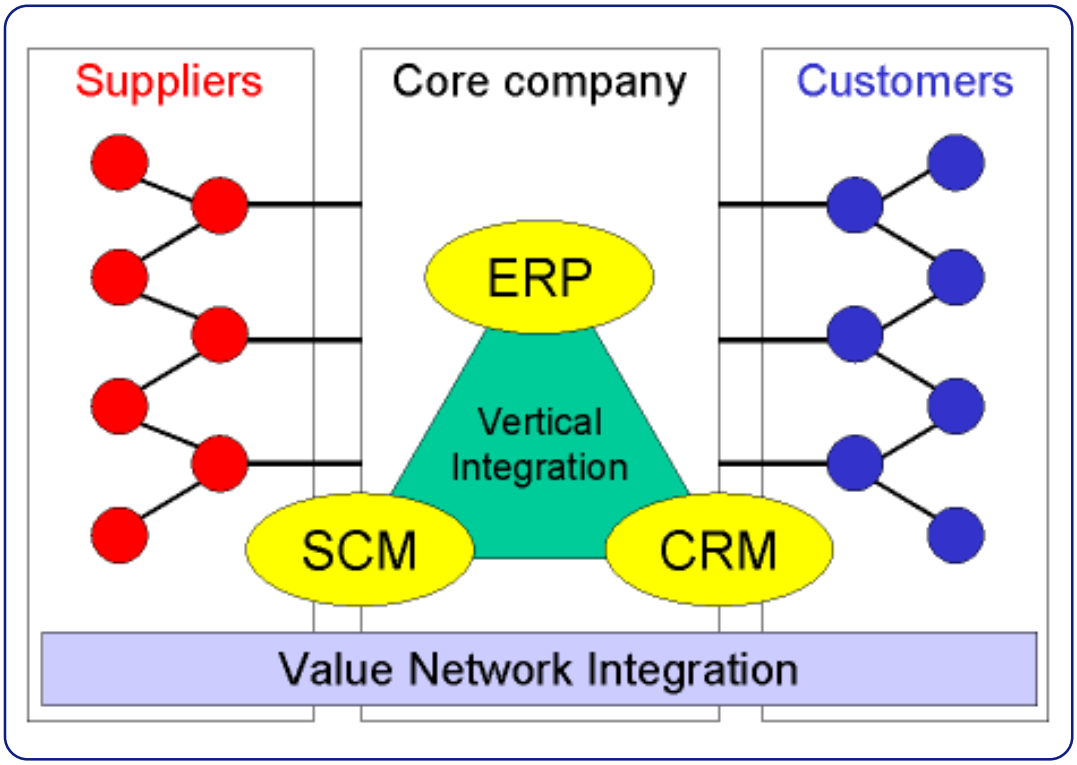
ESPOO 2002 VTT RESEARCH NOTES 2149



Jukka Hemilä

Information technologies for value network integration

VTT TIEDOTTEITA – RESEARCH NOTES 2149

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VTT Industrial Systems

ISBN 951–38–6056–6 (soft back ed.)
ISSN 1235–0605 (soft back ed.)

ISBN 951–38–6057–4 (URL: http://www.inf.vtt.fi/pdf/)
ISSN 1455–0865 (URL: http://www.inf.vtt.fi/pdf/)

JULKAISIJA – UTGIVARE – PUBLISHER

VTT, Vuorimiehentie 5, PL 2000, 02044 VTT
puh. vaihde (09) 4561, faksi (09) 456 4374

VTT, Bergsmansvägen 5, PB 2000, 02044 VTT
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Technical editing Maini Manninen

Otamedia Oy, Espoo 2002

Hemilä, Jukka. Information technologies for value network integration. Espoo 2002. VTT Tiedotteita – Research Notes 2149. 97 p. + app. 1 p.

Keywords enterprise networks, integration, supply chain management, value network

Abstract

Companies have increasingly focused on their own core business and created partnerships with other companies to increase their competitiveness. Linear supply chains of companies create the enterprise networks. The enterprise networks could produce wider product and service entities, and the entire network could be comprehended as a value adding value network for the product or service. VTT Industrial Systems has researched enterprise networks but there is also a need to research supportive applications for business and communications between the applications.

The objective of this study is to define which kind of applications are suitable for managing networked enterprises and supply chains, and how application integration can be achieved. Information sharing for the company's use and with the business partners improves the transparency of a dynamic business environment. The objective is to create a hypothetical model for value network integration in practice by combining the research results of this study. The research is focused on electronic contract manufacturing industry but the technologies and models are applicable also to other industries.

The supply chain and network management and management tools are studied in the literature survey and by using www-material from the Internet. The supply chain and network management and tools are studied also by interviewing software vendors. Information about supply chain management in practice is studied in a joint project by VTT and the customer company by interviews and discussions with the parties involved.

The conclusion of the study is a hypothetical model for value network integration in practice. By use of information technologies, it is possible to improve business and communication between enterprises. From the point of view of the enterprises, it is worthwhile to invest in enterprise networks and to improve the communications between the business partners.

Preface

VTT Industrial Systems have got a long history of researching and studying enterprise networks and their development. This study concentrates on clarifying the supply chain and networked enterprise concepts, and the tools to manage them. The information systems are used to share information for the organisation and for the business partners. Information sharing requires system integration, and the information technologies for value network integration will be presented and estimated in this study.

This study is a part of the InElog- and Polku -projects those have been going on at VTT Industrial Systems. InElog-project has started in May 2001 and will continue for 20 months. The aim of the project is to create an e-logistic model for an electronics contract manufacturer. Polku-project is developing different enterprise networks and methods to manage networks.

I would like to thank Professor Hannu Jaakkola of the Tampere University of Technology and M.Sc. Petri Kalliokoski of VTT Industrial Systems and Logistics Director Jyrki Luojumäki of Incap Electronics. The discussions with the Incap's employees were rewarding and have a great inpact in the practical case of the study. I would also like to thank the whole InElog projectteam and my colleagues for their invaluable guiding. I visited and interviewed a few software vendors and industrial companies during the study, and I would like to thank them too.

Espoo, June 2002

Jukka Hemilä

Contents

List of symbols

Browser	Software that allows you to find and see information on the Internet.
CORBA	Common Object Request Broker Architecture. The component-based programming technology, useful for floor level integration.
CRM	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.
DCOM	Distributed Component Object Model. The component-based programming technology, useful for floor level integration.
DTD	Document Type Definition. XML-document description method.
EAI	Enterprise Application Integration. EAI provides the integration of internal and external information systems and databases.
EDI	Electronic Data Interchange. The electronic communication of the business transactions (orders, confirmations, invoices etc.) of organisations with differing platforms.
ERP	Enterprise Resource Planning. ERP is an information system or process integrating all manufacturing and related applications for an entire enterprise.
FTP	File Transfer Protocol. A protocol that allows you to move files from a distant computer to a local computer using a network like the Internet.
HTML	Hypertext Markup Language. The code used to create a home page and is used to access documents over the WWW.
HTTP	Hypertext Transfer Protocol. The protocol used to signify an Internet site is a WWW site.
Internet	An international network of networks primarily used to connect education and research.
IP	Internet Protocol. The international standard for addressing and sending data via the Internet.

LAN	Local Area Network. Two or more local computers, that are physically connected.
MES	Manufacturing Execution Systems. MES is the name for production activity control and shop floor control.
PDA	Personal Digital Assistant. PDAs are small handheld portable computers.
PDM	Product Data Management. PDM is an important information system in production and manufacturing business.
RPC	Remote Procedures Call. Strong middleware technology on the markets.
SCM	Supply Chain Management. SCM systems are used to handle and manage supply chains and especially the processes.
Server	A computer with a special service function on a network, generally receiving and connecting incoming information traffic.
TCP	Transmission Control Protocol. A protocol which makes sure that packets of data are shipped and received in the intended order.
TCP/IP	Transfer Control Protocol/Internet Protocol.
WAP	Wireless Application Protocol. WAP is a protocol defining communication and information sharing methods.
WWW	World Wide Web. A graphical hypertext-based Internet tool that provides access to homepages created by individuals, businesses, and other organisations.
xCBL	XML Common Business Library. xCBL is the XML component library for business-to-business e-commerce.
XML	eXtensible Markup Language. XML is designed to provide a flexible and adaptable information structure to create documents or communication messages used over the Internet.

1. Introduction

1.1 Background of the study

Today's business has intensified and companies have to work harder for success than before. Companies have had to focus on their own core business areas and use different strategies than competitors and improve their own competitiveness. Companies are now moving from a manufacturing and product-oriented business world to value chain optimisation and customer-oriented type of action. Confidence, co-operation and open information sharing are central for this new type of action. These three things are filtering to the companies' electrical co-operation or e-collaboration (Fiilin 2001). The question now is how it is possible to focus on some special business areas. Suppliers, manufacturers, distributors, retailers and a host of service organisations have discovered that they must either transform their operations and tactics or be bowled over by competitors with more innovative and aggressive supply networks (Poirier 1999). By focusing companies could become strong and strategically attractive network partners. A company can back up the development of its own competitiveness with network partnerships, but its business cannot be based on that (Ollus et al. 1998). Controlling and handling networks requires *network management*.

In today's business, organisations have formed networks for supplying material, manufacturing or creating services, storing and distributing goods and delivering products and services to the customers and consumers (Poirier 1999). The *supply chain* is the network of organisations that are involved in the different processes and activities that produce value in the form of products and services for the ultimate customer or consumer (Christopher 1998). *Supply chain management* is the name of the action of managing supply chains.

But how are networks and supply chains handled in practice? Information technology occupies a leading role when handling and improving supply chain and network management. There are many internet- and mobile-based software solutions, which are specially made for this kind of business action. Companies have usually their own IT-systems, specially made for them and interaction with other organisations could be a problem. Integration to the systems of other organisations makes data exchange possible and that brings competitiveness. IT-system integration is a big challenge in supply chain and network management.

The idea of this study is to clarify what supply chain and enterprise network management is and which tools are used to control and manage them. That is the way towards value network integration. The practical case, scope, objectives, assumptions and methodology of this study are explained later.

1.2 InElog – Supply chain in contract manufacturing research project

In the industrial community, the meaning of effectiveness of action has always been broad. Lately the new industrial paradigms and information technology solutions have created many different opportunities to improve, rationalise and intensify business. Business between companies has been changed as a result of business globalisation and a networking economy. There are new business operation models and networking of enterprises is seen to be the main part of this new type of business action.

This study is a part of the InElog-project (Incap E-logistics) of VTT Industrial Systems. The InElog-project is connected to logistic supply chain management and development of contract manufacturing. The aim of the InElog-project is to develop the company's supply chain management towards customers and business partners and also create logistic actions to be the company's new business focus enhancing the service concept. In developing the supply chain management, information technology has a very important role.

The case company of the InElog-project is Incap Electronics Ltd. The business area of the company is electronic contract manufacturing. Incap Electronics Ltd. is part of Incap Corporation, which is quoted on the Helsinki Exchange Stock Market. Figure 1-1 below presents the focus of the InElog-project from the point of view of Incap Corporation. The dashed line indicates the project focus including Incap Electronics and its four factories.

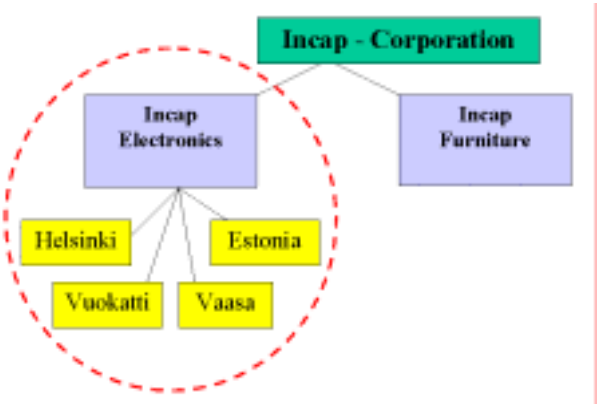

Figure 1-1. Incap Corporation and focus of the InElog-project.

Incap has an idea and a strategy for the future for develop logistic supply chain. Incap is now creating a new strategic concept and building up to a strategic change and that way towards a new business concept. During the project several Incap's suppliers, customers and other important and interest business partners will be contacted. Their opinion is meaningful for the project and the study.

InElog-project started in May 2001, and will continue 20 months. The project has three main parts:

1) Analysis, where Incap's business actions (specially supply chain management and enterprise network) and development target will be analysed.
2) Development, where new logistic and service concepts (e-Logistic) will be developed.
3) Implementation, where new concepts will be implemented and taken in use.

VTT Industrial Systems is a subcontractor in the project and Incap is buying research and development services from VTT Industrial Systems. VTT Industrial Systems has wide experience of business action development and VTT handles the research aspect of the InElog-project. VTT reports of the InElog-project stages and results on public forums and by publications.

This study forms a part of the analysis and development sections of the InElog project. The implementation stage of the project is scheduled for later than the dead line for this study. Nevertheless, this study includes also sections on the implementation and integration into practice.

1.3 Scope and objectives of the study

The scope of the study is to define supply chain and network management as a concept and to specify tools for the management. The purpose of the study is to define information technologies and software solutions suitable for networked business actions.

The main objective of this study is a practical model for value network integration. For this, appropriate software solutions and information technologies for logistical supply chain management are charted. Another objective is to estimate the applicability and potentiality of the solutions referred to in the above for improving the company's business processes included in the project. Before appropriating the software solution and information technologies, the object is to clarify supply chain management and enterprise network as concepts. There are ideas, methods and facts behind the supply chain and network management that are not obvious. Figure 1-2 shows how enterprises are networked and where supply chain management is needed in networked enterprises. The Figure 1-2 also shows how different organisations are linked in the same information network, for example Internet, Extranet or Intranet.

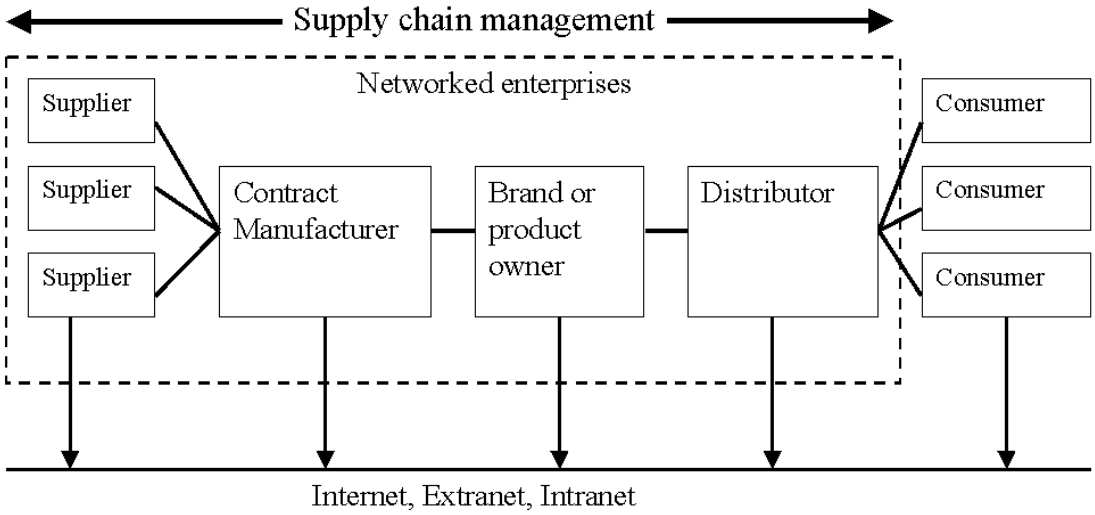

Figure 1-2. Supply chain management and enterprise network in value chain.

One important aspect of this study is to clarify the techniques and solutions between organisations and the Internet, as shown by arrows in Figure 1-2.

The objectives of the study are:

1. Clarify supply chain and network management as concepts
2. Introduce supply chain management tools
3. Clarify how these tools could be integrated and what are the technologies for this integration
4. Introduce supply chain and network management in practice, based on the business case of this study
5. Hypothetical model for value network integration in practice

In conclusion, the aim of this study is to reach its objectives and find solutions for the hypotheses during the time scale that is set.

1.4 Hypotheses of the study

The main assumption of this study is that the use of information technologies will improve co-operation and communication between networked enterprises and organisations. Organisations usually have their own information technology solutions and data interchange with other enterprises could be difficult, but not impossible. Another assumption of the study is that interaction and integration between different solutions could be possible.

The main assumption breaks down into other assumptions. When talking about co-operation and communication between networked enterprises, we could talk about processes between enterprises. There could be a process map of how enterprises act in a network and what the main processes in the business between networked enterprises are, for example order and delivery processes, manufacture planning and forecasting processes. There could also be a model for the value network including supply chain management and network management. Supply chain and network management tools are known, but is there a model how these different tools could be integrated?

The study includes a practical industrial case. This case will introduce how the supply chain and network management is handled in the real world. The section also tries to explain how integration ideas could work in an actual situation. The hypothesis for the practical case is that the presented ideas for the supply chain, network management and integration could be used in the real world.

These hypotheses will be evaluated in this study. Co-operation and management tools will be evaluated in chapters 2 and 3. The hypothesis about the integration technologies and communication aspects will be evaluated in Chapter 4. These sections include also models for interaction and tools used in the supply chain and network management and also in the business processes. The practical and real world hypotheses will be evaluated in Chapter 5. The value network integration is studied in Chapter 6.

1.5 Methodology of the study

The main methodology of the study is a literature survey. There is a wealth of information available about supply chain management and information technologies. Chapter 2 (Network management) contains basic information and business process model and a process map, and these will be studied in the literature survey. Chapter 3 (Network and supply chain management tools) introduces several different tools and software solutions, whose information is studied in the literature survey and by using www-material from the web-sites of the software vendors, and several software vendors will also be interviewed. Chapter 4 (Advanced information technologies for supply chain integration) is based also on www-material and literature survey.

Chapter 5 is a case study and it is based on the project material, interviews and literature survey. The project group members, key persons at Incap Electronics and also industrial companies connected with the project as a vendor, supplier, customer or other important partner were interviewed. Chapter 6 is based on the literature survey, research and interviews with other researchers and consultants.

During the study project interviews and discussions took place with colleagues, consultants and other relevant persons, whose opinions and knowledge are meaningful for this study.

2. Network Management

2.1 Basic concept of network management

A network consists of companies who share the same interests and act together to win in the markets. A network is always composed of individual companies who act in a network to succeed and survive in the business. Co-operation is usually voluntary (Ollus et al. 1998). One of the most important goals of networking is effective adaptation to changing circumstances. Hyötyläinen has created the model of strategic enterprise network and Figure 2-1 is presenting that model (Hyötyläinen 2000). The strategic network is the core of the networked enterprises. A strategic network has one distinct core company that has a central role in the network. A central role means that the core company creates and develops the strategic network and also maintains it. After the strategic network are partner companies in the model of networked enterprises. Partner companies are co-operating with the companies in the strategic network. The relationships between the strategic network companies and the partner companies are close and long term. The third level includes delivery contract companies needed in distribution and logistics, but these are outside the network. (Hyötyläinen 2000).

Ollus et al. has presented the idea of virtual companies (Ollus et al. 1998). Hyötyläinen's strategic enterprise network model includes virtual company idea and it is showed in Figure 2-1. (Hyötyläinen 2000). A virtual company is set up for concrete business tasks, for example, customer projects, delivery projects or product development projects. The consistence of a virtual company depends on the needs and it includes only the best possible know-how from each company. The idea is that together the companies could have special know-how they would not have individually. After the concrete business task, the virtual company is dissolved. (Ollus et al. 1998).

