Capability to Promise (CTP) Handling Strategy in SAP

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Abstract

Nowadays, many companies attempt to adapt their production planning and strategy to make order fulfillment more flexible. In manufacturing, the capacity and capability constraints are key factors which need efficient production planning for controlling service level and minimizing inventory cost. This thesis focuses on looking for the economic and efficient strategies for Capability to Promise or CTP handling. This strategy is proposed to work for Low Volume/High Mixed product manufacturing. Moreover, SAP is used as Enterprise Resource Planning (ERP) system for steering the CTP handling strategies in order to increase automated order handling regarding cost efficiency. The results of this research are both concepts and implementations on how to set CTP handling by using SAP, regarding the demand uncertainty environment in Make to Order (MTO) fulfillment.

Key words: Master / Production planning, Capability to Promise (CTP), Low Volume/High Mixed product manufacturing, SAP and Make to Order (MTO) fulfillment
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Patriya Laoniphon & Wenyi Yu
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<td>AGO</td>
<td>Assembly Group Object</td>
</tr>
<tr>
<td>APO</td>
<td>Advanced Planning and Optimization</td>
</tr>
<tr>
<td>ATP</td>
<td>Availability-to-Promise</td>
</tr>
<tr>
<td>BOM</td>
<td>Bill Of Material</td>
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<tr>
<td>CL</td>
<td>Customer Logistics</td>
</tr>
<tr>
<td>C:M</td>
<td>Control Manufacturing System (A Material handling system used at Ericsson in Katrineholm)</td>
</tr>
<tr>
<td>CTP</td>
<td>Capability-to-Promise</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>ESS KH</td>
<td>Ericsson Supply Site Katrineholm</td>
</tr>
<tr>
<td>ECC</td>
<td>ERP Central Component</td>
</tr>
<tr>
<td>LVHM</td>
<td>Low Volume and High Mix</td>
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<tr>
<td>MTO</td>
<td>Make-to-Order</td>
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<td>MRF</td>
<td>Medium Range Forecast</td>
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<td>MRP</td>
<td>Material Requirements Planning</td>
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<td>MU</td>
<td>Market Unit</td>
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<tr>
<td>PFS</td>
<td>Pick- from-Stock</td>
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<tr>
<td>PIM</td>
<td>Product Introduction Management</td>
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<td>SPG</td>
<td>Support Processor Group</td>
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<tr>
<td>SAP</td>
<td>System, Application and Program</td>
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<tr>
<td>SNC</td>
<td>Synchronization Network Core</td>
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Thesis Structure

Chapter 1 gives a general understanding of the background to the paper, purpose, task definition and research areas.

Chapter 2 consists of a general description of the company, which helps the reader have a good understanding of the organization.

Chapter 3 presents the methodology used during different phases of the thesis.

Chapter 4 contains the theories which are used to support the descriptions, analyses and strategies of the work.

Chapter 5 lists 2 companies’ interview as case study, so as to compare with Ericsson Supply Site Katrineholm's system and support the proposed solutions.

Chapter 6 describes the current state of production planning in Ericsson Supply Site Katrineholm, like products, process and the system.

Chapter 7 uses root analysis cause to discuss the problems behind the CTP setting.

Chapter 8 gives a matrix solution for CTP handling strategy.

Chapter 9 concludes the work, gives recommendation to the company and presents the future study.
1. Introduction

This chapter introduces the background of this study. The purposes of this study are formulated and the problem statements are defined. Besides, the study boundaries are described to show the limitation of this project. Finally, the chapter is ended with summarizing each chapter in a reading instruction.

1.1 Background

The strong competition and globalization market at the present drive many companies to pay attention on customizing their product and offering the best customer service for maximizing their market share. Focusing on a manufacturing industry perspective, the manufacturers yet attempt to satisfy their customer in many ways. One of the ways to achieve customer satisfaction is to concentrate in order commitment or order promising. Manufacturers endeavor to maximize the order commitment precision which is as the significant factor that needs to synchronize the procurement; manufacturing and distribution with the customer demand (Shobrys D., 2002).

Capability-To-Promise or CTP handling is the process of committing orders against available capacity as well as inventory and represents what is the site capability. CTP check is one of the analysis processes which support the order fulfillment process (Shobrys D., 2002) which is used to determine when a new or unscheduled customer order can be delivered. It is the feature available to help manufacturing industry improve the operations and deliver a high level of customer service. CTP check processing evaluates for inbound purchase receipts, supplier lead times, and alternative sourcing options for raw material, production and labor availability. To enhance the customer satisfaction, the stakeholders, such as procurement planning, production planning, and order management, is involved to achieve this point. The procurement planning is required to support the manufacturing by maximizing supplier delivery precision in order to smooth the material flow. In the production planning is required to optimize the capability of production operation and draw up the master scheduling to establish accuracy, responsiveness and order fulfillment. The order management is involved in handling order process verification and fulfillment system. In certain circumstances, the customer demand is not steady and apparently effects the destabilization of supply chain. It is necessary to merge the customer need and all of stakeholder.

Nowadays the CTP handling level can be executed by Supply Chain Management (SCM) systems. These systems are playing the significant roles in manufacturing environment to build the factory site’s impression to customer perspective. One of them is System, Application and Program or SAP which is noted in SCM process as a tool supports SCM processes by visualizing and processing data regarding the particular business requirements (Dickersbach T.J., 2008). Since the SCM processes can essentially affect and change the organization, a strong commitment by the supporter in a sufficiently high position is necessary (Dickersbach T.J., 2008).
In this thesis, Ericsson group is the empirical study to learn how to set CTP handling level in a practical way. The Ericsson group is one of Sweden's largest companies which provide telecommunications equipment and related services to mobile and fixed network operators globally. (Ericsson, 2011b) There are many supply sites around the world such as Sweden, Mexico, Tallinn, China, India and Brazil. Ericsson supply site Katrineholm (ESS KH) is one of the supply sites within Ericsson group. This factory is driven mainly the production of various stations of the mobile telecommunication network and responsible for manufacturing of products with low volumes and high mix (Ericsson internal presentation, 2010g). This means that it is vital to have a flexible and robust scheduling and sequencing in supply chain (Veerakamolmal P., 1998). Ericsson Katrineholm supply site has been developed their production operation and started to implement the concepts of Lean and Agile Manufacturing. Moreover, they are embracing a new system landscape using SAP for improving master and order planning area.

As mentioned above, one of the factors that affects the order commitment process is CTP handling level. To be able to continue align towards the overall strategies for the site at Katrineholm when the new system is going to implement, there is a need in the master planning to increase the knowledge for setting up the suitable CTP handling level by using SAP in accordance with the site strategy for Low volume and High mix (LVHM) products and Make to Order (MTO) fulfillment.

Ericsson's offer to the customers is evaluated based on delivery precision, which is critical to not losing future orders. Product quality has to meet high standards to qualify for customer orders. Ericsson is mainly winning orders on price and delivery lead-time. Internally, Ericsson use production lead-time, delivery precision, and cost of sales as key performances indicators. The ability to deliver larger volumes is expected to be important in the future, indicating an increased importance of volume flexibility. (Selldin, 2005)

The demands placed on Ericsson by its customers give a complicated picture. Low cost is emphasized at the same time as short delivery lead times are important, which does not provide a clear indication if it is an innovative or functional product. (Selldin, 2005)

Internally, the production process is measured using several different performance indicators. Components shipped directly to the final assembly are measured using on-time deliveries. Production is measured on quality performance and production time per unit. Delivery precision is measured for all products. (Selldin, 2005)

1.2 Purpose

The purpose of this thesis is for ESS KH to keep the response speed, flexibility of capability to provide fast delivery within minimum risk. It is a tradeoff among 3 goals of ESS KH as shown in Figure 1.
Figure 1: Multiple goals of the working strategy

Figure 1 shows that the working strategies should support the following goals: maintaining the delivery precision on the first confirmed order to 98%, maintaining the 7 days lead time response and maximizing the automated order handling. These three goals are to simplify the CTP administration and ordering. The first goal is that Ericsson promises customers the date that the products will be delivered to them, the percentage of reaching this promise. The second goal is to maintain the resulting lead time response to 7 days. It is from the day the customer orders to the day when Ericsson responds with the delivery date. The third goal means decreasing the total amount of manual work; this means less workload in CTP orders, supporting high degree of automated orders.

It is difficult to meet all three goals at the same time and a trade-off among the goals has to be found. For example, the first customers confirmation can be reached well if the transportation way is changed, having a large inventory or big capacity, however all of these will cost more in an economical thinking. On the other hand, the lead time response can be reached well if the first customers confirm is well-promised. This increases delivery cost.

Moreover, in order to meet customer demand the management decision should optimize service level with the lowest total cost. Figure 2 illustrates an optimal service level with minimal total cost. It is assumed that the total cost include the costs of lost sales, delays, excess in capability and excess in inventory. These costs increases and decreases exponentially (Ericsson internal document, 2010c).
1.3 Problem Statement
The inaccurate CTP causes ESS KH's CTP setting problem. If the CTP is lower than the customer orders, then ESS KH cannot get orders which they can get. If the CTP is higher than the customer orders, than there will be a waste of production capability, as well as extra inventory.

In order to fulfill the customer promise regarding delivery precision and targets of lead times, cost and capital targets, the research focus will be looking for different possibilities for balancing and fulfilling these preconditions. With the limited capacity, this problem needs to be solved with an order policy built on CTP. The site needs to be sure that there is capacity to fulfill the order, considering the other orders that have already been received and promised. Even if the customer lead time is standard, the site needs to be sure that when the next order is taken, there will be resources to fill it on-time along with the other orders. (Kienleong, 2010) The later chapters will build suitable strategies for Capability to Promise (CTP) to be implemented in SAP, which ESS KH can adapt within the site strategies. With the help of different implementation plans, the strategies will align with the existing system and improve the system.

The two research questions are:
1. How to set the CTP level in an efficient and effective way?
2. How to set the CTP level to align with SAP APO system?

To find answers for these problems, different methods will be used to research different areas. Through literature study, below topics will be studied: MRP, SAP APO, CTP, CTP setting, demand uncertainty, production capacity, safety stock and etc. Through ESS KH's site observation, below departments will be studied: production, purchasing, order management and Dimensioning & Planning. Through ESS KH's site interviews, discussed topics include: current state of CTP level set up, constraints of CTP setting, the effects of unreliable CTP setting up, needed master data in SAP APO, practical process of setting CTP and etc. Through reference companies' interviews, different
comparable areas consist of their ways of working with CTP setting up, the related systems used for setting up CTP, the difficulties they have when they start using CTP as a tool and etc.

1.4 Project Limitation
In this section, the limiting factors and available time for this thesis are defined.

1.4.1 Time limitation
The thesis project was conducted between 24th January and 10th June 2011, while the SAP ONE project, that the thesis is closely connected to, is from 17th January to October 2011. Due to this, this thesis project was not able to follow the whole SAP ONE migration project and check the application process. As this project is finished after 20 weeks, the SAP ONE will go live and be further developed after that time. This limits the real application of our conclusions and to some extent the feasibility.

1.4.2 Tool and System
SAP will be used as system for managing the CTP handling strategy in order to align with the strategies and methods with ESS KH.
2. Company Description

This chapter gives a general understanding of the Ericsson Company. It is divided into three parts: Ericsson Group, Organization and Katrineholm site. The section on the Ericsson Group describes the company's history, vision, objective and product as a whole. Next, the organization part is addressed in order to see the structure of Ericsson by narrowing down to Katrineholm site. The final part definitely will be described in terms of its position in Ericsson which environment factory in Katrineholm work and which parties are involved in the thesis. This chapter is primarily intended for those who have no direct related to the degree project or company and who want to get a brief description of the company.

2.1 Ericsson Group

2.1.1 History

Ericsson has been a leader in driving technology forward, switching from telegraph to telephone all the way to the roll out of 4G (Fourth generation mobile phone system). It has helped from the industry's standards, from NMT (Nordic Mobile Telephony) and GSM (Global System for Mobile Communications) to LTE (Long Term Evolution) which is a next generation mobile wireless broadband technology that will enable operators to offer wireless broadband services. It also has one of the richest telecom heritages and was one of the first companies to establish operations overseas (Ericsson internal presentation, 2010g).

Areas that Ericsson covers are:
- Mobile, 2G, 3G and 4G
- Fixed systems, broadband and fixed telephony
- Transmission and Transport, for mobile, fixed and other types of networks
- The service layer, applications and end-user services
- Services, consulting, systems integration, managed services, deployment and optimization of networks, training and technical assistance
- Cell phones, mobile phones and other mobile communication (through joint venture Sony Ericsson)

The company has about 90,261 employees where of about 18,200 are employed in Sweden. Customers are spread across 140 countries and there is over 1 000 different telecommunications network around the world that uses its technology (Ericsson, 2010c).

2.1.2 Vision

“To be the prime driver in an all-communicating world” is the vision of Ericsson which is the passionate vision to be perceived as Best in Class and the best alternative within the framework for own value proposition. The customers should perceive Ericsson as the best in class suppliers, maintaining the stakeholder confidence to allow it to continue to invest in front-edge technologies and next generation ways of working. It also wants to be perceived as a highly competent partner and competence center playing an important role in the global development in supply. (Ericsson, 2011c)
2.2 Organization

The Ericsson organization is based on two basic functionalities which are creating offerings (Business Unit: BU) and selling offerings (Market Unit: MU). This part will describe overview of responsibility in each unit which is involved in this study from the big view as business unit (BU), Business Unit Network (BNET), Business Unit Network Supply (BNET Supply) to Site Core and Packet Supply respectively as illustrated in Figure 3. After that, Ericsson Supply Site Katrineholm (ESS KH) and Capacity Management department in ESS KH will be described in section 2.3.

![Diagram of Ericsson's organization](image)

Figure 3: The part of Ericsson’s organizations which are involved in this study

**Business Unit**

A Business Unit is a unit responsible for product management, product provisioning, marketing, business management and supply management of a portfolio of packages of total solutions, systems, products and services within its defined scope. Moreover, this unit endeavor to develop and maintain a competitive, high-quality offering and have consolidated financial responsibility and also maximize profitable growth with regard to customer satisfaction and performance. The head of a Business Unit reports to the President & CEO (Ericsson internal document, 2010a).

**Market Unit**

A Market Unit is responsible for manage customer relationships; maximize sales and profitable business through an efficient local operation with financial responsibility through account management, in support of key account managers. The Head of a Market Unit reports to a member of the Group Management Team.
2.2.1 The Business Unit Network (BNET)

The Business Unit Network is one of the Business Unit (BU) within the Ericsson organization as illustrated in Figure 4. It takes care of order planning and order fulfillment of the company’s overall logistics chain.

![Figure 4: The Business Unit Network within Ericsson Group](image)

2.2.2 Business Unit Network Supply (BNET Supply)

Business Unit Network Supply functions as part of the Business Unit Network (BNET) in section 2.2.2 above. The main task to support and satisfy customers with both hardware and software systems to the Ericsson offer by BNET. Supply organization is in turn divided into a number of functions and product areas with underlying of functions and product areas with underlying production units for each product (Ericsson internal website, 2011). One of the areas under the BNET supply is Site, Core and Packet Supply as illustrated in Figure 5.

