themselves. Therefore it is of highest interest that Schenker can fulfil their commitment in an agreed manner. It is in the best interest of everyone that Schenker can perform their duties as efficient and professional as possible; this implies delivering the goods in right time, to the right place, in the right quantity and in intact condition.

[14] http://logistics.about.com/cs/logisticssystems/a/aa060303.htm

To keep the time schedule of every logistics and transport service is today the most important criteria to fulfil towards a customer. Companies work with small margins and avoid having large stock levels that would generate huge inventory costs. Today, many companies work by the philosophy “just-in-time” (JIT) and demand that each delivery arrives exactly as planned. This puts an enormous pressure on transport providers such as Schenker and is more or less forced to guarantee a constant high reliability and efficiency of all their transport services. We are convinced that this can be accomplished by utilizing a series of intelligent mobile services provided by the latest technological systems. Successful implementation of these services will most likely boost the good reputation of Schenker and strengthen their competitiveness against other transport providers even further.

7.2.1 Business Values

Since Schenker mostly acts as a third-part or even fourth-part provider of transport and logistics services, it is of highest importance that they are able to inform customers about deviations that appear in the physical flow where Schenker is responsible. If Schenker are able to supply their customers with information in a quickly manner that helps customers to optimize their supply chain, this will create a high customer business value. They will be better prepared and organize their resources more efficiently. Therefore information will be one of the most important “products” that Schenker can offer their customers.

Customers today require more visibility over the physical flow of their goods between different plants. The possibility to monitor and control the physical flow will be of highest interest and a big help when customers striving for an optimal supply chain. The possibility to offer customers real-time information directly from vehicles regarding the transports status will increase the business value even more.

Schenker will in this way be able to offer their customers an improved supply chain with high efficiency and security. Consequently, Schenker will receive a reputation that they will be a company that offers transports and other logistics services in an efficient way where the goods are delivered on time, in right quantity and to the right place. Other business value is that they could offer transports with a high security level when needed. Schenker will in this way get competition advantages and receives both new customers and keep old customers.

7.2.2 The importance of a system for trailer tracking

For a company like Schenker that disposes a huge fleet of trailers and not tractors, is it very important to have the ability to track both trailers and trucks independently. Schenker has in most cases hired hauliers that use their own tractor, which in most cases is not equipped with devices and other equipment that could support mobile and wireless services. Because of this, it will be of high interest to have the ability to track solely the trailer regardless of what equipment the hauled truck is equipped with. In this way Schenker will still be able to offer their customer a full selection of services no matter of which haulier that is contracted.

Another aspect to have in mind is that the trailers are Schenker’s key assets that generate most of their revenue and to manage their use as effectively as possible is of course of highest concern. With a solution for trailer tracking that Schenker now has introduced will this be a reality.

7.2.3 Schenker Security Services

Due to our focus in security of this work has mainly services towards security areas been investigated. This is however not a disadvantage, on the contrary, we have discovered several additional benefits besides an increased overall security in cargo transport. Many of the services we have found will in fact benefit the areas of both security and productivity, e.g. the positioning service.

The level of security measures needed in a cargo transport will vary from case to case depending on value of the cargo, type of route, technical limitations, etc. We have therefore identified and grouped 3 levels of security: low, high, and very high security. Each of them is adapted to support different types of business cases.

	Low security	High security	Very high security
Positioning unit	GPS	GPS (GSM backup)	GPS (GSM backup)
Communication unit	SMS or GPRS	GPRS (SMS backup)	GPRS (SMS backup)
Sensors	NO	Doors	Doors,
Cargo seal	NO	NO	Electronic, RFID tags
Encryption	NO	YES	YES
Compression	NO	YES	YES
Fortified case	NO	NO	YES
Fortified cables	NO	NO	YES
Surveillance camera	NO	Inside of vehicle	Inside and outside of vehicle
External power source	Extra battery	Extra battery	Extra battery, solar panel, wind fan
Services	Tracking, alert	Tracking, alert, cargo monitoring	Tracking, alert, cargo monitoring

Fig. 7.1 Security packages.

7.2.3.1 Low security

This level offers minimal efforts of security measures and allows quick and easy implementation of the equipment. We propose an independent portable device that is not integrated into the vehicle. This device will include a positioning unit, preferable GPS, and a communication unit. This simple solution suits well in cases where the cargo is of low value but at the same time need the ability to track and trace the vehicle. The device itself can be very "dumb" and just transmit a position by predefined intervals. This package can be suited for use in everyday deliveries.