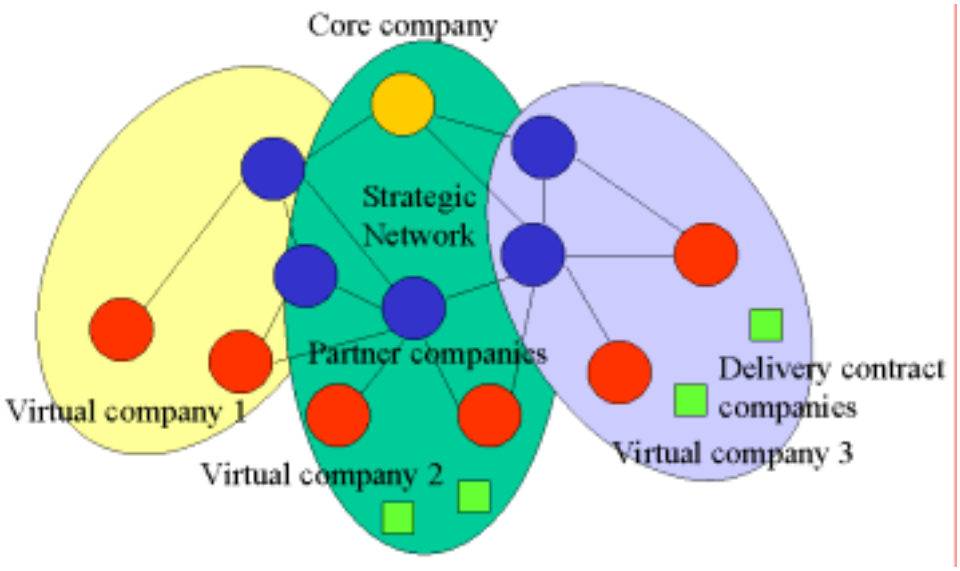

Figure 2-1. Model of strategic enterprise network (Hyötyläinen 2000).

One of the reasons why it is reasonable for companies to create networks and get networked business partners is time saving. To survive in rapidly changing markets, organisations and their way of operation should change as the markets change. One solution in the fight against the increasing speed of business is to make things parallel. The idea is the same when comparing sequential and multiprogramming systems in a computer. Figure 2-2 shows the idea of time saving in a networked operation where different actions are made parallel. (Ollus et al. 1998).

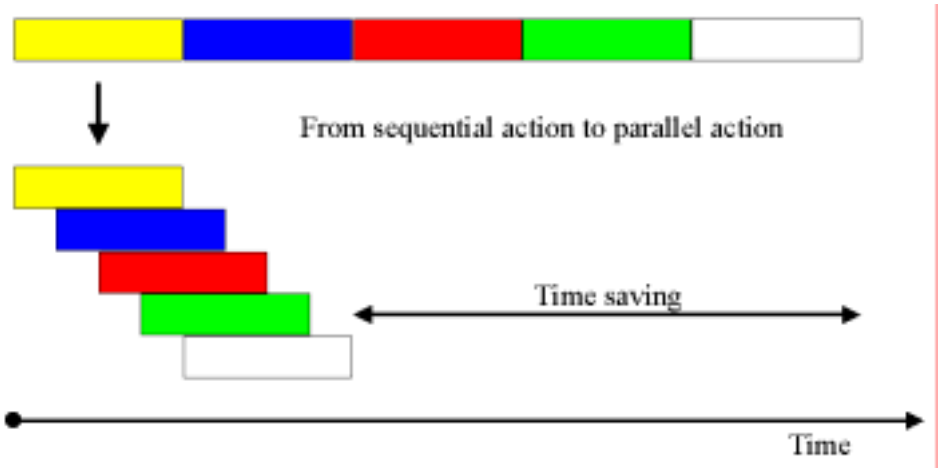

Figure 2-2. Making different actions parallel instead of sequential aims in time saving (Modified from Ollus et al. 1998).

In serial action, all information is available for use when continuing to the next step. But in parallel action this is not the case. Therefore, a new challenge has emerged: to share information in real time when actions and processes advance.

2.2 Supply chains in networked enterprises

There are several definitions for the supply chain. Christopher has defined that the supply chain is the network of organisations that are involved in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer (Christopher 1998). The supply chain encompasses every effort involved in producing and delivering a final product, from the supplier's supplier to the customer's customer.

A supply chain is a system through which organisations deliver their products to the customers and it is a dynamic environment. The supply chains have become more complex in many industries, and the distance between the manufacturer and the end user has increased. More and more material is also moving between companies along the supply chain. Nowadays, it has become vitally important to act fast and to be more responsive. Short order cycle times are a prerequisite for competing successfully in the

markets. Under such conditions, it has become important to get to know more about what the suppliers are capable of and what the customers want. To accomplish this, many companies try to improve visibility along the supply chain by using more advanced information technology. Visibility and transparency in the supply chain are very important aspects and so every player in the chain gets the same information at the same time. The supply chain participants are interested in important information for example: forecasts, product and production information, visions, market position information, and availability of material.

Figure 2-3 shows a traditional linear supply chain with suppliers and other organisations, which produce products for the end users. Traditionally, the supply chain is a clear chain including the sequential players, the material flow and the information flows between them.

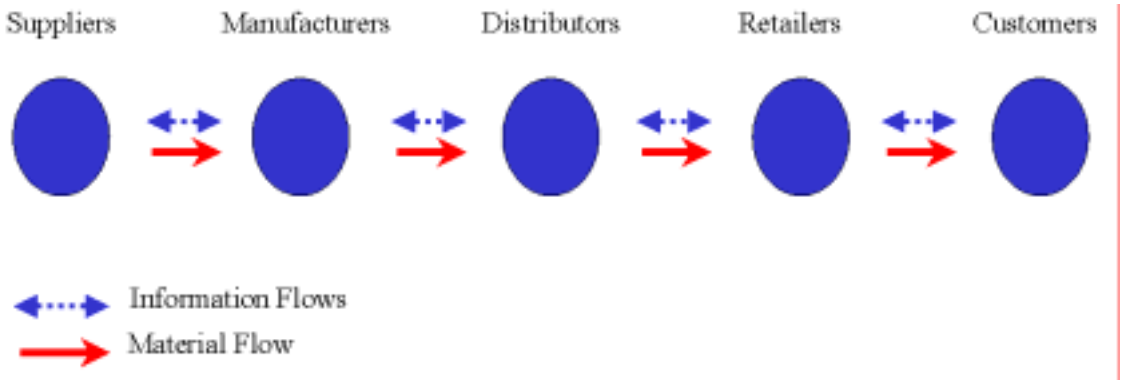

Figure 2-3. Traditional supply chain.

The traditional supply chain model is a simple model for demonstrating the idea of a supply chain, but in today's business this is not enough. The model of a strategic enterprise network (Figure 2-1) gave a clear presentation of networked enterprises and it can be modified to show how the supply chains are located in the enterprise network. Figure 2-4 shows an extended model of a strategic enterprise network with two supply chains.

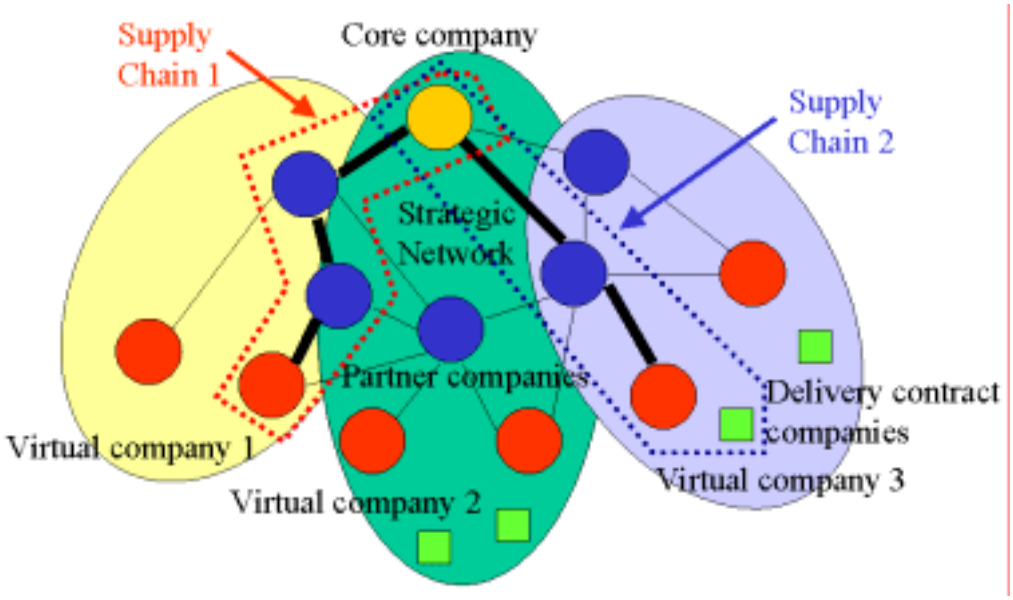

Figure 2-4. Supply chains in strategic enterprise network (modified from Hyötyläinen 2000).

Another point of view is to think that the core company is the centre of the network of suppliers and customers. Modifying the idea of supply chains in the strategic enterprise network, presented in Figure 2-4, the core company can be showed as the centre of a network of organisations. Christopher has presented the model of the supply chain itself is a network (Christopher 1998) and that model can be extended to include delivery contract companies as in Figure 2-4. It has been suggested that a supply chain could be defined as: "A network of connected and interdependent organisations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users." (Christopher 1998). In the model in Figure 2-5, there is no strategic enterprise network, so the partner companies do not work with each other, but they act with the core company. In that way the one supply chain consists of the core company, partner company, partner's partner and delivery company.

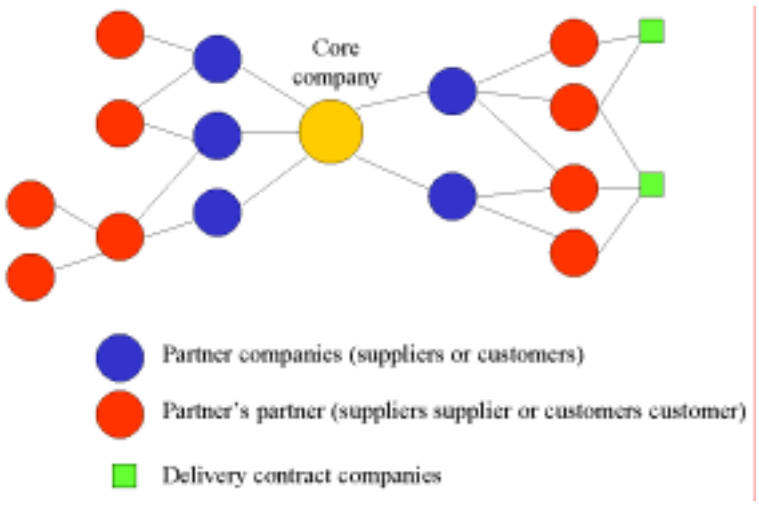

Figure 2-5. Supply chain as a network (Modified from Christopher 1998).

The two presented models (Figures 2-4 and 2-5) introduce the supply chain idea from two different angles depending on what kind of a network is around the core company and what kind of a strategic position the core company has in the network. The situation is also dependent on the core company's business strategy, does it need partners who act also with each other or just partners who act individually with the core company. The situation is usually case-specific.

Information technology is advancing at a phenomenal rate in terms of speed and storage capability with simultaneous dramatic reductions in cost and size (Bowersox and Closs 1996). Figure 2-6 shows how the Internet is connected to the supply chain and the material flows between the supply chain players. The model is extended from the model presented in Figure 2-3 to include the Internet connections. As you can see, there are more information flows than material flows. That is the reason why information technology has got a key role in the supply chain. In Figure 2-6, the information flows could be Internet connections or other ways of communication, but nowadays usually communication and information sharing happens via the Internet. Moreover, communication takes place usually in the supply chains using EDI (Electronic Data Interchange, which technology is presented later). EDI has been widely used over 20 years in business to business communication and information sharing.

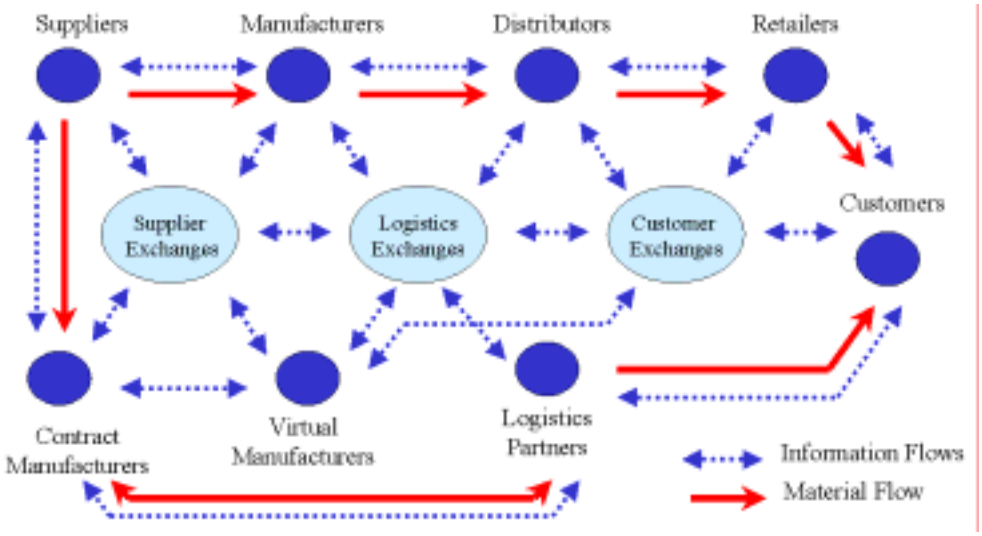

Figure 2-6. Internet connected supply chain.

The supply chain can provide immense competitive advantage to the company, if it is managed properly. As shown in Figure 2-6, there could be several Internet connections or other kind of information flows in the supply chain. Information flows are aspects that make the supply chains more competitive and stronger in business.

When a product offers better features or better quality than the competing product, the customer goes for the product even when the service is not good. But in today's business

features and quality of the products are comparable and customer service acts as the positive value adder. Customer service includes issues such as delivery time, response time, ease of purchase, packaging, support, sales service, etc. The customer always compares these three criteria (features, quality and customer service) with the price of the product and if these benefits match or exceed the price, the purchase is made. Hence to make a sale, the company tries to maximise the value delivered by these three factors. When talking about well-managed supply chains, one could also talk about value chains or value networks. When the chain produces more than just the core product the customer could get more value from the product. Hirsch et al. has introduced in that situation the value chain produces an extended product (Hirsch et al. 2001).

The extended product includes the following elements (Hirsch et al. 2001):

- Technology enablers and solutions resulting from developments such as e-commerce, e-business or more general multi-mode business
- A combination of a physical product and associated services/enhancements that improve marketability
- Intelligent, highly customised, user-friendly tangible products including embedded features, such as maintenance
- Intangible extended products that are information and knowledge intensive and can consist of services, engineering, software, etc.
- Customer focus has shifted from the physical product to the associated value-added services

Bowersox and Closs have presented that a successful supply chain relationship requires individual excellence, importance, interdependency, investment, information, integration, institutionalisation and integrity, and these rules are known as the eight Is that create a successful supply chain partnership (Bowersox & Closs 1996). Table 2-1 is presenting those eight Is.

Table 2-1. Eight I's that create a successful supply chain partnership (Bowersox & Closs 1996).

Individual excellence	Both partners are strong and have something of value to contribute to the relationship. Both are motivated and want to enter into a partnership.
Importance	Relationship is part of the partners' strategies and it plays a key role in the partners' long-term goals.
Interdependence	The partners need each other and neither can accomplish alone what they can together.
Investment	The partners invest in each other to demonstrate their respective stakes in the relationship and each other. The partners devote financial and other resources to the relationship.
Information	The partners share openly information necessary for making the relationship work, including their objective and goals, technical data and knowledge of conflicts.
Integration	The partners develop linkages and shared ways of operating so they can work together smoothly.
Institutionalisation	The relationship is given a formal status, with clear responsibilities and decision processes.
Integrity	The partners behave toward each other in honourable ways that justify and enhance mutual trust.

Then there might arise new questions, why the supply chains? In today's business, enterprises have founded or bought new manufacturing factories or have expanded geographically for other reasons. Multiple locations with different transport and storage facilities make control and monitoring much more difficult. By thinking all actions as processes and by using the idea of a supply chain makes the business effective and stronger. Supply chains are one solution for an organisation to survive and get stronger in business.

It is not enough to understand what supply chains are and how to create them, the enterprises should also manage them. Supply chain management (SCM) is important to benefit from and use all potential of the supply chain.

2.3 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 divides 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 adds 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.

SCM ensures an efficient product flow and information in a timely and dependable way. An efficient information flow requires transparency in the chain. Linking the information systems together requires integration and synchronisation between the systems. Ultimate success in business depends on much more than managing the supply chains, but SCM is a very important aspect.

2.4 Processes in supply chains

Business processes use information to manage all actions that add value. Tompkins defines that from the point of view of the business processes, the supply chain is not a process, but an approach as Just-In-Time (JIT) or Quick Response (QR). (Tompkins 2000). Despite not being a process by itself, the supply chain includes processes.

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 2-7 (Kalakota & Robinson 2001). First in the Figure 2-7 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 2-7 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 2-7 is execution, which includes all actions to make things happen, such as production scheduling and execution, warehouse and transportation management.

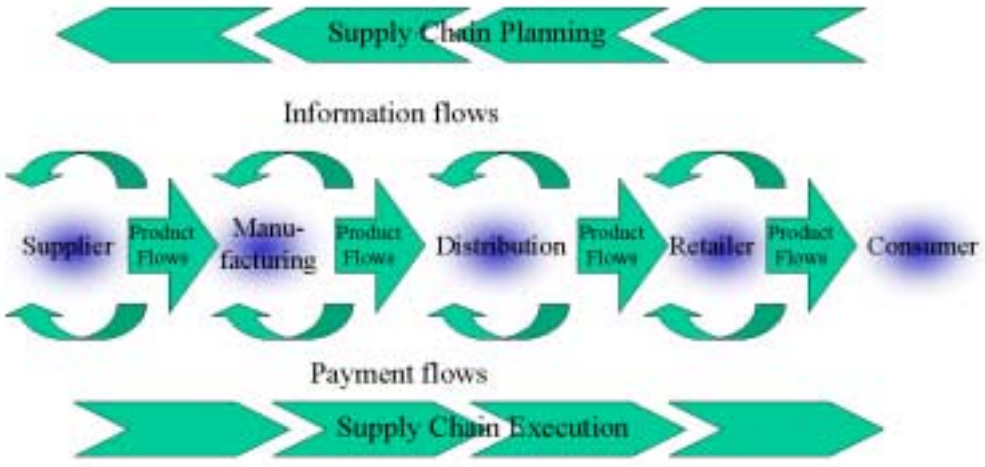

Figure 2-7. A Process view of the supply chain (Modified from Kalakota & Robinson 2001).

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.

Christopher has presented the idea of "value-adding" time and "non-value-adding" time in supply chain processes (Christopher 1998). This idea is the same as usually in processes. In simple terms, value-adding time is time spent doing something that creates a benefit for which the customer is prepared to pay. On the other hand, non-value-adding time is time spent on an activity whose elimination would lead to no reduction of benefit to the customer. In many cases these value-adding problems are connected to logistic processes, for example stocking and delivery. (Christopher 1998).

After this presentation of information about SCM ideas and processes in supply chains, the next question is how to manage them and what the tools for SCM are.

3. Network and Supply Chain Management Tools

3.1 Meaning of network and supply chain management tools

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 3-1 (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 3-1 shows also the need for integration between the different systems.

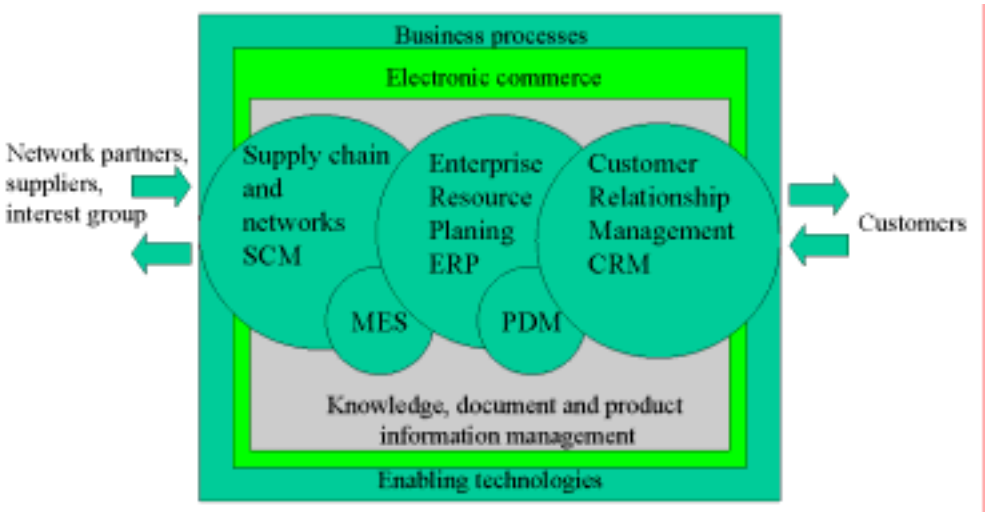

Figure 3-1. Frame of reference for perceiving information systems (Modified from Luomala et al. 2001).

