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Semantic web applications in supply-chain management

Jukka Hemilä

1 Introduction

This document describes ideas of using semantic web in Supply Chain Management (SCM). There are many opportunities in Supply Chain Management to use new technologies, like Semantic Web, but in many case it takes long time to implement new technologies in use. Chapter 2 presents the basic ideas of Supply Chain Management and some applications used in SCM. Chapter 3 presents the ideas of SCM integration, which kind of technologies and standards there is in use. Chapter 4 is evaluating the possibilities of semantic web in context of Supply Chain Management.

2 Supply Chain Management

Business globalisation, fast development of information technology and networking of the economy have affected the competitive and operational environment of companies. Companies have had to change strategies and activity models to survive in the markets. Networking of companies has begun a new element in a new industrial activity mode (Hyötyläinen 2000). Creating networks is a big challenge because there are no models or methods for doing it yet. From a business point of view one of the biggest challenges is to give up old action methods and concentrate clearly on the core business action (Luomala et al. 2001).

James A. Tompkins introduces the philosophy of SCM as "If I build it, the orders will come" and he divide SCM in three parts (Tompkins 2000):

1. Supply - indicates a push
2. Chain - indicates individual, discrete links
3. Management - implies a static environment of control and measurement.

It is important to understand and define what a value chain means in the context of SCM. The value chain is a method of dividing a business into a number of linked activities, each of which may produce value for the customer.

The value chain idea helps in analysing processes that add value and eventually in bringing an organisation into an integrated supply chain. The value chain is a framework that enables analysis of the contribution of individual activities in a business to the

overall level of customer value produced by the firm and ultimately to its financial performance. The value chain idea is that action in business is not just manufacturing or making services. The idea is that every player in the chain ads value and every player gets a part of that value. Also the value is transferred to the next player in the value chain and finally the end user or customer gets the value, not just the product. Christopher has presented that the management of upstream and downstream relationship with suppliers and customers means to deliver superior customer value at less cost to the supply chain as a whole (Christopher 1998).

The key players in supply chain management are:

- Material suppliers
- Supply partners (wholesalers/distributors, retailers)
- Customers
- Software product suppliers and System developers

Supply chain management can be defined as the optimisation of the delivery of goods and services, and optimisation of information from the supplier to the customer. To the customer, the optimisation means that the supplier knows what the customer needs and understands the correct timing in the delivery of goods or services. To the supplier, the optimisation of delivery means that the right products or services are available in the right quantities at the right time. Market dynamics expand and intensify as a result of changing customer demands. Organisations that are in a position to adjust rapidly will survive.

The purpose of SCM is to increase throughput in the organisation while reducing investment and operating expenses by integrating internal and external operations of procurement, manufacturing and logistics into a synchronised process flow. It is mostly concentrated upon the sources of materials and products, vendor co-ordination and purchasing. SCM is primarily concerned with managing enterprise integration with the suppliers, customers, transportation and information providers as it defines and drives the requirements for each.

The supply chain involves the following four basic processes, as the Supply Chain Council organisation has defined (Supply-Chain Council, 2001):

1. Plan
2. Purchase
3. Make
4. Deliver

The above processes define the various efforts ranging from getting an order to the delivery of products. The most significant efforts of these four processes can be illustrated as follows:

1. Managing supply and demand
2. Acquisition of raw materials and parts
3. Manufacturing and assembly
4. Stocking and inventory tracking
5. Order entry and order management
6. Distribution across all channels
7. Delivery to the customer

Kalakota and Robinson have presented the basic processes in a supply chain, which are shown in Figure 1 (Kalakota & Robinson 2001). First in the Figure 1 is supply chain

planning. Planning is a very important process and it includes forecasting and other actions. In business, some impulse is needed for the organisation to begin business actions, and a forecast could be one. Forecasts and other information should go through the supply chain. The arrows in the Figure 1 present the information flows. The supply chain players conduct their own business in the chain and this adds value to a product. The products go through the chain from the supplier to the end user or consumer. The payment flows are going in reverse direction of the information flows. And finally, at the bottom of the Figure 1 is execution, which includes all actions to make things happen, such as production scheduling and execution, warehouse and transportation management.

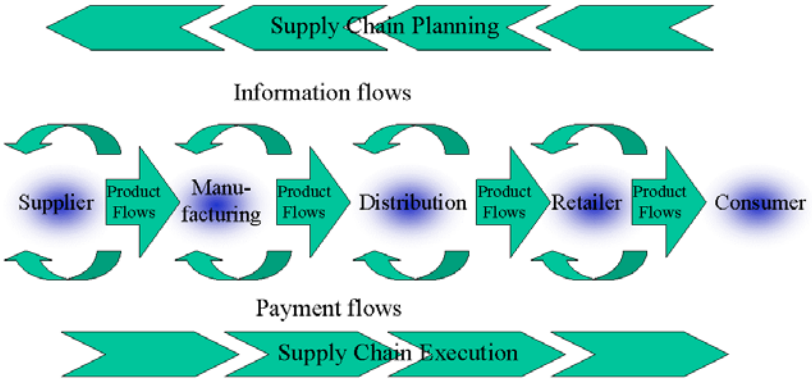

Figure 1. A Process view of the supply chain (Modified from Kalakota & Robinson 2001).