![Figure 5: Business Unit Network Supply (BNET Supply) broken down to Site, Core and Packet Supply](image)
2.2.3 Site, Core and Packet Supply unit

Site, Core and Packet Supply unit will be responsible for driving supply chain and supply process improvements and controlling high and reliable performance within Ericsson's manufacturing, as well as from suppliers. The mission is to contribute to Ericsson’s success by securing a flexible, reliable and cost-effective production and supply of Site, Core and Packet products. One of production sites is managed by the Katrineholm unit (ESS KH) as followed in Figure 6 (Ericsson internal website, 2010).

Figure 6: Illustrating ESS KH is included in Site, Core and Packet Supply

2.3 Ericsson Supply Site Katrineholm

Ericsson Supply Site Katrineholm (ESS KH) is a node production center (NPC) for Ericsson's system solution and responsible for providing low volume/high mix production for core systems and platforms such as wire line, mobile core and multimedia (Ericsson internal presentation, 2010g).

ESS KH produces mobile Core (MSC / MCC server, Mobile Media Gateway and etc.), Multimedia (MMS, UPG, MOIP and etc.) and Wire line (former was telephony). It is specialized on industrialization of new system products and modules and the responsibility goes from early participation in product development projects, to developing maintenance chains for our finished products and systems, with high variation in low volume products (or is called Low Volume/High Mix product: LVHM) which is the core part of the system. Site Katrineholm, this study will focus on capacity management area which will be summarized the whole working area in following part.

ESS KH wants to continue to be an appreciated partner driving Ericsson Low Volume/High Mix (LVHM) supply to perform better than customer expectations on a global basis. The service includes industrialization and prototyping for products in the LVHM product segment, product life cycle management, global master responsibility for the products portfolio, LVHM manufacturing, EOL manufacturing management, AMS services, and consulting services like logistics development, operational excellence and process development. Within the organizational structure of ESS KH, this study will focus on the capacity management department as illustrated in Figure 7.
2.3.1 Capacity Management

Capacity Management is responsible for developing and dimensioning cost efficient and flexible supply chains in order to meet customer needs. The working areas in Capacity Management department include three functions; System, Report and Tool, Order Management and Dimensioning & Planning with one Support & Business Control Operational department. This study area is included in Dimensioning & Planning department, illustrated in Figure 8.

2.3.2 Dimensioning & Planning (D&P)

This study will be included in the Dimensioning & Planning department which is to support ESS KH level in adapting to the strategies and targets for the future within lean and agile philosophies to be able to maximize customer service to minimal cost. There are five working areas at dimensioning and planning (Ericsson internal presentations, 2010a):
1. MRP Process (within Katrineholm site)
2. Buffer dimensioning processes
3. Product Introduction Project (Master Planning/Dimensioning parts)
4. Logistics Development (Order planning processes, capacity planning processes etc. within ESS KH)
5. Logistics Development/ Global engagement (Strategic project core system supply, take part in central BNET supply planning development and supporting clone sites in logistics development)

### 2.4 Functional site structure

In order to provide understanding of the delivery process (which will be explained more in detail in Chapter 6) the following list describes some key supply sites and functions used within the material flows for the deliver process (Ericsson internal document, 2010a).

- Ericsson Distribution Centre (EDC) or Stored Packed Goods (SPG): Warehouse for BU controlled packed material connected to a customer order that awaits pick-up by the DSP. Normally co-located with a global or regional warehouse.
- Node Production Center: Factory for production/assembly of Ericsson material, either Make-to-order or Make-to-stock.
3. Methodology

This chapter presented the selected research design, the way of study and a discussion about the quality of the studies performed.

3.1 Research design

The way to conduct this thesis relied on the company's needs (Ericsson supply site Katrineholm) and authors’ fundamental ideas and opinions. The choice of method was based on the objective of the study. There are three possible methodological approaches to build on when a scientific study is designed; qualitative, quantitative and mixed approach.

Qualitative research can be conducted as a research strategy which includes analysis of texts, pictures, representation of data in figures and personal interpretation of the findings all inform qualitative procedures (Creswell, 2009). On the other hand, quantitative research can be conducted as a research strategy which involves specific methods, especially in survey and experimental research. Those relate to identifying the sample and population (Creswell, 2009). Nevertheless, the characteristics of qualitative and quantitative research approaches are compromised in a so-called mixed approach. Though a research can be predominantly approached in either of the two methods but it can also contain some characteristics of the other (Creswell, 2009).

This thesis is mainly about learning, analyzing and building a potentially strategies for setting CTP level. The expected result of the thesis is more likely to be expressed in a qualitative method than quantitatively. For this reason a qualitative research approach is predominant manner used in this thesis. After research approach (qualitative) was chosen, the designs of the research techniques were made according to the selected approach in order to visualize research problems. The main steps in qualitative research are suggested by Creswell (2009). These are the purpose, research questions, conceptual/theoretical frameworks, data collection techniques, data analysis, write-up the result of the study/conclusions and validation. The table 1 below shows the summary of included research techniques which lead to achieve the three objectives of this thesis.
### Table 1: The summary of included research techniques of this thesis

<table>
<thead>
<tr>
<th>Research Purpose</th>
<th>Research Questions</th>
<th>Methods</th>
<th>Outcomes</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Literature study</td>
<td>• The comprehensive understanding of all concepts to be reflected in the research area</td>
<td>1. Maintaining the delivery precision on the first confirmed order to 98%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interview</td>
<td>• The current state of CTP level set-up today</td>
<td>2. Maintaining the lead time response as 7 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Constraints of CTP levelling setting up today</td>
<td>3. Maximizing the automated order handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The effects of unreliable CTP levelling setting up</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Observation</td>
<td>• The actual production situations and scenarios.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reference companies</td>
<td>• The way of their working with CTP setting up related to ESS KH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The related systems are using for setting CTP level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. How to set the CTP level in an efficient and effective way?</td>
<td>Literature study</td>
<td>• The characteristics of SAP APO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The CTP setting process in SAP APO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interview</td>
<td>• The needed master data of setting CTP in SAP APO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The practical process of setting CTP in SAP APO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. How to set the CTP level to align with SAP APO system?</td>
<td>Literature study</td>
<td>• Their systems which are used for setting CTP?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reference companies</td>
<td>• Comparing with ESS KH’s system</td>
<td></td>
</tr>
</tbody>
</table>
Data collection
The relevant data in this thesis gathered from both primary and secondary data. The sources of the primary data will be interviews and observations. The secondary data will be printed and electronic resources.

1. Primary data
   A. Interview
      Interview approach will be used to extract knowledge from experienced professionals. The four stakeholders in ESS KH are key interviewees; the production planning department, purchasing department, order management department and production department. Moreover, the interview approach will answer what the current state CTP set up today, the constraints of setting CTP level and the effects of unreliable setting CTP level.

   B. Site observation
      Visits to production sites in ESS KH will be conducted in order to understand the production process. It will also enable the researcher to identify the actual production situations and scenarios.

2. Secondary data
   A. Literature study
      This part will be used to set up the theoretical framework which gives a comprehensive understanding of all concepts to be reflected in the research area. In the theoretical frame work basic concepts such as Supply Chain Management, Logistics, Product characteristics, Low-Volume/High-mix products, Order Fulfillment Process, Master scheduling, planning process, ATP & CTP application, MRP implementation, SAP application from SCM with SAP APO are some to mention. The sources of the literatures will be academically legitimate databases for electronic resources and books for printed resources. When necessary, internal resources from the company will be used on issues not addressed by the academic.

   B. Case study
      To choose case study as a research method, one unit was analyzed in the entire of this thesis, Ericsson supply site Katrineholm, Sweden. Reference studies were also conducted in order to allow a comparison with other companies, Volvo Penta in Gothenburg, Sweden and Volvo Construction Equipment in Eskilstuna, Sweden. The other units of analysis were selected from their similar way of setting capability (Yin, 2003) in order to fulfill customer orders by using advanced planning system from their different products and system. External case studies aim to compare the understanding of the use of complicated CTP leveling handling in these companies. The company's internal documentation, figures are graphs from different internal departments are needed for analyzing which describes the products, processes, and systems. The interview is arranged in order to grip on how they work with setting CTP in the best way. The interview question of Volvo Penta is attached in Appendix 1 and Volvo Construction Equipment in the Appendix 2.
Data analysis
Relying on a single cause can limit the solutions and some better solutions can be missing. The root cause analysis, hence, is used to be as a tool to analyze and identify the causes that are beneath the surface problems which will define what the problem is, why it happened and what should be done to prevent it (Thinkreliability, 2011). There are three basic steps in root cause analysis method as following; defining the issue by its impact to overall goals, analyzing the causes in a visual map and preventing or mitigate any negative impact to the goals by selecting the most effective solutions and any negative impact to the goals by selecting the most effective solutions.

After we designed our research methodology, we synchronize the method and project time line with this project’s action plan by dividing into three phases as per Figure 9 below;

![Action Plan Diagram](image)

Figure 9: Action plan of this project

The action plan was divided into three phases; Phase 1 is a so-called Learning current state. This phase includes learning involved product, process and system. Analyzing current situation is in Phase 2, the methodology was conducted by using internal interviews, external case study which includes literature review and comparable companies, Underlining system. Phase 3 is Building which consists of strategies/methods, tool box and implementation plan.

3.2 Validity and reliability
The validity of the paper depends on the result consonant with the reality. Construct validity refers to if the thesis has been carried out in the right. For reliability, it is to certify the fact that the same results could be found if this research's conducted in another time by another researcher.
There are several methods for assuring validity and reliability of the results in qualitative research perspective. In this thesis, multiple views were used to ensure the validity. Interviews and site observations from different involved parties were made. Each department would get the similar interview questions according to research questions in order to get different aspects. Moreover, repeated investigation, either contact via email, telephone or face-to-face, were made to guarantee the information in discussion. This technique can increase credibility of data collection.

The presenting study progress and results to the company supervisor and manager on a regular basis is also one of techniques that was used to ensure that the results of this study are useful to the company.

The choice of reference companies are one of the techniques which enhances the possibility of generalization, compared to a single study. The selection of cases was made from some criteria in order to study the same phenomenon. The similar resource planning system as ERP for achieving order promising was chosen to study similarities between the cases even though they are different product types.

Reliability of this thesis can be heightened according to the guideline from Yin (2003). This book recommends organizing well documented way in order that other researchers can follow the same line of action and come to the same results. The interview questions have been well documented and enclosed at the end of this thesis (Appendix 1 and Appendix 2). In addition, the contact information which could contact in the future is listed at the end of this paper as well (Appendix 3).
4. Theoretical Background

This chapter contains the theoretical background and theories which are used to support the strategies and analyses of the work. It starts off by introducing Logistics and Supply Chain Management to which are the basic knowledge but they are important to understand in the beginning. This theoretical frame of reference deals with demand uncertainty, capacity management and safety stock. The product design and product characteristics are outlined. The master planning is further discussed as well as orders fulfillment process will be defined. At the end of the chapter two relevant software support for supply chain management; SAP ERP and SAP APO is used to described how Capability to Promise (CTP) work with.

4.1 Logistics

Waters, 2003 defines logistics as follows:

"Logistics is the function responsible for the flow of materials from suppliers into an organization, through operations within the organization, and then out to customers."

![Figure 10: The role of logistics (Waters, 2003)](image)

From the Figure 10, it shows the role of logistics in general. Logistics hence include the flow of goods/services and integrated information between the point of origin and the point of consumption. Logistics is a channel of the supply chain which adds the value of time and place utility (Knolmayer, 2001).

4.2 Supply Chain Management

A supply chain is the network or the system of organizations, people, technology, activities, information and resources which are involved transforming natural resources, raw materials and components into a finished goods or service for the final customer (Selldin 2004). Waters 2003 defined supply chain as follows;
"A Supply Chain consists of the series of activities and organizations that materials move through on their journey from initial suppliers to final customers."

Typically, a supply chain is built up of several production activities which involve several production unit and storage points, connected by transportation of goods and by transforming information, as illustrated in Figure 11 (Selldin, 2004).

![Supply Chain Diagram](image)

Figure 11: A supply chain flow

**Physical flow**
The products are transformed through the supply chain from raw material located upstream in the supply chain to the final product for the end customers located downstream.

**Information flow**
Information in a supply chain can comprise of a combination of all involved functions such as sales data, customer orders, inventory levels, capacity availability, production plans and demand forecasts (Selldin, 2004). The information flow will be transferred between the supply chain in different supply chain nodes upstream and downstream.

Logistics and supply chain functions can overlap. Supply chain includes the logistics business functions above, and also includes purchasing, sourcing, procurement, buying, manufacturing operations, production scheduling and inventory control and materials management, facilities location planning, the information technology to coordinate between suppliers, the company, and customers (wholesalers and retailers and end users). In the past, manufacturers focus on logistics management which are small concern for improving manufacturing such as the optimization of transportation and distribution. (Dickersbach, 2008) But for now, supply chain management has more improvements and efficiency (Dickersbach, 2008). This integrates between different logistical functions and between planning and execution. Moreover, supply chain management will take all the processes; plan, source, make, delivery-per supply chain into account. (Dickersbach, 2008) The common supply chain processes cover the five
areas: Demand Planning, Order fulfillment (Sales, Transportation Planning), Distribution (Distribution Planning, Replenishment, VMI (Vendor Managed Inventory)), Production (Production Planning, Detailed Scheduling, Production Execution) and External procurement (Purchasing, Subcontracting) as following figure 12.(Dickersbach, 2008)

Figure 12: The common supply chain processes (Dickersbach T.J., 2008)

4.2.1 Capacity Management

The capacity management is one of significant functions in Supply chain management which is included in production and operation management part. The capacity of a production unit, such as machine, factory is its ability to produce or do that which the customer requires.

In capacity calculation is equal the maximum capacity multiply by availability rate and efficiency rate and yield rate (Logistik, 2010) as follows;

Calculated capacity = Maximum capacity × Availability rate × Efficiency rate × Yield rate

Where:
• Maximum Capacity: These are the total working hours for a given equipment on a 7 days a week/24 hours a day basis
Availability Rate: This ratio is the actual equipment run time compared to the full opening hours. Generally, it deducts the shut down time, idle time and the maintenance time.

Efficiency Rate: This ratio compares the standard run time to complete an operation with the actual time spent to complete the operation.

Yield Rate: This is a ratio which takes into account the defects produced at the line or equipment that is wasting capacity.

