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TRACKING AND TRACING PORTAL FOR PROJECT LOGISTICS

A Review on the Interconnectivity of EDI, ERP and Cloud-based Systems

Master's Thesis in
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ABSTRACT

Tracking and tracing is becoming an essential factor for the success of project logistics. The safety and on-time arrival of shipments has become the primary concerns for manufacturing companies. The paper has introduced an overall approach to track and trace their deliveries from the starting point to the end-customer. Detail implementation of the whole solution will not be presented, yet each component in the system will be analyzed and discussed.

Electronic Data Exchange (EDI) has been around for the last 30 years and is known for providing logistics companies a fast, reliable way to exchange information electronically. EDI, together with Enterprise Resource Planning (ERP), are considered as one of the remarkable emerging technologies which play an important role in supply chain management tracking network. Although the implementation of EDI and ERP systems is not straight forward and not easy to established, many logistics companies are still seeing this as a vital factor which can help companies to establish a sustainable development, increase productivity and reduce costs.

In this paper, the interconnectivity of EDI, ERP, and cloud-based systems in tracking and tracing portal will be analyzed in business perspective in order to define what benefits it could achieve for logistics and supply chain management tracking network. A case study of Logistics Tracking Network (LogTrack) project is presented and examined with the view to implement, evaluate and manage the interconnectivity of EDI, ERP, and cloud-based systems in a practical point of view. Information collected from this research project will be analyzed to provide a list of mapping attributes between these systems and used as a basic for the further development of tracking and tracing portal. The impacts and implications of such system for managing the business logistics are discussed and presented in conclusion.

KEYWORDS: EDI, ERP, cloud computing, logistics, supply chain management, interconnectivity, tracking network

PREFACE

This thesis was done as a part of the studies for the Master's degree in Industrial Management in University of Vaasa. The thesis has been conducted in corporation with LogTrack development team and a multinational company.

I wish to acknowledge each and every person who has contributed to this work. I would like to express special thanks to my supervisor, Professor Petri Helo, for his valuable suggestions and extensive comments. In addition, I want to send many thanks to LogTrack team members for helping me with the researching results.

Last but not least, I would like to express my gratitude to my wife, Dung Tran Phuong, for her biggest mental support, motivation and encouragement during the writing of this thesis.

Vaasa, 05.09.2014

Duy Nguyen Phuong

ABBREVIATIONS

EDI	-	Electronic Data Interchange
ERP	-	Enterprise Resource Planning
LogTrack	-	Logistics Tracking Network
FTP	-	File Transfer Protocol
HTTP(s)	-	Hypertext Transfer Protocol (secured)
XML	-	Extensible markup Language
AIS	-	Automatic Identification System
SCM	-	Supply Chain Management
RFID	-	Radio-frequency Identification
HU	-	Handling Unit
SME(s)	-	Small and Medium Enterprise(s)
EAI	-	Enterprise Application Integration
B2B	-	Business-to-Business
WSDL	-	Web Service Definition Language

1. INTRODUCTION

1.1 Purpose and Scope

In logistics and supply chain management tracking network, in order to be successful in this competitive environment, companies have to strive for organizational operation management sustainability (Addo-Tenkorang et al., 2012). Therefore, e-commerce systems such as EDI and ERP are becoming a more preferred system tool for today's organizational industrial operations management to gain competitive advantage (Van der Aalst, 2000). Flexibility and responsiveness are considered as essential factors in sustainable development. Various technologies and operational strategies have been discovered by organizations to improve their competitive advantage. One of the most effective approaches is to enhance the core supply chain management (SCM) values of business-to-business (B2B) operations with information systems (IS) and enable data-management workflow systems.

Although the implementation of EDI and ERP is not straight forward and not achieved considerably by all small and medium enterprises (SMEs) because of costs and efforts, many logistics companies are still considering integrating EDI and ERP systems to increase their flexibility and responsiveness. In fact, EDI has been around for more than 30 years and more than 80% of the B2B transmission of information use EDI. It is used across many industries such as manufacturing, retailing, healthcare, transporting and purchasing, etc… Especially, in logistics and supply chain management tracking network, it helps to reduce the cost in tracking and tracing as well as to increase the effectiveness in delivery and transportation. One practical benefit of using EDI is, for instance, to reduce labor cost and to eliminate errors of workers when entering information into enterprise systems.

However, the interconnectivity of EDI and ERP systems is quite challenging because of differences between EDI and ERP interfaces. It is noticed that EDI system cannot be integrated directly into ERP systems and a mediate system has to be used as a bridge between these two ones. ERP system is different from companies to companies. Therefore, there is no standard way to establish this mediate system. In this paper, a general approach which was implemented in LogTrack project will be introduced and examined.

In addition to the interconnectivity of EDI and ERP systems, the paper also presents the tracking and tracing portal, which is a cloud-based system, in the perspective of project logistics. There are already different tracking systems available in the market provided by either FedEX or DHL. Nevertheless, these systems are limited to single transportation company and are not suitable for the case company, which need support for global project deliveries. Moreover, there are typically quite many participants who participate into one delivery project such as project manager, transport company, distribution center, supplier and the end-customer. As a result, such systems are not suitable anymore and the case company has developed a new system suited for the need of delivery and purchasing managers. Because of some limitations such as the scope of project is huge and it contains lots of confidential information, the detail implementation of this approach will be out of scope and not be described here. Additionally, since the nature of this researching project is to examine innovative technologies which could help to build the system in the future and the project is not completed yet at the time of writing this thesis, some parts of the integration such as the integration of EDI and ERP systems will not be presented in detail.

LogTrack, which stands for Logistics Tracking Network, is a collaborative research work between a global manufacturing and University of Vaasa. The project is created based on the need of tracking and tracing in logistics network which is becoming a prime concern for manufacturing companies due to the requisite and the importance of ensuring safety and timely arrival of goods and shipments. However, there is no such a system which would be the most suitable for case company's infrastructure. The main target of LogTrack project is to examine the current and near future technical possibilities from manufacturing's point of view. For example, how a manufacturing company managing multiple geographically dispersed projects and hundreds of suppliers, transport companies and warehouse operators could apply these technologies and produce real-time visibility on current logistics assets; or what kind of possible innovative technologies can be implemented to create a tracking system independent of any transport company, suited to the needs of managers who are responsible for ordering, delivery and shipments.

In order to develop such a system, a practical approach which is the combination of DSDM (Dynamic systems development approach) and Spiral (Spiral axiomatic development approach) has been employed. The power of this approach is the use of principles of iterations and incremental value, which emphasized that the project is conducted in repeating phases and values of each phase are added to the project ("Product software implementation method," 2014). During the course of LogTrack project, several iterations have been carried out. Each iteration starts from the basic functionalities and concepts. Then, extended functionalities and open issues will be collected through different steering group meetings.

Vaasa University's development team will be responsible for implementing most of these issues with the help of case company's managers. Finally, several real pilots will be conducted to test the feasibility and effectiveness of the solution. At the end of each iteration, a report including lessons, problems and accomplishments achieved during the course of iteration will be presented to case company's managers. These findings will be applied in the next iteration, which will help the project to develop further.

1.2 Structure of the thesis

The structure of this paper is presented as following:

1. Introduction: The section briefly describes the research problem as well as introduces the research method generally used in the researching project.
2. Literature review: Technical, theoretical terms and information are explained in this section. It focuses mostly on the theory part which is relevant to the thesis topic such as EDI, ERP, logistics and supply chain management tracking network, cloud-based supply chain and tracking systems, and philosophy and derivative initiatives connected EDI.
3. Methodologies: The section describes the background information of project and its research method in detail. It firstly describes about the background of LogTrack project. Then, the interconnectivity of EDI, ERP, and cloud-based systems are evaluated in both inbound and outbound tracking process. Finally, a short explanation about the interconnectivity of EDI and ERP systems is given.
4. Results and Discussion: The section includes a detail explanation of prototype system built in this paper. In addition, it also briefly discusses about advantages and disadvantages of the solution and improvements target in the future implementation.
5. Conclusion. The section gives a brief evaluation of the topic and the results obtained as well as its significance in the given fields.

1.3 Research method

"The research is largely constructive in nature, centered on building a prototype system" (Tikkala et al., 2005). Both problem solving and theoretical knowledge are combined in the constructive research. Basically, the research contains different phases as explained in the following: “find the practically problem” which also has the research potential, “acquire a general and comprehensive understanding of the problem”, “innovatively construct the solution” for the problem, “show the theoretical connections and the research contribution of the prototype”, and “examine the applicability of the solution” (Eero Kasanen, 1993).

The research problem is shortly introduced in section 1.1 and explained further in section 3. A general and comprehensive understanding of problem is achieved by a concise literature review described in section 2, and then “analyzing the problem further and deriving a set of functional and technical requirements for the prototype implementation” (Tikkala et al., 2005) in section 3 and 4. The technical definition of the research problem is mostly based on earlier research in the LogTrack project, derived from the discussion between LogTrack project members and company’s managers, and from the inspection of project reports.

By applying typical software design practices, the prototype system is constructed in the intuitive phase of this research based on defined functional and technical requirements. Main implementation is the integration between SalesForce platform (aka. LogTrack portal) and different systems (ERP system from consolidation warehouse, EDI system from transporting company, tracking data from tracker devices etc…). Detail of the implementation of this integration will be presented in section 4.

In addition to prototype system, several pilots have also been carried out during the course of the project in order to examine the applicability of the solution. Although the detail explanation of these pilots is out of scope and will not be described in the thesis, it is still briefly introduced in section 3.2 in this paper.

2. LITERATURE REVIEW

2.1 Electronic Data Interchange (EDI)

2.1.1 A short introduction to EDI

Electronic Data Interchange, usually shortened as EDI, is a standard format for exchanging business data between companies, so-called trading partners (Lio, 2014). It is commonly known as the easiest, fastest and most efficient way to exchange data between business partners in logistics and supply chain management industry. A typical EDI transaction can be described as following diagram:

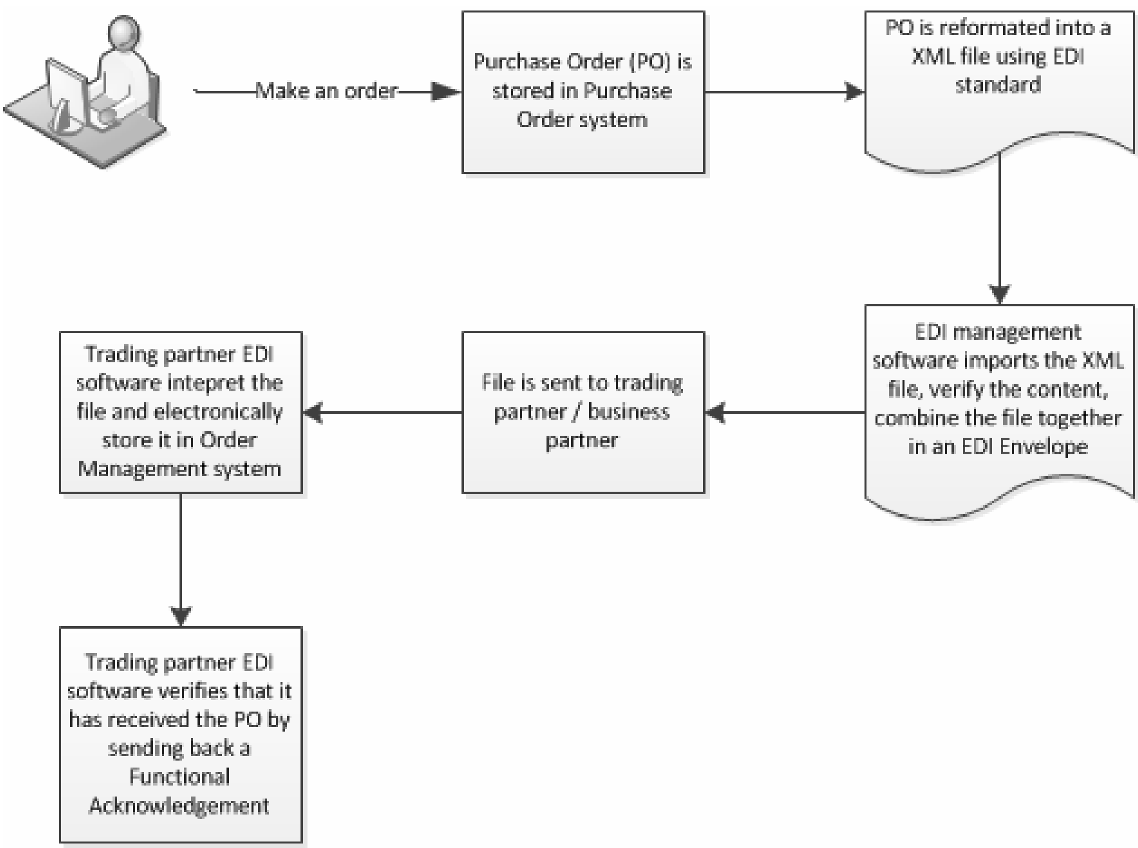


Figure 1: A typical EDI transaction

Comparing with traditional transactions, such as in purchasing and transportation booking, the use of EDI has many benefits ("Introduction to Electronic Data Interchange (EDI)," n.d.):

- Reduce manual data entry
- Reduce postage and handling costs
- Reduce labor processing costs
- Reduce order cycle

- Increase customer service
- Improve accuracy of data
- Reduce lead times
- Reduce paper handling
- Reduce inventory carrying costs

"An EDI document is an electronic equivalent of a paper document such as a purchase order or invoice" (Mrkonjic, February 2007). EDI documents are structured and defined based on standards. There are many standards established all over the world, yet the two most common ones are X.12 used by North American companies and EDIFACT used by companies outside of North America. In this paper, only the EDIFACT standard is focused because it is the most common standard in European countries.

An EDIFACT document can have the following structure ("UN/EDIFACT Message IFTSTA Release: 03A," n.d.):

20 Delayed in the course of transportation
Goods/consignments/equipment have been delayed in the course of transportation.

An example of an IFTSTA for delivery delayed

```
UNA:+.?
UNB+UNOC:3+5790001103651+
146537+110414:1255+1818
UNH+0001+IFTSTA:D:99B:UN:EAN002
BGM+77+11033106550201+9
DTM+137:201103310655:203
NAD+CA+Freja Transport::100
NAD+CZ+WÄRTSILA::100
CNI+1+38383537
STS+1+20
RFF+ACL:24
DTM+7:201103300000:203
FTX+ZZZ+1++delayed reference or link to a website.
UNT+11+0001
UNZ+1+1818
```

Figure 2: An example of IFTSTA structure

The International multimodal status report message (IFTSTA) is a typical transaction set used in EDI between trading partners which are concerned with administration, commerce and transport ("UN/EDIFACT Message IFTSTA Release: 03A," n.d.). The above message contains segments described as below:

- UNA/UNB: interchange headers. UNA means EDI start record and UNB+UNOC means sender/receiver id.
- UNH, message header: starting segment to identify the uniqueness of message, including type of transaction set, version number and country agency.
- BGM, beginning of message: indicating the beginning of message and identifying the consignment for which status is being reported.
- DTM, date/time/period: indicating the date and time related to the consignment.
- NAD, name and address: identifying the trading partner which is involved. CA means Carrier and CZ means Consignor.
- CNI, consignment information: identifying a consignment for which status details are given.
- STS, status: indicating status of goods item
- FTX, free text: providing additional information as free text for the goods item
- UNT, message trailer: ending the message
- UNZ, interchange footer: EDI end record

Following is the list of commonly used UN/EDIFACT standard transaction sets and its corresponding X12:

TRANSACTION SET/DOCUMENT	**ASC X12**	**EDIFACT**
PRODUCT/PRICING TRANSACTIONS		
Price Sales Catalog	832	PRICAT
Price Authorization Acknowledgement/Status	845	ATHSTS
Specification/Technical Information	841	PRDSPE
Request For Quotation	840	REQOTE
Response To Request For Quotation	843	QUOTES
ORDERING TRANSACTIONS		
Purchase Order	850	ORDERS
Purchase Order Acknowledgement	855	ORDRSP
Purchase Order Change	860	ORDCHG
Purchase Order Change Acknowledgement	865	ORDRSP
Order Status Inquiry	869	ORSSTA

Order Status Report	870	ORDREP
Product Activity Data	852	SLSRPT
MATERIALS MANAGEMENT TRANSACTIONS		
Planning Schedule/Material Release	830	DELFOR
Shipping Schedule	862	DELJIT
Ship Notice/manifest (ASN)	856	DESADV
Report of Test Results	863	QALITY
SHIPPING/RECEIVING TRANSACTIONS		
Shipment Information	858	IFTMCS
Receiving Advice	861	RECADV
Non-conformance Information-Disposition Transaction, Cause/Correction	842	NONCON
INVENTORY MANAGEMENT TRANSACTIONS		
Inventory Inquiry/Advice	846	INVRPT
Product Transfer Account Adjustment	844	SSDCLM
FINANCIAL TRANSACTIONS		
Invoice	810	INVOIC
Freight Invoice	859	IFTMCS
Payment order/Remittance Advice (EFT)	820	REMADV

Table 1: Commonly used UN/EDIFACT transaction sets

2.1.2 How EDI works

EDI implementation can be complex, even though its basic idea is quite simple and straight forward. The following example illustrates how a paper-based purchasing process is transformed into EDI purchasing process. Considering the following process in a manufacturing which needs to replace one of its machines:

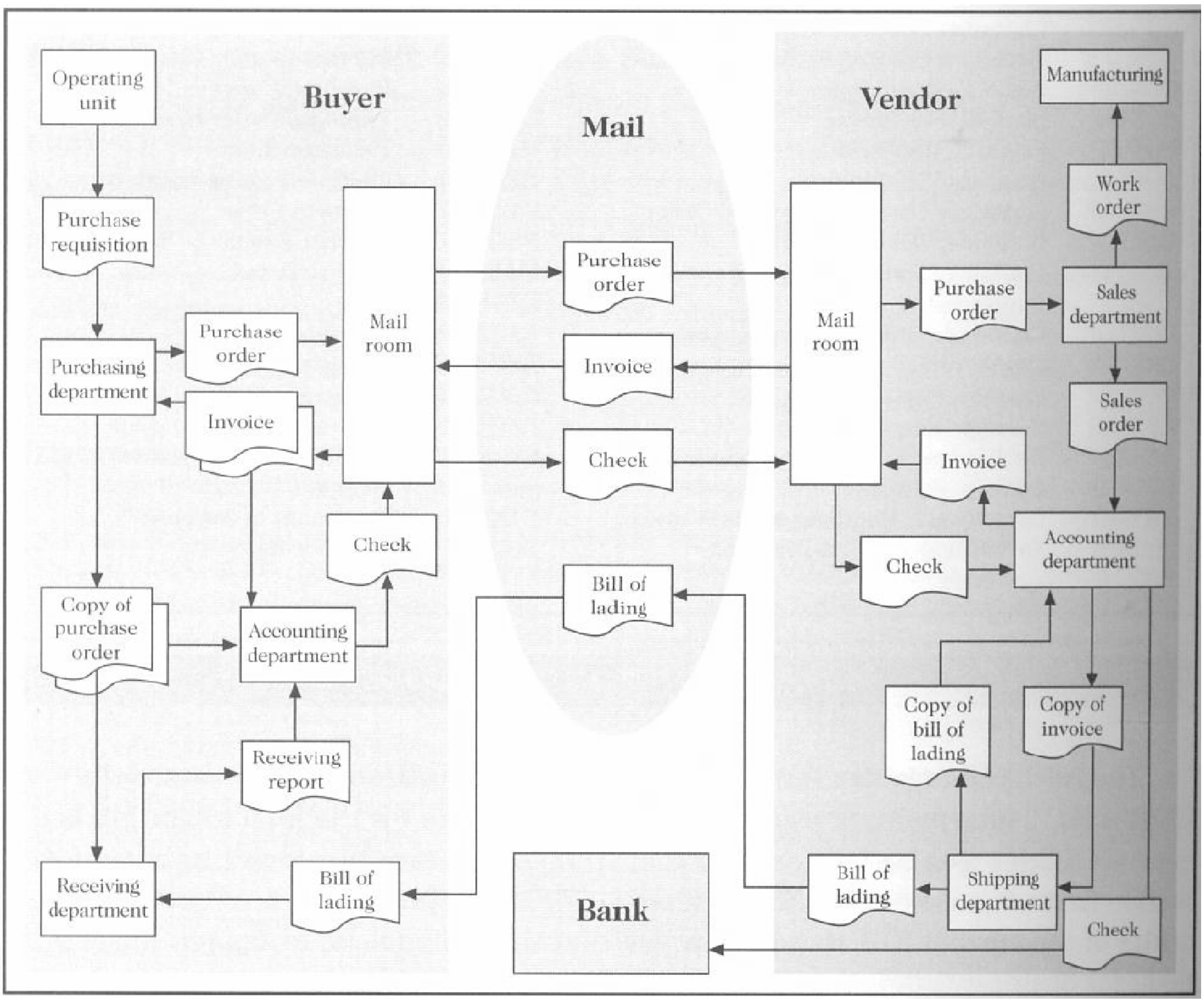


Figure 3: Information flows in the paper-based purchasing process (Schneider and Perry, 2001)

The process can be described as following:

- The production manager decides that one of company's machines needs to be replaced. Then, a purchase requisition form is completed and sent to the purchasing department by the same production manager.
- Purchasing people contacts the vendor to discuss about price and terms of delivery. In addition, a copy of purchase order will be sent to receiving department for keep tracking of order in the future.
- Copy of purchase order is also transferred to accounting department for financial issues.

- The mail room / mail server will send the purchase order to vendor. Later on, this order will be sent to sales department and then to accounting department as sales order.
- The vendor's sales department sends a work order which includes the machine's specification and customer's requirements for the machine to the manufacturing department based on the received order.
- The manufacturing will notify the accounting department and send the machine to shipping as long as the machine is finished. In the meanwhile, accounting will also send an invoice to the mail room / mail server, which will be received in buyer's purchasing department.
- Vendor's shipping department sends bill of lading to buyer based on the copy of invoice.
- When receiving bill of lading, buyer's receiving department will send the receiving report to accounting department after checking item's condition and all other information. Accounting department compares again everything and then sends a check to vendor.
- The check is received at vendor's mail room or mail server and then sent to the accounting department.
- Accounting department will examine whether the checks and other documents (including copy of invoice, bill of lading and sales order) are matched. If all details are conformed, the accounting department will deposit the check to its bank and marks the payment as received.

When transforming to EDI purchasing process, the information flows are much simpler:

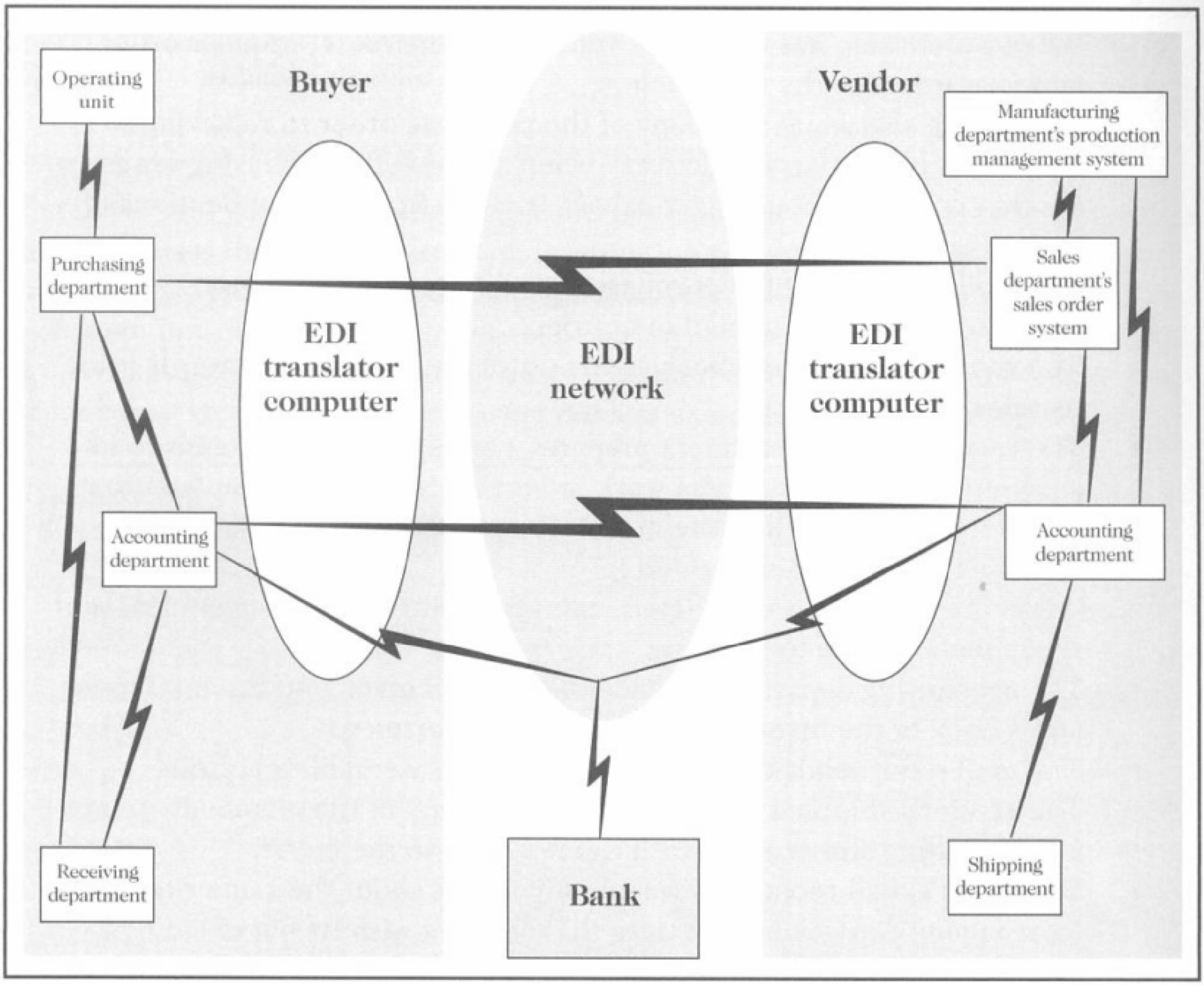


Figure 4: Information flows in the EDI purchasing process (Schneider and Perry, 2001)

The process can be described as following:

- An electronic message is sent to the purchasing department by operating unit manager in order to inform about the need to replace one of its machines.
- Purchasing contacts vendors via phone or email or vendor's web sites to negotiate the price and terms of delivery.
- The buyer's EDI translator software translates the machine's specification and message from purchasing to a standard purchase order transaction set. Subsequently, through an EDI network, the message is forwarded to the vendor. Also, a copy of message is sent to receiving department for keep tracking.
- The vendor's EDI translator software receives the message and converts it back into the normal format which can be used by vendor's system.

- The converted message is then forwarded to sales order system. The system will process the message and send a work order to manufacturing's production management system.
- When machine is completed, the production management system sends a notifying message to the shipping department by which another electronic message is sent to the accounting department, indicating that the machine is ready to ship. The message will be then translated into a standard invoice transaction set and forward back to buyer through EDI network.
- The message is received by the buyer's EDI translator software and translated back to original format which can be used by buyer's accounting system.
- The receiving department of buyer checks the item against its specification and invoices information on its computer system when the machine arrives. If everything is matched, the buyer's accounting department will notify its bank to reduce the buyer's account and at the same time increase the vendor's account by the amount of the invoice.

As it can be seen, EDI helps to reduce the information flows between trading partners, which as a result reduces the cost and errors of paper flow and streamlines the interchanged of information among departments. There are two key factors that help transform the paper-based process into EDI process: the EDI network and EDI translator software.

The EDI network represents the communication network between trading partners, while the EDI translator software represents the application/software which translates an electronic message into a standard EDI transaction set or convert the EDI message back to a usable format. There are many ways to implement the EDI network and EDI translation process, but following are the two most common approaches: direct connection and indirect connection. (Schneider and Perry, 2001)

Direct connection between trading partners

Direct connection EDI means each trading partner will connect directly to each other and their own on-site EDI translator application is operated by themselves, as shown in the below figure:

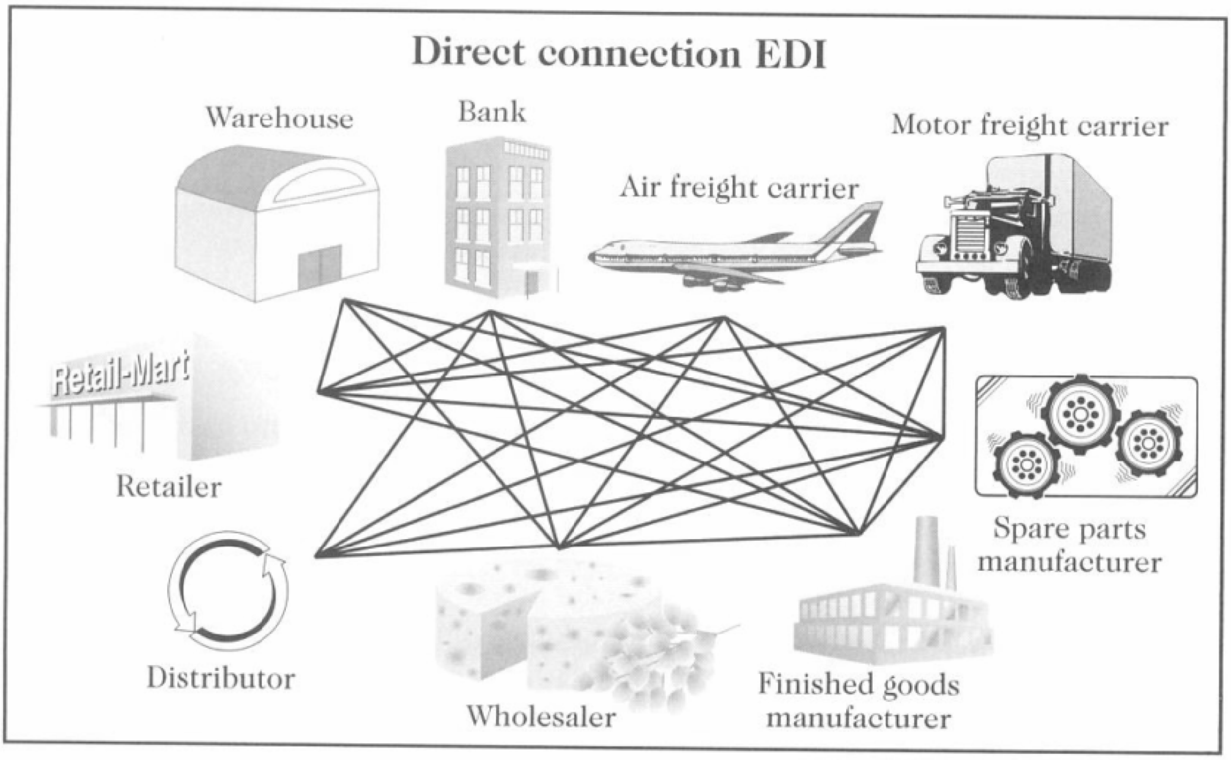


Figure 5: Direct connection EDI (Schneider and Perry, 2001)

In the direct connection network, either dial-up telephone lines or dedicated leased lines are used to connect EDI translator applications. Although the approach is quite simple and easy to establish, this method still has some drawbacks. For example, the implementation of dial-up lines is not very efficient as customers and vendors could be situated in different time zones and it is time-sensitive when conducting high in volume transactions, while dedicated leased lines are too expensive for small and medium businesses, especially when they have to maintain the connection with many suppliers and vendors. Moreover, companies that use different communication protocols can be in trouble when implementing both direct connection options, not only for the company itself but also for its vendors and its customers. (Schneider and Perry, 2001)

Indirect connection between trading partners

Indirect connection means each trading partner will connect to a mediate service, so-called value-added network, instead of connecting directly to each other. Value-added network (VAN) is a company that "provides communications equipment, software, and skills needed to receive, store, and forward electronic messages that contain EDI transaction sets"

(Schneider and Perry, 2001). The following figure illustrates how companies connect to a VAN in the indirect connection EDI network:

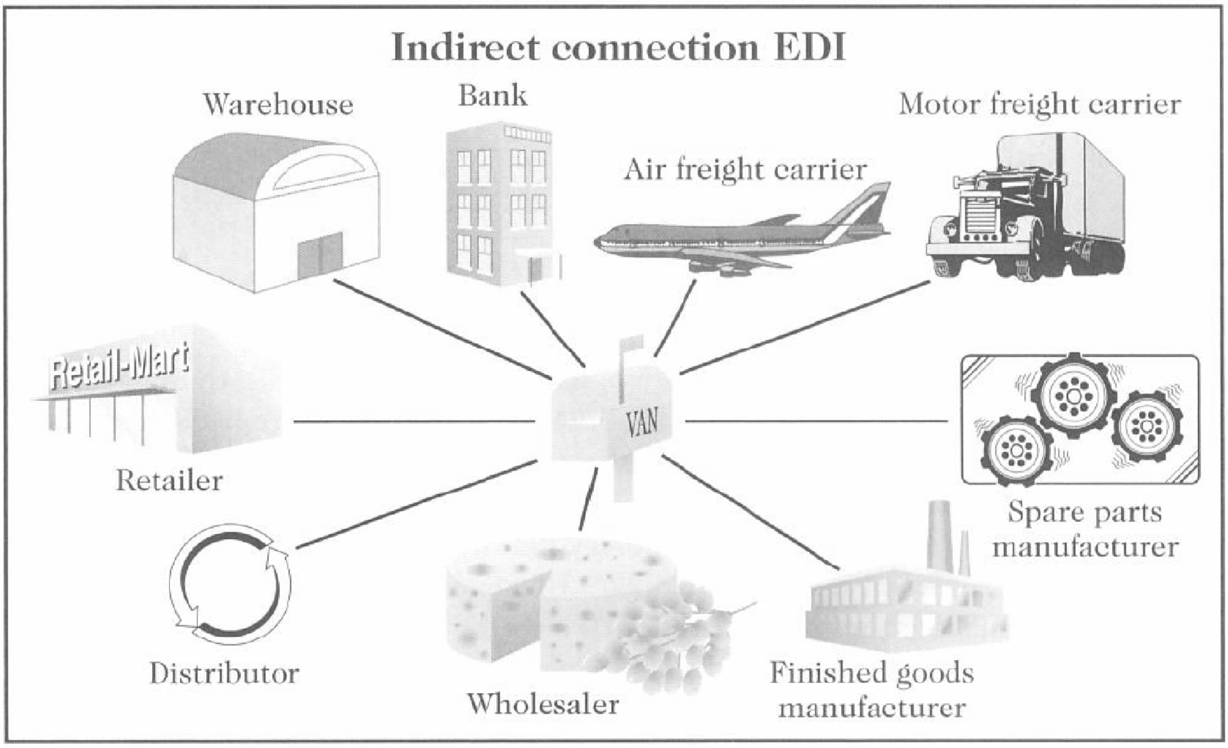


Figure 6: Indirect connection EDI through a VAN (Schneider and Perry, 2001)

Using the VAN brings companies many benefits. They can now completely focus on their business and let the VAN work on the EDI translation and EDI transportation. For instance, in order to send an EDI transaction set to a trading partner, a dedicated or dial-up telephone line is used to connect between the VAN customer and the VAN. And then the EDI-formatted message is forwarded to the VAN by the VAN customer. After that, the message is translated to trading partner's format if necessary and delivered to trading partner's mailbox. A dedicated or dial-up telephone line is used to connect between the trading partner and the VAN, which retrieves the EDI-formatted message. Another advantage of using VAN is company can now only need to support the VAN's one communication protocol. (Schneider and Perry, 2001)

Nevertheless, VAN does also have some disadvantages. One of the major issues is the cost. Companies usually have to pay an enrollment fee, a monthly maintenance fee, and a transaction fee in order to use services provided by VANs. Companies also have to pay for the implementation of EDI translator software that is suited for the VAN. As a result, the total can exceed €50000 and that is not likely affordable for small enterprises. Additionally, other trading partners who handle high in volume transactions find the transaction fee to be prohibitive. (Schneider and Perry, 2001)

EDI on the Internet

As the advent of XML and Internet, companies start to recognize Internet as an efficient tool for conducting business. It is considered as a potential replacement for dedicated and dial-up telephone lines. The low cost implementation and the popularity of Internet have helped companies expand EDI capabilities in a more effective and productive way.