From a process point of view, SCM is the co-ordination of material, information and financial flows and management of the processes between all the participating enterprises in a business transaction.

2.1 Supply Chain Management applications

Networked enterprises need to share information, and that is the reason why different tools are needed. Information creation, managing and sharing is done easily by using different information technology systems and tools.

A clear understanding of the customer service level is the key in implementing any SCM system. Design and development of the supply chain management system is a difficult task. It involves careful analysis and diligent implementation. Understanding the customer requirements and service levels is the first stage of this process. However, the customer level is not the only level that the organisation has to understand. Manufacturers have different SCM needs depending on whether their industry is material, manufacturing, or distribution intensive. Effective supply chain management requires thorough knowledge of distribution channels, their structures, their management and the emerging trends and issues. The inter-organisational dimension of supply chain management suggests that communications and information management is essential if decision making is to be effective.

There are many different frames of reference for perceiving different information systems. Luomala et al. have presented model that is connecting different models made by global software houses (for example IBM, Oracle) and different research organisations

(example Gartner, Forrester), and this model is presented in Figure 2. (Luomala et al. 2001). Individual organisations and also networked enterprises need information systems that support the business processes and share information created in the process. Figure 2 shows also the need for integration between the different systems.

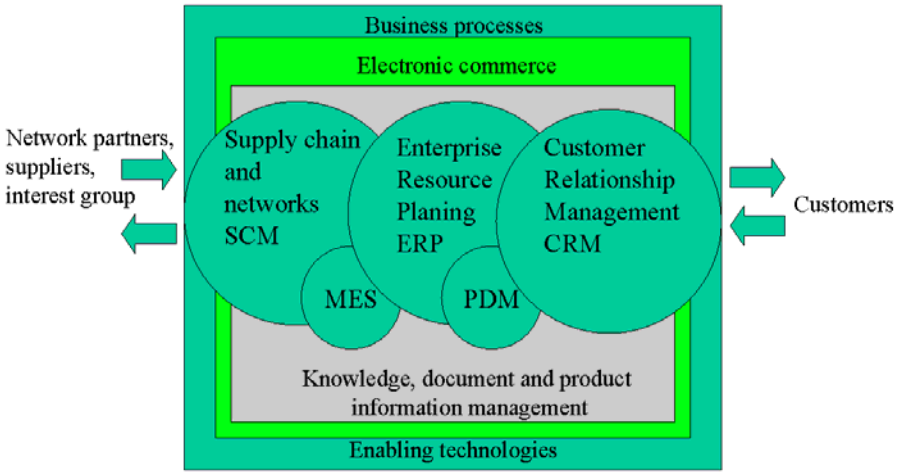

Figure 2. Frame of reference for perceiving information systems (Modified from Luomala et al. 2001).

As seen in Figure 2, there are inputs and outputs from the customers and also from the network partners, suppliers and other interest groups. Inside the organisation there is a need for different systems: SCM, ERP, CRM, PDM and MES. These different systems are basic systems for an effective organisation. The systems are located where they are needed: SCM system to manage suppliers, ERP to manage production, CRM to manage customers, PDM to manage product data and MES to managing manufacturing. These systems are linked or connected to each other and surrounded by knowledge, document and information management. Manufacturing processes and product variations change rapidly nowadays. This fast changing atmosphere needs high quality documentation and product data. The significance of document management and product data management is also emphasised. Also e-business and business processes are surrounding systems in Figure 2 the markets offer many tools, and every one has its own specific purpose. Each system is different and suitable for different needs. Many systems have features of other systems and it is difficult nowadays to say for example which system is clearly an ERP and which is a CRM system.

2.1.1 ERP

ERP is maybe the most known information system related to the organisation of inner management. ERP systems are widely used in the manufacturing industry but also in other industries. But what is ERP? ERP dates back to Material Require Planning systems (MRP) the first systems to use a computer for planning the material and capacity. As the computer resource continued to add more power, the idea came to integrate the material and capacity resource plan with the financial resources of the organisation. The next step towards ERP was the Manufacturing Resource Planning (MRPII) systems. ERP systems came to the markets when computer technology continued to grow more powerful in processing capacity and smaller in size.

O'Leary presents ERP (Enterprise Resource Planning) is an industry term for the broad set of activities supported by application software that help a manufacturer or other business manage the important parts of its business, including product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service, and tracking orders. (O'Leary 2000). ERP can also include application modules for the finance and human resources aspects of a business. O'Leary has defined that ERP systems are computer-based systems designed to process an organisation's transactions and facilitate integrated and real-time planning, production and customer response (O'Leary 2000).

ERP attempts to integrate all departments and functions across a company into a single computer system that can serve all the particular needs of those different departments. In other words, ERP consists of a group of functional modules using or integrated into a relational database system. The core component is usually the financial and accounting component, and other basic components are (Luomala et al. 2001):

- Warehouse management
- Material management
- Manufacturing planning and management
- Personnel management
- Order management

Technically, ERP systems are usually based on client-server architecture. The client could be example the workstation that is running the ERP. The business logic could be located in the server or in the client that are both connected to the network. Nowadays there are many www-browser interfaces to use ERP. ERP systems have usually an EDI (Electronic Data Interchange) interface to share information from the ERP to business partners.