As seen in Figure 3-1, 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 3-1 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.

3.2 Enterprise Resource Planning (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

ERP serves the needs of the people in finance as well as of the people in human resources and in the warehouse. Each of those departments typically has its own computer system, but ERP may combines them all together into a single, integrated software program that runs off a single database so that the various departments can more easily share information and communicate with each other. Nowadays ERP systems have additional characteristics (O'Leary 2000):

- support for multiple currencies and languages (critical for multinational companies)
- support for specific industries (there are specific ERP systems example for health care, chemicals and banking)
- ability to be customised without programming

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. Integration and information sharing are discussed further in the following chapters.

The most known ERP vendor is SAP, but there are many similar vendors globally. The solutions of these global vendors are so extensive, that one solution is enough to handle all processes and actions in an enterprise. These well-known ERP systems are usually expensive investments, so it is reasonable only for large organisations to implement such a solution. Lighter ERP systems are widely used in small and medium sized organisations, and vendors of this kind of solutions in Finland include for example Liinos and Solagem.

3.3 Supply Chain Management (SCM) systems

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. Good SCM systems include acquisition (source), manufacturing (make) and logistics (deliver), but there could be also warehousing (store) and market (sell). There are short-term and long-term decisions within each of these processes. For the decision making, the SCM software solution could include Supply Chain Planning (SCP) and Supply Chain Execution (SCE) systems. SCP and SCE were introduced in the chapter on supply chain processes and in Figure 2-7 (A process view of the supply chain, modified from Kalakota & Robinson 2001). From the system and software point of view, SCP systems provide tools to optimise the entire supply chain and SCE systems provide the real-time data companies need to execute their supply chain and logistic plans.

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. The most known global SCM tool vendors are SAP and i2.

3.4 Customer Relationship Management (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 3-2 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 3-2. 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). The following Figure 3-3 presents the customer relationship lifecycle (Luomala et al. 2001). First in the upper part of Figure 3-3 there are the different steps of the customer's purchase and usage processes. The process starts with the need that the customer has identified and continues to a new need or exit steps. In each step the customer has different needs and answers and solutions for these needs should be provided by the organisation. Organisations have usually marketing, logistics, helpdesk and after-sales services, but information sharing between these actions is usually insufficient. (Luomala et al. 2001).

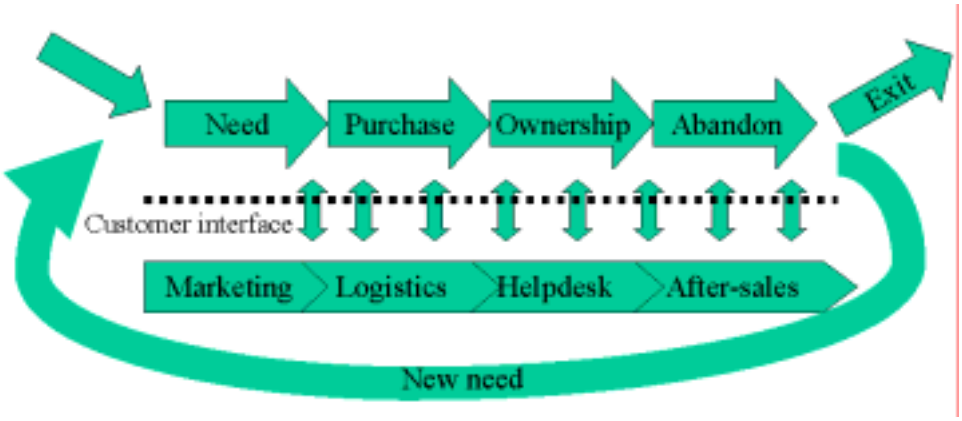

Figure 3-3. Customer relationship lifecycle (Modified from Luomala et al. 2001).

CRM systems and solutions include sales (Technology Enabled Selling, TES), customer service (Customer Service and Support, CSS) and marketing solutions (Technology Enabled Marketing, TEM). Well known CRM solutions are SAP and Peoplesoft, but there are also many lighter versions of CRM on the markets.

3.5 Manufacturing Execution Systems (MES)

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).

MES Systems are factory floor information and communication systems with several functional capabilities. The Figure 3-4 below presents the MES system components. The core functions and support functions are shared in the MES system. The centre component is the Planning System Interface, which is the link to the ERP or another management system. Functions of the MES core are shown in Figure 3-4. Core functions, such as work orders and material flows, are directly connected to production and manufacturing. Support functions, for example quality control support the core functions, and support functions are shown also in Figure 3-4.

Figure 3-4. The MES system: core and support functions.

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.

3.6 Product Data Management (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).

The same advantages of PDM systems are valid in networked enterprises. In contract manufacturing and subcontracting, product data management is emphasised and information sharing linked to product data must be fast and dependable. A PDM system is a good investment, and if integrated to an ERP, it makes the organisation strong and competitive on the markets. Some ERP systems include PDM components and functionality, but there are also purer PDM systems.

3.7 Supply chain management tool vendors

There are many vendors, who offer knowledge and solutions for supply chain management. This chapter is based on software vendor interviews made during the study, on expositions, www-sites and literature material. Usually the basic idea is the same, to provide an enterprise resource planning (ERP) solution and Internet or other connection to business partners. As stated before, ERP, SCM and CRM systems are leading products in the market. Many systems have features from other systems and sometimes it is difficult to define which system is an ERP or another named product. Global software vendors provide very different solutions for different needs. The biggest software vendors usually sell software product licenses and aim at a significant global market share in the information systems of many business areas. The biggest software vendors do not sell any supplementary services or consulting. Normally there are dealership contracts for local selling companies and they are accountable to the vendor for the implementation and consulting. Smaller and local software vendors with their own products usually prove also additional services and consulting.

The normal starting point is to clarify the needs and expectations of the organisation. Small and medium size organisations have naturally smaller needs than large companies. Independent of the size of the organisation, the basic need is the same: to get the information system to improve the competitiveness of the organisation. Then the next thing is to clarify the scalability of the systems, because there are different solutions for a global business and for a local manufacturer. After the requirement specifications, the organisation can study who provides the solution to answer these requirements.

The largest market share for SCM and ERP software at the global level is held by SAP. Other large global vendors are Oracle, Peoplesoft and J.D.Edwards, whose market shares are also in the same category as that of SAP. The solution of SAP (Systems, Applications and Products in Data Processing) is called mySAP.com, and today SAP is installed in over 17000 organisations in over 100 countries around the world. SAP is known to be the largest ERP solution on the market and it is also a very expensive investment. SAP has a sales office in Finland but there is no product development. There are also few software vendors in Finland, such as XR Solution, who develop modules and additional software to SAP. (SAP 2002).

Oracle Corporation is the world's second-largest independent software company. Oracle Applications Release 11i is Oracle’s ERP solution, which is a fully Web-enabled application. Oracle has globally the second largest market share of the ERP markets, but despite that, it is not very well known in Finland. Oracle is very widely used as a database vendor, and with Microsoft they almost dominate the database markets. Almost every solution is based on an Oracle or Microsoft database, although most of the ERP systems are not dependent on any specific database. (Oracle 2002).

PeopleSoft hold the third largest market share globally. The ERP product of PeopleSoft is called PeopleSoft 8 and the application is available via a Web browser. PeopleSoft offers complete integration between PeopleSoft's ERP and Vantive's CRM applications, and will host applications on the Web. Also in summer 2001 PeopleSoft introduced a partnership with Sun Microsystems, and today they provide a CRM solution which is based on Sun's Java technology. PeopleSoft is not well known in Finland, and it does not have a retailer in Finland. (PeopleSoft 2002).

J.D. Edwards offers a solution called OneWorld. OneWorld is independent of hardware or database, and the user interface is based on Internet technology, so OneWorld can be used with a www-browser. OneWorld ERP is integrated in the supply chain management application made by Numetrix. J.D. Edwards offers CRM and business-to-business procurement systems by reselling applications from Siebel Systems Inc. and Ariba Inc. It is also entering the online business-to-business marketplace niche through a reseller agreement with Tradex Technologies Inc. The ERP of J.D. Edwards is based on their own technology, XPI, which enables connection and integration of the organisation to its business partners' systems. As seen, J.D. Edwards has many partners to provide large and extensive ERP solutions. J.D. Edwards has about 6 000 customers around the world. In Finland, the representative of J.D. Edwards is Major Blue Oy. Major Blue also provides its own CRM and HRM solutions to extend the ERP by J.D.Edwards. (MajorBlue 2002).

This was a short introduction to the best known ERP and supply chain management vendors. There are several other smaller vendors, also in Finland. The table 3-1 presents the functional modules of the solutions of these vendors.

Table 3-1. The Functional modules of some ERP solutions of the largest vendors.

Function	**SAP R/3**	**PeopleSoft 8**	**Oracle 11**	**J.D. Edwards OneWorld**
Distribution	X	X	X	X
Finance	X	X	X	X
Front Office	-	-	X	-
HR	X	X	X	X
Web-Based Procurement	-	-	-	X
Logistics	X	X	-	X
Manufacturing	X	X	X	X
Materials Management	X	X	-	X
Order Management	X	X	X	X
Project Management	X	X	X	-
SCM	X	X	X	X
Scheduling	-	X	-	X

The case company of this study, Incap Electronics, is using an ERP solution called IFS. IFS (Industrial & Financial Systems) is a Swedish company, founded in 1991. The company's ERP solution is called IFS Applications 2002, launched in March 2002. IFS provides component-based solutions for small and medium size organisations. IFS Applications –solution is based on the web and portal technologies and it provides over 60 modules and components to support business processes. IFS have more than 3200 employees around the world and sales offices in 43 countries. In Finland IFS employs more than 70 employees and has offices in five cities. (IFS 2002).

Kettunen and Simons have presented ideas of Application Service Providing (ASP). ASP is the name of the service provided by an Application Service Provider. The abbreviation for both is ASP. An Application Service Provider is a company that provides information technology services and software applications for customers by renting. The customers pay for each service according to use. The services include usually software, updating, maintenance and helpdesk. (Kettunen & Simons 2001).

Figure 3-5 presents the idea of ASP, where different software and technology vendors provide solutions and the Application Service Providers connect the different solutions and provide them for the end user companies.

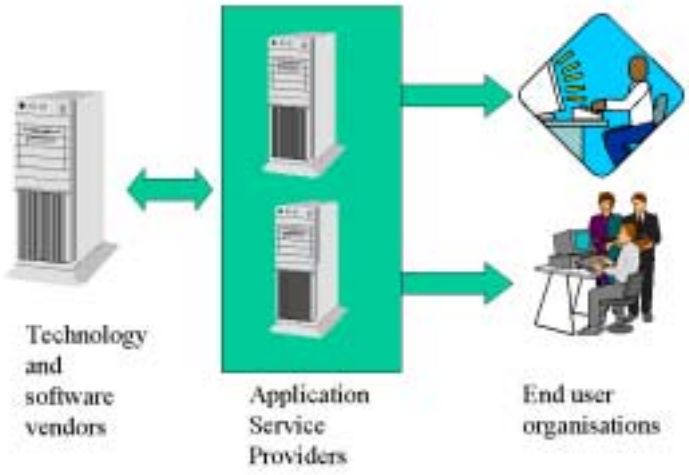

Figure 3-5. Application Service Providing model.

The end users have a variety of solutions to choose from and the organisation can select the services it takes. There are different services for different needs:

- full service providers
- hardware providers
- software providers
- network service providers
- system integrators

The organisation should clarify its needs so that it can choose a suitable service provider. ASP provides the newest versions of software for the organisation, so updating is included in the price. The organisation does not have maintain the software at all, just use it.

The advantages of the ASP concept for an organisation are:

- Newest software versions, without updating and maintenance
- Organisation can focus on its core business
- Use of solutions can be increased or decreased as the situation and needs change
- Lower investment costs than buying the solutions and licenses

The ASP service is very cost efficient, flexible, easy and competent for an organisation that does not want to own its information systems.

4. Advanced Information Technologies for Supply Chain Integration

4.1 Basic concept of 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. Figure 4-1 presents the basic idea of integration. The horizontal arrows show the different integration levels, where application integration includes technology and functional integration.

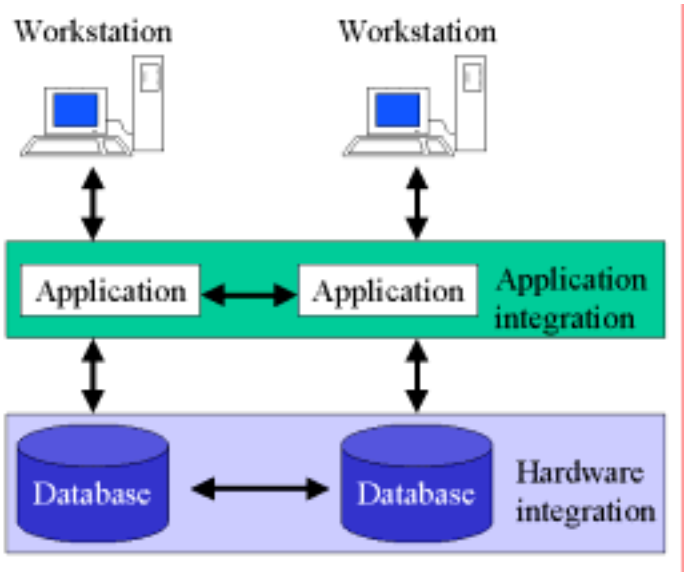

Figure 4-1. Basic concept of integration.

Luoma et al. has defined integration process steps. The first step of the integration is to establish what the core business is and what the core business processes are. The aim is not a catch-all model; the aim is more to concentrate on actions and situation changes that the integrated systems need from each other. It is important to define from which action each system gives information to others and where the systems get the information for use. At the end, the actions are modified for sending to other systems through using middleware or other technologies. (Luoma et al. 1999).

Middleware technology is today a key technology in application integration. Middleware creates an interface or bridge between two different systems and allows the systems to pass data between them. Middleware may consist of custom software written in-house or a software package. Connections between systems are possible using two different middleware architecture models:

- point-to-point model connects two systems to each other
- many-to-many model connects many systems to each other

Point-to-point connections are easier to handle than many-to-many systems. Point-to-point technology uses message-based technologies like EDI (Electronic Data Interchange) and Message-Oriented-Middleware (MOM). Examples of MOM products are MSMQ (Microsoft Message Queue) and IBM MQ Series. Message Brokers are solutions extending message-based solutions so that many-to-many data exchange is possible. New solutions for integration are integration servers, but it is also possible to use distributed objects or technologies useful for component-based programming, such as Common Object Request Broker Architecture (CORBA) and Distributed Component Object Model (DCOM). These technologies are used also in MES and ERP integration

and are a good choice for middleware technology. XML language has also risen to be one of the most used technologies in data exchange and programming. (Luomala et al. 2001, Laudon & Laudon 2000).

Database integration is usually called hardware integration. Databases include also the software to run and manage the database, but databases can be taught to be the hardware of the system. The database is the basic element of any kind of information sharing. SQL (Structured Query Language) and ODBC (Open Database Connectivity) are de-facto standards today in database technology. SQL is used to get information from database by queries and ODBC is a library of standardised transparent data access functions. ODBC provides a standard API (Application Programming Interface) so that any application can use to access data. The API supports queries and updates constructed using SQL. Integration can be achieved between two databases, between a database and an application or between two applications, where one of them is connected to the database.

Integration has two levels in business: integration inside and outside of the organisation. The following chapters (chapters 4.1.1 and 4.1.2) present the differences and special features on these levels.

4.1.1 Integration inside an organisation

Integration inside an organisation means that the organisation's own systems are integrated to each other. Integration inside the organisation covers two levels: integration of functional areas and integration between the organisation's physical locations. Usually organisations have one database for information and all users are connected to that. That is integration on the basic level, having the same database but no special common functionality. Integration inside the organisation is usually more than basic integration. Another level of integration inside an organisation is the integration of functional areas. Functional areas cover different processes that need information sharing and integration, for example sales, inventory and finance. As introduced earlier, organisations have ERP and other systems that have to share information. Integration inside the organisation is called vertical integration. Integration between the locations covers the enterprise's different legal entities (large companies usually have several legal entities) and its different physical sites such as factories, warehouses and sales offices. The benefits of integration are obvious: new design options for the processes, radically changing costs, quality, service and the duration of the processes. The Figure 4-2 below presents the idea of vertical integration.

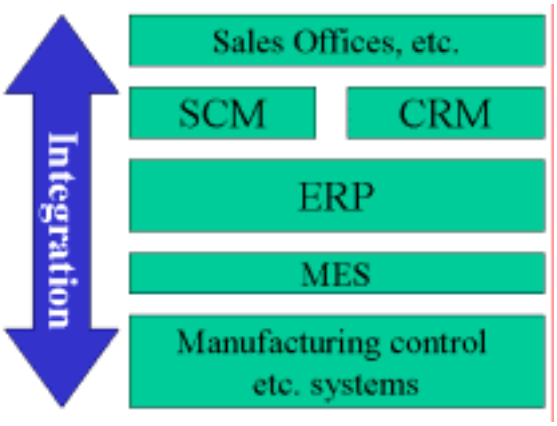

Figure 4-2. Vertical integration.

Integration technologies used inside an organisation could be based on middleware technology. Middleware integration is good in vertical integration, when the integration is between the applications. Using middleware technology requires common semantics for the applications.

Integration inside an organisation requires often information sharing over the Internet. Organisations may have different locations geographically but despite that they must have access to the same common database. In that kind of situations the Internet is suitable for information sharing and the integration should happen over the Internet. Internet technologies are discussed further later on in this study.

4.1.2 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 4-3 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 4-3 illustrates an overall supply chain focusing on integrated management of all operations from supplier acquisition to customer acceptance. (Bowersox & Closs 1996).

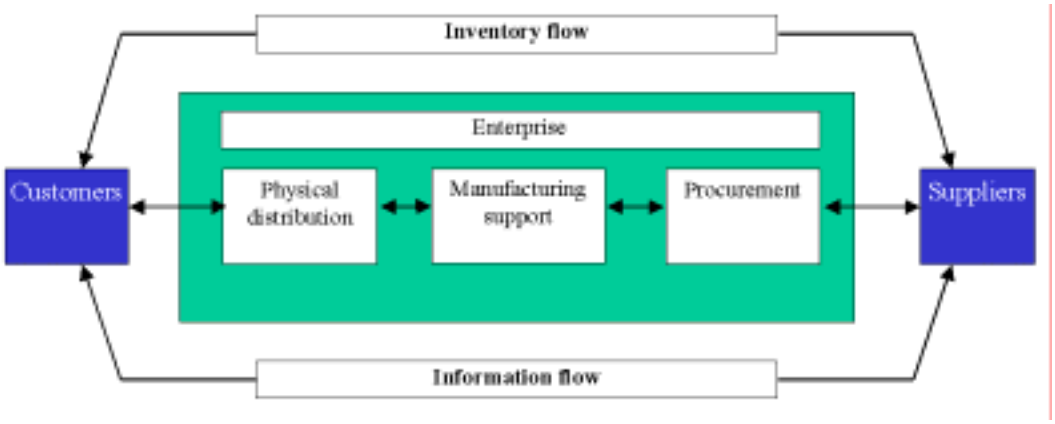

Figure 4-3. Supply chain integration (Modified from Bowersox & Closs 1996).

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.

Integration facts are also valid in value chains. A transparent value chain requires information sharing between many suppliers and resellers. Figure 4-4 presents the value chain integration, the connections between the value chain members and the core enterprise. In the middle of Figure 4-4 is the core enterprise and it's own system integration between SCM, ERP and CRM systems. Figure 4-4 shows business to business integration to suppliers and resellers through the Internet or by using EDI- or XML-based messages. Suppliers and resellers could have web sites or marketplaces (portals) and also EDI connections to provide the connection and transparent partnership for the core enterprise. Figure 4-4 is an example of a market point of view, but the same situation can be found in manufacturing and other industries, where there are not always resellers but customers and other business partners.