4.2.2 Safety Stock
Safety Stock is the extra stock that is maintained to moderate risk of stock outs because of supply and demand uncertainty. The amount of safety stock depends on business policy of each company. Too much safety stock can resulting in high holding costs of inventory. On the other hand, too little safety stock can affect insufficient material or final products which result in losing customers. Therefore, the right balance of safety stock level is essential in manufacturing. The figure 13 below shows that safety stock must be set at a level which covers both excess material consumption within the replenishment lead time and the additional requirements that might occur during delivery delays. (Help.sap, 2011c)

4.3 Product Design or Product Characteristic
In a supply chain perspective, product design or product characteristics are one of method can classify supply chain management. Different product lines result in different supply chain networks. This paper addresses two kinds of product types; High Volume/Low Mix Product and Low Volume/High Mix Product. In this thesis, Low-Volume/High-Mixed (LVHM) product will be the case study which is concerned.
4.3.1 Low Volume and High Mix (LVHM) Products

LVHM manufacturing mainly consider how quickly they can deliver exactly what their customers need. Normally, a LVHM supply chain network involves a wide supply base and highly random customer connections (William, 2001). This network also often combined a deep Bill of Materials (BOM) with many alternative routings. The production planning strategies for LVHM are often opposite from the high volume/low mix production which can balance capacity easier. The master planning normally is used in LVHM is Make to Order or MTO. In the planning of operation, the most important information is the customer orders, inventory levels and capacity availability (Selldin and Olhager, 2004). All of this information is included in Order fulfillment process which will be explained in following part.

4.3.2 High Volume/Low Mix (HVLM) and Low Volume/High Mix (LVHM) product comparison

There are four fundamental differences between two kinds of products which are high volume/low mix products and low volume/high mix products (William, 2001) as following Table 2 below;

<table>
<thead>
<tr>
<th>HVLH</th>
<th>LVHM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply Chain Network</td>
<td></td>
</tr>
<tr>
<td>• Narrow supply base</td>
<td>• Wide supply base</td>
</tr>
<tr>
<td>• Repeat customers</td>
<td>• Dynamic midstream routings</td>
</tr>
<tr>
<td></td>
<td>• Many one-time customers</td>
</tr>
<tr>
<td>2. Logistics Network</td>
<td></td>
</tr>
<tr>
<td>• Frequent inbound</td>
<td>• Infrequent inbound</td>
</tr>
<tr>
<td>• Repetitive outbound</td>
<td>• Random outbound</td>
</tr>
<tr>
<td>3. Inventory and Capacity Management</td>
<td></td>
</tr>
<tr>
<td>• Single, fixed capacity constraint</td>
<td>• Multiple, shifting capacity constraints</td>
</tr>
<tr>
<td>• Node inventory and pipeline inventory</td>
<td>• Safety stock for unique part</td>
</tr>
<tr>
<td></td>
<td>• Risk pooling for common parts</td>
</tr>
<tr>
<td></td>
<td>• Hard to determine how to measure total</td>
</tr>
<tr>
<td></td>
<td>system inventory due to large</td>
</tr>
<tr>
<td></td>
<td>number of nominal trading partners</td>
</tr>
<tr>
<td>4. Net Value</td>
<td></td>
</tr>
<tr>
<td>• Rapid market growth</td>
<td>• Mature, fragmented market</td>
</tr>
<tr>
<td>• Delivers products</td>
<td>• Delivers both products and services</td>
</tr>
</tbody>
</table>

Table 2: Fundamental differences between high volume/low mix products and low volume/high mix products supply chain

Supply Chain Network

The supply chain network can be described by dividing into three streams; upstream supply base, the value-adding midstream and the downstream customer set.
From figure 13 above, we can see that the upstream supply base of LVHM is wider as the Bill of Material across the full product range contains a relatively larger number of unique materials. For the value-adding midstream normally consists of a dynamic manufacturing in order to achieve the required set of alternative product routing. For the downstream, customer set is broader and the finished products are driven by more varied customer needs.

**Logistics Networks**

Variability is the obstacle of a logistics network. It causes logistics connections within the network to be unpredictable (William, 2001) or unexpectedly expensive. For HVLM, the inbound logistics path is more frequent than another. The outbound logistics paths will appear quite repetitive. On the other hand, the frequency and quantity of customer orders for LVHM product will be random (William, 2001). Therefore, both supply and demand sides in LVHM’s logistics networks are dynamic. Moreover, the product variability challenges the logistics network and achieved customer service level. The reason is unless the supply chain is holding stock on every product or option combination, customer need to wait for product to be produced.

**Inventory and Capacity Management**

Concerning the supply and demand pattern, a LVHM scenario leads to different operating characteristics. For the supply side in LVHM, continuousness of supply is based on the careful management of safety stock inventory levels and also material risk pooling ensuring an ability to deal in real-time with multiple, shifting system constraints defined by product mix. (William, 2001) For the demand side, a HVLM demand pattern
is quite weighed toward repeated customer orders from a relatively narrow customer base. This in contrary with the demand pattern in LVHM, that is more weighted toward many different customers placing one time orders. From a supply chain perspective, its responsiveness to demand uncertainty depends on the prompt availability of inventory and capacity.

**Net Value**

From a Supply chain perspective, the LVHM can create a net value included in customer value and shareholder value. Company can gain customer satisfaction because their customers benefit from a perfect delivery at the lower cost on the product mix (William, 2001). Meanwhile, shareholders are satisfied since the profitable revenue growth build on a shrinking asset which is from a larger cash flow for reinvestment and a higher stock value.

### 4.4 Master Production Planning

The master production planning is the common basis for the supply processes (supply recommendations for purchasing, production, distribution etc.) and the order promising process (based on ATP and CTP quantities). By that, supply processes are synchronized with order promising, resulting in reliable order quotes. As a consequence the on time delivery KPI is improved (Knolmayer, 2001). By describing supply chains using some of the SCOR (Supply Chain Operations Reference) process modeling building blocks, SCOR is based on five distinct management processes: Plan, Source, Make, Deliver, and Return. But in this research will not emphasize on the last two processes. The figure 15 below shows the three parts in SCOR model process building block which are explained in this section.

![Figure 15: The main three part in SCOR which are involved in this paper. (Adapted from business-process-it, 2011)](image)

#### 4.4.1 Plan

The plan is the process that balances between aggregate demand and supply to develop the action which best meets sourcing, production, and delivery requirements (business-process-it, 2011). In the planning of operation, the most important information is the
customer orders, inventory levels and capacity availability. (Selldin, 2004) The example of planning as follows:

- Demand planning
- Production management
- Supply chain
- Change Management
- Manufacturing resource planning
- Capacity planning
- Forecasting
- Available/capable to promise.

4.4.2 Source
The Source is the process that procures goods and services to meet planned or actual demand. The example of source process as follow:

- Inventory management
- Procurement
- Vendor management
- Quality control
- Outsourcing/ subcontracting
- Purchase management
- Direct materials sourcing
- Supply management
- Product lifecycle management

4.4.3 Make
This process transform product to a finished state to meet planned and actual demand. The example of actions which is included in "Make" process as follows:

- Bill Of Materials or BOMs and routings
- Production Strategy: Planning, scheduling and control. From the concept of a customer order decoupling point (CODP), the CODP separates the production strategy into two key strategies: (Wikner, 2006)
  - Make To Stock (MTS): This strategy is based on stock-driven support among accumulation of inventory, customer service and capacity utilization which fluctuates with the level of demand.
  - Make To Order (MTO): Different from MTS, this strategy is based on order-driven which fluctuate with the level of delivery precision (from Supplier). (Dickersbach, 2008) MTO 'supports products of wide variety and custom design', 'typically produced in low units volumes', and 'where the firm's competitive advantage is in providing product technology requirements in line with the customer's delivery and quality requirements.' (Selldin, 2005)
Material Requirements Planning (MRP) is a material planning methodology developed in the 1970's making use of computer technology. The main features of MRP are the creation of material requirements via exploding the bills of material, and time-phasing of requirements using posted average lead times. MRP II was developed as the second generation of MRP and it features the closed loop system: production planning drives the master schedule which drives the material plan which is the input to the capacity plan. Feedback loops provide input to the upper levels as a reiterative process. (rockfordconsulting, 1999)

MRP techniques essentially drove the development of manufacturing off-the-shelf software packages, utilizing an integrated data base. These systems evolved into what is now known as Enterprise Resource Planning (ERP) systems. (rockfordconsulting, 1999)

In MRPII operation, forecasts are combined and adjusted for customer orders, and fed to the master scheduling module. Once the master schedule is set, the MRP process explodes the bills of material, usually overnight or on weekends, and develops the requirements for material. The material requirements feed the capacity planning module which tests the schedule developed by MRP against current capacity. This feedback loop creates two alternatives: increase capacity or adjust the master schedule. Netting of on-hand inventory balances and work-in-process is included as a regenerative process. (rockfordconsulting, 1999)

The Issues
Material Requirements Planning of any generation assumes a finely tuned data system, which seldom ever happens. It also works from lead times, a falsity because both external and internal lead times are dynamic and change daily. MRP also assumes infinite capacity which is unrealistic and difficult to manage. The end result is usually an increase of inventory caused by the manufacture of wrong parts, the very thing MRP was designed to resolve. (rockfordconsulting, 1999)

One reason for the excess generation of inventory is that the data system and accuracy required for MRP to properly run is difficult to maintain, and the MRP review system is notorious for printing tons of unused material review reports. It also requires de-expediting to prevent overstocking, which is seldom accomplished because it is often treated with low priority. (rockfordconsulting, 1999)

Finally MRP, utilizing time-phased order point methodology, is a push system that assumes demands rather than reacts to a true demand as in Demand Flow Technology. When driven by a forecast, as it is supposed to do, it reacts to the uncertainty of a forecast and produces parts that one hopes one will need. (rockfordconsulting, 1999)
Pragmatic Applications
Material Requirements Planning techniques have been proven to be ineffective at the micro level. However, if decoupled from the execution systems, provides a good methodology for forecasting both internal and supplier capacity requirements. It is necessary to advocate "cutting the belt" between planning and execution. That is, use MRP for forecasting high level requirements, but use demand flow technology, finite capacity loading, and true pull systems, as Kanban, for executing the daily production needs. (rockfordconsulting, 1999)

MRP Process
MRP Approach uses the information about schedules, products and materials. These come from three main sources: (Water, 2003)
1. Master scheduling: giving the number of every product to be made in every period
2. Bill of Materials: listing the materials needed for every product
3. Inventory records: showing the materials available

MRP Control
MRP-type control 'is appropriate when a wide variety of custom products is produced in low unit volumes', 'supports markets characterized by rapid changes in product technology, high rates of new product introduction, and substantial changes in product design'. (Selldin, 2005)

- Configuration
- Job Scheduling
- Shop floor data collection
- Quality control
- Costing

4.5 Order Fulfillment Process
Order fulfillment is one of key process in managing the supply chain. It is the customers' orders that put the supply chain and fill them efficiently and effectively is the first step in providing customer service. The order fulfillment process involves designing a network and a process that a firm to meet customer requests while minimizing the total delivered cost and maximizing the firm's profit. It needs to be implemented cross-functionally and with the coordination of key suppliers and customers (Keely, 2003). Order fulfillment is a crucial part of many businesses and the process also can be determined in different ways which depends on what kind of business is. Nowadays, there are many softwares that can support order fulfillment as following section. This thesis mainly discuss in the Make to Order (MTO) process which has dynamic demand rate, adaptable production and customer-unique products characteristics. Comparing with Make to Stock (MTS), this process has stable demand rate, cost-efficient production and standardized products. The figure 16 below shows the MTS and MTO which has Customer Decouple point in between to keep the buffer to be cushion.
4.6 Software Support for Supply Chain Management

This section introduces systems in support of logistics and supply chain management. It demonstrates the principles and theory of good design of stored data and integrated information systems support and gives exposure to the most modern implementations of this in the form of the Enterprise Resource Planning software and advanced supply chain management system which this paper will mention only SAP APO (Advanced Planner and Optimizer). (Knolmayer, et al. 2001)

4.6.1 SAP ERP (Enterprise Resource Planning System)

One of the systems which support supply chain management is known as Enterprise Resource Planning System or ERP, with a scope illustrated in figure 17 as follows:
The worldwide market leader of ERP systems is the SAP R/3 system (Knolmayer, et al. 2001). As stated by the vendor, the potential benefits of SAP ERP are efficient business process, inventory reduction, and lead time reduction. SAP R/3 was replaced with the introduction of ERP Central Component (SAP ECC). SAP R/3 can be described as the predecessor of SAP ECC. Moreover, The SAP Business Warehouse, SAP Strategic Enterprise Management and Internet Transaction Server were also merged into SAP ECC.

4.6.2 SAP APO (Advanced Planner and Optimizer)

This study will describe the SAP APO knowledge in order to lay the theoretical background and make more understand in ESS KH's system in Chapter 6. SAP APO is a whole suite of supply chain planner applications which synchronizes supply chain knowledge and provide forecasting, planning and optimization. SAP APO is in real time and any data related to the production, the sales or the supplies is immediately transferred from one system to another without requiring any batch processing. This application provides many functions for both intra- and inter-organization regarding planning, scheduling and monitoring. There are seven modules included in APO package that uses a shared database (Knolmayer, 2001) as shown in table 3. The benefits of the SAP APO is that it provides the basis for an end-to-end supply chain management solution, seamlessly linking all key processes from order generation to production planning to transportation.
<table>
<thead>
<tr>
<th>Module</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply Chain Cockpit (SCC)</td>
<td>Provides advanced visualization capabilities for planning and controlling</td>
</tr>
<tr>
<td>2. Demand Planning (DP)</td>
<td>A toolkit of statistical and collaborative forecasting techniques.</td>
</tr>
<tr>
<td>3. Supply Network Planning (SNP)</td>
<td>Used to calculate quantities to be delivered to a location in order to match</td>
</tr>
<tr>
<td></td>
<td>customer demand and maintain the desired service level</td>
</tr>
<tr>
<td>4. Global Available to Promise (Global ATP)</td>
<td>Uses a rule based availability checking strategy for inventories, allocations,</td>
</tr>
<tr>
<td></td>
<td>production transportation capacities and cost consideration</td>
</tr>
<tr>
<td>5. Transportation Planning / Vehicle Scheduling (TP/VS)</td>
<td>Optimizes transportation route and schedules vehicle resources.</td>
</tr>
<tr>
<td>6. Detailed Scheduling (DS)</td>
<td>Techniques for assigning resources and sequencing production orders.</td>
</tr>
<tr>
<td>7. Production Planning (PP)</td>
<td>Create short-term planning of material and production with consideration for</td>
</tr>
<tr>
<td></td>
<td>capacity constraint</td>
</tr>
</tbody>
</table>

Table 3: The seven modules within APO package (Knolmayer, 2001)

The important functions in SAP APO which support the customer order fulfilment process are Available-To-Promise (ATP) and Capability-To-Promise (CTP). These functions are relate to the customer from order taking, availability check and confirmation to the shipment to the end customer in order to give accurate and fast order promising (Cederborg, 2009). ATP/CTP check in SAP APO can be described as following:

A. Availability-To-Promise (ATP): The supply information of the master plan that is used as the basis for order promising is called available-to-promise (ATP) (Stadtler, 2010). In SAP APO, an ATP check is carried out for the requirement. The system checks if or when a requirement can be met and confirm the respective dates and quantities. ATP is called Product availability check in the system which considers inventory and scheduled production (Dickersbach, 2008)

B. Capability-To-Promise (CTP): CTP concept extends ATP by taking availability of materials and capacity into consideration. CTP can give a picture of whether demand can be satisfied within a given time limit. There are many production constraints should be considered such as availability of resources, lead time of materials or purchased parts. CTP is used to determine when a new or unscheduled customer order can be delivered (Open-source-erp-site, 2011). CTP check is called "Product allocation check" in SAP APO.