2.1.2 SCM

SCM systems are used to handle and manage supply chains and especially the processes. As stated earlier, the supply chain includes four basic processes: plan, acquire, make and deliver. These processes are the focus points of SCM systems, and usually these processes include logistic problems and management issues. Usually in business, the input from the markets comes from the customers. Any enterprise with a requirement to deliver information or products to customers needs to determine which type of a system to use for optimising delivery, storage and transportation management.

SCM is a set of software solutions, internal business practices, and tightly managed trading partner relationships that allow a company to serve its customers more efficiently by better organising and co-ordinating internal and partner activities. A key benefit of SCM systems is a capability for providing accurate real-time cost monitoring and planning data. A good SCM system can help in creating and maintaining a relationship with the customer. The objective of the SCM system is to optimise the value to the customer. The customer is generally driven by the following three criteria in the making of any purchase decision: 1) Product features 2) Product quality 3) Customer service level.

The idea of SCM solutions is to integrate forecasting, planning, and execution capabilities with complete supply chain wide visibility across the supply chain. SCM

customers create value by utilising the synchronised solutions to reduce inventory while accelerating delivery times.

2.1.3 CRM

Customer relationship development has become one of the most important development actions in business. Customers have nowadays more choices to buy products or services than earlier, which is the reason why organisations are focused on managing and developing relations to their customers. Customer Relationship Management (CRM) is a business strategy aiming to organise and handle the business actions connected to customer relationships through the entire lifecycle of partnership with customers. CRM requires a customer-centred business philosophy and a culture supporting effective marketing, sales, and service processes. There are several models for customer relationships and the Figure 3 presents one of them. There are eight steps to manage a customer. The first step is to analyse, which includes the customer's potentiality estimation. If the customer is potential, the next step is to attract and present. The following steps are normal selling processes and finally the post markets activities. After the post market steps, the organisation must analyse the customer again. Maybe the old customer has new needs or is no longer a potential customer. The analysis must provide answers for these questions. That is the simplified way to manage customers.

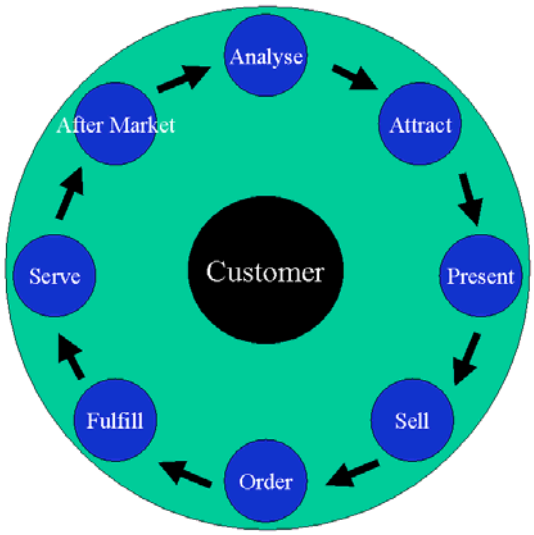

Figure 3. Customer Relationship Management, CRM (Adapted from IFS).

CRM systems are information systems for handling customer relationship management. CRM Guru Community has defined that CRM applications can enable effective Customer Relationship Management, provided that an enterprise has the right leadership, strategy, and culture (CRM Guru Community, 2002).

2.1.4 PDM

Ptak and Schragenheim have presented ideas of Product Data Management (PDM) and this chapter is based on their presentation. PDM is seen to be a very important information system in production and manufacturing business. In business areas with

rapidly changing products, information sharing connected to product data is fundamental. Effective product development is required to support the strategy of quick response to the market, and a concurrent design process reduces the overall time to market. Earlier it was necessary to build a prototype for testing the interference and suitability of products. Today, it is possible to use computer-aided design (CAD) and effective PDM systems that facilitate the design release, distribute the design data to multiple manufacturing sites, and manage changes to the design. (Ptak & Schragenheim 2000).

The PDM system is used for tracking the configuration of the part and for billing the material, for tracking the revisions and history of the design and for building the conditions. Integration between the CAD and PDM systems improves the quality of design and the response time to market. The product could be virtually tested in a computer system and after that a direct link to computer aided manufacturing (CAM) could also be established. (Ptak & Schragenheim 2000).

An organisation faces many internal and external challenges. The benefits of a PDM system linked to these challenges can be divided in four categories:

1. Market share.
2. Customer satisfaction.
3. Profit margins.
4. Returns to stakeholders.

The market share could increase if the organisation used an integrated design system, because the system would help improve the introduction rate of new products and lower costs. A PDM system enables the organisation to fit its products to the markets needs. Profit margins could increase, because the PDM system could decrease the cost of developing a product. New products could be brought to markets quickly and profitably and the resulting competitive advantage would usually result in a better market share and in that way improved returns to the stakeholders. (Ptak & Schragenheim 2000).