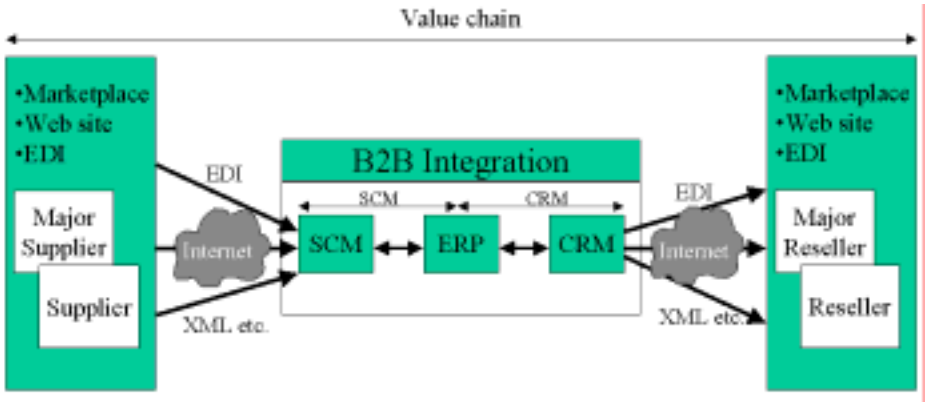

Figure 4-4. Value chain integration.

Figure 4-4 shows a few integration technologies used in business to business integration, but these are not the only ones. Integration technologies between enterprises could be based on:

- Database technologies
- Object-brokers
- Data transfer standards and technologies (EDI, XML, etc.)
- Workflow and Groupware technologies

Enterprise integration could be done independently in large companies, but if the company has got no resources, there are several operators to provide integration services. In Finland there are operators such as Sonera and Elma that provide message transmission and integration between organisations.

4.1.3 Enterprise Application Integration (EAI)

This chapter is based on what Luoma et al. have introduced about Enterprise Application Integration (EAI). EAI provides the integration of internal and external information systems and databases. These information systems represent software applications and the data processed and produced by the applications. The key issue for application integration is how businesses get the applications based on different technologies and differing business models and data structures to work together. These pieces must inter-operate in a common way with minimal disruption to everyday operations, not to mention the pre-existing investment. From the content point of view, these pieces include the applications that handle supply chain management (SCM), enterprise resource planning (ERP) and customer relationship management (CRM). It is recommended to invest in known software and application products that have a large market share. The same product and product family applications usually work together

and in addition, the market leader products of different vendors are usually integrated quite well and reliably to each other. Keeping to few products and vendors usually spares many support and integration costs, but the vendor interdependence increases. EAI helps the application integration between the different vendor solutions. (Luoma et al. 1999).

Moreover, most companies are setting up new e-Business systems, so they need new applications for managing Web-based interactions. The presence of packaged CRM, ERP, and SCM systems would seem to simplify the EAI task. But in reality, integration difficulties are on the increase due to the number of corporate applications, and that increases EAI complexity. Most applications focus on delivering their respective business value and the integration with other applications is addressed with less enthusiasm. For example, major ERP vendors publish Application Programming Interfaces (APIs) that enable communication with third-party applications. APIs work acceptably well but they need a lot of custom programming. As a result, the applications will have to co-operate more closely and to share the same data. The challenge, therefore, is for the organisations to understand how best to accomplish the appropriate degree of integration.

4.2 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).

There are some technologies for connecting network technologies. Internet applications are usually based on open Internet standards such as HTTP, HTML, SHTML, TCP/IP, FTP, SMTP, MIME, X.500, X.509, SSL, etc. Through the use of these standard protocols, companies can interact and inter-operate easily. Internet applications are designed to be compatible with a complex environment that can utilise a wide variety of technologies, such as:

- web browsers and servers
- secure file transfer servers
- customer account management systems
- remote administration tools
- directory servers and databases
- authentication systems
- commerce systems
- messaging systems
- fire walls and proxies

This study does not concentrate on data transfer technologies, so there is no more about network technologies and how the Internet or networks work. Web and network technologies are suitable for example for business to business integration, because almost every enterprise has a network connection to the outside world. The network provides a safe information channel and using the open Internet standards the communication to partners is easy. Network technologies and Internet technologies are suitable for integrating the user interface and the application using HTML and web-servers. Also XML has become one of the most important standards for integrating almost anything. XML enables the integration between user interface and application, application and application or application and database.

4.2.1 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).

Usually WWW and the Internet are understood as the same thing, but WWW is just an element or component of the Internet. The Internet is used for a variety of purposes such as:

1. Electronic mail.
2. Information sharing / retrieval / browsing.
3. File Transfer.
4. News groups / distribution.

The Internet has important rules of communicating with other people and means of sharing information. The Internet is widely used both in business and for entertainment purposes. Figure 4-5 presents the basic structure of the Internet. The Internet consists of many individual networks and it is known to be a network of networks. One network or just one enterprise can be connected to the Internet through a firewall server and HTTP-server. Firewall technology is used for security and authentication purposes. The HTTP-server, or web-server, handles documents in a database. Beyond the HTTP-server there could be for example the local area network (LAN) or just a workstation with a web-browser. All connections and communications to the outside and inside take place through the HTTP-server and the firewall.

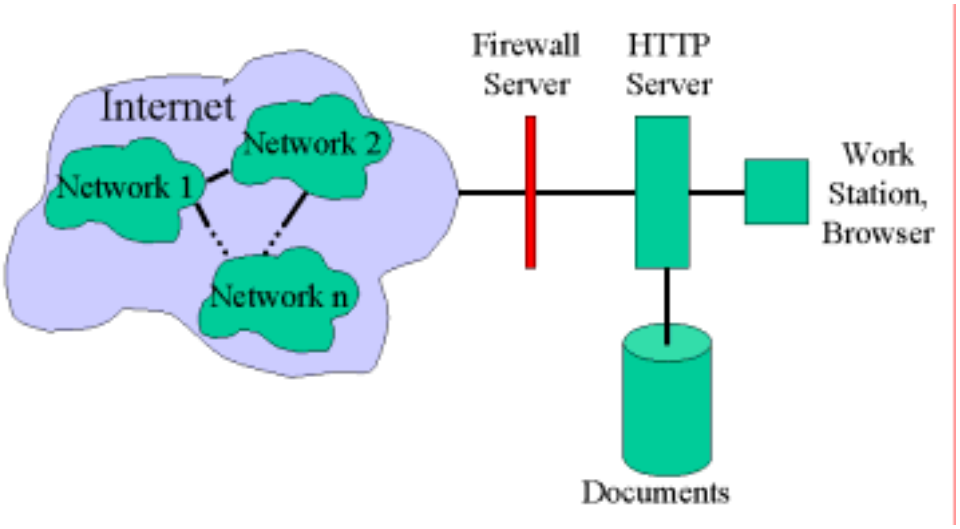

Figure 4-5. Structure of Internet.

The Internet is global network and as stated earlier the organisation could have its own network connected to the Internet.

4.2.2 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. Figure 4-6 shows how the Intranet is located outside the Internet. The organisation has 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.

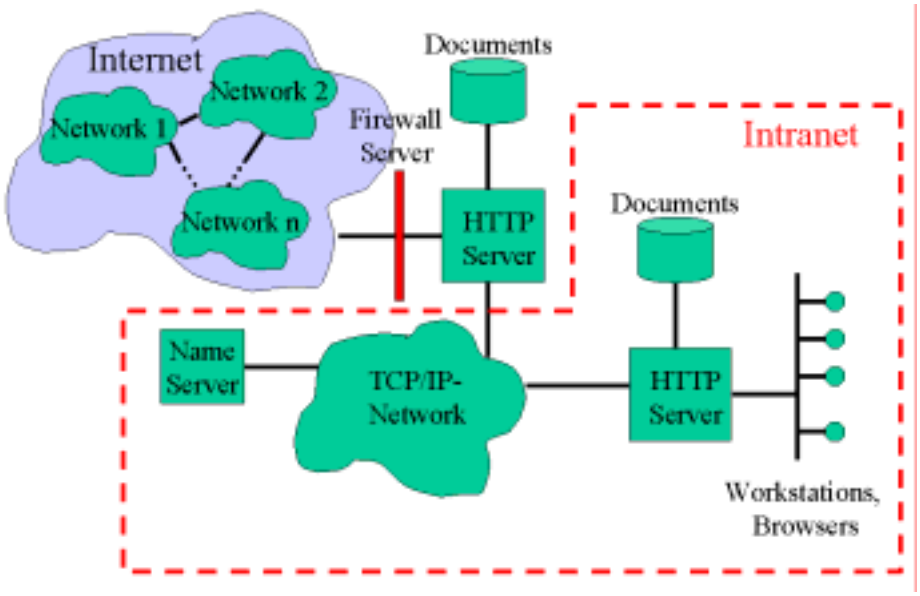

Figure 4-6. Structure of Intranet.

In Figure 4-6, the name server is located on the TCP/IP-network. The name server idea is to change www-addresses to a numerical format and vice versa. People usually remember web-addresses, such as vtt.fi, but computers handle everything in a numerical format. Each location on the Internet has its own IP address, which is a unique computer location on the Internet. Each location has an IP address in dot notation, for example: 205.245.172.72. The same address has a domain name version: whatis.com. The name server changes the domain names in dot notation.

One idea to use the Intranet is that all documents of an organisation are scanned on to a server and run through an Optical Character Recognition (OCR) program, whereby they are digitised. All standard letters and faxes are made into templates using the same type sets and set up in accordance to the policy of the organisation. The workers manuals, the organisation's mission statement, technical manuals, address books, workload charges, meeting calendars, booking systems etc. are all placed on the server in the shape of HTML documents. These digitised documents are then categorised and made freely accessible for all concerned within the organisation, who have the authorisation for a given subject or area. They no longer physically have to move around within the organisation to find the relevant material or people needed to do the task. This policy of openness that the management of the organisation shows will probably even increase the loyalty towards the organisation, as everybody gets better and more relevant information for doing their tasks, knows what is going on within the organisation and knows who is working and with what.

All organisations having an Intranet may also give their staff free access to the Internet, with the advantages and possibilities this gives for information search, collaboration and

communication and at the same time give their staff the opportunity of working partly from home, whenever this is possible and feasible.

4.2.3 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.

4.3 Systems technologies and platforms

Many system technologies have risen and one of the most promising technologies is middleware. Luoma et al. have presented middleware technology, and this chapter is based on that. Middleware technology has become a very important technology in supply chain management tools. Many ERP vendors have based their solutions on middleware technologies. Middleware technology means products and techniques that enable actions in distributed environments. The idea is to provide one single image of a distributed environment, like one computer system, for the users, programmers and administrators. (Luoma et al. 1999).

The basic task of the middleware is to transfer data between applications located in clients and servers, but there is also lot of additional functionality. Additional functionality makes middleware a communication platform for different usage environments. Figure 4-7 presents the basic tasks of middleware technology. (Luoma et al. 1999).

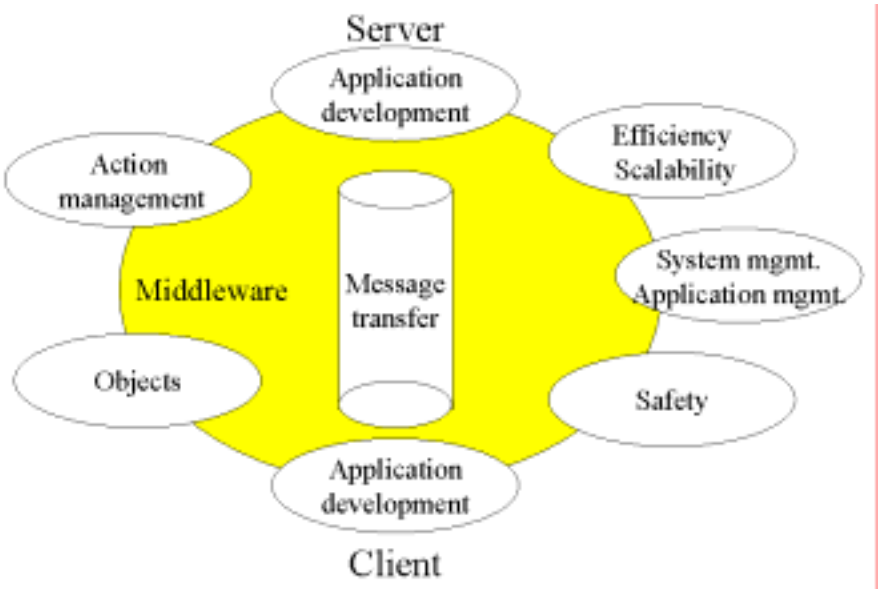

Figure 4-7. Middleware technology, basic tasks (Modified from Luoma et. al 1999).

The idea is that the middleware creates an additional layer between system components, providing generic services such as naming, directory, and communication for different software components. Strong middleware technologies on the markets are Remote Procedures Call (RPC), Message-Oriented, Distributed Objects, Database-Oriented, Transaction-Oriented, and Message brokers. (Luoma et al. 1999).

The oldest type of middleware uses RPC technology. RPC provides the ability to use a function within a program and have that function execute within another program or machine. Message-Oriented-Middleware (MOM) uses messages to communicate

between applications. It can be point-to-point or message transfer. The point-to-point transfer sends the message directly whether or not the receiving application is ready to receive. Distributed objects provide inter-application communications, but they also allow company-wide method sharing and are thus a mechanism of application development. There are two distributed object technologies on the market: COM and CORBA. Database-oriented middleware facilitates communication between the application and database or between databases. Database-oriented middleware can make the querying from several different databases transparent to the application by providing an interface. Transaction-oriented middleware co-ordinates information transfer and method sharing between many applications. Message Brokers are servers that broker messages between two or more applications or databases. When companies use distributed object technologies object transaction monitors (OTM) are needed. The markets provide today several object transaction monitors. Microsoft made the first commercial OTM-product, and after that other important software vendors such as IBM, BEA and Oracle have emerged with their OTM-products. (Luoma et al. 1999).

4.3.1 Integration servers

Application integration inside companies today is difficult, because so many different applications are in use. The cost and complexity of integrating together the organisation's systems and the partner companies' systems is in many cases an obstacle. Future business is going to require massive amounts of application integration across multiple organisations. Integration servers are seen to be one solution for point to point and many-to-many communications. Integration servers also play a key role in the development of distributed systems that span the web, enterprise networks and partner systems. They help companies integrate applications, custom software and legacy systems.

The markets offer integration servers to enable business-to-business communication. World's biggest software vendor Microsoft has integration server called Microsoft BizTalk Server 2000. VTT has got licences to use BizTalk and that was the reason for getting acquainted with BizTalk during the study.

The product is BizTalk Server 2000, and it bases on BizTalk Framework. BizTalk Framework is developed for application integration inside companies and with customers to decrease costs and the complexity of integrating ERP systems. BizTalk server integrates applications and business partners over the web using XML and orchestrates the business processes. The BizTalk Framework is an Extensible Markup Language (XML) framework for application integration and electronic commerce. It includes a design framework for implementing an XML schema and a set of XML tags used in messages sent between applications. The BizTalk Framework itself is not a

standard, but XML is. The goal of the BizTalk Framework is to accelerate the rapid adoption of XML. (Microsoft 2002).

XML-based business documents and messages will be registered and stored on the BizTalk.org web site. Any individual or organisation can download the framework and use it to implement and submit XML schemas to the web site. Organisations will also have the option of publishing their schemas on the BizTalk.org web site in a secure area for private use between trading partners. A steering committee composed of software companies, end users and industry standards organises and manages the web sites and is also developing new schemas. (BizTalk Consortium 2002).

Using the BizTalk Framework there is no need for a common object model, programming language, network protocol, database or operating system for two applications to exchange XML messages. The two applications simply need to be able to format, transmit, receive and consume a standardised XML message. A message flow between two or more applications is a means to integrate applications at the business-process level by defining a loosely coupled, request-based communication process. The BizTalk framework includes many adapters to make integration easy, or different systems, because few software applications today provide native support for XML. For many applications, these adapters take an existing function call, translate it into an XML document, and route the document to a target destination, whether it is a trading partner or another application within a corporate intranet. In February 2002 Microsoft provided 207 different system adapters from 30 different vendors. There are application and technology adapters for all of the most known vendors' products. (Microsoft 2002).

Other products on the market are like BizTalk, but Microsoft has the largest market share. Other known integration servers are IBM's WebSphere and in Finland StreamServe and Iocore's ECG products are also known.

4.3.2 Personal Digital Assistants and WAP

The computer is one of the most important helping devices in human lives. Nowadays the size of the computer has become smaller and smaller. One kind of a small computer is Personal Digital Assistant (PDA). PDAs are small handheld portable computers. The evolution of the PDA began as a pocket calculator and has evolved from there into a handheld computer. They tend to have smaller screens and slower processors, and are often used as organisers. Some have handwriting recognition, while others have small keyboards. The portability and limited data entry capabilities of PDAs make them perfect for communications. The technical term of PDA was established by Apple, that made the first handheld communication product. Apple's product was called the

Message Pad (that became available in 1993), but today it is known as PDA. A PDA is a handheld device that run a pen-centric Operating System (OS) such as the Epoc and is designed to capture small pieces of information in daily life. There are several functions for the PDA, such as organiser, communication and entertainment. The communication between mobile computers and office-based machines and networks will need to apply wireless techniques. SCM and ERP software vendors have made interfaces for PDAs and today it is possible to use a few ERP systems through PDA. Technology is progressing and new solutions to use the PDA are often introduced.

Wireless Application Protocol (WAP) came on the market loaded with big expectations. The main idea was to provide entertainment and information services for normal users. Also there was the idea to use WAP in industry. WAP is a protocol defining communication and information sharing methods. The user of WAP services needs to have a WAP phone. From the industrial and manufacturing point of view WAP could be good way for mobile communication with company systems. Despite the expectations, there are no special solutions and applications that have support for WAP. Mobility is not today an important issue in manufacturing but when talking supply chain management it means added value. For example sales person could check the latest stock and production situation with WAP and share the latest information with business partners and customers. WAP leads a quiet life today and new technologies for providing mobile services have already surfaced.

4.3.3 Workflow

Workflow is one integration technology, but not very widely used. Workflow management systems are used to streamline and automate business processes and process management. Workflow management systems can be either separate products that integrate with other applications, or parts of some larger application. Workflow can be used with office applications, groupware systems or PDM systems. (Nyberg 2000).

Workflows are usually represented as high-level process graphs, which hide the underlying complexity of the workflow management system. Workflow definition language is used to describe the workflow system, but most systems offer some kind of graphical user interface or higher level tool to define the process. The high level tool generates the necessary code to be used by the workflow system, which can be edited using a standard text editor. To facilitate co-operation between different workflow management systems, the Workflow Management Coalition has defined several standards. The are standards for workflow definition languages, and for the interoperability between systems. XML has influenced this standardisation work tremendously. (Nyberg 2000).

The WfMC (Workflow Management Coalition) has over 300 member organisations around the world, representing all facets of workflow, from vendors to users, and from academics to consultants. The coalition has developed a framework for the establishment of workflow standards. This framework includes five categories of interoperability and communication standards that will allow multiple workflow products to inter-operate within a user's environment. (Workflow Management Coalition 2001).

According WfMC web pages, the coalition’s mission is to (Workflow Management Coalition 2001):

- Increase the value of customers' investment in workflow technology.
- Decrease the risk of using workflow products.
- Expand the workflow market through increasing awareness for workflow.

Integration servers such as BizTalk have got support for workflow system integration and information sharing. Workflow is a technology that is currently used by an expanding user group.

4.3.4 Groupware

Groupware systems are used for human to human integration. In other words, groupware systems are used to share information from human to human and for advancing teamwork. Groupware is like Intranet, but it is its own software application. Groupware applications are widely used and even in Finland there are a few groupware application vendors, for example Teamware Group and Novell.