Moreover, there is the advanced method of rules-based ATP (RBATP) that enables ATP/CTP checks in other plants than where the sales order is registered (Ericsson
internal document, 2010a) and the method for triggering production from ATP check: multi-level ATP (ML-ATP) that enables ATP/CTP checks for the materials in the planned/production order direct in the Sales order (Ericsson internal document, 2010a).

The objective of ATP/CTP checking is to reduce the time spent by production planners in expediting orders and adjusting plans because of inaccurate delivery-date promises. However, the ATP and CTP checks constitute a reasonable approach to due date quotation; there is a need for suitable methods to make these checks.
5. Study of Reference Companies

This section will depict two case studies, Volvo Penta and Volvo Construction Equipment, which are the comparable companies with ESS KH. The study of reference companies are one of the methods which were chosen in order to see what kind of problems other companies have relate to ESS KH, how could ESS KH solve and work with it. This part will give the conclusion what is the benefit or bad (Pros/Cons) effect from setting CTP in each company. The interview questions for both companies were attached in the end of this thesis (Appendixes 1 and 2). These research questions are dealt with in two different reference companies, presented in detail as follows.

5.1 Case Study 1 - Volvo Penta

Volvo Penta is a company whose products are engines and using Oracle as its system. Its process is Order to Delivery. This process makes this company a comparable case study. The process includes the scope for Supply & Demand planning and concepts & solutions for order promise. Its orders are over multi-distributions.

Volvo Penta uses MTO (Make to Order) and BFS (Buy from Stock) flow. MTO is the main flow. Both ATP and CTP are used in both flows for promising customer order. Their tool is JD Edwards 9.0, one of the ERP systems. This tool is used to promise orders: in-house build application.

Volvo Penta site manufacture and scratch products, buy semi-manufactured products, and buy from suppliers. This manufacturing use safety buffers in item, time or capacity to solve uncertainty demand problem. Volvo Penta uses pure ATP and mix ATP & CTP to promise orders. They have different order lines, which lead to different promising methods. In CTP, there is another check called CTPCO which they only capacity not materials.

5.1.1 Forecast

Planning department gets forecast and put them into the planning system. Then they analyze how much do they really need and calculate the forecast to convert forecast into promise orders and supply forecast. The forecast covers 2 years with weekly adjustment, while the sales only have 1 month adjustment. This causes the LT is prolonged sometimes.

With putting buffer into forecast, the promise can be more flexible, for example high season, low season and items' maintenances. The whole sales items have buffers. They don't have the KPI for the forecast.

If back order process occurs, planners will ask for increasing the supply to get more items.
5.1.2 ATP & CTP

Volvo Penta is using cumulative ATP quantity, which is sales order is converted to demand quantity. The parameters of ATP are listed as below:

- quantity on hand (quality issues are not included)
- purchase orders in transit (from suppliers)
- purchasing orders (confirmed by suppliers)
- DRP order messages (DRP-Distribution Resource Planning)

Maximum Item Lead Time is one parameter for both ATP and CTP. This data shows that after the number of days, it is always able to supply. This means, if there is not forecast for this item, how many days’ suppliers can give the item. Then after these days, the supply ability will be infinite. This gives sales no limitations.

Volvo Penta's CTP / CTPCO's parameters include Freeze Fence. Below listed the settings during order promise in Oracle system:

1. set allocation date: consume all materials, when everything is finished - connect to 4
2. set schedule pick date (distribution working date)
3. set work order start date (LT to manufacture) - connect to 7
4. set work order requested date
5. set promised delivery date: transport, routing and etc.
6. set ship date (depends on how often it is)
7. set external purchase order request date (the date when is able to start working on that)

In most of the time, setting 1 = setting 2 (when inventory can pick the products). This makes the importance of buffer between them, which leads to production flexibility. In the system, it starts from customer requested date and goes back routing. To control the inventory means the flexibility of production, like default production lines which is based on different configurations.

While setting up CTP, the critical items are selected to be focused on to promise. The rest are just set up high. The low volume items' CTP will be based on forecast. CTP setting up is based on forecast so far, with the consideration of capacity and materials. CTP level is set on customer order product or finished goods. The table 4 below shows the statue of Volvo Penta's CTP setting up. All critical materials need to be available on the same week, (even they promise a certain day to customer) otherwise this promise day will be moved to a free week. Planners will find a week where everything is available.
In table 4, for capacity, the available work hours / day is how much time to produce = how many days to promise. For materials, the forecast is controlled by logistics planners. This is the constraint when they set up CTP. But they will adjust this forecast.

Volvo Penta has external supplier and internal suppliers for the MTO flow. For external suppliers, there are production agreements to keep track on them. They purchase orders, while Volvo Penta follows how suppliers fulfill their promise and their level of
capacity. The production agreement lists the capacity on per day which the suppliers should have in 12 months horizon.

5.2 Case Study 2: Volvo Constructions Equipment

5.2.1 Product and Process
The product in this site is medium volume/low mix product type. There are two main flows: axles and transmission. Each flow consists of machining, hardening, assembly and painting. VCE deliver the components (axles /transmissions) primarily to the following Volvo product families; Articulated Haulers, Loaders and Graders (Hallin C., 2011a). There are 2000 material pieces. First 200 pieces are from manufactured which mostly are expensive material. And 1800 pieces are from purchased which are mostly small/cheap component. The production main process in this manufacturing is Make to Stock according to Customer Order Decouple Point (CODP). This means they have planned what they will have for stock.

The customer of VCE mostly is internal customers such as Volvo in Köping. The Lead Time of the product here is quite short dynamic and various queue time during 5-25 days and has small batches, for instance, the lead time of the of transmission flow is 20 days, which means 20 days of inventory from getting raw materials to delivering to customers. According to the Toyota Production System (TPS) principle, the production site in VCE try to reduce the batch size to make it One-Piece. It is not easy to decrease the set up time to reach the goal of decreasing batch size.

5.2.2 System
The SAP within VCE which will be used and implemented in October is called SAP "Factory Master". SAP APO will be implemented in 2012 or 2013 later in VCE due to the complexity of this system. Nowadays, there are two systems are used in the production planning;

1. APS- APP for Transmission flow (with capacity constraints). APS is a very centralized system according to daily buckets. VCE can see from the system that how late their promises will be. There are some vital functions for supporting production planning such as; Order Scheduling: This function will move backlog into available time automatically as illustrating below in Figure 16;
The run capacity check is also one of the vital functions in this system. After planner shift backlog into available times, the orders need to do leveling such as which orders should move to some other time that has enough available capacity. This function will do run capacity checking. Alert Monitor is warning from this system whether materials are available or the inventory need to be increased.

2. ERP- MAPICS (without capacity constraints)
However, the backlog has been the problem in VCE, now VCE solved by increasing weekly over time for the system, increasing cycle time, OEE (Overall Equipment Effectiveness), utilization, increasing set up time, working overtime, considering employee absence, available time of shifts in order to improve production flexibility.

5.2.3 Planning Structure
There are four planning according to period of time; the first, LRF (Long Run Forecast) will scope 6-8 years speculation such as investing new machines, 2 times / year. The second planning is Monthly planning loop (Aggregated planning). This planning is for this year and the coming year with reviewing it every month, then break down into 6 months. Checking the load will foresee it for 6 months. This planning will do both of assembly and machine flow. Mostly it is about machine and space and scope of this plan is within 2 years. The third planning is weekly planning. This plan is running MRP on week basis. This is included capacity constraint setting and level demand. The last is daily planning: Checking capacity will happen in this planning and the planner, and then move around orders.

5.2.4 Setting CTP
The production planning in VCE also have setting capable-to-promise or CTP level which is a tradeoff between increasing/decreasing capacity, inventory management and promises to customers. It will be relied on two factors; Forecast which is based on monthly basis and is accurate within 2 or 3 months and Demand that is based on which its daily basis. Demand also influences the forecast accuracy. The probability to get a sales influences forecast probability, the latter one influences the probability to get real
production orders. For example, sales notify the production the percentage of getting this order is 60%. Then the production will produce 60% of the orders, which if they will come later for real.

The goal of VCE for setting CTP is not only to have CTP agreement with customer but also to have the 'Plant' functionality. This means all Swedish sites work in the same system and transparent platform, with reporting consequences of delay.

Logistics department in VCE, who is in charge of setting CTP, needs to work on master data quality to get the right parameters such as important elements as following:

- Machine capacity: Load of machines is required by calculating run time, set up time and cycle to get capacity hours per working day times of a machine

  \[
  \text{Total capacity} = \text{amount of product} \times \text{cycle time of machine} \times \text{set up time}
  \]

- The bottlenecks in production which take the longest production lead time in operation.
- Labor capacity: This data calculate hours a day and working days which include available time and shifts, with a monthly perspective. Maintenance is part of the workload (running prevention rather than correction)
- Utilization of machines: It is the output from machine to see how much machine can produce.
- Flexibility level: Flexibility is the extra capacity (Over/free capacity), for example, +60% of actual capacity means that the production capacity can increase the utilization up to 60%. This is the significant factor for setting CTP in VCE regarding monthly planning basis.

Practical manual tool which uses in logistics planning is Microsoft excel to simulate the flexibility to see what will happen if do some changes in production. There are three levels for controlling extra capacity in operation; if extra capacity is less than -10% of actual capacity, it is accepted, the yellow color is set. If extra capacity is more than -10% of actual capacity, it means that production and production planner need discuss each other. The orange color is put and if there are 3 shifts. The policy in VCE should not be 3 shifts so this situation needs to increase production or other solutions depend on production's decision. The red color is set to be warning sign.

5.2.5 Material constraints

Material constraint is one the factors which affect the material flow in VCE. Purchasing department sends purchased information to suppliers via Electronic Date Interchange (EDI). Materials should be arrived with right quantity on right date. The lead time of suppliers is within 7 days but the supplier lead time can +10% to 20% of lead time. This is part of the procurement agreement that VCE have with the suppliers which includes commitment about safety stock. However, purchasing department measures supplier performance in delivery precision, deviation late time, and quantity & time. As a result
of procurement agreement, overall supplier performance in VCE is quite high performance with 90%.

5.3 Suggestions

Volvo Penta is working on keeping the balance between the buffering size (maintenance fee of items) and products to go out. In order to make flexible CTP levels, there should not be too many limitations, as don't build too many details on production scheduling. This means don't set up full production scheduling. For the system, it is important to increase the data quality, because the stock numbers and lead time could be wrong. Last but least, critical items' setting up are quite important. This setting is based on capacity and materials.

The good master data was mention from VCE that is one of the significant factors to get the reliable CTP level. Planner needs to have enough information from all involved party in order to be achieved a longer period time in reality. Moreover, the planner should set clear responsibility, for example, who should update the CTP or how to gather the needed data such as use the matrix to map the right person for a certain CTP update. VCE concerned about the production flexibility as the key for setting CTP as well. CTP figure should be set in different product level and different flexibility of machine in order to get the flexibility in production planning and more trustworthy. The automated resource planning system is also recommended to support the master planning, for instance keeping the good sample to update the master data in the system such as mean value, deviation with trustful statistics and showing the situation of OEE and utilization each week. The planner can compare how much material the production has in the stock, as well as good correspond with the real situation.
6. Current Situation Description

This chapter describes the current situation of ESS KH's products, ERP systems and different departments' functions.

6.1 Product

6.1.1 Low Volume and High Mix Product

ESS KH's products are called "low volume" compared to other manufactures, however, in figure below, there are relative high volume products and relative low volume products are classified by Volume Value and Demand Pattern. Volume Value is equal to Yearly requirement multiply by Component value. The break point is 80 percentile. Low volume means 80% of the products with the lowest volume value are defined as low. High volume means 20% of the products with the highest volume value are defined as high (Ericsson internal presentations, 2010a). According to this classification, the node product will be categorized into 4 different classes: A, B, C, and D. as following figure 17;

As a result of time limitation, some relative high volume product families will be chosen. This thesis focuses on five product families; AXE, MGW, RNC, GGSN and SGSN which will be useful for ESS KH. These families represent 85% of the Katrineholm site's entire volume.

**AXE** is the product which connects the phone call (fixed and mobile) and sends out the bill and keeps track on the mobile phone (Ericsson internal presentation, 2010f). This product family is the oldest product family in ESS KH with quite broad variety. There are many SM in these product families which are in common with other different families. The relative volume is quite high. ESS KH purchase 50-60 boards from external suppliers which are in Sweden, Poland and China.
**MGW** (Mobile Media Gateway) is used for data traffic by changing traffic between mobile station and the fixed network (Ericsson internal presentation, (2010f)). There are around 20 different boards which are the components of MGW and two of them can ESS KH produces at the module department.

**RNC** is for controlling and optimizing the traffic between AXE and the mobile network. This product family is a relative high volume product for ESS KH and has a continuous flow of orders every month. All the material for RNC is purchased and some of the CPP boards for RNC common with MGW.

**GGSN** (Gateway GPRS support node) provides an interface between the mobile network (GSM, WCDMA or LTE) and internet and corporate intranets. GGSN is the first product family in the SAP ONE implementation. This product family is a lot of different varieties in this product family.

**SGSN** (Serving GPRS support node) is the wireless network (2,5G data traffic (GPRS) providing packet-data switching and mobility/session management in GSM, WCDMA and LTE networks

### 6.1.2 Product level

The product description needs to be described at the beginning in order to comprehend the product level within ESS KH and the group of products which are included in this study.

As mentioned above, product family is the group of objects which are delivery to customers. One product family includes Nodes level (First-tier product level) and Standard Modules (Second-tier product level) which includes purchased standard modules and manufactured standard modules in figure 18;

![Diagram](image)

Figure 21: Illustrating the two product levels; Node level and Standard Module level
Node level (First-tier product level) is the product level that will assemble the objects which will be delivered to the end customer or Delivery objects according to customer's need. Different nodes include different standard modules. Standard Module level (Second-tier product level) is the Product level normally kept in stock at the Node Production Centre or the Regional/Global Warehouse. Standard Module can be assembled or kitted to make up Nodes and can also be sold and delivered stand-alone as bulk, spare parts etc. (Ericsson internal document, 2010a). Standard Module can be purchased product from supplier and manufactured product from module department within ESS KH.

Therefore, the objective of this study is to determine good CTP-strategies for Nodes level and Standard Modules level within these high volume products and evaluate how they will affect the total process.