2.1.5 Manufacturing Execution Systems

Ptak and Schragenheim have presented the Manufacturing Execution System (MES), and this is based on their presentation (Ptak & Schragenheim 2000). MES is not such a well-known information system in industry. In normal production or manufacturing the ERP system manages resources and there are different kinds of control and monitoring systems on the floor level. Earlier there were no systems between the ERP and floor level control systems. The MES system is the solution to fill the gap. Once the business plan through sales and operations plan has been made, the organisation can make material and capacity plans and the implementation phase can begin. The visibility of actual activity as compared to planned activity is essential in maintaining control of the production operation. MES is the name for production activity control and shop floor control. (Ptak & Schragenheim 2000).

ERP vendors have recently included MES functionality modules in their ERP solutions, but there are still pure MES solutions on the market. Integration between MES and ERP systems could be achieved in several ways. ERP has the functionality to report on-time statistics both for the start and completion date, lead-time, and process capability as a normal function of the system (Ptak & Schragenheim 2000). All data input into the ERP system from the MES system require the data to be accurate. It is possible to create and Internet connection between the ERP and MES systems using XML technologies. It

is a bigger problem to connect the MES systems to automation systems or to other floor level systems. Common Object Request Broker Architecture (CORBA) and Distributed Component Object Model (DCOM) are technologies for floor level integration. Also client-server based technology JavaRMI is used for integration. Intellution, Motorola and Adasoft are globally known MES vendors.

3 Supply chain integration

Integration means to bring something in contact with something else. Supply chain and network integration means to bring supply chain partners, or network partners in contact with each other. When taking about integration in business, usually everyone means information system integration. There are many kinds of business solutions in the markets, and information sharing is a hot topic today. Integration is one answer to the information sharing issue in business. Information sharing must happen at the right time or preferably even in real time, if the organisation wants to be competitive.

System integration means:

- to get information from different information systems
- to modify information in many information systems
- information and actions are similar in many information systems

Integration is useful because manual actions take time and may cause errors. The aim of integration is also to automate functions, so the organisation has more time for its core functions. System integration could be effected on three levels: hardware integration, application technology integration and application functional integration. Hardware integration means to integrate computers and networks that make data transfer possible. Application technology integration covers data transfer communications, programming interfaces and data formats. Functional integration covers data structures and the logic between applications.

3.1 Integration between enterprises

Integration between enterprises is the topic that is very important in the supply chain and networked enterprises. The basic idea is the same as in integration inside an organisation, but there are some technologies used only in enterprise integration. Figure 4 shows logistic integration of the internal co-ordination of acquisitions, manufacturing support, and physical distribution including also customers and suppliers. There are also the flows for materials and information that penetrate the supply chain. Figure 4 illustrates an overall supply chain focusing on integrated management of all operations from supplier acquisition to customer acceptance. (Bowersox & Closs 1996).

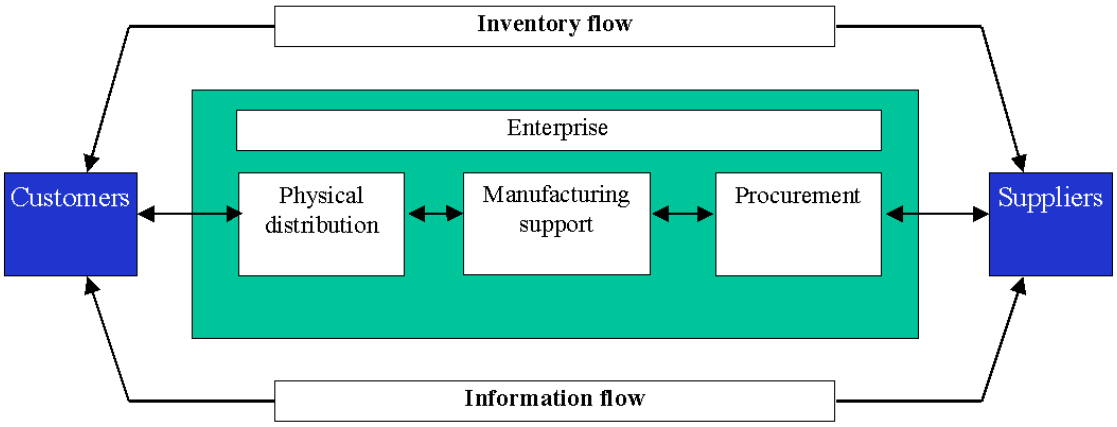

Figure 4. Supply chain integration (Modified from Bowersox & Closs 1996).

Integration between enterprises is called horizontal integration and it includes more than just the logistic point of view. Business integration between enterprises usually means connections to an ERP system. The information that interests the business partners, is usually located in the ERP. ERP is like the "heart of the enterprise", because the ERP database includes the manufacturing and order information. The partners are usually interested in the manufacturing information. Manufacturing covers the warehouse situation, production line information, forecasts and many kinds of information for the partners. It is another matter whether the enterprise wishes to give information for its partners. Integration between system and ERP system could be done in several ways for example: by using middleware technology, web technologies or communication standards.