7.2.3.2 High security

In order to achieve the level of high security requires a rather sophisticated device that must be able to support a range of external ports for use in sensor-reading. Both digital and analogue inputs and outputs might be needed. The device and the accompanying equipment will be an integrated part of the vehicle in order to provide the services such as doors sensors and camera surveillance. This is a solution suggested for valuable goods transports and will therefore also require a high integrity of the information flow. That is the reason of why we need encrypted transmissions to prevent unauthorized people from reading the vehicle position in real-time. Compression is often needed in order to minimize the amount of data packets during transmissions.

7.2.3.3 Very high security

The last proposal is suggested to those cases with extreme focus on security. In addition to the security measures described above, we will also fortify all the security equipments with near indestructible armour, in order to defend against physical force. Radio “jammers” (signal interference), however, will still be difficult to guard against. It is possible to detect this kind of activity by continuously checking the vehicle e.g. every 10 seconds and alert when no signal is detected for a longer period. This level of security will also demand a high reliability of the power supply. Solar panels and wind fans are possible solutions to assure the power supply to the device in the trailer.

7.2.3.4 Summary of security services

We have come to the conclusion that with relatively little means we are able to generate significant security improvements. The positioning service, sensors and wireless technology are sufficient elements to fulfil a set of security aspects that we have summarized identified during this work, those are presented below.

1. Full visibility
2. Reliable information
3. Intrusion detection
4. No tampering of goods
5. No tampering of equipment
6. Alarm
7. Instant reaction

We believe that smart devices and mobile services are the key to overcome many of the challenges in a nomadic information environment especially in the transport industry, and security is a perfect area to address.

7.2.4 Communication technology

To communicate and share information with mobile units is only possible with wireless technologies. We see two clear distinctions in this area: local and global. Local wireless technologies are utilized between two objects that are in near vicinity of each other, for example a driver and his vehicle. WLAN and Bluetooth are example of these types of communication carrier. The global wireless technologies are complete opposite; these technologies are developed to allow communication in a worldwide basis. Technologies suited for this purpose are GSM, GPRS and the upcoming 3G. The coverage for these technologies is, according to our survey among communication companies, good enough for this business case.

7.2.4.1 Drawbacks and advantages with GSM

GSM is a communication technology that is very well widespread and established in the world today. The GSM technology has also been used since 1991 and is therefore considered reliable and stable. GSM has three means of transmitting data: SMS, GSM-data and GPRS. One big drawback with SMS is the transmission capacity and the cost it will bring to use, however, it is still the most popular method of sending text information throughout the GSM network. In order to use GSM-data, it is necessary to have a modem-park at the receiving end. Each transmission needs a free modem to establish a circuit-switched connection and this will eventually have a severe limitation in the amount of simultaneous connections.

Each country in Europe has at least two network operators of GSM. It requires roaming-agreement between all operators in order to get GPRS fully functional in all parts of Europe. However, this is already taken cared of according to one of the leading mobile network operator (Vodafone) in Europe. They declare that GPRS is available where GSM is available.

However, GPRS has one limitation. When many users are using the same GSM-cell, then the GPRS traffic could be unavailable due to that voice traffic is prioritized over GRPS traffic. Advantages are packet-switched transmission and communication costs, which will decrease significantly compared to SMS. When using GPRS, you are connected to the network all the time but will only pay for the data/information you transmit. This will allow higher control in cost calculations.

7.2.4.2 Summary of Communication technology

The cost of transmissions will probably become the largest expense when the project is up and running. That is why it is of the highest importance to be able to control this and adjust the settings whenever there is a need for it. It is important to point out that all the GSM related transmissions methods are only available where GSM coverage exists. This could lead to possible problems if the vehicle is out of the coverage area for an extended time and become unable to transmit their location. The coverage of the European roads plays therefore a significant role in the success of GSM technology. However, the GSM network is under constant expansion and Europe will probably have the largest roads sufficient covered. This problem would perhaps eliminate itself in due time.

