Master Thesis in Informatics

Towards Seamless System Integration in Road Haulage Firms

Shadi Goharpour & Shahin Seifzadeh

Göteborg, Sweden 2005

IT University of Göteborg

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Business Technology

REPORT NO. 2005:53

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ISSN: 1651-4769

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Abstract

Organizations in competing environments have tried to use IS/IT for improving their performances by introducing enterprise systems into their organizations. In the context of road haulage firms this had lead to a plethora of mobile and stationary systems to cover different tasks. Solely, interests for integration and communication between these systems have emerged. By integrating different enterprise-wide systems and applications the synergy effects can be utilized leading to increased organizational competitiveness towards higher and greater business values.

The great variety of mobile and stationary systems developed by diverse vendors creates a mobile-stationary divide in existing systems. It can also lead to incompatibility issues in communication when integrating different systems, which must be handled. Handling this problem usually involves great costs in terms of time and spending valuable organizational resources and thus needs to be addressed. A vision of a 'total solution' to remedy this problem is Ubiquitous Transport Systems. UTS aims to function as an IT-infrastructure applicable to the transport industry, working as a solution for seamlessly integrated systems eliminating the existing mobile-stationary divide.

To contribute to the realization of the vision of ubiquitous transport systems a project "Standardization of Data Transport" has been carried out, as a part of an action research project "Value-Creating IT for Road Haulage Firms". The aim of the project has been to develop a basis for a communication standard interface functioning as mobile-stationary gateway usable for road haulage firms and system vendors in the transport industry facilitating system integration. Further, the organizational business values that system vendors and road haulage firms can gain by using the mobile-stationary gateway is presented.

This report is written in English.

Keywords: System integration, Ubiquitous transport systems, Mobile-stationary gateway, Business value

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1 Introduction

In the past decades information systems (IS) and information technology (IT) have played an important role in many business areas. Organizations in intense competing environments have tried to use IS/IT for improving their internal performances, and developed information systems to increase productivity in a wide variety of business functions. These improvements have resulted in a plethora of in-house developed systems, dealing with specific business activities in an organization. (Andersson and Lindgren, 2004)

When applying strategic view of the entire organization, a fragmentation of information system support is likely to appear (Markus and Tanis, 2000; McKenney and McFarlan, 1982). For handling this problem information systems known as enterprise systems have gain market. Removing the information fragmentation of the function oriented legacy systems is the main purpose of these systems (Davenport, 1998).

The urge for improved, quicker and more economical work processes have been among the motivating and driving factors in developing IS and IT. This includes the development of wireless technology and telecommunication, which have contributed to appearance of new types of enterprise systems supporting organizational infrastructure that creates new business opportunities for many organizations. Transport organizations are an example, due to the existence of moving mobile and stationary units in their distributed environment. Nonetheless, the fact that coordination of these units is important and central to the organizations survival. Fundamental activities in such organizations can be supported and managed using enterprise systems.

Road haulage firms are an interesting and important part of the transport industry and can gain great benefits by using enterprise systems to optimize and facilitate their daily tasks. Coordinating a geographically distributed and a moving workforce are typical for road haulage firms (Andersson and Lindgren, 2004). Drivers and trucks in such labor forces are primarily used for picking up and delivering goods on timely bases. The delivery or pickup sites may differ each time and depends on every specific order assignment. Because of the wireless technology and telecommunication improvements a wide range of sophisticated applications have been possible to develop supporting these daily tasks. These tools can for example handle positioning of trucks and cargos. The geographical position of trucks can be presented on maps for quick overview of the geographic resource distribution. Performance parameters from vehicles (e.g. speed, fuel level, temperature, etc.) can be recorded. The recorded data can be sent using wireless communication (Andersson and Lindgren, 2004). Such applications primarily intend to reduce time and fuel consumption making an assignment more profitable.

The emergence of ubiquitous computing facilitated by rapid developments in mobile and wireless communication technologies and ongoing miniaturization of computing devices, offers new possibilities and opportunities for organizations attempting to improve their productivity and effectiveness (Lyytinen and Yoo, 2002). But for being able to realize the vision of a 'total solution' (Brown and Vessey, 2000) for the transport industry, a unitary IT-infrastructure is needed. Ubiquitous transport systems (UTS) can be the answer to this problem. UTS refer to seamlessly integrated computing environments applicable to the transport industry. Hence, the realization of UTS is aggravated by the existing "Mobile-Stationary Divide" in the transport industry, which needs to be addressed (Andersson and Lindgren, 2004). This mobile-stationary divide can diminish through usage of a "Mobile-Stationary Gateway" (Hanseth, 2001) integrating arbitrary systems.

1.1 Problem Area

Existence of homogeneous information systems, i.e. enterprise systems, which can communicate and share information without any obstacles, would indeed facilitate processes for organizations. However, this could only be the case in a perfect world. In reality there exist many organizations, which use different stationary and mobile systems. In the context of road haulage firms these systems are mostly developed by different vendors for covering different tasks. This creates a fragmented flora of existing systems in use by organizations, where systems (stationary or mobile) usually don't support interaction, nonetheless communication with other systems resulting a mobile-stationary divide. Consequently a new integration for each system that needs to be accessed is of a necessity. To constantly having to perform new integrations is costly, time consuming and many times very complex. Further it often results in special solutions for many of these integrations and can in the future lead to more expenses and problems for organizations, in this case road haulage firms. The current existing IT-infrastructure in the transport industry diminishes the possibility of ubiquitous access to important information provided by different systems. Therefore realization of an IT-infrastructure offering this possibility in terms of ubiquitous transport systems (UTS) is considered to be important for organizations in the transport industry. Empirical studies indicate that the lack of standardization in this area also contributes to the difficulty of this realization. This apprehension is primarily shared by the users but even vendors seem to agree on it. Achieving a co-operation between different actors (e.g. system vendors, contractor of haulers, road haulage firms) in the field, specifically for development of a standard for this purpose is also a problem that needs to be addressed. The lack of knowledge for some users in this area, due to little involvement in IS and IT is another problem. This leads to difficulties when trying to introduce new applications or implementing new enterprise systems in road haulage firms and transport organizations in general.

For realizing a solution for seamless integration of different systems our project called "Standardization of Data transport" was initiated. As a part of a collaborative action research project called "Value Creating IT for Road Haulage Firms" it aimed to develop a communication standard interface functioning as a mobile-stationary gateway.

1.2 Focal question

This thesis includes a development of a communication standard interface functioning as a mobile-stationary gateway contributing to the realization of ubiquitous transport systems as an IT-infrastructure for the transport industry. It also focuses on issues regarding business values that organizations can gain by using such mobile-stationary gateway. Hence, we seek to answer the following questions:

-How can a communication standard interface be designed to support seamless integration of different mobile and stationary systems in transport organizations?

-How can transport organizations gain benefit from using such a communication standard interface?

1.3 Disposition

This thesis is divided in different sections related to each other as illustrated in Figure 1.

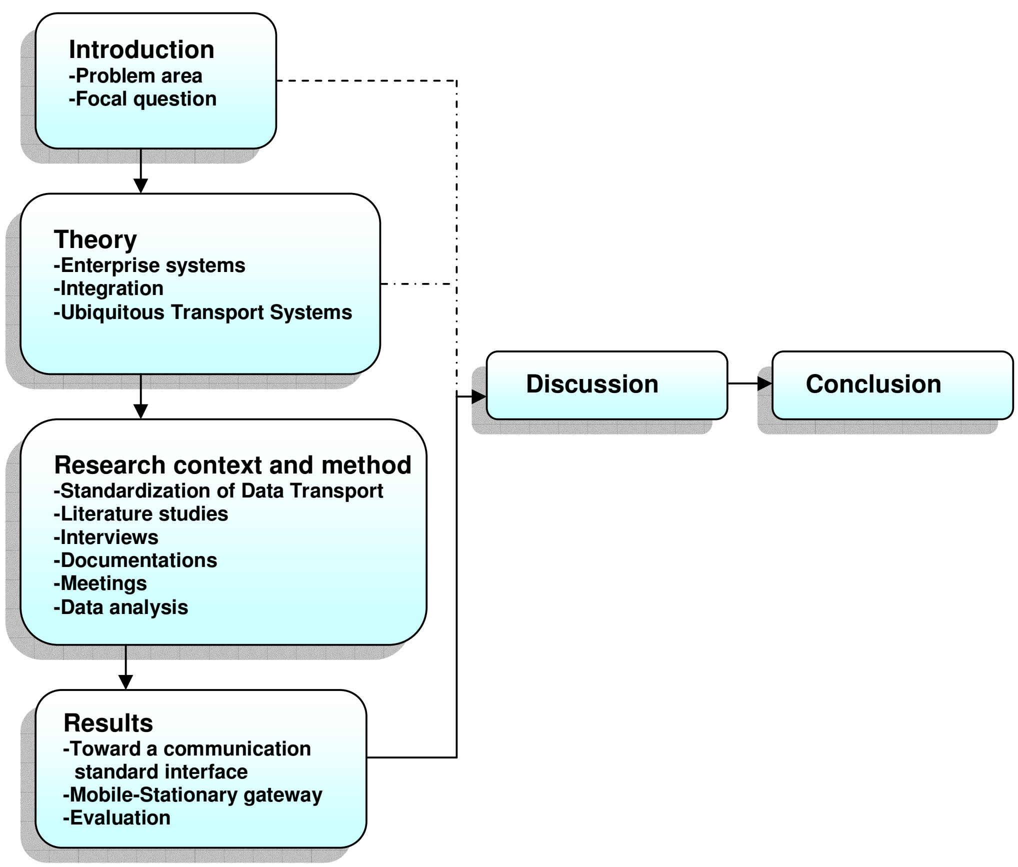

Figure 1. Illustration of sections and relations between them.

Section 1: In this section we start by giving an introduction and background to the problem area; finishing with focal questions that this thesis aims to answer.

Section 2-4: These sections present a framework consisting of three different theoretical areas. These are Enterprise systems, Integration and Ubiquitous transport systems.

Section 5: Here, the research context including our project "Standardization of Data Transport" as a part of the "Value-Creating IT for Road Haulage Firms" will be presented; followed by descriptions over used methods for proceeding with the work.

Section 6: In this section the results of our work will be presented. This includes gathered information used, the developed communication standard interface aimed to function as a mobile-stationary gateway and the results of the evaluation on the developed mobile-stationary gateway and its organizational benefits.

Section 7: Here, we discuss the various affects that the developed communication standard interface can have on organizations, in this case system vendors and road haulage firms.

Section 8: In this section answers to our focal questions are presented.

2 Enterprise systems

Enterprise systems help organizations deal with their supply chain: inventory management, customer order management, human resource management, and all other activities that take place in a modern business. (Davenport, 1998)

According to Sandoe et al. (2001) enterprise systems seem to offer a vehicle for enhancing competitive performance, increasing responsiveness to customers and supporting strategic initiatives. Sia, et al. (2002) describes enterprise systems as an IT-infrastructure that has a range of features facilitating the gathering, tracking, reporting and analysis of workplace behaviors.

Enterprise-wide systems are aimed to solve problems such as fragmentation of information in large business organizations. Davenport (1998) clarifies that many big companies collect and generate quantities of data, which are not kept in a single repository. Instead, the information is spread across dozens of separate computer systems, which are housed in an individual function, business unit, office etc. Every of these so called legacy systems may provide invaluable support for a particular business activity. Further, Davenport (1998) explains that maintaining diverse systems e.g. storing and rationalizing redundant data, reformatting data from one data to use in another, and for programming communication links between systems to automate the data transfer lead to enormous costs. There are even indirect costs involved, which are considered as more important than direct costs. For example if a company's sales and ordering systems can not talk to its production-scheduling systems, then it's manufacturing productivity and customer responsiveness suffer.

To get a general view over the structure of an enterprise, Figure 2 illustrates a model over the anatomy of an enterprise system.

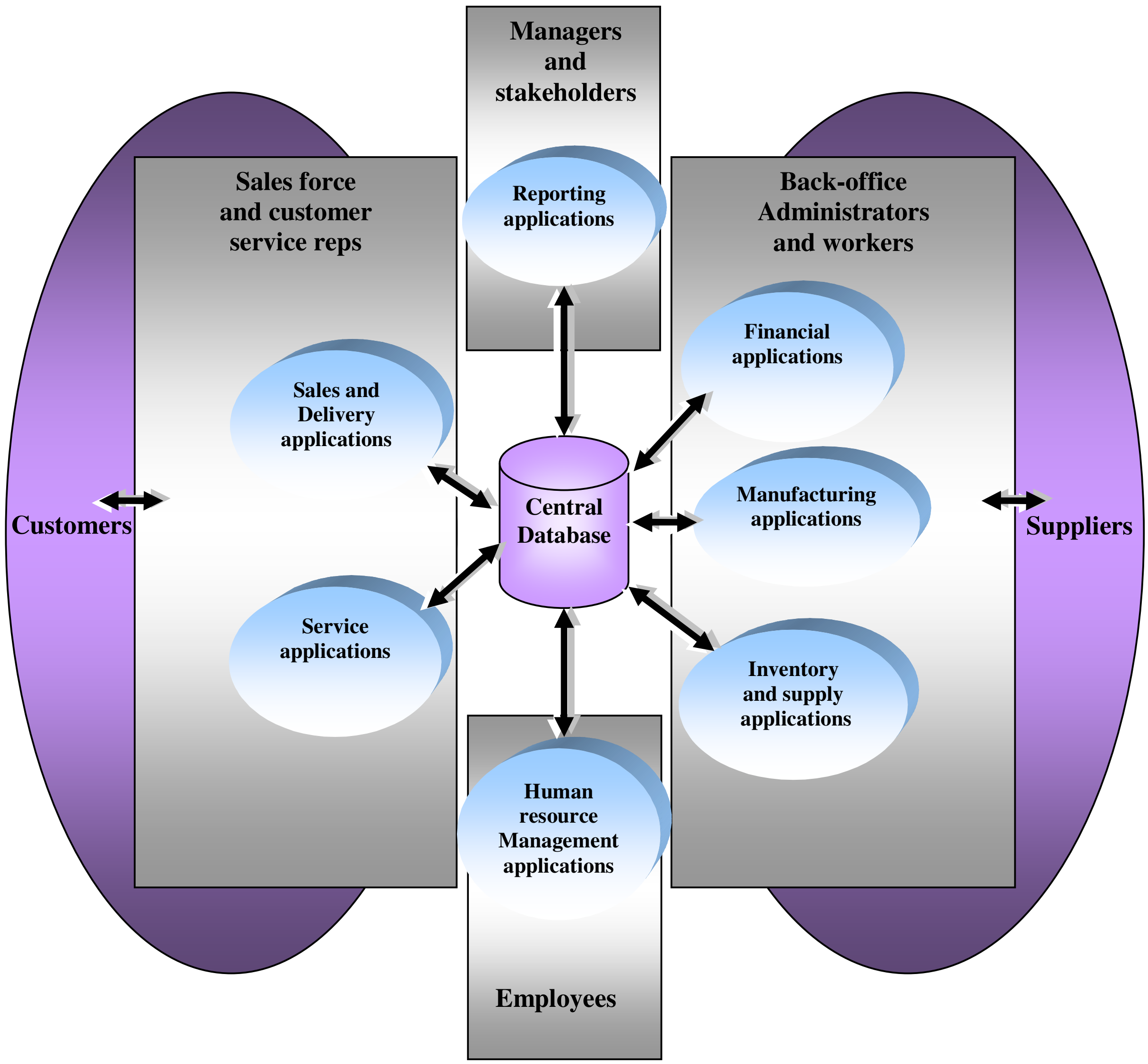

Figure 2. Anatomy of an enterprise system.

Most companies that install enterprise-wide systems need to adapt or in some cases completely rework their process to fit the requirements of the system.

> *"The business often must be modified to fit the system" (Davenport, 1998)*

It is the vendors, whom structure the enterprise systems. Consequently existing systems are not always the best solutions for customers. Some customizations in some level are though possible. Since systems are modular, companies can for instance install only those modules that are most appropriate to their business. (Davenport, 1998)

Moreover, Davenport (1998) argues that enterprise systems have direct and often impossible effect on a company's organization and culture. Systems allow companies to update management structures and get more flexible organizations, by providing universal, real-time operating and financial data. They even allow centralization of processes. When new information is entered in one place, related information is automatically updated. Companies use enterprise-wide systems to get more management.

As Nah et al. (2003) imply, an enterprise system supports a process oriented view of an enterprise, and standardizes business processes across the enterprise. According to Gattiker and Goodhue (2000) important elements of enterprise systems include data standards, process standards, process restrictions and integration.

2.1 Implementation

To improve the information flow across subunits and through an organization, many firms implement or install enterprise systems (Davenport, 1998).

Ragowsky and Somers (2002) explain that the success or failure of an enterprise system implementation for organizational transformation is highly dependent on the method used for introducing the system.

> *"Many of the issues involved in implementation are not so much technical as they are people-related and culture-related." (Ragowsky and Somers, 2002)*

Holland, Light & Gibson (1999) claim that, business and IT legacy systems determine the degree of IT and organizational change required for enterprise systems implementation success. The greater complexity of legacy systems leads to greater request of technical and organizational change.

There are some factors that have been identified as critical for a successful implementation of enterprise systems. Nah et al. (2003) give the following list of factors.

Factors	Include
Appropriate business and IT legacy systems	Business setting Legacy systems
Business plan and vision	Business plan and vision Project mission and goals Justification for investment in enterprise systems
Business process reengineering (BPR)	BPR Minimum customization
Change management culture and program	Recognizing the need for change Enterprise culture and structure management User education and training User support organization and involvement
Communication	Targeted and effective communication Expectation communicated at all levels User input
Enterprise systems teamwork and composition	Balanced or cross-functional team Partnership, trust, risk sharing and incentives Empowered decisionmakers
Monitoring and evaluation of performance	Track milestones and targets Performance tied and compensation
Project champion	Existence of project champion Project sponsor commitment
Project management	Assign responsibility Control of the project scope Define project milestones Enforce project timeliness
Software developing, testing and troubleshooting	Configuration or overall enterprise systems architecture Appropriate modeling methods Testing Integration
Top management support	Approval and support from top management Top management publicity and explicitly identified project as a top priority Allocate resources

Table 1. Factors affecting implementation success of enterprise systems.

2.2 Benefits

In an integrated enterprise system, a transaction in one subsystem instantaneously and automatically updates other subsystems (Gattiker and Goodhue, 2000). Enterprise systems link all or many business functions and operating locations together so that all have access to all relevant information as transaction occur (Davenport, 1998).

There are number of benefits gained using enterprise-wide systems. Below is summary of such benefits:

- By eliminating manual activities, enterprise systems decrease the costs involved for administration and information sharing (Gattiker and Goodhue, 2000).

- Communication and coordination benefits at corporate level (Goodhue and Wybo, 1992).

- Enhanced timeliness of information through enterprise system (Gattiker and Goodhue, 2000).

- IS maintenance costs may be reduced and the ability to deploy new IS functionality may increase (Ross, 1998).

- Reduced lead-time for customers (Schlack, 1992).

- Improving information flow across sub-units through standardization and integration of activities.

According to (Ragowsky and Somers, 2002) using same enterprise system applications don't necessary mean the same benefits for all companies. Solely, different organizations should choose enterprise system software packages that better suit and support their needs as well as their demands.

2.3 Problems

Despite of the fact that there are many benefits using enterprise-wide systems, there are also some problems to consider. Vogt (2002) describes two problem characteristics related to enterprise systems, namely *generality* and *complexity*.

Existing enterprise systems on the market can generally be used in almost any organization regardless of the purpose, i.e. manufacturing or distributing. This is referred to as generality. Complexity on the other hand is the fact that these systems usually can run every aspect in any business, which makes them difficult to implement, set-up and maintain.

- Reliability, a single system that controls the entire business, making the company highly dependent.

- Big-bang seduction, a company chooses to abandon its working systems and change it to enterprise systems.

- Overeager customization, an enterprise system serves many different companies and is not customized to one particular.

- Cultural hurdle, the difficulty of employees to embrace the new system when having to face a changing environment, inconvenient retraining and uncertainty.

In excess of the revealed problems there are even other disadvantages related to enterprise-wide systems, which are listed below:

- High implementation costs (Ragowsky and Somers, 2002)

- Costs related to training (Ragowsky and Somers, 2002)

- Too complicated to use (Baily, 1999)

- Not fitting the organizational needs (Ragowsky and Somers, 2002)

An enterprise system requires its own logic on a company's strategy and culture. Functions related to financials, human resources, operations and logistics, and sales and marketing can be covered by the scope of an enterprise system. Enterprise systems drive a company towards common processes and full integration. (Davenport, 1998)

3 Integration

Integration is the linking of information and process of distinct subsets of an organization. Integration can occur between operating entities or between functions. (Gattiker and Goodhue, 2000)

Techtarget (2004) has an explanation for the concept of integration. Integration (from the Latin integer, meaning whole or entire) generally means combining parts so that they work together or form a whole. Further, Techtarget (2004) explains that components that is said to be integrated can meet one or more of the following conditions:

- The components share a common purpose or set of objectives in the loosest form of integration.
- The components hold on to the same standard, set of standard protocols or share a mediating capability.
- The components where designed at the same time with a common purpose or architecture.

Integration can be viewed as a way to glue or tighten a widespread business on an organizational level, involving cultural and knowledge issues, on an information level where system specific issues are dealt with, and on a technical level. (Spender and Grevesen, 1999)

Gattiker and Goodhue (2000) mean that integration requires data standardization and process standardization. Standardization and integration simplify communication and better coordination (Goodhue and Wybo, 1992). According to Magoulas (2003) no integration is possible without mutual understanding. For achieving a successful integration people must come together and work for mutual understanding.

The traditional view on IS integration has been that information systems with various connections must directly access each other's databases. This, in order to get information or perform diverse updates on the current information (Magoulas, 2003). Hugoson (1989) claims that this way of handling integrations between information systems results in so called "spaghetti structures". He further argues that these kinds of structures often are hard to survey and can at the same time be instable and inflexible.

3.1 Information integration

Encyclopædia Britannica (2004) describes information as; the communication or reception of knowledge or intelligence. Techtarget (2004) on the other hand describes information as stimuli that have meaning in some context for its receiver.
Information stored in a computer is generally referred to as data. When this data is processed (e.g. formatted) the output data can be perceived as information. When information is packaged or used for understanding or doing something, it is known as knowledge. Techtarget (2004) also claims that information integration is to provide the user with a unified view of data combined from different sources.

According to Kleewein et al. (2002) information integration is a technology approach that combines core elements from several systems (data management systems, content management systems, data warehouses and other enterprise applications) into a common platform.

Abrams (2003) sees some issues involving information integration. These are:

- Difficulties in accessing relevant information, even if it exists.
- Fear of overlooking something important.
- Information overload.

Often integration is accomplished by providing the user with a representation of information that hides the details of the data sources and lets the user focus on specifying what he or she wants. (Callaghan, 2002)

Jhingran et al. (2002) and Sheth (2003) state that supporting access to heterogeneous data sources is an important challenge in information integration. There are three barriers that need to be overcome for achieving this goal so that information can be used effectively within an enterprise. These are:

- Data heterogeneity

  It must be possible to process data with diverse formats.

- Data "federation" and distribution

  Data is distributed in different organizations and no longer resides on one logical server.

- Data usage for competitive advantages

  The access speed can be increased by moving the data to a more accessible location.

3.2 Data integration

It has been proven that in many large organizations today, a common language of logically compatible data does not exist (Goodhue et al, 1988). There are often different identifiers for key business entities in a single company e.g. customer or product, or different calculating key concepts, such as profit and return on investment (ROI) (Goodhue et al, 1992).

Data integration generally means the standardization of data definitions and structures through the use of common conceptual schema across a collection of data sources (Heimbinger and McLeod,1985; Litwin, et al., 1990). Data integration ensures that data have the same meaning and use across time and across users (Martin, 1986). Sheth and Larsson (1990) mean that data standards will help to eliminate potential errors when translating information. Even the possibility for any uncertainty of what a field represents will be removed. Further, (Huber, 1982) argues that they simplify reconciling or translating of information defined inconsistently across multiple sub-units in an organization.

Goodhue et al. (1992) explain data integration as a common definitions and set of codes representing a field between IS or databases. In addition Goodhue et al (1992) claim that, the data integration can enhance along two dimensions:

1. The number of fields with common definitions and codes.
2. The number of systems or databases using these standards.

There are several organizational impacts when using data integration in an organization, which is shown in Figure 3.