3.2 Network technologies

Open information sharing is seen to be the most powerful way to make business with partners. Sharing the right, needful and timely information is usually almost a crucial condition in business life. Sometimes there is even a need to share strategically important information with confidential partners, but then the organisation must act very carefully. It is not always enough to get systems integrated, also the human resources have to communicate and share information with each other by direct conversation or by using

different communication tools. Usually real time action is the starting point, but there are also situations where it is enough if the information is available, but not in real time.

Many questions and challenges concerning information sharing and communication could be answered by using the Internet. Creation of a global network has abolished the meaning of geographical location. Internet technologies have developed fast and parallel to the data transfer technologies. These developments have had the impact that increasingly larger amounts of data and information can be shared increasingly faster via the network. Despite the increased volume of data sharing, it can still be controlled and aimed for specified target groups. The information networks can be classified by their extension and target group into: Internet (global network), Extranet (for a specified target group outside the organisation) and Intranet (for information sharing inside an organisation).

3.2.1 Internet

Laudon and Laudon (2000) have introduced what the Internet is and this chapter is based on that. The Internet is perhaps the most known and the largest implementation of networking linking hundreds of individual networks all over the world. The Internet is a global network of networks using TCP/IP protocols or interacting with networks via gateways, providing the users with electronic mail messaging, remote login, file transfer, network news, WWW, and other related services and tools. The Internet has a range of capabilities that organisations use to exchange information internally or to communicate externally with other organisations. (Laudon & Laudon 2000).

Internet refers to a system of networked computers. These computers or servers can be located around the world. Each of these computers has their own unique Internet address or name. The servers are in turn used by their own community of users. Today, the Internet consists of millions of computers that are acting as servers and about 30 million users globally. It has been estimated that the number of Internet users is growing at the rate of one million new users per month. Fortunately, not all users are on the Internet at the same time. The enormous and growing number of Internet users is one reason why the World Wide Web (WWW) is increasingly referred to as the World Wide Wait. Security is another concern on the horizon. (Laudon & Laudon 2000).

3.2.2 Intranet

After the spreading of the Internet, the need for a similar function for internal use in organisations has expanded. The Intranet is like a "mini size" Internet, only accessible to a limited group of people or within a limited geographical area, usually for one organisation. Geographically limited means that the Intranet is not a global network, but it could cover multiple locations. For example an enterprise that has four different factories in different locations could have the same Intranet. In that kind of a situation, the Intranet is still for limited group of people. So the idea is to utilise the facility of the Internet internally in the organisations and groups whose are connected to the network.

Intranet can be run as a completely internal network. It is placed on the server of the organisation and only accessible on the internal network or a partly external network,

where people located at other geographical locations can access the Intranet via a dial-up network or the Internet.

Intranet is located outside the Internet. The organisation could have its own Firewall server, which acts as a gate for the Internet. Beyond the firewall, there could be the organisation's HTTP-server, which includes all documents for those outside the Intranet. So these documents are for Internet users and random visitors. The organisation could have its own TCP/IP-network and different locations of the organisation could be connected to that by their own HTTP-servers. In addition to the HTTP-server at each location, there could be a local area network (LAN) or another type of network where the workstations are connected.

3.2.3 Extranet

An Extranet can be considered as something in between an Intranet and the Internet. The Extranet is an outsourced Intranet that is fully connected to the Internet. It is an Intranet with limited access for outsiders making it possible for these to collect and deliver certain information on the Intranet of the organisation. The Extranet was earlier known as Extended Intranet.

By granting authorisations to pre-specified persons or groups trough the use of passwords, it is possible to vary the degree of access to the Extranet. Those groups could be for example customers, suppliers, or consultants.

The advantages of the Extranet are plentiful:

1. Suppliers can go on to the Extranet and see the stocks. They can see when it is time to make further deliveries if a minimum stock level has been set, whereby the suppliers will be able to better control their own production levels and purchase of raw materials.
2. The organisation can take part in the savings that their suppliers achieve through using Extranet in management and decision making.
3. The organisation will save handling cost on the paperwork.
4. At the same time the organisation saves resources, manpower and communication costs normally connected to these actions.
5. The organisation can offer the staff the possibility of working from home or other places with an Internet connection, on tasks that do not absolutely demand their presence in the geographical location of the organisation.
6. The customers can check delivery and financial statuses with the organisation without having to tie up the staff of the organisation.

Extranets have become a very popular means for business partners to exchange information. Extranet making it possible to control the access to sensitive material such as regional price lists, terms of business, types of products available.

3.3 Standards for SCM communication

Communicating with someone who speaks a different language is not easy. Although achieving some level of understanding is possible, comprehension does not come quickly or confidently. The Internet is fuelling the growth of e-business and changing the way products and services are bought and sold. Businesses are redefining their roles and interacting in new and different ways, transforming supply chains into enterprise

networks. Although internal company operations may be efficient, communication through the enterprise network is grossly inefficient.

There are nowadays several standards for communication between organisations. EDI (Electronic Data Interchange) has been the strongest standard and it is very widely used. For over 25 years EDI has given companies the prospect of eliminating paper documents, reducing costs, and improving efficiency by exchanging business information in electronic form. But there is one point why EDI is not used by every organisation: it is expensive. Only large companies are able to afford to implement it, and much EDI communication is centred around a dominant enterprise that imposes proprietary integration approaches on its trading partners. Creating point to point connections between two organisations requires a lot of work and some operator to transmit the messages. EDI is still very strong, because it is well standardised.