Groupware systems usually include:

- discussion forum
- e-mail
- calendar
- document management

Groupware systems are often based on Internet technologies and the user interface is a web browser. Groupware systems can be used with PC-computer, PDAs and cellular phones. Groupware technology is today based on XML, so integration to other systems is easier. Groupware solutions are usually used inside an organisation but they are suitable also for communication and information sharing between enterprises.

4.4 Standards for communication and integration

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.

4.4.1 Electronic Data Interchange (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. Finland has a few EDI operators, the most known of these are Sonera, Elma and Anilinker.

4.4.2 XML

XML (Extensible Markup Language) development is organised by a consortium called World Wide Web Consortium (W3C). W3C defines on their www-pages "The Extensible Markup Language (XML) is the universal format for structured documents and data on the Web" (World Wide Web Consortium 2002). W3C has made the XML specification and it defines XML to be a meta-language and it could describe other languages. XML is designed to provide a flexible and adaptable information structure to create documents or communication messages used over the Internet. XML is a simplified subset of the Standard Generalised Markup Language (SGML), which provides a file format for representing data, a schema for describing the data structure, and a mechanism for extending and annotating HTML with semantic information. (World Wide Web Consortium 2002).

The XML standard defines the syntax of the XML language, so that XML includes the structure and content of the electronic document. XML documents contain objects and those objects may contain elements. Each element could have many attributes. Elements could be universal, for example: <First Name>, <Address>, and <City>. Elements could be also industry or even company specific, for example: <price>, <manufacturer>, and <componentID>. XML allows each of these data types to be easily recognised and used to create sites optimised around both the data and the people using it. (World Wide Web Consortium 2002).

The earlier technology for defining the construction of XML documents was DTD (Document Type Declaration), but today this is done with XML Schema. W3C defines "XML Schemas express shared vocabularies and allow machines to carry out rules made by people. They provide a means for defining the structure, content and semantics of XML documents." (World Wide Web Consortium 2002). Schemas are a richer and more powerful way of describing information than what is possible with DTDs.

XML documents need to be well formed and valid. Well formed requires that a document has an XML prologue and that all elements have start tags and matching end tags. The valid document must be accompanied by a DTD that defines its structure. The DTD may be included as a part of the document itself, or it may be stored in a separate document. Most complex DTDs will probably be stored as separate documents. A DTD is basically a list of element, entity and attribute declarations in a simplified SGML declaration style. Also schemas could be used as a replacement for DTDs. (World Wide Web Consortium 2002).

A number of commercial vendors make XML software tools. Many XML tools are available also freely on Internet. As a conclusion, XML provides the grammar of information description, but not a common information semantics. Many information semantic standards use XML as a grammar. XML is already widely used but XML usage is still spreading fast.

4.4.3 XML/EDI

The XML/EDI Group is a consortium for developing XML/EDI. When the features of XML and EDI are summarised the result is XML/EDI. XML/EDI provides a standard framework for exchanging different types of data, for example invoices, healthcare claims and project status. With XML/EDI, the information being transformed via an Application Program Interface (API), web automation, database portal, catalogue, a workflow document or message can be searched, decoded, manipulated, and displayed consistently and correctly. The transferred data is first implemented in EDI dictionaries

to include business language, rules and objects. Thus by combining XML and EDI a new powerful paradigm different from XML or EDI has been created. (XML/EDI Group 2001).

The XML/EDI Group's E-Business framework defines how organisations can use the current standards and existing technologies to enable a simple and meaningful electronic information routing process. The framework formulates advantageous business practices through fully automated electronic communication, making secure document exchange transparent to the end-user. The XML/EDI framework allows data transfer to happen dynamically and seamlessly both internally in the organisation or between the organisation and a business partner. (XML/EDI Group 2001).

EDI has been in use for a quarter century. Despite the long history and numerous advantages of EDI, only an estimated 125000 organisations in the world have an EDI system. Due to cost and complexity, small and medium size businesses find it difficult to implement and maintain a traditional EDI system. For these reasons, most organisations do not want to operate using EDI and have looked for new choices for EDI. Internet-based communication systems have become a strong choice for EDI connections. The use of the Internet and Internet-based communications has grown very fast in the last few years. The XML/EDI framework, along with related Internet technologies, is rewriting the rules of how people interact in the business environment. XML/EDI is relevant to all connections in a business relationships, whether a manufacturer, consumer-oriented or service-oriented organisation. (XML/EDI Group 2001).

4.4.4 xCBL

xCBL (XML Common Business Library) is the result of collaboration between Commerce One and the leading XML standard bodies, e-commerce enterprises, and hardware and software vendors. xCBL has its origins in EDI semantics, so it supports all essential documents and transactions in business-to-business commerce. xCBL is a set of XML building blocks and a document framework that allows the creation of robust, reusable XML documents to facilitate global trading. xCBL is the XML component library for business-to-business e-commerce. This standard is created, maintained, and supported for use free of charge by anyone needing document definitions for their e-commerce applications. Usage of xCBL promotes interoperability between applications. This interoperability allows organisations everywhere to easily exchange documents across the Internet, giving global access to buyers, suppliers, and providers of business services. (Commerce One incorporation 2002).

xCBL is made available in numerous formats. Regardless of which type of structure validation syntax is used inside an organisation's applications, the business documents, with very minor modifications, remain the same. One of the hardest parts of achieving interoperability is enabling the exchange of business documents, and xCBL is the solution to this problem. (Commerce One incorporation 2002).

Many important software vendors such as Microsoft support xCBL. XCBL-based messages could be used with Microsoft BizTalk integration server. Because xCBL bases on EDI, it could be mapped on the EDI standard. Mappings from xCBL to ANSI X12 and UN/EDIFACT are available for certain documents in the xCBL -library. (Commerce One incorporation 2002).

4.4.5 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).

4.4.6 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).

RosettaNet plans to integrate support for the ebXML Messaging Services Specification in future releases of RosettaNet Implementation Framework (RNIF). RosettaNet is committed to developing business process standards required to support the complex

needs of the industry. RosettaNet also aims at ensuring interoperability across all supply chains and networked organisations. (RosettaNet Consortium 2002).

4.4.7 papiNet

In 1999, a group of European paper companies and their main German customers within the printing industry, set up the original European project to develop a set of business transaction standards for their industry based on the new XML technology. The purpose of papiNet is to develop, maintain and support the implementation of global electronic business transaction standards for parties in the buying, selling, and distribution of forest and paper products. The aim is to improve the reach and richness of communication throughout the supply chain, increase efficiency in transactions and marketplace activities, and to support interoperability among trading partners. The papiNet standards are open and freely available. papiNet facilitates open communications and commerce within the forest and paper products industry and across industry boundaries. Critical mass is achieved by involving key players up and down the global supply chain. (papiNet Consortium 2002).

According to the papiNet www-pages, the papiNet benefits include (papiNet Consortium 2002):

- Reduced manual work and paper-free administration
- Reduced errors, lead times and working capital
- Common business solutions
- Increased electronic information availability
- Improved material requirements planning
- Inclusion of smaller or less technically-sophisticated partners in the electronic trading base

In March, 2002 papiNet announced the release of four XML-based messaging standards, expanding the amount of messages to nine. These four messages complement the five messages released in June, 2001 (Purchase Order, Order Confirmation, Call-Off, Delivery, and Invoice), providing the ability for the paper industry and its customers to electronically communicate all business transactions involved in the procurement and order processes. (papiNet Consortium 2002).

Major forest industry companies in Finland, for example UPM-Kymmene, Stora-Enso and Metsä-Serla are taking part in the papiNet community. At present, there is no information available of papiNet piloting projects or implementations in Finland. papiNet is an example of industry specific standardisation based on XML technology. (papiNet Consortium 2002).

5. Case study

5.1 Incap Electronics Ltd.

The information of Incap Corporation is based on the situation before January 4th 2002, when a letter of intent to unite with JMC Tools Oyj was made public. Incap Electronics Ltd. is part of Incap Corporation. Incap Corporation includes the subsidiaries Incap Electronics and Incap Furniture. The main business sector of Incap Electronics is electronics manufacturing services and Incap Furniture does contract manufacturing of furniture. Incap Corporation has been publicly listed on the Helsinki Exchanges since May, 1997. The Corporation's net turnover was EUR 87 million in 2000 (EUR 71 million in 1999), with 835 persons employed at the end of the year. Incap operates at seven locations in Finland and has subsidiaries in Estonia, Latvia and the United States. Incap's headquarters are located in Espoo, Finland. This study concentrates on Incap Electronics. (Incap Electronics Ltd. 2001).

Incap Electronics (later Incap) is a contract manufacturer of electronic and sheet metal products. Incap provides contract manufacturing services to the electronics industry and the services include design, manufacturing and logistics as well as box-build and product integration. Incap’s net turnover was EUR 49 million in 2000 (EUR 34 million in 1999), accounting for 56 % of Incap Corporation's total net turnover. Most of its products are exported through customer companies. (Incap Electronics Ltd. 2001).

The manufacturing of electronic products includes automatic and manual PCB (Printed Circuit Boards) assembly and testing. Incap's sheet metal products are manufactured with new technologies. Incap has a flexible manufacturing system that includes punching, cutting and bending, automatic press lines and press brakes. Incap provides also design services: (Incap Electronics Ltd. 2001).

- Design for Manufacturing and Assembly (DfMA)
- Prototype design
- Design for Testing (DfT)

Incap participates in its customers’ product design process as an expert consultants for component selection, manufacturing and testing technologies and delivery logistics. Incap's design for testing at the R&D process allows the customers to focus their resources on the core competencies and ensures a short time to the market. The share of box-build products and product integration is increasing. Incap's services include the assembly of end products containing both electronic and sheet metal components and subassemblies. This box-build and product integration service may also include final packing of the product and delivery to the end users. (Incap Electronics Ltd. 2001).

Incap has two quality certificates. Lloyd's Register Quality Assurance awarded the international ISO 14001 environmental and ISO 9002 quality certificates to Incap. These quality certificates guarantee that Incap's operations are internationally competitive in view of both quality and environmental soundness. (Incap Electronics Ltd. 2001).

5.2 Incap Electronics SCM - Present state

The electronics industry has changed in last few years. Previously, there were the product or brand owners who ordered material from the suppliers and made the products themselves and had their own distributors or resellers. A few years ago the structural change in the electronics industry brought about the idea of contract manufacturing. There are still product or brand owners in the electronics industry today, but they do not make all the products themselves. Contract manufacturers are strategic partners of the product or brand owners and they make the products or components for them. One contract manufacturer may have partnerships with many product owners. Contract manufacturers are using several suppliers for the material supply. The product owner could have several distributors and assemblers to deliver the products to the markets. Ollus et al. (1998) have presented the idea of structural change in the electronics industry, illustrated by Figure 5-1 below.

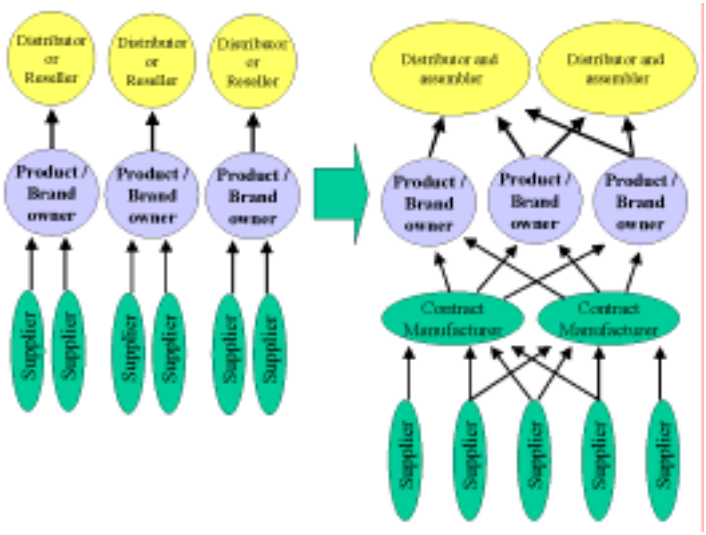

Figure 5-1. Structural change in electronics industry. (Modified from Ollus et al. 1998).

Incap Electronics is a contract manufacturer for the electronics industry. The company has no products of their own, but Incap is a manufacturing partner for a few important product and brand owners. Incap's biggest customers are Nokia, Vaisala and ABB. For example Nokia has used contract manufacturers since the structural change of the electronics industry. The idea is the same as in networked enterprises: to concentrate on the company' own core business and contract out other work. Contract manufacturing

has its own risks and difficulties. Recession periods in business have sometimes turned out to be difficult for some organisations that act as a partner for one product owner. Incap has three big customers as mentioned, and all of them are in different business areas. In that way Incap is in a more secure position and a slump in one business area does not disturb the entire business. Incap's biggest contract manufacturer competitors in Finland are Flextronix and Elcotec. Another difficulty connected with contract manufacturing is the material supply. Contract manufacturers have usually the same material suppliers. A couple of years ago the electronics industry had an allocation period, when components were hard to get. The suppliers could not supply material for contract manufacturers and the contract manufacturers could not provide products for the customers. Contract manufacturing has the same difficulties as business at usual and finding good, reliable and long-term relationship is almost a vital condition.

VTT Industrial Systems and Incap created a project to clarify Incap's present state, visions and development actions related to supply chain management. The InElog-project is aiming to create an e-logistics concept for Incap. During the project VTT made several interviews with Incap's employees, customers and suppliers. The views about the present state, visions and development actions in this study derive from these interviews, the basic business analysis of Incap made by VTT, and the models created during the InElog-project.

From the system point of view, the present state of Incap’s supply chain management before the InElog-project includes EDI connections to a few customers and suppliers, www-pages and e-mail for information sharing and the IFS enterprise resource planning system. Incap has a quality control system, KaskiCheck. Information sharing with partners is primarily done by e-mail and telephone. The sales personnel are in contact with the customers also through visits. EDI is used for making forecasts, orders and order responses. Incap has Sonera as the EDI operator. Incap has no CRM or SCM systems, but its ERP includes that kind of functionality. Product data is stored also in IFS and CAD systems are used for design and product development

5.3 Incap Electronics SCM - Visions

According to Incap's web-site, they aim at customer satisfaction and effectiveness, which requires open and systematic communication of information throughout the organisation (Incap Electronics Ltd. 2001). Customer satisfaction is the most important aspect in contract manufacturing. If the customer is not satisfied with the supplier, they contract with someone else. The customers require more and more services, and it is not enough to make the product, but the customers also need logistic services and

information services. Incap has a vision to improve their logistic and information services, and the InElog-project is a part of these improvements.

The vision of Incap for the future is to present three improvements: DFX, CRM and E-logistics. DFX includes design for manufacturing (DFMA) and design for testing (DFT). These actions make manufacturing effective and improve quality. Customers need information about quality and are requiring high quality. DFMA is a new service, where the manufacturer relays ideas to design to make the manufacturing easier, more efficient and the quality higher. The new idea of contract manufacturing is to take part in the product owner's design and development. Manufacturers have some ideas of component selections, layouts and manufacturing technologies that the product owners are not necessarily aware of. The best situation may be achieved if the component suppliers and the entire supply chain take part in the customer's product development, but that is only a vision in real life. CRM is one future improvement. Key account management is a new idea for taking care of major customers. Organisations have appointed key account managers to handle and serve customers. E-logistics is service completeness, which includes several different services. The InElog project of Incap and VTT concentrates on the conceptual design and implementation of e-logistics. Incap's vision for e-logistics includes the idea of an assembly and delivery hub. The idea of moving into an assembly and delivery hub is based on the customers' location. The main customers are located near Helsinki in Finland. Incap has four factories and they all deliver products for the customers. After creation of hub, the factories would make the products and deliver them for final assembly in one factory, which is acting as the hub. Then final products are delivered to the customers and logistic expenses are radically decreased. The next step after the hub is the creation of a distribution centre. The distribution centre idea is that the contract manufacturer makes the final product and delivers it straight to the markets. Then the product or brand owner develops the products with the partners, controls the production, handles the marketing and upgrades the brand. The E-logistics information flow is connected to the product owner too, but it does not take part in the manufacturing or assembly in any other way. Figure 5-2 presents the idea of a hub (Step 2 in Figure 5-2) and a distribution centre (Step 3 in Figure 5-2) compared to today’s situation (Step 1 in Figure 5-2).

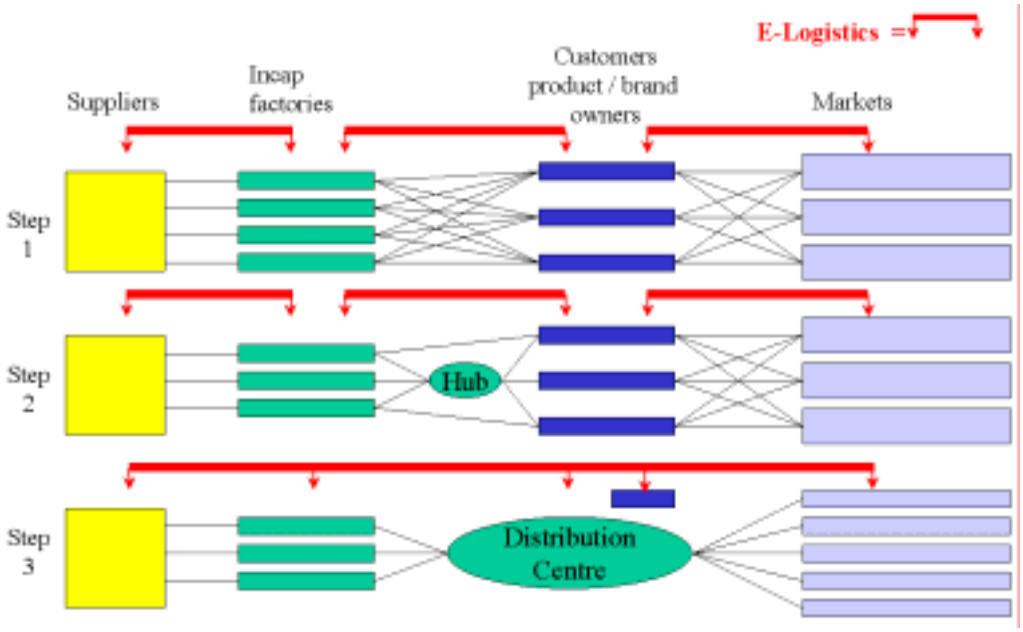

Figure 5-2. Idea of assembly hub and distribution centre (modified from Kalliokoski & Hemilä 2002).

Incap has estimated that they could not produce enough value adding services, so they have not created a delivery hub yet. Incap has a vision of value adding services that will be created later.

5.3.1 Vision from the customers' point of view

Several interviews were made with Incap customers during the study. Because there is confidentiality between VTT, Incap and Incap's customers, no names are mentioned here. The study presents some common requirements and wishes the customers have made to Incap. Information sharing is the first thing to be mentioned. The customers use EDI and Extranet for serving important data for the contract manufacturers. Telephone, mail, e-mail and fax are used for communication between humans. The customers are making their information systems more effective and are willing to improve the quality of existing services. The information the customers share with the contract manufacturers is usually linked to orders. The customers know their sales and manufacturing goals. The sales department forecasts the market situation and knowing the manufacturing resources, the customers publish forecasts for the partners and contract manufacturers. Nevertheless, the customers have got difficulties to create right and reliable forecasts.

Transparency in the supply chain is a key word according to the customers. EDI is the main message transformation method and some additional services, such as the Extranet, are needed. The customers' vision is to maintain the EDI connections, because

they work well. Despite the working EDI-based data transformation, the customers have a vision of XML-based transactions to substitute EDI transactions, but the development requires well-formed standards and piloting projects. The customers were interested in Incap's visions to improve transparency and development connected to DFX, CRM and e-logistics. Design for testing and test services for guaranteeing the quality are almost in every customer's mind. Design and product development services are especially aspects that the customers were satisfied with. The customers' vision is that Incap become a part of their development. Incap is using outside planning offices, and this is not enough for the customers. Lifecycle information of the components is required and the customers do not have that. Some products have long lifecycles and the customers have guarantees and after sales services for the products. Long lifecycles create sometimes difficulties if the lifecycle of the spare part components has also ended. A substituting and suitable component can usually be obtained but the customers do not have the same component knowledge as the contract manufacturers and especially the component suppliers.