6.2 Dimensioning & Planning

In Dimensioning & Planning department, master planners are responsible for estimating production capacity, setting safety stock (buffer dimensioning) and etc. CTP adjustment is one of master planners' important tasks. Dimensioning and Planning department checks following points: (Karlsson, 2011, Ericsson internal email)

a. whether Material for prototype production is available in production plant
b. whether Prototypes/project orders placed (system/e-mail/web) and confirmed and have the following data; Product number, quantity, delivery date, delivery address and signed by authorized person.
c. Material for pre-PRA delivery secured (pre-series and early deliveries) order placed and confirmed.
d. ABC-classification decided, flow models and buffer levels are set for the product.
e. Pre-series/project orders placed and confirmed.
f. Material for pre-series production is available in production plant
g. Material flow is established for all products. (In house)
h. Outbound Buffer levels decided for all products (min- and max-levels and/or Safety stock).
i. Production site capacity supports forecast
6.2.1 Forecast

Forecasts and customer orders are used to establish the master plan and to generate a production plan. Suppliers of units and accessories (NPC suppliers) as well as supplier of mechanics and filters (production suppliers) can see the current state of demand, and inventory levels. (Selldin, 2005)

From the Figure 22 above, ESS KH receives monthly MRP (Manufacturing resource planning) on the node level. It a gross forecast and covers 11 months ahead. Forecast foresees customers' requests in the future and orders consume capacity and forecast. It checks the coming months' capability and considers the materials constraints. Then Dimensioning & Planning department calculates and adjusts regarding historical data. For the Node level, the MRP will be adjusted based on weekly basis, then send to purchasing for checking materials. For the Standard Module level, master planners get historical information from supply developers and purchasing department, such as the amount of boards will arrive for the coming week or 1 to 3 months away. Purchasing will recheck the MRP on the standard module level which based on daily basis by using pipe chain tool.

The global forecast is decided by top management knowledge and involved data such as MRF (Medium Range Forecast) from customers, product managers, and key account managers and so on. Global core planning uses these information to make the demand forecast. ESS KH updates forecast objects continuously with historical demand, market information and PIM (Product Introduction Management for new products and developments) through CAB (Corrective Action Board for introducing new products and making revision like updating BOMs) (Ericsson Internal presentations, 2010a). The
rolling forecast (budget input) and TDM (tactical dimensioning meeting) input is continuously contributing to MRP creation. The current month is covered by the former forecast and the coming two weeks' orders are planned in earlier time.

**TDM (Technical Dimensioning Meeting)**
The Technical Dimensioning Meeting is the meeting for discussing production capacity and material availability, other contents include: (Ericsson internal presentation, 2010a)

- Create presentation on Pre-TDM material to dimension the production capacity and material availability on midterm based on the MRP
- Monthly participation in TDM for Core System Supply (Head of Capacity Management)

The structure of the demand planning is built on forecasts from global planning, which leads to a process as shown in figure:

<table>
<thead>
<tr>
<th>Manual</th>
<th>SAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dimensioning &amp; Planning (D&amp;P) get gross forecast on node level from EDC (supply planning tool), then D &amp; P extract the MRP to excel, use historical objects in excel file)</td>
<td></td>
</tr>
<tr>
<td>2. D&amp;P will get the gross forecast in each Standard Modules. Then, D&amp;P put forecast object into similar articles (create a mix) together via historical figures and calculate the most likely demand</td>
<td>4. D&amp;P spilt it the demand volumes for each Standard Modules and put it into the system</td>
</tr>
<tr>
<td>3. D&amp;P build a file with these data into weekly buckets for SM (family is daily buckets)</td>
<td>5. SAP puts the quantity automatically and makes MRP calculations like lead time</td>
</tr>
<tr>
<td>6. D&amp;P adjust MRP within 8 weeks' horizon (including backlog forecast handling) to daily buckets (get a smooth for VMI for Supply chain) pipe chain reads the forecast, use SNC for VMI</td>
<td>7. After the MRP is run, purchasing department and production could see the net demand for our suppliers of SM (buy according to the demand)</td>
</tr>
</tbody>
</table>

Table 5: The structure of the demand planning is built by manual and SAP

For example, there are 5 standard modules in 1 node A and the same type of standard module for 2 pieces in 1 node B. If customer orders 3 pieces of node A and 4 pieces of node B, the total amount of this standard module will be $5 \times 3 + 2 \times 4 = 23$ pieces.
Dimensioning & Planning department communicates about forecast accuracy every week. Forecast can be used to dimension supply chain within ESS KH providing the right capacity and buffer levels. The orders, however, should trigger replenishment material.

For one Standard Module, master planners look at all consumptions of the product code of this type of AGO (Assembly Grouping Objects) into forecast, break them down into parts. Then they have the ability to calculate the amount of SM (Standard Modules). AGO (Assembly Grouping Objects) and SM (Standard Modules) are both in one file with BOM (Bill of Material) structure in AGO (Assembly Grouping Objects). It is important to look for the right level. Once the check is done, master planners can see the historical consumption and forecast of the data, the flat consumption and variation consumption.

### 6.2.2 Master Planning

Besides adjusting the forecast, Dimensioning & Planning department takes responsibility for master planning as well. This section describes two key masters planning principles in Make to Order scenarios which are backward and forward scheduling.

- **Backward and Forward Scheduling**
  Within Make to Order scenario, there are two master scheduling processes for order fulfillment: Backward and Forward scheduling as follows. (Ericsson internal presentation, 2010b)
**Backward scheduling**

ESS KH performs backward scheduling on Node level first. Current state is setting 7 days backwards. Backward scheduling will check the routing, production lead time, production time, test and packing. When customers want products, they want them delivered from Ericsson Distribution Center (EDC). ESS KH, hence, needs to finish the orders one day before the request date, which means that required materials should be available even earlier. Thus, when the capacity check is done, the order is checked on the AGO (Assembly Grouping Objects) level first, then on the component level. In this way, master planners do backward checks.

Backward scheduling from customer's request date to determine production start date is done with the following constituent and see in Figure 23. (Ericsson internal document, 2010b)

- Route
- Picking time on Ericsson Distribution Center (EDC)
- Transportation time for stock transfer is defined in the transportation lane
- Production start date is calculated in the planned order by backward scheduling using the routing.
- If the scheduling results in production starts in the past, the system changes to forward scheduling from today’s date and calculate first possible material availability date on sales order.
- If backward consumption is used the planned order finished date will be according to customer requested date and must manually be leveled according to production capacity.

![Diagram](resources/diagram.png)

**Figure 24: Backward scheduling flow**

**Forward scheduling**

When it is not possible to do backward scheduling of the customer request date such as there is not enough capacity or the order start date falls in the past the, forward scheduling will be performed (Ericsson internal document, 2010b).
Backward and forward scheduling as well as routing is made by the system itself. In the backward planning, it shows when to pick up materials. If an order is not confirmed in a very short lead time, the order desk will check with the production and stimulate the order into the later production.

- **Consumption of CTP (Capability to Promise)**
  Consumption of CTP is the consumption of free capacity. It is different from scheduling of production. The consumption is only done on CTP, while scheduling of production means where to plan orders according to CTP levels. Then master planners will plan backwards in order to decide when the product should be produced with the consideration of routing. This means they look at the requested delivery date to make the routing and decide when to start producing. The CTP check is performed first towards backward consumption, and if there is not enough capacity, a forward consumption will be performed. Current setting is 7 days backward and 28 days forward (Ericsson internal presentation, 2010b). If one more day is set up in the system, the possibility of automatically confirming the date increases. Consumption has variations during lead time. It is related to normal consumption and uncertainty of demand rather than allocation of CTP in planning or confirmation. Consumption of free capacity is done backwards from material availability date. This is to certify that many orders on same day/transportation routes are not consuming capacity for orders with higher lead-time priorities.

**c. Frozen Horizon**
The Frozen Horizon is the planning lead time on the product family level. It should be aligned with the planning fence for the specific family and be adjusted against different products (Ericsson internal document, 2010b). It is one of the master data in APO (Advanced Planning and Optimization).

Within Frozen Horizon, Customer Logistics Management gets orders and these orders are confirmed by Market Unit. The system should automatically remove free capacity / CTP. (Ericsson internal document, 2010b) The frozen horizon is the period from ESS KH receiving an order to giving customer the delivery date. So during the Frozen Horizon, ESS KH cannot schedule orders automatically. Daily production planning needs to actively monitor unused capacity which has a risk to be lost. (Ericsson internal document, 2010b)
6.3 Order Fulfillment

There are two customer order fulfillment flow within ESS KH: Make to Order (MTO) flow which is produced by customizing to customer's specifications and Pick from Stock (PFS) flow which is a standard module or assembly in ESS KH or alternative plant. Figure 3 illustrates the process focus in this thesis: the MTO which includes both Node level (first tier level) and Standard Module level (second tier level).

Make to Order (MTO) Flow

MTO flow is the main order fulfillment process in ESS KH. MTO products are produced internally to the specific customer order and delivered to the agreed location via the EDC (Ericsson Distribution Centre). The flow of MTO is included physical flow and information flow as follows:
6.3.1 Physical Make to Order process
The physical flow of MTO is initiated and planned by the CL (Customer Logistics) and a material requirement is released to trigger the production activities at the NPC. The produced and packed goods are sent to the EDC by the NPC. The distribution from the EDC to the agreed location is managed by the Transport Planner at Ericsson. The MTO flow can be explained in the following steps (Karlsson, 2009) and illustrated by figure 20 below:

![Diagram of MTO flow process]

1. Make-to-Order products order is received, verified and booked.
2. The order is planned including verification/update of the defaulted sourcing scenario and pick-up location, ATP/CTP and release of material requirements to the NPC.
3. Production/assembly is performed at the NPC.
4. The goods are packed at the NPC.
5. The packed goods are shipped to the EDC by the NPC.
6. The packed goods are received at the EDC.
7. The packed goods are put-away at the EDC.
8. Preparing delivery for distribution.

From the figure 27 above, the physical MTO flow is explained, and then the information MTO flow in NPC which locate in ESS KH will be described in the next section.

6.3.2 Information flow
To set CTP level, different departments in ESS KH need to communicate effectively in order to transfer information with each other in the most efficient manner. The information flow of Make to Order (MTO) process is included manual process and
automated process with SAP ONE. Figure 21: Aggregated information Make-to-Order flow in a “swim lane” shows the information MTO process which is included communication among departments in ESS KH as follows:

<table>
<thead>
<tr>
<th>Aggregate MTO Flow Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
</tr>
<tr>
<td><strong>Order Management</strong></td>
</tr>
<tr>
<td>Backorder Process</td>
</tr>
<tr>
<td>Changed Planned Order</td>
</tr>
<tr>
<td>Informed Customer Logistics</td>
</tr>
<tr>
<td>Reject Planned Order</td>
</tr>
</tbody>
</table>

| **Production** |
| Node Production | Convert to Production order |

| **Purchasing** |
| Create Purchasing Order manually | Send Production Order to Purchasing |
| Send Purchasing Order to Supplier and confirm Purchasing Order | Send Purchasing Order to Order Management |

*Note that in orange box is charged of Dimension & Planning department*

From figure 28 above, the information flow will be explained as follows:

- **Order flow of order management department**

In Ericsson Group organization's structure, the order management is separated into two parts; Local Order Desk (LC) is order desk at local company, branch office. This part will place orders towards Central Order Desk. The local order desk in ESS KH is the department which is in charge of handling order flow. The order desk will receive the customer order from the Customer Logistics (CL). SAP APO will do check by ATP/CTP checking function. After both of ATP and CTP check on both levels, the planned production order has been created automatically. But if sales orders get stuck due to lack of material (ATP) or capacity availability (CTP) (Ericsson Internal Presentation, 2010c). This results in unconfirmed orders and leads to the backorder process.

The backorder process is the process within ESS KH for handling the order past due, which is the order (immediate or past due) of an item whose current stock level is insufficient to satisfy demand (Supplychainmetric, 2011). The methods for calculating the number of orders can vary. For example, the backlog can be the number of items that are not confirmed (not allocated) and past the Requested Delivery Date (or
Requested Ship Date). Another way is to count the items with stock confirmed (already allocated), but past customer due date (cannot delivery to customer on time). In backorder process, order desk will work with backlog orders manually according check list such as codes numbers and contact information. When the order is not confirmed by APO, the order will move to be a backlog order. The order management will take care of backorder process manually by sorting and moving the requested date. The backorder process will be included in the ATP check and CTP check which checks if the cause is missing material or missing capacity. In case of missing materials, they will send email to the purchasing department. Another case, missing capacity, order management will send the backlog orders to Dimensioning & Planning in order to recheck the capability. When the sales order gets confirm, order desk team convert the order to a planned production order manually.

After that the planned production orders need to be 100% clarified, which should fill the other important information such as customer contact. If classification of planned production order is confirmed, the "Planned Production Order" will be converted to "Production Order". If classification of planned production order is not confirmed 100%, order management will send the order to CLs department to reject planned production order manually. Moreover, after the purchasing department gets confirmation about the material from supplier, the purchasing department will send purchase order to order management department via emails and then the order can have a Purchase Order number with confirmed date and can add Purchase Order reference into the production order manually.

An exception for order management

Apart from above, swapping order is one of the duties of order management outside the information Make to order flow according to figure 28 Swapping orders is the situation when some customers are not satisfied with the first confirmed order or the ATP/CTP checking from the SAP is not confirmed as in result in postponing customer delivery date. This leads to Customer Escalation. In the case of customer escalation, the customers will contact MU (Market Unit). MU sends the customer escalation information to CL (Customer Logistics) to check whether they can get the products earlier. CL will fill in the information which Node Production Centre (NPC) need and then check with NPC. Sometimes this date can be reached, sometimes it can't. NPC is not allowed to do the prioritization. The delivery date suggestion from NPC will be presented to the demand manager in Ericsson in Stockholm/Kista. The demand manager will approve or disapprove to this 100% clarification.

- Order flow of production department
  Production orders are released and sent to Node Production Centre (NPC). The production department will use this production order to establish the operation plan in the production site.

- Order flow of purchasing department
Purchasing department receives the production order information which is used for creating Bill of Material (BOM) by APO. Hence, purchasing can know which products should be purchased. The next is purchasing creating Purchase Order (PO) manually. Then the purchase order will be sent to suppliers. After purchasing department get the confirmed purchase order from suppliers, they will send confirmed purchase order back to order desk.

6.4 The System in ESS KH

This chapter will explain Control Manufacturing system (C:M) and SAP system. C:M is the order and material handling system in ESS KH and SAP is one of the Enterprise Resource Planning (ERP) systems. The systems' characteristics which will be explained in this chapter are essential for using in setting CTP level.

6.4.1 Control Manufacturing system (C:M)

In different plants within the Ericsson Group, they use their own systems to manage customer orders. C:M (Control Manufacturing systems) platform is an open VMI (Vendor Managed Inventory) used to manage customer orders within ESS KH. This system is quite flexible and enables manually added input data in the system. In order management, they can create orders manually by adding product numbers and requested delivery date into C:M. In order to transfer information between departments, C:M need the middle system to transform information between system in each department such as MWS (Main Warehouse System), pipe chain (Supply and Production system ), CBS (Sales) and Knallban (Production management system). The advantages of the C:M is quite easier to do some changes by manually as a result in the smooth order flow when they get unpredictable problems. Nevertheless, C:M system has high first set-up and maintenance cost and need another translation between files. As a result of these disadvantages, Ericsson Company wants to improve work excellence and cost efficiency by a global system which means merging all information into one platform, SAP ONE is, hence, the project to fulfill this objective.