In the last few years, Extensible Markup Language (XML) has rapidly become the first choice for defining data interchange formats in new e-Business applications on the Internet and in communication between enterprises. Companies with large investments in EDI integration will not abandon them without a good reason. XML enables more open, more flexible business transactions than EDI. XML might enable more flexible and innovative business models than EDI. But the challenges of designing messages that meet business process requirements and standardising their semantics are independent of the syntax in which the messages are encoded. Many ERP systems still support EDI connections but XML is gaining ground also in that sector.

3.3.1 EDI

Electronic Data Interchange (EDI) was devised as a way for companies to exchange business documents automatically and electronically in a standard way. EDI works by providing a collection of standard and computer-readable message formats and an element dictionary in a simple way for businesses to exchange data via any electronic messaging service. There are several definitions for EDI and one is "the direct computer-to-computer communication of inter company and intra-company business documents in a machine-readable standard format" (Lim & Prashant 2001). This study does not concentrate on the technical details of EDI or its standard.

Because EDI is capable of supporting the organisation’s legacy and ERP systems, EDI has made a special contribution to the strategic supply chains of companies. Traditionally, the focus of EDI activity has been on the replacement of pre-defined business forms, such as purchase orders and invoices, with similarly defined electronic forms. EDI provides a faster, more accurate and even cheaper method of communication with the customers compared to other methods, for example mail or telephone and EDI also increases operational efficiency.

EDI is used around the world, although usually European organisations use a standard called EDIFACT whereas the organisations in the United States generally use ANSI standards. The advantages of receiving a document that was entered into a company's information system without human effort resulted in expanding the standards to many other documents beyond simply purchasing and shipping. Organisations can request information about the inventory levels in the suppliers' and customers' warehouses, about the order status, send funds electronically along with an automatic

notification that an invoice has been paid, and many other types of automated transactions.

EDI connections usually need operator services. Point-to-point connection between two enterprises is complicated to build and keep up, so in many cases organisations should buy the connection services from the operators.

3.3.2 RosettaNet

This chapter is based on material what the RosettaNet consortium shares in their web-site (RosettaNet Consortium 2002). The RosettaNet consortium includes more than 350 high-technology companies, who create the standards for facilitating dynamic, flexible trading-partner relationships for supply chain companies and creating new efficiencies and business opportunities. The RosettaNet consortium is organised world widely and the organisations from Finland are a part of the RosettaNet Nordic Consortium. RosettaNet was initially aimed for the electronics industry, but because the electronics industry is connected to many other industries such as the metal and plastic industries, RosettaNet tries not to be for one line of business only. (RosettaNet Consortium 2002).

RosettaNet standards enable businesses to speak the same language: RosettaNet dictionaries provide a common set of properties for business transactions. RosettaNet Implementation Framework (RNIF) provides common exchange protocols and RosettaNet Partner Interface Processes (PIPs) define the business processes between trading partners. Unlike organisations focused on implementing proprietary solutions, RosettaNet leverages on the existing open e-business standards, guidelines, and specifications for platform, application, and network communication. RosettaNet creates a framework that crosses the boundaries of individual companies to enhance the interoperability of business processes. (RosettaNet Consortium 2002).

By establishing a common language or standard processes for the electronic sharing of business information, RosettaNet opens lines of communication so that companies realise the full potential of the digital economy, including dynamic, flexible trading networks, operational efficiency, and new business opportunities. RosettaNet offers companies leadership, influence, and collaboration in the development and deployment of the e-business standards vital to the evolution of the global, high technology trading network. (RosettaNet Consortium 2002).

RosettaNet e-business standards enable companies to optimise their trading network. Companies are able to create business models leveraging the global reach of the Internet in a dynamic new way and introduce highly flexible processes into their e-business operations. The benefits are many, including operational efficiency, such as shortened cycle times, improved customer service, and reduced inventory, that saves them time and money. Companies also can take advantage of new business opportunities and strengthen existing trading relationships. (RosettaNet Consortium 2002).

3.3.3 ebXML

ebXML was created and the development will continue as a co-ordinated activity between the members of UN/CEFACT and OASIS (Organisation for the Advancement of

Structured Information Standards). The ebXML consortium presents their mission as being to provide an open XML-based infrastructure enabling the global use of electronic business information in an interoperable, secure and consistent manner by all parties. ebXML is a modular specification that enables enterprises of any size and in any geographical location to conduct business over the Internet. Using ebXML companies have a standard method to exchange business messages, create trading relationships, transfer data in common terms and define and register business processes. (ebXML 2002).

The technology made available exchange of data in EDI format for most companies. ebXML software is less expensive and easier to implement than an EDI solution. For companies that use paper-based forms, the man-hours saved through using business data exchange will be even greater. ebXML is based on XML technology and data transfer is possible through the Internet. Open standards and Internet ensure a cheap, but secure way of data transfer. (ebXML 2002).