The vision of the customer is to make the partnership deeper and by that way make the partnership reliable, open and long-term. Business-to-business integration is a vision that the customers see as a potential development target. Getting real-time information about orders, manufacturing, forecasts and others from ERP system to ERP system is a future development target.

5.3.2 Vision from the suppliers' point of view

Incap's suppliers were also interviewed during this study. The relationship between VTT, Incap and the material suppliers is confidential so no names are mentioned here. Incap has a few EDI connections with material suppliers. The material suppliers are normally global suppliers and many of them have created EDI connections for their customers. Many prefer EDI but are interested in other communication and data transfer formats than XML. The suppliers are taking part for example in the RosettaNet standard development and are using XML-based transformation in the United States. In Europe, many supplier are waiting for the results from the XML-based transformation in the United States before they will pilot it in Europe and in Finland.

One of the main ways of sharing information with the material suppliers is Incap's Extranet, which was developed during the InElog-project. The suppliers do not always have their own Extranets for sharing information but they can use the customer's Extranet to get information about orders, order responses, and forecasts.

The suppliers have a vision to take part in product development also. The material suppliers have information about components and their lifecycles. The suppliers have

usually categorised their components: A-components are standard components from stock, B-components are rarely used components, and C-components are non-standard components and not recommended. MIP (Market Innovative Product) components are expensive, but recommended for design products. The manufacturers' buyers ask often what components is last-buy for getting information about the recommended components. The suppliers could publish the list of recommended components for their partners. Usually the suppliers give the manufacturers lists based on history and including estimates for the future. The list of recommended components is usually a competitive weapon for the suppliers and for that reason they are not willing to share this information but with strategic partners.

5.4 Incap Electronics SCM – Development actions

Incap is a part of the customers' value chain and aiming to increase the customers' competitiveness. Incap's complete service helps their customers provide high-standard products to demanding global markets. Incap is aiming at open and reliable long-term co-operation at all organisational levels. In addition to Incap's own resources they utilise strategic network partners with various types of expertise. Incap is aiming at a transparent and uninterrupted flow of information in the entire supply chain, which is attained by using the Internet and other electronic solutions. The InElog project of Incap and VTT is a part of improving the flow of information by applying e-logistics throughout the product lifecycle from product design to maintenance design and after sales services.

The goal of the InElog project is to define Incap's e-logistic strategy and divide the strategy according to the goals into development actions in practise. The InElog project concentrates on developing ways of actions and information systems. In practice this means developing the transparency of the supply chain, fast reacting to changes, electronic information management and new service completeness both for the customers and suppliers. The development actions require network wide co-operation, where the customers and suppliers take part actively in Incap's e-logistics development activity and processes. Both the customers and suppliers were well disposed towards the project and for example every planned interview came true. The customers and suppliers talked openly about their way of actions, development goals, visions, and co-operation expectations. The partners were interested in Incap's visions and are willing to support the development actions. The operational model of the project is customer and supplier specific pilot projects. Experience from the pilot projects guides the selection of the methods and technologies taken into use in the entire supply chain and network.

Several development targets have formed during the project:

- Intranet and Extranet
- Product lifecycle model
- Extended product
- EDI connections
- XML-based communications
- Electronic invoicing

These development targets were taken under construction during the project and are explained in the following chapters. The results and conclusions from the development steps are not yet clear, but the study explains the situation in spring, 2002.

5.4.1 Incap’s Extranet and Intranet

Incap's Extranet was taken into use in spring, 2001, for the customers and suppliers. The Extranet did not include much information when it was published. Incap has outsourced its information technology maintenance and management. Since outsourcing, the databases and servers have been managed by a strategic partner. Information sharing and updating of the www-pages remained at Incap's responsibility. The customer and supplier interviews of Incap were conducted at the beginning of the InElog-project, and the Extranet was modified based on the feedback. The new Extranet is based on applications of Incap's information technology partner. The Extranet includes several services for the customers and suppliers: forecasts, supplier-specific efficiency indicators, and shared documents such as meeting memos and contact information. There is the opportunity to create special services for the suppliers and customers if they so wish. For example, one of the customers asked if they could have special and different Extranet services for their different business units, and that was possible. However, development actions are still needed, for example the customer forecasts are not always reliable whereby publishing the forecasts for the suppliers is not reasonable.

Incap has also introduced the Intranet. The Intranet is used to distribute information for the employees. There is daily information such as name days and menus. The Intranet has made it possible to download meeting agendas, meeting memos and other important documents that are meant for every employee of Incap. The main goal of developing the Intranet is to harmonise Incap's organisation culture and strengthen resource management.

The Extranet and the Intranet are working well and every party of the organisation has taken them into use. Incap has continued developing the networks and there is more and more information available for the customers and suppliers. The outsourced technical maintenance is working well and the solutions have fulfilled the requirements.

5.4.2 Incap's product lifecycle model

The InElog-project has also raised questions connected to Incap's products and product lifecycles. It is not enough to develop information services, the organisation must also develop things that the customers are ready for pay for and buy. Long-term relationships with the customers and business partners require responsibility and services connected to earlier products throughout the lifecycle of the product. There are many steps in a product's lifecycle that require co-operation with the customers. The first thing in the lifecycle research was to analyse the present state of the product lifecycle, presented in Figure 5-3.

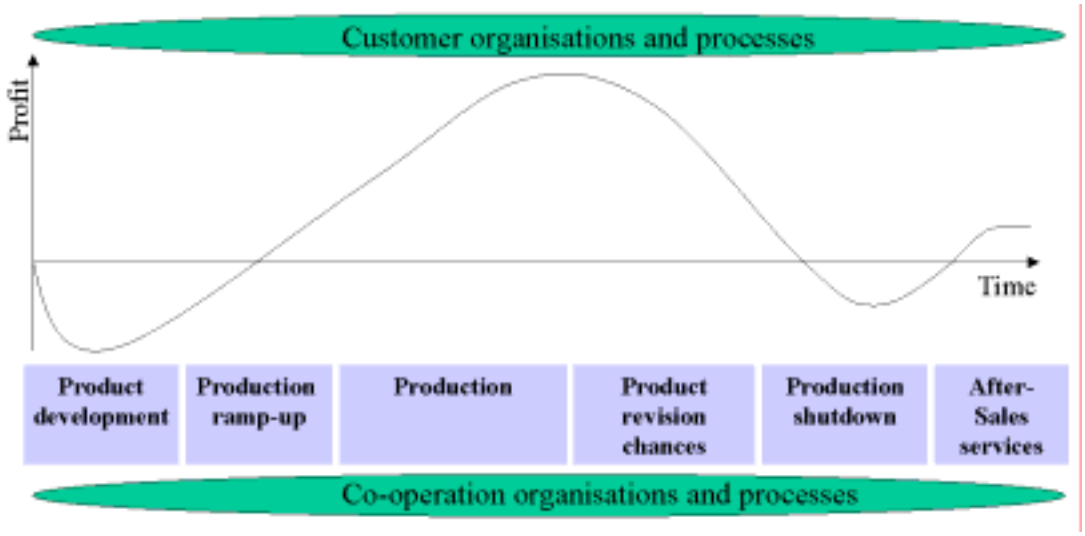

Figure 5-3. Present state of Incap's product lifecycle (Kalliokoski & Hemilä 2002).

The curve in Figure 5-3 presents the cash flow in Incap. The lifecycle processes are linear and sequential. The product life cycle begins in product development and continues in production ramp-up. The cash flow is negative, because resources are used but no one is paying anything. The negative cash flow will turn up because the customers start to pay during the ramp-up and in the production period the product becomes productive. In many cases product revision changes are required, but then usually the cash flow turns again negative because the organisation must invest but gets the same price than in the production period. Usually the production shut down decision comes too late and the net profit is already negative. After sales services may bring

positive cash flow. Figure 5-3 shows also the co-operation partners and customers having their own processes during the product lifecycle.

The first thing in developing the product lifecycle was to define the cash flow and the net profit to be more positive. Also the starting point was defined in another way than before. Figure 5-4 presents a new product lifecycle model developed during the project.

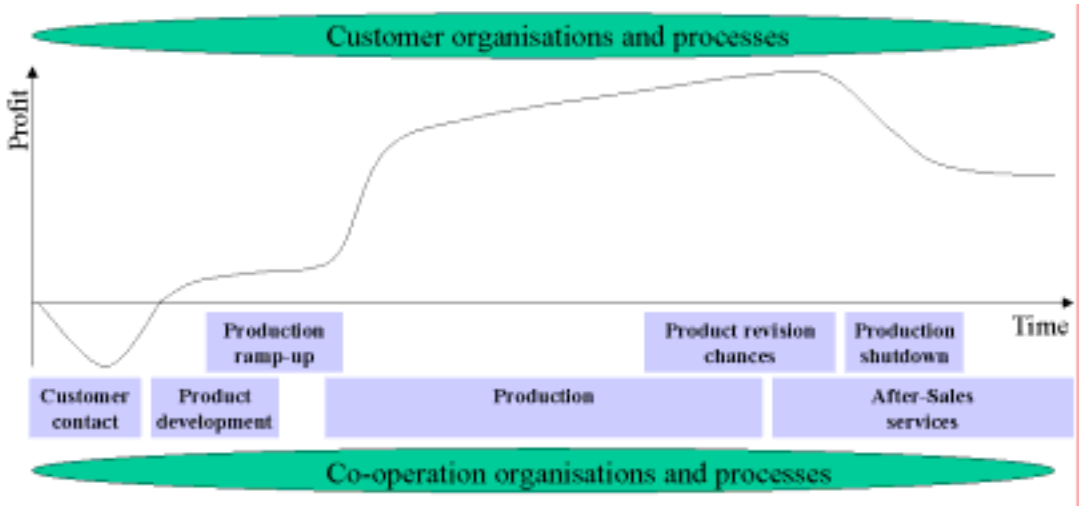

Figure 5-4. Incap's new product lifecycle model (Kalliokoski & Hemilä 2002).

The ideas to make the cash flow and net profit positive are based on parallel and timely actions. The first period in the product lifecycle is contact to the customer. The customer contact generates negative cash flow, but the idea is that the second meeting is adding value for the customer and that costs. The customer contact could be done as supply chain and network partners whereby the customer could get the whole service and product. The contract manufacturer knows the manufacturing and developing methods and the suppliers know the component markets. The customers could have the brand or product idea, but not knowledge of how to realise that. The customer contact requires also customer estimation, where it is estimated if the customer is suitable, solvent and in accordance with Incap's business strategy.

After the customer contact, product development is started and as soon as possible the ramp-up period, preferably simultaneously. During the product development the suppliers could help with the component knowledge and give information about availability, for example. The ramp-up period includes prototype manufacturing and testing. The production begins simultaneously with the ramp-up period and the net profit gets positive quickly. The important things in the production period are cost and quality control. Product revisions are made early if necessary and production according to old revisions could still continue. Product revisions are developed and made together with the partners and the customers pay more for new revisions. That makes more net profit than in the old lifecycle model.

Product revisions include:

- Material revisions
- Document revisions
- Pricing revisions
- Production / Test process revisions

After sales services begin when the production ends. After sales are value adding services and the customers have to pay for them. At the end of the lifecycle there is the production shutdown. Various information is needed at the right time: when the production ends and when the availability of a certain component ends. If production of the product continues but the component is at the end of its lifecycle, information about suitable replacement components is needed. If the production ends, information about how long the components will be available is needed.

Information is needed from every member of the supply chain during the entire lifecycle of products. Information systems and system integration will help communication and data transfer. The Extranet is used to share production information through the product lifecycles. Incap has the customers' forecasts and makes its own production forecast for the suppliers and distributes it using the Extranet or EDI. Incap's ERP includes material management where component information is stored. ERP also includes cost analysis, cost monitoring and quality monitoring, as far as the information is needed. The testing tools are planned to be improved and updated. The testing tools are not networked at the moment but in the future they will be. If the testing tools are connected in the network, the information would be transferred in real time in the ERP and also to the customers.

5.4.3 Incap's extended product

The product life cycle model was the basis for creating Incap's extended product in the InElog-project. A product requires services, and those services add value to the product. The customers are willing to pay extra if they perceive the services as being value adding. During the study the process specification is continuing. There are some known and some unknown processes connected to the extended product. The lifecycle processes are known, but the supporting processes are still undefined. The goal is to improve Incap's customer relationship management with advanced operational models and supporting information technology services.

The extended product includes the core product, which in Incap's case is "complete solutions in contract manufacturing" and "Prototype manufacturing". The second level in the extended product includes the services included in the price of the product that

are important to the customers. The third level in the extended product includes customer specific services that are services for extra pay. The third level services could be done with or without the customer, but the customer benefits from those services. Figure 5-5 presents the extended product, its three levels and the planned services.

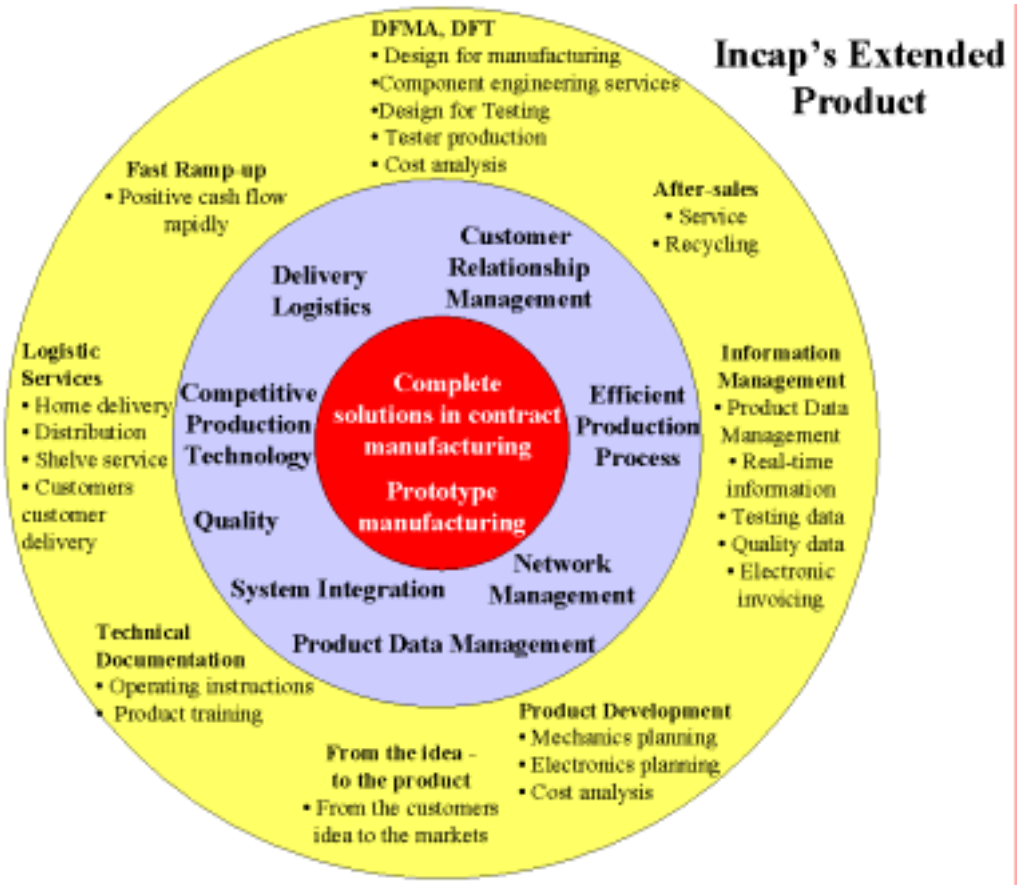

Figure 5-5. The concept for Incap's Extended Product (Kalliokoski & Hemilä 2002).

The services are planned, but their content is still undefined. There are some ideas for the content, as presented in Figure 5-5, but the processes are not clear. Some processes are defined and for example the logistic network has been developed with a logistics partner. The ideas of an assembly hub and distribution centre are connected and support the extended product model. The InElog-project is developing information flows and in that way comprehensive e-logistics. In addition, electronic invoicing has risen as one development action and that is also one service in the extended product concept.

5.4.4 EDI connections

EDI is the main communication standard in business to business communication so far. Incap had few EDI connections before the InElog-project, but the numbers are now increasing. Incap uses Sonera as the EDI operator. Sonera had some difficulties in

transferring the messages before Incap took Casebox into use. Casebox is like a mailbox where the incoming and outgoing messages are stored before handling. Incap's EDI is based on an x400 network operated by Sonera. Incap's ERP system IFS generates a text file, which is sent to Sonera for transformation into EDI format. Incap has three EDI messages in use: Delfor (forecast message), Deljit (used for asking home delivery, also known as Order message), and Invoice. In addition Incap has tested Order-response messages. All these messages are normal messages based on the EDIFACT standard.

In Finland the business code is used as the address of the message, but not in other countries. This is a problem in international business, but Incap's ERP can handle both the business code and a normal address as the address of a message. There is a development project in Finland where the new EDI standard is used. This standard is an abbreviated version of EDI and much information is taken away from the messages. This also creates some problems in international business.

Three major customers are sending messages to Incap and almost twenty suppliers are receiving messages from Incap. The goal is that by the end of the year 2002 there are six incoming EDI messages and 17 outgoing messages.

5.4.5 XML-based communication with customer

The InElog-project included a meeting with one of Incap’s customers at which the InElog project and e-logistics were discussed. The customer was very interested about piloting XML-based messages to replace EDI messages and operator services. The InElog project will focus on XML-based piloting with selected customer and suppliers in the future, and on continuing the development actions already started. The main target of the InElog project in the future is to produce network logistic services for the customers and partners of Incap, other related processes and information technology solutions for global implementation.

The XML piloting project between Incap and a customer will begin in summer, 2002. The idea is to replace EDI messages: order, order response and invoice. Many XML standards are developed, but not implemented. The aim of the project is to clarify the differences between the different standards and implement the most suitable one. The integration server may be Microsoft's BizTalk Server 2000, which is developed for this kind of a purpose. The project idea is presented in Figure 5-6.

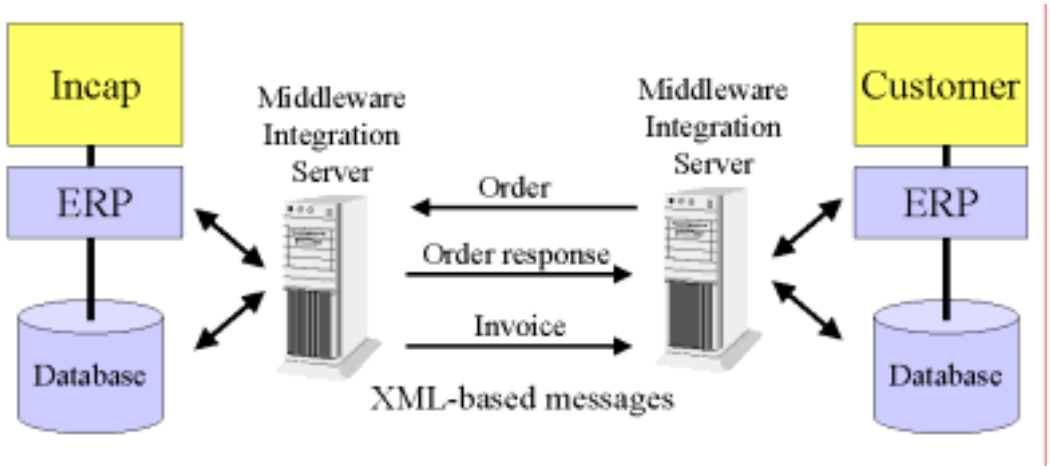

Figure 5-6. XML-based messages piloting between Incap and customer.

Figure 5-6 presents the project situation, where Incap and the customer have their own ERP systems and databases for them. The integration servers are connected to the ERP systems and databases. The servers make data transfer between the organisations possible.

Incap has a facility for piloting XML-based messages until the ERP system is upgraded. The IFS version in use does not support XML-based message transfer and the system could not generate XML format messages. The new version of IFS has the XML feature, and its connectivity box handles message transformation from one standard to the other.

The project will start in summer, 2002, and this is the reason why there is no more information available at present. The piloting project is linked to high technology, and in the future XML-based messaging is estimated to replace EDI.