6.4.2 SAP ONE

Ericsson is implementing "SAP ONE (Operation and Numbers driving Excellence) Project" which is a global concept supporting the processes within Ericsson. It is a predefined ready-to run solution based on SAP R/3 and handles Supply (Logistics and Production), Finance (Accounting, Controlling, and Project Steering), Sales, and Customer Support (Ericsson Internal website, 2009). According to the SAP ONE Project, the package of SAP is implemented within ESS KH for integrating and aligning all supporting system processes to one platform. Within the area of this study, there are mainly two involved modules; SAP ECC (ERP Central Component) and SAP APO (Advanced Planning Optimizer). SAP ECC is a subset of SAP R/3 that will be used instead of C:M. In order to get more efficiency, SAP ECC needs to work with another module: SAP APO. SAP APO complements SAP ECC in some functions such as Financial Book (Karlsson, 2011) and supports in some missing parts such as Rules Based ATP (RBATP). Both of them are linked to each other with batch and online interface which means that there is no need for middle system to translate files between them. Even though there is high cost in first setting up in the beginning, the
maintenance cost in the long-run is anticipated to be low. Moreover, SAP APO can process large amount of orders in a short time which can enhance working efficiency.

**Information flow of Make-To-Order process in SAP**

From the figure 21 in section 6.2.1 that has shown aggregate information Make-To-Order process, SAP support the order fulfillment process of Make-To-Order to transfer the information among each departments within ESS KH as follows:

1. Order management department receive the sales orders,
2. SAP check material availability by using Availability-To-Promise or ATP check and capacity availability by using Capability-To-Promise or CTP check function. These processes are the so-called "**Confirmed by APO**" process which Dimensioning & Planning department is in charge of putting master data into this step. Two checking functions in Confirmed by APO on both levels will be explained as follows:

**ATP/CTP check on Node level**

- The process will start with checking product available (ATP check) on Assembly Grouping Object (AGO)'s family which is a group of different Nodes level. ATP check will represent the product availability.
- After ATP check is confirmed, and then capacity availability (CTP check) is checked.
- CTP check will be performed in order to representing production capacity per day (Ericsson internal document, 2010a) In the production plant, the capacity check is carried out by using the product allocation functionality (see detail in chapter 4). The capacity is maintained in daily buckets with consumption logic based on master data. The consumption logic must be set up on each Node Production Centre (NPC) plant.

If ATP/CTP check is confirmed on AGO's family (daily basis), secondly the system will check ATP/CTP check on Standard Modules level (weekly basis) automatically.

**ATP/CTP check on Standard Module level**

- ATP checking (Product Available): This checking will check within the component lead time if there is sufficient stock, planned receipts, requirements etc. ATP on Standard Modules could equal to Safety Stock plus confirmed purchase amount. Confirmed ATP check means that the Standard Modules will be available for produce the Nodes product so system will only check ATP stock and go to step 3. If ATP is not confirmed, then it will check CTP.
- CTP checking (Product Allocation): The CTP check on individual Standard Modules will represent the suppliers capacity to deliver and will be entered per weekly buckets with consumption logic +4 days which is done by APO (Ericsson internal document, 2010a).

If ATP/CTP check is not confirmed on both of levels that order will transfer to Backorder Process which is the order management department's responsibility (see more detail in section 6.4 order management). When accepting the ATP/CTP results the following updates/transaction are done; Confirmed quantity on the sales order item, Stock transfer requisition from production plants to distribution plant created, Quantities...
in production allocation and in the material requirement lists are updated and go to step 3.

3. A planned production order has been created either automatically or manually processed in the Backorder process (Ericsson Internal presentation, 2010c).
4. System checks that order has all of needed 100% classification or not such as end customer address or contact. If so, the process will go to step 4. If not, order management will inform customer logistics and rejects planned order.
5. The system converts the "Planned Production Order" to "Production Order" automatically. This production order will send to Node Production site and the first confirmed order is sent to the end customers.
6. Send the production order information to purchasing
7. Bill-Of-Material (BOM) is created to see what products to purchase.
8. Purchasing create Purchase Order (PO) manually.
9. Send PO to supplier and purchaser confirm PO directly
10. Purchasing sends PO to Order management
11. Order management will add confirmed PO information in Production Order.

Moreover, there is the alert monitor in SAP APO which can work in safety stock level. When the safety stock is lower than the number which is supposed to be, the alert monitor will pop out to remind the materials is under the level. This triggers production order or purchasing order. Therefore, SAP APO will reduce the manual work of ATP and CTP check of order management department. The total workload of order management department will be reduced. Moreover, as a result of reliable setting CTP level, the company can reach automated order handling and the first confirmed customer order. This critical part will be the target of this study.

6.5 Production

In Make to Order scenario, the production is replenished by the customer demand. Production site produces materials which will become shortage soon, then refills the buffer after meeting the capacity. There are buffers between Standard Module Production and Node Production. ESS KH produces 180 products categories, but for some product families every component is purchased such as RNC because of capacity & inventory constraints in production site. Operation productions in ESS KH are separated into two departments: Module Production department which assemble standard module products and Node Production Centre (NPC) department where produces node products.

Module production capacity, material preparation capacity, node assembly capacity and node test (per capacity group) are four capacity checking areas in weekly master planning meeting. These four areas support results for delivery precision and other costs through adjustments of capacity and material plans for the next 3 weeks to 2 months. (Ericsson internal presentations, 2010a)
6.5.1 Node Production
Node Production's capacity is around 200 nodes per week.

Production Operations Steps (Hellgren, 2011):
1. Pick: Standard modules will be picked from supermarket or warehouses.
2. Mount: The pieces are picked to the subrack and mounted the subrack directly to the order. Then the boards are mounted in the subrack.
3. Assemble: Assembly the nodes in the line with the standard modules to the customers’ demands. The last station in the line is a quality station where the checking the quality of the node visually.
4. Test: Node test, either in Common Test Solution (CTS) or single test solution. After nodes are tested, a final inspection checks is made.
5. Quality audit: Production takes a sample on node level and makes a quality audit. About 20-25 orders (both nodes and spare orders) are checked every week.
6. Pack: The order is picked up by the outgoing goods department and gets packed.

Test
Test section is the main bottleneck in operation which is the result in taking the whole production time longer. For example, SGSN on node level, while buffer level can be increased by suppliers, the test becomes the constraint. The flat demand for production will be easier to make the planning. For purchased standard module in this product family, test issues can be 6 types of nodes contains almost the same materials mix-up and the constraint is from suppliers. Customers can order from 1 to 20 nodes. Test has capacity limits.

Even though the bottleneck on node level is quite varied, there are three potential bottlenecks according to production interview (Hellgren, 2011): Test, assemble flow and packing. Test is the most common one among these three.

To take AXE family's circuit board supplier as one example, one factory produces all circuit boards of AXE. ESS KH tests them in the system on site while 80% of them have already been tested by suppliers. Test is node production's bottleneck now. There are two kinds of test solutions in node production: Common Test Solution (CTS) and single test solution. The capacity is 250 cabinets per day with only day shifts.

- Single Test Solution
Single test solution's capacity is based on different product families. The orders are grouped via product families. Different computers locate next to product families and one test program only tests one family at one time. The different product families have different bottlenecks. In the future, these products will use CTS too.

- Common Test Solutions (CTS)
CTS is a newly developing test station in ESS KH. This improves the flexibility of production. Now the orders are grouped as product family such as AXE, SGSN, GGSN and so on. There are several CTS stations for AXE, SGSN and so on but "AXE CTS" is not used to SGSN.
Now there are 8 CTS stations and 5 of those are today dedicated to AXE. The other 3 are dedicated to SGSN, GGSN and CPG. There is a large capability around 100 units. This number is more than the single test solutions.

6.5.2 Standard Module Production

ESS KH only receives Standard Module's forecast based on the customer order points (customer order point is at supermarket in node production). Then they become the demand of the day. This department produces standard modules directly to buffer with the demands of open orders for nodes.

SMT (Surface-Mount Technology) is a method for constructing electronic circuits onto the surface of printed circuit boards. The total operation time is based on SMT which is often the bottleneck of operation. When the whole production batches are full, production site will decrease the numbers in each batch rather than reduce batches. The smaller batch size leads to shorter waiting time and more capability.

Capacity

Standard Module's production capacity is 3000 units a week, regardless of product family. This is the capacity level which production department can promise in order to reach the right service level, with the consideration of what the Standard Module department has in buffer. Once the production planning reached 3000 boards in a week, the capacity will be put to next week. However, 3000 boards are a bit more than what Standard Module actually produce (2800 to 2900 boards), due to the large amount of varieties. SAP APO can process 200 different types of boards among 3000 boards a week. This means Standard Module production department can produce roughly 200 different boards.

Workload

There are four shifts; day, night, evening and weekend. Monday to Thursday is the machines run 24 hours per day; Friday 13 hours per day and Saturday, Sunday 12 hours per day which means total hours per week are 133 hours.

Machines

When the Standard Module department is running at full capacity, a machine break down will affect the production. The maintenances are done once a year which is more seldom than it ought to be. The reason why maintenance is not planned as often as intended is that production site do not work 24 hours per day and 7 days a week. This means there will be time at nights and weekends to repair the machines; however this is only done when machines break down.

Components in machines have increased 50% recent months. Due to the high amount of components, it is important to have visibility on machines. This means the display on machines are visible and it is possible to add components while machines are working. The production is not supposed to wait for components. ESS KH buys most materials and for some of them ESS KH assembles them.
Supermarket
The supermarket is the main storage keeping the standard modules in the ESS KH's production site. There is only safety stock on Standard Module level. Currently there are around 7000 boards in buffer of 200 variants, mainly the boards for producing node level products. Production department's goal is to produce for buffers, which includes buffers located in the main warehouse. Dimensioning and Planning department set up how much safety stock in the supermarket for a short period and how much buffer in total ESS KH needs on a factory level.

Safety Stock
Dimensioning & Planning department works on setting up the safety stock level, adjust them to reasonable levels and update them. Safety stock's setting up is based on the service level into ABCD classification. The safety stock setting is changed 2 to 4 times a year now. However, production site suggests changing it more times a year.

The setting is adjusted by suppliers' buffers, their performances and master planners' perspective of whole process. This means the buffer level will be enough if the suppliers can deliver the right amount on right time. However, there are many boards under the safety stock levels.

In preferable situation, forecast is supposed to be the guideline for the production planning, while characteristics of components like frequency of consumption (past, present and future consumptions) for setting safety stock level. The balance could be using low buffer level for high forecast and high buffer level for low forecast.

Master planners check the safety stock to convert orders to purchasing orders. This means purchase orders are safety stock driven, via forecasts received from Dimensioning & Planning and customer orders received from order management (Ericsson internal presentation, 2010e).

Safety stock cannot be created casually, since it costs money to put products in stock (inventory cost). Currently, the safety stock levels on most material are lower than they are supposed to be. The reason to have safety stock is the uncertainty for the lead time. It is like a short term buffer, and helps to keep the first confirmed customer order. The safety stock level is related to Standard Module's service level and it varies depending on the fluctuation of orders.

Today there are 'short buffers' for every board. Production department produces more often and has a lower buffer. The production is based on a classification, which is decided by lead time, MRP, frequency of consumption and how does the future production look like. The frequency of consumption is categorized into seldom consumption, infrequently consumption, and frequently consumption. This classification can be divided into two types below:

- The buffer level is based on data rather than customer orders. The buffer itself should cover the variations.
The buffer level is in Node Production Centre (NPC) and influences NPC’s performances.

Flexibility
The production team discusses how much boards should be produced or used according to the daily basis scheduling. The production team plans the employees in each operation with relatively high flexibility. The workers can be moved between cells and the number of workers can also be increased or reduced due to temporary/outsourcing contract.

Bottleneck
The bottleneck is the process which has the longest operation time. Bottlenecks are changing, since the orders are changing. It can be different day by day. In each bottleneck, the production team sets the red line as a signal according to Kanban system, so as to consider the problem and solve it.

For purchased Standard Modules, suppliers test the product at their site and ESS KH tests products after putting them on nodes.

6.6 Purchasing
Purchasing department has direct contact with all suppliers and regular communication with order desk.

Purchase Order is safety stock driven, via forecasts received from Dimensioning & Planning and customer orders received from order management (Ericsson internal presentation, 2010e). Thus, the purchasing depends on whether the forecast is right or not. The forecast analyzers ask suppliers for feedback. Forecast response is whether suppliers can meet ESS KH's forecast or not. Purchasing department gets continuous response every week to see how large variations of the products the suppliers can deliver and purchasing department measures suppliers via these responses accuracy.

6.6.1 Types of Suppliers
ESS KH has different suppliers. Their lead times vary from 1 or 2 days to 25 days. There are three types of suppliers of ESS KH:

- Traditional supplier
  Traditional suppliers are those who purchasing department places orders at, and then they send confirmation back via email or EDI (electronic data interchange). Purchasing department either purchases the buffer level or keep it, or purchases via customers’ orders. Suppliers who do not have buffer levels cannot provide a good promise.

- Automatically orders
  For this kind of suppliers the system automatically places the order, especially for some low value components.
• VMI (Vendor Managed Inventory) supplier
VMI suppliers keep buffering level for ESS KH. The higher the buffer, the more flexibility there is, from the ESS KH perspective. Some VMI suppliers' buffer information is visible while others are not. The latter one may cause problems in that ESS KH can't promise to customers. This lowers the visibility of the supply chain. If ESS KH doesn't have that information, it is hard to set up CTP ahead correctly. Some suppliers allow customers to follow their orders in their ERP system of notes via a web interface while some do not allow.

For VMI products outside the Lead Time, it is to set up unlimited capacity unless extremely large orders come in. In that case the Dimensioning & Planning needs to communicate with purchasing department whether this large demand can be fulfilled. This means if ESS KH knows suppliers have lots of stock at their place, it is possible to set higher CTP level. Buffer size decides the flexibility of suppliers. The right buffer which suppliers keep results in a higher flexibility ESS KH.

6.6.2 Evaluation of Suppliers
The reason to evaluate suppliers is to have a better control and monitoring of them. In this way, it helps ESS KH to work on ‘first customer confirm’. The reasons of late delivery could be quality issues, shortage of materials and etc. Sometimes suppliers will deliver some materials in time, with some late delivery.

The evaluation is mainly based on delivery precision which varies for different suppliers. The flexibility measurement is the method purchasing department is looking for to have more visibility of supplier's capability in the future. Two measurements are used currently:

• **Measurement on monthly bases**
  This is used on traditional suppliers to track their delivery time precision. Different sizes of supplier (small, medium or big size) will have different performance levels. Suppliers should answer on monthly buckets whether they can meet the forecast or not. Dimensioning & Planning uses this value to set CTP. In the measurement, even one day late is still measured as late. The purchasing department accepts 3 days earlier.

• **Measurement on service level**
  The service level measurement is to evaluate a VMI supplier who keeps buffering levels for ESS KH. The buffer levels on cheap products are according to the principle 'keeping more, leading to more flexibility'.

Pipe chain is used as a VMI tool towards suppliers. It shows dates, when and what to deliver, days of durations. Pipe chain is a good visualized communication tool as well, e.g. illustrating materials on the way by trucks. Also, any replanings will make the pipe changed. It starts from the most urgent material requirement and the ESS KH goal is to delivery any Node Product in a week.