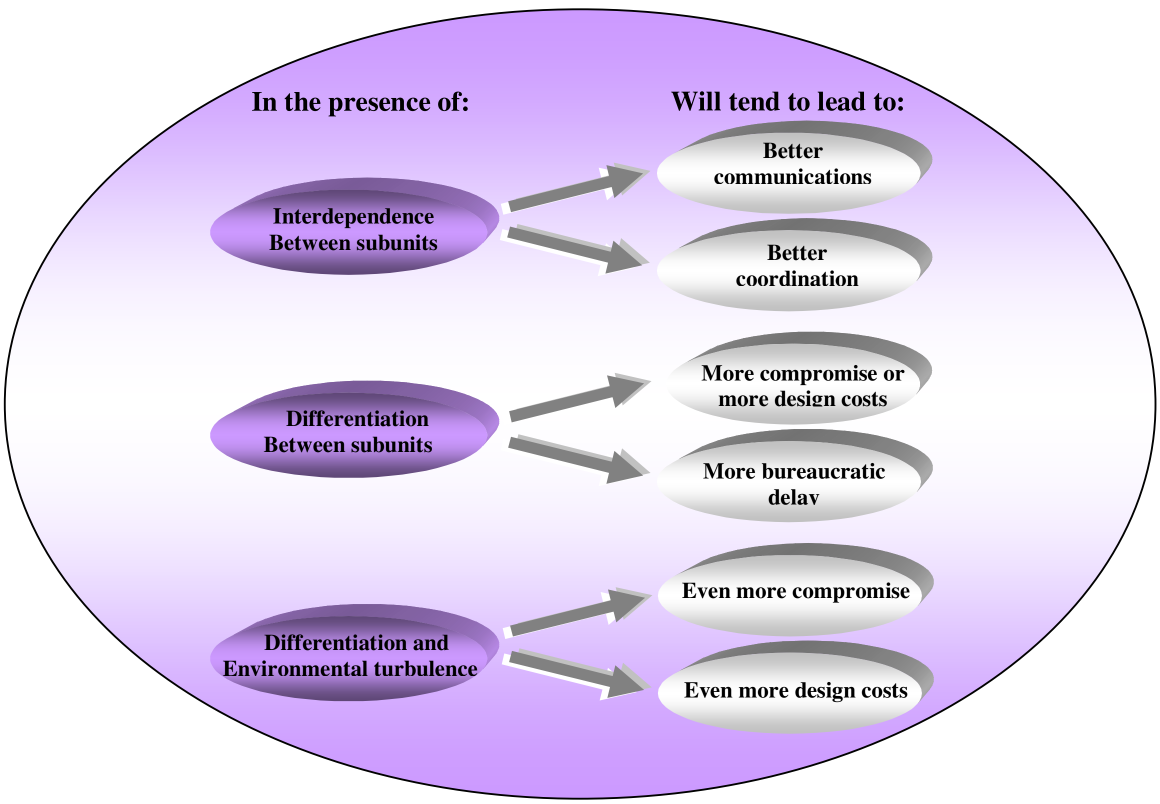

Figure 3. Organizational effects through data integration.

3.3 Enterprise system integration

To provide easy and efficient access to information, different enterprises share similar types of problems. Over the past years organizations have tried to create various systems to manage their information and data. Many of these enterprises have found themselves with several unrelated enterprise systems among their departments, especially after mergers. Enterprises need to integrate their diverse systems to be able to function more effectively. Of the same reason also providing standardized access to the available information is important.

Enterprise system integration is common and high prioritized in the new fast expanding business world. Organizations want to get more competitive and many times more global. Due to merges and growth by acquisition organizations struggle to get a comprehensive view over all the different systems that have arisen, and to integrate them.

According to Market Visio (2003) in the past decades IT development has been very fast. New generations of enterprise systems have constantly been created, with the aim of replacing earlier generations of systems. However, because of the expenses involved in new implementations of the unique set of functions in existing systems, many organizations tend to hold on to their legacy systems. This leads to an increasing number of systems in organizations and an increased interest for better integrations between systems and applications.

Further, it is more effective to gather information from the same place by integrating systems and applications. This way the value of information increases. When all systems, internal and external, can communicate and exchange information with each other, profits can be gained from information systems. For example the external system that handles the costumer information, the business order-system, and the internal article database can integrate. This makes a good foundation for a more efficient business to business trade. (Market Visio, 2003)

Sandoe et al. (2001) emphasize that an organization may either choose to integrate because they see problems in their operations, both with internal processes and external relationship, or there are several technical reasons for enterprise integration. As business become increasingly global, integrated systems show promise for tying together the geographically distributed organization. Many of the organizations that have focused on system integration during the last years have been able to show profit (Market Visio, 2003).

The integration is a complex challenge, though in reality systems are likely to be on several different platforms and rely on different databases and data structures. That can be inconsistent and incompatible with each other. Schell (2001) implies that integration of multiple systems is a tricky concept to handle. It is difficult to get multiple systems to work together, whether they are written in a same language, running on same databases or platform. It would seem that integration of systems in such cases should be quite painless when using state-of-the-art, componentized, object-oriented, eXtensible Markup Language or XML-enabled development for each system. To get multiple systems to function effectively as a unified enterprise resource is a major challenge for marketers.

3.3.1 Enterprise system integration strategies

There are two types of system integration strategies, namely loosely coupled and tightly coupled.

Loosely coupled systems

Loosely coupled strategy is by Schell (2001) described as, when data is passed between systems without any concern about the methods each system uses to manage the data. Interacting systems can function effectively as long as they understand the meaning of the data they receive, i.e. what it represents. Also integrated applications can carry out coordinated functions as required. This way each system can operate independent, even though data from other systems may be necessary for achieving wanted results. As shown in Figure 4 loosely coupled systems can communicate through messages without any direct access to each others e.g. databases to get needed information.

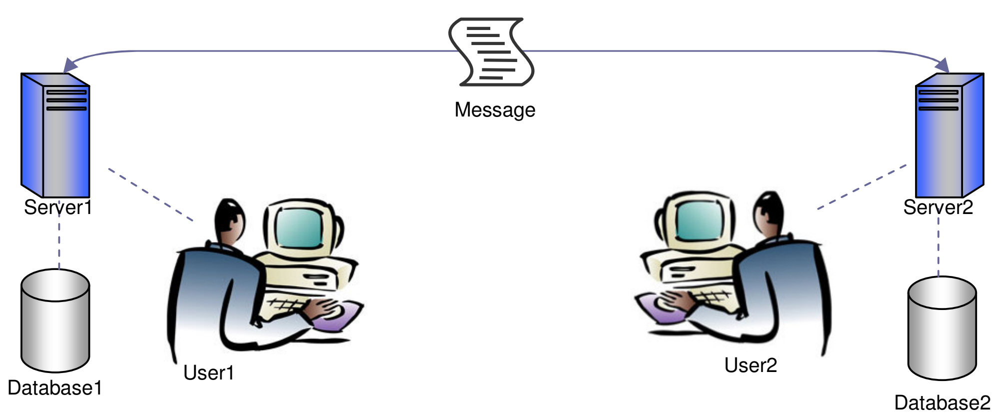

Figure 4. Loosely coupled systems communicating through messages.

Tightly coupled systems
Schell (2001) describes tightly coupled strategy as, when systems are linked so that each system requires functionality from another system to get its own job done. A system will begin a process, pass data to another system, wait for the other system to process that data and return an answer or an update (or request data from another system in order to complete its function). It then completes its original process. Tightly coupled systems have a direct access to the system they are integrated to (e.g. its related database), in order to get the desired information (see Figure 5).

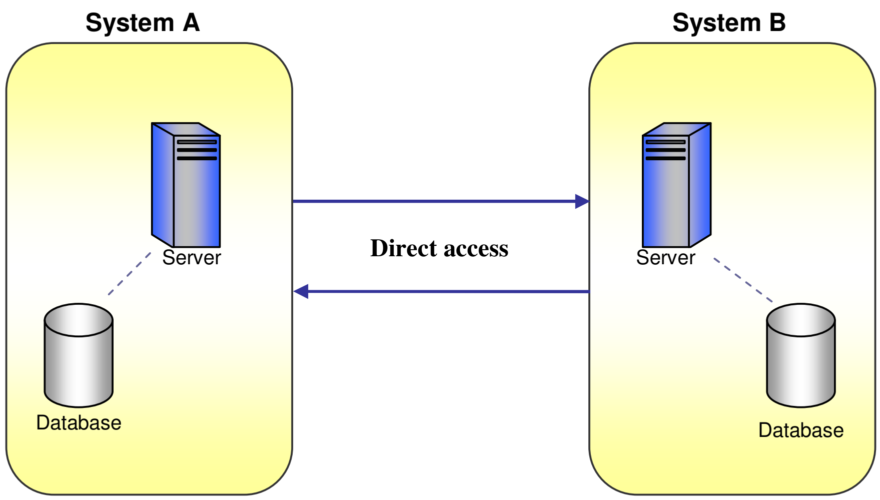

Figure 5. Illustration over two tightly coupled systems.

Using protocols designed for supporting business process integration (BPI) to enable the linking of diverse systems to each other is the future of system integration. Most parts of these protocols are dependent on XML. Even if in theory a BPI protocol is available, it is in practice still some years away. (Schell, 2001)

3.4 Enterprise Application Integration

Enterprise Application Integration (EAI) is a business computing term for the plans, methods, and tools aimed at modernizing, consolidation, and coordinating the computer application in an enterprise. In a fully functioning EAI platform it is possible to exchange specific applications without affecting the main purpose within the system.
There are several definitions of EAI and many authors define it differently. Yet, the common idea of integration is found in them all. Green (2000) defines EAI as the integration of dissimilar application systems to share information via a common user interface. Linthicum (2000) takes the process view and defines EAI as the unrestricted

sharing of information and business processes among all connected information systems in the enterprise. Taylor (2000) states that EAI is moving IS towards a platform for supporting electronic commerce. Erasala et al (2002) define EAI as the integration of applications that enables information sharing and business processes, both of which result in efficient operations and flexible delivery of business services to the customer. Implementing EAI does not always involve deserting current or legacy applications. It rather unlocks the value of these applications and deploys their functionality in a scalable way.

According to Erasala et al (2002) the core of EAI is the need to share and manage information, but the methods of doing this could be complex and varied. Extending useful information to all as well as avoiding information fragmentation is the driving focus of any EAI approach. Erasala et al further implies that given the enterprise-wide connectivity that EAI systems seek to accomplish, they may be expected to have certain basic characteristics and criteria. Five such characteristics have been identified by Green (2000):

1. EAI systems are directed towards integration at the business level—they can include all business and data processes.
2. EAI methods re-use and fully distribute all applicable business processes and data.
3. EAI methods involve no real understanding of specific system functions to integrate the applications. This ability to integrate with minimal understanding of specific functions is due to the technology's focus on the user side of the application, which requires no system knowledge.
4. EAI technology does not require source code or code administration rights to any of the target applications.
5. EAI technology generally requires no changes to the existing hardware infrastructure.

Interactivity between systems can be achieved either by invasive methods, non-invasive methods, or a combination of the two. Invasive methods involve direct interaction with the legacy system, or the target application at a source level. This can be useful if changes and enhancements to the business logic are proposed. But, occasionally, there can be operational issues with the existing application or other integration issues concerned with the legacy system itself. Therefore, this is generally looked on as a higher-risk strategy. Non-invasive methods usually do not cause operational issues and are valuable if the existing legacy application is currently meeting all operational needs. This approach presents the least operational risk. It establishes an interaction between systems via direct terminal links. (Erasala et al, 2002)
Such direct terminal links can be established by using gateways between different systems creating a network between the integrating systems.

3.4.1 Gateways

As the networks were growing, the need for communication between users of different networks appeared. This lead to a generally acknowledged need for one universal network, providing the same universal services to everybody. This universal network could be realized using gateways. A gateway can be defined in general terms as a link between elements. Within computers or telecommunications it is used to represent an object linking two different networks, different communication protocols or standards. For example the large and heavily used network JANET linking English universities was linked to ARPANET (current Internet) through gateways. Gateways between different networks or standards play the role of a converter or translator between different formats. (Hanseth, 2001)

Further Hanseth (2001) implies that the term in some cases is used in a broader sense, meaning that even standards or whole networks can be seen as gateways between different computers and applications.

> *"Gateways are key tools for succeeding in building and maintaining the networks we are striving for." (Hanseth, 2001)*

Gateways are key tools to enable the change of an infrastructure from one version to another and accordingly avoid being trapped in a lock-in situation. They help transforming one network from running one protocol standard into another network running another standard. Gateways can be used as a bridge enabling communication between different systems from arbitrary vendors. For example in transport industry they can be used for integrating stationary office systems and applications such as order systems with mobile systems and applications for handling of e.g. operational and vehicle data.

4 Ubiquitous Transport Systems

Ubiquitous means being or seeming to be everywhere at the same time (Dictionary.com, 2004). The term ubiquitous transport systems (UTS) refer to seamlessly integrated computing environments and it is aimed to function as an IT-infrastructure for integrating enterprise systems and applications applicable to the transport industry and its road haulage firms. As Pearlson (2001) explains, an IT-infrastructure consists of physical components, chosen and assembled in a manner that best suits the business plan and therefore best enables the overarching business strategy. Andersson and Lindgren (2004) refer to UTS as heterogeneous and distributed computing environment which intend to facilitate information sharing and seamless interoperation of the traditional business, mobile, and pervasive computing resources in transport organizations.

> *"UTS requires capabilities for integration of people, distributed and heterogeneous mobile and embedded technologies, and stationary transport business systems. In this way, such ubiquitous computing architectures hold the promise to offer transport organizations seamlessly integrated computing environments by identifying, adapting, and delivering the appropriate mix of stationary, mobile, and pervasive applications." (Andersson and Lindgren, 2004)*

As stated by Lyytinen and Yoo (2002) the fundamental characteristics of a ubiquitous computing environment are high levels of mobility, services and infrastructures, and the diverse ways in which data are processed and transmitted. According to Andersson and Lindgren (2004) the capability of identifying, adapting, and delivering the appropriate combination of stationary, mobile, and pervasive applications to the organization's computing environment is a must for an effective ubiquitous computing architecture. Ubiquitous computing makes it possible for organizations to improve their productivity and effectiveness. This affects organizations with a set of stationary and mobile systems in a distributed environment, where it is vital for the organization to coordinate its systems and to be able to communicate between them. Transport organizations are considered as such organizations. (Andersson and Lindgren, 2004)

UTS include mobile aspects as well as the relevant functionalities of present enterprise systems. A vision is to achieve a 'total solution' that can satisfy all transport organizations needs and demands, regarding information. The vision of UTS is to tie, i.e. integrate, different systems together, whether they are stationary or mobile. Yet, a big problem subsist, making the realization of such 'total solution' rather hard to accomplish. It consists of mobile-stationary divide of existing advanced technologies developed by different vendors. This divide is a huge obstacle when integrating stationary office systems and mobile applications into a seamless computing environment (Andersson and Lindgren, 2004). Stationary office systems can consist of transport order systems, economy systems including systems for handling wages, payments etc. Mobile applications on the other hand can consist of embedded vehicle sensor networks and telecommunication services, embedded systems for handling real time operational and vehicle data, and so on.

By tying different mobile and stationary systems can for example orders easily and quickly be sent to desired vehicles and be handled more effectively. In the same way other relevant and important information can be sent as massages between different systems. When different systems are able to communicate, the existing mobile-stationary divide can decrease.

Mobile-Stationary divide

According to Lindgren et al (2004) transport organizations, i.e. road haulage firms have started to implement and use different types of mobile and stationary IT-support systems to carry out their day-to-day businesses and to improve their competitiveness. However, their ability to combine different systems is restricted due to the existing situation of different mobile and stationary systems developed by different vendors not supporting each other. This leads to a mobile-stationary divide in existing advanced technologies. As Andersson and Lindgren (2004) describes, the mobile-stationary divide refers to a set of challenges associated with integration of mobile and stationary people and systems into a seamless computing environment.

This mobile-stationary divide involves some lock-in effects that make it difficult for road haulage firms to choose freely between existing systems and vendors. Further, it can force them to stick to their first purchased system, and to use later purchases in a complementary manner. The reason for this is explained by Lindgren et al (2004) to be the integration advantages associated with purchasing the same system from the same vendor simplifying their ability to utilize vehicle data for improving their cost control.

> *"Once a road haulage enterprise has invested in a brand-dependent fleet and vehicle management system, it finds itself with only two options when investing in a new truck. Either it purchases the truck supported by the systems vendor, or it purchases another truck while simultaneously inflating the value of its original fleet management system investment." (Lindgren et al, 2004)*

Road haulage firms seldom have one single brand of trucks in their fleet. They usually also have a variety of stationary and mobile systems to cover different tasks (Lindgren et al, 2004). This makes way for problems, considering that truck companies usually offer systems supporting their own brand. This leads to a situation where small road haulage enterprises are locked-in by specific suppliers (Shapiro and Varian, 1999). All these factors contribute to the mobile-stationary divide existing in the transport industry.

Lindgren et al (2004) points out that road haulage firms also can be locked-in by the information itself. Small road haulage enterprises have to have access to their contractors systems for being able to get information they depend on, e.g. information about available assignments, contracts, and price information (Shapiro and Varian, 1999). Contractors of haulers usually do possess information about the assignments. For small road haulage firms this information would be very valuable for conducting various types of cost and benefit analyses. Possessing transportation assignments and important information related to them often forces small road haulage firms to depend on the contractors (Lindgren et al, 2004). Shapiro and Varian (1999) emphasize that, because of the costs involved for developing own system small road haulage firms are locked-in by specific contractors and their systems. In addition Lindgren et al (2004) states that, due to the expenses involved for purchasing a full-range fleet management system as well as developing the required information management, many road haulage enterprises have to accept that they do not control the information about their own assignments and operations generate.

The existing mobile-stationary divide is a problem that needs to be addressed. Using a communication standard interface functioning as a mobile-stationary gateway for integrating different systems from different vendors is a way of solving this problem.
Through UTS potential effects of the existing mobile-stationary divide can be diminished, which could open way for many possibilities for the transport industry and the road haulage firms in particular. Therefore it leads to our project with the purpose of taking one step further towards the goal of realizing the vision of UTS, by realizing a communication standard interface functioning as a mobile-stationary gateway diminishing the mobile-stationary divide. Following sections will describe our process of work and accomplished results.

5 Research context and method

“Value Creating-IT for Road Haulage Firms” is a project that aims to identify and analyze how new IT support for road haulage firms should be developed and initiated with respect to road haulers’ needs. The vision of this project is to realize an IT-infrastructure, namely UTS for transport industries. The idea is not to intertwine applications, but to create possibilities for seamless integrated computing environments for free standing systems. The vision include creating a possibility for a driver to be able to access any arbitrary contractor of haulers, order-system etc.

The purpose of the project is being realized through action research, where truck manufactures, researchers, system vendors, and road haulage firms together survey, develop, initiate, and also evaluate systems and services for road haulage firms. This project has a unique combination of actors from different parts of the supply chain, whom in reality both compete and cooperate. This project has started in July 2003-07-01, and will go on until June 2006-06-30. Viktoria Institute that is an IT-research institute is responsible for this project.

To be able to get a more clear representation of road haulage firms, a description of how the road haulage firms function is given below:

The anatomy of Swedish road haulage firms

As known, road haulage firms in general work as transporting some kind of goods from one place to another, using trucks. These organizations seem to be alike, dealing with similar things, often in similar ways. As an example, can trucks, drivers, and transport activities be an organization’s core, which are common in road haulage firms. Nonetheless, in that core business activities, organizational structures, and size differ, the road haulage business sector is far from identical. Road haulage firms cover both local distribution and long distance transport. This can involve loading and unloading goods several times a day up to several days of interval. There are number of roles generally found in road haulage firm. These roles are dispatcher, driver, management, administrative personnel, and vehicle maintenance personnel. (Andersson and Lindgren, 2004)

- *Dispatchers* manage the incoming assignments and organize drivers and trucks.
- *Drivers* handle the transport of goods, which involves loading, unloading, the actual driving and planning of routes, as well as interacting with clients.
- *Managers* are responsible for economic planning and follow-up.
- *Administrative personnel* taking care of tasks like salary and invoicing.
- *Vehicle maintenance personnel* are involved in e.g. supervising of fleet status, service time scheduling, and the changing of tires.

The restrictions of these task related roles are fluent. Depending on business size, several persons can have a similar role or same person can have more than one role.

5.1 Standardization of Data Transport

During the project "Value-Creating IT for Road Haulage Firms" several empirical studies have been performed. This has lead to better inputs and guidelines for start of our project i.e. "Standardization of Data Transport", and also made it more simplified and effective. The project did start in August 2004 and lasted throughout January 2005 (see Figure 6).

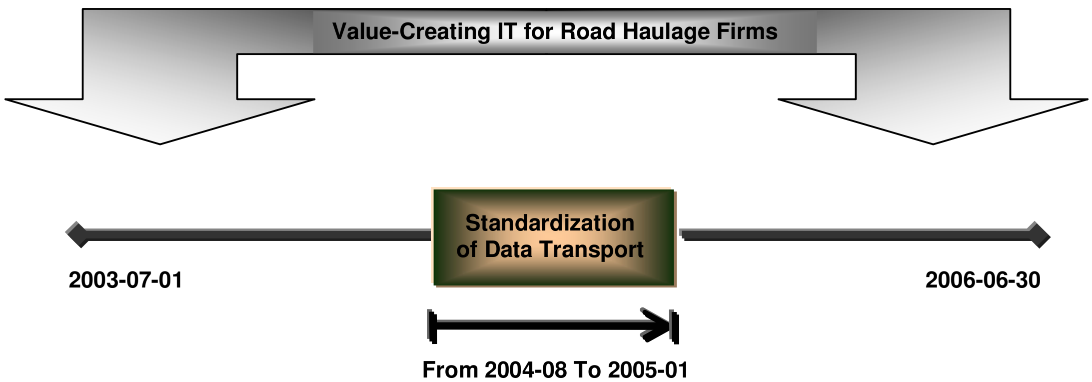

Figure 6. Duration of projects.

The aim of this project was to create integration possibilities, where freestanding systems existing in distributed environments can communicate and integrate. This can be realized through a standardized interface between these systems functioning as a mobile-stationary gateway. During the project a basis for a communication standard interface was created. This interface includes a structure over common data considered as important for transportation between different systems developed by arbitrary vendors, whether stationary or mobile.

The project has been carried out as a collaborative action research with participation of three different groups of practitioners from the programs Business Technology, Information System in Logistics, and Mobile Services and Telematics, where each group consisted of two members. A joint effort was made to contribute to the realization of the vision of UTS. Later the focus of our thesis have been to study business values that system vendors and road haulage firms can gain by using the developed communication standard interface as a mobile-stationary gateway.

The process of work has been divided in three different phases as illustrated in Figure 7, where the first phase of the project involved the process of developing a basis for a standard interface for communication in XML. This process was started with gathering of relevant information.

The second phase of the project involved the process of evaluating the developed standard interface. The aim of the evaluation process was to review the developed standard interface together with all the involved actors. This process was an important step in accomplishing a functioning standard interface that could be accepted and use by both system vendors and road haulers. In this process we looked for both positive and negative responses expressed towards the developed interface. Opinions of all the involved actors were very important contributing to the revising process.

In the third phase inputs from the evaluation process were taken in consideration in the process of revising the developed standard interface. During this process some modules and data parameters were added and some data parameters were removed to adjust the interface. Here, the developed standard interface was documented.

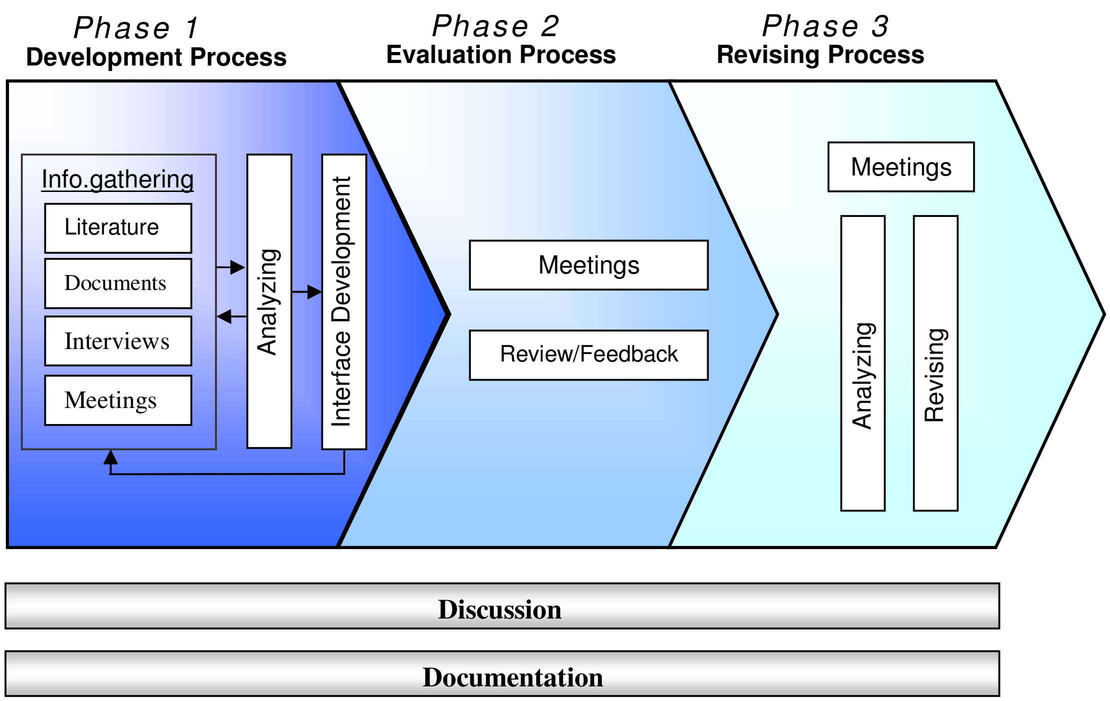

Figure 7. The process of work in the “Standardization of Data Transport” project.

A unique combination of actors from different parts of the transport industry was involved in the project. This group of actors included several system vendors, truck manufacturers and road haulage firms. This combination of actors was expected to give us a wide perspective and different angles of approach of the present situation and an overview over exciting problems.

The involved actors in our project were, Scania, Volvo, NL-Partner, Transware, IBS, Transics, Hogia, MobiOne, Mobistics, Vehco, TRB Miljö AB and two consultants from the transport industry.

System vendors

Here follows a brief description over participating system vendors.

Hogia

Hogia group consists of about 20 companies, supplying software for either a certain application (i.e. accounting or payroll) or a certain line of business (i.e. auditing firms, real estate or trucking companies). Hogia is a supplier of systems for booking and administration of ferry services including harbor terminals, and the supplier in Sweden of scheduling and follow-up systems for trucking companies. They have offices in Sweden, Norway and Finland.

IBS

IBS (International Business Systems) develops a number of softwares providing business solutions that covers the fields of collaborative sales and procurement, customer service, order management, demand-driven manufacturing, inventory management, business performance measurement and financial control.