EDI Outsourcing and Web EDI

Nowadays, because of the quickly changing of the global trade and technology, it is likely too challenging for a company to keep up and maintain the complex of EC/EDI relationships with its trading partners. They have sought for an alternative which is outsourcing their EDI operation or subscribing to a web EDI service. The company still handles the data integration with its system and the data transport with its service provider. Yet all the EDI operations such as data transformation, translation, and transport with its trading partners will be conducted by its service provider (Mrkonjic, 2007). Following diagram describes how the flow of data changes through EDI outsourcing or Web EDI:

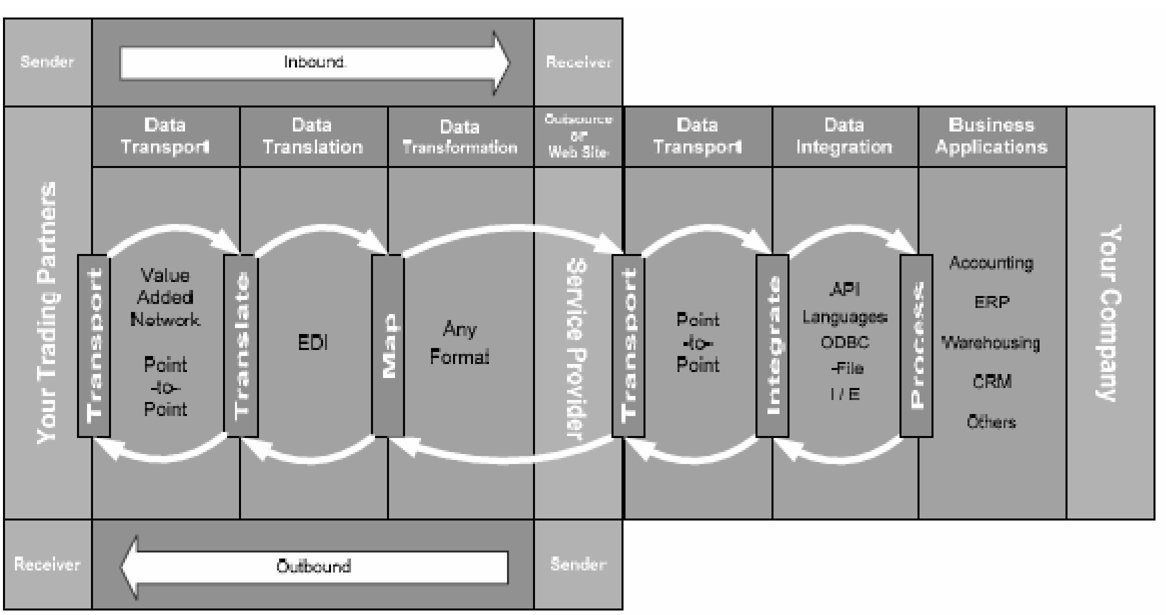


Figure 7: EC/EDI relationship through EDI outsourcing or Web EDI (Mrkonjic, 2007)

2.1.3 History and Development of EDI

Electronic data exchanges have been around since 1960's, but it was actually introduced in the mid of 1980's. At that time, EDI was mostly used to exchange files in a structure and standard format (Mrkonjic, 2007). During the next period of time, EDI has evolved together with a wider range of technologies to make it become one of the most significant technologies in the field of Electronic Commerce (EC) and, therefore, helps companies to improve the productivity and competiveness.

The history and development of EDI can be illustrated as following diagram:

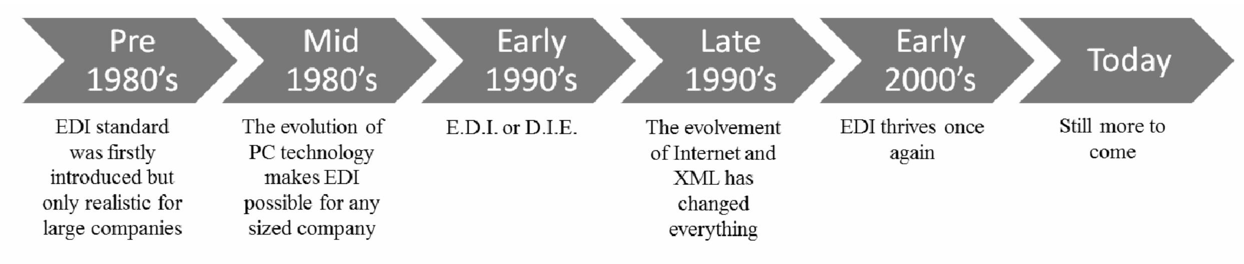


Figure 8: EDI throughout the decades

Pre 1980's – Before there was EDI

Before EDI was introduced, it was only realistic for large and global companies to exchange files electronically. It is economic sense only when they have large trading partners with high volume of data. The cost for setting up the environment and for exchanging data is far more expensive than benefits it can bring back. Therefore, the paper was the only practical option for carrying out the business for small and medium sized enterprises (SMEs). (Brewer, n.d.)

Mid 1980's – EDI attracts attention

In 1973, FTP protocol was published, which enabled file transfers between companies through Internet. In 1978, Telenet, the first Value Added Network started. Then, in 1981, the first EDI standard, ANSI X12, was published ("Concise Timeline and History of Electronic Data Interchange (EDI) | Electronic Cash News @," n.d.). The advent of Personal Computer technology made EDI possible for any sized company. At that time, it was realistic for large companies to bring EDI technology into their smaller suppliers due to the help of EDI translation software vendors and Value Added Networks' services. But the installation cost for suppliers was quite expensive. Hence, the combination of exchanging data over internet and paper was still used throughout companies and EDI was considered as a "fax machine", and integrating EDI with ERP software was "the furthest thing from anyone's mind" (Mrkonjic, 2007).

Mid 1990's – E.D.I. or D.I.E.

During this period of time, companies started to recognize the importance of EDI technology and tried to adopt it in order to not fall behind their competitors. Additionally, large companies, who had integrated their business applications with EDI from beginning, were developing further to standardize the process of exchanging data electronically. (Glushko and McGrath, 2005)

Late 1990's – The Internet has changed everything

The rise of Internet and World Wide Web (WWW) has made EDI no longer the only technologies for conducting business transactions electronically. Companies were reluctant to implement EDI because it was perceived as too complicated and costly implementation. However, with the emergence of XML – the Extensible Markup Language, it was possible for small and medium enterprises to adopt EDI in the most beneficial way because EDI developers see XML as "a more expressive, maintainable, and therefore lower cost syntax for creating business messages" (Glushko and McGrath, 2005).

Additionally, during this period of time, suppliers and manufacturing companies also realized that it is necessary to integrate EDI into business applications such as Enterprise Resource Planning (ERP) or their accounting system. It was recognized that the integration can help companies, especially logistics companies, increase productivity and reduce costs.

Early 2000's – EDI thrives once again

The advent of Internet and XML has taken EDI to a new level. In 1996, EDI over the Internet (EDIINT) was formed. In 2001, AS2 Communication Standard was created by EDIINT to support communications of EDI using HTTP protocol ("Concise Timeline and History of Electronic Data Interchange (EDI) | Electronic Cash News @," n.d.). ERP developer teams have also been aware of the significance of allowing EDI data and other data formats to be integrated into their system. In addition, new services were also introduced during this time so-called EDI outsourcing and web EDI. Small and medium companies, which felt difficult to follow the development of EDI and its standards as well as demands from their trading partners, considered these as their rescue because they would rather pay someone else to handle the EDI problems and complexities than implementing themselves.

Today – Still more to come

For the past two decades, the development of EC/EDI has made it possible to conduct business transactions in a way that no one could ever imagine by 1980's. The emergence of Internet and XML has made it possible for any sized companies to adopt EDI in the most favorable way. In fact, there will be no reason nowadays why suppliers and Logistics Company cannot generally implement EDI in their business. In other words, it is compulsory for companies if they do not want to fall behind their competitors in this competitive market. ("Concise Timeline and History of Electronic Data Interchange (EDI) | Electronic Cash News @," n.d.)

2.2 Enterprise Resource Planning (ERP)

2.2.1 A short introduction to ERP

Enterprise Resource Planning, usually shortened as ERP, is "the business management software which allows the organization use a system of integrated applications to manage the business" ("What is ERP (Enterprise resource planning)?," n.d.). For example, ERP software applications can be used to manage product planning, suppliers interacting, and customer services. In addition, it helps to control and monitor materials purchasing, inventories and orders tracking. ("What is ERP (Enterprise resource planning)?," n.d.)

Enterprise Resource Planning or ERP is "an industry term for integrated, multi-module application software packages" that offers significant benefits to support multiple business functions. In other words, ERP is described as "a software system that integrates application programs in finance, manufacturing, logistics, sales and marketing, human resources, and other functions in a firm." One of the benefits of ERP is to handle many business transactions at the same time efficiently due to the shared database which is connected with different functions and data processing applications in the company. (Vollmann et al., 2005)

It is built based on one common database, which is used to maintain needed data coming from many sources such as Manufacturing, Supply Chain Management, Financials, Projects, Human Resources and Customer Relationship Management. By integrating data, functions and processes into one single system, the company can save a great deal of time and cost. Moreover, decisions and tasks can be finished quickly with fewer errors because of the visibility of data across the organization in ERP. For example, when the order is made by customers, it is stored directly into ERP system. It is then possible for people from different departments to follow the same information and act upon it. ("Enterprise resource planning (ERP) – Concepts, Methods and Frameworks | IT PASSION - 'IT professional Blog,'" n.d.)

Implementation of ERP system within an organization is not straight forward. In order to implement an ERP system successfully, an enterprise would require some key actions. First of all, it is necessary to understand customers' requirements and expectations as well as their impact on the company's operation. Failing to achieve this could lead to a meaningless planning system. On the contrary, when this process is well-established, it can provide excellent answers for "what if" questions to help managers to determine beneficial mixes of orders and customers.

Secondly, it is also required to understand the material flow process. It is nearly impossible to develop an integrated management system for an unwell-understood process. This is the key point in a successful implementation as one of the functions of ERP system is to simplify the tasks by integrating data, operations and processes into one single system. In other words, "a thorough understanding of the overall business strategy and material flow process will result in the best application of the tools" (Ptak and Schragenheim, 2000).

Last but not least, successful implementation of ERP system would require knowledge about the control system requirements and the expected results. For example, it is essential to provide methods for communication among development team members and final users. Expecting users to change to a new system which they are not familiar with is impracticable. Therefore, people for whom the system will benefit should have a broad view what the system does and which benefits it can bring back as well as how they can fully utilize the new tool in their daily processes. (Ptak and Schragenheim, 2000)

2.2.2 How ERP connects functional units

A typical ERP system consists of many functional and integrated modules. All modules are connected to the same relational database which is updated in a real time. ERP systems are different from various vendors as they decide how many modules it can have or how these modules will be organized. Nevertheless, at least these four major areas should be focused within one typical ERP system: finance, manufacturing and logistics, sales and marketing, and human resources (Vollmann et al., 2005). The figure below illustrates how ERP is centered as the core of information system in these four modules:

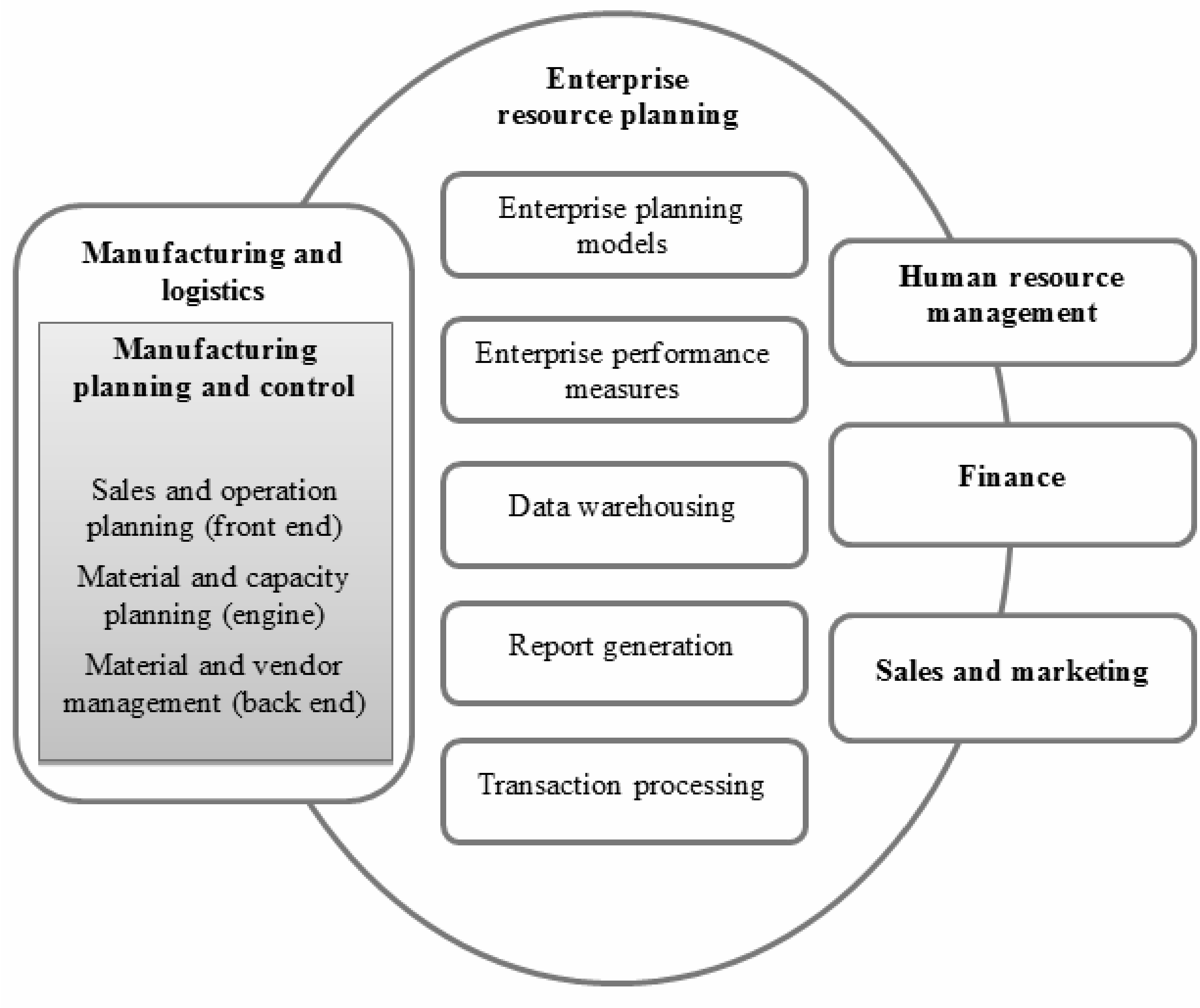


Figure 9: The scope of ERP applications (Vollmann et al., 2005)

Finance

As the company is expanding more and more, many enterprises find that they are having conflicting and mismatched financial data because business units have to make their own decision in many cases. ERP system helps them to resolve this issue by providing a common platform where all business units can use to update financial data in real time. For instance, manufacturing department can use this to trigger production environment when there is actual order from customer; at the same time this information will be also accessible to accounting department, which can be used to update account payable when the order is actually shipped.

Manufacturing and Logistics

Undoubtedly, this is the most essential and complex module in the system. Typical components include: sales and operations planning, material management, plant maintenance, quality management, production planning and control, and project management. Additionally, the integration of ERP system in logistics can help companies strengthen the cooperation between suppliers, manufacturers and clients involved in the logistic process ("How can ERP system help Logistic Chain?," n.d.). It will also improve indicators in logistic chain such as break of stock, date of delivery, or changes in a production line ("How can ERP system help Logistic Chain?," n.d.).

Sales and Marketing

This module mainly focuses on customer management, sales order management, forecasting, distribution, billing, invoicing, and order management. This group of systems is quite significant to global companies because it allows firms to manage sales process worldwide.

Human resources

This set of applications supports the capabilities needed to manage, schedule, pay, hire, train and develop personal resources in the organization. Typical functions consist of payroll, benefits administration, applicant data administration, personal development training, workforce training, time management, schedule and shift planning, and travel expense accounting. ("How can ERP system help Logistic Chain?," n.d.)

2.2.3 History and Development of ERP

The term of ERP was firstly introduced in 1990s, but its root date is 1960s. ERP is the evolution of MRP II which is the advancement of MRP originated from Inventory Management and Control. The brief history and development of ERP can be illustrated as following diagram:

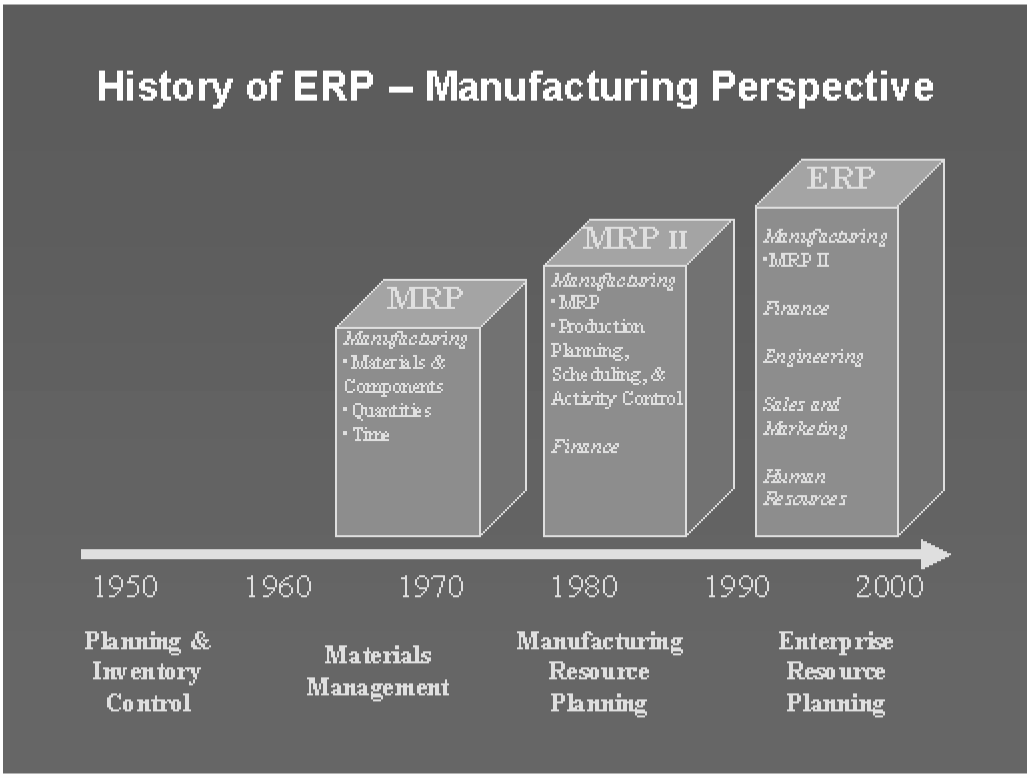


Figure 10: History of ERP ("ERP - Enterprise Resources Planning," n.d.)

The idea of Inventory Management and Control was recognized back to 1960s. But at that time, the concept was quite simple. It was enough to measure product lifecycle in years and it was not a big issue if extra items were ordered. However, in 1970s, that concept was silently crept in on the horizon. The company cannot afford anymore to order some of everything. Forecasting customer's orders was required, but it is impossible to achieve with the current inventory system. Therefore, Material Requirement Planning (MRP) was introduced as a replacement for the old concept. The new system enabled the company to schedule production processes as well as forecast customer's requirements. Productivity and quality were improved within companies which had implemented this tool effectively. ("ERP - Enterprise Resources Planning," n.d.)

In 1980s, companies recognized that managing materials and inventory was not enough, and Manufacturing Resource Planning (MRPII) was evolved. MRPII was involved with manufacturing processes such as finance, human relations, materials and inventory. It is the integration system of all aspects of manufacturing process. With the help of MRPII, we could plan and control all the resources of a manufacturing company more efficiently.

“The changing pace of technology had once again leveraged forward the planning and control systems in recognition of real business need” (Ptak and Schragenheim, 2000). MRP and MRPII has expanded beyond the inventory control and manufacturing process to other non-operational functions such as accounting, human resource, and by 1990s, Enterprise Resource Planning (ERP) came into existence. ERP has brought the whole planning and control system to a new level. Companies can now use ERP as a central system integrated with other resource planning for the enterprise including product design, information warehousing, material planning, finance, scheduling, capacity planning, and communication systems.

Nowadays, ERP has extended more to embrace business intelligence (BI) while also dealing with "front-office" functions such as sales force automation (SFA), marketing automation and e-commerce. The use of ERP in companies has widened more and more in a broader range of industries, from the whole sale distribution to e-commerce to manufacturing (“What is ERP (Enterprise resource planning)?,” n.d.).

2.3 Logistics and supply chain management tracking network

Supply chain management is defined as “an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user” (Cooper and Ellram, 1993). This means not only business processes and activities, such as inventory management, but also the whole channel of suppliers and manufacturers are coordinated to each other. There are many benefits of supply chain management (SCM). The term supply chain management is firstly recognized in the logistics literature as an inventory management approach. Hence, the first advantage of SCM is to reduce inventory investment in the chain, increase manufacturer’s productivity, and improve inventory management process, such as by creating streamlined inventory management and removing irrelevant elements. Another benefit of SCM is to strengthen the partnerships and supplier networks, balance out supply and demand, and improve planning and forecasting capabilities for all partners of the supply chain. Because of its importance, it is clearly necessary to give supply chain and supply chain management a greater attention as “means of becoming or remaining competitive in the globally challenging environment” (Cooper and Ellram, 1993).

Characteristics of SCM

"Supply chain management is different from other channel relationships" (Cooper and Ellram, 1993). According to M.C. Cooper, following characteristics can be used to differentiate SCM and other traditional ones: "inventory management approach, total cost approach, time horizon, amount of mutual sharing and monitoring of information, amount of coordination of multiple levels in the channel, joint planning, compatibility of corporate philosophies, breadth of supplier base, channel leadership, amount of sharing of risks and rewards, and the speed of physical and information flows within and between entities" (Cooper and Ellram, 1993). The comparison of these elements is illustrated in below table:

Element	Traditional	Supply Chain
Inventory Management Approach	Independent efforts	Joint reduction in channel inventories
Total Cost Approach	Minimize firm costs	Channel-wide cost efficiencies
Time Horizon	Short term	Long term
Amount of Information Sharing and Monitoring	Limited to needs of current transaction	As required for planning and monitoring processes
Amount of Coordination of Multiple Levels in the Channel	Single contact for the transaction between channel pairs	Multiple contacts between levels in firms and levels of channel
Joint Planning	Transaction-based	On-going
Compatibility of Corporate Philosophies	Not relevant	Compatible at least for key relationships
Breadth of Supplier Base	Large to increase competition and spread risk	Small to increase coordination
Channel Leadership	Not needed	Needed for coordination focus
Amount of Sharing of Risks and Rewards	Each on its own	Risks and rewards shared over the long term
Speed of Operations, Information and Inventory Flows	"Warehouse" orientation (storage, safety stock) Interrupted by barriers to flows; Localized to channel pairs	"DC" orientation (inventory velocity) Interconnecting flows; JIT, Quick Response across the channel

Table 2: Traditional and Supply Chain Management Approaches Compared (Cooper and Ellram, 1993)

These characteristics can also be used to examine roles of purchasing and logistics in term of initial decision to form a supply chain (SC), planning for the formation of SC, and operations of SC, as illustrated in table 2.

Element	Initial Decision	Planning	Operations
Inventory Management Approach	Alert top management to potential savings	Help identify where savings can occur	Monitor and suggest adjust-ments to the system
Total Cost Approach	Alert top management to potential savings	Examine P & L channel cost advantages	Continue evaluating cost advantages
Time Horizon		Long term agreements for parts and services	Monitor current performance
Amount of Information Sharing and Monitoring		Identify current systems, plan interfaces	Manage the flows
Amount of Coordination of Multiple Levels in the Channel		Selection of third parties	Several will involve P & L
Joint Planning	Identify potential SC participants	P & L Included	Functional planning
Compatibility of Corporate Philosophies	Input on culture		Front line interactions
Breadth of Supplier Base	Identify potential suppliers	Prequalifying suppliers	Monitor performance
Channel Leadership		Facilitate planning	Support leader's goals
Amount of Sharing of Risks and Rewards		Determine cost sharing arrangements	Keep track for P & L
Speed of Operations, Information and Inventory Flows	Provide estimates on improvement	Identify improvement opportunities	Inventory and information management & monitoring

Table 3: Purchasing and Logistics (P & L) Contributions to the SCM (Cooper and Ellram, 1993)

In other words, purchasing and logistics play a vital role in establishing and managing the supply chain. They will be “key functions in the operation of supply chain” and should provide “leadership in its formation and management” (Cooper and Ellram, 1993, Dorp, 2002). Specifically, they both serve roles outside and inside the firm. For example, regarding to OUTSIDE roles, purchasing helps interact with suppliers in the channel, while logistics focuses on the downstream aspects with customers and third party providers as well as assists purchasing in obtaining better coordination of inbound transportation and warehousing. Regarding to INSIDE roles, purchasing interfaces with operations of organization such as purchasing functions, planning and payments functions, while logistics interacts with marketing via customer service and with manufacturing with regard to product availability (Cooper and Ellram, 1993).

Supply chain management tracking network

"Tracking of shipments is an important element of customer service in the transportation industry" (Kärkkäinen et al., 2004). In fact, tracking the logistics/SCM network is nowadays conceived of as a highly motivated approach for distribution and delivery companies (Shamsuzzoha et al., 2011). It is necessary for not only manufactures but also their customers to collect information about shipments and material flows to ensure safer and timely arrival of their shipments. Logistics companies started to recognize the importance of monitoring and managing the shipment from the start point to the end position in order to improve their customer service.

The definition of tracking in the logistics theory has not been agreed universally (Shamsuzzoha et al., 2011). It is usually associated with tracing commonly termed as "tracking and tracing" (Shamsuzzoha et al., 2011, Kärkkäinen et al., 2004). The term tracking is defined as "the gathering and management of information referred to the current location of shipments", while the term tracing signifies "the storing and retaining the manufacturing and distribution history of products and its components" (Shamsuzzoha et al., 2011, Kärkkäinen et al., 2004). There are two major reasons why it is essential to implement tracking systems in logistics network: (Kärkkäinen et al., 2004)

- First of all, tracking of shipments is needed because it provides the connection between the information systems and the material flow in the supply network. Without tracking systems, it would be difficult to obtain an efficient co-ordination of logistics flows.
- Secondly, logistics companies can leverage tracking systems for administrative purposes such as to help in eliminating or reducing paper works, which increase the preciseness of information flow and decrease the cost of labor. Moreover, data collected from tracking systems can be integrated with ERP systems to provide users important information, for instance, to determine where costs are acquired or where profits are made, and to examine whether the quality of the process is acceptable or not.

Functionality and scope of manufacturing's logistics and supply chain network need to be concentrated and identified before implementing any tracking systems (Shamsuzzoha et al., 2011). Different relations can produce different tracking and tracing requirements which may have various effects on the organization (Dorp, 2002). The business scope of tracking systems is described with the four generic perspectives illustrated in below table:

Type of perspective	View of perspective	Explanation of perspective
Enterprise perspective	View tracking and tracing within a manufacturing company	Horizontal dimension: deal with not only manufacturing domain but also other functional domains Vertical dimension: differentiate between strategic, tactic and operational planning and control levels of the manufacturing system
Multi-side perspective	Focus on the multi-side aspects of tracking systems	In this perspective, it is important to pay attention to the material and information flow through the multi-side network. For instance, different processing requirements of sister plans can result in different sets of tracking and tracing data.
Supply-chain perspective	Evaluate tracking and tracing from supply-chain point of view	The perspective refers to supply chains as integrative approaches for dealing with planning and control of materials from suppliers to end-users. In other words, all required information of supply chain need to be managed efficiently and effectively.
External environment perspective	View tracking and tracing from the viewpoint of authorities, governing bodies or branch organizations, which are affecting the activities of supply chain	Requirements of tracking and tracing are usually embedded in legislation. For example, following lists some of the essential directives of European Economic Community (EEC): ➢ Packaging and packaging waste (94/62/EEC) ➢ The official control of foodstuffs (89/397/EEC) ➢ The functional labeling of products (79/112/EEC) ➢ Liability for defect products (85/374/EEC)

Table 4: Four generic perspective of tracking and tracing systems (Dorp, 2002)

2.4 Other cloud based supply chain and tracking systems

With the emergence of Internet of Things (IoT), cloud computing is becoming a vital factor in boosting supply chains to obtain "their upside potential, more efficient means of collaboration, communication and shared risk" (Columbus, n.d.). Cloud computing can be defined as "A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers" (Buyya, 2009). Several elements are included in the Cloud such as clients, data center, distributed servers, and web services. The major advantage of cloud computing is that it offers high availability, scalability, sustainability, security, reliability and high efficiency. By using the same platform access, it can help to eliminate the compatibility problem and provide easy connection to every part of supply chain (Tiwari and Jain, 2013).