6.6.3 Material Flexibility

There are two points to achieve the goal of flexibility of materials: buffer at ESS KH and buffer at VMI suppliers.

To take AXE family as an example, one supplier is responsible for lots of boards in this family. The planning lead time for this supplier is 3 weeks including 6 to 7 transportation days. The planning lead time depends on what buffer this supplier has. If there are enough buffers there, then ESS KH can have the boards in 3 days with Express transportation. However, this supplier has no buffer currently.

ESS KH's lead times for AXE to customers are 10 days, but ESS KH is supposed to use safety stock to cover the differences between 10 days and 3 weeks. If there are 500 boards in stock, it will be enough to cover today’s anticipated demand uncertainty.

It works the same for VMI suppliers who have safety days. ESS KH should have 10 days (maximum) as safety time to run most boards in stock. In this case, ESS KH can meet rush orders to be more flexible. The safety stock is measured every week.
7. Current situation Analysis

Following the current situation description, this chapter defines problems of setting CTP levels today, analyze what affects the CTP level setting up and what happens if CTP level is unreliable, and identify levels for different scenarios. The current situation of ESS KH is examined from planning, production and purchasing perspectives to check bottlenecks, and problems behind the incorrect CTP setting up. Data needed for setting up CTP is also mapped, which includes constraints from different departments. These analysis help to identify major issues of CTP setting up at ESS KH, and lead to proposed solutions in the later chapter.

Root cause analysis is used for identifying the current event causes and revealing the current problems. Polarized thinking about upstream vs. downstream cause’s slow response, excess inventory and distorted purchasing behavior. Low demand visibility on demand and a disconnected business process means that industry is sluggish to react to changes in the economy and forces it into a perpetual shortage-glut cycle (Kienleong, 2010). Problems causing unreliable CTP levels are divided into three parts according to customer order-driven supply chain; Demand Problem, Production Problem and Supply Problem.

Figure 30: Root cause analysis

7.1 Demand Problem

Demand problem is uncertain demand with inaccurate forecast, huge backlog at ESS KH and order re-allocation.

7.1.1 Demand Uncertainty

Demand uncertainty depends on different types of nodes. The problems are how to aggregate them to become different CTP groups and what is the time frame to set up
CTP like week or month. The more flexibility leads to lower lead time. The strategy of CTP leveling requires what kind of flexibility of CTP that ESS KH can have and how to connect this to forecast, with the consideration of customers' fluctuated orders. The figure 32 below shows the demand uncertainty of one node in AXE product family:

![A node of AXE family order intake on weekly basis](image)

Figure 31: Demand uncertainty on one node of AXE.

Some nodes' orders come often while some come randomly. There is no even flow for node level. Thus the CTP level cannot be set up even either. The high fluctuation demands are on weekly base.

In the next chapter, there will an emphasis on looking for the solutions of the nodes which orders come often, since most nodes at ESS KH site belong to this group. There will also be CTP solutions for different types of nodes. For some special products which orders come randomly, they are required more manual work to deal with them. The solution is setting up low CTP per day to get a much more even flow. The number per day is connected to the production leveling and capability.

### 7.1.2 Forecast Inaccuracy

The forecast is not accurate to set up CTP. ESS KH still experiences problems when using the monthly forecast to be the guideline for setting daily plan since there is a fluctuation of customer orders in daily buckets and forecast numbers have a very high fluctuation.

Dimensioning & Planning department gets the forecast from global planning on monthly basis. Master planners compare the numbers with the ones they get in the previous month and follow the gaps between forecast and demand each month. They also look up historical data to understand which kind of demands are coming. They check whether the site can meet the large portions and how can they manage this request feasibility from different situations.
7.1.3 Order Re-allocation
When the total order volume is within the production capacity, there are no priorities among products. The re-allocation is among 200 different categories of boards. This situation occurs when the volume of customer orders are more than 3000 boards on Standard Module level a week (Paulin, 2011). Customers’ orders are prioritized for buffer building in order to keep ESS KH's first confirm. In some extreme situations, AXE family is prioritized before smaller product families.

The unsatisfied material visibility leads to allocation problem too. Logistics master should solve this problem by improving the allocation, making equal percentage of locations and set the allocation priorities.

Order re-allocation affects order promises to customers, since it leads to huge order past due (backlog). It is not easy for master planners to decide where to put these orders. Without re-allocations, the situation will be products 'first in, first out'. However, with this recycle of decision making, it takes much longer time than daily plan.

7.1.4 Order Past Due (Backlog)
As described in section 6.4, Order past due problem is that ESS KH does not get materials when they are supposed to be in the production site. This means material constraints causes huge order past due problems. When the system checks materials within the product, if one component is stuck, then this order will be put in backorder process. Thus, it is hard to know the capability to see the materials in a limited time or in advance. The backlog influences the forecast accuracy and makes it hard for master planners to check CTP.

There are huge backlogs on products in SGSN and RNC families. The backlog is caused by components issues, which is due to suppliers' problems. It is hard to get rid of the backlog. ESS KH wants to produce more than 100% forecast to solve the backlog problem. Master planners could give suppliers forecast more than 100%. However, it depends on whether suppliers can deliver to ESS KH. In this case, it is important to have flexibility in supply chain.

The information of backlog is updated by Dimensioning & Planning department once a week. With other departments, they have to push suppliers to get enough materials to start production.

7.2 Production Problem
This section emphasizes the constraints on node level and standard module level. It represents the main issues of the production and a detailed analysis.

7.2.1 Node Level
As described in last chapter, test is the bottleneck of the node production.
Test
The capability depends on what system is tested in the CTS. For example the SGSN node takes about 4 hours to test and the GGSN node about 2 hours. AXE products take about 12-24 hours but often about 18 hours if everything works as it should (Hellgren, 2011).

In a near future the CTS will be more dynamic which means that any nodes can be connected to it. It is a fully dynamic test process which is able to test all kinds of nodes. The advantage of CTS is there is only one bottleneck in the node production. It also depends on the total volume of nodes.

Around 60% nodes (mainstream nodes - nodes should be delivered in 1 week) should be tested in CTS. Production department plans 15 CTS stations which they are probably buy 5 to 7 stations more lately. The ideal capacity of CTS is 200 cabinets a week.

### 7.2.2 Standard Module Level

The challenge of production's capability planning is that there are different kinds of boards with different kinds of bottlenecks. From production department's perspective, the bottleneck in each is quite variant. Some boards have bottlenecks in their SMT lines. Some boards have bottlenecks in some certain components. Others could have test capacity as their bottleneck. It needs to pay attention that several boards are tested in parallel which makes CTP setting up more difficult.

Production department is trying to reduce the mix (types of boards) of the products, so it is necessary to increase the buffer. It means increasing buffer to cover the customer orders. Then the frequency of consumption is a key factor to decide the buffer level. For example, AXE family has large orders and quite stable consumption. So it has a low buffer level.

The problem of Standard Module production is that it is hard to find a good capacity level. The number 3000 boards a week is based on historical figures. If the forecast goes up for the coming weeks or months, production department needs to increase the capacity.

Other problems occur sometimes like repairing boards, quality issues (test problems), machines' break down, cable problems in test and etc.

Safety Stock
If the buffer is more flexible in close time, ESS KH can confirm more orders. However, due to the areas and costs of warehouse, production site wants to decrease buffer level to safety stock level. Therefore, purchasing department puts safety stock as maximum purchasing level. This means they try to avoid purchasing more than safety stock level now. It is supposed to be higher than this level (at least minimum level) before next purchasing order is triggered. Standard Module production produces many boards straight to customers' orders. This leads to capital tied-up situation which is there are no...
buffer for some critical items. To take AXE family as an example, this family is always short of some certain boards to assemble. These boards don't have buffer and need to be tested in the system.

7.3 Supply Problem
Supply problem is caused by material shortage which due to unpredictable bad performance of suppliers.

Purchasing department is trying to keep the safety stock level and place orders based on the lead time. Each component has different lead times. For hubs, purchasing department places the order the day before, since hub only needs 8 hours or 1 day to produce. Hubs need to recover inspection time too, which is one day. For multimedia products, purchasing department buys when ESS KH get the customer orders and does not keep any stock of this kind of products. But the problem is that if the materials of hubs are late, how master planners should react to adjust planning.

7.3.1 Material Shortage
Order desk and purchasing department check the material shortage on daily basis. Both purchasing department and order desk see materials' shortage problem. However, getting material information in such a short time makes it hard to change the production plans.

Master planners estimate the current situation of material availability, like materials' bottlenecks, late orders, assembling lines and etc.

Material Visibility
The disturbance in supply chain is also one of the reasons for low material visibility. This makes Dimensioning & Planning department hard to plan well and set the accurate CTP for the coming weeks. Dimensioning & Planning department plans orders 14 weeks ahead while the materials' visibility is 1 to 3 weeks (lead time from supplier are usually 1 to 3 weeks).

Low material visibility leads ESS KH's first confirmation delivery precision to 75% to 90%. (Ericsson internal presentation 2011i) Performance in Node Production Centre (NPC) affects the delivery precision of Ericsson Distribution Centre (EDC). This figure means that material visibility can decrease the 1st confirm delivery precision for 10% to 25% to end customers. Dimensioning & Planning department is trying to plan relatively far away while the materials' situation is not clear when the planning is done. That is why master planners don't know what materials' situations will look like, especially when ESS KH's test capacity's information is not very easy to check. The reason why the planning is not that flexible is that master planners plan 3 to 14 weeks ahead. (Ericsson internal presentation, 2011i)

Material constraints are another reason for this complex situation. It is hard to plan well with the complexity of the nodes and large numbers of orders. Moreover, one type of
material is planned by 4 different master planners. Since this type of Standard Module belongs to different nodes or cabinets, and different master planners are responsible for different nodes. They collaborate to set up CTP for Standard Modules.

Dimensioning & Planning department gives suggestions to order desk where to put orders and master planners see material constraints, lead time and bottlenecks for different products, while order desk knows where is the available capacity, where to put orders. Dimensioning & Planning department works for general production plans, while order desk works on orders, gives Order Acknowledgement to customer, and production department releases the production orders and lead time routing for production. So Dimensioning & Planning department is aware of the start time, whether the production orders should start earlier or later, depending on producing speed. It is possible to pull in some orders to fulfill in the production. This depends on the material availability.

To take AXE family as an example, the biggest problem is getting materials. Purchasing department should get the information of all materials' delivery date and amount from suppliers.

For SGSN family, materials are the constraint of this family. This problem is caused by suppliers, too. Master planners set up CTP based on material constraints. The information is like suppliers' ability of delivery, weekly response from suppliers, quality problems, safety stock level and test bottleneck on node level.

For MGW family, due to the backlog order problem, suppliers get the forecast is normal forecast plus backlog orders.

### 7.3.2 Suppliers' Performance

In 7.3.1 section, material shortage problem is caused by suppliers' low performance. For example, all materials in RNC family are purchased. This makes suppliers' performance a key factor. Purchasing department uses pipe chain to trace the material flow. However, the material visibility is still low from suppliers, due to the insufficient information from suppliers.

Purchasing department follows material situation by suppliers' weekly responses. Purchasing department sends consumption plan to suppliers and suppliers give confirmed volumes one or two weeks ahead. However, with the material agreement between ESS KH and suppliers, suppliers cannot fulfill the delivery promise all the time. Some suppliers do not have a buffer level for their finished products. They only have buffers for their components.

For example the suppliers for AXE's Standard Modules are in China, the service level of VMI (pipe chain) is only 50%. There are lots of access materials at suppliers' sites, due to the low accuracy of forecast. The better situation would be having buffer to be more flexible.
It is important to collect the correct value from suppliers like MRP. For low performance suppliers, purchasing department will increase more buffer and order in a longer time. Suppliers have their own capacity and flexibility. To put in a longer term view, suppliers should reach a new way of delivery. Delivery precisions and the capability are not the same. Today only delivery precision is measured. The capability is a more flexible thing which should be measured too. The CTP setting up would be better if both of these can be measured.

### 7.4 CTP Setting Up

After analyzing the problems in different areas above, this section will go through the CTP setting up problems on both node level and standard module level. In order to propose solutions and implementation plans, different factors and constraints of setting up optimized CTP level will be identified, also input data from suppliers, production sites and other related sources will be mapped.

#### 7.4.1 CTP (Capability to Promise) Setting Problem

There are some CTP setting up problems listed below:

- CTP setting up is grouped via AGO families now. In the thesis, the focus is looking for the right CTP level to group Standard Modules. There is no basic guide line for classify them at ESS KH site so far.
- For VMI products, CTP is set as unlimited capacity rather than daily capacity agreement with suppliers. However, some suppliers’ buffer information is not visible for ESS KH and some don’t have buffer in real situation. This means it is very hard to get the buffer information to set the right CTP.
- In SAP ONE, there is a risk to set up CTP level too high, because master planners do not want to set small numbers to block orders. This means the high CTP level can make the system take more orders while ESS KH does not have enough production capacity and can't promise customers. As a result of too high CTP level, all stakeholders will spend waste time on administrative work of backorder process.

#### 7.4.2 CTP on Node level

On the node level, Dimensioning & Planning department checks CTP on the objects which ESS KH delivers to customers. Master planners group delivery objects as AGO families to set up CTP and use forecast as baseline with some adjustments. The AGO families (CTP families) are divided via the test time as their bottlenecks. Node test department gives feedback about the capability they have. When CTP level is full, master planners need to wait until the CTP level has enough space to put new orders.

From the case study of Volvo Construction Equipment, it is important to ramp up the production to see the problem, as how much flexibility do production site has, what if staff are sick in production site, then how to apply these to increase or decrease the CTP
with this flexibility. Combined with the site situation at ESS KH, the needed information of node production are:

- Capacity
- Bottleneck
- Production Time (Different nodes take different time to produce)
- Quality Control

For the node production, bottleneck is the key CTP setting up factor. It influences production capability and reflects on the CTP level.

7.4.3 CTP on Standard Module level

a. Data Mapping

After CTP consideration in node level, master planners break down the numbers into Standard Module level. This is the most challenging task for them. Now setting up CTP on Standard Module level is based on forecast, historical data and actual order. In this section, we are going to figure out which kind of data or information from purchasing or production department do we need to set up CTP.

Following data are taken into consideration and analyses to make the CTP setting strategy more reasonable:

- Forecast from the global planning (Monthly basis)
- Historical data which is collected from the previous demand
- Actual demand (Daily basis)
- Consumption of Standard Module
- Production capacity and production time
- Bill of Material structure
- Material visibility
- Vendors lead time and delivery time
- Constraints of setting CTP

Based on the former sections in this chapter, setting up CTP is based on critical Standard Modules, like the one which is on different nodes, or the one is always lack of at production site to assemble (since purchasing department doesn't hold board at suppliers' site).

b. Constraints

Pick from Stock (PFS) Flow

Beside Make to Order flow, PFS flow is the other flow at ESS KH site. PFS flow is that customers want some components and they get them from the stock. The main problem caused by PFS flow is large risk of consuming of single items on Standard Module level. Pick from Stock flow converts orders to APO confirm too. When the production order is created, the stock transport requisition is converted automatically to a stock transport order. The stock transport requisition is converted to a stock transport order either automatically by a batch job or manually a ahead of pick and pack. (Ericsson
internal document, 2010b) But if the order is not confirmed, it goes to the back order process. In PFS flow, fulfillment is based on stocks rather than order-driven. ESS KH is responsible for picking from the storages and sends them away. There are no values will be added here. When Dimensioning & Planning department sets the capacity of CTP on Standard Module level, the PFS order consumes the CTP level in 1 or 2 weeks. This situation affects Make to Order process by interrupting the back order process. When an order is received, lots of activities are going on. The issue which ESS KH facing is that PFS is automatically created, while it still can't meet the demand and this situation happens quite often. This means customers are checking CTP in NPC now. Preferably, customers can only check CTP in Ericsson Distribution Centre (EDC) rather than NPC. According to project time limitation, this research will focus on setting up CTP for MTO flow process while delimiting the PFS effect.