MobiOne

MobiOne develops, sells and provides services for standardized mobile applications for supply chain management. These systems are standard applications, for product distribution, service assignments, order acceptance and sales administration. They have offices both in Sweden and Norway.

Mobistics

Mobistics develops software for transport management in terms of order-handling, navigation, positioning, and vehicle information.

NL-Partner

NL-Partner is a company that develops enterprise systems for contractor of haulers and big road haulage firms. The company cooperates with several other vendors. They have offices in Sweden, Denmark and Norway.

Scania

Scania is a global company with operations in Europe, Latin America, Asia, Africa and Australia. Scania is a manufacturer of heavy trucks and buses as well as industrial and marine engines. The company also markets and sells a broad range of service-related products and financing services. Scania Fleet Management is one of the products developed by Scania for transport management purposes.

Transics
Transics develop software especially aimed for the transport sector. These applications handle orders and follow-ups for drivers as well as vehicles. Besides of its headquarters in Belgium, Transics has offices in France and the Netherlands, and even employees who are also active in the German, Spanish, and Swedish markets.

Transware
Transware is a transport software and communications supplier for the transport business. Transware provides total solutions ranging from sophisticated Internet applications, administrative software for the office user to mobile data software for the mobile user. Transware is a subsidiary to the Norwegian company called ERGO Group AS.

Vehco
Vehco develop and market computer-based solutions for trucks and road carrier companies. Their product Co-Driver is a solution for vehicle follow-up and communication between office and truck.

Volvo
Volvo is a global company. Volvo group is organized in business areas; Volvo trucks, Mack, Renault trucks, Volvo buses, Volvo construction equipment, Volvo Penta, Volvo aero, and Volvo financial services. Volvo design and develop solutions for global coordination. Among their IT-solutions can Fleet management be mentioned, which is a satellite communication solution between e.g. a driver and his vehicle.

Road hauler
A brief description of involved road haulage firms follows here.

TRB Miljö AB
TRB Miljö AB is a trade association in the context of road haulers. It is owned by 13 road haulage firms in equal parts. TRB Miljö AB works and functions as a resource and competent center for partners, where environmental activities are coordinated. They work together with e.g. customers, authorities, universities, vendors and organizations with interest in environmental issues involving heavy traffic.

The involved firms are:
Alltransport, ALWEX Transport AB, BDX, Bilfrakt, GDL, GLC, Jämt frakt, LBC Frakt, MaserFrakt, Samfrakt, Sundfrakt, SÅAB, and T-Last.

5.2 Literature studies

The most common written sources for gathering information are books, reports and published articles in scientific journals (Patel and Davidson, 1994).

For finding relevant information about the domain and details on topics addressed in our work, literature studies have played an important role as a method. Materials about the problem area and related theory have been gathered from different types of literature sources (e.g. articles, books, websites, etc.). They have contributed to the understanding of the problem area and its related topics, so that gained knowledge could be used as a basis for reasoning and coming to conclusions regarding the problem.

The main part of the literature studies have been based on articles. Information has primarily been collected through different scientific databases on the Internet, such as Science Direct. The gathered information has been used for learning purposes and to connect to the empirical work, as well as verifying various statements made by different authors in the problem area.

5.3 Interviews

To be able to carry through the project, interviews were used as a method for achieving the best work results possible.

Interview is a technique based on questions for gathering information (Patel and Davidson, 1994). This method can many times facilitate the process of information gathering, due to the possibility of asking direct questions about a specific issue from e.g. an expert.

Through this method we had the opportunity to ask organizations about their enterprises, relationships to other vendors, costumers and own developed systems. At the same time we had a chance to make a better presentation of our project "Standardization of Data Transport".

By doing qualitative interviews, relevant information about the problem area, involved organizations, their costumers, systems and solutions have been gathered. Purposes with interviews have been to collect important and useful information to the project, and to provide information about relevant issues to consider. By using this method we also did benefit from the knowledge, insights, ideas, and opinions of the interviewees. Further, the method helped us to get an insight in how different organizations solve the problem of their systems communicating and integrating with systems developed by other vendors.

For doing interviews in the best way possible, two groups consisting of three persons in each group was formed. The reason for such grouping was to gain the most possible benefits from all the group members' competence, experiences and backgrounds. In this way every group contained one member from each of the programs Business Technology, Information System in Logistics, and Mobile

Services and Telematics, so that every aspect of the problem could be covered. At the same time this would speedup the process of the information gathering through interviews. Thus, more interviews could be performed and more relevant information useful for the work gathered.

During this process there were several problems that we had to deal with. One of them was to find interview persons in every organization with the right competence and knowledge about the issue. After we found which persons to interview, it took some time to actually meet each correspondent. Yet, the biggest challenge of all was to make involved organizations to trust us on the information we wanted them to share. To overcome this, we had to sign various confidential agreements for some organizations, so that we could perform interviews, take part of their information and documentations. Because of these challenges the project did suffer in terms of loss of valuable time and potential delays. This made it more difficult for us to carry through the work. To compensate these problems, we had to work more intense in the time left for the project.

However, a total number of 10 interviews were performed during this work. These interviews included different organizations and different persons, some with technical insights and some with an organizational overview.

Table 2 shows a list over organizations that have participated in interviews and the role of each interviewee in respective organization.

Organization	Role
ASN-IT & Management	Consultant
Hogia	Costumers services Software developer
Lars Aspholmer Programming AB	Consultant
Mobione	Technician
NL-Partner	Salesman
Scania	Product manager for Transport Management Services
Transics	Responsible for Transport Management Services in Sweden
Transware	Salesman
Vecho	CEO Technician (Customer supply and support)
Volvo	Telematics Chief

Table 2 Company names and the role of interviewees from each company

An interview template with several questions was used in all interviews as a start point for discussions around issues interesting for the work. The template also helped to structure every interview.

The duration of each interview has been 1-3 hours. All the interviews have been recorded digitally to enable the possibility for a later use. During each interview notes have been taken to clarify various issues. All the interviews have been listened to several times. Interesting and relevant parts of recorded interviews have then been transcribed so that important information collected from the content of each interview is gathered.

5.4 Documentations

To perform the project, we did inquire documentations that could be interesting for our work from all the involved organizations. We were mainly interested in documentations about the communication interface used by respective organization. For accomplishing the best results, it was very important to get information about how different organizations had solved the problem of communicating with other external systems developed by other vendors. Attempts were made to gather as much information as possible from each organization. This was proceeded either by, calling, sending emails, through meetings or interviews. We did face several challenges during the process of information gathering.

The biggest challenge was to get the involved organizations to share information and send their respective documentations, which was very important and useful to the project. Few organizations were not willing to share any information at all. We had to sign confidential agreements for some of the organizations for being able to get any documentation. Then we had to wait for receiving the documentations. These were all time consuming. Some of the organizations sent their material too late, and due to the lack of time, it could not be used in our work. But there were also organizations that provided us with useful documentations and that in time. Received documentations were studied in details. Relevant and interesting information was then selected, so that we could benefit from them as an input for developing the communication standard interface as well as getting an overall view.

We did also study several existing standards, namely Pharos Mobile, and FMS, and used them as inputs to our work.

Pharos Mobile is a standard developed by e-com Logistics for expedition transports in particular. The problem with this standard is that it is too large, too detailed and yet to small, meaning that it has its focus on package transportations in details.

FMS-standard is a standard developed by six truck manufacturers for reading several parameters from a vehicle. It contains parameters for data about the vehicle engine, fuel consumption, and so on. This standard is already used by some system vendors for handling vehicle data.

Documentations and information about different certifications and classifications of driver license and loads has been gathered through the organizations Räddningstjänsten and Vägverket.

The gathered information was summarized and important parts were documented so that it could be used later. The contents of the documents were discussed within the group and some decisions were made upon the information presented. These decisions and the gained knowledge were then used in the process of developing a basis for a communication standard (see Appendix C), useful for transport organizations in particular.

5.5 Meetings

During the project many meetings were kept within the project group to discuss and to decide on various issues important to the project. Some of these meetings were kept on fixed basis and some when necessary. In addition, two important whole day meetings were kept in the middle phase of the project in order to evaluate the results of the developed communication standard. The first meeting was with system vendors and took place on Viktoria Institute in Gothenburg. Here we presented our results and got feedback on our work. Different ideas and the produced documentation were discussed. Relevant and considerable information regarding achievable business values were also discussed. Further, it was discussed how to proceed with the work. During this meeting we had the opportunity to ask questions about issues needed to be clarified. It was decided that they would come back with additional inputs and suggestions after further studies on our proposal within their respective companies. The participating organizations are listed in Table 3.

Organizations
ASN-IT & Management
Hogia
IBS
Mobione
NL-Partner
Scania
Transware
TRB Miljö AB
Vecho
Volvo

Table 3. Organizations participant at the Viktoria Institute meeting.

The second meeting was with the customers i.e. road haulage firms. This meeting took place in Bilfrakt in Skellefteå. Even here we presented our results and got some feedbacks and ideas about our work. Also in this meeting we had the opportunity to ask questions about issues needed to be clarified, but this time from road haulers point of view. Discussions during this meeting also include important information regarding business values by using the communication standard interface developed.
It was decided that they would return with additional inputs and relevant documentations after further studies on our proposal within their respective companies. The participating road haulage firms in this meeting are listed in Table 4.

Road haulage firms
Alltransport
ALWEX Transport AB
BDX
Bilfrakt
GDL
GLC
Jämt frakt
LBC Frakt
MaserFrakt
Samfrakt
Sundfrakt
SÅAB
T-Last
TRB Miljö AB
Vägverket

Table 4. Road haulage firms at the Skellefteå meeting.

The purpose of these meetings was to create an opportunity, where all the involved actors would have a chance to give their opinions and inputs on the standard being developed. This way they could influence the process of work and make sure that issues important to each were not left out.

5.6 Data Analysis

We have used an iterative and interpretive analysis approach for analyzing all the gathered information and the collected data found in documentations, available standards, interviews and meetings (Walsham, 1995). This was an important part in the process of selecting relevant data when developing the communication standard interface.

We started by studying documentations for each system separately to get an overview on its functionality and structure. Then we sought to find what different systems from different vendors have in common and how they differ concerning the data being transferred. Further, we compared and analyzed the data parameters used in the studied systems and did select parameters common to all of them, this to create a common base supported by all the involved systems.

Moreover the data parameters in the FMS-standard and Pharos Mobile were analyzed to get an understanding of their usage and relevance to the communication standard interface.

Other parameters expressed as important during interviews and meetings by different system vendors and road haulers were also discussed, analyzed, compared and included when found relevant.

6 Results

In this section the results of our work will be presented including all the gathered information used as input for realizing a communication standard interface making it easy to integrate different systems from different vendors. Further, the developed communication standard interface aimed to function as a mobile-stationary gateway will be presented. Finally, the result of the evaluation on the developed mobile-stationary gateway is presented. This includes feedbacks from involved actors on the developed communication standard interface as well as its organizational effects and benefits.

6.1 Towards a communication standard interface

Through our studies we have found that in the transport industry there exist many different systems, both stationary and mobile, varying in functionality and business task coverage. However, since these systems are often developed by different vendors, it leads often to compatibility problems between existing systems creating a mobile-stationary divide as a result. Consequently the transport industry is faced with a complexity that is often rather hard to handle.

System vendors usually support their own developed systems. In some cases they even support systems from vendors in their partnership. But they are far from supporting all systems developed by all system vendors on the market. This seems to be almost impossible to accomplish, considering the competition factor and the number of existing systems and vendors. Thus, whenever two systems need to communicate the problem of incompatibility occurs. Yet, "*there are many successful and working system integrations" (Road hauler)* to the benefit of road haulage firms in the transport industry. "*These integrations have one thing in common, which is that they are project based." (Road hauler)* This means that for every new system integration a specific project is required involving undesirable costs and usage of valuable organizational resources.

Figure 8 presents the existing situation over integrations between different stationary systems (e.g. offices using different systems) and different mobile systems (e.g. trucks using different systems) in the transport industry today. The figure also shows that every system can only communicate with the system it is integrated with, and it is not capable of communicating with other systems.

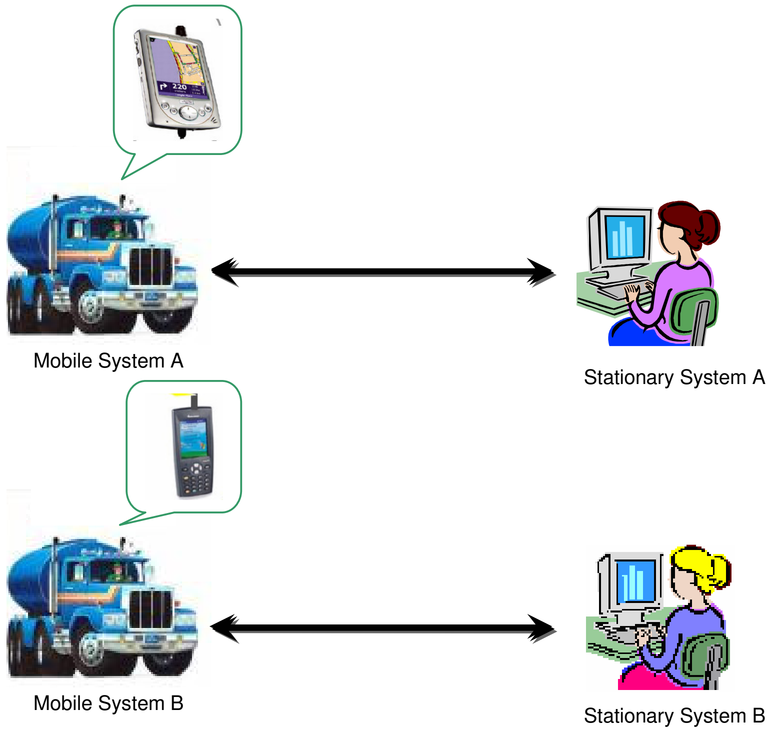

Figure 8. Traditional integrations between stationary and mobile systems.

Systems from different vendors usually can not communicate. This is something that customers i.e. road haulers experience as a big problem, when introducing new systems in their enterprises. Today a new integration is required for each time a new system is introduced. "*If the contractor of haulers decides to change or replace their systems a new integration must be performed for every existing mobile unit."(Road hauler)* This is a necessity for systems to be able to communicate and transfer data and share information. Not being able to integrate existing systems with new ones, costs both money and time for road haulage firms.

Road haulage firms want to have the possibility of communicating between different systems, choosing freely between the systems offered on the market, and to be able to use the systems most appropriate to their businesses and demands. This without having to consider which vendor a system belongs to.

> "*As it is today the costumers have to choose systems supported by their present system vendors. Or they have to pay a whole lot of money and time for implementing special solutions for integration, if they want to be able to choose other systems than the ones supported by their present system vendors".(Road hauler)*

Integrations today are both costly and time consuming. In addition, they require some information that may be important and sensitive to organizations to be handed out, which can involve risks loosing costumers, business possibilities or in worst case scenarios even business concepts, as some vendors see it. Yet, it is often the costumers, who have to pay for integration between their systems.

Our findings indicates that mainly costumers, i.e. road haulage firms, but also system vendors wish for a IT-infrastructure allowing easy and fast integrations between different systems; so that they can communicate and data can be transferred between them as shown in Figure 9. This is considered as important for handling different types of assignments.

> *"What we want to emphasize today is that you need different types of information in different types of assignments. If it is a construction, you will need one type of information. Is it container, you will need another type of information." (Road hauler)*

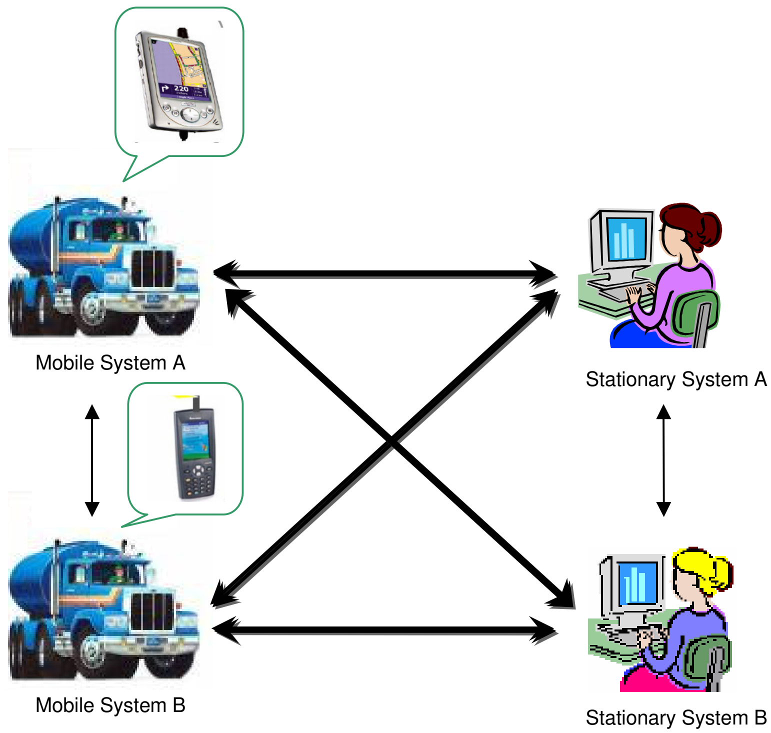

Figure 9. Possible integrations between different systems.

Through our studies we have come to understand that there are various interpretations regarding system integration among system vendors. The apprehension that systems can integrate without having to access specific information that can be vital for an organization is not shared by all vendors. There are organizations that see system integration as a risk of loosing their own systems or secrets of their businesses to other competitors. One reason is that some vendors think that having to hand over vital information is a must and a natural part of system integration, nonetheless that the integrating systems must interfere in each other in order to integrate. However this is not the case, though there are different types of system integration; meaning that systems can integrate without any direct access to critical information.

It has come to our knowledge that it is of interest to find a way for quick and simple integrations between different stationary or mobile systems from different vendors without the systems interfering in each other. This can be solved through a standard for data transfer between different systems enabling them to communicate. We have found that many system vendors are positive to, and can gain benefits and business values from this as well as road haulers. Having the communication and integration between different systems solved means no extra undesirable costs in terms of time, money and other resources for the costumers in the future. Solely, they can focus on their own business tasks using their systems as simplifying tools as they are meant to.

Sending data back and forth between different stationary and mobile systems is considered as important in the transport industry. An example is sending order data between an office and a vehicle. Therefore the main focus of a standard should be on transferring data between stationary and mobile units. Such a standard also opens possibilities for communication and integration between other systems, like stationary to stationary or mobile to mobile. A system vendor implies that *"this standard should primarily be between vehicle and transport planning systems, but same architecture can probably be used for communications between transport planning systems as well"*.

To be able to realize a communication standard interface functioning as mobile-stationary gateway, as the one realized in our project, is an important step in the right direction for reaching the goal of seamless integrating systems in the transport industry.

6.2 Mobile-Stationary Gateway

Using the gathered information as input, we have accomplished to realize a basis for a communication standard interface presented in Appendix B, C and D. This interface can be seen as a mobile-stationary gateway for data transfer between different stationary and mobile systems enabling communication and easier integrations. This standard interface can with advantage also be used for communications between stationary to stationary and mobile to mobile systems as shown in Figure 10. It aims to create a possibility for different systems to integrate without dictating how such integration should be done and how the communication standard interface should be used. The reason is to give the users, e.g. organizations, the possibility to choose and use the solution most suitable to them and their unique situation, for example using techniques such as web services. This way the heterogeneity and the complexity of existing systems can be preserved intact.

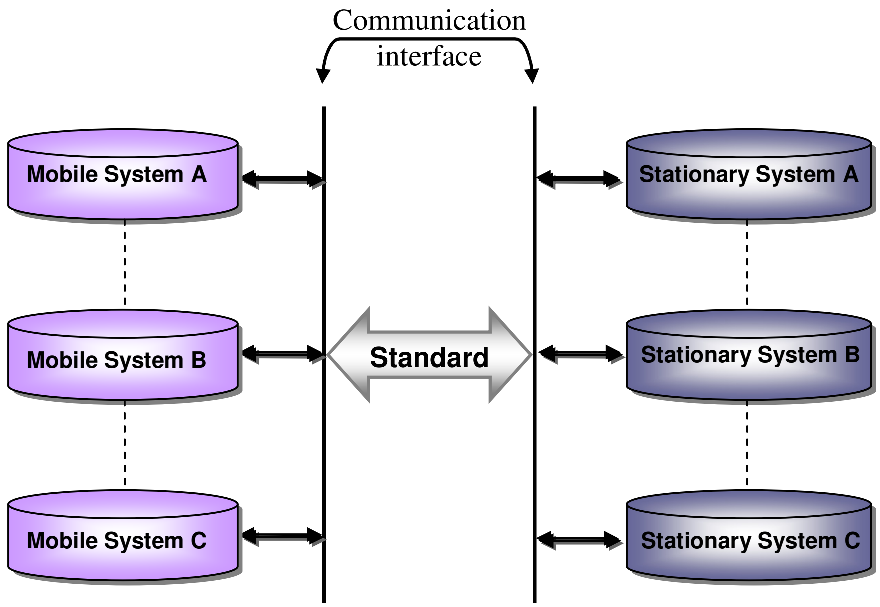

Figure 10. An illustration over communication between several different stationary and mobile systems through the realized standard interface.

There have been some previous attempts for integration through a standard in different areas of the transport industry. Among them can Pharos Mobile be mentioned. Both the system vendors and the road haulers understood Pharos as too big and to complex. A road hauler stated that *"Pharos has some problems. Foremost it is not possible to adjust to construction transports. What is done is for expedition traffic"*. The knowledge of such problems experienced by system vendors and road haulers, among other things, lead us to the conclusion of creating a standard interface that is simple, comprehensive, flexible and easy to adapt.

In addition, we have seen that many vendors already use XML in their systems and solutions, which have been one of the reasons for us to choose XML for this standard interface. The flexibility and expansion possibilities of XML have been additional reasons.

> *"The XML-standard facilitates this type of system integration". (Consultant)*

The developed communication standard interface is aimed to be used for sending messages between different systems. A message is comparable to a letter and is edified by a XML-structure. This makes it easy to understand and divide in to minor components allowing an object oriented structure. It consists of two fundamental parts, namely an Envelope and a Message. The envelope contains the addresses of the sender and the recipient of the message, a unique message identification, and the message it self. Message identification gives a full control over the handled messages as well as a history of the messages sent. This is also useful when a message needs to be traced. The message on the other hand contains an XML-structure representing the actual information to be sent. The structure of the interface has been mainly inspired from different system vendors.

The developed standard interface consists of a number of modules containing data parameters with the possibility for future expansions (see Appendix C). This is an important issue; due to the fact that the standard interface can gradually be developed and more modules and data parameters can be added later. It is important for a standard interface to support this option, though there are many different types of assignments and especial cases, each with a specific set of information.

By studying different documentations we have tried to find what different systems from different vendors have in common and how they differ concerning the data being transferred. From here, we have selected data parameters common to all these systems, added some other parameters that different system vendors and road haulers expressed being important and included them in different modules within the communication standard interface (see Appendix D).

Through our studies we found that there is a need for the possibility of sending orders to and from stationary and mobile systems, e.g. between an office and a vehicle. We have also noticed that the ability of sending data about the vehicle it self, i.e. vehicle data, is interesting to many system vendors and road haulage firms. Such data can for example represent information about e.g. fuel consumption, fuel level, motor temperature and so on. In the same way there is an interest for being able to send operational data from a vehicle, e.g. information about position, load temperatures, etc. But still handling orders seems to be more interesting for all the involved actors. That is to be able to instantly send orders to different vehicles. It has also come to knowledge that there are occasions that a driver needs to receive an order at site from another company. This is many times difficult to accomplish. Though the system used by the driver usually differs from the system used by other companies, which means that they are not capable of communicating with each other. Moreover the possibility of creating new orders by the driver on a site seems to be a desirable feature.

> *"The possibility for a driver to create new orders at site is interesting."*
> *(System vendor)*

It has also been expressed that there is a need for a way of addressing a vehicle with all its belongings, including its driver. This is important when sending different messages to a vehicle equipped with a mobile system. Most of the system vendors we talked to claimed that it is the driver that a message is sent to. During interviews and discussions, it came to knowledge that in fact most of the time it is the vehicle it self that is addressed. As a solution, the concept of *Equipage* for dealing with mobile units was utilized and included in the standard interface. An equipage can consist of one to several different components. These are driver, vehicle, load carrier and equipment. The concept of equipage helps to simplify the handling of these components.

Sending messages to a receiver only by knowing one address was by road haulage firms expressed as a desired possibility. A road hauler gave this example: *"You would like to be able to send messages to a vehicle, e.g. only by knowing its registration number"*. The concept of the equipage can help to realize this wish. Only by knowing which equipage, a message can be sent to a desired receiver. The message is simply sent to that specific equipage.

An equipage is always unique with a unique set of components building its structure. By having an equipage to refer to, information about all the components building a specific equipage is accessible and gathered in one place. When ever the structure and components of an equipage is changed, it will instantly be revealed on the equipage. All equipages can this way always be updated. Further, information can be sent to different equipages knowing that the message will get through, without having any concerns about if it is e.g. the vehicle or the driver that message should be sent to. The received message can then be passed on to the desired component within the equipage.

The concept of *equipage* has been discussed with all the involved system vendors and road haulage firms. A positive response was given on this concept, since it helps to ease the issue of addressing a vehicle and its belongings.

> *"The concept of equipage is good, especially as a basis. This way all the information related to an equipage can be sent as a package." (System vendor)*

The developed communication standard interface includes different modules and data parameters for handling some important areas. These are:

- *Order:* For handling different types of orders.
- *Equipage data:* Aimed for handling equipage related information including data about the driver, vehicle, load units, its equipments and their positions. Also parameters for handling operational data including the already existing FMS-standard and all its parameters have been included here.
- *Identification message*: For identifying the driver and the vehicle and their capabilities.
- *Text message:* To send arbitrary text messages.