As it has been defined above, SCM typically involves the supervision of material flows of goods and products from supplier, then to manufacturer, wholesaler, retailer, and finally to the end-customer or consumer, while cloud computing basically involves the use of computer-based programs to store and manipulate information. Integrating cloud-based services into supply chain management can lead to both financial and operational benefits (Tiwari and Jain, 2013). Figure below illustrates the SCM architecture in Cloud Computing:

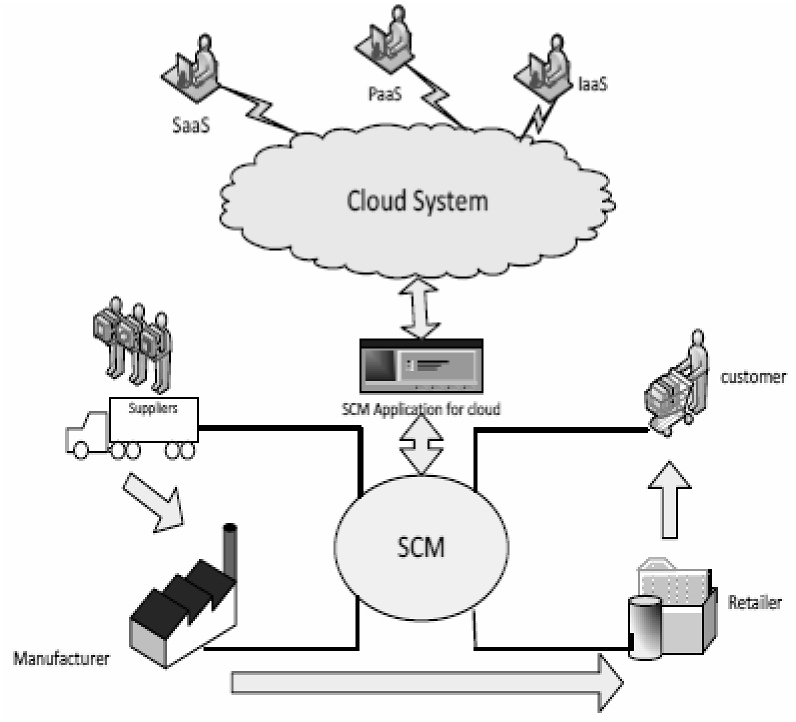


Figure 11: SCM architecture in Cloud Computing (Tiwari and Jain, 2013)

A recent study conducted by SCM World, which is a leading global community of supply chain professionals with more than 150 companies participating, has listed several key factors which are necessary to ensure the success of integrating cloud computing into supply chain. For instance, some of the essential factors are "Cloud computing adoption in supply chains is heavily dependent on the legacy ERP systems in place, as they provide the system of record corporate-wide" or "Sales & Operations Planning (S&OP), Transportation Management Systems (TMS), Spare Parts Management and Store Shelf Optimization are the four supply chain strategies that are the most cloud-friendly and have the greatest potential to deliver the network effect throughout a supply chain" (Columbus, n.d.). The report has also showed that the greater supply chain collaboration with the use of could computing can lead to problem solving twice as fast.

Role of cloud computing in Logistics Tracking Network

Logistics management is an essential part of SCM. It involves the process of material acquisition, warehousing, and transportation. By using logistics management under cloud, several benefits can be achieved. For instance, the visibility "which provide timely connectivity along multiple supply chain participants" can be improved. It does not only help manufacturers to "coordinate their operations and manage their customers" but also "allow the customer network to have a transparent view of the entire system" (Tiwari and Jain, 2013). Moreover, real time visibility of inventory and shipments can be provided and logistics tracking can be enhanced by utilizing cloud-based systems, which is a remarkable advantage for the success of logistics tracking network (Tiwari and Jain, 2013).

In the latest Logistics Trend Radar report, published by DHL, cloud computing and super grid logistics were ranked among the trends of highest mid and long term impact perspective due to the fact that these innovative technologies are expected to promote new types of process model and service provider in the future of logistics. Nevertheless, such a complex software system is only affordable by large logistics companies in term of time and resources. SMEs have to cooperate and collaborate with each other in order to achieve it. This raises two big questions for SMEs that how to cope with such a data models on one side and how to organize and control these cloud-based collaborative business processes (Arnold et al., 2013).

A generic use case model, so-called LOGICAL, has been presented by Arnold, Oberländer and Schwarzbach (Figure 12). The model cannot be considered to be completed; however, it can already partially provide answers for two open questions raised above.

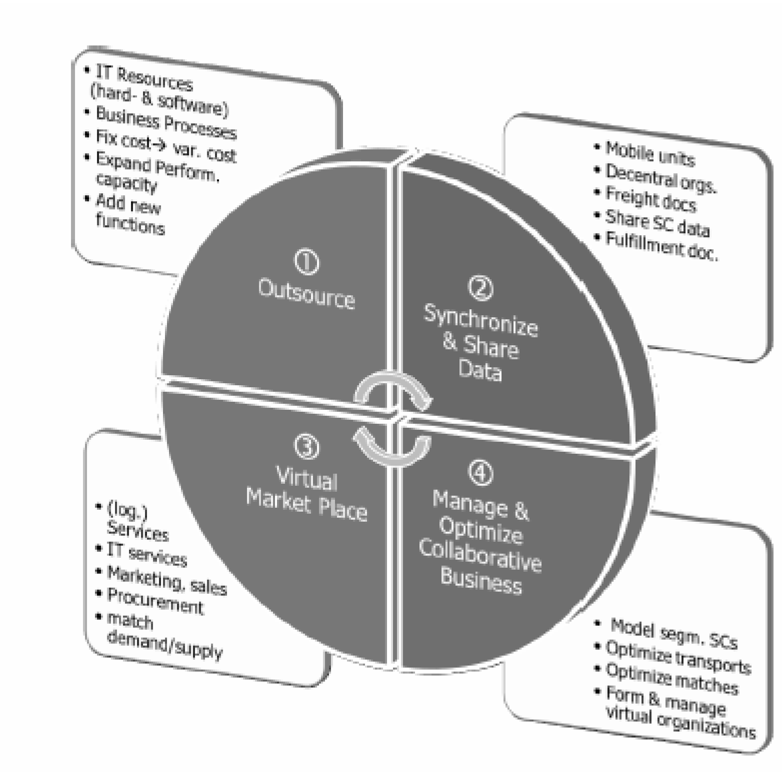


Figure 12: System of generic use case of a logistics cloud (Arnold et al., 2013)

The model contains 4 different parts which are interrelated in multiple ways:

(1) Outsourcing: IE resources and related services such as hardware, software applications and database are outsourced from local IT systems into a cloud
(2) Synchronizing and Sharing data: the process is created and utilized by multiple users from different partners
(3) Virtual Market Place: a market place for product and service offers and demands. E-commerce activities will be added to the corporate business models through the platform
(4) Managing and Optimizing collaborative business: a platform is created for activities of various business partners

In reality, many logistics service providers (LSPs) have recognized the importance of cloud computing and already applied the innovative trend into their business process. For example, FedEx, an American global courier delivery service company, by applying cloud computing into its environment, has shortened test and deployment time as well as improved processing performance and decreased development effort ("Webinar: FedEx's Private Cloud Success Story | Appistry," n.d.). Another example is UPS, one of the largest shipments and logistics companies in the world, has developed a cloud-based technology platform to enhance its international supply chain management. The platform, so-called UPS Order Watch, allows its customers to "more efficiently collaborate with international suppliers and better manage their inbound supply chains" with improvements to the service such as "added capabilities to enable greater accuracy and timeliness of overseas vendor bookings; improved processing and management of suppliers; automated exception management; near real-time shipment status and detailed line-level visibility of in-transit inventory; improved internal operational processes; and facilitation of purchase order (PO) consolidation and optimized shipping plans" ("UPS Introduces New Cloud-Based Technology Platform to Improve International Supply Chain Management - UPS Pressroom," n.d.).

2.5 Philosophy and derivative initiatives connected EDI

2.5.1 Collaborative Planning, Forecasting and Replenishment

Collaborative planning, forecasting and replenishment (CPFR) is "the most recent prolific management initiative that provides supply chain collaboration and visibility". It is a concept that aims to enhance supply chain efficiency with demand planning, synchronized production scheduling, logistics planning, and new product design. The term was firstly introduced in

1995 by Wal-Mart, W. L. Surgency, along with software companies such as SAP and Manugistics based on the need to set up a process that would link customers' demands with replenishment needs through the entire supply chain. Later in 1998, the first model of CPFR was defined by the Voluntary Interindustry Commerce Standards Association (VICS) aiming at "structuring and guiding supply chain partners in setting up their relationship and processes" (Attaran and Attaran, 2007). Generally, CPFR can be considered as "the last stage in the evolution of supply chain collaboration using four forms of electronic-transactional information sharing and collaborative processes"(Industry directions and synca systems) (Figure 13):

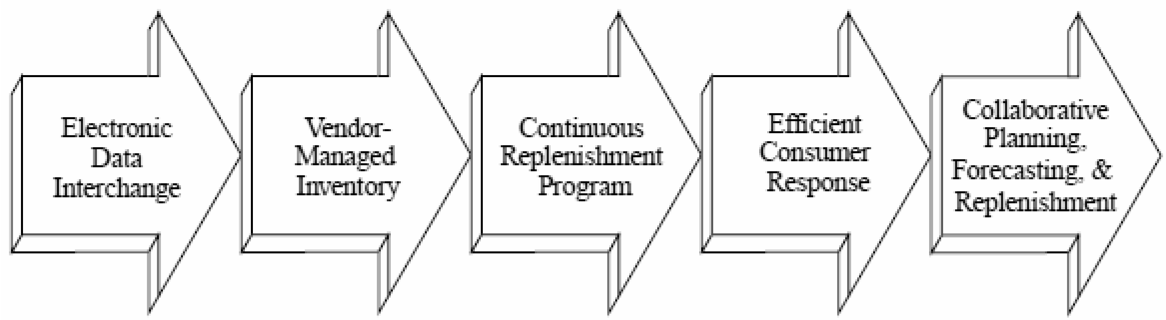


Figure 13: Evolution of supply chain solutions (Industry directions and synca systems)

CPFR does not only inherit advantages from other four models but also have its own more compelling characteristics. For example, CPFR is different from other solution models such as Efficient Consumer Response (ECR) in a way that its "critical mass (participations of many buyers and sellers)" is required in other models before any benefits are recognized, while the buyers' performance can be improved by having a collaborative relationship with only one vendor in CPFR. CPFR consists of 4 essential stages: planning, forecasting of demand and supply, execution, and analysis. Both customer and supplier take part in the supply chain to enhance the effectiveness of the collaboration, such as having customer and supplier join in in the forecast can improve the preciseness of the forecast such as demand, order, and sales. Components of CPFR model, where the center of the model is end-customer, are illustrated in the below picture:

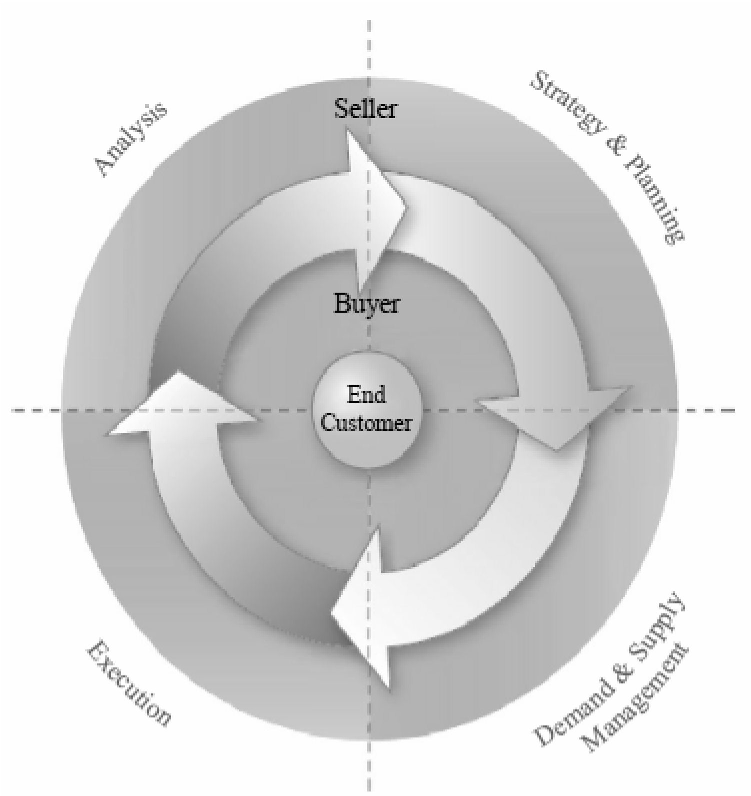


Figure 14: The components of CPFR model (Voluntary interindustry commerce standards)

The design of CPFR model can be various in different industries, yet the general structure and concept should be the same. By applying CPFR, companies' supply chain performance can be significantly enhanced through collaborative demand planning, synchronized production scheduling, logistics planning, and new product development. Most manufactures and industries can get considerable benefits from CPFR. Nevertheless, companies that have various demands, or deal in a product on a periodic basic, or those that deal with highly differentiated products might gain the most benefit from the CPFR model.

2.5.2 ebXML

ebXML stands for Electronic Business Extensible Markup Language. It is a global standard for electronic business and an end-to-end B2B XML framework. ebXML was developed as a joint initiative by OASIS and UN/CEFACT. It was considered as a replacement for the old and existing B2B frameworks during that time such as EDI and RosettaNet which are too heavy-weight and rigid, and hence not adequate for certain business. ("ebXML introduction - What is ebXML, An overview of ebXML," n.d.)

The vision of ebXML is "to create a single global electronic marketplace where business can find each other, agree to become trading partners, and conduct business" (Hofreiter et al., 2002). All the operations performed in this global electronic market will be handled by exchanging XML documents. In other words, we can simplify the data-centric formula of ebXML as EDI + XML + Business Process Models including business objects = ebXML, which is illustrated in below figure:

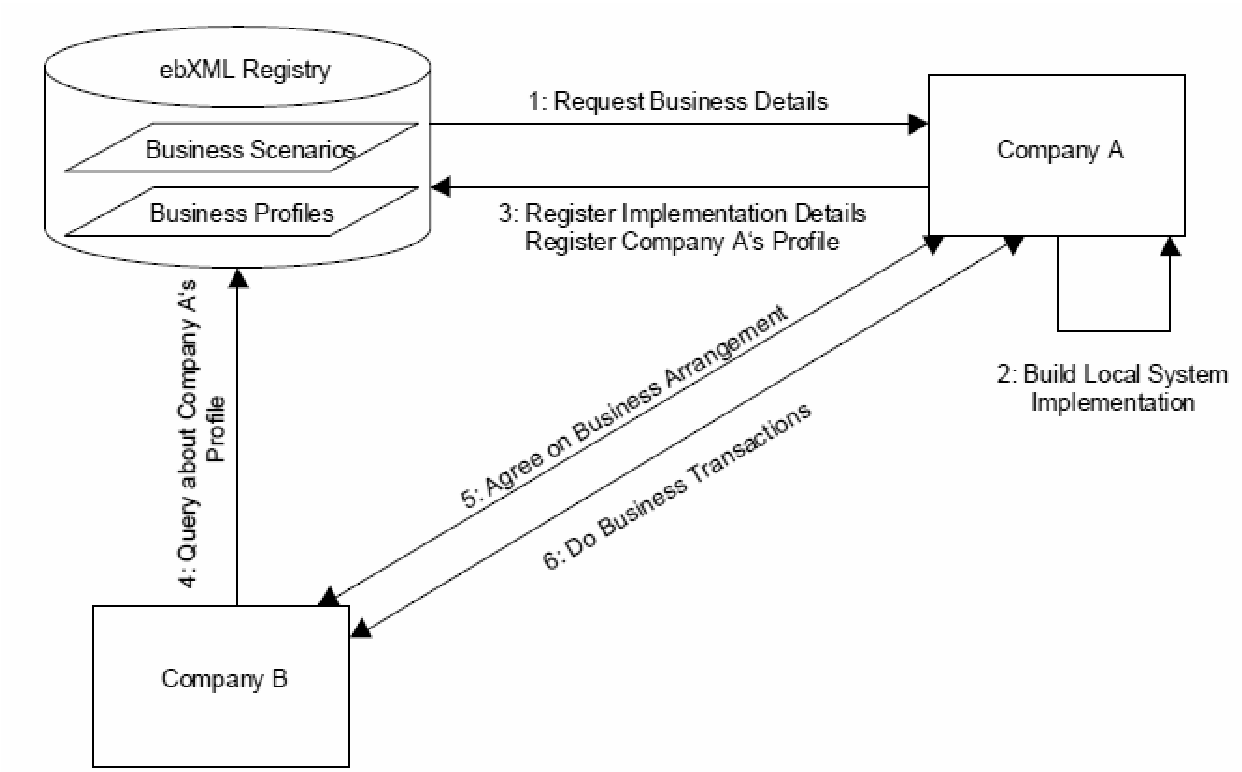


Figure 15: ebXML scenario (Hofreiter et al., 2002)

In this scenario, there are two companies involved: a large corporation (company A) and a SME (company B), which helps to describe "how organizations prepare for ebXML, search for new trading partners and then engage in electronic business": (Hofreiter et al., 2002)

- At first, business details from ebXML registry are requested by company A in order to see what is available online. After that, based on this information, company A can decide whether it is needed to build its own local ebXML-compliant application.
- Next, company A registers its implementation details to the ebXML registry and then submit the business profile which describes the company's ebXML capabilities and constraints, and its supported business scenarios.

- Finally, company B, who wants to conduct business with company A, searches and retrieves company A's profile from ebXML registry. After discovering business scenarios supported by company A, a Collaboration Protocol Agreement (CPA) which describes how to do business will be made based on the request sending from company B to company A. Upon agreement of the CPA by company A, they are now ready to use ebXML to conduct e-business.

The business processes and the business documents has been described in the ebXML specification in order to elaborate how these ones are exchanged to meet the needs and to support the above ebXML scenario. Accordingly, two views from the early work on OpenEDI, the Business Operational View (BOV) and Functional Service View (FSV), are used to define the related aspects of all business interactions in the actual architectural model of ebXML. The diagram of business transactions and associated data interchanges are addressed in the first one, while the second one concentrates on the supporting services and meeting the deployment needs of ebXML, as illustrated in figure 16 and figure 17 respectively. (David Webber and Dutton, n.d.)

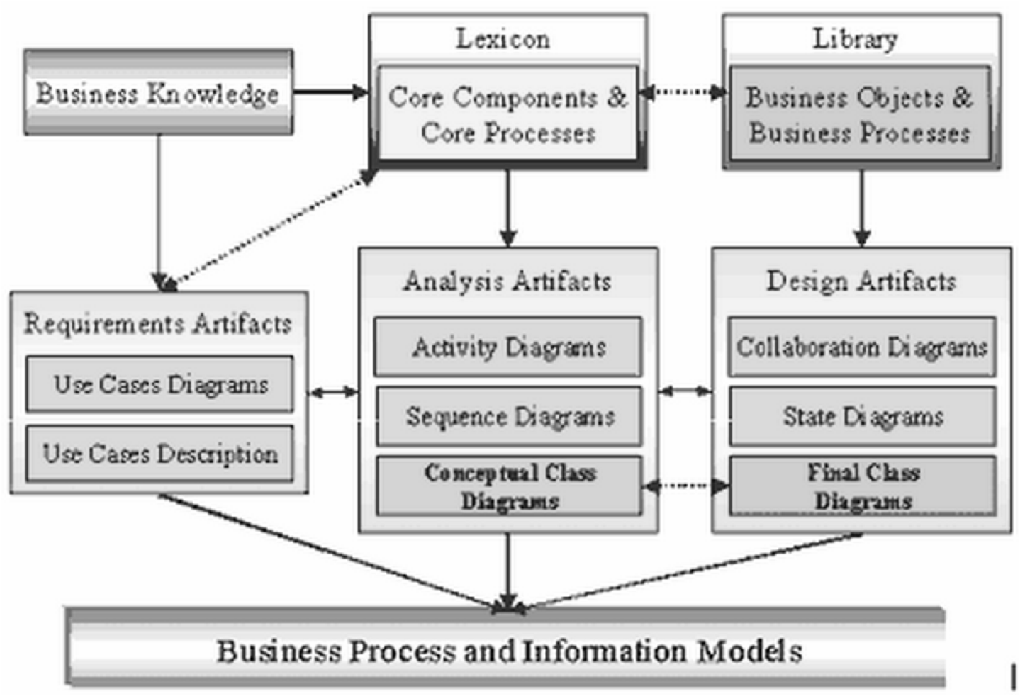


Figure 16: The Business Operation View (David Webber and Dutton, n.d.)

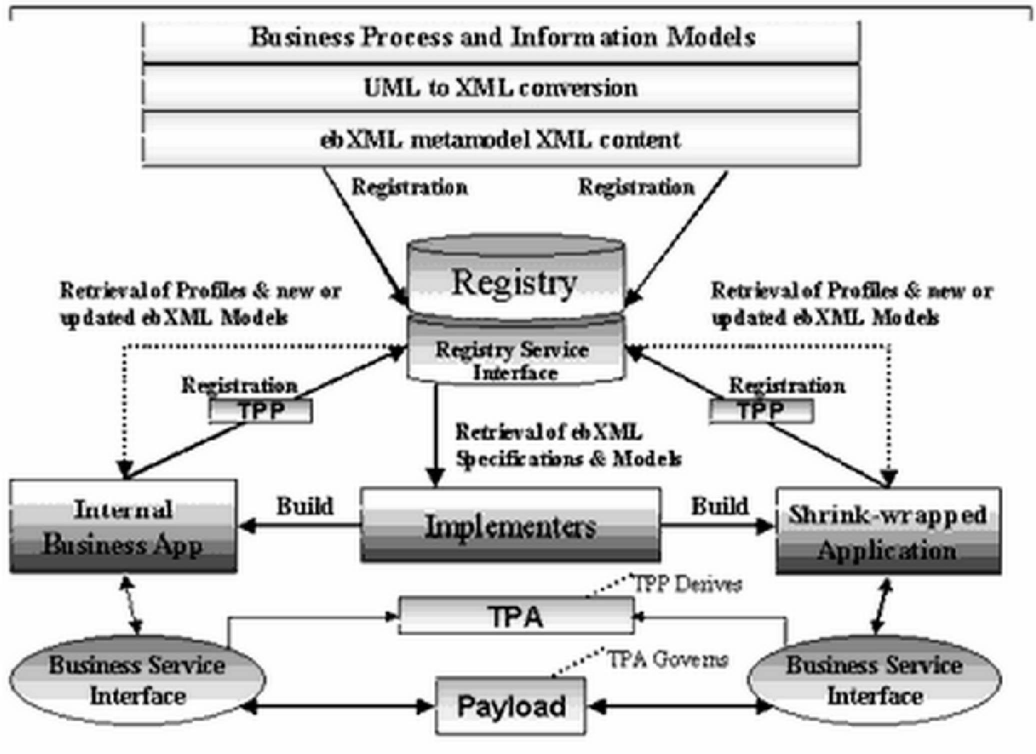


Figure 17: The Functional Service View (David Webber and Dutton, n.d.)

In conclusion, "ebXML specification and development has reached quite a state with respect to the level of transport and routing" (David Webber and Dutton, n.d.). Although the term is quite new and there are still many open issues, ebXML has been adopted more and more nowadays and is becoming an essential standardization in supply chain and logistics industry.

2.5.3 WebEDI

Although EDI has been employed successfully in large enterprises and in specific industries, it is still not broadly adopted due to the fact that SMEs which do not handle large amount of EDI transactions will be reluctant to implement EDI because of high costs of implementation and communication. WebEDI is an internet-enabled EDI platform. It is considered as a more proper solution which allows SMEs to integrate their systems with their business partners using EDI. The primary obstacle of traditional EDI is cost. Therefore, with the growth of Internet, it is apparently more suitable for SMEs to carry out EDI transactions over the Internet as it offers a lower-cost solution. (Fu et al., 1999)

The WebEDI is implemented in a way that the EDI operations are shared between the company and its service provider and the service provider will act as the company's IT department. The EDI transaction is processed through a web browser in real time and then sent to a user company or company's trading partner. Following diagram shows how EDI data flows through WebEDI:

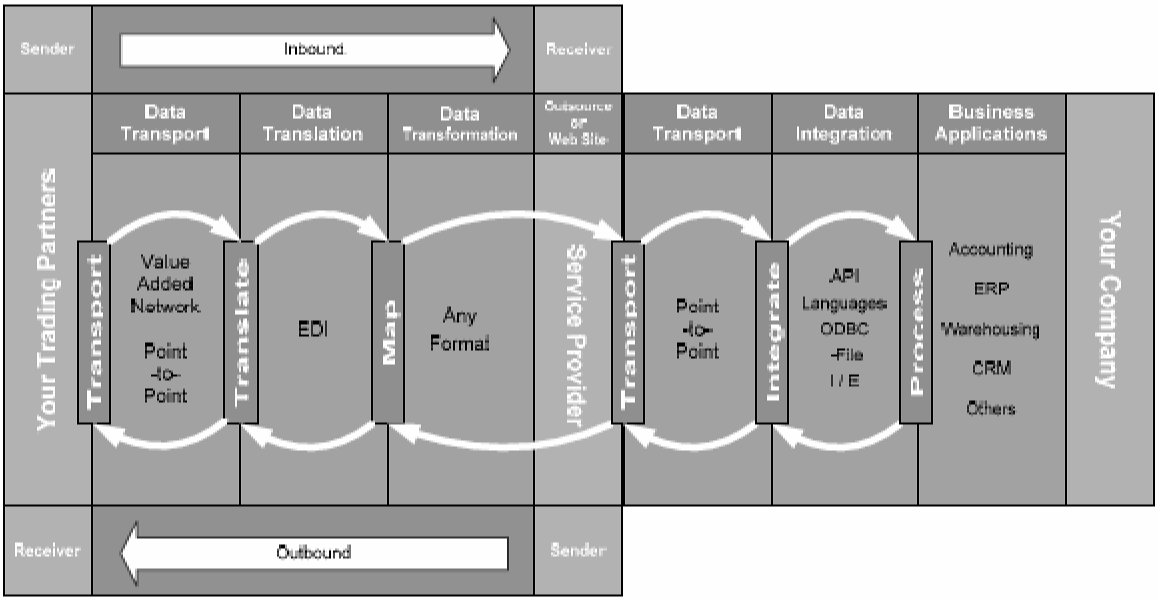


Figure 18: EC/EDI Relationship through WebEDI (Mrkonjic, 2007)

A typical WebEDI system can consist of following components:

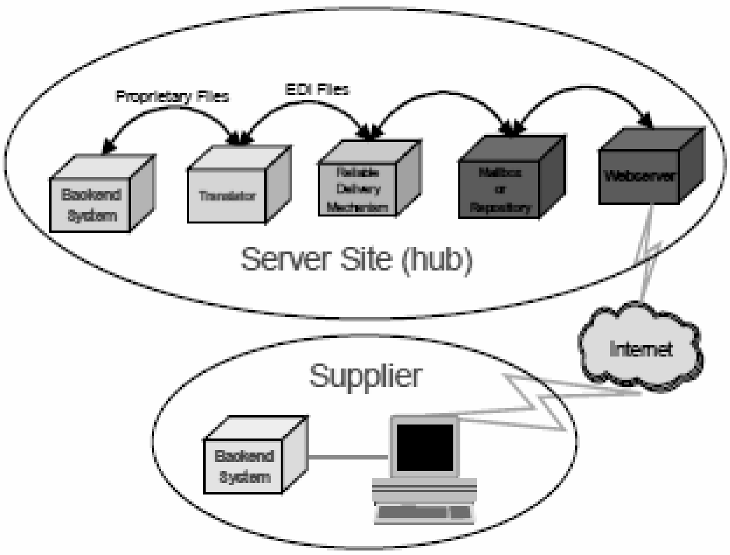


Figure 19: System architecture (Fu et al., 1999)

- Backend system: An application system and its underlying data are included in backend system in order to handle daily business processes. It mainly works on the formatted document sent/received to/from trading partners.
- Translator: The document is translated to different EDI standards (e.g., X12, EDIFACT) and vice versa in the translator.
- Mail boxing or Repository: The component works as a value-added service. Its main task is to deliver or forward the message to right trading partner and keep the original document in repository for tracking and tracing issues.
- Webserver: Authentication is provided by prompting suppliers with usernames and passwords. After that, suppliers will be able to fill out certain forms for conducting business transactions.
- Adapter: Suppliers use adapter to import document into their backend system. The process is conducted in a way that the document will be converted into the format which is accepted by the backend system.

WebEDI is a less expensive alternative, yet also gives various VANs' advantage. There are many benefits of utilizing WebEDI:

- Offer suppliers ability to carry out automated EDI transactions using only PC, the Internet and a web browser.
- Provide security services and SSL transport.
- Support Internet EDI as well as XML/EDI.
- Support end-to-end backend integration which enables suppliers to integrate their ERP system with the business flow of EDI.
- Can coexist with the traditional VAN-EDI
- Offer more user-friendly services and more usability such as mail boxing, email notification, document tracking service, query status and report.

Due to these advantages, WebEDI is becoming more and more popular and plays an important role in the EDI world.

2.5.4 GS1/RosettaNet standards

Comparing to other philosophy and derivative initiatives connected to EDI, GS1/RosettaNet is probably the biggest and the most widely used supply chain standard around the world. In fact, unlike EDI which is mostly used in transport and logistics, GS1 standards are used in various ranges of industry sectors such as retail, healthcare, transport and logistics, automation, or financial services and defense sectors. It has more than 110 member organizations serving 2 million companies in over 100 countries. (“Overview (About GS1) | About GS1GS1 - The global language of business,” n.d.)

GS1 is “an international non-profit association which focuses on the design and implementation of global standards and solutions in order to improve the efficiency, visibility, security, and the interoperability of supply and demand chains around the world” (“GS1 US Annual Overview,” n.d.). As the market is getting more and more competitive, the only way that small and large enterprises can move forward is to work together. Hence, GS1 enables companies across sectors to speak the same “language” when conducting business together. There are many reasons why GS1 System of Standards is more compelling than other ones. They are, for instance, “global, robust, multi-sector, user-generated, and scalable” (“GS1 US Annual Overview,” n.d.). As a result, it makes possible for companies to identify, capture, and share information automatically and precisely.

GS1 System of Standards consists of two main elements: “GS1 Automatic Identification Standards and GS1 Communication Standards”. GS1 Automatic Identification Standards includes several components: “GS1 Identification Keys and Application Identifiers, GS1 Data Carriers and the EPC Identifier”, which are basically used for naming and differentiating any object, thing or location as well as including information which carrier/format/standard data are associated with. On the other hand, GS1 Communication Standards deals with transactional data, which acknowledges “the completion of a business transaction such as eCom standards”, and allow trading partners in the supply chain network to share master data using Global Data Synchronization Network (GDSN) (“GS1 System of Standards,” n.d.). Figure 20 shows the basic structure of GS1 System of Standards:

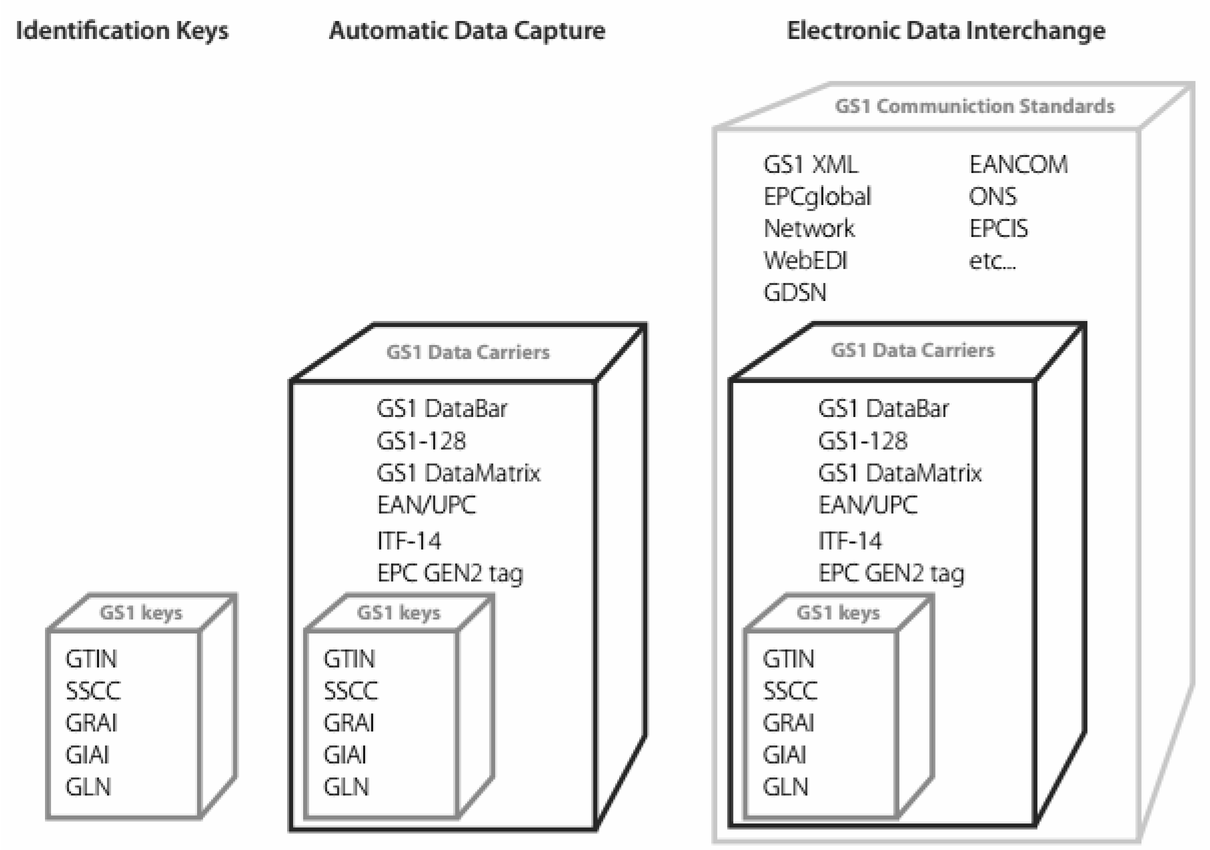


Figure 20: Structure of GS1 System ("GS1 System of Standards," n.d.)