The first piloting project based on ebXML is continuing in Finland. The project was started to gain information on international developments. Tieke (Tietoyhteiskunnan kehittämiskeskus ry.) has lead the project since it started in May, 2001. The first piloting project has ended and the final report is available on the Internet. The outcome of the pilot project was ebXML standard-based Document Type Definitions (DTDs) about the pilot companies' supply chain processes and the DTDs needed in data transfer between the pilot companies. (Tieke 2001).

4 Semantic web in Supply Chain Management

The entire value network is an information flow when totally integrated and information sharing is possible for each company of the value network. Turquoise arrows at the bottom of Figure 5 mark the material flow. The material is going from the supplier to the manufacturer or from the manufacturer to the customer, depending on the role of the networked companies.

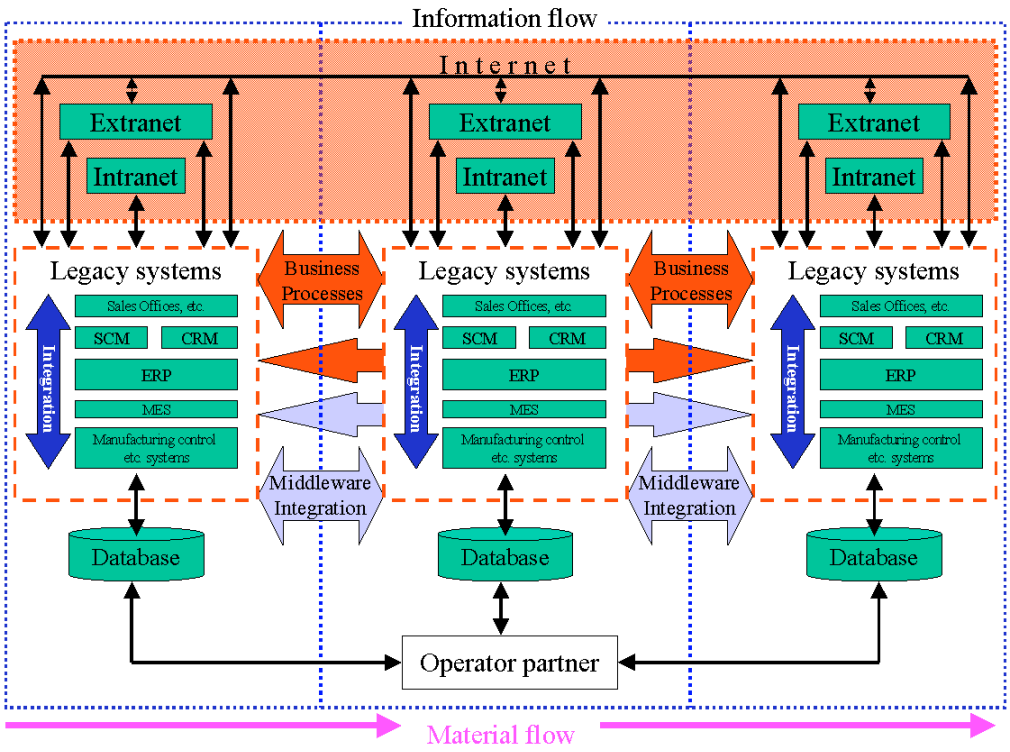

Figure 5. Integration in practice – the hypothetical model (Hemilä, 2002).

Figure 5 presented the hypothetical model for value network integration. It is possible to extend the model to include as many companies as the value network requires. The model does not include more functionality in the Internet than the Intranet and Extranet. It is possible to make Internet-based marketplaces or create other kind of functionality. Integration could be achieved also on the hardware level. Every company in the network could have its own operator partner. The business processes can take place between other companies than those next to one another in the network. Value network integration could be one business opportunity for semantic web technologies. Next chapter is presenting some ideas of utilising semantic web in supply chain management.

4.1 Business opportunities with Semantic web

The Semantic Web has already been the subject of much bluster among the XML developer community and will doubtless continue to be so. Arguments rage over the usefulness of the technology, the difficulty of using RDF, and so on. However, the Semantic Web vision of a machine-readable web has possibilities for application in most web technology - while some complain about its lack of definition, its broad scope properly reflects the quietly radical effect it will have on the Web.

Christian Ohlms has presented his opinions that the Semantic Web will significantly enhance the capabilities of today's web. Figure 6 is presenting Ohlms's ideas about the situation between today's web and e-business needs.