By adding modules and data parameters covering these areas, we have accomplished to realize a basis for a communication standard interface that can function as a mobile-stationary gateway between different integrating systems.

After realization, the communication standard interface has been evaluated. Inputs from the evaluation have then been taken in consideration and used to revise the interface.

Testing the interface will be the next step in carrying forward this standard. This test will be carried out by involved actors (i.e. system vendors, road haulage firms, practitioners, etc.) with actual systems used by involved organizations. The result will then be used for further developments of this standard interface for communication.

6.3 Evaluation

The aim of the evaluation was to review the developed communication standard interface together with all the involved actors, so that we could take part of their thoughts and opinions on the developed communication standard interface and its organizational effects.

The need for a standard creating better system integration possibilities and an easy way for different systems to communicate was corroborated by both system vendors and road haulers.

> *”A wished situation would be that there exists a standard way, so that you always know that what you send can always be received and be understood by the receiver, without having to know what they use for hardware, software or which vendor they have.”(Road hauler)*

According to system vendors, costumers feel the need of having a “standard solution” and they have already started to talk about it. “*There are many asking for it.”(System vendor)* and as another system vendor implies “*It is interesting, because it is talked about very much in the market now, that is to say customers about a standard solution.”* This has lead to that some costumers are not being ready or willing to invest in any new systems yet. One of the reasons for not wanting to invest in any systems is that they do not want to lock in themselves to any specific system due to the limited communication possibilities. System vendors see this as a problem.

> *“If I take Scania I have not locked me in a corner, or a contractor of haulers do not need to force a specific system on my drivers, but they actually can choose and they use mixed systems, this I think is a advantage to open up, so that it is not dangerous or difficult for them.” (System vendor)*

Having a standard makes it easier for every part to follow something that exist and are understood in the same way. According to another road hauler “*It is good to have a standard; to have something to follow”*. It facilitates the communication process and makes the parties feel secure when sending data; knowing that by using the standard information can be sent, received and understood. The only important thing for the communicating parties are to know how and what to send assuming proper functionality; or as a road hauler express *“The only thing I need to know is that this way I can reach the other party”. (Road hauler)*

A desire to being able to easley send messages to different systems without any concerns about the system type and its vendor have been expressed by road haulage firms.

> *“It is desirable to be able to send messages to a receiver, for example a driver, and to know that the message will be received, without having to concern about the system in use.” (Road hauler)*

Today it is required to have information about the recipient system and the vendor it is developed by to be able to send messages correctly. The following example was given:

> *"For example cell phones, how they worked before and how they work today. In the past when someone made a call, the person had to know which vendor and which country he or she is calling, to make the call. But now you do not have to know anything but the phone number. Not even in what country the person that you are calling is. This standard will make same thing possible for the transport industry". (Road Hauler)*

Further in discussions during the evaluation it was brought up that every organization enters the necessary information about its costumers into its systems. Considering the fact that some organizations cooperate, there are times that cooperating organizations have same costumers. In these cases the information about the same customer is entered several times but in different systems. This leads to redundancy in data storage, which could be diminished by having the possibility to access the needed information from another system.

> *"Imagine we have a new costumer, who already is a customer to Hogia. Hogia has entered all information about the user and the vehicle and then even we enter all the information about the user and the vehicle. This is something that we want to avoid. So you just have a unique ID, and the only thing that needs to be done is to check with other vendors for information, is there anyone who has information about this user or this vehicle? And then get the relevant information. That way we would avoid this double work." (System vendor)*

Through discussions we became aware of the road haulers need for improved and faster follow-ups, which can lead to faster debiting and more incomes for the firm. This can be possible by integrating different systems through a communication standard interface since relevant information from different systems can quickly be accessed. A consultant from the transport industry stated in this matter that *"the economic systems and transport management systems are two different systems, but they naturally should integrate, so it makes it possible to follow up income per car as much as possible"*. He further emphasized that it is then possible to *"match it with the costs"*, and continued that *"costs per car are wages costs, writing-offs and fuel costs."* This is something that road haulage firms can gain benefit from.

Moreover, it have come to our knowledge that system vendors seem to think that integration through a standard will affect the market by creating a need for costumers to demand actual values to be reported from their systems. A system vendor utters that as it is today *"values being sent are estimated values"* and that *"with a standard actual values can be sent"*. Another system vendor implies that *"costumers have not demand this yet, because they know that the technology for it does not exist"*. Having these in mind, we also found that environmental issues are becoming more and more important, foremost because of the increasing demands from the National Road Administration. Hence, costumers can in the future start demanding environmental reports based on actual values if it can help them to reduce their costs.

> *"With no doubt, there will also be an interest for this, I think. Especially in conurbations, for example with environmental categorized vehicles, may be some regulations will appear, so that emissions are not allowed to exceed a specific value on a distance. If we have the data all the time, we can process it and we give something back to the hauler in particular because they accept this to be introduced." (Road hauler)*

As we have seen, it is interesting to be able to send various environmental values, not least to the National Road Administration. A road hauler expressed that *"to be able to send values on exhausted gas to the National Road Administration is something that is interesting and happens"*. The possibility of sending parameters with actual values in situations such as this contributes to the competitiveness of system vendors as well as road haulage firms. This comprehension is shared by both these parties.

> *"To be able to see exact values is a competitive advantage; because a costumer wants that. He wants to reduce his carbon dioxide values." (System vendor)*

> *"If I can have the possibility to extract environmental data I will use it. Besides it is a competitive advantage." (Road hauler)*

Moreover, also issues regarding the ownership and the maintenance of the standard interface were by all parties expressed as important issues that needed to be addressed.

> *"Who is going to own the standard? What happens if XML2 or XML3 arrive? Who is going to decide that now we will change?" (System vendor & Road hauler)*

> *"Somebody has to own the interface" (Road hauler)*

We have noticed that, both road haulers and system vendors want a neutral actor who can own and maintain the standard. This because of reasons such as not wanting to spend time, money and other resources on the development and maintenance of the standard; nonetheless the competitiveness issues it involves. For a standard to succeed, it is important that it is realized by a neutral and independent actor. Otherwise there is a huge risk for it to fail. As a road hauler expressed *"There have been previous attempts from vendors and have failed, though the other vendors have denied it per default".* The reason has been that the effort was initiated by a vendor, seen by other actors as a potential competitor. As the time being this responsibility is upon Viktoria Institute.

System integrations are usually time consuming and costly, which can be reduced with help of a standard. *"It is obvious that you save time, by reducing the integrations time"* as a system vendor implies. Easy, fast and working integrations are something that also road haulage firms can take advantage of as we have noticed.

> "*We sure earn money on being able to get the orders out and to be able to get back acknowledgements and to be able to invoice fast. The hauler also makes profit this way." (System vendor)*

Considering all the issues that have been discussed during the evaluation indicates that using such a communication standard interface involves benefits and business values for both system vendors and road haulage firms. This will be pointed out and discussed further in discussion.

7 Discussion

IT, supporting the organization is many times vital for the organizations survival. At the same time it can help to facilitate various work processes. Due to the fast growth of the market, higher demands, harder competition, and rapid developments in technology, organizations today need to use different types of systems, i.e. enterprise systems, to support their businesses. As Davenport (1998) implies, enterprise systems help organizations to deal with their business activities and to improve the information flow across subunits and through organizations. This also includes organizations in the transport industry. In the context of road haulage firms there are both stationary (e.g. in offices) and mobile (e.g. in moving vehicles) systems in use by existing enterprises to ease and speedup the daily tasks. Solely, a need for enterprise system support in a mobile context exists. For making the use more effective and optimized, so that systems in use better can support the business, it is of interest to integrate these systems. This way the synergy effects can be utilized.

Existing systems are usually developed by different vendors, which make the communication between them rather difficult or even impossible. This means that for every new system being introduced a new integration must be performed involving undesirable expenses. This involves costs in terms of time, money and consuming other resources of the enterprise. It is also to be considered that the existing mobile-stationary divide in the transport industry (Lindgren et al, 2004) makes it harder to integrate different systems. The ability of integrating different systems increases the possibility to attain an information system that can support the organization with respect to its infrastructure. It opens new possibilities and improves existing processes and daily tasks for both vendors and road haulers. To be able to realize an easy and economical way of integrating different types of systems (whether stationary or mobile), supporting the organization requires a solid IT-infrastructure. As even Brown and Vessey (2000) emphasize there is a need for a unitary IT-infrastructure in the transport industry. This IT-infrastructure helps to facilitate system integrations within or cross organizations. Ubiquitous transport system is a solution that is intended to function as an IT-infrastructure applicable to the transport industry (Andersson and Lindgren, 2004). As March et al. (2000) describes, UTS can be as a special case of distributed and heterogeneous computer architecture aimed to facilitate efficient and seamless system integrations in transport organizations. Through UTS different systems can integrate and cooperate easier and more effective over stationary and mobile boundaries. Using a standard interface for communication functioning as a mobile-stationary gateway can facilitate the realization of the vision of UTS.

By using a communication standard interface for integration, information can become more accessible and data easier to transfer between different systems. Also the redundancy of data storage decreases, which organizations can benefit from. Having access to relevant information when needed, organizations will save both time and resources leading to business value as many of them have pointed out. Such standard interface could contribute to increased investments on behalf of the costumers and make the organizations to see the potential in using IT.

There are factors that affect the realization of a standard, in this case an interface for communication and transferring data between diverse systems. Factors like different organizational backgrounds, priorities, focuses, goals, and competence make it difficult to realize such a standard interface as we experienced during the development process of our project.

It is important that systems in the transport industry can communicate and integrate without interfering in each other. The reason is, as our empirical findings indicate, that here organizations usually are interested in integrations, but they tend to hold on to information valuable to them. Consequently system integration is considered as important but not at the cost of risking loosing business secrets and ideas to competitors. Being able to perform integrations cross organizations without having to reveal vital organizational information to potential competitors creates business value for the involved organizations.

The developed standard interface in the "Standardization of Data Transport" project (see Appendix D) creates new possibilities and capabilities for new services, applications and so on. Lyytinen and Yoo (2002) state that emerging enterprise applications, architectures, and frameworks will enable new services and workflow configurations that will foster changes in organizational structures. Development of key enabling capabilities, with respect to infrastructure, enables new services to be provided (Lyytinen and Yoo, 2002). Moreover, communication standard interfaces help to make investments in new systems more secure, due to the possibility of communicating with other systems developed by other vendors. Thus, it also helps to decrease possible lock-in effects to consider when investing in new systems. As described by Lindgren et al (2004) lock-in effects arises when a system is locked to or dependent on a specific vendor making its usage restricted. For example the problem will occur when there is a need for adding new functionalities, expanding, or integrating with other systems.

Using the developed standard interface makes loosely coupled system integration possible. Loosely coupled system integrations are easier to handle. They are usually more flexible and provide a better overview. Here systems do not need to know how the other systems they are integrating with work. Neither it is necessary for systems integrating in such way to have direct access to each others databases in order to get, change or update any information. The communication between integrating systems are instead handled through sending different types of messages. Hence, the only thing they have to know is how to format and send a message that can be understood by the receiving systems. Using a standard for communication helps to facilitate this process. Thus, systems developed by different vendors can be able to communicate with one another. But, the information exchange is restricted by the communication interface in use.

In a complex working environment such as the transport industry, loosely coupled system integration can be considered as more suitable for organizations, due to the prevailing competition among involved actors.

The purpose of IT investments is to create business value. Introducing enterprise systems in organizations is such an investment. Organizations, in this case system vendors and road haulage firms can gain benefit and business values by integrating different enterprise systems and applications. System integrations through the developed communication standard interface can have various affects on organizations as even our empirical findings indicate. These affects can then lead to business values as discussed below.

System integration affecting system vendors:

-Appearance of new services: Integration of diverse enterprise systems and applications creates a possibility for development of new services not possible earlier. This contributes to the development of organizations offering these new services as well as the branch it self.

-Increased co-operation with other organizations: Many times organizations have not the possibility of providing all the services that their costumers need and demand. Co-operating with other organizations through integration of diverse enterprise systems opens ways for satisfying these needs and demands. This way services that are missing in one system can be complemented by services provided by other systems in other organizations.

-Increased circle of customers: By being able to provide services satisfying costumers' needs an organization will be able to keep current costumers as well as attracting new ones.

-Decreased costs and organizational developments: Instead of spending money, time and other organizational resources on developing e.g. services that other organizations already have solved, organizations can continue to focus on the things they are good at for further refinement of services they are experts on. This way competence within organizations will be used more effectively leading to time and money savings, as well as organizational developments.

-Branch development: Through system integration relevant information will be accessible and more functionality can be added. The functionality of integrating systems can then be used in a complementary way. Solely, by integrating systems from different system vendors will lead to appearance and development of services in areas not possible earlier contributing to development of the branch. System vendors can then with advantage offer these new services to their costumers creating business value for both parties.

-Redundancy of information decreases: Once information is introduced to a system other organizations within the partnership can with advantage reuse that information over and over without having to reenter the same information several times in all their systems. This leads even to decreased time consuming.

-Faster and more flexible information sharing: Organizations can quickly exchange information and access relevant information when needed making them more flexible. This helps organizations to perform various tasks faster and to better serve their costumers.

-Organization optimizing: By having fast access to needed and vital information and knowledge through system integration an organization can function more optimized. By optimizing an organization greater business value will be gained.

System integration affecting road haulage firms:

-Possibility to retain legacy systems: By integrating different systems organizations have the possibility of continuing to use the systems they already have invested in. Functionalities in new systems can this way be employed at the same time. This reduces the need for new investments for changing all the systems in the organization so that different systems within the organization can communicate.

-Decreasing costs: Not having to reinvest for replacing existing systems with new ones, contributes to decreasing the costs. Integrating existing systems with new ones to obtain new functionalities is the key for this to succeed. Costs involved for changing systems include not only the investments for purchasing the system and its belongings, considered as tangible costs. It also includes many intangible costs like maintenance and personal training.

-Increased ability for handling different types of assignments: Integrated systems can create the possibility of taking various types of assignments and processing more orders faster then before. This contributes to the competitiveness of organizations.

-Faster and better information sharing: System integration offers faster access to necessary information and can promote information sharing. This helps to optimize the organization in performing various tasks leading to better use of its resources for accomplishing its goals.

-Faster follow-ups: Having fast and direct access to needed information through system integration, without any concerns about where the information is stored and how it can be accessed, will increase the speed of processes regarding follow-ups. Solely, faster debiting and more incomes for the firm will be possible.

> *"It is more efficient to gather useful information from the same place by integrating systems and applications. This way, the value of information for coworkers, costumers and suppliers increase. When all systems, internal and external, can communicate and exchange information with each other, profits can be gained." (Market Vision, 2004)*

8 Conclusion

System integration can contribute to increased optimization, improvements and success for organizations. The accessible information through integration opens new business ways and possibilities that organizations can use with advantage. To enable integration between different mobile and stationary systems, a gateway can be used as a communicating bridge between the integrating systems. A communication standard interface functioning as a mobile-stationary gateway can be designed as presented in Appendix A, B, C and D to support seamless integration of different mobile and stationary systems in transport industry. Through this mobile-stationary gateway, different systems whether stationary or mobile, can integrate as loosely coupled systems helping to eliminate the existing mobile-stationary divide. Moreover, it gives the costumers the possibility of being able to use systems developed by arbitrary vendors with diminished lock-in effects. This way the developed communication standard interface also serves the overall vision of UTS. It helps to create a functioning IT-infrastructure, where freestanding and heterogeneous systems existing in distributed environments, such as transport industry, can communicate and integrate.

Organizations, i.e. system vendors and road haulage firms in the transport industry can gain many benefits and business values from using the developed communication standard interface as a mobile-stationary gateway when integrating systems. Here is a summarized list over benefits that can be gained for both system vendors and road haulage firms:

System vendors

- Appearance of new services
- Increased co-operation with other organizations
- Increased circle of customers
- Decreased costs and organizational developments
- Branch development
- Decreased information redundancy
- Faster and more flexible information sharing
- Organization optimizing

Road haulage firms

- Possibility to retain legacy systems
- Decreasing costs
- Increased ability for handling different types of assignments
- Faster and better information sharing
- Faster follow-ups

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Available at: <http://www.transics.com>. [2004-12-10]

Transware
Available at: <http://www.transware.se>. [2004-12-10]

TRB Miljö AB
Available at: <http://www.trbmiljo.se>. [2004-12-10]

Vehco
Available at: <http://www.vehco.se>. [2004-11-12]

Volvo
Available at: <http://www.volvo.com>. [2004-11-20]

Vägverket
Available at: <http://www.vagverket.se>. [2004-10-30]

Appendix A. Standardisering av datatransport

Nyttoskapande IT för åkeriverksamheter: standardisering av datatransport

Utkast till standard, version 1.3

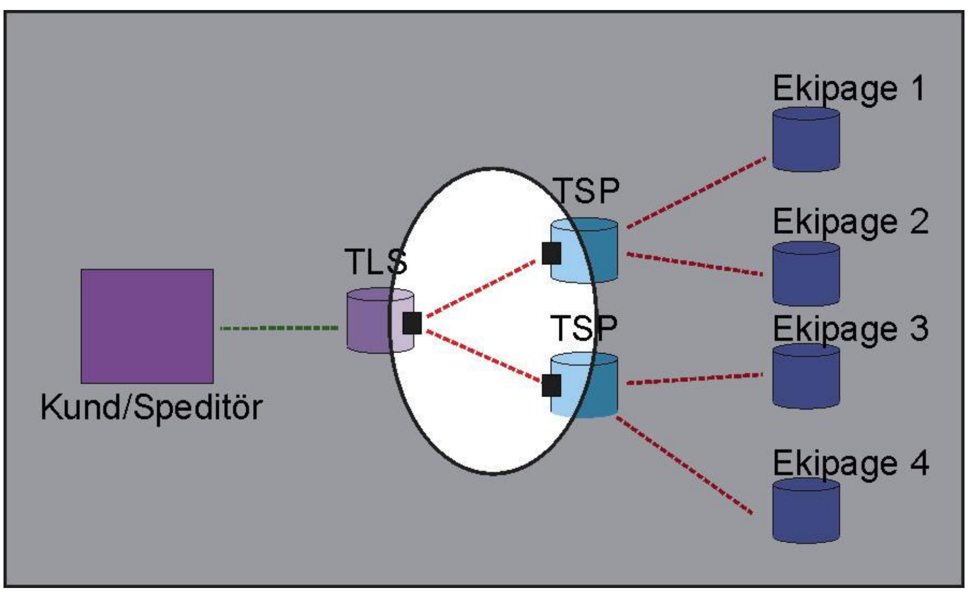
Innehållsförteckning

1 Abstrakt

I och med den snabba utvecklingen inom telematik och trådlöskommunikation öppnas stora möjligheter för att skapa nyttiga informationssystem inom transportindustrin. Idag utvecklas system för både föraren och kontoret. Dessa system har olika uppgifter och syfte, men kan ge ett ännu större utbud av nya tjänster när de sammankopplas. Det har gjorts flera lösningar där detta varit i åtanke och där utgången varit lyckad. Problemet med sammankopplingen är att det ofta sker efter det behov som en viss kund eller företag har, vilket i sin tur gör integrationen dyr och specialanpassad. Denna standard ska ligga till grund för datatrafik mellan fordon och kontor, för att skapa sömlös kommunikation.

2 Introduktion

Åkeriverksamheterna spänner över ett antal olika informationsbehov. Dessa löses med flera olika system, i vissa fall datorstödda, i andra fall pappers eller kunskapsbaserade. Målet med arbetet är att få till ett underlag för att skapa en standard för datakommunikation inom åkerinäringen i Sverige. Inom branschen finns idag ett flertal olika leverantörer av IT-system, där dessa system täcker olika stora delar av den informationsmängd som skapas och behandlas inom ett transportföretag. Uppdelning skär ofta mellan transportledningssystem (TLS) och telematikserviceleverantör (TSP, Telematic Service Provider). Vid integration av olika leverantörers system uppkommer stora kostnader för transportföretagen. Kostnaderna uppkommer då nya IT-system måste integreras med de befintliga för att undvika att data blir isolerad i systemen. Genom att knyta systemen samman ges möjlighet till ökad effektivitet och ekonomistyrning.



Figur 1. Områdesbeskrivning

Den främsta fördelen med integrerade system är att kunna skicka körorder från trafikledarsystem till fordonssystem, detta är även en önskan ifrån transportföretagen. Det finns även önskemål att finna ett sätt att standardisera fordonsrelaterad data, såsom förarinformation, egenskaper på fordonet samt motordata. Standarden ska medföra en sömlös kommunikation mellan system oberoende av leverantör, plattform och infrastruktur.

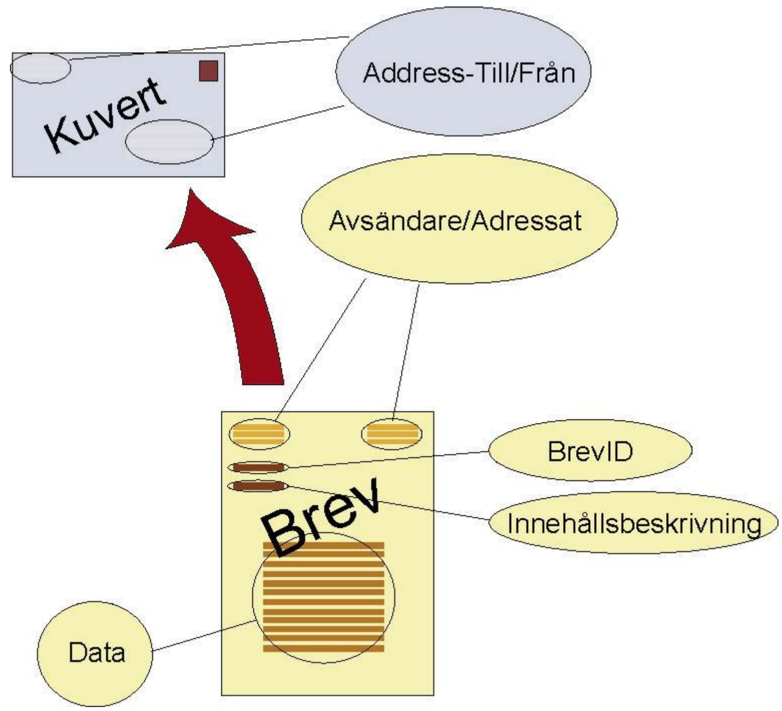
3 Modulstrukturer

För att skapa en standard över datatrafik på ett strukturerat och dynamiskt sätt behövs en meddelandestruktur för transporten. Strukturen skall vara databäraren för att kunna skicka och ta emot data som är relevant för själva ärendet. Framtagandet av strukturen har inspirerats av flera olika systemleverantörer och befintliga standarder. Olika strukturer har vägts mot varandra. Det finns två varianter, den ena står för en objekt- och modulbaserad struktur, den andra är en rak struktur med datamängderna staplade i ett dokument. Värt att beakta är att några strukturer har givit mer input än andra, i många fall beroende av en mer omfattande dokumentation.
De system som bygger på moduler av olika meddelandetyper ger en utbyggbar struktur. Fördelarna är just att de är lätt utbyggbara med sina moduler. En nackdel är att det blir många objekt och det kan leda till att strukturen blir svårförstådd utan en god dokumentation.
I den rakare strukturen med alla fält staplade på varandra väljs vilka fält som ska utnyttjas. Strukturen är möjligen mer lättförstådd men utbyggnaden blir omständlig.

Befintliga standarder är många gånger väldigt komplexa men ändå smala och inriktade mot enskilda områden inom transportverksamheten. Andra strukturer är smidiga och dynamiska med ett huvudmeddelande som kan ta olika former. Problematiken med dessa strukturer är att de ofta är inriktade mot affärssystem med faktureringsuppgifter och övrig ekonomirelaterad data. I stort saknar samtliga system övergripande information om fordon, förare och dess komponenter.
Utifrån dessa strukturer och mängder beslutades att prioritera dynamik och utbyggbarhet. När det gäller val av exakta datamängder jämförs datamängderna i samtliga system för att reda ut vilken data som är mest relevant. Det är en balansgång mellan att kunna ha tillgång till all data och att hålla datamängderna rena och lättförstådda.

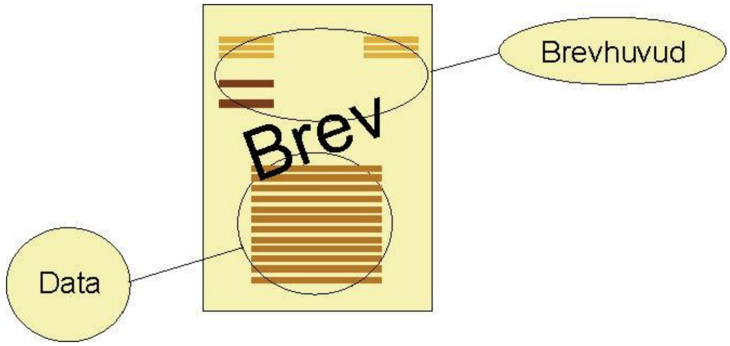
4 Meddelandestruktur

Meddelandet liknas med ett vanligt brev. Det gör att det blir överskådligt, lättförstått och nedbrytbart i mindre komponenter, vilket möjliggör objektorienterad struktur.



Figur 2. Meddelandestruktur

Meddelandet är indelat i två grundläggande delar, Kuvert och Brev (meddelande). Kuvertet är förpackningen som endast håller adressen till enheterna som skickar och tar emot, och packar in Brevet. I övrigt kan liknelsen mellan brevpappret och XML göras. Pappret är det medium som håller informationen när brevet skickas, likaså är XML mediet som håller information i meddelandet när det skickas. Brevet innehåller grundstenarna Adressat, Avsändare, MeddelandeId, MeddelandeInformation och Innehåll. Meddelandeidentifikation är ett sätt att ha full kontroll över vilka meddelanden som handhas och vi får möjlighet till historik och spårning av meddelanden. MeddelandeId är en unik identifierare som pekar ut att det är exakt det här meddelandet som menas.