5.5 Electronic invoicing in Incap Electronics

The number of companies using electronic invoices is growing and electronic invoices are estimated to replace paper invoices some day. The business processes have strong support from electronic information systems and invoicing should have the same support as well. The markets today provide systems for electronic invoicing. Business-to-business electronic invoicing requires taking care of the entire supply chain and enterprise network from the sender organisation's invoicing system to the receiver's accounts and accounting systems. Different electronic invoicing systems need to be connected to different systems:

- financial management
- ERP system (or systems)
- order management systems
- material receiving and warehouse management systems
- capital assets accounting
- filing systems

The electronic connections and data sharing require support for different data formats and XML-based systems are spreading on the markets. Traditional invoice handling requires manual work, it takes time, and it is sensitive for mistakes. Electronic invoicing systems save resources and with electronic invoicing the organisation will:

- improve its service
- decrease mistakes and handling time
- vacate resources for more effective work
- automate filing
- improve supply chain management

It was realised during the InElog-project that improvement of the information flow also influences invoicing. An enormous amount of data is connected with invoices and invoicing affects resource management and material management. In the contract manufacturing business the manufacturer may have many suppliers and customers. All material movements include invoices, whether incoming or outgoing material. Material management is supported by the ERP system at Incap, and all incoming and outgoing material is marked in the system. Despite the data being stored in the ERP system, there was no electronic invoicing connected to that data. Today all invoices come in paper format. In this kind of a process the sender takes invoice information from the information system and the invoice is mailed in paper format. The recipient gets mail and moves the invoice information manually to its own information system. This kind of process is not very rational activity. Incap has about 30000 incoming invoices and 24000 outgoing invoices per year going through the invoicing process. For example one supplier sends 3000 invoices per year and that means about 15 per day. This number of invoices indicates that something might be wrong with the processes. The electronic invoicing development in the InElog project included process and solution analyses, actions and evaluation.

5.5.1 Process analysis

The invoicing processes were defined during the project. The first step in the invoicing process is the identified purchase need. This need is updated in the ERP system, or ERP generates it automatically according to order or warehouse statuses. Persons should have rights to create orders in the ERP system. In the case of Incap, frequent purchases are made without marking them in the ERP system. All members of staff do not have the right to create purchase orders in the system, but they make orders to suppliers anyway. This creates a conflict when the materials are delivered and the invoice is received, but there is no order in the system. The material is updated manually in the system and the invoice is paid without an existing order in the system. The normal way of action is through the order process. The order is made in the ERP system and the person in charge accepts the order. The order is sent to the supplier and the supplier returns an order confirmation if needed. The materials are updated in the ERP system when they arrive. The suppliers send the invoice in paper format, because it is not possible to receive other formats. Other formats than paper are key words in the future. All invoices are mailed at Incap's Vuokatti factory and the invoices are handled there. The invoicing process continues with invoice checking and acceptance. If the order and invoice match, the invoice can be paid. Usually there are not many differences in the invoices and this is one development focus. The invoices could be checked automatically if the order and the invoice information were in the system. Then the correct invoices could be accepted automatically, and any differences checked manually.

Features of the process:

- All purchases should have an order in IFS, only invoices without an order (for example telephone, electricity), are accepted without an order
- The aim is to abolish purchase invoice checking
- posting, price and currency should be correct when the order is made
- every invoice different from the order must be checked by the person in charge
- purchase invoices must be filed electronically in IFS

Invoices without orders are sent via mail or fax for acceptance and after acceptance the invoices are sent back to Vuokatti. Invoices including an order are checked and accepted at Vuokatti or if there are differences between the order and the invoice, the invoice is sent to the buyer for checking. In the worst case, the invoice is sent to Helsinki, where it is sent to Vuokatti and Vuokatti sends it back to Helsinki for checking and after that Helsinki sends it once more back to Vuokatti for accounting.

The Incap purchase order and purchase invoice handling process is presented in Appendix A. The process analysis makes it clear that Incap has room for improvements in its process and working methods. Electronic invoices would help the checking and acceptance. Invoices could be circulated more easily in electronic format. The circulation is not as big a problem, as the cumbersome way of action. The orders should be done in the IFS system. When the order is done correctly, the invoices could be checked and accepted at Vuokatti and there would be no need for circulation.

5.5.2 Solutions analysis

After the process analysis, a solution analysis was made and a few electronic invoicing service providers and software vendors were interviewed. In Finland many different solutions for electronic invoicing are available. The starting point for getting familiar with the available solutions was Incap's needs. Incap's needs are defined to be the need for handling incoming purchase invoices in electronic format and also the option for extending the service to handling outgoing invoices. The interviewed vendors were Elma, Posti, BasWare, Novo and IFS.

Elma has a solution for purchase invoices handling based on a service provider model. Elma is an operator who is responsible for transfer of invoice data electronically straight in the customer’s system regardless of the applications, platforms or data communications. Elma's application is called Elma eCom Connection, which handles data transfer between the customer and Elma. Elma provides some services in electronic invoices and the invoices could be in:

- EDI-format if the invoices are transferred using Elma EDI service.
- Elma eInvoice -network invoice, which is Elma's own invoice service, where the invoices are transferred in to the receiver's network bank or invoice handling system.
- Verkkolasku.com –format is for small customers having a few invoices per month. Verkkolasku.com is Elma's own Internet-based system.
- Paper invoices through a scanner operator or the company’s own scanner. Scanned invoices could be stored in a database and handled using applications.

Elma's service is only extended EDI service. Elma is an operator, but they have extended services connected to invoicing. Elma does not provide invoice circulation, but that is not needed in Incap.

Suomen Posti Oy has got business services and electronic invoicing is one of them. Posti's service is the largest service on the markets, enabling every incoming invoice to be handled electronically. Posti provides Laskunet service, which enables changing paper invoices into an electronic format and network invoices in the same application. Posti provides a service centre that includes purchase invoice handling, invoice scanning and interpretation services. Laskunet provides tools for accounting and interfaces to many applications. Laskunet is Internet-based and the browser tools for invoice viewing, checking and accounting actions are handled via the same application. Posti will send the electronic invoices to the organisation for checking and acceptance through Laskunet. When the invoice has been checked and accepted, the invoice data and picture could be sent to the financial management systems for payment and accounting.

Posti's service could be extended to handling outgoing invoices. The Laskunet service produces invoices from the material the customer has given, and the invoices are made in the desired format as e-letters, network invoices or in another format. Posti have made many different solutions and services and they have interfaces for many different systems and applications. Posti's service is extremely extensive and too heavy for small and medium size organisations. A good point in the system is that it handles every possible format of invoice.

The BasWare eFlow solution is used for handling, checking, circulation, cost direction, acceptance and transfer of electronic invoices into the financial management systems. E-mail is used for the circulation and collection of all information. BasWare's eFlow is an application family, and its PIP (Purchase Invoice Processing) is used for purchase invoices handling. PIP manages network and EDI invoices and paper invoices are handled using a scanner. BasWare provides a FastScan application for scanning and with the advanced scanner system it can handle about 60 invoices per minute. BasWare PIP includes four modules used for specific activities:

- PIP Master for orders matching, database search and posting. The master application includes an interface to for example ERP systems
- PIP Monitor is used for reporting
- PIP Admin is for administration (usernames, passwords, user groups, and other management)
- PIP Agent is a module that handles circulation

The BasWare solution is very good for circulation and the change from paper invoices to electronic invoices. A negative aspect is that the BasWare solution needs an operator partner. BasWare has business partnerships with a few EDI operators, but for the

organisation this means extra expenses. BasWare provides an Internet-based solution, myeflow.com, which enables an electronic invoicing process. The BasWare solution is quite expensive although it requires an operator partner. BasWare's Internet-based solution is not yet progressive and they are do not specially sell this service. The value adding service that BasWare provides is the circulation, but that is not the main problem in Incap's case. The scanner application is a good solution, especially the "learning system", which makes it possible to teach the system to identify invoices.

Novo has an electronic invoicing system called Rondo. Rondo's functionality is much like BasWare's eFlow, but Novo does not have a scanner application. Novo's Rondo is a circulation and acceptance application. Novo's solution requires also operator services. The user interface of the Novo solution is not as good as BasWare's and there are not as many features. Novo's solution is good for filing because it has its own database for storing data. If the organisation has another circulation system or does not need an application for circulation at all, Novo's Rondo does not give much value.

Incap has the IFS ERP system and ERP is a base for electronic invoicing. Every important piece of data is stored and handled in the ERP system, so electronic invoicing should be easy to introduce. The IFS system supports EDI invoices and IFS include purchase invoice receiving and sales invoice sending. The IFS system has an EDI translator, but the invoices cannot go through that. The data transfer uses the connectivity box, which collects data transfer information and the transfer statuses.

IFS includes the purchase invoice management functionality. When Incap receives an invoice in paper format, it must be scanned and the scanner creates a picture and a text file. The Import Supplier Invoice functionality of IFS connects the picture and the information in the text file and the information could be manually checked. IFS does not include automated invoice checking. The invoice information may be corrected if necessary and the invoice can then be accepted. IFS includes document management where the invoices could be stored but Incap has not taken this into use.

IFS is developing their ERP system and the new IFS 2002 version includes an electronic invoicing system, eFaktura, which is in piloting tests during this study. IFS's eFaktura will include for example circulation and posting. There is no more information available about IFS eFaktura or of the new features of IFS connected to electronic invoicing.

5.5.3 Actions and evaluation

After the process analysis and software vendor meetings it was the time to make decisions what to do with the electronic invoicing. Electronic invoicing systems seem to be very expensive. The vendors made cost estimates and the systems are similar to one another The starting point of the development was to improve the order process. The problem in the order process was using of the ERP system. Incap's employees were not required to make orders in the system. There were too many invoices without orders in the system. If there is no order in the system, there can be no acceptance inspection. Another idea is to make an invoice based on the acceptance inspection, but the suppliers are not yet interested in that kind of a model. The idea is clever because then there would be no need to match orders and invoices. The acceptance inspection inserts information of the incoming material in the ERP system and generates an invoice automatically. The financial management could then pay the invoice immediately and the organisation would pay the right amount for the received material. A new improvement was that no one was allowed to order anything without making the order in ERP. Incap is training its employees to make the orders in ERP and Incap has appointed key persons responsible for accepting orders and invoices. The user rights are also streamlined, so everyone who has the right to order material, has also the rights to make an order in the system. Incap is continuing factory by factory the introduction of the new order process, starting from the Helsinki factory.

Another thing in the order process is order rows. Incap receives about 100000 order rows and those rows are in about 30000 invoices. That means circa 3 rows per invoice, and that is too few. Incap orders too many times and too little per time. The solution is to order bigger amounts of material at one time or define the minimum order amount. For some materials a two-box method could be created. The suppliers would check the material stock and if one box is empty, the supplier would bring a new box of the material. The two-box method is suitable for cheap consumable material, often quoted as A-material by the suppliers. The two-box method brought its own difficulties such as the capital involved due to the rise in the stock value.

Optimisation of the entire order process is a difficult task, because when talking about minimum order rows, the ideal situation from the system point of view is one row per order. In that kind of a situation the order and invoice in an electronic format could be easily checked automatically by any systems. But that kind of action requires the orders and invoices to be electronic and excludes the manual work needed to manage them.

At this time it is not reasonable to invest in any other systems to improve the order process and invoicing but ERP. New version of the IFS ERP system is required in the piloting project of XML-based messages starting in summer, 2002. The new version

also supports electronic invoicing in EDI and other formats. Development in the process and employee training is one solution to resolving the problems at this time. If Incap feels some need for an electronic invoicing system later, the IFS solution must be checked. IFS's eFaktura comes across as a powerful tool for managing invoices electronically. Also ERP is and will be in a central position for managing material and manufacturing, so investments in the ERP system are profitable. If there is a need for invoice circulation and a management system, the BasWare solution with FastScan application will be the right investment.

6. Value Network Integration in Practice – Hypothetical Model

6.1 Network processes analysis

Value Network Integration in practice begins with a wide process analysis. Entire network processes should be analysed, how everyone makes business and what is the functionality of this business between organisations. The core company and its processes occupy a central role, but the core company's partners are also important. Companies could have many roles in the network, for example:

- supplier of raw materials
- manufacturer of materials
- producer of components
- assembler
- product or brand owner
- distributor
- retailer
- end user

Networked companies have basic processes regardless of the company's role in the network. The business processes usually include planning, purchase, manufacturing, and delivery processes. These are the same basic processes the Supply Chain Council has defined to belong to a supply chain (SCC 2001). The core company's process analysis defines also the support processes of the organisation as well as the information and support systems in use. The process analysis inside companies helps the following analyses and actions, such as developing the integration inside the organisation.

The process analysis continues to define the processes between the core company and its partner companies. The core company's basic processes, purchase and delivery, are connected with the partner companies. Purchase processes are connected especially with suppliers. Companies purchase raw materials, materials, components, part deliveries, and subcontracting from the suppliers. The core company's business is in a central role, in other words what the company is doing and what is its business idea. The case company for the study is an electronics contract manufacturer, so it uses suppliers for delivering raw material and components, but also uses subcontractors for example in painting. The process analysis between the core company and its suppliers produces information about the processes, business and support systems used between the companies.

Delivery processes are connected with the core company's customers. In contract manufacturing, the main company in the network owns the brand or the product. The contract manufacturer offers product or manufacturing services and even development and design services. The basic processes in customer relationships are manufacturing and delivery whether a contract manufacturer or a brand owner processes. Delivery processes include support processes such as the invoicing process. The delivery process analysis gives information about customer management and sales process activity, and about supporting systems.

Analysis of the processes of the core company and its closest partners is not enough. Processes at the next level should also be analysed in the value network for example business processes between the supplier's supplier and the customer's customer. Transparent value network includes processes that go through the entire network, for example the forecasting process. Reliable quality forecasts for the entire network could be difficult to make, but not impossible.

Thorough network analysis and analysis of the business processes between the networked companies gives an impression of the value network and the processes of the networked organisation. Figure 6-1 presents the value network processes, where the processes between the closest networked partners are marked by blue arrows, and red arrows mark the processes through the entire network.

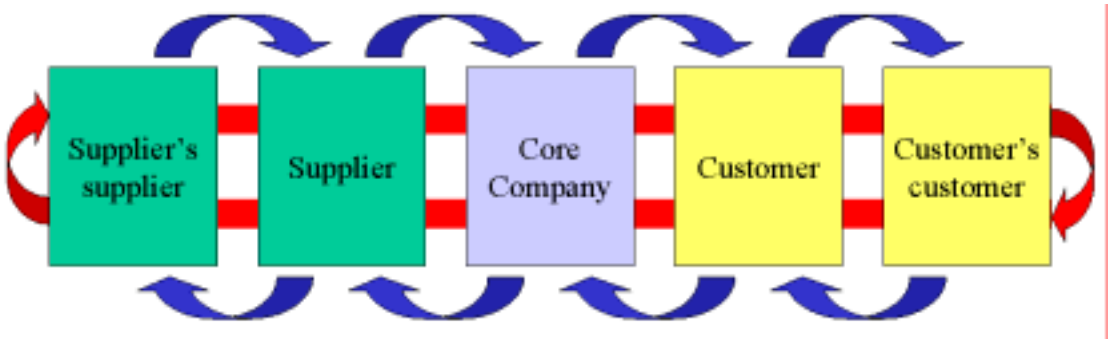

Figure 6-1. The processes in value chain, marked by red and blue arrows.

Figure 6-1 presents the processes surrounding the core company and only 2 layers of suppliers and customers are showed, but the model is the same regardless of the number of layers.

6.2 Integration inside the company

The process analysis produces information about the organisation's processes. There are many different processes in the business inside the organisation. Process analysis gives information also about the information systems and applications used in the

organisation, and there are many different solutions depending on the business area. The process analysis does not give information about the functionality of applications and solutions and about interfaces to other systems. The process analysis tells us where the systems are used, but not how. The key word for a company's system integration is interfaces. The system interface defines which systems can be integrated and how to integrate these systems. Technology is making it possible to integrate different systems today, but the interfaces should be analysed first.

ERP systems are holding a central position in the manufacturing industry. The functionality of ERP systems t varies greatly depending on the solution. Extensive ERP systems can handle all the organisation's business processes, but on the other hand, ERP could support only for example material management. Other systems to integrate could be MES, PDM and CRM systems, and almost every supporting system of an organisation can be integrated with integration technologies. Today software and system vendors have equipped their solutions with integration enabling technologies.

The practical integration depends on the systems in use, but it is not reasonable to integrate all possible systems. Integration inside an organisation faces the same technologies that are presented in earlier chapters of the study. The same technologies and ideas of integration are valid in every company of the value network. Integration inside the organisation is always case-specific and requires analysis by system specialists.

6.3 Integration between networked companies

Integration between networked companies requires technological analysis of the information systems in the networked organisations. On the other hand, if the executive of the value chain integration is taking part in the process analysis, the required information will be available. Usually different teams execute the integration and the process analysis. In every case basic process analysis, technological analysis inside every networked organisation and analysis of the interfaces between the systems of the networked organisations are needed.

There are many technologies for integrating networked organisations, but in practice the integration targets should be analysed. The situation is same as in system integration inside the organisation: it is not feasible to integrate all systems, only the supporting information systems agreeing with process analysis. The size and role of the network organisation in the network are important issues for integration. It is not reasonable for the organisations in different roles to make all information available in the network.

Integration between networked companies depends on the company's resources and strategies. Some organisations have realised that it is impossible to execute integration or other information technology projects. At the opposite end, other companies will use their own resources to develop information technology systems and even create integration. Despite the different resources in companies, the markets provide applications and hardware to integrate systems and there are service providers to provide integration. The technology to be used also depends on the company's resources and business strategy. As discussed in study technology chapter, the EDI system is the most used communication and integration technology in small and medium size organisations and also in large companies. The companies do not make their EDI connections, but they use operator services. Operators have the strength that they can change one message format into another. Today, different Internet technologies are becoming available for communication and data transfer between organisations, and these are usually XML-based. Companies can handle XML-based data transfer and there is no need for operators. The markets provide today integration servers based on middleware technology used for just that kind of situations. The servers include a graphical user interface, which helps changing the message formats. The XML standards are not yet developed enough, so it is hard to choose the standard that could be someday the de-facto standard.

6.4 Value network integration implementation, maintaining and development

Implementation of integration in the value network will be hard, like implementation in all information technology projects. Correctly analysed, defined and planned integration would have a bigger chance of succeeding. Every part of the integration entity should succeed in order for the integration implementation to succeed, but it is not reasonable to realise all parts at once. It is reasonable to begin the implementation at by integrating the networked companies' own systems, so make the vertical integration first. When the companies' own systems are connected together, it is easier to extract important information from the companies. Integration between networked companies is dependent on the resources and business strategies: do it yourself or contract out. First, it is reasonable to integrate the closest business partners in the network, with them the organisation usually has the most transactions. Later the focus could move to integration of the entire value network. The easiest way is to use operators, because they have usually already concepts and interfaces in many systems, and then the operators are response for the data transfer.

The already existing interfaces of the operators to different systems make the whole value network integration faster and clarify the entire concept. Figure 6-2 presents the

use of operators and also shows the difference between the usage and non-usage of an operator. Without operator services the companies are responsible for their own data transfers and there must be a point-to-point connection for every business partner. The situation is the same regardless of the role of the company in the network.

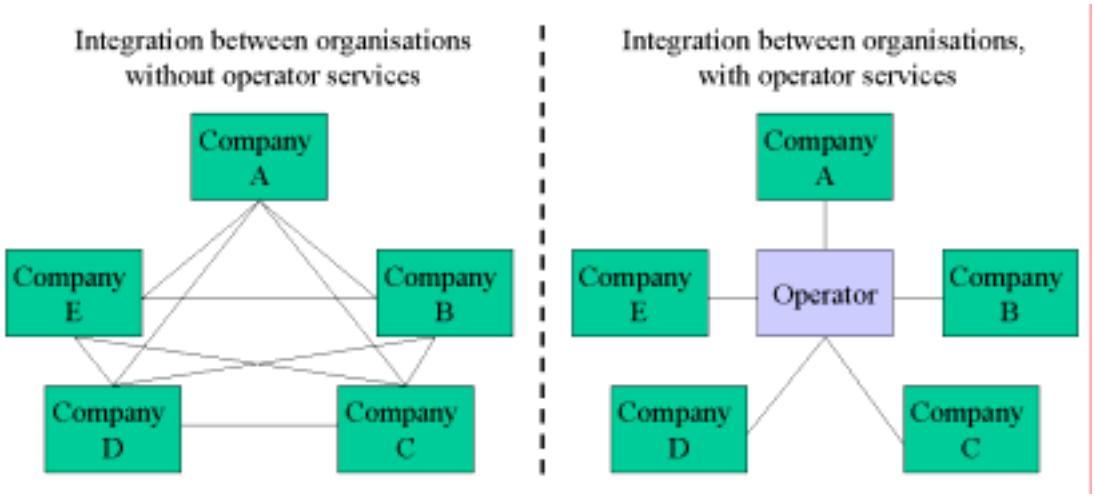

Figure 6-2. Integration between organisations with and without operator services.