Depending on each industry sector, GS1 implementation and usage can be different and varied. However, the main target should be the same: identify, capture and share information among trading partners, as illustrated in figure below. In this scenario, the whole product or material chain is tracked from manufacturer to distributor to end-customer using different kind of technologies, from the most basic one such as barcodes to the most advanced one such as EPC/RFID, and the information are shared between different stages of process, e.g. ordering, transporting, planning, or invoicing, or various departments within the company. ("GS1 System of Standards," n.d.)

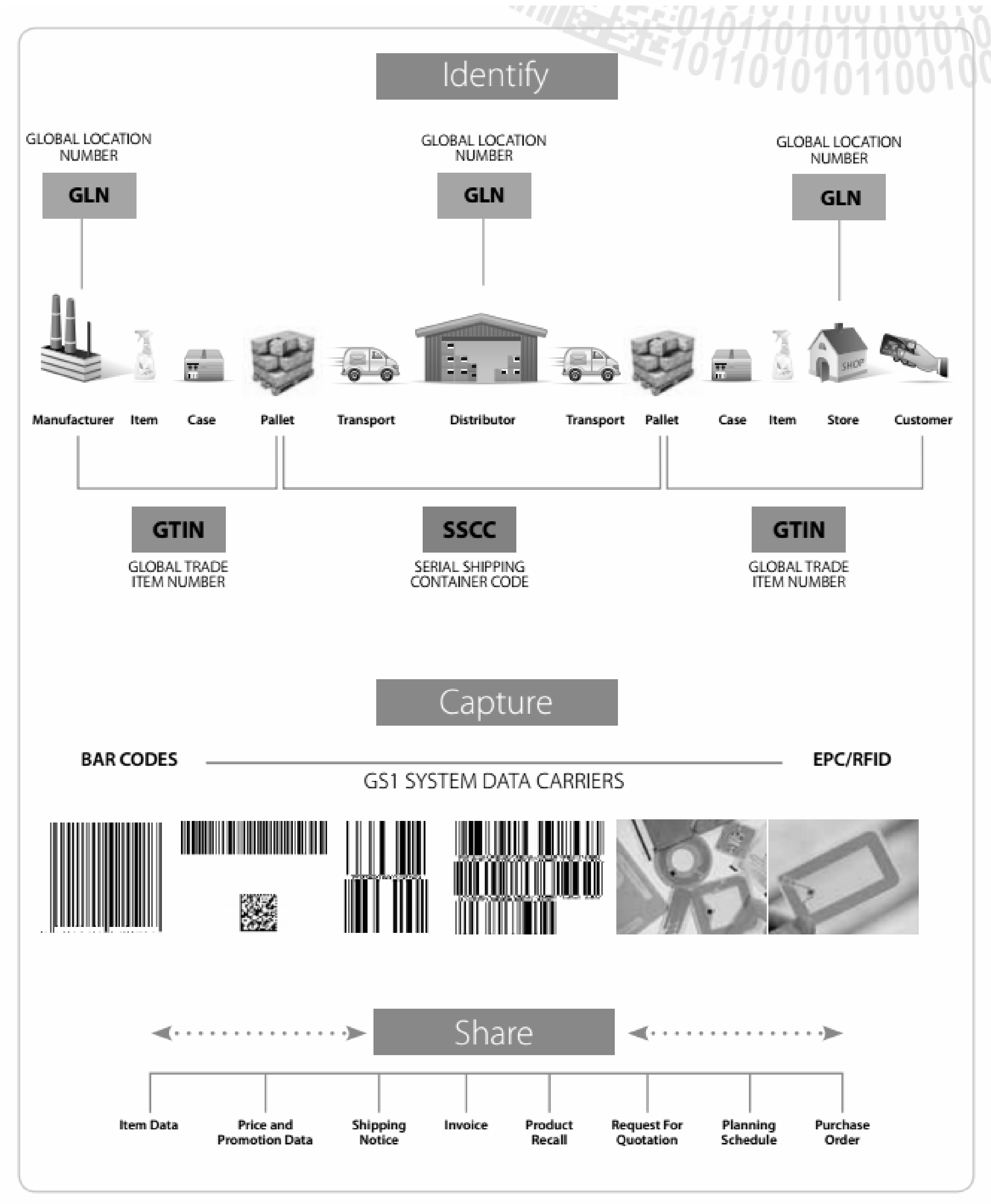


Figure 21: Overview of GS1 System throughout main functionalities ("GS1 System of Standards," n.d.)

RosettaNet, which is a subsidiary of GS1 US, was founded in 1998 as a non-profit consortium of more than 400 leading information technology companies, aims to create and implement a common set of standards for e-business. It was considered as a replacement for EDI with the emerging of collaborative forecasting in 1990s, although many companies still use EDI as the primary transactional business standard. However, due to the lacking of semantic and process standards, it is not efficient anymore to use EDI in real-time, business-to-business (B2B) transactions which are significant for many new marketplace initiatives such as collaborative forecasting. As a result, companies and their partners started to look for a new set of standards. ("RosettaNet PIPs," n.d., "What is RosettaNet? - Definition from WhatIs.com," n.d.)

RosettaNet standards were formed in 1998 as a result of growing needs for industry-wide e-business process standards. It supports exchanging information between trading partners in real-time such as products, services, marketing, sales leads, orders and inventory. RosettaNet specifications, also referred to as Partner Interface Processes (PIPs), are categorized into clusters (high-level business function) and segments (sub-function) to provide "common business-process definitions for all RosettaNet message exchanges" ("RosettaNet PIPs," n.d.). Following table lists clusters and segments defined in PIP directory:

Clusters	**Segments**
0: RosettaNet Support	0A: Administrative 0C: Testing
1: Partner Product & Service Review	1A: Partner Review 1B: Product & Service Review
2: Product Information	2A: Preparation for Distribution 2B: Product Change Notification 2C: Product Design Information 2D: Collaborative Design & Engineering
3: Order Management	3A: Quote & Order Entry 3B: Transportation & Distribution

	3C: Returns & Finance 3D: Product Configuration
4: Inventory Management	4A: Collaborative Forecasting 4B: Inventory Allocation 4C: Inventory Reporting 4D: Inventory Replenishment 4E: Sales Reporting 4F: Price Protection
5: Marketing Information Management	5A: Lead Opportunity Management 5B: Marketing Campaign Management
6: Service and Support	6A: Provide and Administer Warranties, Service Packages, and Contract Services 6B: Provide and Administer Asset Management (Merged with 6A) 6C: Technical Support and Service Management
7: Manufacturing	7A: Design Transfer 7B: Manage Manufacturing WO & WIP 7C: Distribute Manufacturing Information

Table 5: List of clusters and segments in PIP directory

PIPs define standards for "public business processes between trading partners" (see Figure 22) ("What is RosettaNet? - Definition from WhatIs.com," n.d.). A PIP defines "the roles, choreography, contents of business messages, and other design details for a particular RosettaNet message exchange" ("Introducing RosettaNet Solutions," n.d.). For example PIP 3A4 (Request Purchase Order) defines business processes, roles (buyer and seller), and document exchanges for requesting purchase order from trading partners, as illustrated in Figure 23.

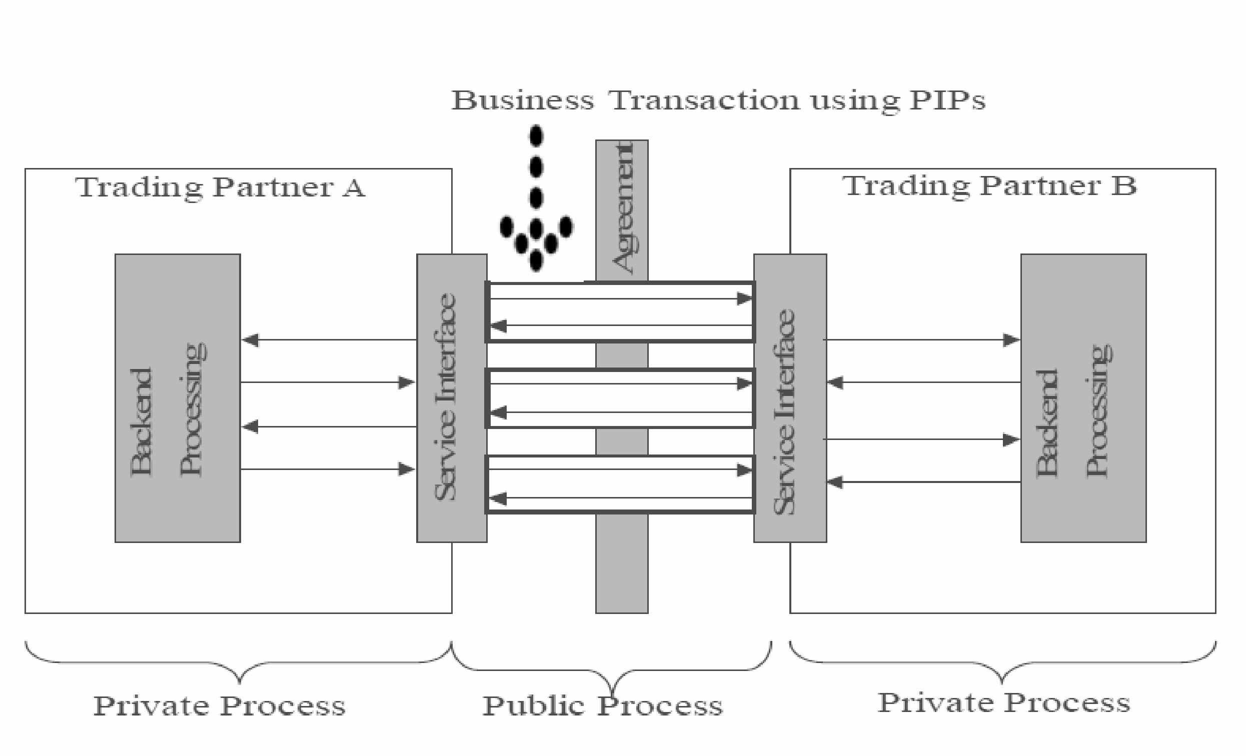


Figure 22: Public and private processes ("What is RosettaNet? - Definition from WhatIs.com," n.d.)

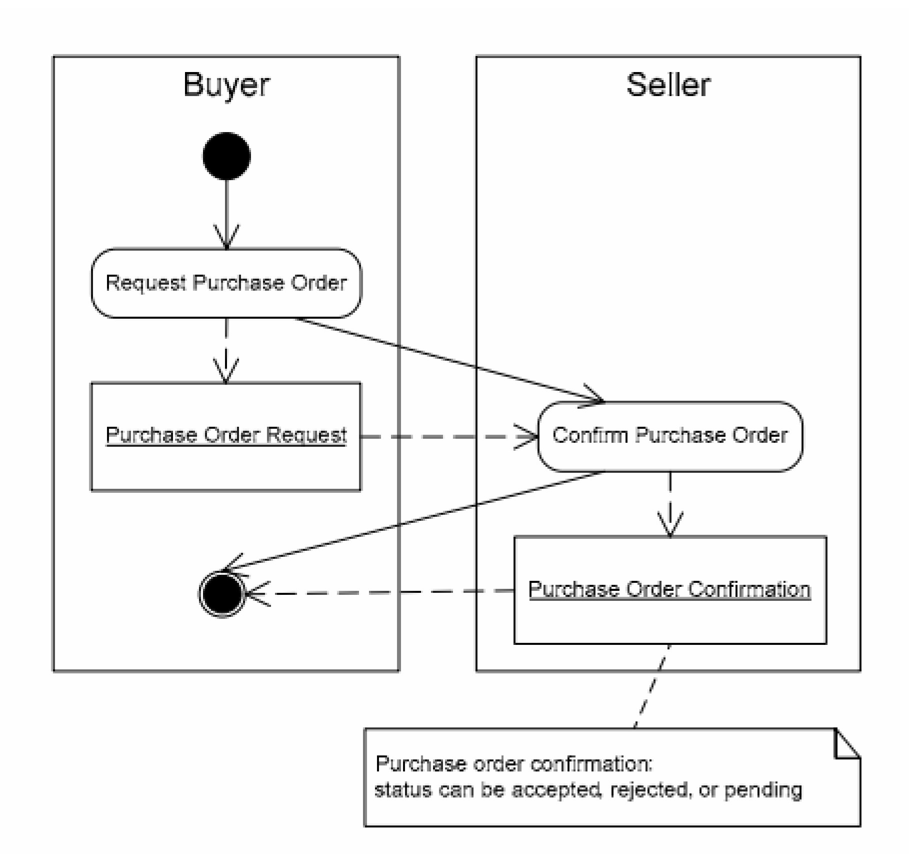


Figure 23: An example RosettaNet business document exchange with the 3A4 PIP as a UML activity diagram ("Introducing RosettaNet Solutions," n.d.)

In addition to defining PIP specifications, RosettaNet also defines an exchange protocol for PIP implementation. This infrastructure is called "RosettaNet Implementation Framework (RNIF)". The RNIF specification defines "the packaging, routing, and transport of all PIP action messages and signal messages" ("What is RosettaNet? - Definition from WhatIs.com," n.d.). Specifications for security and reliability are also included in this implementation framework. Usually, positive or negative signals, so-called receipt-acknowledgement signal, will acknowledge action messages whether it has been received and is validated or not. The latest version of RNIF (version 2.0) is an improved messaging specification of RNIF 1.1 (see Figure 24).

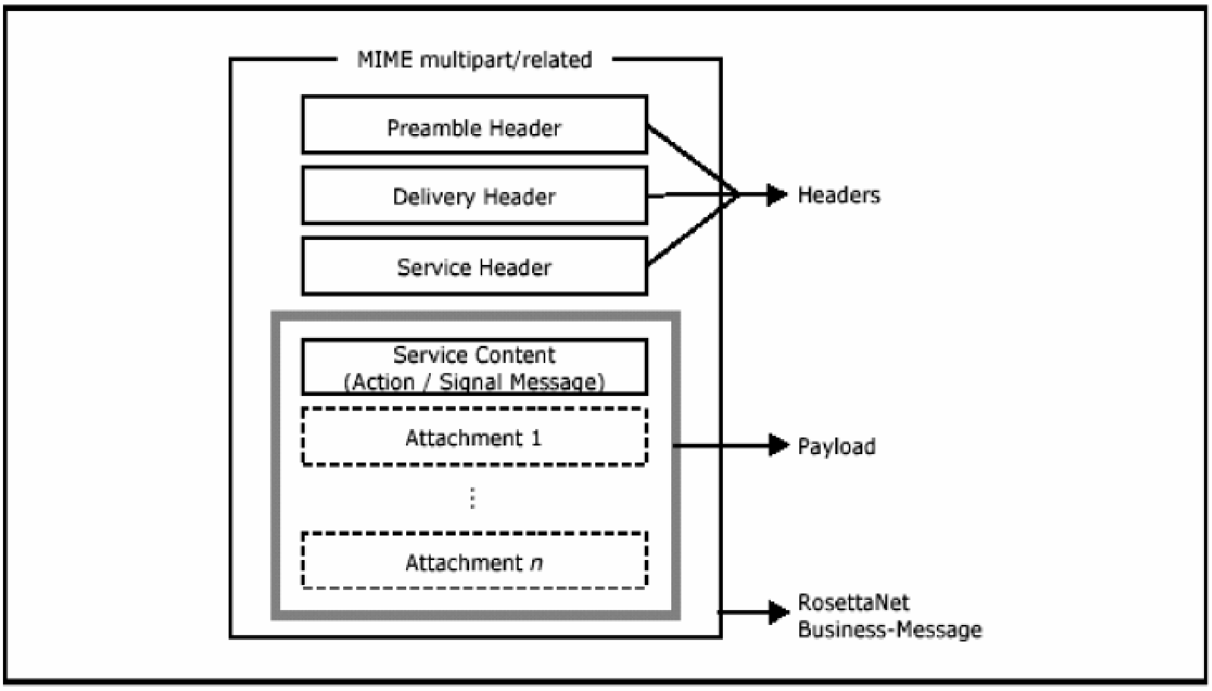


Figure 24: RosettaNet RNIF 2.0 compliant message ("What is RosettaNet? - Definition from WhatIs.com," n.d.)

3. METHODOLOGIES

In order to implement the interconnectivity of EDI and ERP systems in industrial establishments, we have chosen a case company which is also a university's industrial partner in a research project.

3.1 Background of LogTrack project

Traceability of supplier products is becoming more and more challenging due to the increased number of products and options. In fact, it is increasingly important to be able to track information concerning the physical location, condition and environment of the transported cases and products in case company's delivery projects. In order to have this information available, it requires a tracking system to be used in the project logistics.

Logistics Tracking Network (LogTrack) began as a two-year research project aiming to analyze "the new technological opportunities on real-time shipment tracking in dispersed manufacturing environment" (Shamsuzzoha and Helo, 2012). The project was implemented as a work package and a part of TEKES industrial collaboration. The project was implemented by case company and University of Vaasa and involved many activities such as implementing LogTrack system, conducting real pilot cases, extending B2B relationships between partners, etc. The project would give Wärtsila Ship Power project, transport and delivery managers the possibility to pro-actively view the status of the supply chain and be able to recognize and correct problems that are starting to brew - are all handling units for one project really where they should be?

Following lists main tasks in the project:

- Describe and analyze information flows within the logistics chains
- Describe and study the list of specifications for the tracking system.
- Describe and examine the list of tracking technologies.
- Conduct pilot tests for the tracking system and the command center
- Define time-schedule for the implementation of new real-time tracking system.
- Analyze the investment costs of real-time tracking system implementation.
- Evaluate the potential partners in delivering the IT-solution.

The project was targeted to reduce up to 70% of transport- and logistics-related administrative problems, e.g. locating missing goods, correcting faulty markings, locating goods in warehouse, rectifying order errors, communicating goods' statuses to customer, producing new paperwork for lost goods, etc.

The main idea of LogTrack system is to provide the possibility to track shipments all the time and all the way from factories, suppliers through consolidation points and then, finally to end-customers. Following figure describes how the tracking routes are flowed in this system:

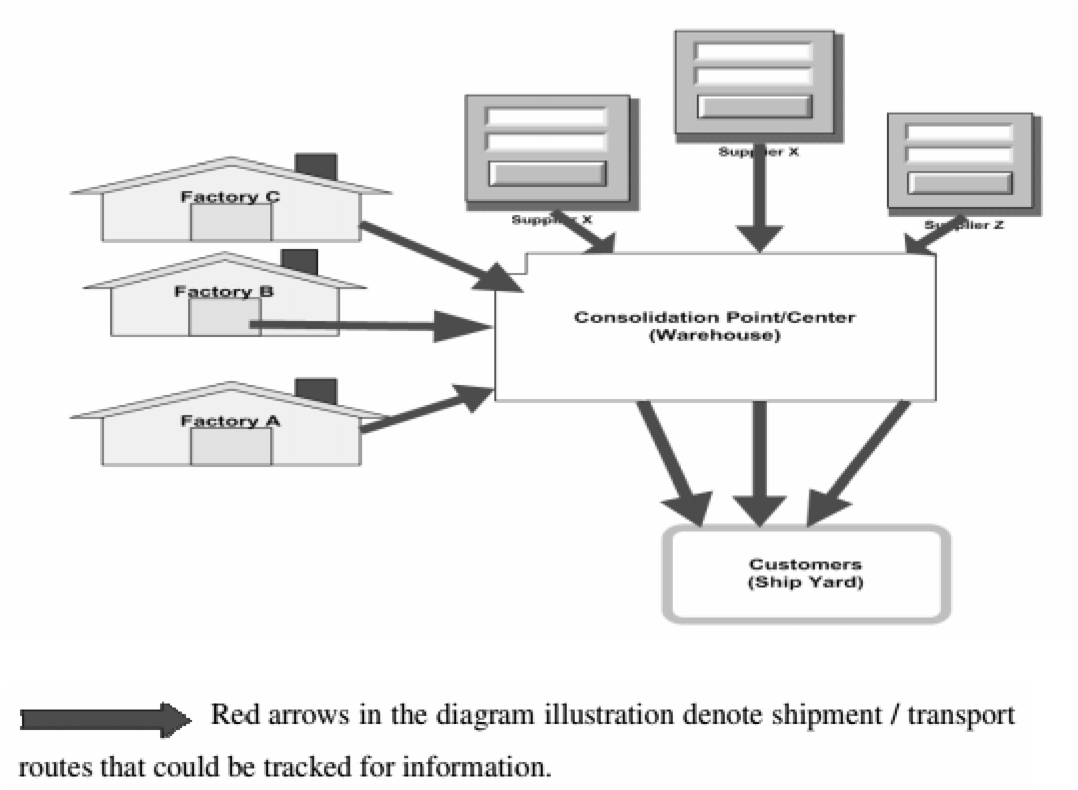


Figure 25: Tracking route for the LogTrack system

Additionally, as it has been mentioned before, the system should also provide Wärtsila managers the ability to view/manage the whole supply chain in real time without the need of paperwork. To support that, data from different sources such as ERP/SAP or EDI systems (suppliers) should be integrated into LogTrack portal and provided on the cloud where the user has access to (Figure 26).

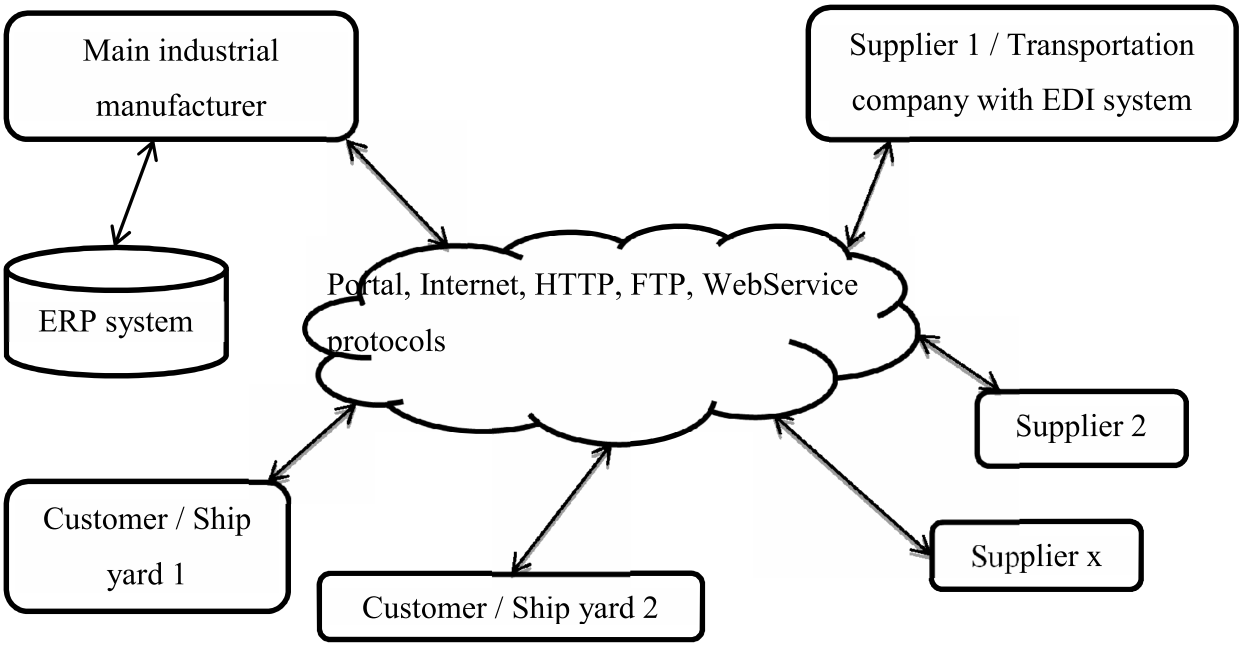


Figure 26: The architecture of industrial manufacturer SCM interfaces

LogTrack portal was implemented as one part of the LogTrack project. The portal was developed and deployed on SalesForce, a cloud computing platform, to reduce the cost and complexity of buying and maintaining the underlying hardware and software and provisioning hosting capabilities. An overview of LogTrack portal is illustrated below:

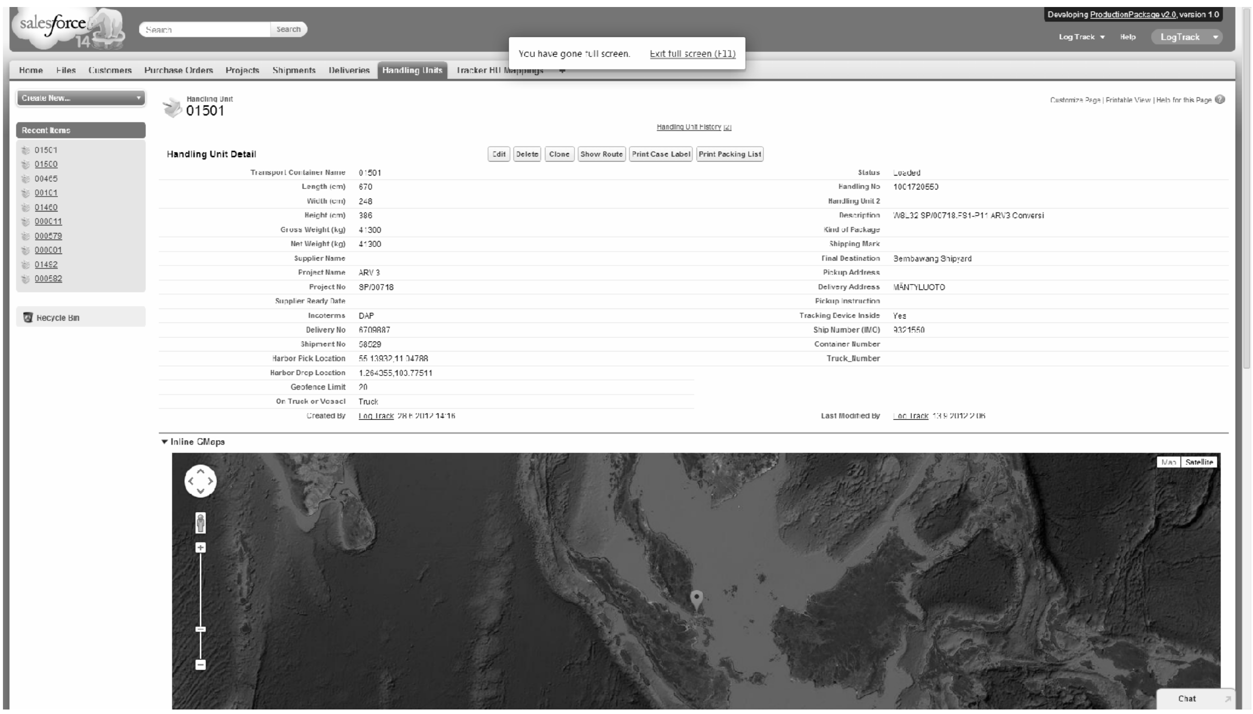


Figure 27: Overview of LogTrack portal

The project was divided into 3 phases (Table 6) and continuously lasted for one and a half years (Figure 28).

Phases	Tasks
Phase 1: System creation	1) Implementation team creation and purchasing planning 2) Involving partners, contracting participation conditions 3) Integrating tracking system prototype into existing computer systems 4) Purchasing hardware
Phase 2: Implementation	1) Installation of hardware, software start-up 2) Training managers, warehouse personnel in using system, attaching hardware 3) Ramping up the actual usage of RFID tags, GPS-trackers, etc. 4) Informing customers, insurance agencies about new tracking possibilities
Phase 3: Monitoring and development of functions	1) Definitions of standard performance reports from the tracking system 2) Monitoring supplier conformance with new case label/RFID tag usage 3) Reviewing project, transport and delivery managers' feedback on system functionality 4) Limited functionality improvement to system/processes 5) New project proposal based on project experience if necessary

Table 6: Phases of LogTrack project

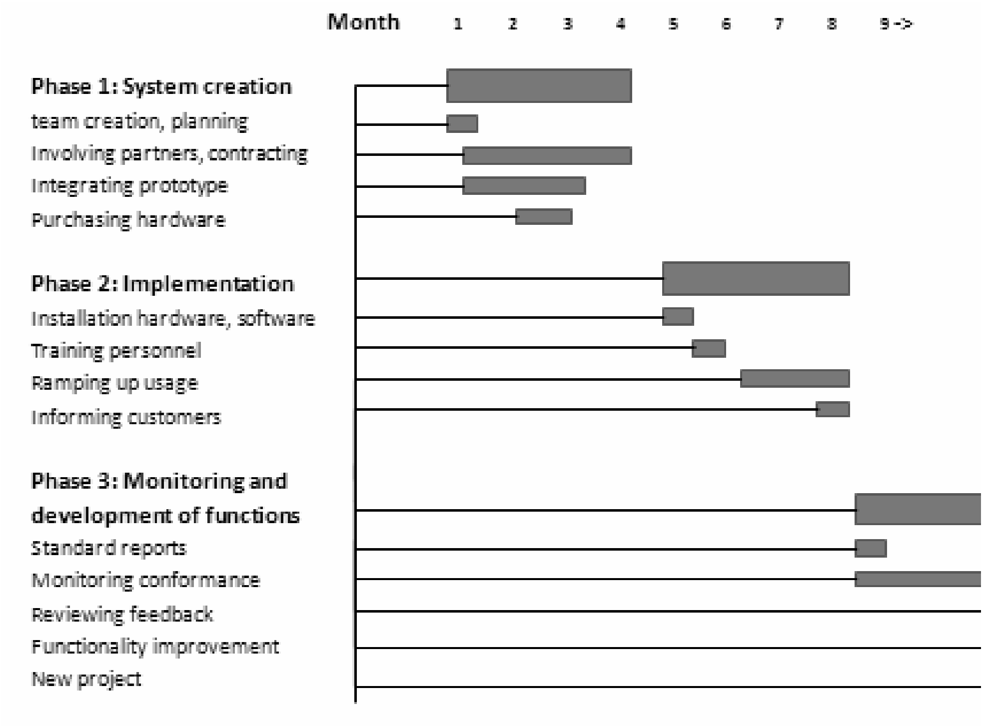


Figure 28: Project schedule

3.2 Inbound and outbound tracking

Nowadays, it is highly fashionable to have an outside transport company to handle the company's logistics needs. This involves keeping track of deliveries and shipments, and making sure that the inbound and outbound flow of goods are as "Just-In-Time" as possible.

However, the company's operation strategy will effect on the decision of selecting this third-party logistics company. Especially, in this case company, many issues made the solution more complicated. First of all, the comapny separates the inbound and outbound flow of goods, and use different methods for each. The inbound is handled by a single transport company, either by Kuehne & Nagel or Freja Transport, while the outbound is handled by transport companies chosen on a shipment-to-shipment basic – the companies offering the best prices and terms for a certain route selected for that single shipment. Some of these companies have their own EDI systems, some implement advanced tracking systems monitoring their fleet of trucks, and others do not have anything. Furthermore, a total of six different consolidation warehouses (each under different ownership) is used to collect the streams of incoming goods, which also makes selecting a single outsourcing company more difficult.