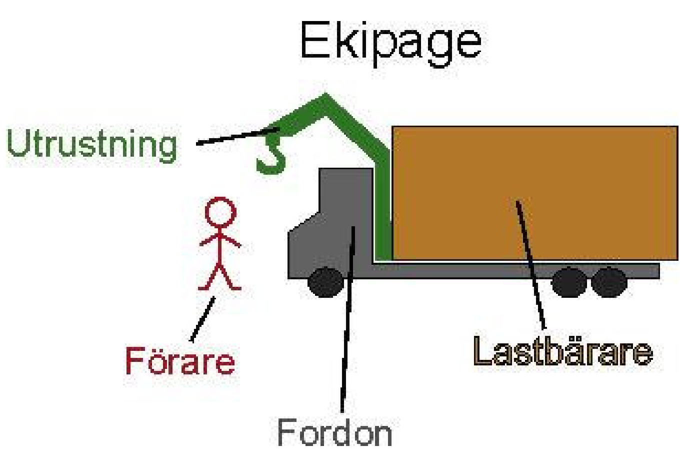
Figur 3. Meddelandestruktur

Kuvert är en enkel förpackning med adressen till och från.

Brevet är indelat i två huvuddelar, brevhuvud och data. Brevhuvudet innehåller Adressat, Avsändare, Brevidentifikation och Innehållsbeskrivning.

Adressaten och Avsändaren är antingen en Användare eller ett Ekipage. Användaren är kontakten på administrationssidan och Ekipaget är föraren med sitt fordon.

Innehållsbeskrivning visar på vad det är för data som meddelandet innehåller. Är innehållsbeskrivningen Order, så är det en körorder som skickas i data, är det Meddelandestatus, så är det en status på om det tidigare meddelandet blev mottaget och läsbart osv. Det är en fördel att flera meddelandetyper kan skickas samtidigt, då detta skulle ge möjlighet att separera data mer och på ett lätt sätt kunna koppla samman olika data, till exempel levererat gods med position och körtid. Meddelandet delas upp av olika typer av meddelandeinformation, de är Order, OrderStatus, GetOrder, EquipageData, GetEquipageData, MessageStatus, IdentificationMessage, GetIdentificationMessage och TextMessage.



Figur 4. Ekipagebeskrivning

Ekipage har skapats som ett utryck för den mobila enheten, vilket kan ses som ett mobilt nätverk. Detta nätverk är över tid föränderligt men utnyttjar en eller flera uppkopplingar (beroende på konfigurationen av de system som används). Ekipaget som enhet har diskuterats under lång tid och har tagits upp på alla de intervjuer som hållits. I de system som finns visas en viss beskrivning av detta, men inget befintligt system använder sig av ett övergripande begrepp kring ekipaget. Vi har följande enheter i ekipaget: Förare, Fordon, Lastbärare och Utrustning. Ekipaget bildar en enhet som kan adresseras och visar transportledare på vilken last som kan och får köras, både vad det gäller fordonets, lastbärarens (flak, tank etc.) och förarens (licenser, etc.) möjligheter. I befintliga system kopplas ofta en förare med ett fordon hårt på den administrativa sidan. Detta leder till att i många fall vid sjukdom sätts en ny förare i fordonet utan att det uppdateras på den administrativa sidan, vilket i sin tur kan leda till att farligt gods körs av icke godkända ekipage. Tanken med ekipaget är att det skall uppdateras så fort en förändring sker till exempel vid byte av släp, byte av förare eller annan ändring.

Det finns ytterligare fördelar med Ekipage som begrepp. Det råder en stor förvirring idag om vem/vad som skall adresseras vid en sändning. Vid diskussioner med systemleverantörer hävdar de många gånger att de skickar meddelandena till föraren. I själva verket är det fordonet som adresseras, vilket kan leda till bekymmer och missförstånd då det inte är den förväntade föraren som sitter i fordonet.

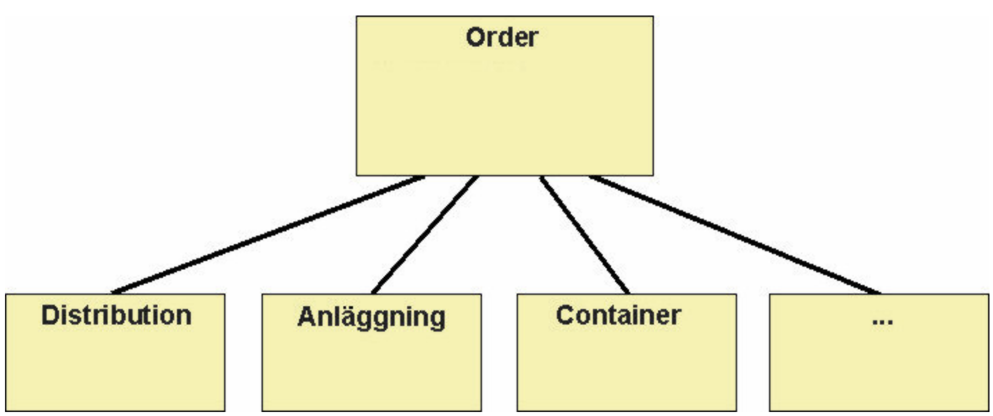
5 Moduler

5.1 Order

En order i ett affärssystem innehåller en stor mängd data som inte är av intresse för föraren. Den orderinformation som hanteras i standarden har anpassats med detta i åtanke. Det finns fyra elementära ingredienser som behövs för körorder:

Plats	Upphämtning och Avlämnings adresser
Tid	Vilka tider är kopplade till körordern
Gods	Vad och hur mycket det är som ska transporteras
Beskrivning	Övrig information som kan vara föraren till nytta såsom öppettider kontakt personer mm.

Som en följd av att transporterna har olika karaktär, så skiljer sig även orderinformationen åt i de olika fallen. Exempelvis så kräver en containertransport delvis en annan typ av information än vad paketdistribution gör.
För att det ska var möjligt att hantera detta så har ordermeddelandet delats upp i flera olika moduler efter uppdragstyp, i standarden benämnda ordertyper. I dagsläget finns två moduler definierade: container och fjärrtransport. I och med att standarden byggs ut för att kunna klara av fler uppdragstyper så kommer också nya moduler att skapas.



Figur 5. Ordern byggs upp av moduler som är anpassade till olika uppdragstyper.

För att hantera ordermeddelandeflödet så används olika typer av status som är kopplade till ordern, exempelvis för att tala om att godset är lastat eller lossat, att ordern är ändrad m.m. Detta hanteras med hjälp av meddelandetypen orderstatus som är identisk med meddelandetypen order, detta för att på ett enkelt sätt kunna skicka den information som är relevant.

5.2 EkipageData

Varje del i ett skapat ekipage ses som en dataproducerande enhet i ett mobilt nätverk. Därför innehåller förslaget olika moduler som var och en innehåller data om respektive enhet i ett ekipage. Dessa kan hanteras som separata moduler, vilket skapar möjligheten att kunna lägga till nya moduler eller helt enkelt endast använda de moduler som behövs vid hantering av fordons- och driftsdata.

Data som är kopplad till varje enhet i ett ekipage har valts ut efter diskussioner och utifrån den uppfattade behovsbilden samt den insamlade informationen från systemleverantörer. De moduler som innehåller data om de olika enheter som bygger upp ekipaget är FörarData, FordonData, LastbärareData (en Lastbärare kan innehålla flera Lastbärare), Utrustning , position och tidstämpel.

Data kopplad till varje enhet skickas i form av olika meddelanden.

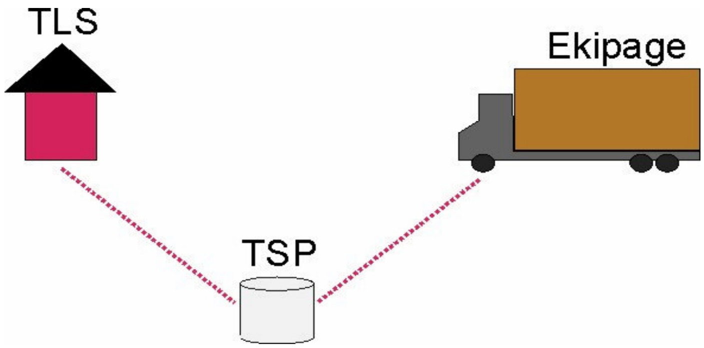
5.2.1 Förardata

Förardata modulen ska innehålla data gällande förare. Här ingår en modul för tidsrapportering. Med denna modul blir det lättare och smidigare att föra in arbetstider och ha kontroll över utförda arbeten. Samtidigt skapar det möjlighet att enklare kunna följa upp lönsamhet och utföra avräkningar, vilket är ett viktigt behov inom branschen. Tidsrapportering ligger som en separat modul för att förenkla datahanteringen. Om så önskas kan det enkelt slopas utan att påverka resten av strukturen.

5.2.2 Fordonsdata

Fordonsdata modulen innehåller data gällande fordon. Här finns modulen FMS-data.

Främst kunder men även systemleverantörer har visat intresse för möjligheten att kunna skicka data som ingår i FMS, som kan användas för beräkning av till exempel bränsleförbrukning, miljöberäkningar etc. Inläst FMS-data skickas från ett fordon till en server hos en TSP som är kopplad till fordonet. Där görs eventuella beräkningar på mottagen data för att sedan skicka vidare behandlad data till exempelvis ett kontor (TLS).



Figur 6. Figuren visar hur FMS-data skickas.

Samtliga parametrar i FMS-standarden har tagits med som en del av fordonsdata. Anledning till detta har varit att utifrån en standard som är framtagen av sex stora fordonstillverkare kunna bygga en standardstruktur innehållande fordonsdata som kan användas. Vidare används FMS-standarden redan av en del för hantering av fordonsdata. Det framlagda förslaget till standard ger möjlighet till att behandlad eller obehandlad data kan skickas vidare från ett TSP. Vidare är det möjligt att strukturen byggs ut så att extra önskad data kan inkluderas vid behov.
FMS-data finns som en egen modul under fordonsdata modulen. Motiveringen är att ge möjligheten att enklare välja eller välja bort data som ingår i FMS

5.2.3 Lastbärardata

I denna modul ska data som är relevant till lastbärare ingå. Temperatur anses vara viktig information som ska kunna erhållas från en lastbärare, vilket har stor betydelse för det gods den innehåller. Således har en parameter som kan användas för att hantera temperatur lagts till för varje lastbärare. Även lastbärarID finns med för att kunna koppla data till tillhörande lastbärare.

5.2.4 Utrustningsdata

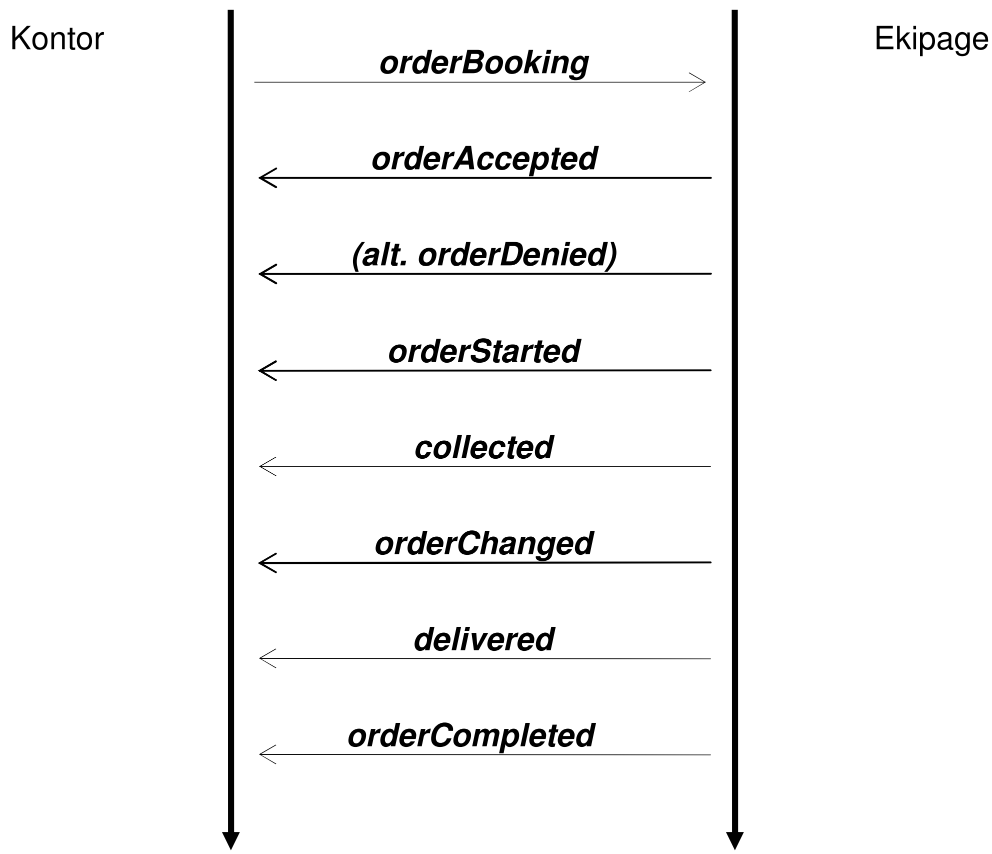
I denna modul ska data som är relevant till utrustning ingå. UtrustningsID finns med som en parameter för att kunna identifiera den tillhörande utrustningen.

5.2.5 Position

Denna modul är till för att möjliggöra positionering av ett ekipage, fristående lastbärare eller utrustning. Tanken är att det ska vara möjligt att kunna lokalisera en enhet oavsett om den ingår i något ekipage eller ej. Vidare är det möjligt att enkelt utesluta denna modul om så önskas.

Bilaga. Case: Container

Detta case beskriver en containertransport med där containern skall hämtas på ett ställe, tömmas på ett annat och lämnas på ett tredje ställe. Figuren visar ordermeddelandeflödet.



Bokning av order
Detta meddelande skickas från transportledaren till ekipaget.


```
<Order>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <littra>Stora bygget 1</littra>
          <LoadSite>
               <name>Stora bygget</name>
               <address>Byggvägen 15</address>
               <postalCode>567xx</postalCode>
               <city>Göteborg</city>
               <country>Sweden</country>
               <contact>Lars Svensson</contact>
               <phone>031-2345xx</phone>
               <Position>
<latitude>31.4</latitude>
      <longitude>44.2</longitude>
               </Position>
          </LoadSite>
          <LoadTimeSlot>
               <startDateTime>2004-11-10T10:00:00+01:00</startDateTime>
               <stopDateTime>2004-11-10T10:30:00+01:00</stopDateTime>
          </LoadTimeSlot>
          <TipSite>
               <name>Lilla Tippen</name>
               <address>Tippvägen 13</address>
               <postalCode>234xx</postalCode>
               <city>Göteborg</city>
               <country>Sweden</country>
               <contact>Sture Karlsson</contact>
               <phone>031-2355xx</phone>
               <Position>
<latitude>33.4</latitude>
      <longitude>42.2</longitude>
               </Position>
          </TipSite>
          <TipTimeSlot>
               <startDateTime>2004-11-10T10:30:00+01:00</startDateTime>
               <stopDateTime>2004-11-10T11:00:00+01:00</stopDateTime>
          </TipTimeSlot>
          <DeliverySite>
               <name>Vägbygget</name>
               <address>Storvägen 13</address>
               <postalCode>576xx</postalCode>
               <city>Göteborg</city>
               <country>Sweden</country>
               <contact>Kalle Andersson</contact>
               <phone>031-6777xx</phone>
               <Position>
<latitude>36.4</latitude>
      <longitude>42.2</longitude>
               </Position>
          </DeliverySite>
```

```xml
          <DeliveryTimeSlot>
               <startDateTime>2004-11-10T11:00:00+01:00</startDateTime>
               <stopDateTime>2004-11-10T11:30:00+01:00</stopDateTime>
          </DeliveryTimeSlot>
          <Customer>
               <id>123</id>
               <name>Byggbolaget AB</name>
               <address>Företagsvägen 7</address>
               <postalCode>343xx</postalCode>
               <city>Göteborg</city>
               <country>Sweden</country>
               <phone>031-2498xx</phone>
          </Customer>
          <Consignment>
               <consignmentId>2384789242</consignmentId>
          </Consignment>
          <ContainerInfo>
               <containerId>433891</containerId>
               <containerType>öppen</containerType>
               <GoodsInformation>
      <AdditionalInfo>
           <headLine>Innehåll<headLine>
           <text>Byggavfall</text>
      </AdditionalInfo>
               </GoodsInformation>
               <Measurement>
      <Quantity>
          <unit>m3</unit>
                           <quantity>10</quantity>
                      </Quantity>
               </Measurement>
          </ContainerInfo>
          <OrderStatus>
                 <orderBooking>status</orderBooking>
          </OrderStatus>
     </Container>
</Order>
```

Acceptans av order

Detta meddelande skickas från ekipaget till transportledaren.

```xml
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <OrderStatus>
               <orderAccepted>status</orderAccepted>
          </OrderStatus>
      </Container>
</OrderStatus>
```

Alternativt ordern nekas
Detta meddelande skickas från ekipaget till transportledaren.


```
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <OrderStatus>
               <orderDenied>status</orderDenied >
          </OrderStatus>
      </Container>
</OrderStatus>
```


Statusmeddelande ordern har påbörjats


```
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <OrderStatus>
               <orderStarted>status</orderStarted>
          </OrderStatus>
      </Container>
</OrderStatus>
```


Statusmeddelande containern har hämtats


```
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <OrderStatus>
               <collected>status</ collected >
          </OrderStatus>
      </Container>
</OrderStatus>
```


Statusmeddelande ordern ändras
Föraren ändrar avlämningsplats för containern efter samtal med ansvarig på Stora Bygget, som vill ha containern lämnad på annan plats.


```
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <TipSite>
               <name>Byggtippen</name>
               <address>Sandvägen 9</address>
               <postalCode>426xx</postalCode>
               <city>Göteborg</city>
```

```
                <country>Sweden</country>
                <contact>Arvid Johansson</contact>
                <phone>031-2389xx</phone>
                <Position>
<latitude>31.4</latitude>
      <longitude>41.2</longitude>
                </Position>
          </TipSite>

          <OrderStatus>
                < orderChanged >status</ orderChanged >
          </OrderStatus>
      </Container>
</OrderStatus>
```

Statusmeddelande containern har tömts

```
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <OrderStatus>
               <delivered>status</delivered>
          </OrderStatus>
      </Container>
</OrderStatus>
```

Statusmeddelande containern har lämnats på avlämningsplatsen och uppdraget är avslutat

```
<OrderStatus>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <OrderStatus>
               <orderCompleted>status</orderCompleted>
          </OrderStatus>
      </Container>
</OrderStatus>
```

Appendix B. Data Transport Standard Document

Data Transport Standard Document

Table of contents

1 Document

1.1 Document Status

Second draft.
OrderInformation types yet to come:
StatusInformation types yet to come:

1.2 Document history

First draft 2004-10-12
Second draft XXXX-XX-XX
StatusInformation is added.

1.3 Function

The message is divided into two parts. First the message head, which keeps the information of sender, receiver and the data definition, and then the data structure that, keeps the data of orders, vehicles, drivers, statuses, etc. depending on the data definition in the message head.

1.4 Message Structure

To simplify the message structure, compare it with a mail. The message is packaged into an envelope; the envelope got the addresses of the communicating computers, and the specific message.
The message is divided into two major parts, message head and data. Message head is sender, receiver and message information. Sender is either a User or an Equipage. User could be the traffic controller and the Equipage is the key to the mobile unit, further explained later in the document. It is possible to send the message to several users or equipages at the same time. Message Information marks what kind of data the message is sending.
The data is divided by MessageInformation, the different types are e.g. OrderData, OrderStatus, EquipageData. It is possible to combine and send several different types of data at the same time. E.g. send EqupiageData; Position and FuelAmount, together with an OrderStatus. This makes it possible to do follow ups for cost and environmental issues.

1.5 Equipage

Equipage is a soft key to the mobile unit. With the key “Equipage”, it is possible to recognize the mobile units set up. Who is the driver, what vehicle, what load unit is mounted on the vehicle, which trailer (LoadUnit) is attached to the vehicle, what equipment is mounted to the vehicle and/or to the load unit. The Equipage is a mobile network with one connection thru which all units are accessible. The Equipage key is dynamic and can be configured as needed. It is even possible to use the Equipage key to access a parked trailer by using the equipage, LoadUnit and Communication, LoadUnit identifies the trailer and Communication keeps the information of the connection type, GSM, GPRs, Mobitex, which ever is used.

2 Data Sets

2.1 Envelope

The XML-message is built up with two blocks. The first part is Envelope, where it is decided who are the two parts interested in the message. addressTo is the receiver and addressFrom is the sender. The second part is the message to be sent packaged into the Envelope.

Example:

```
<Envelope>
      <Message>2.1.1</Message>
      <addressTo>127.0.0.1</addressTo>
      <addressFrom>127.0.0.2</addressFrom>
</Envelope>
```

2.1.1 Message

In the first level of the Message there is a messageId, which is a unique identifier used for error handling and for receipts of sending notifications.
Sender and Receiver defines who within the system is sending and who is receiving and there configuration.
MessageInformation points out what kind of information the message carries.

Example:

```
<Message>
      <Sender>2.1.1.1</Sender>
      <Receiver>2.1.1.2</Receiver>
      <MessageInformation>2.1.1.3</MessageInformation>
      <messageId>IdCode</messageId>
      <version>Viktoria_Schema_1.0</version>
      <sendTime>2004-11-11T19:20:10+01:00</sendTime>
</Message>
```

2.1.1.1 Sender

Sender is either a User or an Equipage. User is the traffic controller and the Equipage is the key to the mobile unit. How to use the soft key Equipage read the section Equipage.

Example:

```
<Sender>
      <Equipage>
            <Driver>Arne Arnesson</Driver>
            <Vehicle>123Abc</Vehicle>
            <Communication>
                  <GSM>
                        <numberTo>xxx-xxxxxx</numberTo>
                        <numberFrom>xxx-xxxxxx</numberFrom>
                  </GSM>
            </Communication>
      </Equipage>
</Sender>
```

2.1.1.1.1 Equipage

Equipage is a soft key to the mobile unit. Marks what components are used, by Id:s and marks the connection type and includes the address.

2.1.1.1.2 User

User is the traffic controller. Communication via IP-number.

2.1.1.2 Receiver

Receiver is equivalent to Sender; the only difference is the multiplicity. It is possible to have more than one Receiver. By making Sender and Receiver equivalent, creates the possibility to send from Equipage to User, from User to Equipage, from Equipage to Equipage and User to User.

2.1.1.3 MessageInformation

Declaration of message content

Example:

```
<Messageinformation> 2.1.1.3.*</Messageinformation>
```

2.1.1.3.1 MessageStatus

Example:

```
<MessageInformation>
      <MessageStatus>
            <status> Error </status>
            <messageId> 123456 </messageId>
            <remark> Type mismatch  </remark>
            <errorCode> 123 </errorCode>
      </MessageStatus>
</MessageInformation>
```

2.1.1.3.2 Order

In the standard the order message is build in module, containing some fields that are common regardless of transport type.

The Order number identifies the order. Sub number is used to be able to connect several assignments to a single order number. An order that contains several activities can be connected together with an order number to simplify e.g. invoicing. It is a way to organize many activities of the same type.

Example:

```
<Order>
      <OrderNr>32143</OrderNr>
      <SubNr>001</SubNr>
      <KundNr>223</KundNr>
      <KundNamn>Viking AB</ KundNamn >
      <Littra>Bohus</Littra >
      …
</Order>
```

2.1.1.3.2.1 Container

The container module contains the fields Ordernumber, Subnumber, Littra. It also holds the modules LoadSite, DeliverySite, TipSite , ContainerInfo, Customer and Consignment and a additionalInfo filed for additional information. The ContainerInfo module holds information like containter-type and quantity.

Example:

```xml
<Order>
     <Container>
          <orderNr>123987</orderNr>
          <subNr>0</subNr>
          <littra>Stora bygget 1</littra>
          <LoadSite>
            …
          </LoadSite>
          <LoadTimeSlot>
            …
          </LoadTimeSlot>
          <TipSite>
               <name>Lilla Tippen</name>
               <address>Tippvägen 13</address>
               …
          </TipSite>
          <TipTimeSlot>
            …
          </TipTimeSlot>
          <DeliverySite>
            …
          </DeliverySite>
          <DeliveryTimeSlot>
            …
          </DeliveryTimeSlot>
          <Customer>
               <id>123</id>
               <name>Byggbolaget AB</name>
            …
          </Customer>
          <Consignment>
               <consignmentId>2384789242</consignmentId>
          </Consignment>
          <ContainerInfo>
               <containerId>433891</containerId>
               …
          </ContainerInfo>
          <OrderStatus>
                 <orderEntry>status</orderEntry>
          </OrderStatus>
     </Container>
</Order>
```

2.1.1.3.2.2 Long distance

The Long distance module contains the fields OrderNr, SubNr (sub number), Littra. It also holds the modules LoadSite, DeliverySite, Customer and Consignment, OrderRow and additionalInfo.