Using of operators entails a negative point: the expenses of implementation and maintaining. Maintenance costs depend on the selected strategy and way of action: to use an operator or not. The use of operator services creates continuous maintenance costs, but results in carefree connections and data transfer. With operators, new standards and message formats can be introduced and it is also easier to create new connections to other companies. Maintenance contracts with an operator partner usually ensure the newest standards in data transfer and very versatile connections and interfaces to the business partners. Operators have connection and routing contracts with other operators, so the possibilities to transfer data anywhere expand. Without operator services the companies must take new standards into use by joint agreement. Then every company must create its own message inverter for mapping the messages in the common format.

The borders between integration maintenance and development are faltering. Maintenance can also include development, for example the implementation of new technologies. Without operator services, the development requires much resources from the company and knowledge about new technologies and standards. On the other hand, when using operator services, the operator's core business is data transfer services and being a specialist in the area requires continuous learning and testing of new technologies. So the operator provides the development resource and the company can concentrate on its own core business. The strategic question is the same: does the company concentrate on its core business and use partners in supporting services, for example, operator services.

Value network integration development could include creating new functionality. For example electronic invoicing could be the network wide development topic. Different operators provide invoicing services, but the companies could send invoice data as any other business data. Other network wide services could be for example forecasting, where the aim is to share real time and reliable forecast information for the entire value network. Developing extra and support services is always case-specific whereas the value network process analysis gives information of network wide needs.

6.5 Integration in practice - hypothetical model

We can create a hypothetical model for value network integration in practice for combining all assumptions, facts and conclusions. Figure 6-3 presents the hypothetical model for integration inside an organisation. The heart of the model is the company's legacy systems (ERP, SCM, CRM, and other possible systems), that contain all the important data. System integration uses the same model as presented earlier in the technology section of this study. Company systems could be linked and integrated on the Internet and the company's Intranet and Extranet. The Intranet is used for the company's own purposes and access is denied to outsiders, but the company could provide access for the partners in the Extranet. The company systems are integrated in a database or the systems could have each their own database. The information and data is stored in databases.

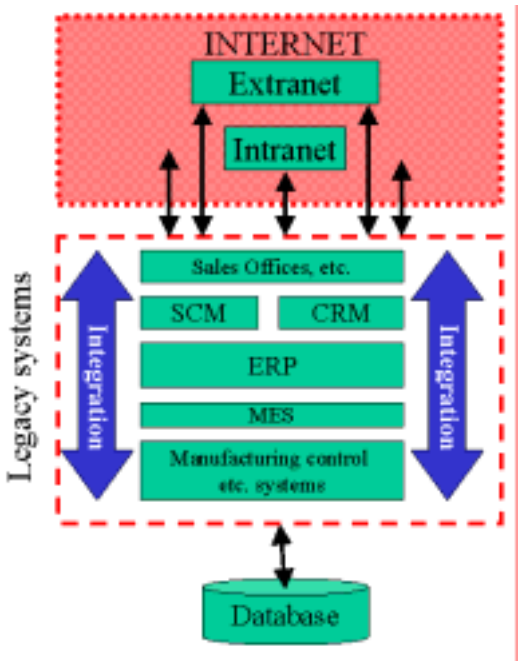

Figure 6-3. Integration inside companies in practice – the hypothetical model.

Figure 6-3 presents a common model and every company could have this kind of a system environment or a variation of that. The model in Figure 6-3 can be extended to cover the entire value network. Figure 6-4 presents the value network integration in practice. Figure 6-4 presents a situation between three networked companies, but the model is the same if there are more companies. Figure 6-4 presents the business processes between the value network companies, marked by red arrows. The business processes are case-specific and each partner company has different processes. System integration could be based on many technologies and middleware is one of them. Light blue arrows in Figure 6-4 mark the system integration. All companies could be connected to an operator, and every company could have its own operator who is connected to the others. Operators are used specially for EDI-based transactions.

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 6-4 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.

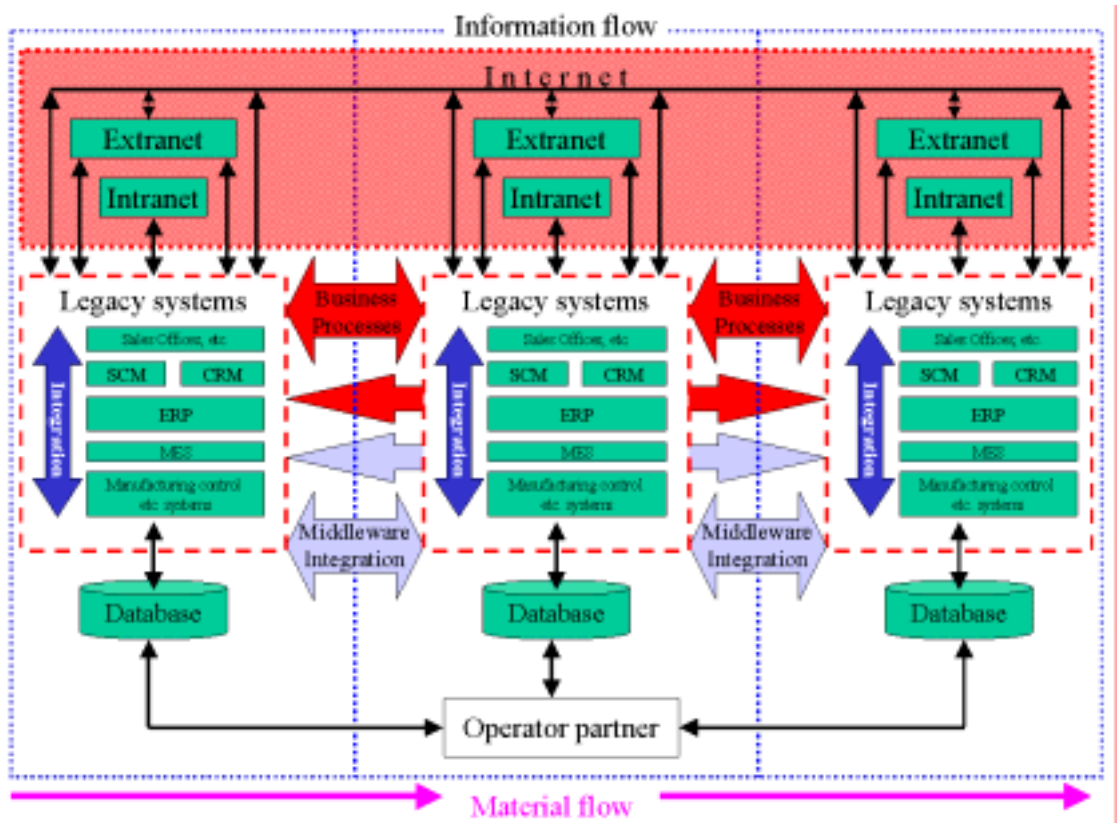

Figure 6-4. Integration in practice – the hypothetical model.

Figure 6-4 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. This was the hypothetical model for value network integration.

7. Conclusions and recommendations

7.1 Conclusions of the study

The main hypotheses of the study are that information technology could improve the communications between companies and system to system integration is possible to create. These hypotheses appear correct. The practical case demonstrated the needs and expectations of a network partnership and how every company in a network is willing to improve communications and data transfer. Today not all companies have implemented communication and data transfer systems, but there is pressure to develop this field. It became clear from the literature and interviews that many system vendors have equipped their solutions with open interfaces that make system integration possible. Integration technologies have advanced fast and today the markets provide many kinds of services and solutions for integration. Some systems are even possible to integrate by plug and play, so the connecting lines and systems are integrated. The study presents the common model for system integration and discusses which systems are reasonable to integrate. Technologies are case-specific in integration, so the common model does not present any technologies.

Integration technologies are in many cases XML-based, but XML standardisation is still under development. There are many standardisation projects in the world. RosettaNet, which aims at XML-based message format standardisation is the most known of these. Implementation of XML-based systems and technologies is used in the world, but in Finland this technology is only just emerging.

The practical business case makes clear that not many business-to-business integration have been implemented. The dead line for this study prevents further presentation of the results and experience about integration in practice in the business case. The Intranet, Extranet and EDI connections have been taken into use, and they are working well. The case company has its own management system (ERP) for handling the manufacturing and supply chain. The ERP system is anyway under construction and development. During the study it was defined that for example electronic invoicing requires updates and development in ERP. The study results would have been better if the XML-based pilot project could have been included. However, the case company is investing in XML-based integration and the piloting project will start in summer, 2002.

As the final conclusion, it can be stated that value network integration is possible to create. Despite the possibilities, in practice the companies are not yet ready and willing to invest resources in value network integration development.

7.2 Proposal of the study

The study hypotheses were proved, so the companies are recommended to invest in information technologies and data sharing with the business partners. The technologies are advancing, but many support systems in business and management are already available. Company networks are an almost crucial condition in business survival today, so the companies are wise to create networks. Concentrating on the core business is effective and saves resources. Companies should use partners for support functions and for system maintenance, but it is reasonable to handle some solutions inside the organisation.

The starting point for business development and the way towards network integration is process analysis. Organisations should correct their own processes first. Business processes drive the entire business and the analysis gives information about deficiencies and also advantages. A process analysis gives information about the need of support systems and applications. After analysing the inner processes, the outer processes should also be analysed and all business processes between the partners should be defined. After defining the common business processes the need for information flow improvement becomes clear.

An organisation should invest in their value chain as phased in the following list:

- analyse inner processes
- execute integration inside the organisation
- create company network to support business
- analyse outer processes
- create system integration between the networked companies
- extend the integration to the entire value network

System integration between companies brings efficiency and rationalises business. Implementation could be difficult but not impossible, and using specialist partners would help. Well planned is half done, as the saying goes, and that is also true in value network integration.

7.3 Further research questions

In the future it would make sense to get familiar with XML standards. Knowledge of the standards helps to perceive the whole system integration area of technology. Standard development is usually organised by industrial companies and end user organisations.

XML standard development projects need support groups, which offers a possibility to participate in this work. In Finland, there are some boards for developing XML standards, and they it is easier to get involved with these than with international development groups. For example, RosettaNet have their own member board in Finland, which it is possible to join. Integration platforms and hardware offer an interesting research area and so do commercial integration servers. In future business, business processes can be described in the server and process supportive messages can be used in the transactions. XML technology development boards are creating new business transaction messages, and it is reasonable to follow these developments.

The semantic web is a new forthcoming technology, the research of which is worthwhile. The semantic web brings new meta-information possibilities into the Internet and communication technologies. Semantic web technology utilisation in business and industry is not yet clear, but it could be the answer to many questions. Keeping in the information mainstream and on top of the development are challenges, that require continuous effort.

8. Summary

The main objective of this study is a hypothetical model for value network integration in practice. There are four sub-objectives before the main objective can be reached. First, it is reasonable to make clear the concepts of a supply chain and networked organisations for understanding the value network concept. There are many facts that are connected to and valid in supply chains and supply chain management. For example, business processes are a fact in the supply chain but the processes themselves are case-specific.

The supply chain and network could be managed using different tools and applications. To clarify these tools is the next objective towards the main objective. The most known management tool is the ERP system in the manufacturing industry, but there are many other basic tools for managing supply chains and networked enterprises. The tools alone are not enough, but there must also be information sharing in the network. The systems are inside organisations, but integration makes data sharing possible. System integration is a way to share real-time information from system to system at the right time and place. Many technologies are available for integration and the third objective of this study is to clarify these integration technologies. The technologies could be shared: communications, platforms and systems, and communication standards. The study presents the main ideas and solutions in the technology of the field.

The fourth sub-objective of the study is a practical case presentation. The study is a part of the InElog project of VTT and Incap Electronics Ltd. The project develops different services and integration with partners. The aim of the project is an e-logistics concept for Incap for enhancing competitiveness and making the business more effective. The case study aims to present how different supply chain and network management solutions help business.

Achieving the main objective requires implementation of the four sub-objectives and when these are reached, the hypothetical model for value network integration in practice can be created.

The study concentrates on electronic contract manufacturing, because of the case company. The models and decisions are anyway universal for every industry. The study tries to present a general impression of supply chain and network management and the related tools, systems and technologies.

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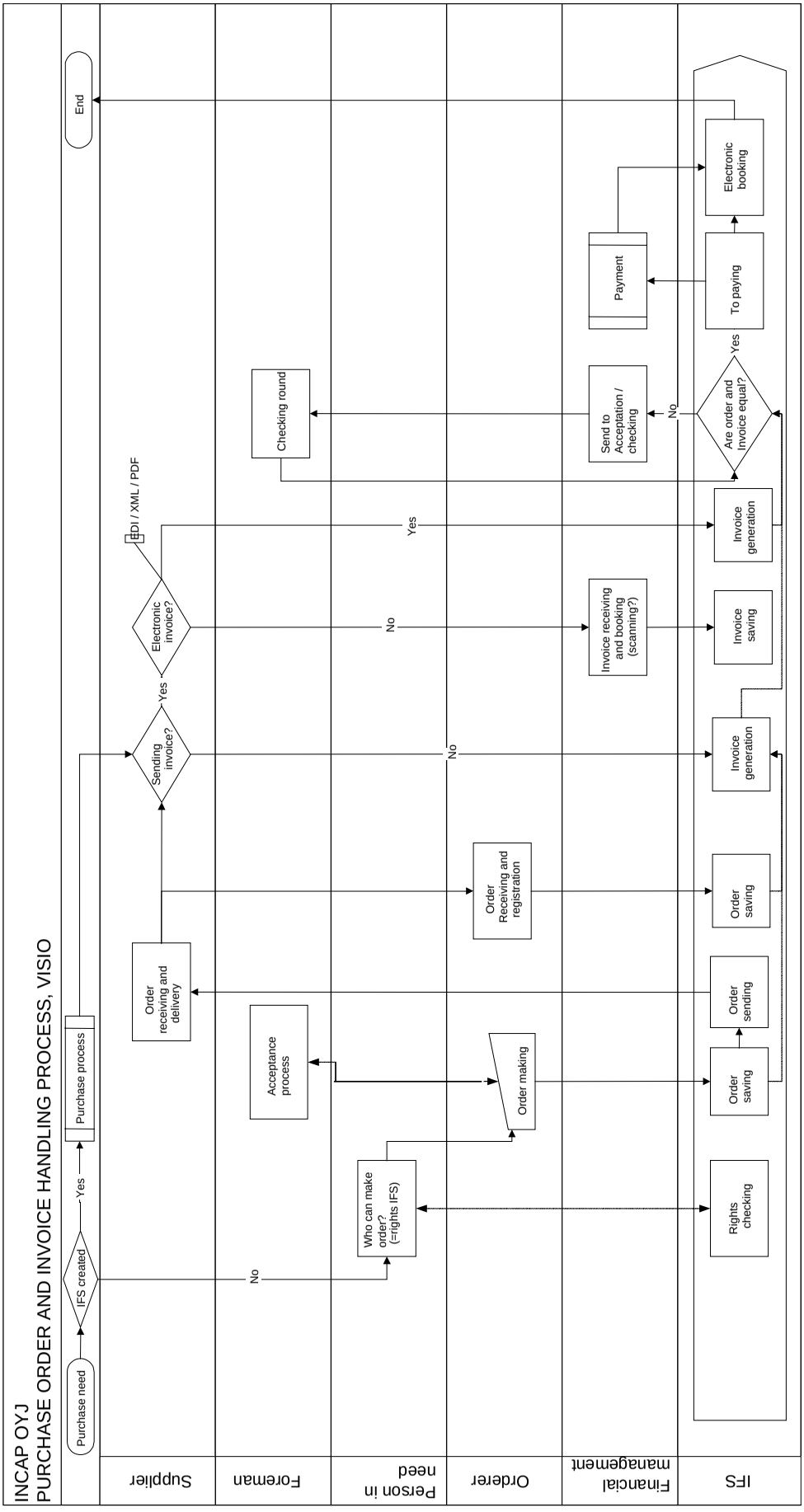
Appendix A: The Incap purchase order and purchase invoice handling processes



Published by

Vuorimiehentie 5, P.O.Box 2000, FIN–02044 VTT, Finland
Phone internat. +358 9 4561
Fax +358 9 456 4374

Series title, number and report code of publication

VTT Research Notes 2149
VTT–TIED–2149

Author(s)
Hemilä, Jukka

Title

Information technologies for value network integration

Abstract

Companies have increasingly focused on their own core business and created partnerships with other companies to increase their competitiveness. Linear supply chains of companies create the enterprise networks. The enterprise networks could produce wider product and service entities, and the entire network could be comprehended as a value adding value network for the product or service. VTT Industrial Systems has researched enterprise networks but there is also a need to research supportive applications for business and communications between the applications.

The objective of this study is to define which kind of applications are suitable for managing networked enterprises and supply chains, and how application integration can be achieved. Information sharing for the company's use and with the business partners improves the transparency of a dynamic business environment. The objective is to create a hypothetical model for value network integration in practice by combining the research results of this study. The research is focused on electronic contract manufacturing industry but the technologies and models are applicable also to other industries.

The supply chain and network management and management tools are studied in the literature survey and by using www-material from the Internet. The supply chain and network management and tools are studied also by interviewing software vendors. Information about supply chain management in practice is studied in a joint project by VTT and the customer company, by interviews and discussions with the parties involved.

The conclusion of the study is a hypothetical model for value network integration in practice. By use of information technologies, it is possible to improve business and communication between enterprises. From the point of view of the enterprises, it is worthwhile to invest in enterprise networks and to improve the communications between the business partners.

Keywords
enterprise networks, integration, supply chain management, value network

Activity unit
VTT Industrial Systems, Tekniikantie 12, P.O.Box 1301, FIN–02044 VTT, Finland

ISBN	Project number
951–38–6056–6 (soft back ed.) 951–38–6057–4 (URL: http://www.inf.vtt.fi/pdf/)	A1SU00403

Date	Language	Pages	Price
July 2002	English	97 p. + app. 1 p.	B

Name of project	Commissioned by
InElog	

Series title and ISSN	Sold by
VTT Tiedotteita – Research Notes 1235–0605 (soft back edition) 1455–0865 (URL: http://www.inf.vtt.fi/pdf/)	VTT Information Service P.O.Box 2000, FIN–02044 VTT, Finland Phone internat. +358 9 456 4404 Fax +358 9 456 4374

The study discusses about the supply chains and the networked enterprises. The document clarifies supply chain and network management as the concepts, and the tools to handle them in practice. Markets provide very different kind of management tools for different needs, and the study presents a few commonly used management tools. Information sharing through the whole network of enterprises requires system integration. The study presents integration technologies inside the organisation, as well between the networked enterprises. The study includes the practical case from the field of electronic contract manufacturing. The conclusion of the study is the hypothetical model for value network integration in practice, which summarises the ideas presented in study.

Tätä julkaisua myy
VTT TIETOPALVELU
PL 2000
02044 VTT
Puh. (09) 456 4404
Faksi (09) 456 4374

Denna publikation säljs av
VTT INFORMATIONSTJÄNST
PB 2000
02044 VTT
Tel. (09) 456 4404
Fax (09) 456 4374

This publication is available from
VTT INFORMATION SERVICE
P.O.Box 2000
FIN–02044 VTT, Finland
Phone internat. + 358 9 456 4404
Fax + 358 9 456 4374

ISBN 951–38–6056–6 (soft back ed.)
ISSN 1235–0605 (soft back ed.)

ISBN 951–38–6057–4 (URL: http://www.inf.vtt.fi/pdf/)
ISSN 1455–0865 (URL: http://www.inf.vtt.fi/pdf/)