All in all, the whole supply chain is brought together by a large amount of different transport companies. Switching to a single operator would be a major strategic choice and it would be hard to combine data collected from different companies as their systems are varied by size, technology and protocol. Each company is expert in certain routes, and it would be difficult to find one single global transport company which is expertise in all the routes previously covered by up to 40-50 companies if not impossible.

Therefore, to achieve proactive (future problem-solving) tracking of products and components, the global manufacturing must create an independent tracking system, suited to the needs of managers who are responsible for purchasing, delivery and shipment. The tracking system should be able to receive and integrate tracking data from different sources – in fact, lots of tracking data is already available in services around the world, and the only problem lies in the integration. One major point of this integration is the interconnectivity of company's own ERP system, EDI systems of other transport companies, and the LogTrack cloud-based portal, which will be mainly focused in the below chapters.

3.2.1 Inbound process

The interchange of EDI and ERP systems is mostly presented in the inbound process. In other to understand more about this process in the logistics tracking network, we have conducted interview with case company's delivery and purchasing managers. Details of logistics operations in the inbound process are illustrated in below diagram:

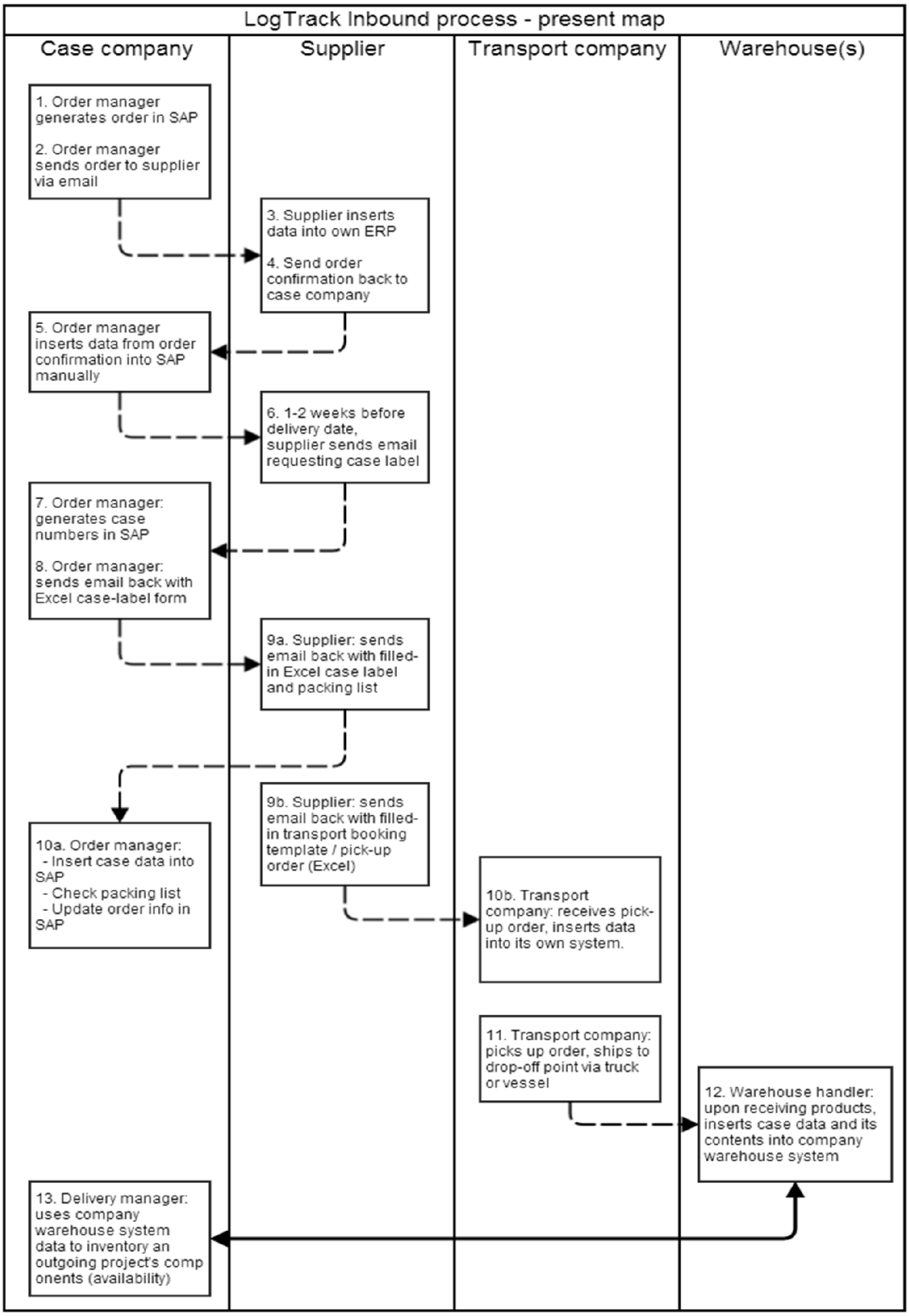


Figure 29: LogTrack inbound process – present map

Following is the average time on which order and delivery managers spend to perform these processes:

Task	Time consumption
1. Generate order in SAP and send it via email	10 min
2. Supplier inserts to own ERP	20 min
3.	
4.	
5. Insert confirmation data into SAP	5 min
6.	
7. Generate case numbers and send	5 min
8.	
9a.	
9b.	
10a. Update packing list	10 min
10b.	
11.	
12. Insert data into warehouse system	5-10 min
13.	
Total	**55-60 min**

Table 7: Average time consumption for inbound process

As it can be seen from the picture, without EDI, the whole inbound process is fairly complicated and involves quite many partners (suppliers and transport companies). It has generally about thirteen steps and it takes approximately one hour for order and delivery managers to perform these steps, not including time and efforts when communicating with other suppliers as well as the time other suppliers use to carry out their steps. It is also important to notice that as all the operations are performed manually by managers; therefore, it is very easy to make a mistake, for instance when inserting data from order confirmation into SAP or when filling certain form and sending to other people.

The whole process is much simpler when integrating EDI into ERP system. With the use of Internet and EDI, we can get rid of email and paper handling systems in the inbound process efficiently. Human-human communication will be reduced as much as possible and replaced with computer-computer communication which is more precise when handling daily routine jobs. The future inbound process is described as below:

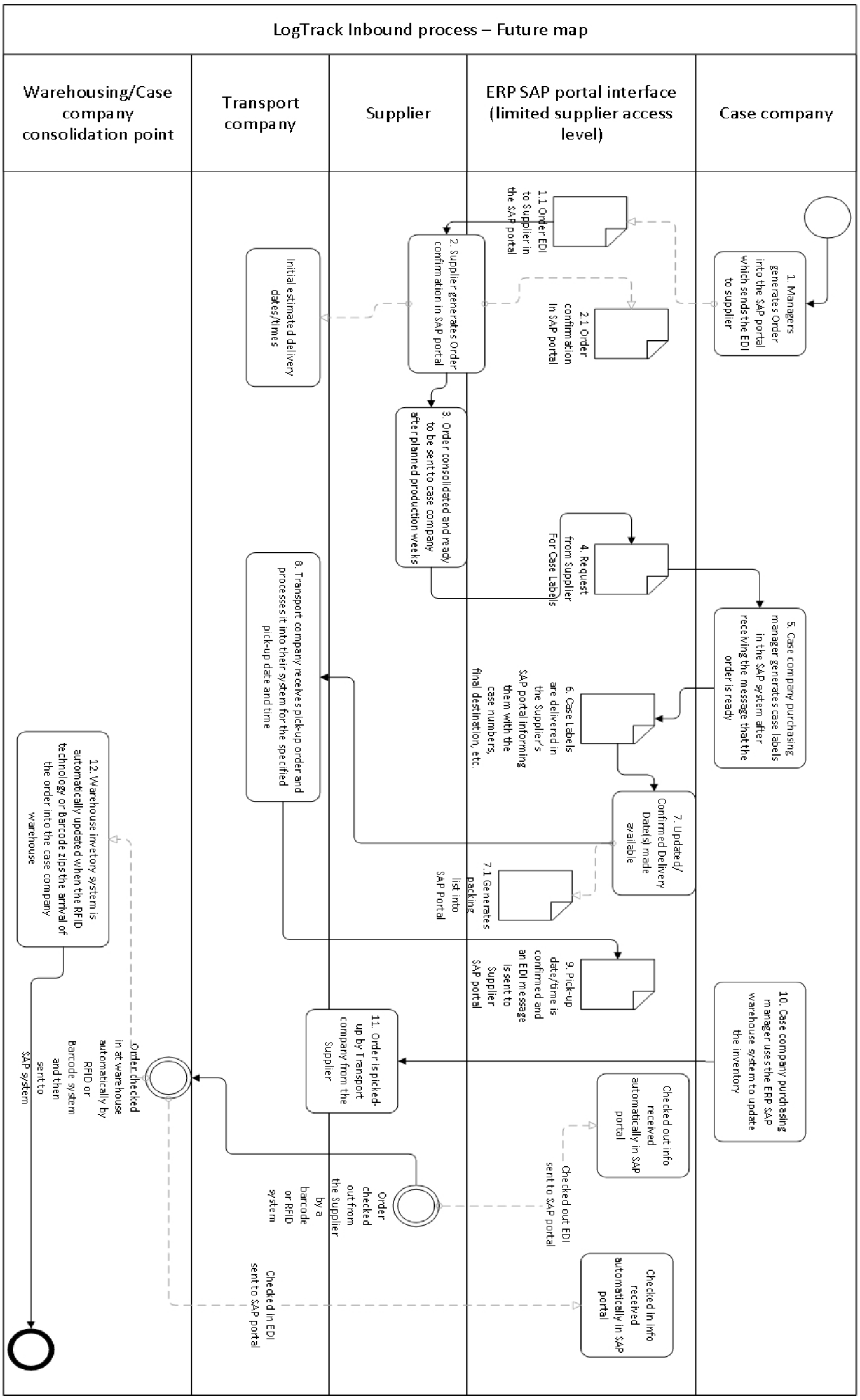


Figure 30: LogTrack inbound process – future map

The ERP SAP portal (LogTrack portal) interface is presented in the diagram as the bridge system between the case company and the supplier and the transporting company. The

LogTrack portal consists of many EAI systems which are hosted in a cloud computing environment and communicating with each other via either web service or FTP or HTTPs protocol. Most of the operations in inbound process will be handled by the portal automatically and the portal also communicates with case company's SAP indirectly. More details about the integration between LogTrack portal and the case company's ERP SAP system will be explained in section 4.

Additionally, email and paper handling systems will be replaced by EDI which helps to reduce cost and error of paper handling and to streamline the interchange of information between the case company and its partners. For example, upon receiving the order information, order manager will generate the order info to LogTrack portal which sends the EDI to supplier. Upon receiving the Order EDI, the supplier will generate the order confirmation including estimated delivery dates and times in LogTrack portal and send back the Order EDI confirmation. The whole process will be more efficient and less time consuming. Data will be accessible for both the case company and the supplier, and we can avoid unnecessary user's errors when inputting data into ERP system. For instance, it takes 10 minutes for order manager to generate order in SAP and export Excel format for sending, and another 20 minutes for supplier to insert data to its own ERP, as well as extra time for sending and receiving email. That amount of time can be reduced significantly because LogTrack portal provides a user-friendly interface which helps the user insert data more quickly and it will also handle the EDI interchanges automatically. In other words, delivery and purchasing managers will not need to be worried if the other partners have received the correct document or if it has been sent and received and processed in the other partners' side.

EDI can also boost the interchange with the transporting company and the supplier with the use of RFID and barcode system. Upon order's picking up by the transporting company, the supplier can check out the order automatically by using a barcode reader or RFID system and change its status from "Ready to go" to "Loaded". Upon order's dropping at consolidation point, the supplier can also check in the order automatically using a barcode or RFID system and change its status from "Loaded" to "Arrived at consolidation point" (Figure 31).

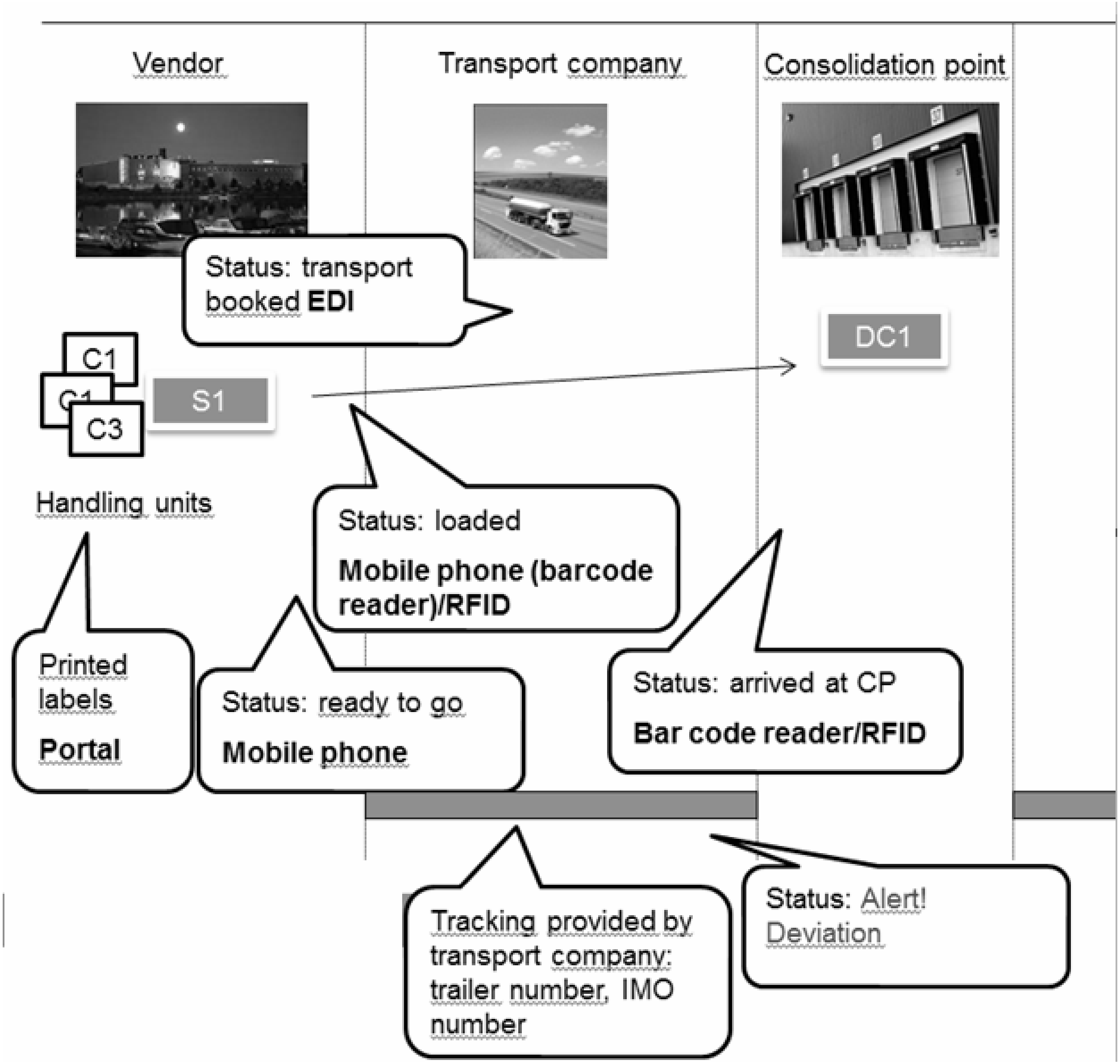


Figure 31: Vision of transparency of Inbound process

Nowadays, most of transporting companies such as Freja, UPS, or FedEx have their own EDI and tracking (GPS) system. By communicating with transporting company via EDI, it also enables the case company opportunities to receive back other valuable information such as the location of shipped package. For instance, transport booking reference / template can be made and sent via EDI instead of using paper-email handling system. The transporting company, in return, will send back the status update and other information via EDI with transport booking reference id. Upon receiving EDI message, the portal will process the message and update necessary information in case company's SAP system. The communication can be made by FTPs or HTTPs protocol. Following is one example how the process resembles (figure 32, 33, 34):

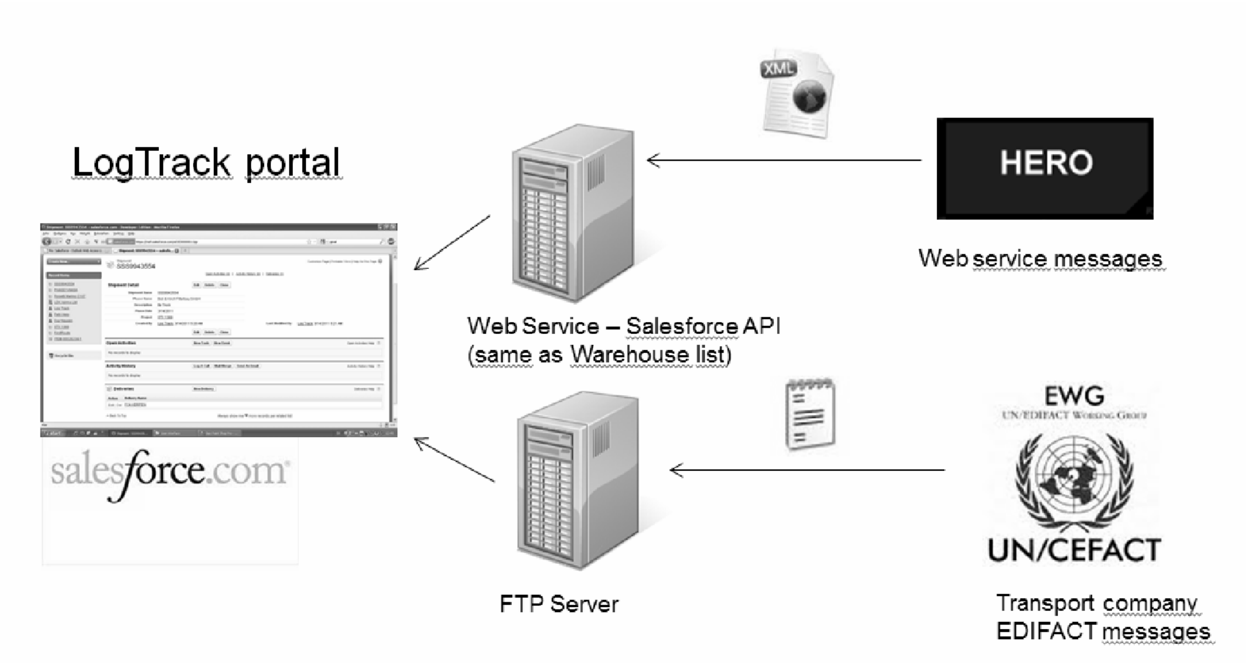


Figure 32: Process flow upon receiving status message

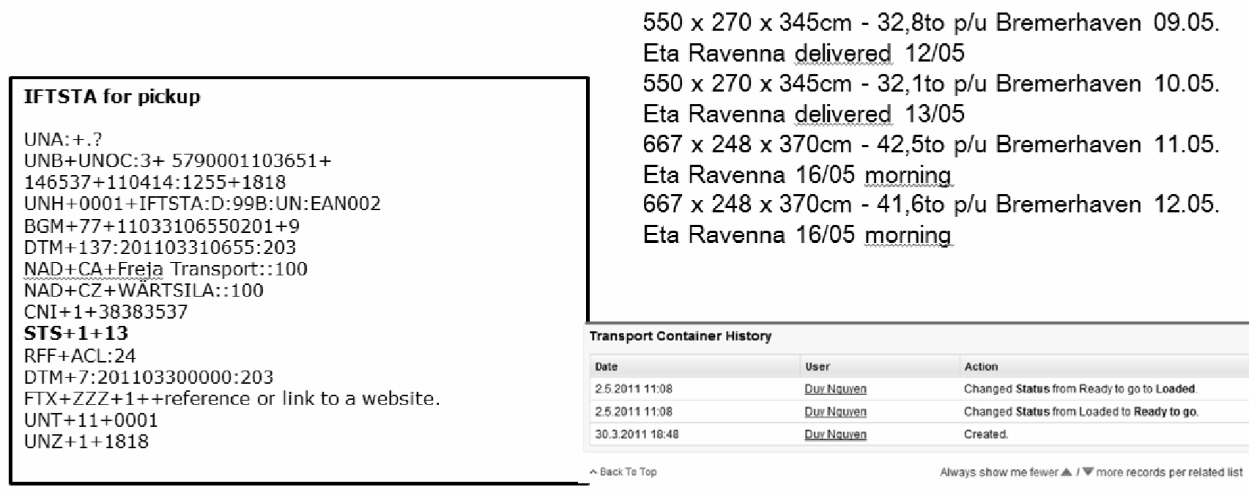


Figure 33: Example of EDI message sent by transporting company

20 Delayed in the course of transportation
Goods/consignments/equipment have been delayed in the course of transportation.

An example of an IFTSTA for delivery delayed

```
UNA:+.?
UNB+UNOC:3+ 5790001103651+
146537+110414:1255+1818
UNH+0001+IFTSTA:D:99B:UN:EAN002
BGM+77+11033106550201+9
DTM+137:201103310655:203
NAD+CA+Freja Transport::100
NAD+CZ+WÄRTSILA::100
CNI+1+38383537
STS+1+20
RFF+ACL:24
DTM+7:201103300000:203
FTX+ZZZ+1++delayed reference or link to a website.
UNT+11+0001
UNZ+1+1818
```

22 Delivery completed as per instruction
Delivery of the goods/consignments/equipment has been completed as per instruction.

An example of an IFTSTA for deliverd

```
UNA:+.?
UNB+UNOC:3+ 5790001103651+
146537+110414:1255+1818
UNH+0001+IFTSTA:D:99B:UN:EAN002
BGM+77+11033106550201+9
DTM+137:201103310655:203
NAD+CA+Freja Transport::100
NAD+CZ+WÄRTSILA::100
CNI+1+38383537
STS+1+22
RFF+ACL:24
DTM+7:201103300000:203
FTX+ZZZ+1++reference or link to a website.
UNT+11+0001
UNZ+1+1818
```

Figure 34: Example of delayed and delivery completed status messages

3.2.2 Outbound process

To understand more about outbound process, several real pilots have been conducted in LogTrack project. The main idea of LogTrack pilot projects is to verify the feasibility and benefits of a common Logistic ICT state of the art portal assessable to manufacturing, its suppliers, its transport partners as well as its customers. The portal is served as a common communication platform for all their production and logistics stakeholders. Therefore, information and data from different resources will be collected into the portal and accessible to the case company and its partners. In the inbound process, data is mainly involved with delivery or shipment information such as handling unit number, shipment number, delivery number, project name, purchasing order, while in the outbound process, the portal will mainly collect requisite tracking data such as ETA, location of each specific shipment at any specific time in real time, loading and unloading alert and time, temperature, shock and humidity.

In general, the outbound process is not as complicated as the inbound one, yet it plays an essential role in the whole logistics chain. Only the transporting company is involved in outbound process. When the equipment is pickup from consolation point or warehouse by the transporting company, its status is changed to “Loaded”. The equipment can be shipped either by truck or by vessel or by both. Tracking is always needed in this process (mostly for engines) as it is important to ensure that materials are shipped to the end-customer in a right time and at a right place. When shipments arrive to the end-customer, status is changed to “Received at end-customer”. Finally, tracking devices will be returned back to case company for future usage. The whole process is illustrated as below diagram.

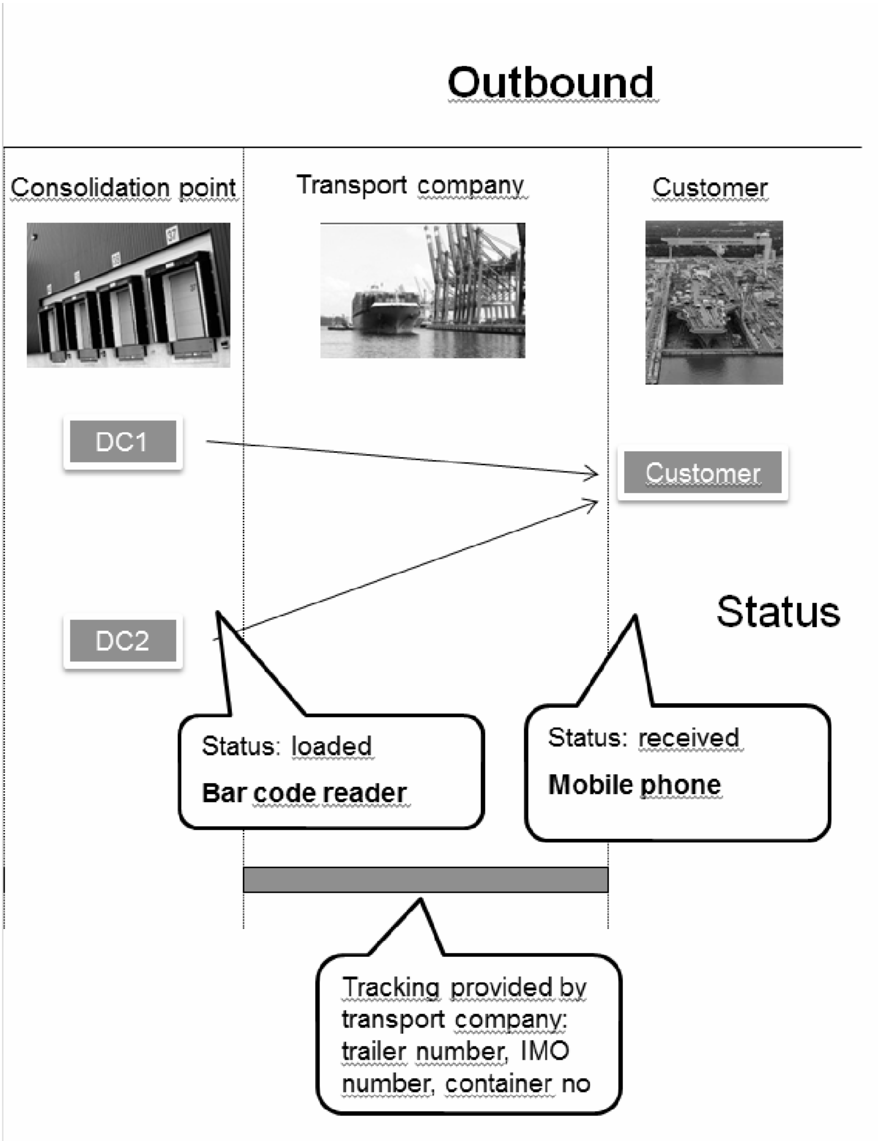


Figure 35: Vision of transparency of Outbound process

There are four pilot projects conducted throughout researching time, but this paper lists only two cases which are the most important in outbound process.

In the first pilot (the second one) which is a buildup or an improvement of pilot 1, engines and equipment are mainly shipped via truck. The complete route of this pilot is: from ABB warehouse (Vaasa) to Turku harbor by truck, to be shipped to Germany and continue via truck to Ravenna (Italy) (Figure 36).

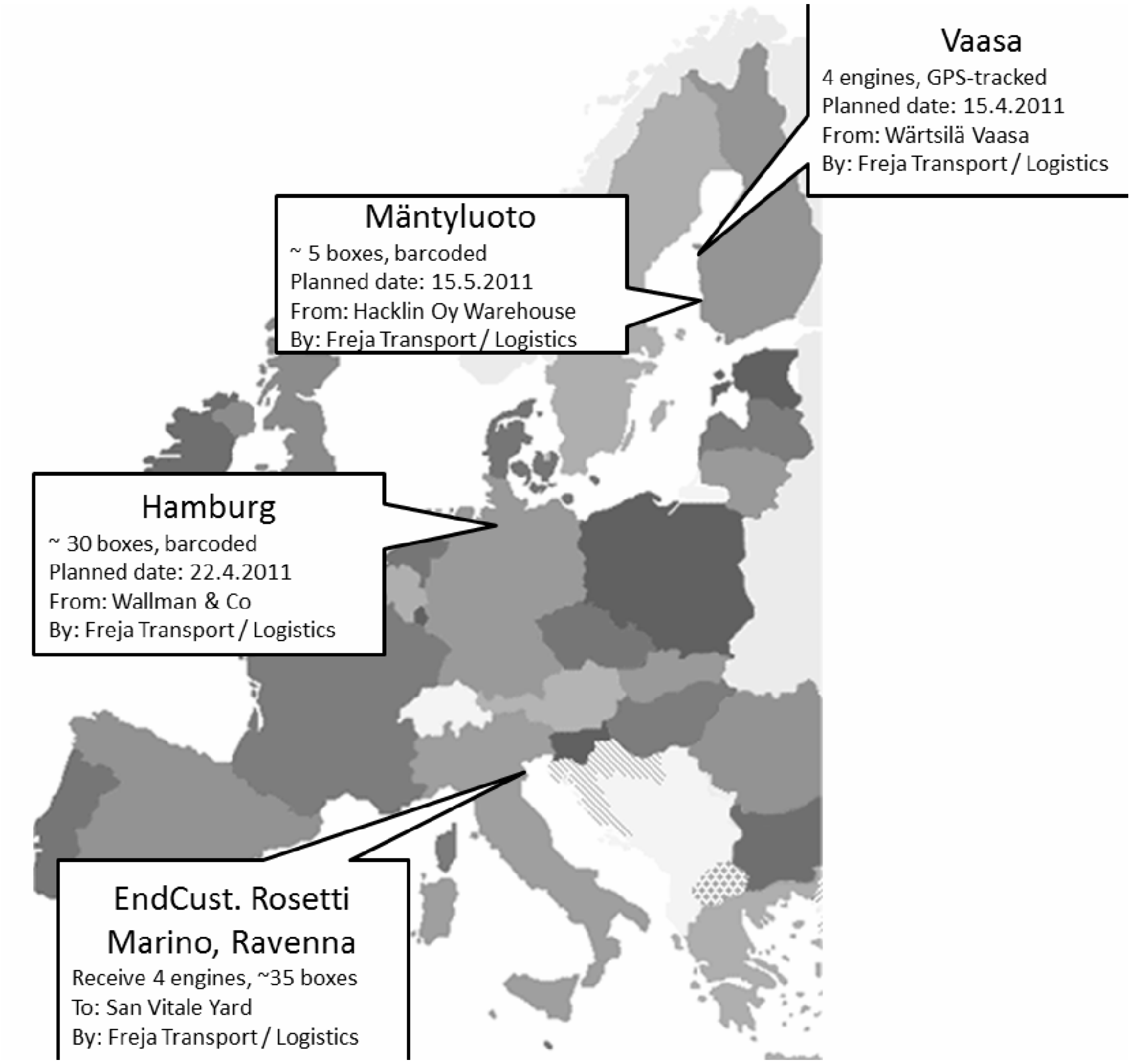


Figure 36: First outbound pilot project – Ravenna, Italy

In this pilot, the TINO trackers (basic model) were firstly tested in the field. TINO tracker is an improved tracking device and has more advanced functions than other ones used in the previous pilot project. The aim of this pilot is to test the feasibility of LogTrack portal as well as its functionalities. For example, several test cases were created to test both inbound and outbound process: case labels and packing lists for deliveries were created automatically by portal and then printed out and laminated and fixed on the boxes; shipment information was registered into portal by SAP integration software automatically; or the integration between Hacklin warehouse and the case company was also evaluated. Although it was recognized as a successful pilot, there were still many things need to be improved in the future ones such as battery life of the trackers, or the data transmission (SIM card) when sending shipment out of Finland.

In the second pilot (the fourth one), engines are shipped mainly by vessel. The complete route is: from manufacturing's factory (Onkilahti) by truck to Mäntyluoto harbour (for storage), by truck to Turku harbour and finally by vessel to Singapore (Figure 37).