Example:

```
<Order>
<OrderStatus>
<LongDistans>
<orderNr>89836</orderNr>
        <subNr>0</subNr>
        <littra>Section A </littra>
          <LoadSite>
                  <name>gräddgatan </name>
                  <address>…</address>
                …
          </LoadSite>
          <LoadTimeSlot>
               <startDateTime>2004-11-10T11:00:00+01:00</startDateTime>
               <stopDateTime>2004-11-10T11:30:00+01:00</stopDateTime>
          </LoadTimeSlot>
           …
      <customer>…</custmer>
      <orderRow>
      …
      </orderRow>
      …
</LongDistans>
</OrderStatus>
</Order>
```

2.1.1.3.2.3 OrderRow

Contains orderRowNr, rowText (description), GoodsInformation, Measurement and additionalInfo. The Measurement Module then contains two parameters Quantity and Size. Quantity is for giving the weight of the cargo and size for giving the measurement of the cargo in unit e.g. meter.

Example:

```
<orderRow>
      <orderRowNr>78</orderRowNr>
            <orderRowText>…</orderRowText>
            <GoodsInformation>
                  <ADR>
                        <adrClass>9.0</adrClass>
                        <AdditionalInfo> …</AdditionalInfo>
                  </ADR>
            </GoodsInformation>
            <measurement>
```

```
                    <quantity>
                          <unit>litre</unit>
                          <quantity>223</quantity>
                    </quantity>
                    <size>
                          <unit>mm</unit>
                          <width>1500</width>
                          <length>1800</length>
                          <height> 3000</height>
                    </size>
              </measurment>
</orderRow>
```

2.1.1.3.3 GetOrder

Request of information can be fetched for any type of Transport. Among others the order status information can be re-created.

Example:

```
<GetOrder>
     <LongDistans>
        <orderNr>564342</orderNr>
        <subNr>1</subNr>
        <littra>stora bygget </littra>
     </LongDistans >
…
</GetOrder>
```

2.1.1.3.4 OrderStatus

The OrderStatus module is used to indicate if the order is e.g. changed or confirmed, it can also be used to indicate if loaded or unloaded. The fields in this module are orderEntry, orderAccepted, orderDeneid, orderStarted, collected, delivered and orderBooking.

Example:

```
<Order>
 <OrderStatus>
   <Container>
      <orderNr>89836</orderNr>
      <subNr>0</subNr>
       <littra>Section A </littra>
      <OrderStatus>
            <orderAccepted>status</ orderAccepted>
      </OrderStatus>
   </Container>
 </OrderStatus>
</Order>
```

2.1.1.3.4.1 Describing some modules

There are notations in the XML-structure to explain the modules. Below we explain some of modules that are used, among others, for handling orders.

Site

The Site module is a complex type which is used to describe different sites, like LoadSite, DeliverySite and TipSite (for Container), containing fields like name and address to specify the site.

Customer

The customer module is a complex type used to handle customer information e.g. id (customer identification number), name, address and contact information etc.

littra

Littra is a simple type and contains information about the working site and can be used in any type of transport. Orders with the same Littra can be collected for example invoicing.

Measurement

The measurement module is used to describe measure of height, length and width. It can be used to describe the measures of e.g. a container or cargo.

orderBooking

The orderBooking is an order inquiry indicating an order is send to equipage. It can either be accepted or denied with help of a status message that is included in the OrderStatus module.

2.1.1.3.5 EquipageData

This module contains data about different components that together builds an equipage and the equipage itself. Thereby it holds information produced by driver (DriverData), vehicle (VehicleData), load units (LoadUnitData), equipments (EquipmentData) and the position of an equipage.

Parameters loadUnitID and equipmentID included in LoadUnitData and EquipmentData must be set and have to be unique for each load unit or equipment. This is important for finding the related load unit or equipment. EquipageData contains even a timestamp parameter (readTime). This parameter holds information about the date and time when data about the equipage was read and is not the same timestamp find in Message module, which represents the time for when a message was sent. A timestamp in this module can be useful in cases of data being buffered before it is sent (e.g. bad connection etc.).

A module for handling FMS-data (FmsData) is included under VehicleData module and can be used when necessary as in the example below. All the parameters in the FMS-standard are included in this module.

Example:

```
<EquipageData>
	<VehicleData>
		<FmsData>
			<totalFuelUsed>20.5</totalFuelUsed>
			<fuelLevel>30</fuelLevel>
		</FmsData>
	</VehicleData>
	<LoadUnitData>
		<loadUnitID>PIC777</loadUnitID>
		<temperature>8.25C</temperature>
	</LoadUnitData>
	<EquipmentData>
		<equipmentID>EQ87</equipmentID>
		<AdditionalInfo>
			<headLine>Crane</headLine>
			<text>Broken</text>
		</AdditionalInfo>
	</EquipmentData>
	<Position>
		<latitude>31.4</latitude>
		<longitude>44.2</longitude>
		<height>15.7</height>
		<direction>189.6</direction>
	</Position>
	<readTime>2004-11-05T14:08:39+01:00</readTime>
</EquipageData>
```

Components i.e. a load unit can also be handled separately, e.g. when it is detached from an equipage. This is done by building an equipage that only contains the desired component, in this case a load unit. Following example illustrates the handling of data related to such a load unit.

Example:

```
<EquipageData>
	<LoadUnitData>
		<loadUnitID>PIC777</loadUnitID>
		<temperature>9.13C</temperature>
	</LoadUnitData>
	<Position>
		<latitude>12.1</latitude>
		<longitude>34.2</longitude>
		<height>55.3</height>
		<direction>245.2</direction>
	</Position>
	<readTime>2004-11-05T16:32:56+01:00</readTime>
</EquipageData>
```

Information related to a driver can be handled in the same. Following example illustrates how a time report can look like.

Example:

```
<EquipageData>
      <DriverData>
            <TimeReport>
                  <date>2004-10-05</date>
                  <week>41</week>
                  <startTime>08:30:00</startTime>
                  <endTime>17:30:00</endTime>
                  <totalTime>8</totalTime>
                  <breakStartTime>12:15:00</breakStartTime>
                  <breakEndTime>13:15:00</breakEndTime>
                  <totalBreakTime>1</totalBreakTime>
            </TimeReport>
      </DriverData>
      <readTime>2004-10-07T11:10:09+01:00</readTime>
</EquipageData>
```

2.1.1.3.6 IdentificationMessage

By sending an IdentificationMessage an equipage is able to identify itself (who am I, how do I look and what am I capable of). This message can describe the equipage configuration and contains information about the driver (driver's license, certifications etc.), vehicle (VehicleDescription etc.), load unit (LoadUnitDescription etc.), equipment and company.

The number of load units and equipments in an equipage is determined by the multiplicity of that specific module.

VehicleDescription and LoadUnitDescription modules are added for describing more detailed information about a vehicle and a load unit when sending an identification message. The parameter lists in VehicleDescription and LoadUnitDescription are not considered to be complete. Hence more parameters can be added to these modules (e.g. VehicleDescription can be extended with information about what type of load unit or equipment can be dragged by a vehicle). The reason for including these modules has been to illustrate how the possibility of expanding the structure can be used. If desired the modules can be left out completely.

Example:

```
<IdentificationMessage>
      <DriverInfo>
            <driverName>Johan Johansson</driverName>
            <driverID>123</driverID>
            <DriverLicense>
                  <licenseCategories>CE</licenseCategories>
```

```
                  <validity>2005-10-12</validity>
            </DriverLicense>
      </DriverInfo>
      <VehicleInfo>
            <vehicleID>REG123</vehicleID>
      </VehicleInfo>
      <LoadUnitInfo>
            <loadUnitID>ABC222</loadUnitID>
            <LoadUnitInfo>
                  <loadUnitID>148</loadUnitID>
                  <additionalInfo>Empty</additionalInfo>
            </LoadUnitInfo>
      </LoadUnitInfo>
      <EquipmentInfo>
            <equipmentID>M44</equipmentID>
            <equipmentDescription>Crane</equipmentDescription>
      </EquipmentInfo>
      <company>Alfa</company>
</IdentificationMessage>
```

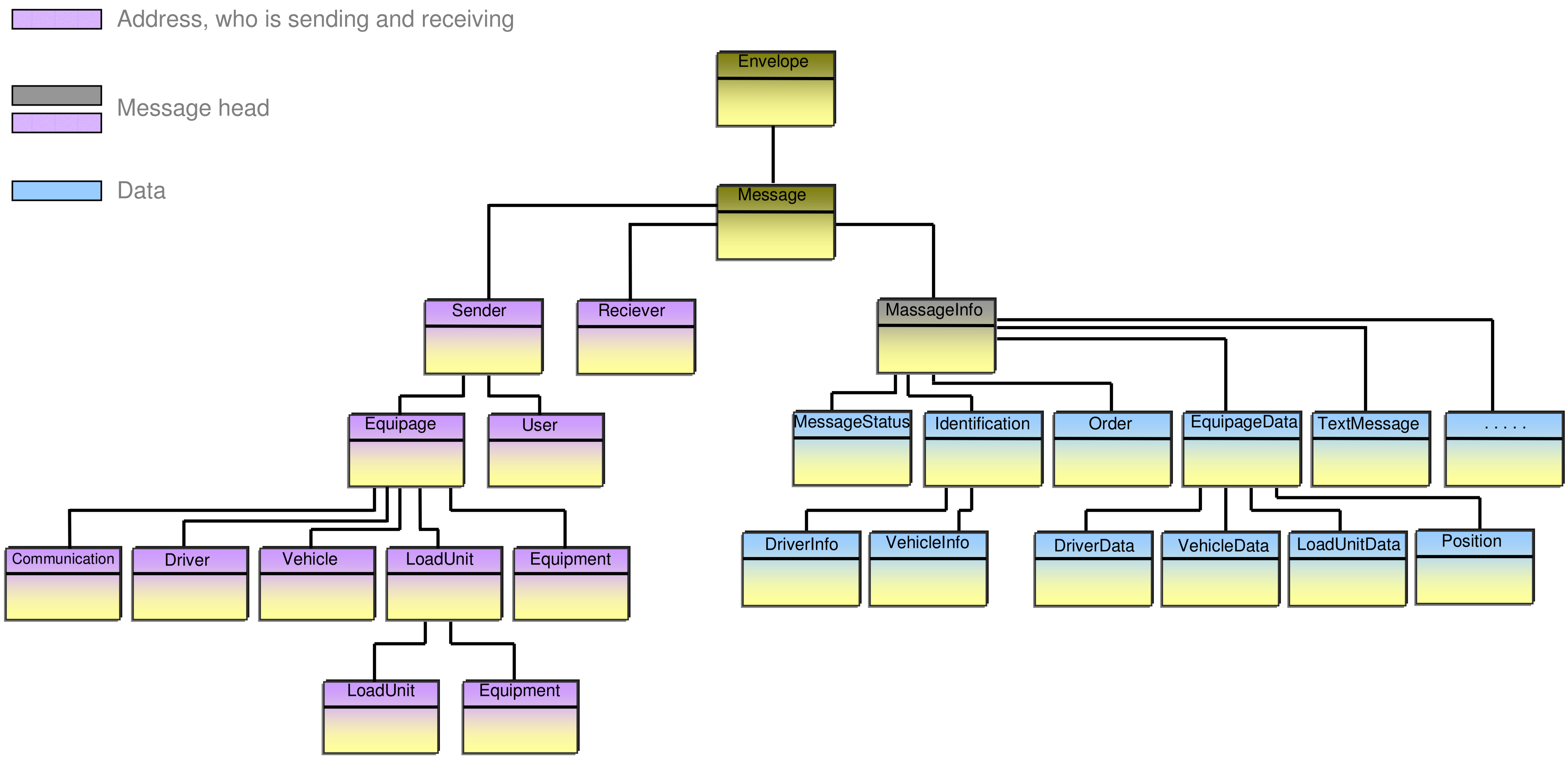
2.1.1.3.7 TextMessage

As the name indicates this message type can be used for sending text messages. A text message contains a subject and the message itself.

Example:

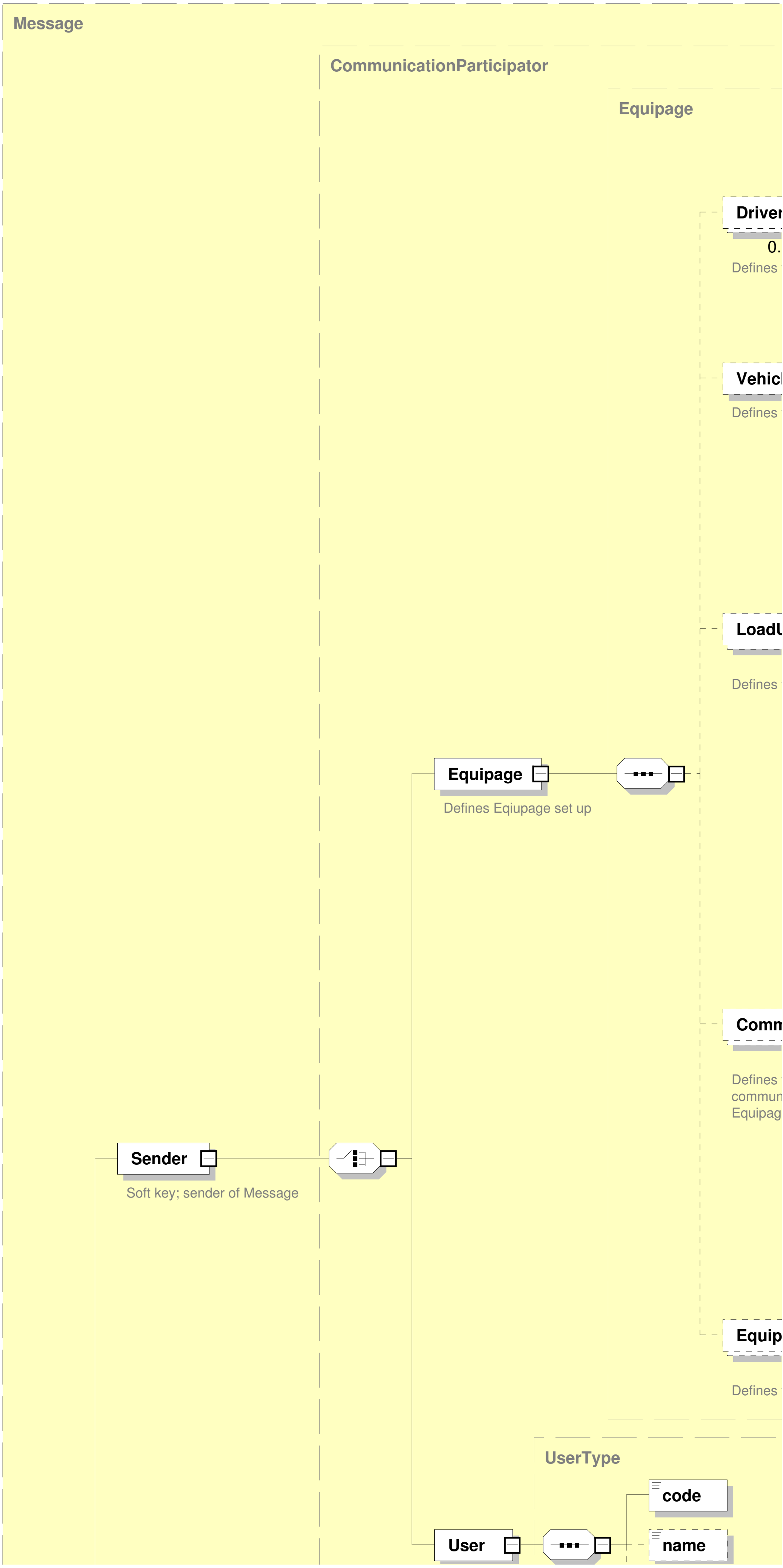
```
<TextMessage>
      <headLine>Transport delay</headLine>
      <text>I've got a flat tyre and will be 1 hour late.</text>
</TextMessage>
```

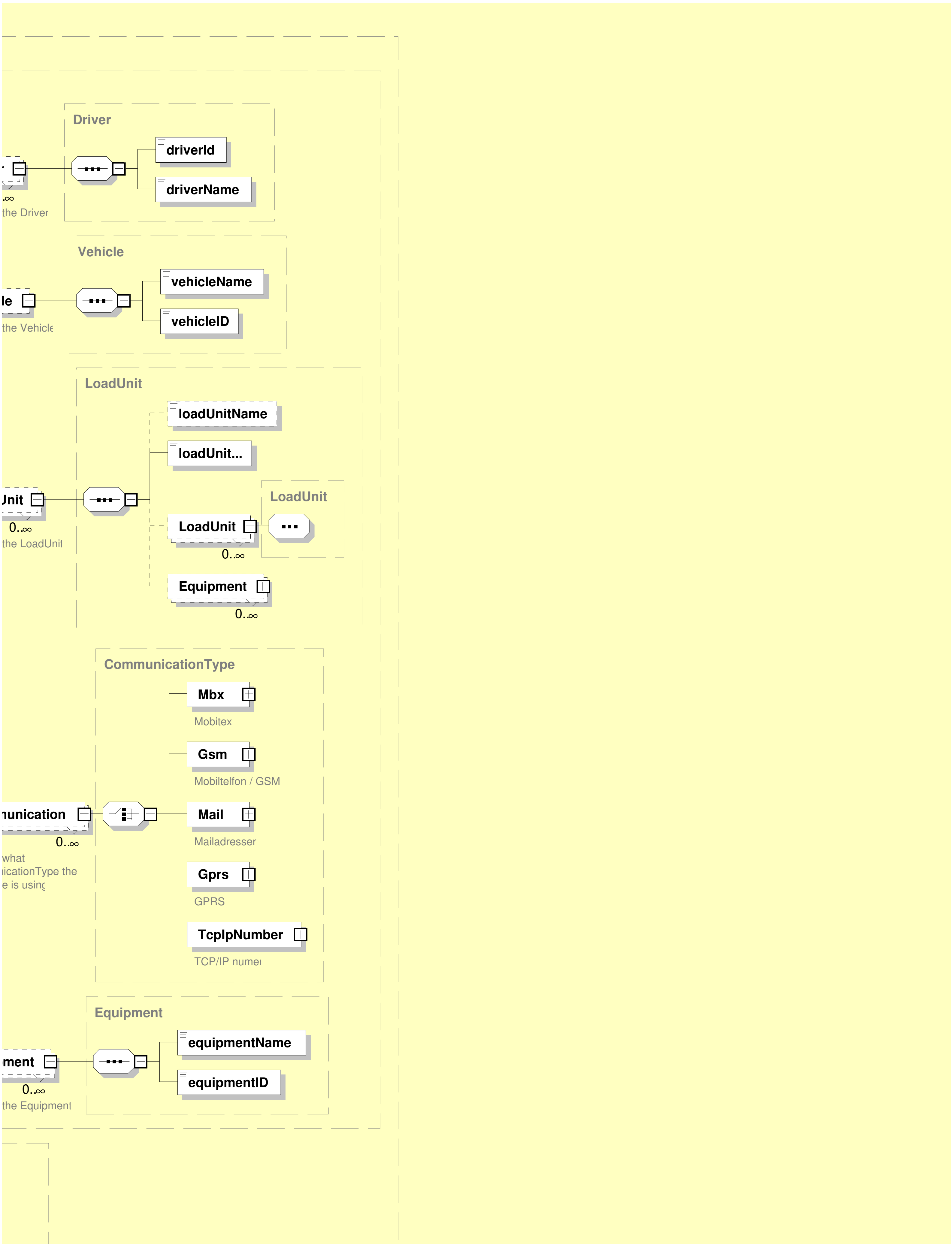
Appendix C. Simplified model over XML-Structure for communication standard interface

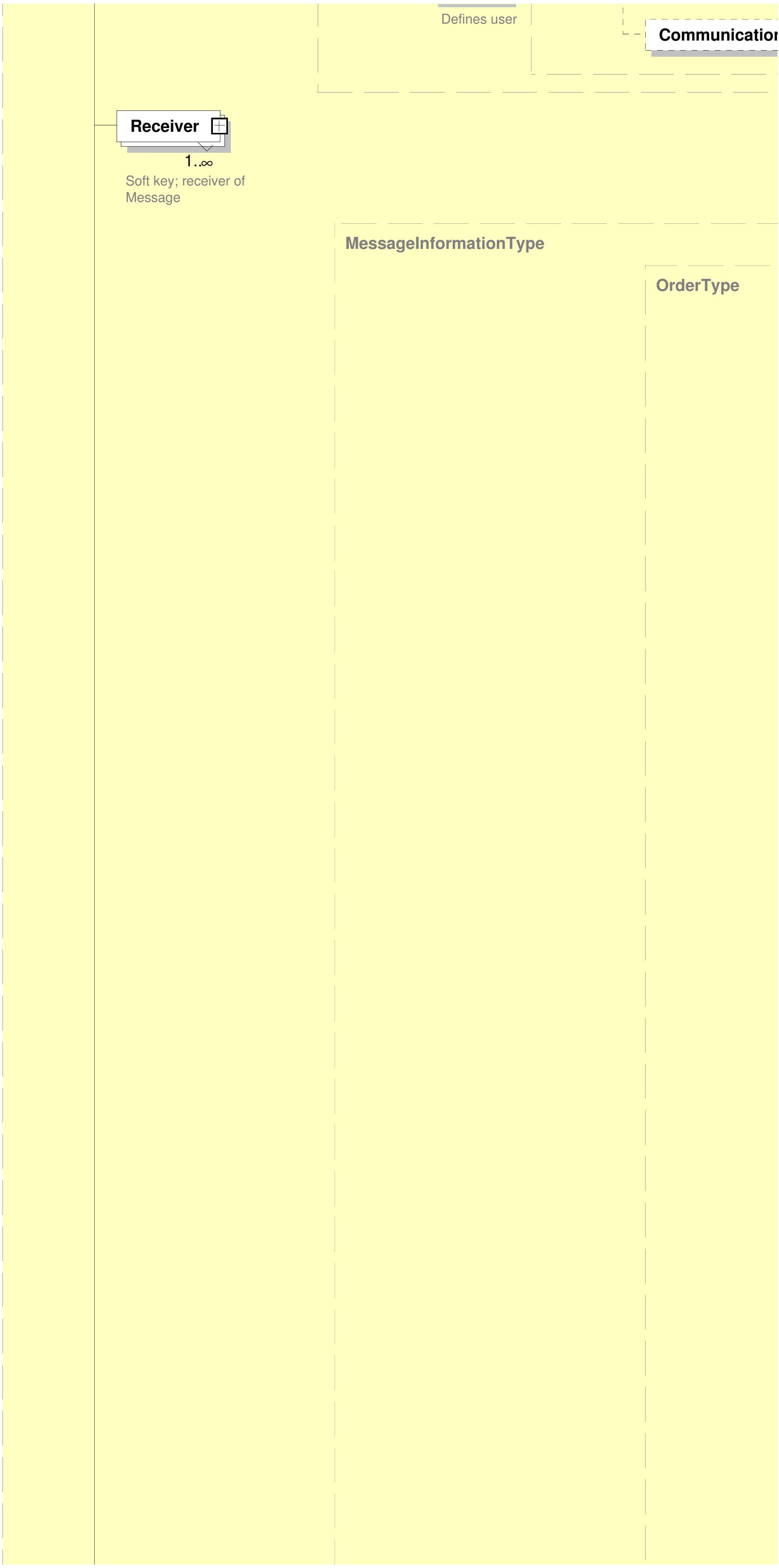


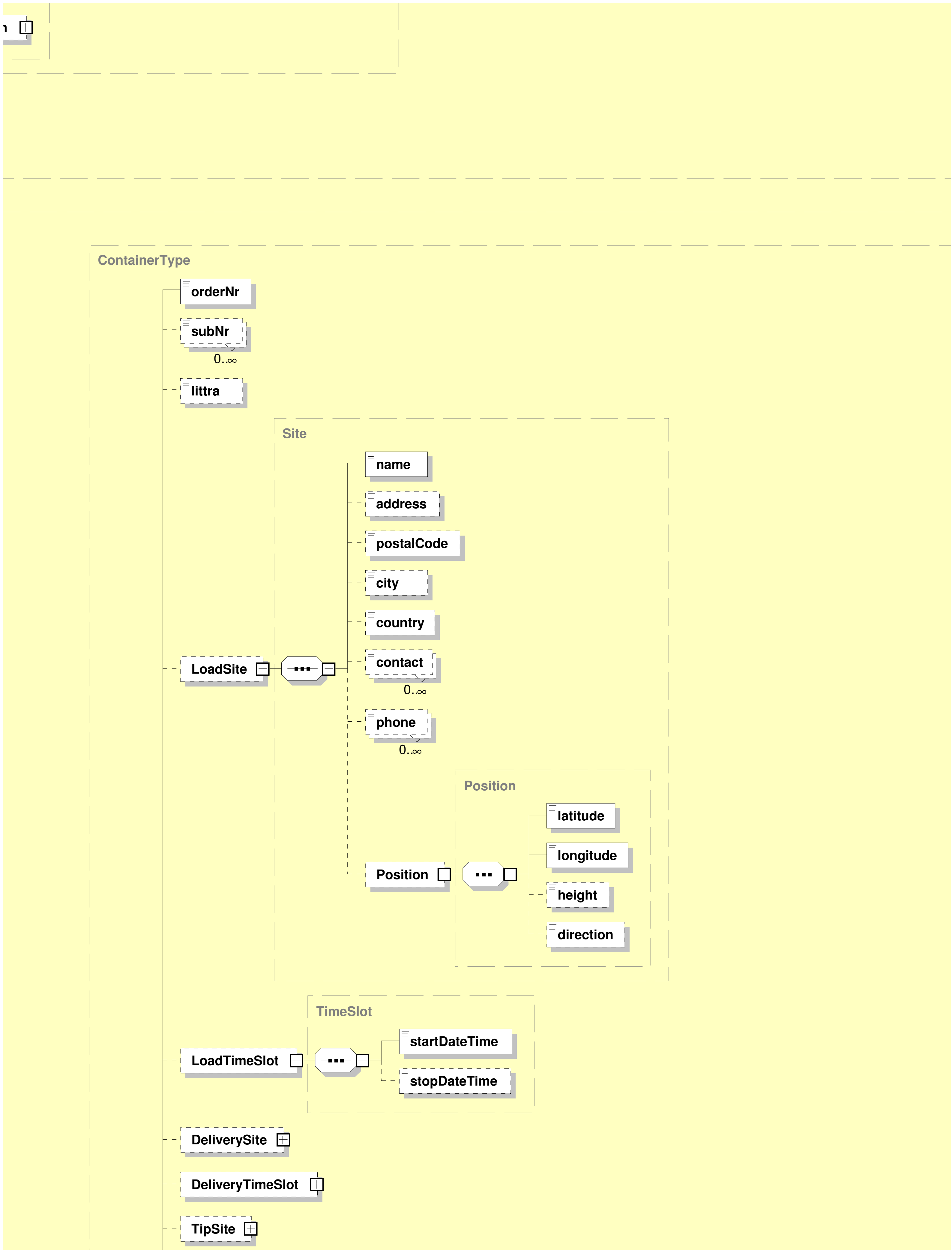
XML-Structure over communication standard
interface showing several included modules.