7.2.5 Positioning Technology

The accuracy of positioning a mobile unit today is down to a level of meters. There is today two ways of tracking a mobile unit. First you have the GSM-alternative where you are able to track a GSM device within its coverage area. This is not the first alternative that you choose if you must have a high accuracy on a position. GPS is much superior in this case. We will therefore, in this business case, strive for using GPS in first hand, and GSM-positioning as a back-up when GPS positioning not is possible.

One further alternative to have in mind is the European system for satellite navigation, GALILEO, which is planned to be operational from 2008. GALILEO will provide a wide range of improved and more reliable services and better accuracy to users over the entire surface of the earth. One further advantage is that GALILEO is built for civilian use in first hand and will be fully backward compatible with GPS.

7.2.5.1 Summary of Positioning Technology

Tracking and positioning of trailers is a vital part in this business case. Especially, there is a difficulty to hide the antenna that is required by the GPS receiver. The antenna must have clear sight in order to have contact with the satellites. Another drawback is when e.g. a trailer or vehicle is inside of solid buildings, ferries, etc., then the GPS will seize to function.

7.3 Transport security

Transport Management is an area of supply chain management where it lacks in research, even less in the security segment. Today this area is of highest interest due to the recent years of international terrorist acts and increasing theft activities. Leaders from all over the world have begun to address the issue of transport security. There is an increasing need for improved security during road transports and new mobile and wireless technologies make it possible (Bowman, 2003).

"*Transport security is the combination of preventive measures and human and material resources intended to protect transport infrastructure, vehicles, systems and workers against intentional unlawful acts.*" (European Commission, 2003)

Security in freight transport has always been an important issue to address, but lately have this matter been in focus even at top level of European Commission (EC). They world today is facing more criminal and terrorist activities. The cost for theft in the transport industry alone is estimated to hit the European economy several billions euros each year. It is easy to assume that profit from these stolen goods may fund further criminal activities. Even terrorist incidents that target the transport infrastructure could make severe impact to the European economy and paralyze the transportation network.

7.3.1 Security areas to address within the supply chain

There are several areas in the field of transport security that needs to be focused on. You can never achieve a total security due to the enormous complexity of the logistic industry. Security breaches can occur in all levels within the industry and add to the international nature, makes it even more challenging. There are though some areas that could need extra attention when designing security applications.

Key infrastructures

Airports, docks, major terminals, tunnels etc, are all critical areas to protect and is essential to a functioning supply chain. If any of these becomes disabled due to terrorist attacks and other unlawful activities would cause devastating consequences to the global economy.

Security standards

Standards are important to follow and give a common framework for involved parties to follow. However, the various actors in the logistic industry implement different measures in different ways to counterattack security problems. There has still not been established a minimum security standard among many of the international transport service providers. However, there are global organizations like TAPA, see section 4.X.X, which will aim to resolve this issue.

Theft

Theft and burglary are a serious problem in the transport industry and involves risking lives and health of millions of drivers around the world. The industry loses colossal amount money; the National Security Council in the United States estimates more than 10 billion in goods are stolen annually in their country. (Carlson, 2000) Electronics and other hi-tech consumer products are most theft-attractive and one single trailer can be worth millions of Euros.

Inside jobs

One of the most devious threats to security is when somebody leaks sensitive information to external parties. These kinds of treacherous acts can neutralize all security measures in one blow. Just think of the large amount of people involved in the supply chain and it only takes one person to compromise the entire security system. The risk may be higher when most of the transports are contracted to external haulers.

Information secrecy

Sensitive information such as routes, cargo value, schedules can have devastating consequences in the hands of wrong person. These kinds of information should only be accessed by a few key-personal in order to limit the possibility of spreading. However, the personal security of these people should be increased since they may be target of threats and extortion due to their knowledge.

System security

When more IT-support is implemented in the organization with purpose to increase security and counterattack threat may in some cases impose an even greater security risk itself. This paradoxical situation is possible since all critical and vital information is stored at one central place and may be very attractive to hackers working for criminal or competing organizations. Whenever the hacker succeeds to get access into the company network, then it has all the means to acquire sensitive data since all systems are connected to each other in one way or other. In most cases will a password and username be sufficient to gain access to the majority of the systems; some people may still write down their passwords on post-it notes next to their computer.

Security awareness

The security is only as strong as its weakest link. No matter how advanced security systems you implement in one node it will be completely useless if the previous node is lacking in the security policies. The easiest way to increase security throughout the whole industry is simply educate and inform the employers about security in their daily activities.