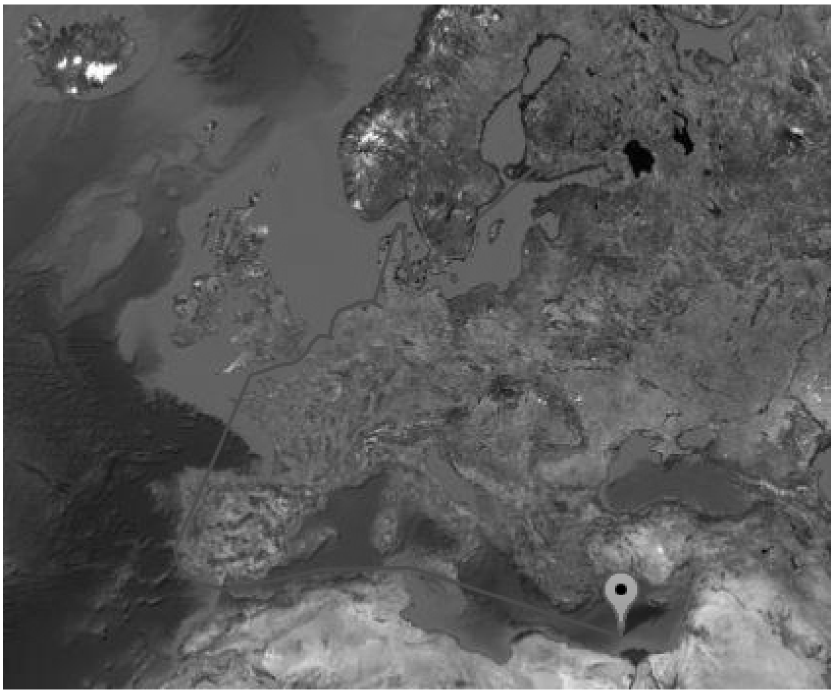


Figure 37: Second outbound pilot project – Singapore

In this pilot, TINO trackers (with extended battery) were used. It is the same tracker as in pilot 2, yet the battery life has been extended so that signal can be sent for a longer period of time (one month). The pilot 4 mainly focused on the outbound process. A new integrated tracker-AIS system was developed and firstly used to seamlessly combine location data from a tracker devices (when on land) and AIS ship tracking data (when on sea). A method of geo-fencing was implemented in portal to switch between sources of data: when a tracker device and a predefined vessel converge on the same geo-location (a harbor and a radius of 10 km around it) the tracking system will start using location data from the AIS tracking system instead of the tracker. When a ship arrives at a predefined destination harbor, the tracker will again become the main source of location data. (Figure 38)

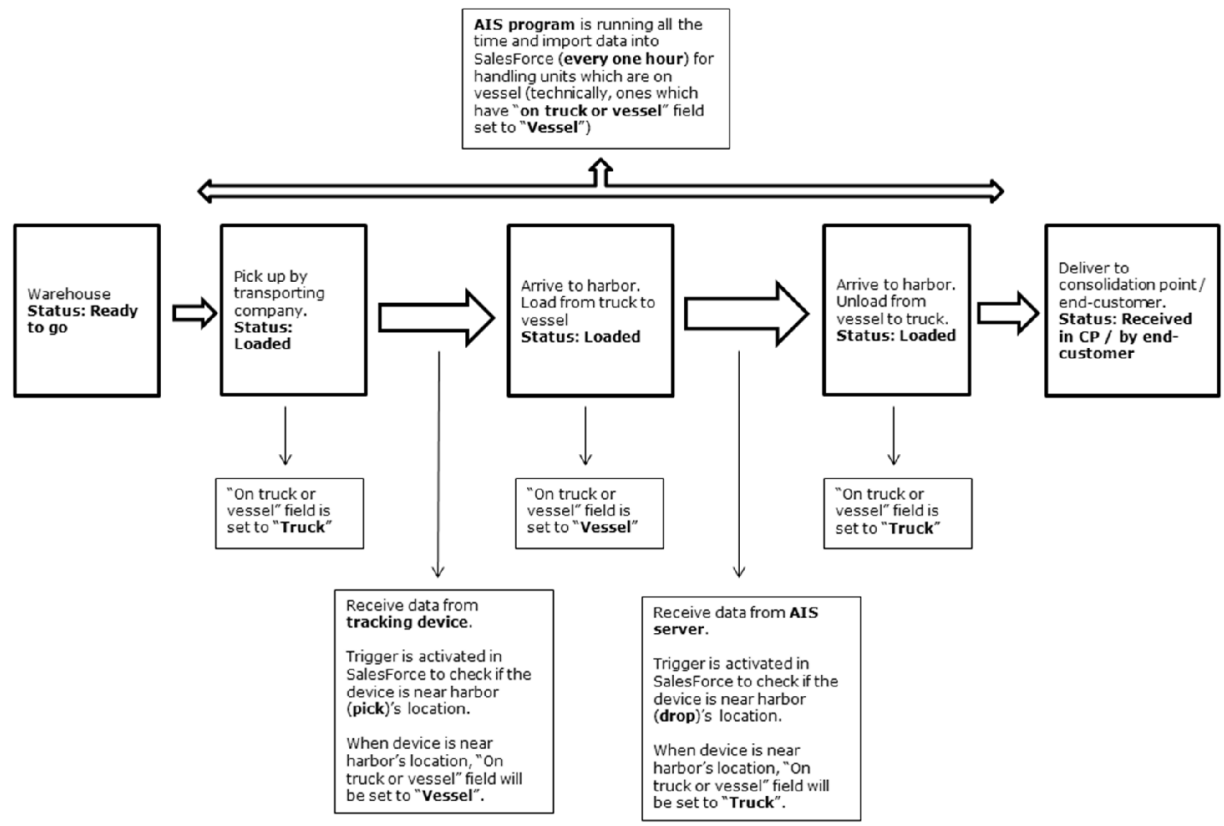


Figure 38: Technical data flow of AIS-LogTrack system

This pilot project was completed successfully. Fully outbound process has been evaluated and the result was very promising. For instance, the extended-battery trackers were able to transmit in excess of one month or the AIS ship-tracking system worked flawlessly, providing tracking data for the long period of time when GPS-tracker are shielded inside of the cargo hold. The automatic changeover between tracking device and AIS tracking system worked relatively well - the only issue was that the IMO-number (identification) of the ship could not be automatically inserted into the system (since not being shipped from the EDI-connected Hacklin warehouse) and thus had to be manually inputted for the AIS tracking system to work correctly.

3.3 Interconnectivity of EDI and ERP systems

In logistics industry, various requirements specifications need to be considered for tracking the delivery shipments. It involves both inbound and outbound in term of logistics and supply chain management. Especially, in the inbound logistics where various documents have to be exchanged between the company and trading partners, the use of EDI and ERP systems can help company handle the process faster, more efficiency and reduce errors of manual data entry as well as labor processing costs (Mrkonjic, 2007). An EDI transaction between two trading partners involves many components:

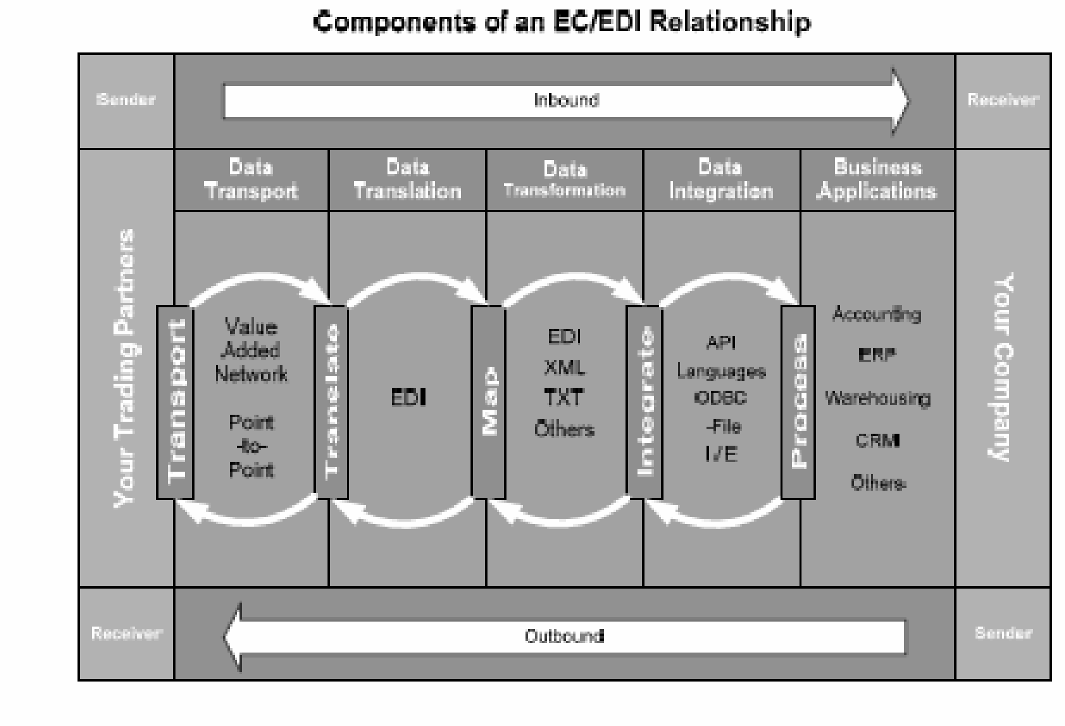


Figure 39: Components of an EC/EDI relationship (Mrkonjic, 2007)

Data transport

In data transport process, electronic files are transferred from trading partners / suppliers to the main industrial manufacturer and vice versa. There are many ways to implement this process, but following are the 2 most common protocols used for this transmission:

- File transfer protocol (FTP): is a standard network protocol used to transfer files between different computers. File transfer protocol secure (FTPs) can be used to enhance the security between partners.
- Hypertext transfer protocol (HTTP): is similar to FTP, but instead of transferring the whole file, the file will be converted to hypertext, encrypted and posted to the web server. Hypertext transfer protocol secure (HTTPs) is recommended to use to avoid eavesdropping and increase security.

Data translation

EDI data will be meaningless or hard to understand if there is no translator. Data translation is the process in which EDI message is interpreted and evaluated. It ensures that the data is matched to EDI standards (X.12 or EDIFACT). Additionally, it also performs checks and balances before data reaches the intended business application. Following functions can be performed by an EDI translator: compliance checking, control number checking, trading partner management, tracking and auditing, and document repository.

Data transformation

EDI message receiving from trading partner has to go through EDI transformation where the message is interpreted, analyzed and mapped to ERP system. Following figure illustrates how mapping can be done:

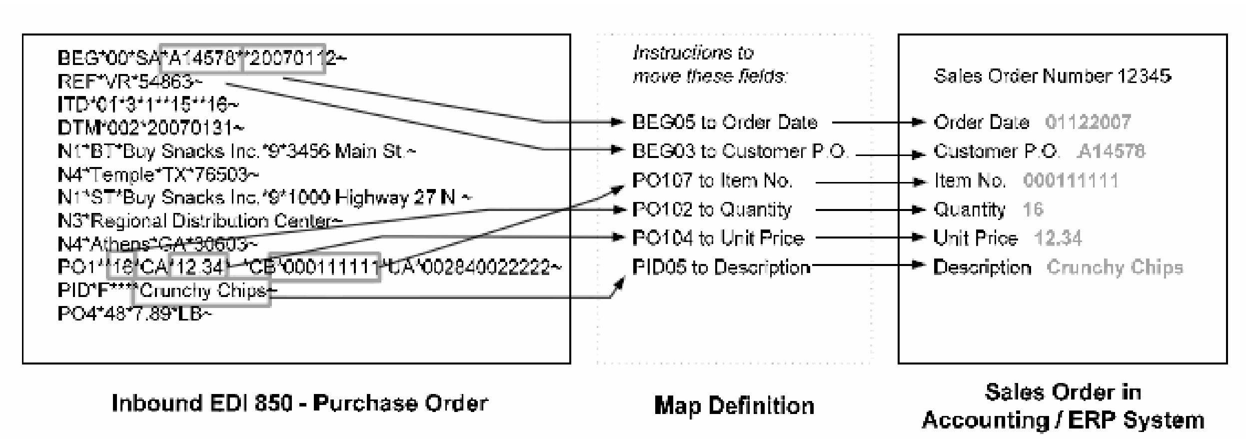


Figure 40: Mapping example between EDI and ERP systems

If the manufacturer/supplier is new to EDI-ERP and reluctant to establish EDI-ERP integration due to lacking of resources, overwhelming and complexity, they can outsource the implementation to web container / portal. For example, the supplier / transportation company can outsource their EDI operation and subscribe to a web EDI service, and the manufacturer can export data to the portal where its customers and suppliers have access. However, there are certain factors which the company has to take into consideration when outsourcing, such as security risks and cost for paying the service.

Data integration

The following diagram shows how the integration process works using a doorway analogy:

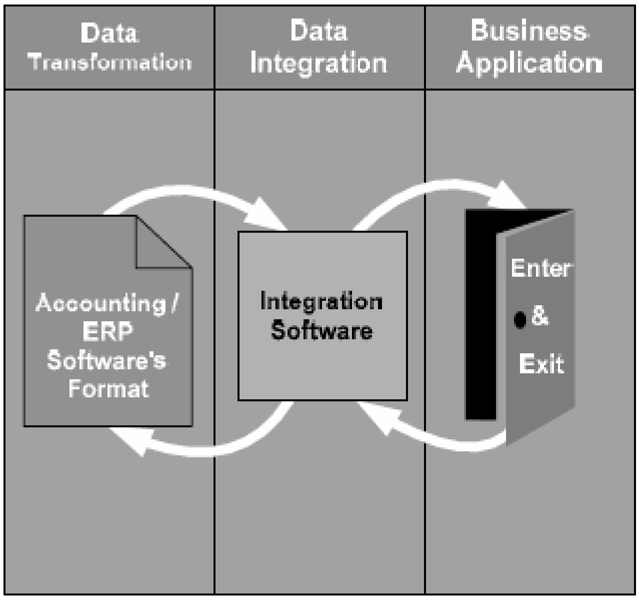


Figure 41: How integrating EDI works

Typically, there are two ways the integration software communicates with ERP application:

1) The ERP application interacts with the integration software directly through the" door"

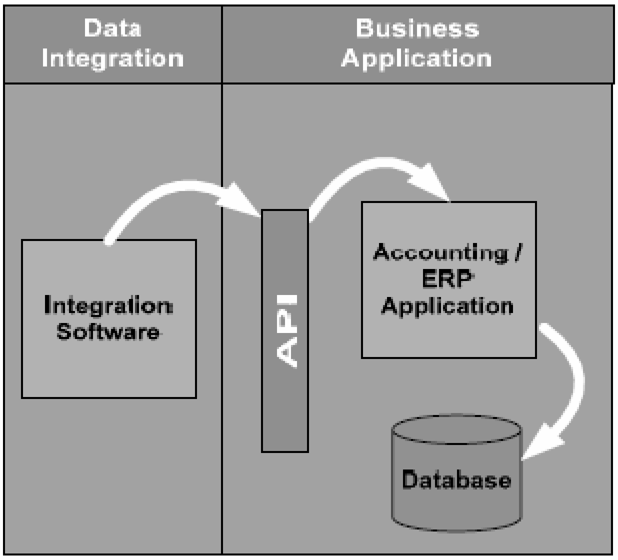
2) The ERP application interacts with the transaction which is handed-off by the integration software at the "door".

It depends on the ERP software to define which approach should be used because some ERP systems accept an EDI transaction in its raw format, but some do not.

There are different methods describing how EDI is integrated with ERP system:

Method 1: Application Program Interface (API)

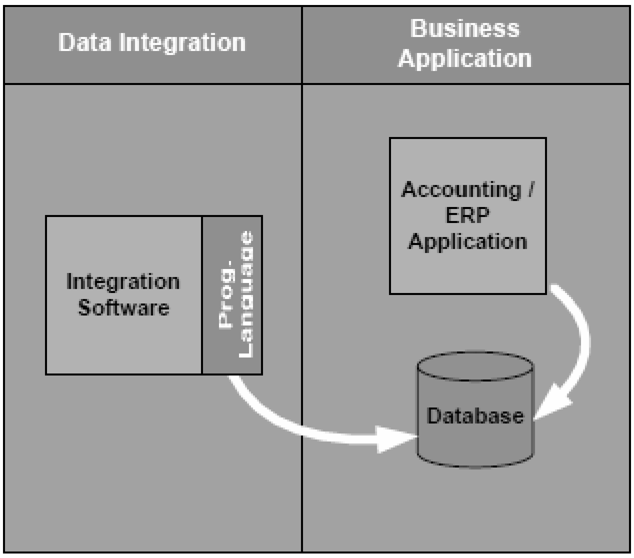
The integration can read and write data to ERP system's database by utilizing the API provided by ERP software. For example, the integration software can "call" the API and pass the data to the ERP software. If the data is invalid, the API will not allow the data to be written to the database and an error message will be returned to the integration software.



Method 1: Application Program Interface

Method 2: Programming Languages

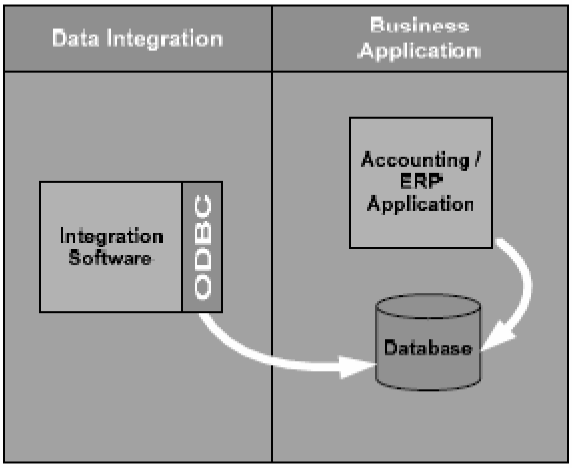
Integration software can work directly with ERP system's database by using Software Developer's Kit (SDK) provided by ERP software. SDK is a set of software development tools which helps developers to implement application to communicate with target system using their own programming language. Following are examples of languages used by the integration software vendors: ProvideX, Dexterity, C/Front, SQL.



Method 2: Programming Languages

Method 3: Open Database Connectivity (ODBC)

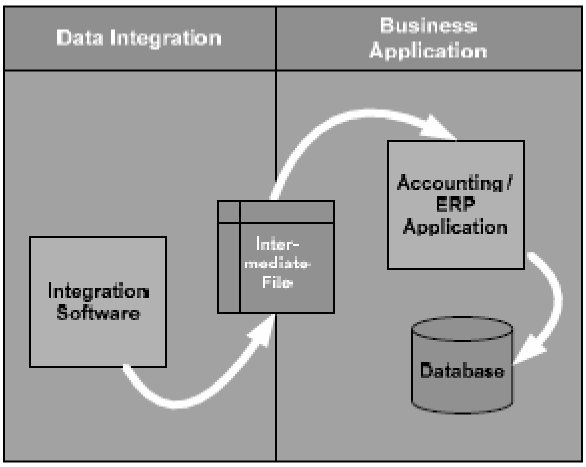
This method is a combination of an API (method #1) and SQL (method #2). By the use of ODBC, the ERP software is bypassed and the integration software communicates with the database directly to read and write data.



Method 3: ODBC

Method 4: Intermediate File

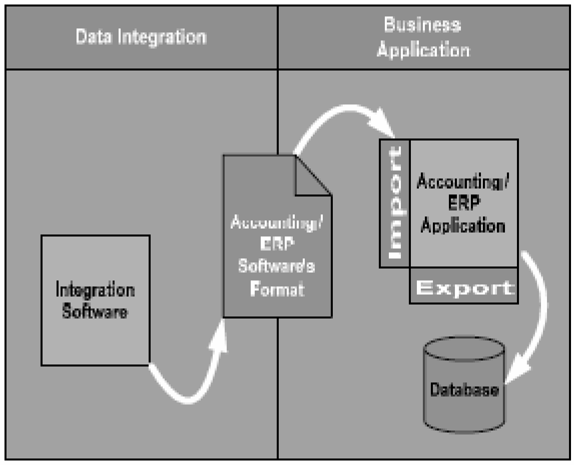
In this method, an EDI transaction will be translated to a format specified by the ERP software and then an intermediate file will be created on the server. The ERP software will "poll" the server periodically to check if there is any new transaction / text files in waiting. If so, a process is initiated to import those transactions / text files into the ERP software. The ERP software will process the file and read/write data to database or reject and return errors if the file is invalid. The process is automated without the need for a user to interfere.



Method 4: Intermediate File

Method 5: Import / Export (I / E)

In this method, a predefined formatted text file which is mapped from an EDI transaction by the integration software will be imported into the ERP software for processing. A user must log in to ERP system and choose "Import" function from the application interface and select the file to be imported. The export function is opposite of the import one in that it takes data from the database and writes it to text file.



Method 5: Import / Export

In LogTrack project, it was aimed to establish the connection between Freja and the manufacturing. Freja is a transportation company and has its own EDI system. The main target is to integrate this EDI system with company's ERP system. A mediate system has been developed and acts as a bridge between these systems. In other words, data collected from company's ERP system will be transferred to the mediate system, and then transfer to Freja's EDI system. And vice versa, information will be transmitted back from Freja to mediate system and then to the global manufacturing. The data flow can be illustrated as following diagram:

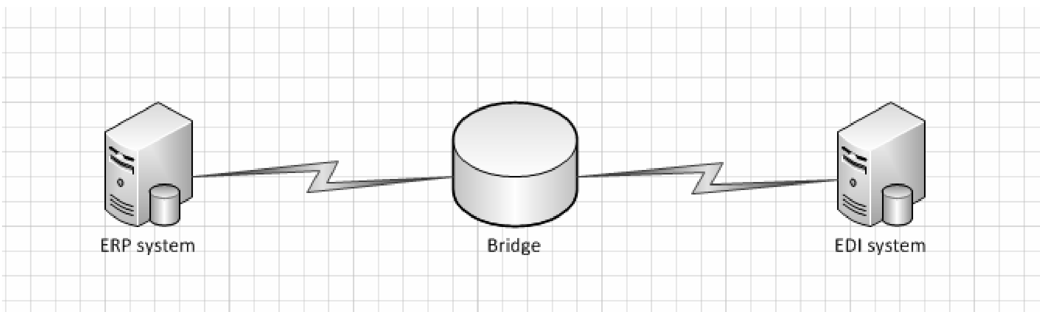


Figure 42: Data flows between EDI and ERP systems

There are many reasons why Freja's EDI system cannot be integrated directly to the case company's ERP system. One of them is security. The company's IT infrastructure is big and complicated. Hence, it is not easy and recommended to expose company's intranet network to Freja's network. Another reason is the feasibility. Both Freja's EDI and company's ERP systems have been developed for quite a long time and they all play a vital part in their business operation. Therefore, it is not easy to change any small part in the system and even though it is possible to do so, it will require much effort and time to implement that. As a result, a mediate system, so-called LogTrack portal, has been developed to solve this problem. As explained earlier, LogTrack portal is a set of software applications. Some of them are deployed to SalesForce which is a cloud computing platform, while the others are installed on an independent IBM server located in the case company's intranet network. The section 4 will explain each component separately as well as its implementation and its role in the whole integration.

4. RESULTS AND DISCUSSION

The communication platform is built on different technologies such as MS SQL server, .NET Framework, International Maritime Organizations (IMO) services, Automatic Identification System (AIS), FTP server, and so on. This integration will seamlessly provide effective and efficient data exchange amongst industrial system of the manufacturer and its suppliers and customers in the supply chain network (Addo-Tenkorang et al., 2012). Figure 43 illustrate a possible architecture of the entire supply chain management system where EDI is a part of supplier's system and ERP is located within the main industrial company. For other suppliers and customers who do not have interface information system, they can access data and the integrated system through portal on the internet.

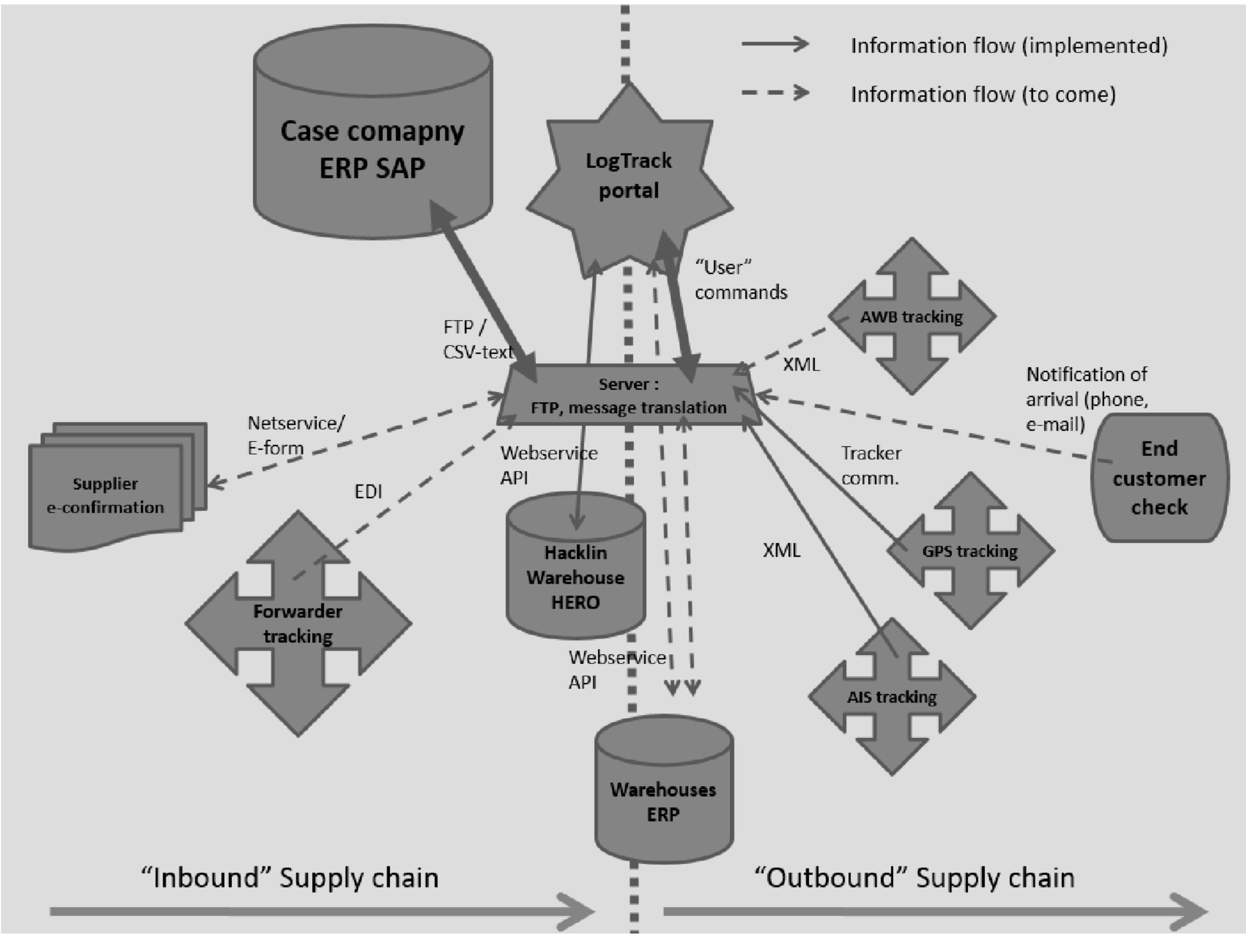


Figure 43: The architecture of industrial manufacturer SCM interfaces

The whole integration contains many software and components. Following is the list of major ones developed in this integration chain:

- LogTrack Portal: a cloud-computing platform developed in SalesForce. This is the most important component in the integration. It is considered as a central server which is integrated with different systems to receive and combine data from different sources and then provide access to data for the case company and its partners. Most of the business operations are implemented in the portal, such as functions to create case label, packing list, way bill or functions to find missing shipments, or to list history routes of shipments, etc…
- Portal-SAP integration: written in C#-programming language to help case company's managers to import SAP data to portal. Data are exported into CSV files by SAP software. The program will pick up the files automatically and import its content to portal.

- Portal-AIS integration: written in C#-programming language as one part of the outbound tracking process. The program will be automatically activated when materials are shipped via vessel. Data is collected from AIS feed live hub and imported to portal.
- Portal-Tracker integration: written in C#-programming language as the other part of the outbound tracking process. Data is collected from TINO tracking devices (or any trackers via TCP protocol) and then imported to portal.
- Portal-EDI integration: includes a small FTP client written in JAVA-programming language. Its aim is to receive/transport FTP message from/to Freja's EDI system.

The following diagram illustrates how these components interact with each other:

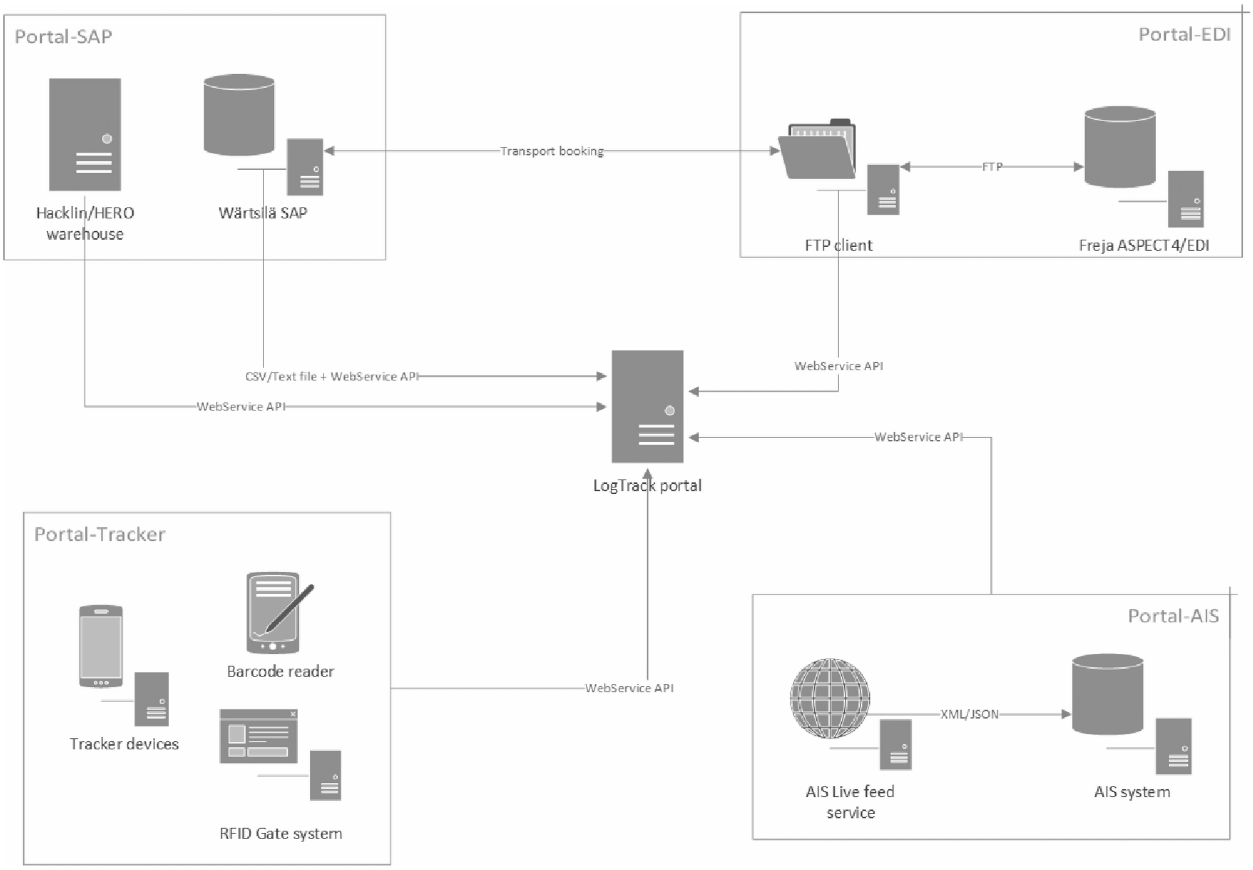


Figure 44: Major data flow of the whole integration chain

4.1 Portal-EDI integration

As it has been mentioned in section 3.3, in the data transport process of ERP-EDI relationship, electronic files are transferred from trading partners / suppliers to main industrial manufacturer and vice versa via either FTP or HTTP protocol. We have used FTP protocol in this researching project because it is the recommended one and has been already applied in Freja transporting company. The program works as following:

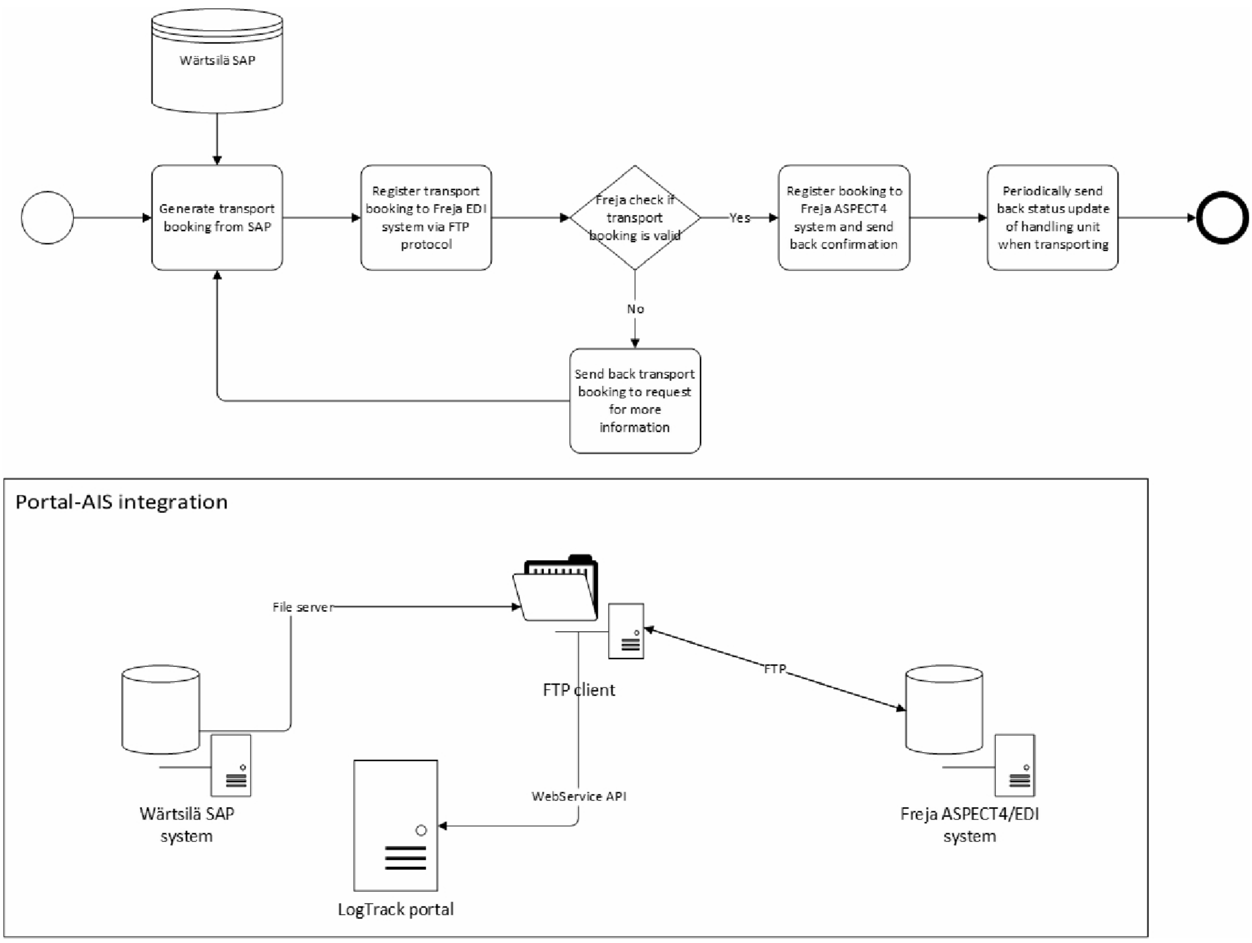


Figure 45: Data flow of Portal-EDI integration

In order to receive the status update from Freja via EDI/FTP, the transport booking has to be also registered via EDI/FTP. Previously, the transport booking is sent via email to the transporting company and data is manually entered into their system after receiving the information. The process has been improved so that the transport booking will be created in Excel and then converted to XML file which will be sent to Freja EDI system via FTP client software. The software is also responsible for receiving status update back from Freja when components are shipped via truck. Upon receiving message status from Freja, the FTP client will push that information to LogTrack Portal for post-processing.