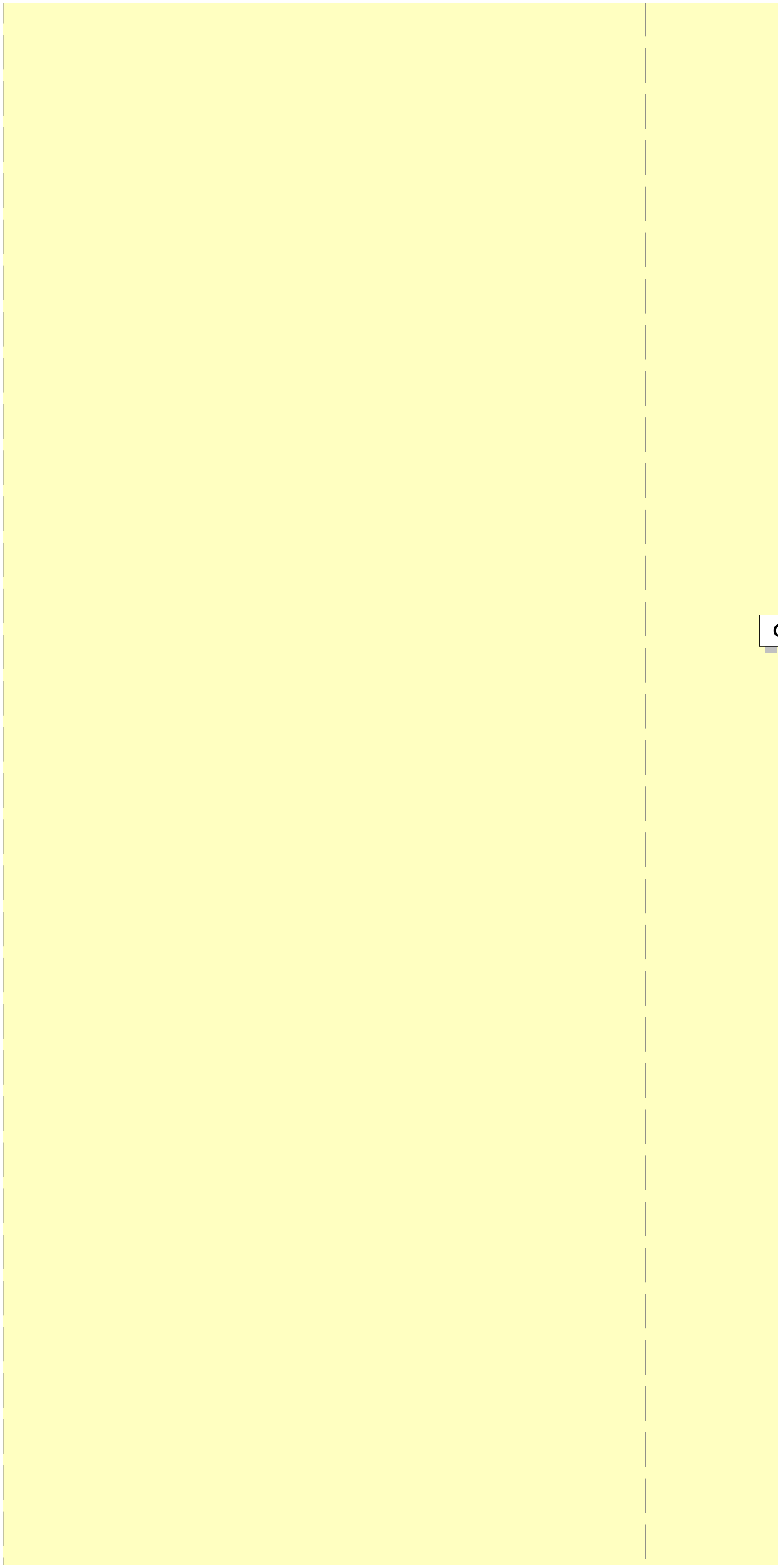
Appendix D. XML-Structure for communication standard interface

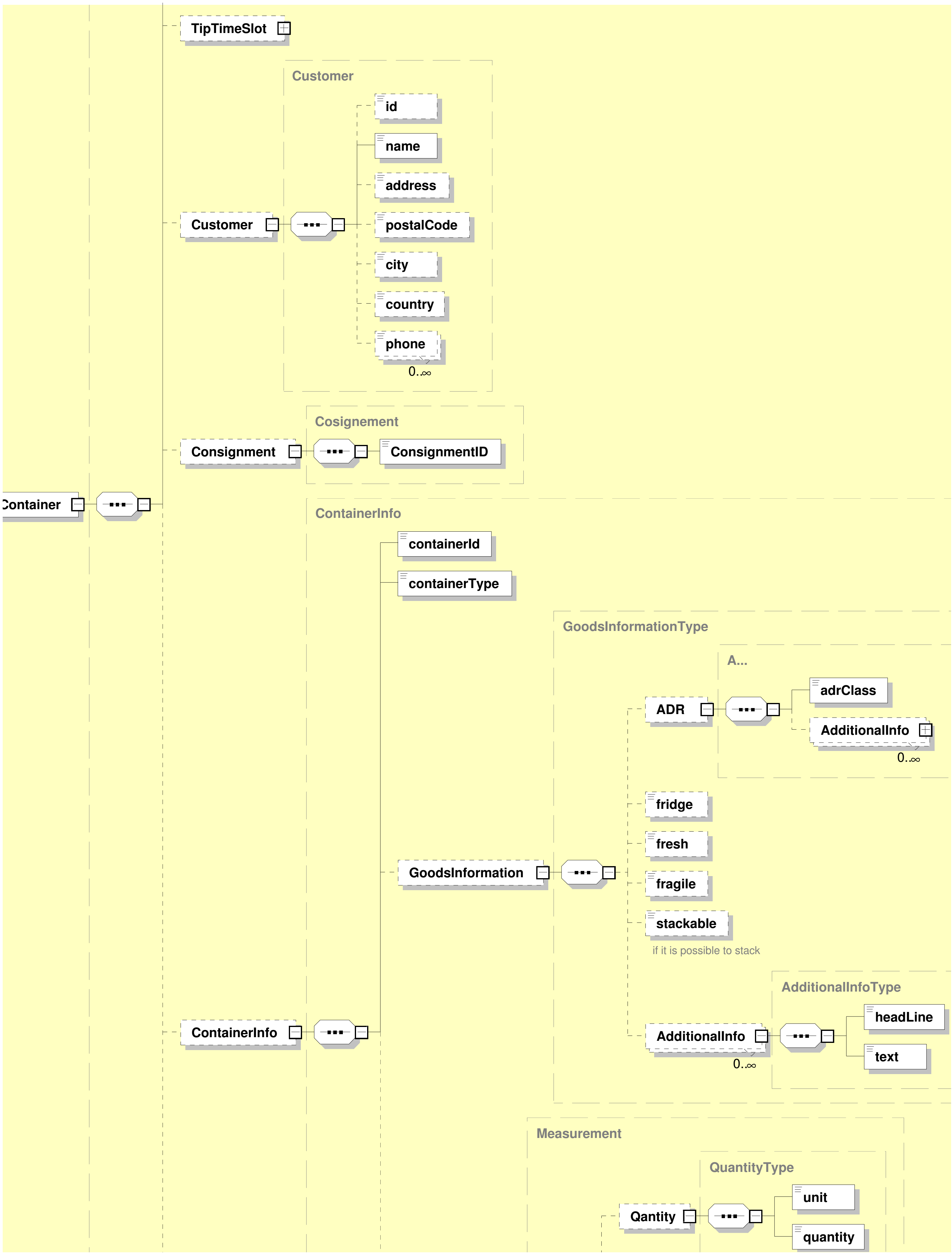

Message
CommunicationParticipator
Equipage
Sender
Soft key; sender of Message
Equipage
Defines Eqiupage set up
User
UserType
code
name

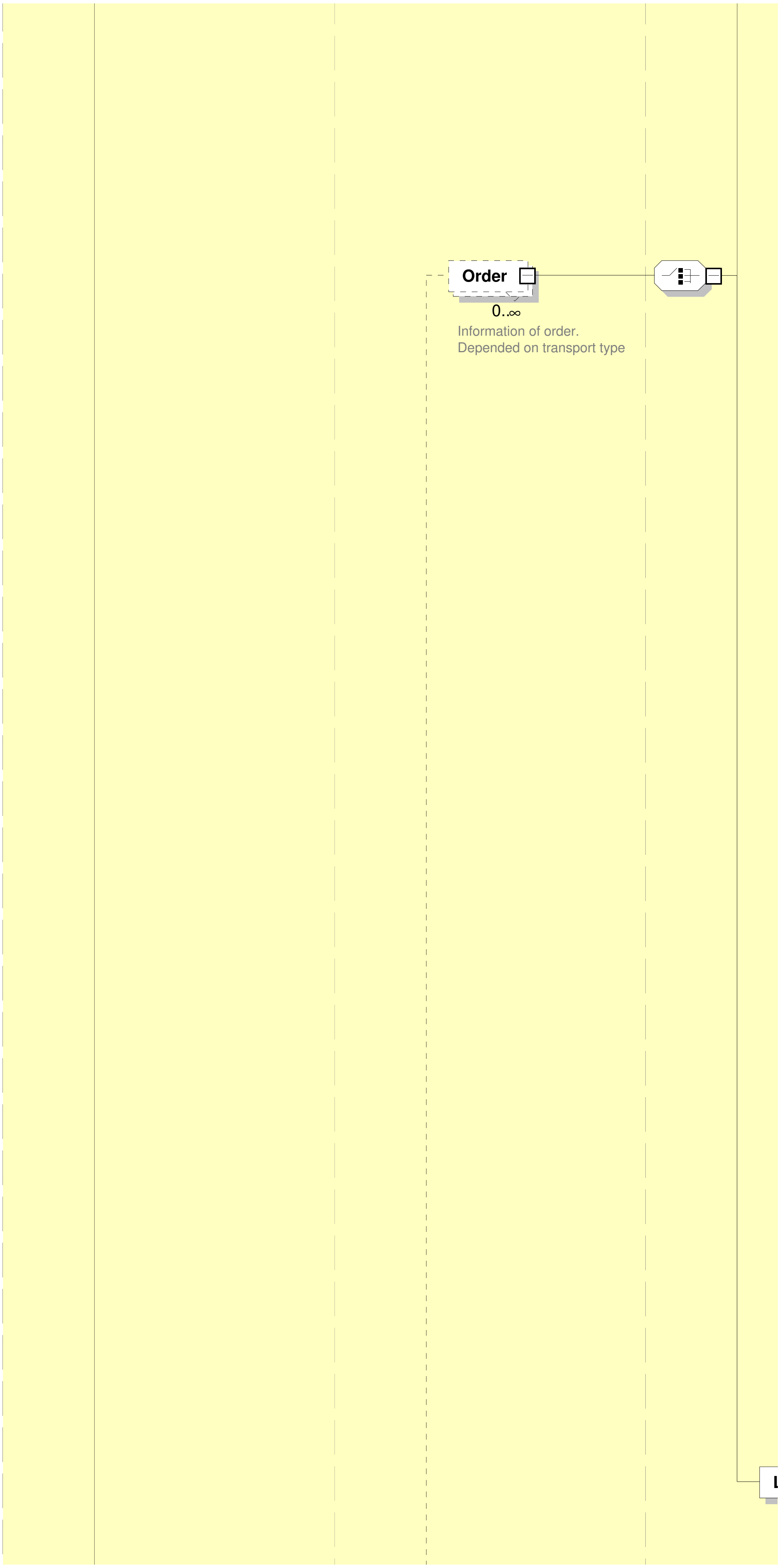

Driver
driverId
driverName
the Driver
Vehicle
vehicleName
vehicleID
the Vehicle
LoadUnit
loadUnitName
loadUnit...
LoadUnit
LoadUnit
0..∞
Equipment
0..∞
0..∞
the LoadUnit
CommunicationType
Mbx
Mobitex
Gsm
Mobiltelfon / GSM
Mail
Mailadresser
Gprs
GPRS
TcpIpNumber
TCP/IP numer
0..∞
Equipment
equipmentName
equipmentID
0..∞
the Equipment

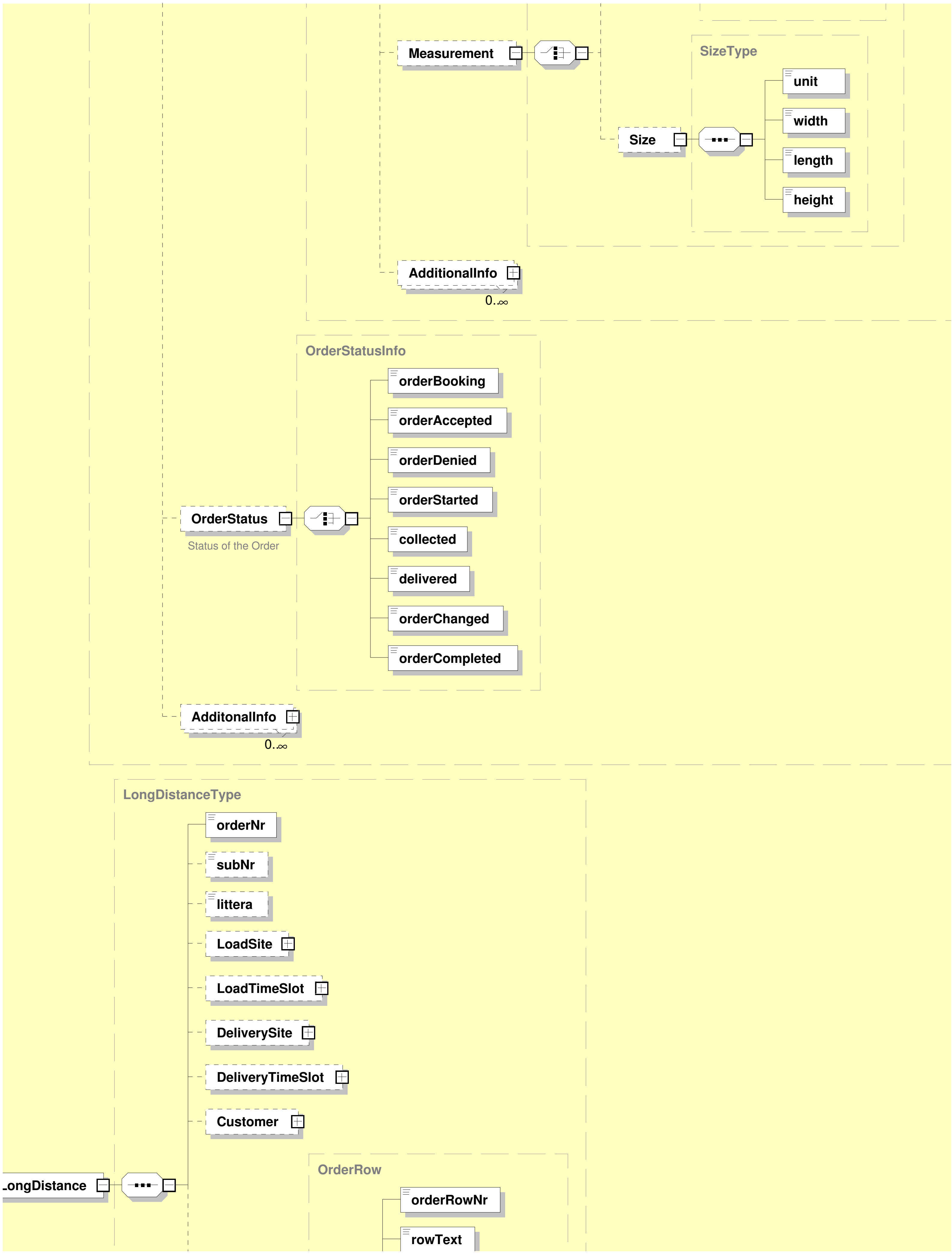

Defines user
Communicatio
Receiver
1..∞
Soft key; receiver of Message
MessageInformationType
OrderType

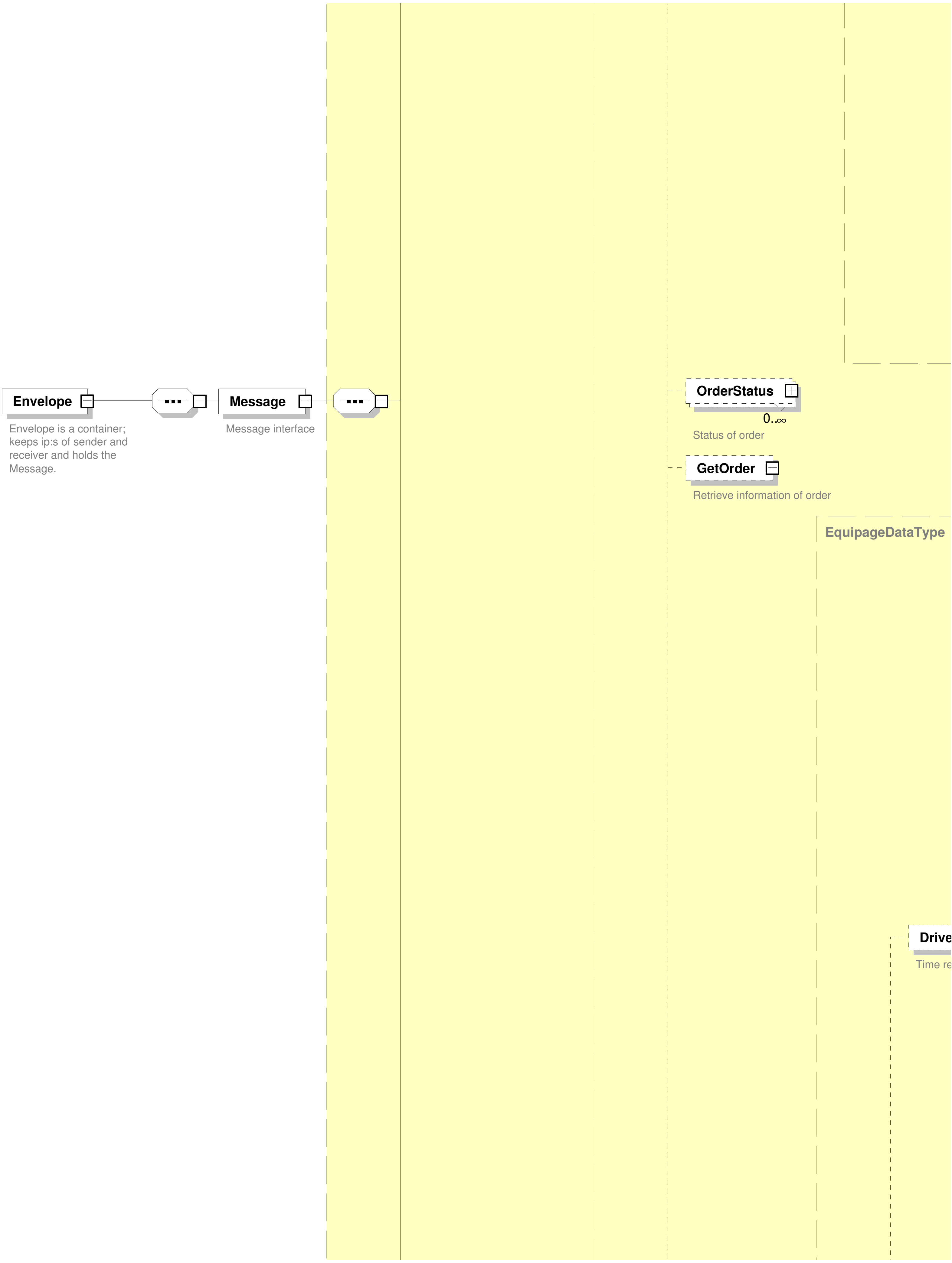

ContainerType
orderNr
subNr
0..∞
littra
Site
name
address
postalCode
city
country
contact
0..∞
phone
0..∞
LoadSite
Position
latitude
longitude
height
direction
Position
TimeSlot
LoadTimeSlot
startDateTime
stopDateTime
DeliverySite
DeliveryTimeSlot
TipSite

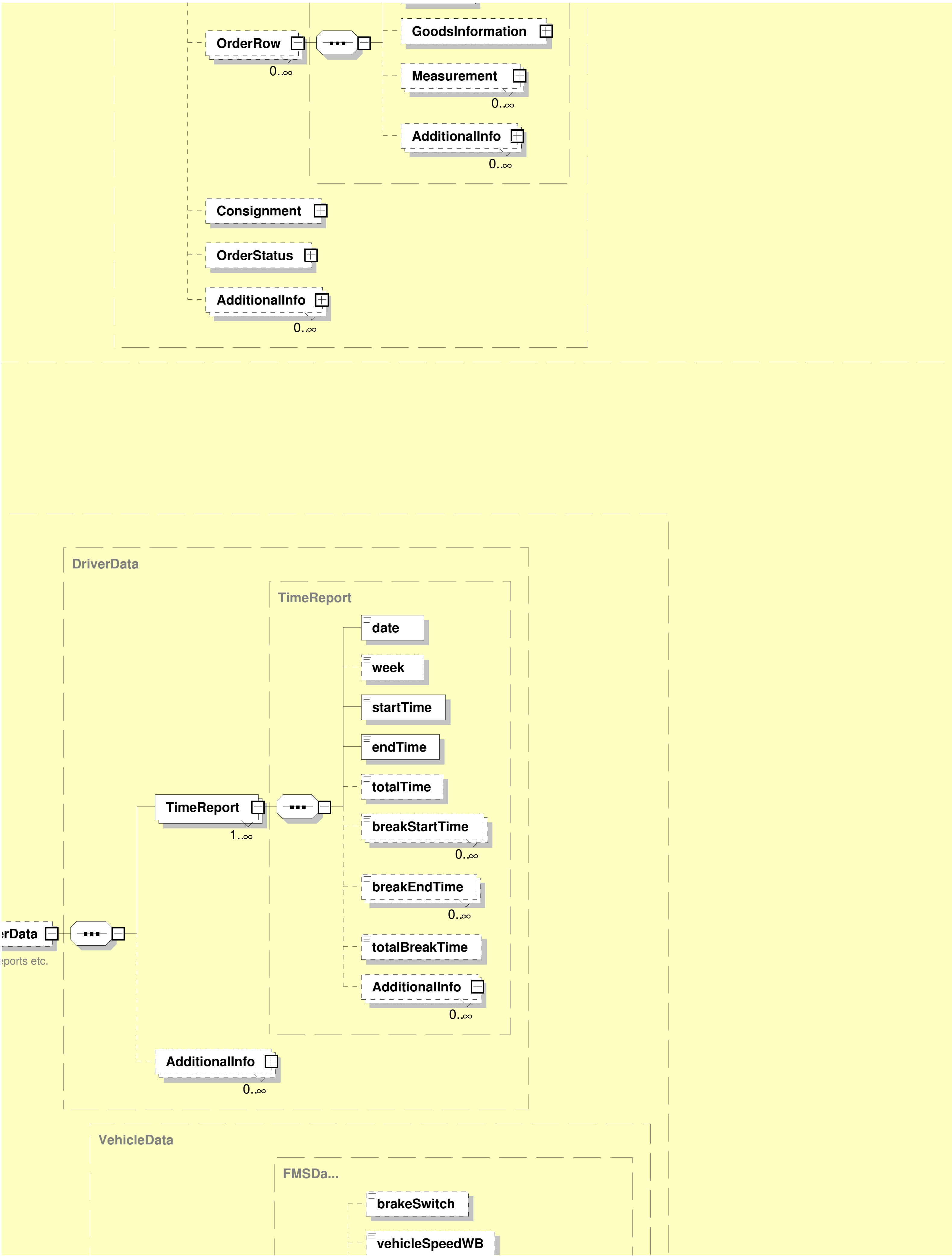


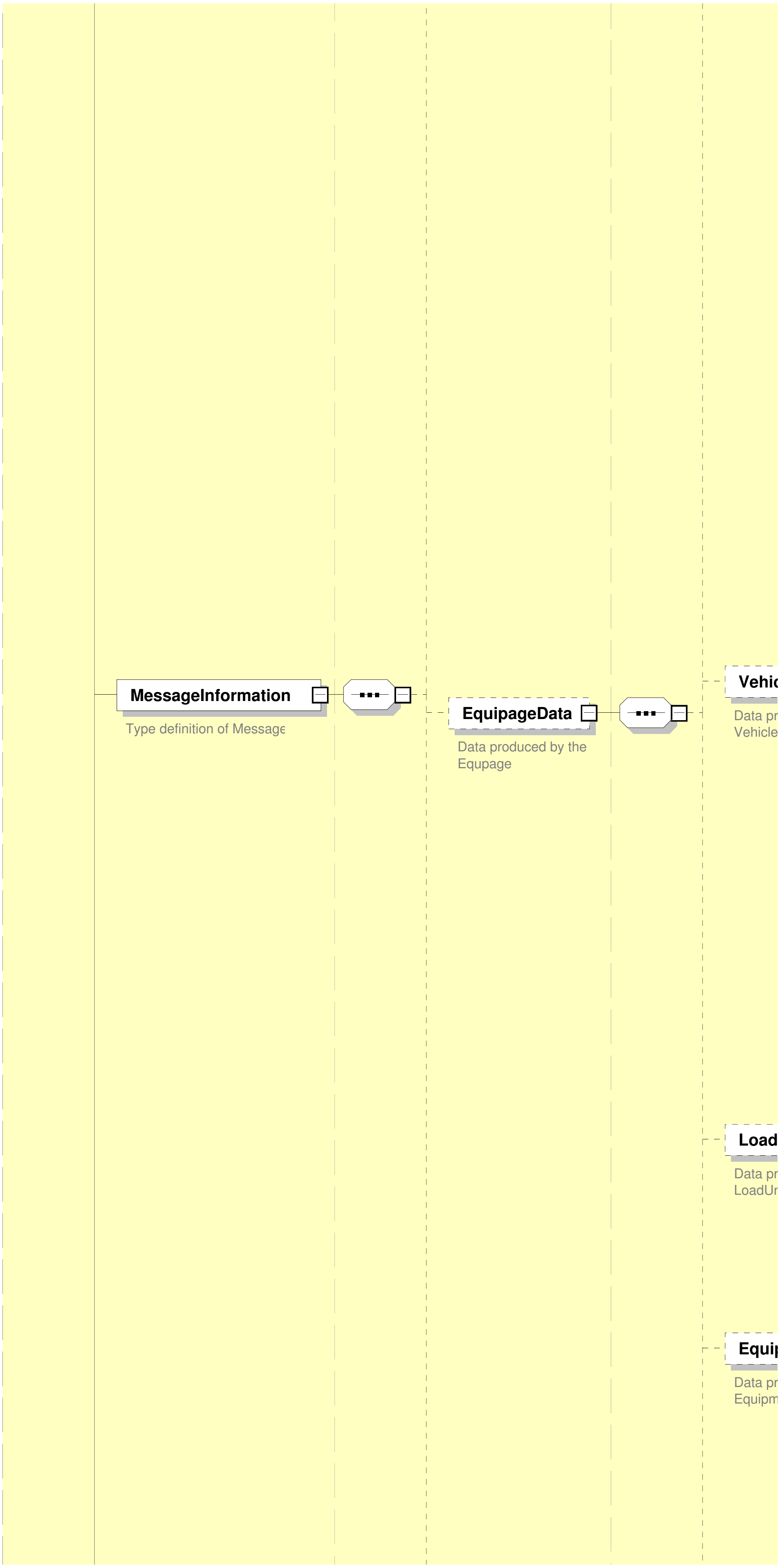

TipTimeSlot
Customer
Customer
id
name
address
postalCode
city
country
phone
0..∞
Cosignement
Consignment
ConsignmentID
Container
ContainerInfo
containerId
containerType
GoodsInformationType
A...
ADR
adrClass
AdditionalInfo
0..∞
fridge
fresh
fragile
stackable
if it is possible to stack
GoodsInformation
AdditionalInfoType
headLine
text
AdditionalInfo
0..∞
ContainerInfo
Measurement
QuantityType
Qantity
unit
quantity