7.3.1.1 Security cost

The security areas mentioned above are only a fraction of all the areas that could be needed to address for increased total security of transportation industry and a sustainable supply chain in the future. However, security doesn’t come for free, there could be large investment in order to improve the security processes. There is currently no comprehensive information for added cost of security measures. Some analytics predict that added security cost in trucking and aircraft carriers would be as high as $2 billion. This must be considered relative to profit margin. There is chance that current margins will not sustain these new security investments. The goal is to achieve a win-win situation and find a way enhance security and supply chain productivity at the same time. Increased security is expensive, but it is perhaps possible to mitigate the total cost if some security enhancement can also improve efficiency, customer service and theft losses. The savings generated from these areas could perhaps finance a part of the security investments.

7.4 Win-win approaches

Cost and expenses are often the most breaking factors for integrating new technology into existing processes. It is therefore of very high importance to identify approaches that would generate win-win situation for the involved participants, that will benefit both a better supply chain and increased overall security. It would also be easier to share the burden of the large investments among the actors in the supply chain.

7.4.1 Vision of the possibilities

It helps if you have an optimistic vision. Some people would argue that if security implementation would be “thoughtfully done”, it would reduce the supply chain cost by 20-30 percent. The core of a “thoughtfully done” security would emphasize consistent, predictable flow and help drive more variance out of the entire system.

7.4.2 Improving Supply Chain Management

Security can come from improved business practices too. There are huge benefits in improving vertical coordination within supply chains and better horizontal coordination to improve security within industries, cutting across supply chains. Yossi Sheffi, Co-Director of MIT’s Center for Transportation Studies, also argues that standardization adds a security bonus to business benefits.

7.4.3 Improving Visibility and Control

Improving visibility in the supply chain is the single most recommended approach to simultaneously improve supply chain management and security. Bad visibility affects both business performance and security; it limits flexibility and enables opportunities to cargo tampering.

Excellent visibility has three types of benefits.

1. The first is efficiency and productivity, saving cycle times and labour hours. Accurate visibility information enables optimizing assignment of equipment and people across functional areas such as operations and maintenance. Successful optimization reduces the cost of providing service.

2. The second is service quality. Increased awareness adds flexibility and making it possible to recognize and reach early to problems. Carriers can respond more effective to priority changes and route changes. Perhaps the most important of all, user and customer confidence will increase.

3. The third is shipment and service integrity, which is directly related to security. Better monitoring will naturally improve security against tampering and theft.

There are two means to better visibility. The first is the information system(s) that manage, manipulate, and display visibility information. The second is the event- or transaction-driven tools that convert a physical event into a data entry for the software systems. This is important because it determines the quality of source data in the software systems.

There are five visibility-related technologies with potential to enhance both security and supply chain productivity.

- Supply chain software such as asset management tools and logistics portals that are tuned to accommodate security applications.
- Electronic cargo seals, low cost and simple aimed at theft prevention.
- Point or portable sensors that can monitor cargo and its conditions, such as intrusion detections and contraband “sniffers”.
- Wide area communication technologies integrated with sensors and GPS-like locations technologies are almost crucial.
- Biometrics tools to enable positive identification of authorized personnel.

If both the security and supply chain managers keep in mind the goal of weaving together the best from the two perspectives, productivity and security, it may be possible to make significant advantages and increased profitability for all involved parties. This kind of collaboration among the actors in the supply chain will require one vital element - a well functioning flow of information throughout the whole network.

7.5 The Importance of Information Exchange

We have regularly during our work being noticed that efficient information exchange between companies involved in a supply chain is of highest importance. An effective information flow within a supply chain will create opportunities for all parties to gain greatly advantages in form of more efficient and effective processes. This will create a win-win situation for all involved parties and creates cost reductions and a more efficient utilization of assets and facilities.

A supply chain has changed from a set of linear processes where all companies strives for as high internal effectiveness as possible. They just have had focus on their own processes and optimised them in a manner without having the other external parties in mind. Today there has come to all knowledge that all parties must collaborate and have both internal and external processes in mind for receiving an efficient and effective supply chain. This is strengthen by an establishment we have seen in several research papers and articles during our literature studies, roughly summarized this describes that companies involved in a supply chain must work together for to make the whole supply chain more effective.