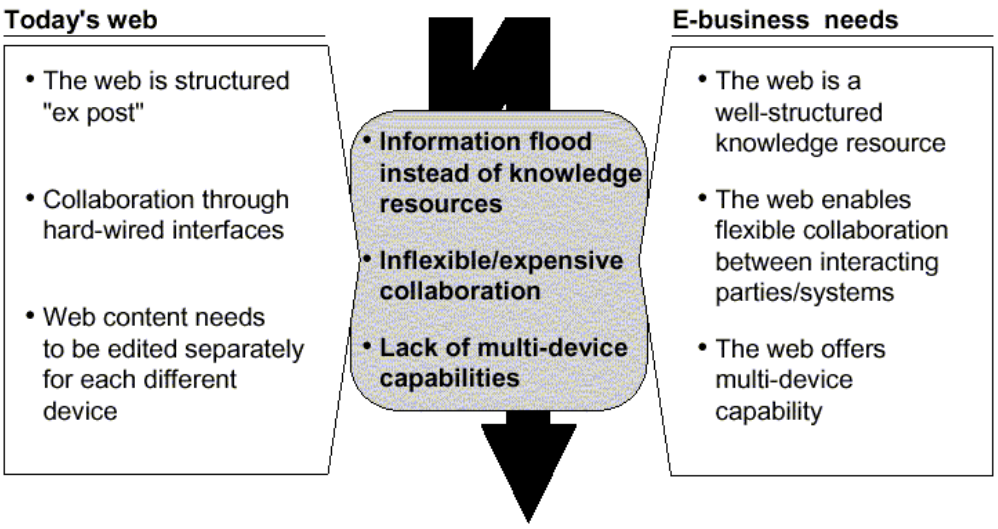

Figure 6. Today's web is less and less suited to cope with modern e- business needs (Ohlms, 2002).

E-business is one opportunity for semantic web in SCM. There are many market places and other solutions for commerce over Internet, and in many cases there are lot of information provided and also lot of needs for information. Semantic web could be solution to manage and find right information for end users. As semantic web idea is create information machine readable and semantic web is used for intelligent information search, so there might be great opportunity for semantic web in the field of e-business. As mentioned earlier, the e-business and e-commerce is very important part of SCM, could semantic web provide new business opportunities.

Ohlms has made a table of information technology trends and benefit from Semantic Web technology, which are presented in Figure 7.

Trend	Description	Benefit from Semantic Web technology
• **Information management**	• Metadata, content, and document management, business intelligence, and EIP	• Precise, elaborate knowledge modelling, generation, navigation, and retrieval
• **System integration**	• Process, application, and data integration, both intra- and inter-enterprise	• Flexible data integration through shared metadata layers/ontologies
• **Multi-device capability**	• Connectivity to ubiquitous electronic devices, e.g., active/passive sensors, and smart devices	• Multi-device capability through unambigious definition and specification of any web resource
• **E-procure-ment**	• E-enabling/tight integration of the supply chain, private/public exchanges	• Indirect benefits through easier information management/system integration
• **CRM**	• Mobile sales/field force, call center, self-service, e-/m-commerce	• Indirect benefits through all of the above

Figure 7. Most major IT trends might benefit from Semantic Web technologies (Ohlms, 2002).

As seen in Figure 7, system integration could be handled by Semantic Web technology. Ohlms has written (Ohlms, 2002), that flexible data integration through shared metadata layers or ontologies is one benefit from semantic web technology. Then there is rising new question, who makes the metadata? Organisations and companies have lot of doing in field of information technology, without creating metadata. But someday technology makes metadata creation easy, and if there is some standards for metadata, companies might take technologies like semantic web in use.

According Ohlms, the market adoption phase in years 2003-2007 is going to be:

- Creation of many heterogeneous new ontologies - RDF definitions proliferate, slowly achieving critical mass
- Large infrastructure vendors enter market; likely acquisition of ontology authoring/ management, and data collection tools
- Horizontal applications, e. g., proof and trust services, appear
- Opportunities for first vertical applications along the entire business value chain
    - Portal/ BI, e. g., web content creation, document/ knowledge management, business intelligence tools
    - R& D, e. g., development collaboration
    - SCM, e. g., e- procurement/ marketplaces, catalog management, workflow automation
    - CRM, e. g., e-/ m- commerce platforms, web services, multi- device support
    - ERP, e. g., multi- device payments/ exchange of financial information, expert finder

Ohlms has estimated that after the year 2007 the semantic web technologies market adoption phase is (Ohlms, 2002):

- RDF have achieved critical mass, starting to consolidate
- Carve- out: infrastructure industry consolidation and survival of only a handful of large players
- Some providers of horizontal applications, e. g., proof and trust services, or payment services, can establish de facto standards, gaining a strong business position
- Ubiquitous computing starts to enter mainstream phase, ontologies are embedded into IT products
- Ontologies become more sophisticated, simple agent applications proliferate

My opinion is that semantic web technology is not yet ready for take in use. Specially context, like supply chains, companies uses EDI or even RosettaNet, nut there is still large gap to take new rising technologies in use. Also software vendors (like ERP vendors) haven't yet based their solutions in semantic web technologies, so my opinion is that normal companies (like small and medium sized companies) have not even heard about semantic web yet. Ohlms' estimations of market adoptions are futuristic and my opinion is that semantic web does not have critical mass in field of Supply Chain Management by the year 2010. Web services are quite strong development area today. Many ERP and other software vendors have designed their solutions to utilise web services and solutions could be used over Internet. There is also opportunity for semantic

web technologies, so solutions will consist of intelligent semantics and ontologies. Still there is long way to achieve critical mass in the field of semantic web and web services.

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6 Assignment

Määrittele muutamia (2-3) sovellusalueita, joissa Semantic Web teknologiaa voitaisiin toimitusketjunhallinnassa hyödyntää. Minkä tyyppisiä toimintoja tai prosesseja voitaisiin mielestäsi Semantic Web teknologioilla hallita? Miksi Semantic Web teknologiat toimisivat valitsemissasi toiminnoissa ja prosesseissa nykyisiä teknologioita paremmin?