During the course of LogTrack project, Freja has been selected as the main inbound transport company. It has been agreed that Freja transport will send updated for handling units through exchange of standardized XML files to the tracking portal (via FTP client). The status messages will alert Goods Loaded / Offloaded, mainly, but actual location (coordinate) updates could probably be implemented in addition, at a later stage. Below is one example of encoded message (in UN EDIFACT standard format):

```
UNA:+.?
UNB+UNOC:3+ 5790001103651+ 146537+110414:1255+1818
UNH+0001+IFTSTA:D:99B:UN:EAN002
BGM+77+11033106550201+9
DTM+137:201103310655:203
NAD+CA+Freja Transport::100
NAD+CZ+WÄRTSILA::100
CNI+1+38383537
*STS+1+13*
RFF+ACL:24
DTM+7:201103300000:203
FTX+ZZZ+1++reference or link to a website.
UNT+11+0001
UNZ+1+1818
```

Figure 46: EDI messaging example

The letter codes are standardized – the relevant lines are DTM (time stamp) and STS + Code.

- STS+13 means collected
- STS+21 means passed on to the next one in the delivery chain.
- STS+22 means delivery completed as per booking instructions.

Other lines stand for carrier, consignor, consignment information, free text, etc. The free text line could for instance be used to transmit coordinate data of the deliveries on an hourly basis.

4.2 Portal-Tracker integration

The integration is used mostly in outbound process. The integration can also be used in inbound process, yet it is more beneficial and efficient to track engines and big components within outbound process. Below diagram illustrates how data is transferred in this integration:

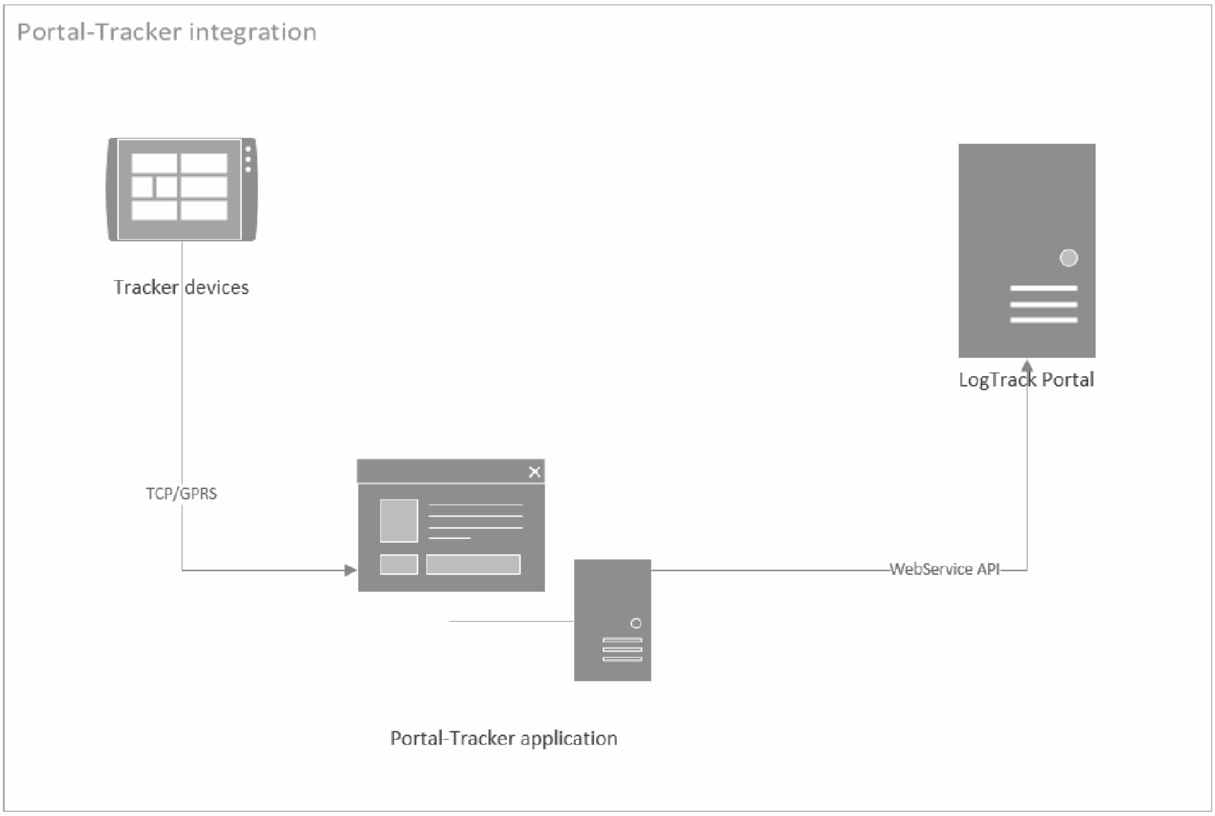
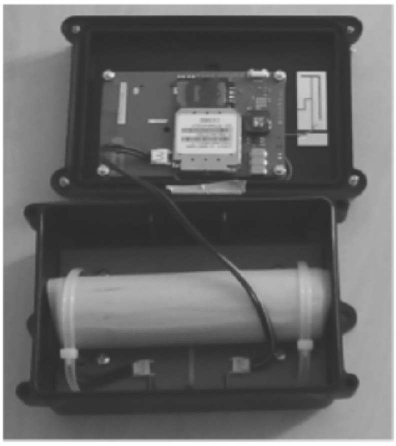


Figure 47: Data flow of Portal-Tracker integration

In order to know exactly where a certain handling unit is located, we have to leverage the advantage of Global Positioning System (GPS) and General Packet Radio Service (GPRS) technologies. Technically, a GPS/GPRS tracking device can produce location data accurate to within few hundred meters and transmits this information in real-time to a specific server. By attaching these devices to shipments, managers will be capable of tracking and tracing these shipments throughout the whole supply chain.

During the course of the LogTrack project several types of GPS trackers were tested under different circumstances to provide a better understanding of their possibilities and weaknesses, and to provide a reasonable hardware recommendation for future implementation projects. Following is the list of GPS-tracker models which have been testing in actual pilots:

Model Name	Picture	Possibilities and Weaknesses
GS902B Tracker		This tracker is manufactured in China and is intended for use in a personal vehicle. The GPS signal is quite good, yet a big external battery is needed because it consumes pretty much energy (no hibernate/sleeping option when standing still).
WAPICE Tracker		The tracker is provided by Wapice Ltd. It offers quite many possibilities because of its high complexity. In practice, it can work with different kind of input devices – measure temperature, humidity, shocks, acceleration etc. – according to the needs of user. However, there still problem with power consumption because of its constant operation.
TINO Tracker		The tracker is produced by a German company and is considered the most “professional” one. It is used commonly in Freja transports. The first testing unit comes with internal batteries (6xAA) and has ability to activate power saving mode when not moving. The device is capable of transmitting location, speed and temperature.
TINO Tracker (with solar panel add-on pack)		This tracker is the same as previous TINO tracker. Yet, the battery life has been extended with a solar panel add-on pack (include a solar panel and a rechargeable lithium battery). The idea is to have the tracking device attached to the top of product where the solar panel can recharge the battery during the day. The

		prototype has been proved to work but not as expected. It can extend the battery life, but not much.
TINO Tracker (with extended battery life)		The tracker is also identical to the basic model, except that the six AA batteries are replaced with one Tadiran DD battery (non-rechargeable). This external battery is extremely powerful and can help the tracking device to operate more than one month. Although the prototype is promising as it is considered the most successful tested device, it is still not very economical because switching these batteries for new ones is fairly expensive and not easy.

Additionally, a checkpoint system of tracking has been also developed during this integration. Product tracking does not necessarily mean that users have to know exactly where the product is at that time. Often it is enough to know where the handling unit was last time and who was last made responsible for the handling unit, especially in the inbound supply chain, of which time spans spent on transport are relatively short. The inbound supply chain of the case company is usually quite simple – handling units are collected from different places by suppliers and then transported to a central consolidation warehouses.

However, although the supply chain is simple, it can still take an industrial manager several hours to call around to track the missing handling unit. A check point system, whereby a handling unit's current status would be updated whenever it passes through a certain location or involved party, would allow the manager to quickly locate where a box is or was last time.

A summary of the checkpoint system is presented in below diagram:

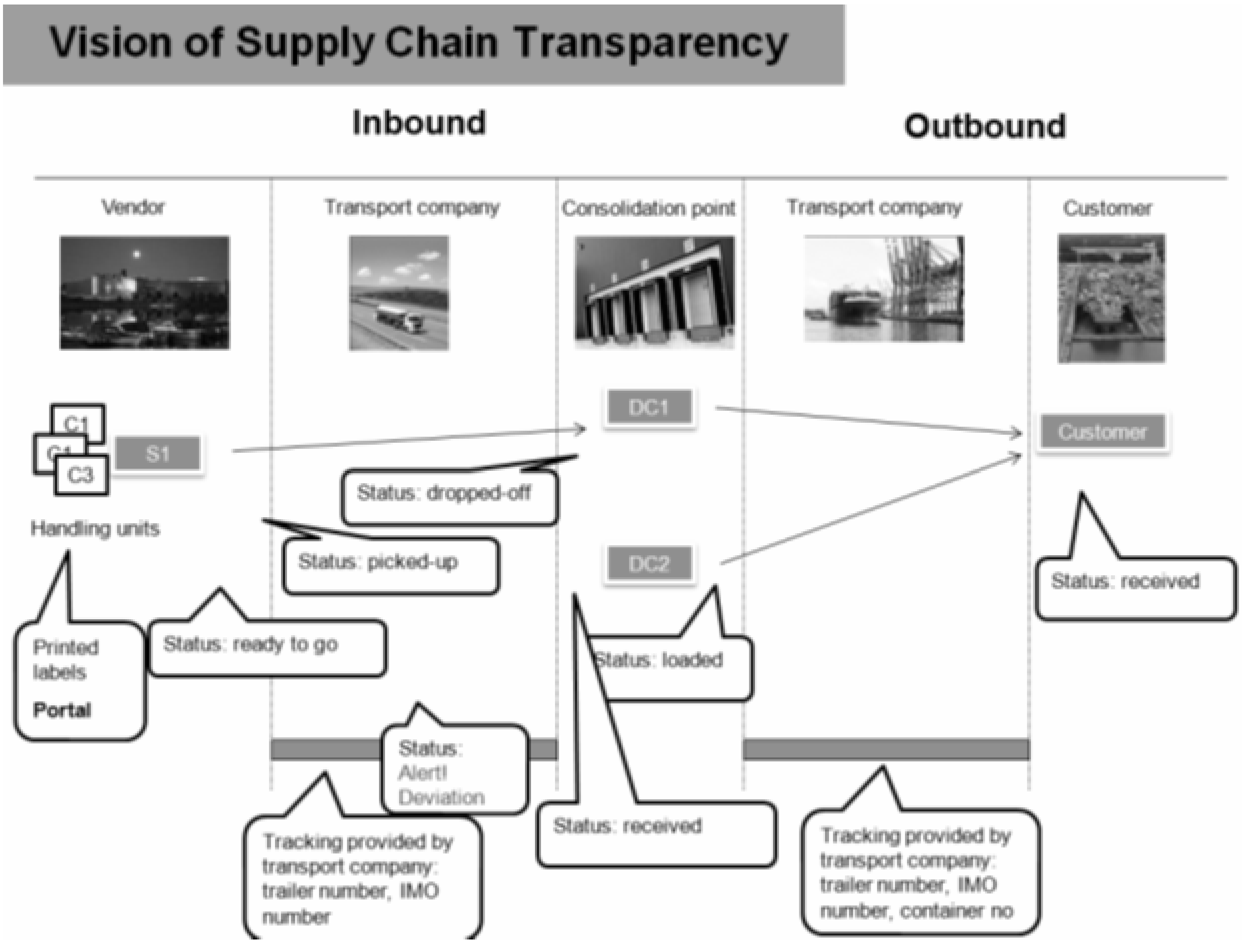


Figure 48: Checkpoint tracking system

Typically, there are six different checkpoints through which case company's handling units can possibly pass:

1. *Ready at the supplier:* This status would coincide with transport booking - when supplier is ready to order a transport (usually one or two days before pick-up), the tracking system would receive notice at the same time as the transport company is notified.

2. *Picked up at supplier:* The tracking system would receive notification about this status when handling units are picked up by the transporting company. Since the main inbound transport company (Freja) used by the global manufacturing has already implemented a telemetric tracking system of their own (weight sensors on the truck axles register changes on pick-up), they could automatically provide notification of goods received. Another alternative is to use the mobile tracking software which has been developed in the early phase of project. The main purpose of this software is to enable engineer ability to manually change status of handling units.

(2.5) The transport company might also provide actual location data from the tracking devices on their truck if available. Information can be registered via EDI/FTP protocol. This integration will be the target for future improvements.

3. *Delivered at consolidation warehouse:* notification is provided upon dropping off at the consolidation warehouse. The notice of this status can be provided by either transporting company through their truck telemetry system or by engineers who update the handling units' status manually through mobile tracking software.

4. *"Accepted" at consolidation warehouse:* This step is a formal repeat of the former, but more accurate, as individual boxes are accepted into the consolidation warehouse's own inventory system, correct down to the single handling unit.

5. *Leaving consolidation warehouse:* when a truck or a vessel is picking up the shipment for outbound delivery, the consolation warehouse inventory system (Hacklin warehouse/HERO) would provide a status update, coupled with identifying data about the outbound carrier such as ship number, truck number, and container number. This information is registered directly to LogTrack portal through WebService protocol.

(5.5) If a tracker device is included inside the shipment, it will provide location data for the shipment as long as it is on land and GPS/GPRS signal is available. When shipment is on board of vessel, location data will be provided through an AIS system (see "Portal-AIS integration" section for more information)

6. *Arrived at final destination:* When a shipment finally arrives at the end customer, the customer will make the final confirmation of goods received. Once this happens, the final status update can be entered manually to "close" the shipment. In the future an electronic "sign-over" method could be developed to formalize goods received intact and complete.

4.3 Portal-AIS integration

This integration is used together with Portal-Tracker integration. The integration is also mostly used in the outbound process. The whole integration works as following:

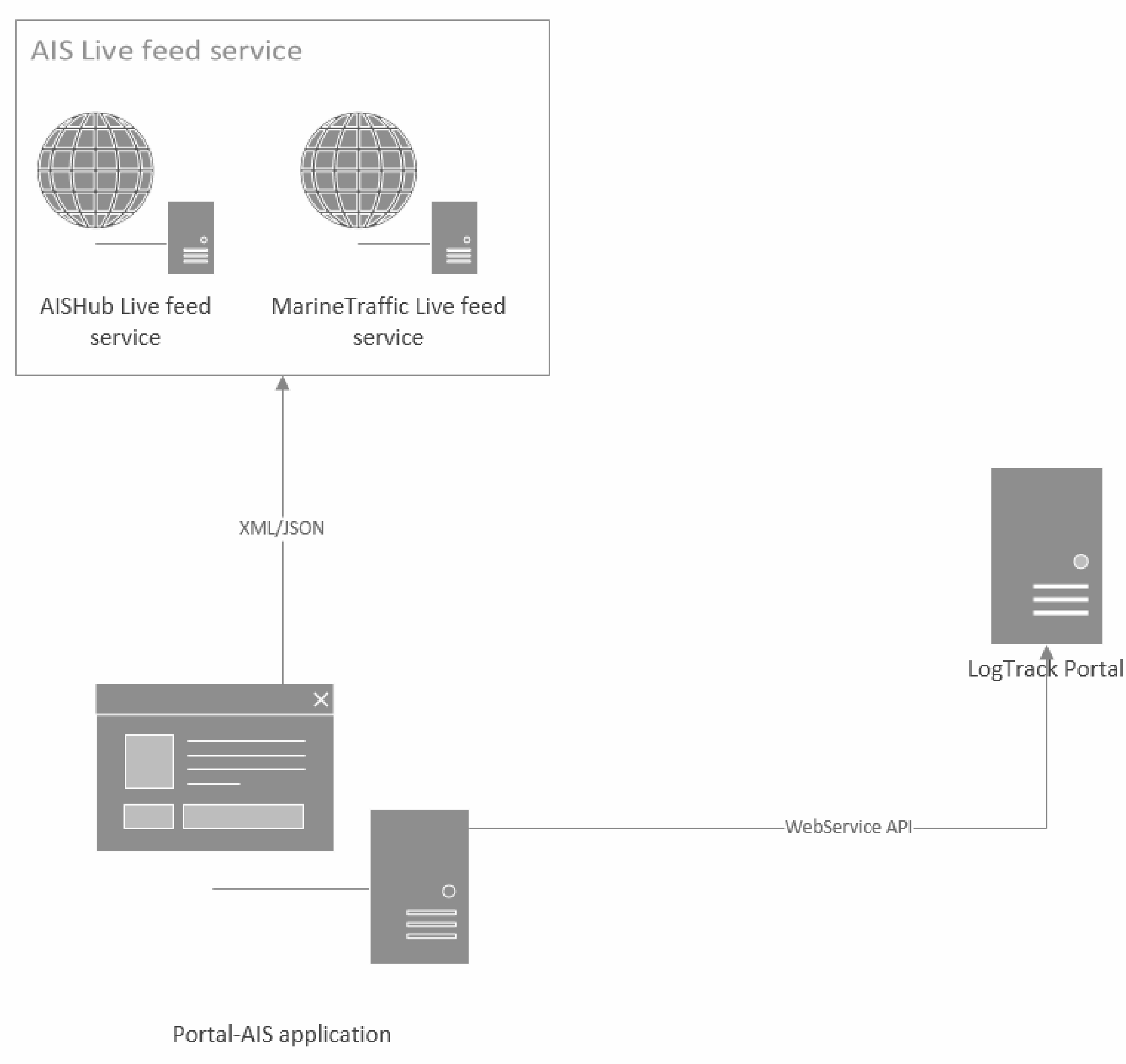


Figure 49: Data flow of Portal-AIS integration

Early on in the researching project, the problem of sea transport became obvious because tracking devices do not function inside a ship or metal container (no GPS/GPRS contact). In order to support for sea tracking, an AIS integration system has been developed to cover the gap in the tracking chain. Data will be fetched from an AIS live feed such as AISHub every hour and imported to LogTrack portal to allow the portal to use this location data to track relevant ships on the basis of ship ID / IMO number (provided by consolidation warehouse or transporter). This ship location service will complement the use of tracker devices (for land transports) to achieve a very wide goods tracking coverage.

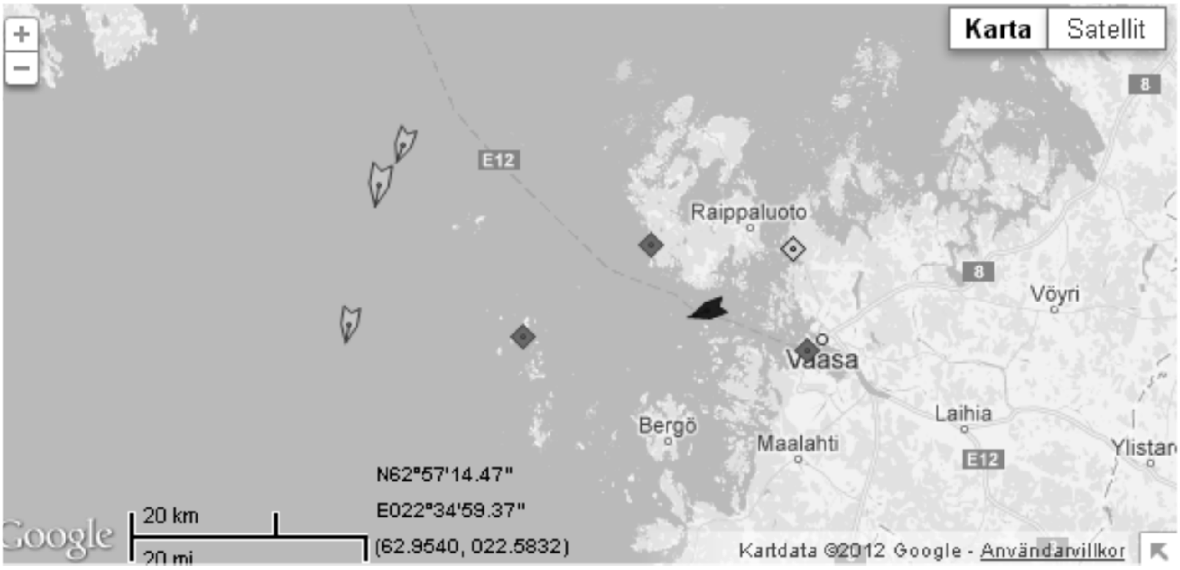


Figure 50: AIS ship-tracking service (Marinetraffic.com)

Data is downloaded in either XML or JSON format via web service protocol. The web service URL of AISHub is accessible at:

http://data.aishub.net/ws.php?username=A&format=B&output=C&compress=D&latmin=E&latmax=F&lonmin=G&lonmax=H&mmsi=I&imo=J

Where:

- A: AISHub username, provided by AIS Hub administrator
- B: format of data values (0 – AIS encoding, 1 – Human readable format)
- C: output format (xml or json)
- D: compression (0 – no compression, 1- ZIP format, 2 - GZIP)
- E: South latitude
- F: North latitude
- G: West longitude
- H: East longitude
- I: MMSI number (web service returns data for the requested vessel only)
- J: IMO number (web service returns data for the requested vessel only)

For example, in order to download all data for vessel (MMSI=123456789) in json format without compression and encoding, the AIS integration software will trigger the following url:

http://data.aishub.net/ws.php?username=USERNAME&format=1&output=json&compress=0&mmsi=123456789

Following is one example of returned data in human-readable format:

Human-readable format (B=1)

```
vessel MMSI="413811000"  TIME="2011-04-12 10:40:27 GMT"  LONGITUDE="118.44586666667"
 LATITUDE="38.874833333333"  COG="356"  SOG="0.1"  HEADING="116"  NAVSTAT="1"  IMO="9118824"  NAME="JIN
HAI XIANG"  CALLSIGN="BVKU"  TYPE="70"  A="197"  B="27"  C="20"  D="12"  DRAUGHT="7.5"
 DEST="CAOFEIDIAN"  ETA="04-10 07:00"
```

Although the integration helps to enhance the tracking coverage of manufacturing quite a lots, there is still some limitation because of poor AISHub coverage comparing to other sites such as MarineTraffic (Figure 51 & 52). The future target for this integration will be to combine AIS data of both sites to improve the tracking coverage much more.

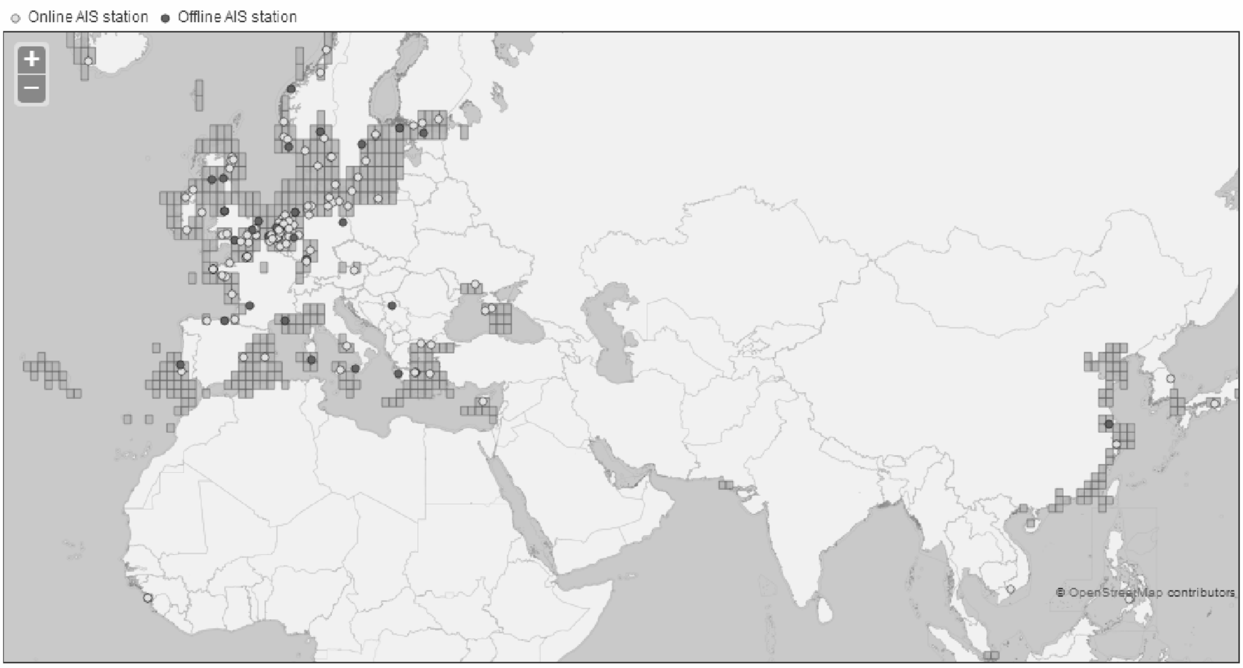


Figure 51: AISHub coverage

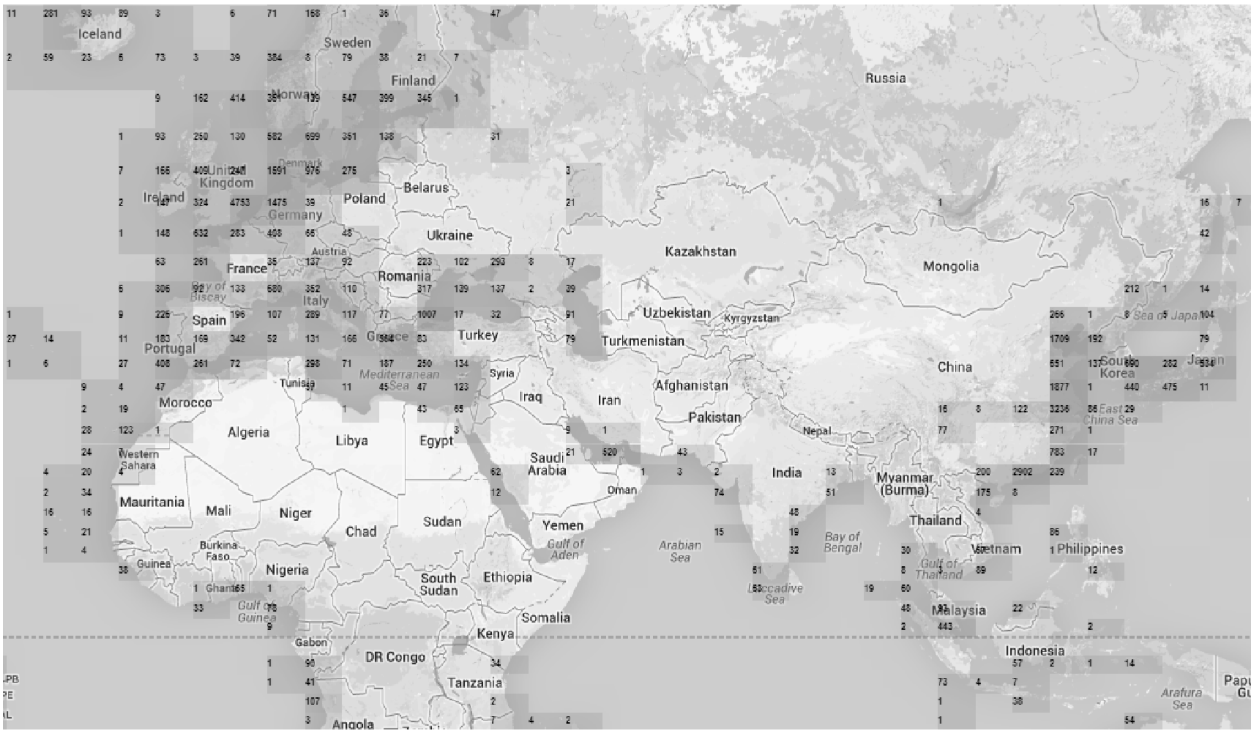


Figure 52: MarineTraffic coverage

4.4 Portal-SAP integration

This integration places an essential role in the inbound traffic. The integration helps to integrate tracking data from different ERP systems (case company's own and Consolidation warehouses) to LogTrack portal. Below is the data flow of Portal-SAP integration in general:

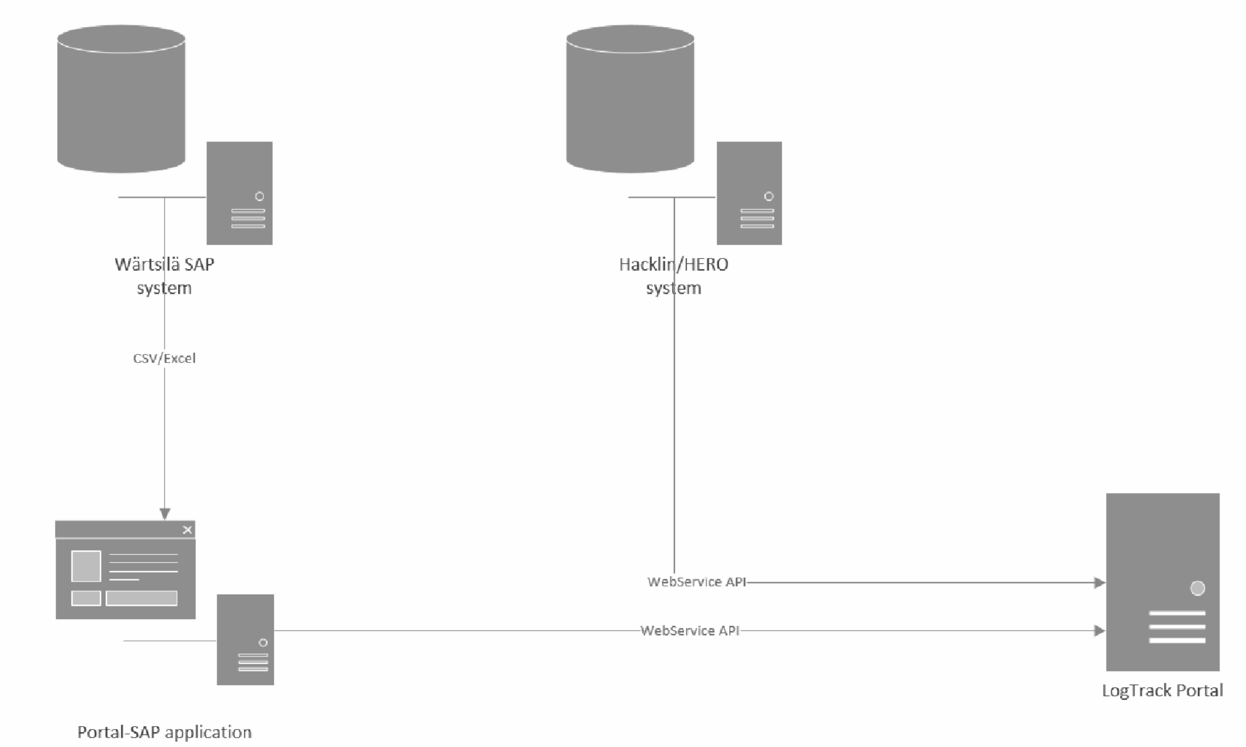


Figure 53: Data flow of Portal-SAP integration

The case company's SAP system contains much of the data necessary for running of the tracking portal (Handling unit numbers, project numbers, shipment data, delivery numbers and names, final destinations, etc.). This data must be integrated with the portal in order to keep both systems coordinated. HUs are the basic unit of tracking – without HU, tracking and status change data from other companies and sources are not linked correctly.