The first thing that was made for an effective collaborating between companies was that they started to connect their logistics information systems to each other. This was made through wired proprietary networks between companies plants and in this way they where able to watch a suppliers stock level, put purchase orders, etc., directly in the suppliers information systems. This sped up the information exchange radically since you not eliminated lot of manual work as phone calls and paperwork to the supplier. This kind of EDI systems was the initial step for an increased speed of the information flow. The EDI systems have yet their drawbacks. First of all they are very expensive to implement and therefore smaller companies involved in a supply chain have difficulties to invest in this kind of systems. Secondly EDI systems often are dependent on a specific platform that creates difficulties when companies different information systems shall exchange information. In recent years there have been different standards developed, such as EDI X12 standards and UN/EDIFACT, to neutralize this kind of problems. The evolution of EDI has today progressed towards web-standards like XML which enables even more flexible and efficient information exchange.

The introduction of the Internet network has radically facilitated the information exchange between collaborating companies. Utilizing the Internet network does not require large investments in new expensive infrastructure upgrades. Internet has made it possible to integrate all companies, in all sizes, involved in a supply chain.

The information exchange process has in the past mainly occurred between plants within the supply chain. Today, wireless networks are dramatically reshaping the supply chain into a dynamic supply web. In this web, wireless devices allow the supply chain to instantly sense requirements, problem, or change throughout the network. This access real-time information will enable faster decision making and greater communications among parts of the supply chain. This network of wireless transmissions will inevitably introduce new security aspects to take into consideration. One important issue will be to assure the integrity of the data flowing throughout the network, preventing unauthorized tampering and collecting of this data will be extremely crucial in order to attain and maintain a high level of security.

We have been noticed throughout our work about the importance of information exchange between parties involved in a supply chain. Therefore, we argue that companies must work towards common standards for information exchange. All the new mobile and wireless technologies will sooner or later be intertwined with each other and this will introduce even greater challenges if common standards are not followed.

7.6 Standards

7.6.1 Technological standards

The world of technology contains almost infinity variation of different technical science. Technological advances have reached enormous progress today and there are no signs of weakening trends, on the contrary. Technological breakthroughs occur almost every year and existing technology improves constantly. This will, and has, lead to a myriad of different specifications of standards in the world of computer and information technology. In chapter 5, we have only described a fraction of all the technology standards regarding wireless communication. It is easy to draw to the conclusion, without standardization will a chaotic world become even more chaotic.

It is necessarily, perhaps even crucial, that all the transport service providers operate to agreed standards. The security standards must be applied to all modes of transport: road, rail, and aviation, waterborne. Since the attacks of 11th September 2001 have various improvements in aviation and maritime security already been adopted and extensive cooperation between international organizations has begun to take form. One approach would be to adopt the security guidelines provided by the TAPA.

7.6.2 TAPA

The Technology Asset Protection Association, TAPA, is an organization of security professionals and related business partners from high technology companies such as Ericsson, Intel, Motorola etc. The purpose of this organization is to address the emerging security threats that are common to the technology industry, due to the high value of these goods. The rapid invention and development of high technology during the 1990’s has made computer and communication related products smaller, faster, more powerful and most important more desirable to criminals. A wave of worldwide criminal activities began to target freights in transit and traffic lanes. TAPA was therefore founded to attack the cargo theft problems facing the high-tech industry on a collective level. TAPA was founded in United States in 1997 and has been active in Europe since May 1999 as TAPA EMEA (Europe, Middle East and Africa). They have formed two key initiatives in order to aid the process of better security:

1. *“To draw up a set of agreed Freight Security Standards (FSR) to act as a guide to shippers of hi-tech freight on the standards of freight security required by the manufactures. This is now being implemented across the World.”*

2. *“To set up a common pool of information related to criminal activities against TAPA EMEA freight in transit – Incident Information Service (IIS). This information is stored centrally, constantly updated with new incident reports ad along with other related information services is freely available too all TAPA EMEA members and relevant Law Enforcement Agencies.”*

There are a few issues that have contributed to the increase in theft of computer related products in transit. The following list will highlight the most significant topics:

- Technology products continue to become smaller and more portable, increasing the risk of theft
- The huge relative value of technology gear enhances its attractiveness
- Organized and multi-national criminals are getting aware of technology products and its potentials
- The opening of word-wide distribution channels to emerging markets
- High increase in demand for hi-tech products among consumers

The TAPA organization is beginning to gain international reputation as a worldwide benchmark for the best of class in security handling, guidelines and practices. By applying their guidelines, will member companies also have a positive affect on the insurance rates provided by the insurance companies.