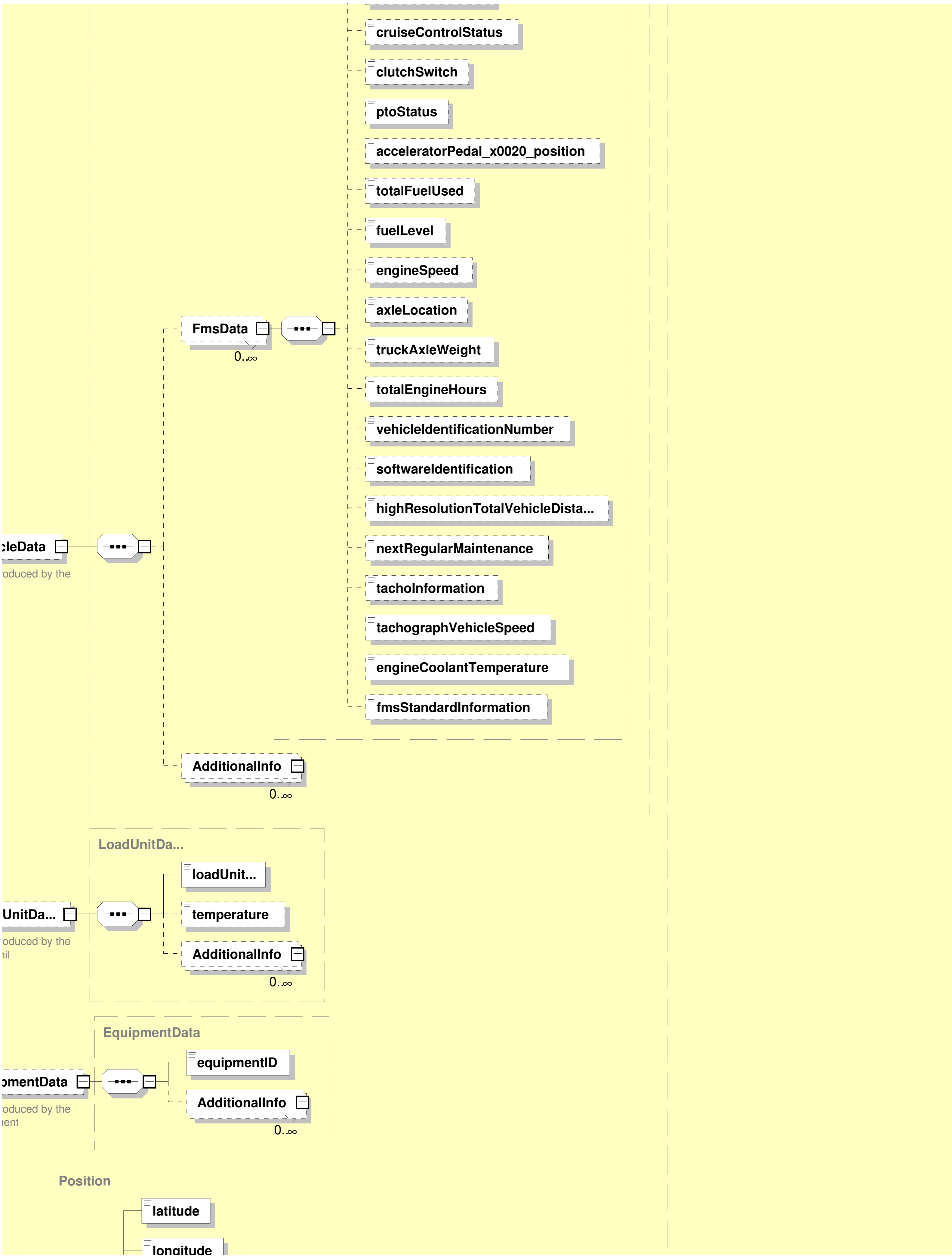

Order
0..∞
Information of order.
Depended on transport type

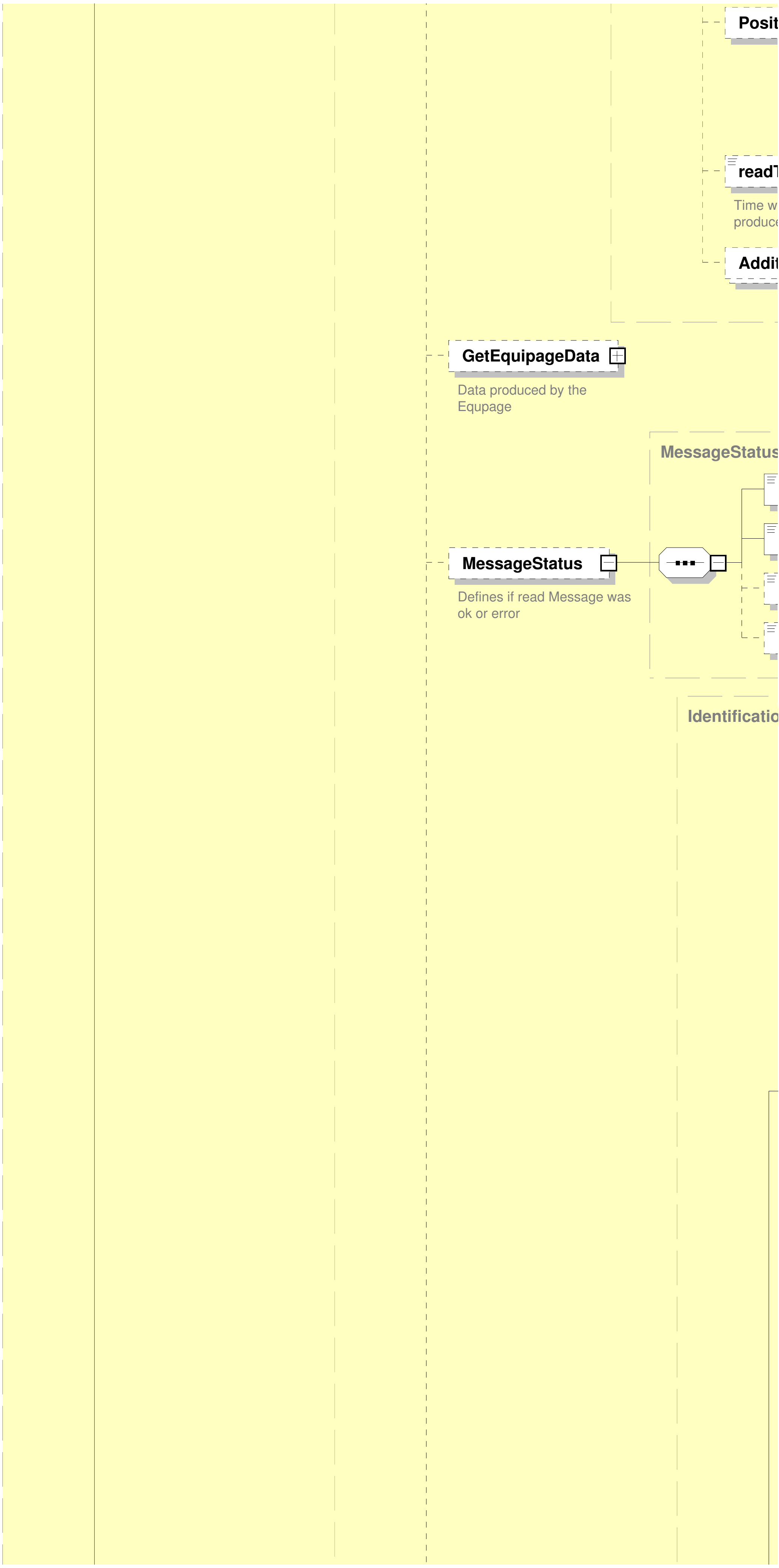

Measurement
SizeType
unit
width
length
height
Size
AdditionalInfo
0..∞
OrderStatusInfo
orderBooking
orderAccepted
orderDenied
orderStarted
collected
delivered
orderChanged
orderCompleted
OrderStatus
Status of the Order
AdditonalInfo
0..∞
LongDistanceType
orderNr
subNr
littera
LoadSite
LoadTimeSlot
DeliverySite
DeliveryTimeSlot
Customer
OrderRow
orderRowNr
rowText
LongDistance

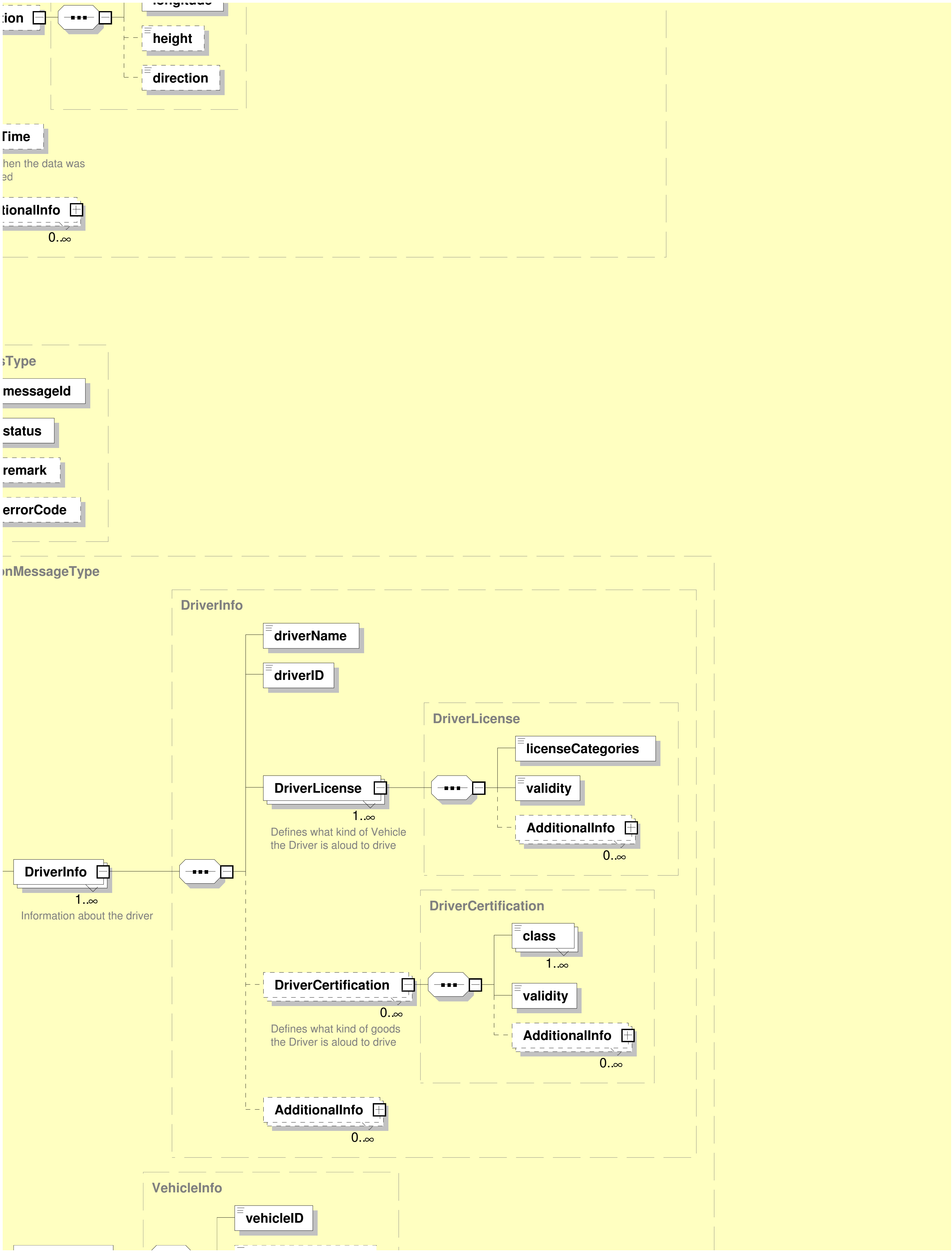

Envelope
Envelope is a container; keeps ip:s of sender and receiver and holds the Message.
Message
Message interface
OrderStatus
0..∞
Status of order
GetOrder
Retrieve information of order
EquipageDataType
Drive
Time re


OrderRow
0..∞
GoodsInformation
Measurement
0..∞
AdditionalInfo
0..∞
Consignment
OrderStatus
AdditionalInfo
0..∞
DriverData
TimeReport
date
week
startTime
endTime
totalTime
TimeReport
1..∞
breakStartTime
0..∞
breakEndTime
0..∞
rData
ports etc.
totalBreakTime
AdditionalInfo
0..∞
AdditionalInfo
0..∞
VehicleData
FMSDa...
brakeSwitch
vehicleSpeedWB

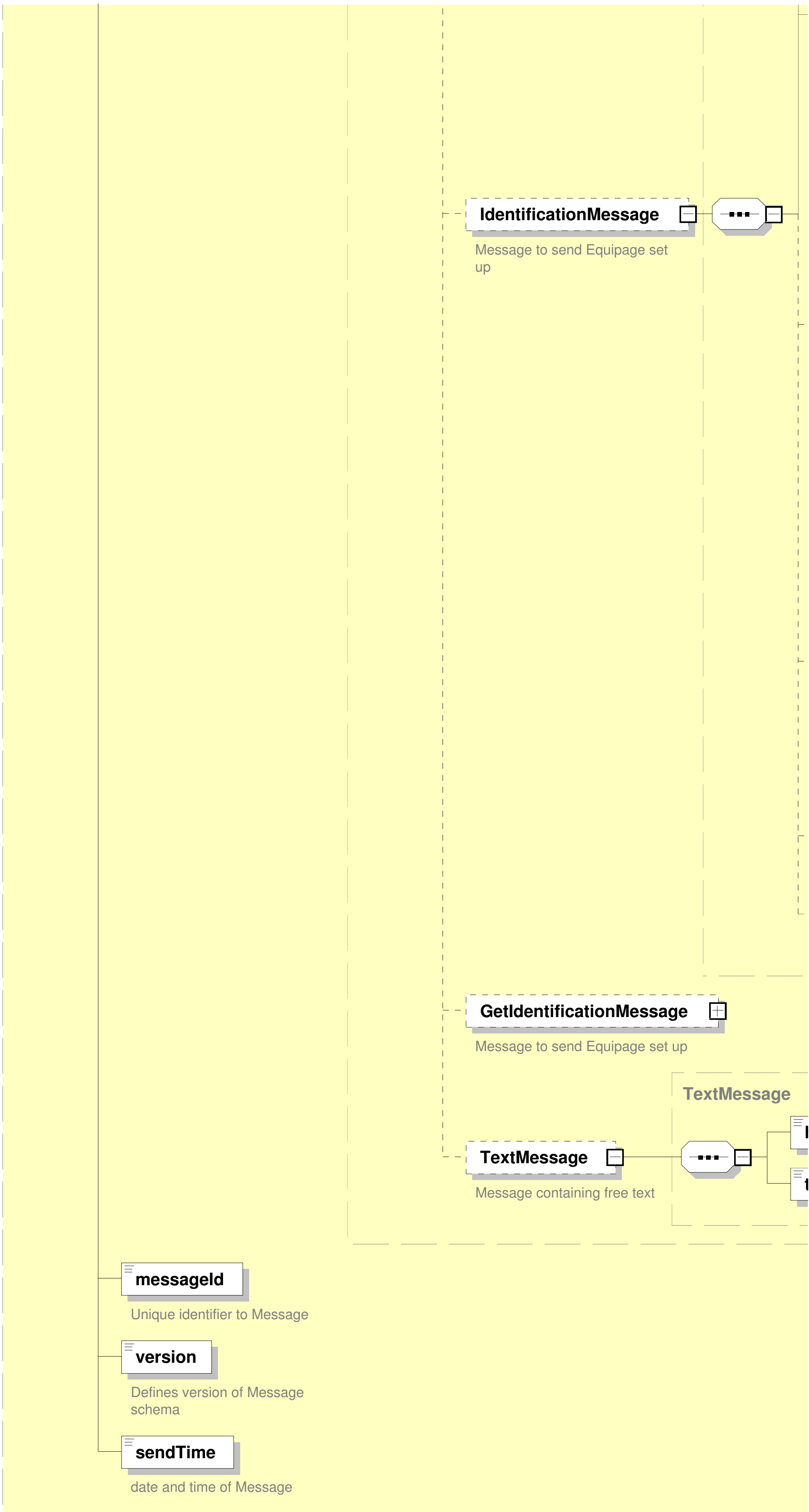

MessageInformation
Type definition of Message
EquipageData
Data produced by the Equpage
Vehic
Data pr
Vehicle
Load
Data pr
LoadUr
Equip
Data pr
Equipm

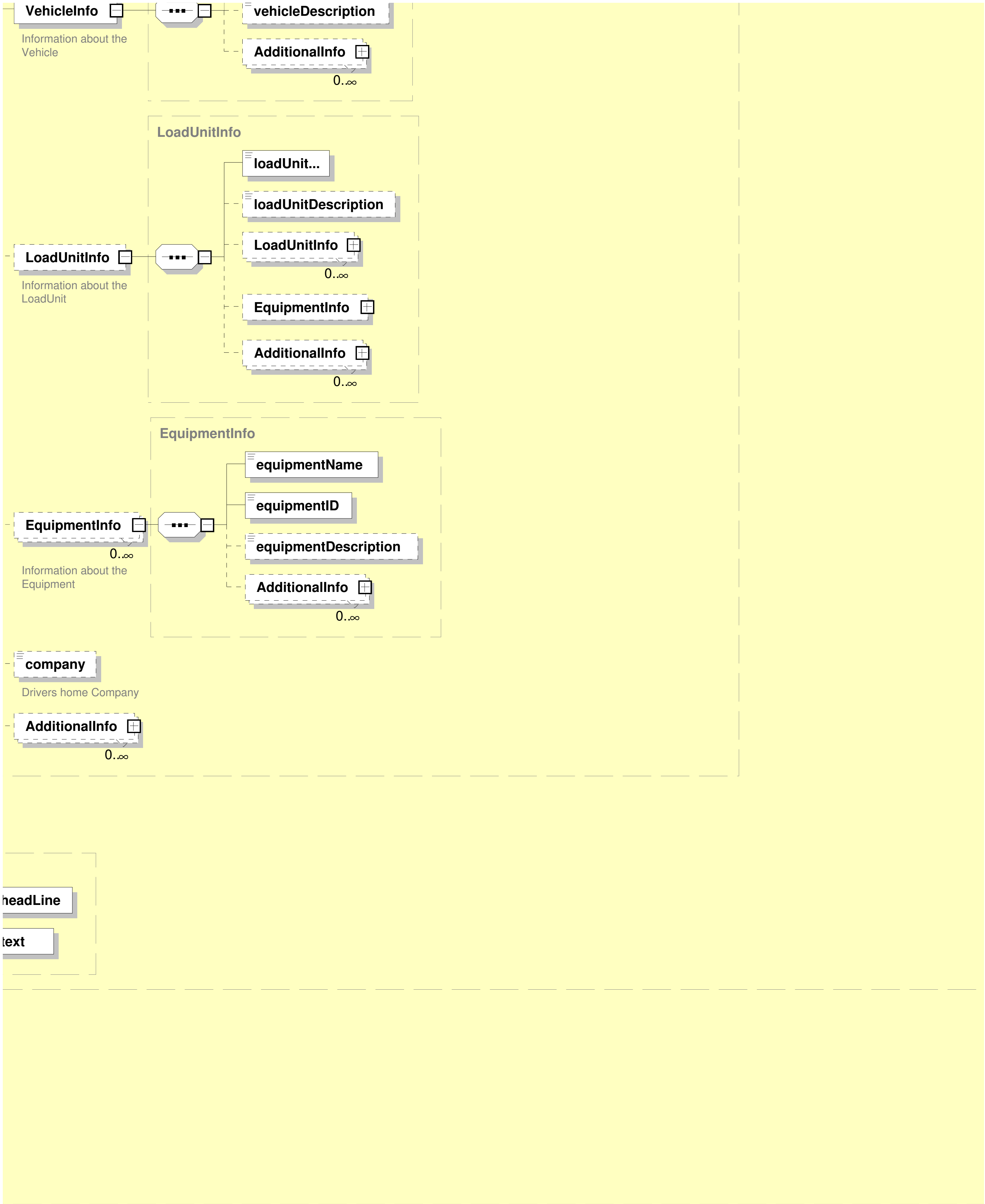

cruiseControlStatus
clutchSwitch
ptoStatus
acceleratorPedal_x0020_position
totalFuelUsed
fuelLevel
engineSpeed
axleLocation
FmsData
0..∞
truckAxleWeight
totalEngineHours
vehicleIdentificationNumber
softwareIdentification
highResolutionTotalVehicleDista...
cleData
oduced by the
nextRegularMaintenance
tachoInformation
tachographVehicleSpeed
engineCoolantTemperature
fmsStandardInformation
AdditionalInfo
0..∞
LoadUnitDa...
loadUnit...
UnitDa...
temperature
oduced by the
nit
AdditionalInfo
0..∞
EquipmentData
equipmentID
pmentData
AdditionalInfo
oduced by the
nent
0..∞
Position
latitude
longitude


Posit
readT
Time w
produce
Addit
GetEquipageData
Data produced by the Equpage
MessageStatus
MessageStatus
Defines if read Message was ok or error
Identificatio



longitude
height
direction
Time
hen the data was
ed
tionalInfo
0..∞
sType
messageId
status
remark
errorCode
onMessageType
DriverInfo
driverName
driverID
DriverLicense
licenseCategories
validity
AdditionalInfo
0..∞
DriverLicense
1..∞
Defines what kind of Vehicle
the Driver is aloud to drive
DriverInfo
1..∞
Information about the driver
DriverCertification
class
1..∞
validity
AdditionalInfo
0..∞
DriverCertification
0..∞
Defines what kind of goods
the Driver is aloud to drive
AdditionalInfo
0..∞
VehicleInfo
vehicleID


IdentificationMessage
Message to send Equipage set up
GetIdentificationMessage
Message to send Equipage set up
TextMessage
TextMessage
Message containing free text
messageId
Unique identifier to Message
version
Defines version of Message schema
sendTime
date and time of Message


VehicleInfo
Information about the Vehicle
vehicleDescription
AdditionalInfo
0..∞
LoadUnitInfo
loadUnit...
loadUnitDescription
LoadUnitInfo
0..∞
EquipmentInfo
AdditionalInfo
0..∞
LoadUnitInfo
Information about the LoadUnit
EquipmentInfo
equipmentName
equipmentID
equipmentDescription
AdditionalInfo
0..∞
EquipmentInfo
0..∞
Information about the Equipment
company
Drivers home Company
AdditionalInfo
0..∞
headLine
text