This data is exchanged with the tracking portal via daily web service interchange (on the basic of shared custom CSV / Excel files, exported from SAP and imported to portal automatically). In order to achieve this, a C# program has been developed. Technically, purchase orders and shipment information will be exported manually by the case company's managers from SAP or automatically by Excel Macro. CSV files will be then copied to the server where C# program is running. When new files are copied there, the software will parse the data and import it to portal. Below is one example of CSV file which will be parsed and imported to tracking portal:

Shipment	TPPt	External ID 2	External ID 1	Descrip.of Shipment		
55637	FI04	100054527	SP/91611	Thursters		
Picked items locat.	Purch.Doc.	Delivery	Handling Unit	SU	Description	
		6481472	1001587094	PC	Test123	
HU identification 2	Loading weight	Total Weight	Un.	Height	Width	
	15.445	15.touko	KG	325	255	
Length	Unit of dimension	CoD	Point of departure	DepPnt	Overall transportation status	Departure Point
390	CM	CN	Shanghai	SHANGHAI	Shipment end	Shanghai
Suppl. 1	Suppl. 2	Addit.text 1	Container ID	ServcAgent	External Delivery ID	
MAIN	MSA001	sent input to Freja 14.6/planned missing		87353	SP/91611 - 100054527	
Ship-To Pt	Unloading Point	DepPstlCde	DC	DestPstlCd		
54943		200082	AE			
Destination	Departure: Unloading pnt	Destination: Unload.point	DestinAddr	Dest.point	DestLoadPt	
Dubai						
VendorDest	IncTm	Addit.text 4	Addit.text 3			
	CIF	EXW date: 30.6.2011	Lamprell LEL/10/102			
ActShipEnd	PlanShipEn	CurrShipSt	PlanShipSt	ShpCmplDte	Sh	
23.7.2011	23.7.2011	8.7.2011	8.7.2011	14.6.2011	8	
CurrShipSt	ActShipEnd	PlShptCmpl	Suppl. 3	Suppl. 4	Addit.text 2	
00.00.0000	00.00.0000	14.6.2011			LC ok, LDS 31.7.2011	

The program communicates with tracking portal via web service protocol. There are 2 versions of Application Program Interface (API) from which the program can utilize:

- Enterprise Web Service – "Used by enterprise developers to build client applications for a single Salesforce organization. The enterprise WSDL is strongly typed, which means that it contains objects and fields with specific data types, such as *int* and *string*. Customers who use the enterprise WSDL document must download and re-consume it whenever their organization makes a change to its custom objects or fields or whenever they want to use a different version of the API" ("SOAP API Developer's Guide," n.d.)
- Partner Web Service – "Used for client applications that are metadata-driven and dynamic in nature. It is particularly - but not exclusively - useful to salesforce.com partners who are building client applications for multiple organizations. As a loosely typed representation of the Salesforce data model that works with name-value pairs of field names and values instead of specific data types, it can be used to access data within any organization. This WSDL is most appropriate for developers of clients that can issue a query call to get information about an object before the client acts on the object. The partner WSDL document only needs to be downloaded and consumed once per version of the API" ("SOAP API Developer's Guide," n.d.)

The structure of LogTrack portal was changing all the time during the project. Therefore, because of flexibility, the Partner Web Service WSDL (Web Service Description Language) has been used in order to implement the integration with tracking portal.

Hacklin consolidation warehouse in Pori uses the newly adopted HERO ERP system (by LeanWare Oy). Hacklin warehouse (as an important consolidation point of the manufacturing) was used during the project as a prototype for future data exchanges between the case company and its other consolidation warehouses. During the project's run, several solutions were tested to the level of actual implementation: Hacklin is already now able to receive forecast data of incoming goods from the company and can transmit warehouse data from HERO directly to both company's Warehouse System and the LogTrack Portal. This data includes goods' status changes, goods' location in warehouse, outgoing ship number / container number, etc.

Hacklin is in the process of improving their own inventory and clearing capabilities by implementing a system of portable barcode scanners carried by their personnel - this system can communicate status changes of the goods in real-time by scanning bar codes on case labels. However, the manufacturing's plans of implementing an RFID system within a specific area of Hacklin's warehouse may come to leapfrog this development, providing an even more automatic system of goods-clearing and inventory.

The Hacklin data is communicated with the LogTrack portal via the Salesforce Webservice interface (as explained above). Similar data exchange solutions could and should be negotiated with other consolidation warehouses in the global manufacturing network, to achieve a better situational awareness of goods' locations. Below is one example of data exchanging between Hacklin and LogTrack portal:

Handling Units [1]

SP Project Stock Item Detail Edit Delete Clone

Item ID	I-00056	Owner	Log Track [Change]
Handling unit number	1001720550	Case number	
Status	Stock-Out	Warehouse Code	FI-Mäntyluoto-Hacklin
Project Number	SP/91390	Internal location	
PO number	4501715949	Forwarder in	
Delivery Number	6573017	CMR Number In	109441
Description		Forwarder out	FREJA TRANSPORT
Height	48,00000	CMR Number Out	10066
Length	58,00000	Next destination	
Width	45,00000	Hacklin ID	13428
Volume m3		Supplier	Amot Controls UK Roper Industries
Grossweight	132,00000	IMO number	
Stock in date	21.11.2011	Container number	
Stock out date	24.11.2011	License plate	
Created By	Log Track, 8.12.2011 13:28	Last Modified By	Duy Nguyen, 29.7.2014 10:22

Edit Delete Clone

Handling Units New Handling Unit Handling Units H

Action	Transport Container Name	Handling No
Edit | Del	01501	1001720550

Handling unit number (in this case is 1001720550) is the unique key to link between SP Project Stock Item and Handling Units. When new SP Project Stock Item is created or an existing one is updated, the UpdateContainerFromHacklin Apex trigger will be activated, which updates the status of matching HU:

Handling Unit Detail Edit Delete Clone Show Route Print Case Label Print Packing List

Transport Container Name	01501	Status	Stock-Out
Length (cm)	670	Handling No	1001720550
Width (cm)	248	Handling Unit 2	
Height (cm)	386	Description	W8L32 SP/00718.FS1-P11 ARV3 Conversi
Gross Weight (kg)	41300	Kind of Package	
Net Weight (kg)	41300	Shipping Mark	
Supplier Name		Final Destination	Sembawang Shipyard
Project Name	ARV 3	Pickup Address	
Project No	SP/00718	Delivery Address	MÄNTYLUOTO
Supplier Ready Date		Pickup Instruction	
Incoterms	DAP	Tracking Device Inside	Yes
Delivery No	6709887	Ship Number (IMO)	9321550
Shipment No	58529	Container Number	
Harbor Pick Location	55.13932,11.04788	Truck_Number	
Harbor Drop Location	1.264355,103.77511		
Geofence Limit	20		
On Truck or Vessel	Truck		

For example, the status of handling unit number 1001720550 is changed from Stock-In to Stock-Out in this case (the “Stock-In” and “Stock-Out” statuses are corresponding to

"Accepted at consolidation warehouse" and "Leaving consolidation warehouse" in the checkpoint system respectively).

4.5 LogTrack Portal

During the course of the LogTrack project, a prototype of LogTrack portal was created in the free developer edition of the SalesForce platform. There are four groups of users who are involved in this LogTrack portal:

- The case company's users (delivery managers, project managers, logistics managers, purchasing managers)
- Suppliers
- Consolidation warehouses
- Transport company

However, in this prototype, only the manufacturing's users have direct access to portal through the SalesForce interface. Suppliers will provide handling unit data (dimension, weight etc.) for the portal via web form or Excel template (the web form system is not developed yet in this prototype; hence, the communication works mostly via email). The future implementation is to extend LogTrack portal so that it can support different user's roles with different interfaces and provide access to the portal for Suppliers. The transport company will similarly supply status updates and possibly goods' location to the portal through Portal-EDI integration. The consolidation warehouses will have a two-way communication with the tracking portal via WebService API (as explained in Portal-SAP integration section). They will provide the tracking portal with status updates (and data such as ship numbers and container numbers) but will also be able to receive forecast data on incoming handling units.

With the help of tracking portal, finding "lost boxes" should become easier. For instance, whenever a box is "lost" due to faulty markings, transport error, or warehouse misplacement, managers can narrow down the search field to certain area. If the handling unit number of the missing box is known, the delivery/project manager can go directly to the handling unit tab - either by using the search function or by browsing the handling unit list. Here the user can see all the tracking data currently available for this handling unit - dimensions and specifications; status update history (passed checkpoints); and tracker data (if available) in a list and plotted on a Google map. The system will show any tracking data available, either from a GPS tracking device, from the transport company or from a ship tracking service, etc. If the user clicks the "show route" button, the last recorded location points will be plotted and on a map with a red line connecting them. If the delivery/project manager does not specifically know the handling unit number of the missing box, the project/shipment/delivery tabs will allow the user to browse all handling units under said shipments/deliveries. (Figure 54, 55, 56 & 57)

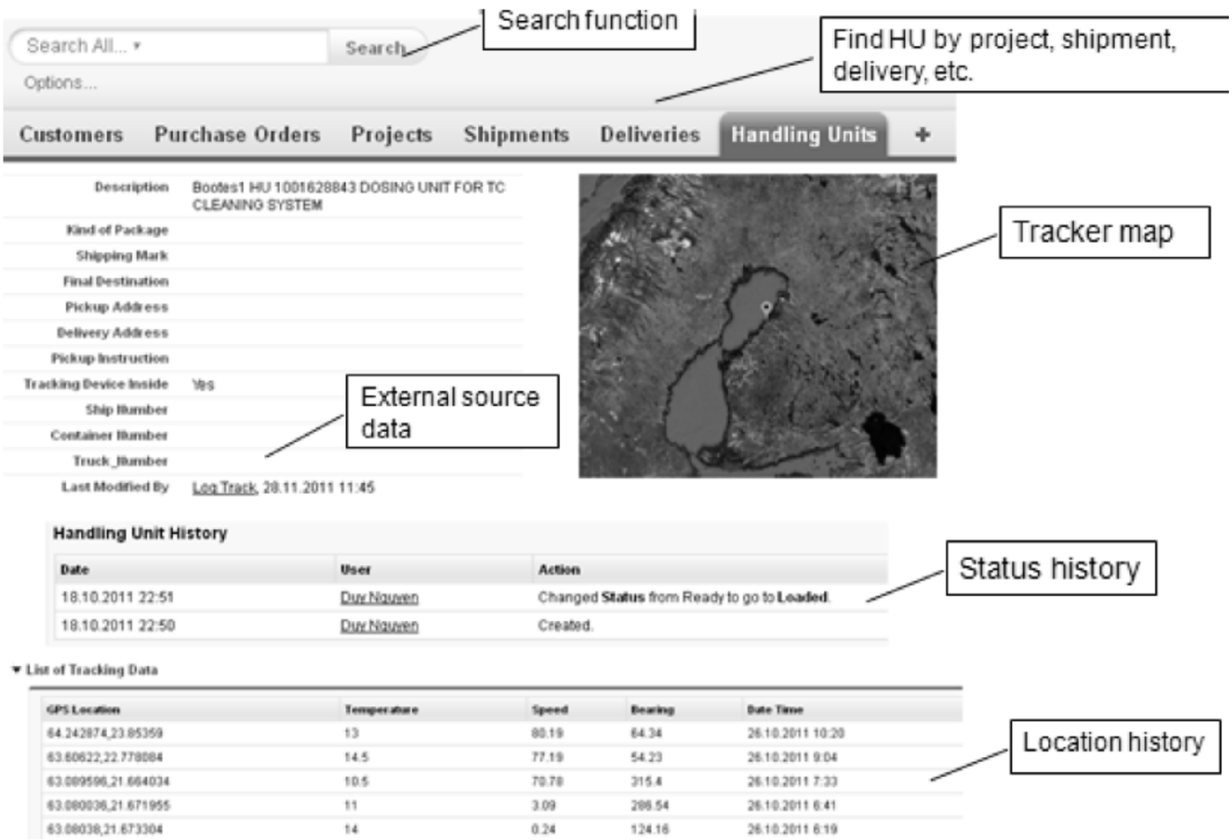


Figure 54: Tracking portal interface

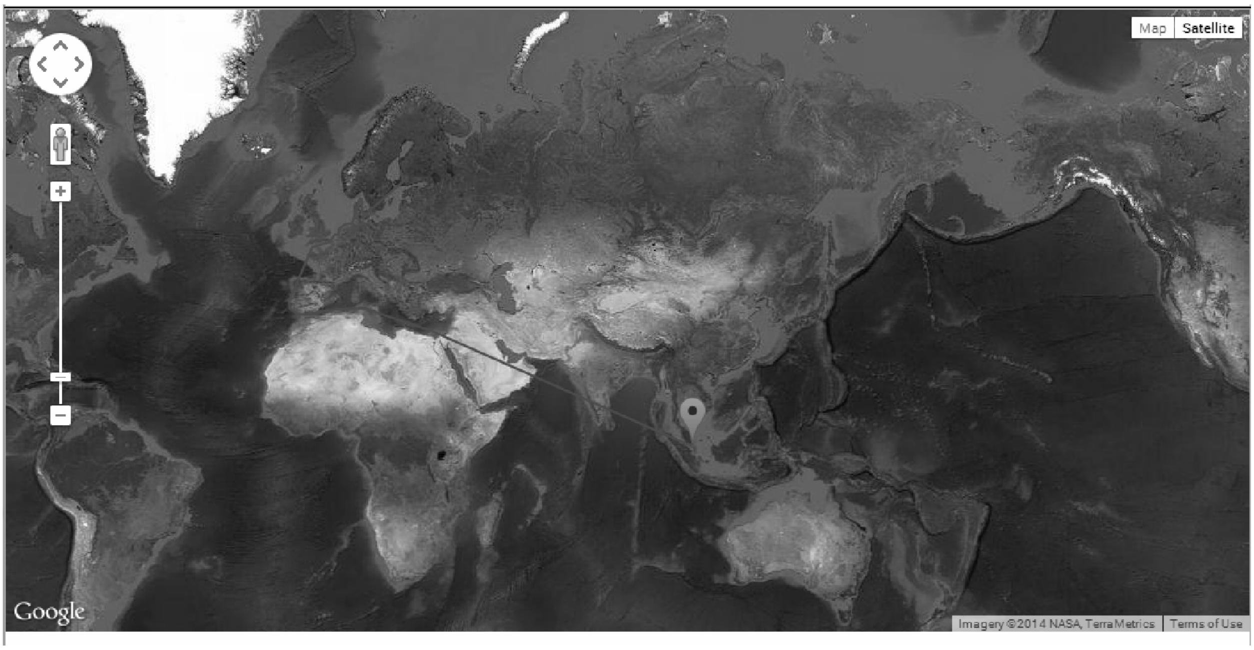


Figure 55: Route history of a handling unit

Shipment Detail Edit | Delete | Clone

Id	00465	Description	
Additional Text			
Project	00101		
Shipment No	58529		
Created By	Log Track, 6.6.2012 9:52	Last Modified By	Duy Nguyen, 20.6.2012 11:36

▼ Case Specification

Delivery No	Handling No	Description	Delivery Address	Status
6671463	8000125649	DOSING UNIT FOR WET CLEANING OF TC	M�NTYLUOTO	Ready to go
6671466	8000126396	FUEL FEED PUMP	MÄNTYLUOTO	Ready to go
6671460	8000126199	DOUBLE BELLOW NS500 L=560	MÄNTYLUOTO	Ready to go
6676832	8000130187	HEXAGON SCREW M12*60	MÄNTYLUOTO	Ready to go
6678396	8000131105	LUBRICATING OIL PUMP CWR ENGINE	M�NTYLUOTO	Ready to go
6691869	8000140558	SEAL KIT	M�NTYLUOTO	Ready to go
6694150	1001713082	Temperature control valve (LT)	M�NTYLUOTO	Ready to go
6694150	1001713083	Temperature control valve (LT)	M�NTYLUOTO	Ready to go
6694036	1001713043	Power Unit	M�NTYLUOTO	Ready to go
6685088	1001708899	CENTA CX-240-TOS1-70-H2-1020	M�NTYLUOTO	Ready to go
6685088	1001708950	CENTA CX-240-TOS1-70-H2-1020	M�NTYLUOTO	Ready to go
6685088	1001708951	Hub: coupling hub	M�NTYLUOTO	Ready to go

Edit | Delete | Clone

Deliveries New Delivery

Action	Id	Delivery No	Start Date	Purchase Order	Supplier	Status
Edit | Del	000579	6671463				
Edit | Del	000580	6671466				
Edit | Del	000581	6671460				
Edit | Del	000582	6676832				
Edit | Del	000583	6678396				
Edit | Del	000584	6691869				

Figure 56: Shipment overview

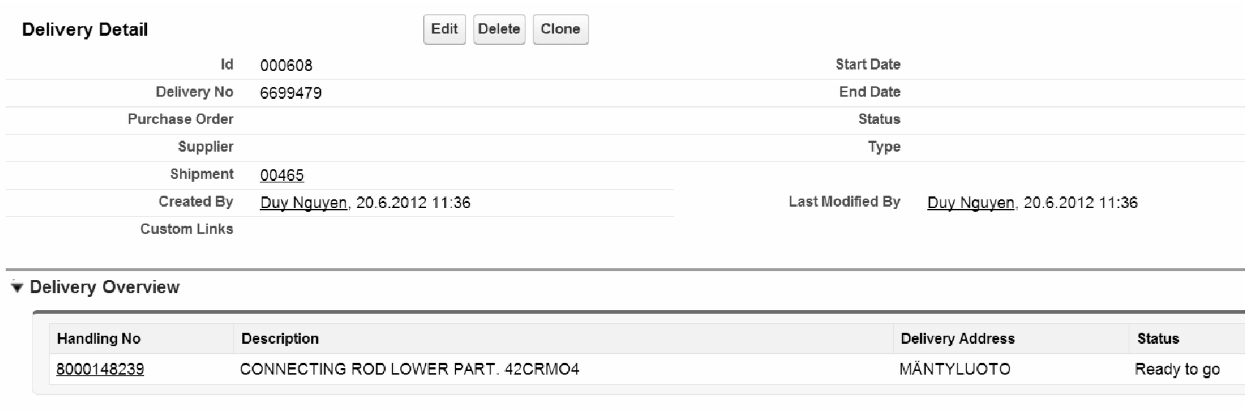


Figure 57: Delivery overview

In addition to help managers to find lost goods more easily and faster, the portal also offers the case company's managers options to create proactive overview which can help them to reduce time to resolve logistics problems. For example, the user can choose to order the handling units in a specific shipment/delivery after current status, supplier, or expected shipment date - any number of different factors. This means that the manager can easily pick out the handling units that have not yet been shipped and that are looking suspiciously late. (Figure 58 & 59)

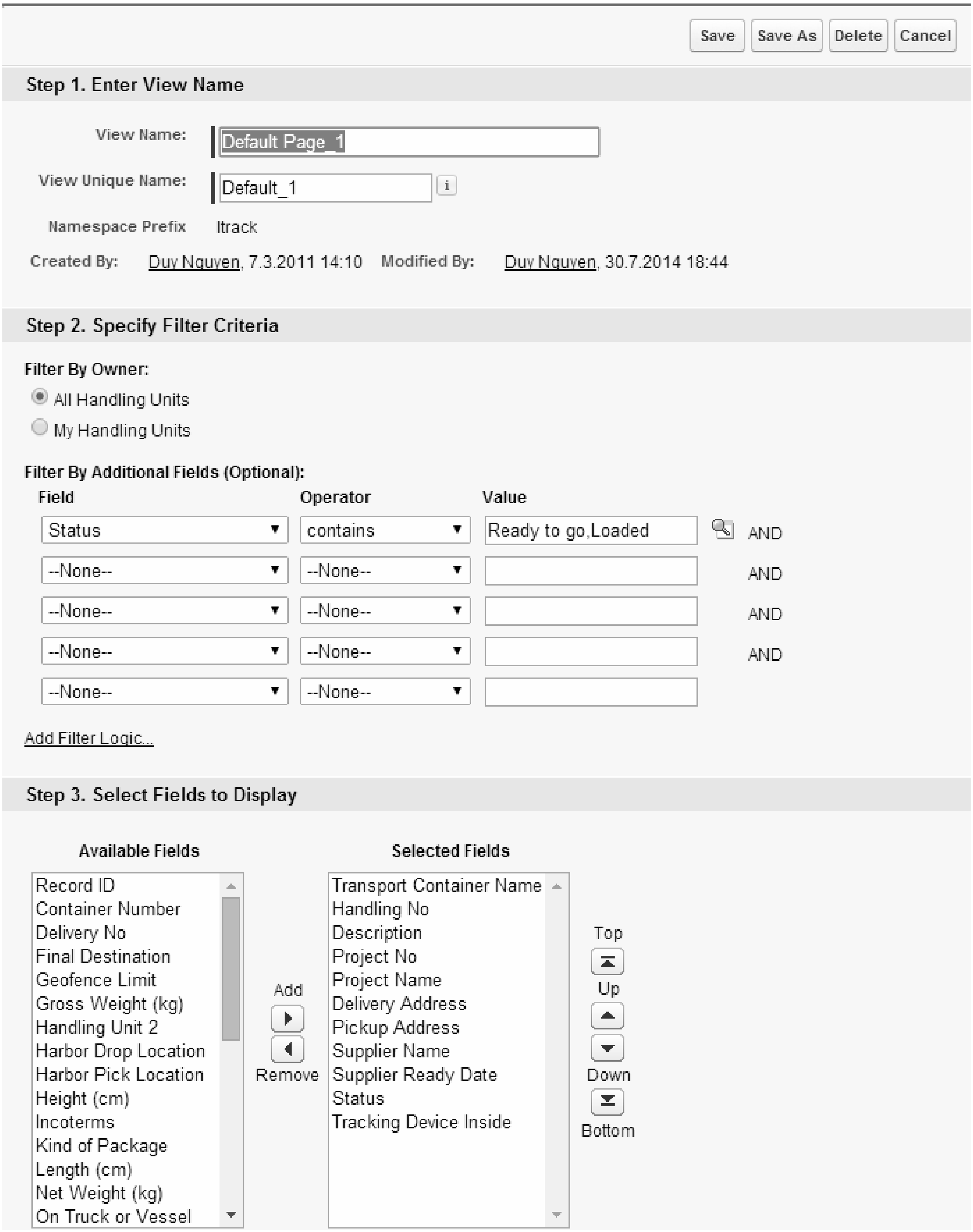
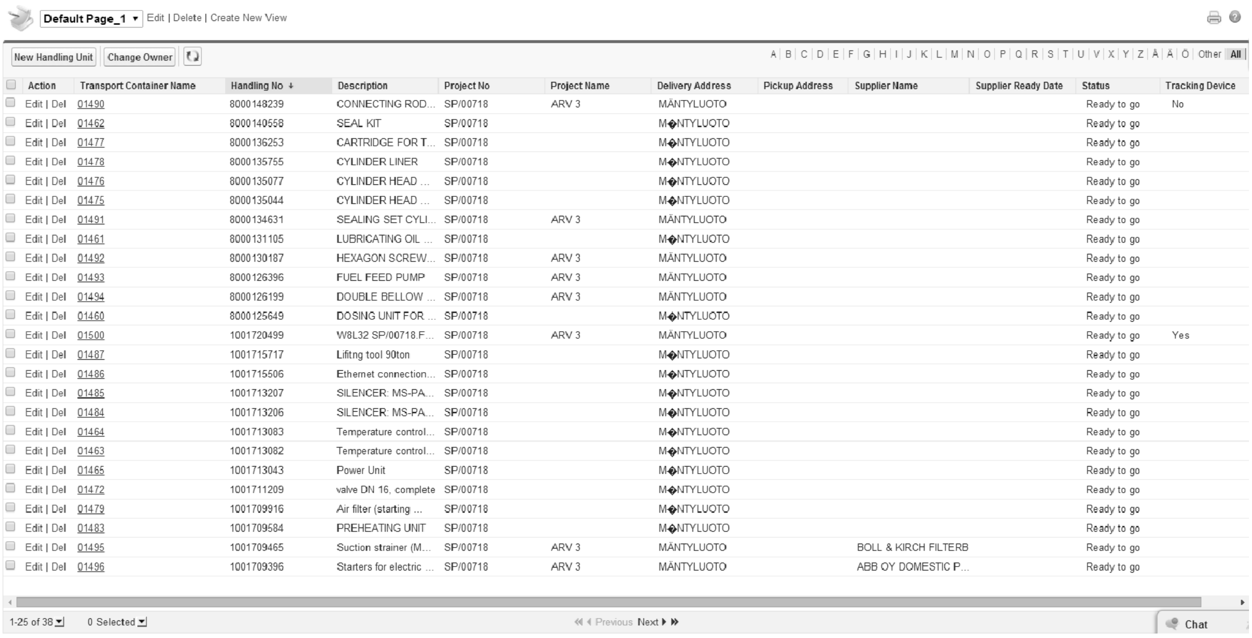


Figure 58: Steps to create a specific view for user



Default Page_1 Edit | Delete | Create New View

New Handling Unit | Change Owner

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | X | Y | Z | Å | Ä | Ö | Other | All

Action	Transport Container Name	Handling No ↓	Description	Project No	Project Name	Delivery Address	Pickup Address	Supplier Name	Supplier Ready Date	Status	Tracking Device
Edit | Del	01490	8000148239	CONNECTING ROD...	SP/00718	ARV 3	MÄNTYLUOTO				Ready to go	No
Edit | Del	01462	8000140558	SEAL KIT	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01477	8000136253	CARTRIDGE FOR T...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01478	8000135755	CYLINDER LINER	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01476	8000135077	CYLINDER HEAD ...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01475	8000135044	CYLINDER HEAD ...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01491	8000134631	SEALING SET CYLI...	SP/00718	ARV 3	MÄNTYLUOTO				Ready to go	
Edit | Del	01461	8000131105	LUBRICATING OIL ...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01492	8000130187	HEXAGON SCREW...	SP/00718	ARV 3	MÄNTYLUOTO				Ready to go	
Edit | Del	01493	8000126396	FUEL FEED PUMP	SP/00718	ARV 3	MÄNTYLUOTO				Ready to go	
Edit | Del	01494	8000126199	DOUBLE BELLOW ...	SP/00718	ARV 3	MÄNTYLUOTO				Ready to go	
Edit | Del	01460	8000125649	DOSING UNIT FOR ...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01500	1001720499	W8L32 SP/00718.F...	SP/00718	ARV 3	MÄNTYLUOTO				Ready to go	Yes
Edit | Del	01487	1001715717	Lifitng tool 90ton	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01486	1001715506	Ethernet connection...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01485	1001713207	SILENCER: MS-PA...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01484	1001713206	SILENCER: MS-PA...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01464	1001713083	Temperature control...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01463	1001713082	Temperature control...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01465	1001713043	Power Unit	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01472	1001711209	valve DN 16, complete	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01479	1001709916	Air filter (starting ...	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01483	1001709584	PREHEATING UNIT	SP/00718		M�NTYLUOTO				Ready to go	
Edit | Del	01495	1001709465	Suction strainer (M...	SP/00718	ARV 3	MÄNTYLUOTO		BOLL & KIRCH FILTERB		Ready to go	
Edit | Del	01496	1001709396	Starters for electric ...	SP/00718	ARV 3	MÄNTYLUOTO		ABB OY DOMESTIC P...		Ready to go	

1-25 of 38 | 0 Selected | Previous Next | Chat

Figure 59: Proactive overview of Handling Unit tab

5. CONCLUSIONS

EDI and ERP systems have been used widely in industrial manufacturers. They placed an essential role in the logistics and supply chain management tracking network, in which they have been providing an effective and efficient approach for exchanging data amongst trading partners and used as a central platform of many IS systems in the supply chain network. The integration of EDI and ERP systems has been considered as the key factor in the sustainable development because they can help companies increase the flexibility and responsiveness significantly as well as reducing the cost of business operations. The paper has pointed out both advantages and disadvantages of the integration. Alternative approaches are also introduced to give manufacturers more options in choosing the most suitable implementation plan. Further research can be applied on the implementation of EDI and ERP systems separately so that they can be interconnected without using the mediate platform.

The implications of the research paper are immense in the logistics technology management perspective. It is always needed to applied innovative technologies in business operations to enhance the productivity and to gain competitive advantage. The productivity of the logistics manufacturers highly depends on the behavior of their respective supply networks. Safe, error free and on time delivery of the raw materials, components or parts contribute to the scheduled manufacturing/assembly operations. In order to ensure these environments, delivery shipments needed to be tracked and traced with regular interval and the value of business operations such as purchasing or ordering has to be increased by utilizing the benefits of information systems in daily activities (Shamsuzzoha et al., 2011).

To support the requirements, there is no single technology rather than a combination of various systems and processes. From LogTrack project, we can conclude that the future system should at least include the following aspects:

- Information from different sources should be collected into a centralized location and provided based on requests of participants involved.
- Development of integration systems between manufacturing company and its suppliers and transport companies is requisite. Different standards and technologies can be employed such as EDI, AIS, XML based web-service, etc.
- Use of tracking devices for expensive goods is needed.

- Transaction monitoring system on each event during the logistics chain can be implemented by using RFID and bar code systems.
- Visualization of supply chain within portal can be achieved by using Google Maps and other technologies.

Although the mediate platform has been proven that it was working properly in LogTrack project, it is still necessary to carry out more real pilot cases in order to test the reliability and scalability of the system. More customers, suppliers and industrial manufacturers need to be involved to increase the credibility of the solution.

On the whole, the system has a huge impact on the logistics and supply chain management tracking network, especially on the case company. Although it is highly fashionable to hire outside transport companies to handle company's logistics needs, the issue is more complicated when it comes to the global manufacturing due to the separated inbound and outbound flows of goods. Therefore, such a system is totally necessary and suitable for the case company. The cost for implementation might be a lot, yet the payback period should be short because of all the advantages and benefits it can bring back. For example, the system does not only ensure the safety and timely arrival of one of the most expensive and important piece of equipment shipped, the engine, but also enhance the customer satisfaction. Frequent updates on the progress of shipment can be easily achieved using this tracking system. It is not limited by the type of carrier, either on truck or vessel, and that is a remarkable improvement comparing to other tracking systems (e.g. DHL, UPS etc.). In addition, lots of time and efforts when switching between different input sources can be saved when combining all the information into one centralized location, the portal. Company's managers and suppliers do not have to log into their ERP system as information about projects and shipments are already presented in the system in a user-friendly way.

Last but not least, the idea of such a system can be applied in any logistics companies. To illustrate, the implementation of checkpoint system using RFID and bar code systems which is presented in this paper can be used as the basic approach/principles for logistics companies which want to utilize disruptive innovations such as RFID in their tracking system.

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