7.7 Future Work

The logistics and transport industry is an area in great expansion and many and thus gives many opportunities for additional interesting research fields. We have in this thesis work, in cooperation with Schenker, presented an architectural model of how a mobility platform could be designed, primary technically, in order to fit into a large organization such as Schenker. We see a clear need for further work in the user and usability area of this platform. These new tools will naturally introduce new workflows, techniques, possibilities etc. to drivers, operators, customers and so forth. The user perspective is an important segment to address in order to maintain and develop an environment with technological means.

Another important field of research is to investigate the reliability of all the wireless technologies, since they will play a crucial, part of the success of all the mobile services. The Transition and roaming capabilities of these technologies are significant issues to analyze due the huge expansion and variety of different protocols, standards etc.

8 Conclusion

This section aims to answer our two research question.

Our aim with this thesis work was to examine how mobile technologies and devices can be utilized and supported in a nomadic information environment targeted to increase the security of cargo transports in transit. We have concluded that mobile technologies provide intelligent, powerful, and necessary services that enable a better and more efficient supply chain management. These services will have the ability to reshape the old linear supply chain into a dynamic supply web where disturbances can instantly be sensed and followed by immediate actions. There is one service we have found to be extremely important – the positioning service. This service alone will provide full visibility over the physical flow and simply this fact will increase the security level of cargo transport remarkably. In addition, most of the services aimed for increased security will also have a positive impact on efficiency and productivity. We will therefore argue that by integrating mobile services into the physical flow will generate a win-win situation for all involved parties. Despite of the large costs in investments of equipments, systems, etc., will it in the long term perspective definitely pay off in form higher efficiency, less error rates, better customer service, increased security, and so on. Same tools are utilized to both increase security and increase efficiency.

In order to realise these services and test them in a real environment was therefore the Schenker mobility platform designed. This platform will work as an initial step aimed to support the concept for trailer tracking with a high focus on cargo security. This proved to be highly complex out of many aspects. The mobility platform was composed of many components, technologies and software systems in order to provide value added services for road transports. The best approach to build this platform was naturally to start small and increment one step at time. This tactic requires a modular architecture of well defined components which can be replaced or upgraded when needed. It was also very important for Schenker that this mobility platform became an integrated part together with their other business critical systems in order to utilize all of them as a combined resource of customer value. This scenario can only succeed if all systems follow common standards agreed by the industry; this is especially important when dealing with information exchange between internal and external (e.g. customer) systems. XML standard is a very good example of how it enables different information systems to exchange advanced collection of data regardless of their origin in terms of platform, OS and data source.

Our findings and conclusions would hopefully be further clarified in the diagram presented below:

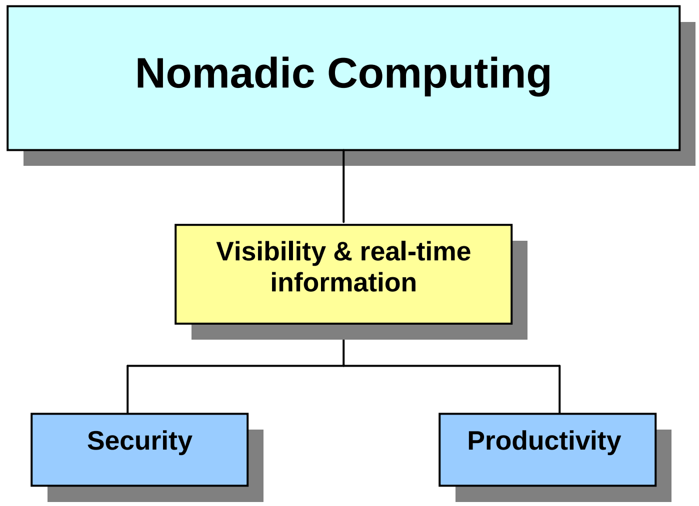

Fig 8.1 Concluding diagram.

Nomadic computing enables a high degree of visibility and provides critical real-time information instantly to all actors within the supply chain. These conditions will increase both security and productivity at the same time and with same tools.

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