Figure 32: Pick From Stock (PFS) Flow (Karlsson P., 2009b)
8. Solutions & Implementations

In the previous chapter, the current situation of ESS KH, such as process and system, are analyzed and discussed. It shows the constraints among each related stakeholders for setting CTP level on both Node level and Standard Module level. This chapter presents the proposed solutions and methods which are applied to this project's specific problem statement. Solutions include what CTP factors limit effect on standard module capability in numbers, how CTP handles forecast and various demands to fill the gap. This chapter will describe and analyze the proposed solution according to the problems to be solved in this project, how to set the CTP in the best way with SAP APO system to get efficient response to the customer being both reliable and flexible, and it will indicate who is responsible for each solution. The matrix of strategy will show different parameters in CTP value setting and other solutions would be increasing master data quality.

8.1 Solution

As matrix below, the solutions are divided into two scenarios and separated them with outside 8 weeks horizon and inside 8 weeks horizon. This matrix uses different periods of time as horizontal line and different product levels as vertical line.

<table>
<thead>
<tr>
<th>CTP Level Decisions</th>
<th>Scenarios</th>
<th>Outside 8 weeks horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inside 8 weeks horizon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Adjustment)</td>
</tr>
<tr>
<td>1. Node level</td>
<td>Higher than forecast</td>
<td>Bottleneck (Production)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>› Group 1: CTS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>› Group 2: other test solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alert monitor in SAP Production Flexibility</td>
</tr>
<tr>
<td>2. Standard Module level</td>
<td>Group standard module into commodities both of outside and inside 8 weeks horizon</td>
<td>Alert monitor in SAP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Critical Standard Module’s Delivery Time &amp; Volume</td>
</tr>
</tbody>
</table>

Figure 33: CTP Matrix
CTP strategy Matrix Explanation:

8-Week Horizon
8-week horizon is used as the criteria to classify the solutions, because 8-week is a master planning window. It is the period that ESS KH receives most of the orders and master planners have better information in this time period like material visibility and more reliable information from suppliers. Inside 8-week horizon's planning is near time planning, forecast cannot be changed. In the short term period, with the reasonable knowledge of what the capability will be, master planners adjust CTP and try to be more flexible for setting CTP.

8.1.1 Node Level

CTP level based on forecast and bottleneck
This scenario leads to the in-house problem on node level. Master planners should set up a high capacity for production to receive more orders. The number depends on forecast, actual demands, previous knowledge, and then they adjust the numbers via production bottleneck and monitor the numbers with Alert Monitor in SAP APO in near time. This strategy leads to a high flexibility on both of production and planning. It is not good to set a low capacity, because the low CTP setting prevents the system to get order intakes.

A. Outside 8-week horizon

Setting CTP based on bottleneck
It is more important to have good figures of CTP based on forecast and CTP level should be set higher than the forecast level with a reasonable capacity. The reasonable capacity means how much the production site can raise their capacity. This prevents the problem when there are some materials missing. It is not good to set up the CTP level low, and then there will be constraints to get more orders.

If the CTP level is increased to high level outside 8 weeks' horizon, ESS KH will have less constraints of taking orders. This means it is possible to deliver CTP very high to make sure the CTP will not block orders.

However, CTP level calculation should be based on forecast in percentage rather than the fixed CTP in order to get more flexibility in capacity planning. The general strategy is working with forecast and also there could be some adjustments for different nodes. Then master planners will adjust in near time. With the knowledge from purchasing and production, master planners can divide nodes into low cost and high cost products, and afterwards they see the material constraints such as buffer or value of the materials to adjust each node’s CTP.

Bottleneck
On node level, the bottleneck of node production is the limitation to set the CTP level. As described in Chapter 6 and 7, test process in the constraint. Based on this fact,
master planners should group the node level products via using the same test solution, then CTP level can be established on the capacity of test solutions.

- **Single Test Solution**
  40% nodes use single test solutions.

- **Common Test Solution (CTS)**
  60% nodes (mainstream nodes) run through CTS. The near time flexibility can reflect on changing buffers and shifts. The long time flexibility can reflect on training new staff and buying new CTS machines. If the production department gets notice that they need to raise the capability in 1 month, they will combine CTS machines with Single Test Solution's machines. Production department can also add night and weekend shifts. If they get notice 2 months ahead, they will buy a new machine since it take about 2 months to buy a machine to make it work. If they get notice one year ahead or even earlier, they can get more trained personal. For example, it takes 1.5 years to train a skillful AXE tester. This means some products can increase capability quickly by adding shifts, some take a while.

The ideal situation is that there are 18 CTS machines to reach a very good flexibility. All kinds of nodes can go through one CTS machine. It is a common infrastructure, with different nodes for different time. GSN family (GGSN, SGSN) takes 2 to 3 hours. Nodes in AXE family take much longer time, since they are big equipment. Production department increases some buffer for waiting for new machines to be more flexible. When there are not many orders, the CTS machines can be put in the corner since they do not occupy much space.

**B. Inside 8-week horizon**

**Production Flexibility & Capability**

Dimensioning and Planning department makes capacity planning, informs the production to get different volumes of boards. If master planners have to increase every board’s capability, then the production's capacity will not be enough. However, this situation does not happen often.

Capability's flexibility is based on the time horizon, which is how much time does production needs to reach this flexibility of CTP. Outside 8-week horizon, master planners set high CTP. Inside 8-week horizon, master planners adjust the CTP numbers with the production possibility to increase the capability to meet the demand. If the production has the flexibility, master planners should set the CTP according to the estimation for the future capacity. This CTP level depends on the forecast and current CTP level. This new CTP level makes it possible to receive orders. Also, with the time goes by, master planners need to change the CTP then it won't keep the high level to increase capacity too much.

According to production baseline now, 500 nodes per week will be the maximum with 8 weeks ahead notice. This number is from 2 production lines and each one has 220 pieces as maximum. It is not possible to build one more line in 8 weeks.

The possibility to increase the capability also depends on the ramp up of the production
capacity in certain time period. For example, if the production is aware of increasing capability in 2 months to meet the customers' request or in 1 month or in 2 weeks, the increase possibility of future capability depends on the baseline of the production at the moment.

As shown the figure 35 & 36 below, if the baseline of production is 100 nodes, it takes 7 weeks to increase 300 nodes in order to reach 400 nodes; if the baseline of production is 300, it takes 7 weeks to increase only 100 nodes in order to reach 400 nodes. To understand this figure in another way, in 2 week time period, the pieces can be raised by 100 if the baseline is 100; but it can't be raised by 100 if the baseline is 300. This means in certain time period, the higher the baseline volume, the harder to increase the capability. If the production department can know much earlier, then they can build new lines, get more shifts and train more employees.

Figure 34: Production Baseline from 100 pieces (Hellgren J., 2011)
Monitor CTP via Alert Monitor
Alert Monitor in SAP APO is a useful visualized tool for keeping track of consumption of CTP levels. It shows the relation between CTP levels and confirmed order quantity on dates. Master planners should make some adjustments by putting reasonable CTP in near time on weekly basis. The Alert Monitor can highlight where master planners need to take action. Master planners can set the alarm about percentage and time horizon. It is better to have an earlier warning, since there will be enough time to react on it. If master planners see the possibility of rising up the CTP level, they will communicate with production and purchasing department to increase the CTP on both first and second tier levels. If the CTP level can't be increased, then no new orders will be confirmed. By using this monitor tool to set the correct limits, Dimensioning & Planning department can be proactive and improve the strategy of CTP levels before reaching limitations.

In the actual process, by double click the product number, the warning can be checked. The colors and signs are used to represent warning level of current CTP limits. The CTP level setting up is a continuous handling CTP via using Alert Monitor based on current situation. With the reasonable numbers set up on CTP level, master planners are aware of what is going on for the coming week or even longer. There are three signs in the system: Blue light warning, Yellow light warning and Red light warning.
- Blue light warning A%*: it means that the actual demand has consumed A% of CTP.
- Yellow light warning B%*: It means that the actual demand has consumed B% of CTP. In a limited time, the system cannot take any orders. In this case the CTP it is necessary to discuss the possibility to increase capacity in order to prevent excess demand (confirmed actual demand is more than CTP level). Before the CTP level is
consumed 100%, masters planners need to react. The actions taken depend on
different kinds of products. Some nodes might take a week.

- Red light warning 100%: It means that the actual demand has consumed all of CTP.
  It is not possible to take any orders in this time period of this product. The order
  will get stuck and go to the back order process.

*A% and B% can be set up by master planners for different nodes and standard
modules.

![Diagram showing CTP level and actual orders comparison](image)

**Figure 36**: The concept of alert monitor compares CTP level and actual orders.

### 8.1.2 Standard Module Level

For standard module level, CTP level is expected to be in the same level as supplier's
capability due to the fact that the company needs to know the amount of material that
the factory can get and when the supplier can deliver. Basically there are many material
constraints in ESS KH in standard modules. It is easier and practical to group them into
a few categories and set CTP in each groups.

Supplier delivery precision was considered as criteria to group standard module. But it
is very hard to track on single supplier's performance whether they can fulfill and it
quite varies on monthly bases. For some commodities, suppliers can highly fulfill the
forecast. Some of them cannot fulfill it or can only deliver 10%. Therefore using
delivery precision of suppliers to group standard modules is not the best to choose.

Grouping by commodity can be one of the solutions of setting CTP level. Moreover, the
flexibility in CTP levels can be increased by setting in different critical standard
modules.
A. "Outside 8 weeks" time period

Setting CTP based on Commodities

Grouping standard modules into commodities is based on the suppliers capability estimation from purchasing department. The CTP level is according to suppliers’ estimation whether they can deliver and it is based on supply mapping, collecting and receiving capability response from these suppliers. There are 7 commodity groups for setting CTP levels. Each commodity and the CTP setting up percentage are listed in the table as below:

<table>
<thead>
<tr>
<th>Commodity</th>
<th>CTP based on MRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Power</td>
<td>+20%</td>
</tr>
<tr>
<td>2. Climate</td>
<td>+20%</td>
</tr>
<tr>
<td>3. Enclosure</td>
<td>3.1 Sheet metal</td>
</tr>
<tr>
<td></td>
<td>3.2 Assembled</td>
</tr>
<tr>
<td>4. Small Mech</td>
<td>4.1 ANS</td>
</tr>
<tr>
<td></td>
<td>4.2 Fasteners, labels, licenses</td>
</tr>
<tr>
<td>5. Interconnect</td>
<td>5.1 VMI with hub</td>
</tr>
<tr>
<td></td>
<td>5.2 Hub products</td>
</tr>
<tr>
<td></td>
<td>5.3 Others</td>
</tr>
<tr>
<td>6. EMS</td>
<td>+/- 0%</td>
</tr>
<tr>
<td>7. OEM</td>
<td>7.1 Not Forecast SM</td>
</tr>
<tr>
<td></td>
<td>7.2 Hub : Forecasted (Must be defined per Suppliers)</td>
</tr>
<tr>
<td></td>
<td>7.3 Without Hub</td>
</tr>
</tbody>
</table>

Table 6: CTP level on Standard Module level per commodity

The general CTP setting up is based on grouping standard modules into commodities. This grouping method put same standard module commodity for different products with weekly adjustments. This means the flexibility depends on the time frame like weekly or monthly. The suppliers input are the factors of this scenario. Also it is necessary to have an alert monitor at this level too in near time planning. The percentage of CTP level of MRP is considered by the experience of supplier development, hub agreement, and buffer flexibility and supplier performance.

The master planners can adjust the numbers on lower level by using the commodities list as a general base. CTP check should combine the information of suppliers and production capability in ESS KH's production of each standard module level product.

Moreover, considering planning flexibility, master planners should set specific CTP per week for the critical Standard Module (SM) manually in near time planning. Critical SM in the matrix means those are always lack of in node production site to assemble. For example, ESS KH is expecting 100 pieces from suppliers in the 10th week but suppliers reply on the 9th week that they cannot supply this amount for the coming
week. Then, the master planners should adjust the CTP level according to the amount and time that suppliers can deliver, which means CTP level should be the number at the maximum amount that suppliers can deliver to ESS KH.

The percentages of CTP level of MRP in the table are calculated by estimating suppliers’ capability, hub agreement and buffer flexibility from suppliers.

Suppliers have to respond whether they could fulfill the percentage or not for the forecast they get. So far they are reacting on a monthly base. In general, supplier of ESS KH will reply the percentage of products they could fulfill based on the forecast, whether it is higher or lower.

The numbers showed in the table 6 are on monthly base, which is supposed to divide them into weekly bases, since suppliers give purchasing department weekly response. These numbers ramp up different weekly responses and other information to see the monthly base adjustment. The percentage in the table 6 means the flexibility the supplier’s capability.

From the table 6, the master planner can set high level of CTP for some standard modules which belongs to some commodities.
1. Power: CTP level is set + 20% of MRP.
2. Climate: CTP level is set +20% of MRP.
3. Enclosure: CTP level can be + 30% of MRP.
4. Small Mechanic: There is unlimited CTP because ESS KH have agreements with ANS, which is the supplier of this commodity. ANS is quite restricting to set the buffer via ESS KH's forecast. Later, SNC - SAP solution for purchased materials flow based on supplier but flexibility should be the same.
5. Interconnect: There are VMI supplier with hub agreement, other supplier with hub agreement and the others (supplier without hub agreement). For the suppliers who have hub agreements with ESS KH, they will stock some buffers in the result of more buffer flexibility so the CTP level can be set +15% and + 20% of MRP respectively. And the CTP level of suppliers without hub or others in the table 6, it should be set just +10% of MRP because ESS KH buys the materials directly according to customer orders (without forecast).

6. EMS: CTP level of EMS is + or -0% of MRP due to there is no flexibility in this commodity. EMS produces unique customer designed products which provide only for ESS KH. ESS KH buys the production not just product and all components are decided by Ericsson such as quality and suppliers they have to buy from. EMS is quite strict buying components according to forecasts from ESS KH. If ESS KH sends forecast to
them 100 units for the next month, EMS will be able to provide products to ESS KH just 100 according to forecast they got. Therefore, CTP level of EMS commodity should be set + or -0% of MRP. EMS, Ericsson own design.

7. OEM: OEM group is customer driven. Suppliers own design. For the supplier group who do the hub agreement in OEM commodity, ESS KH can set the CTP level up to +20% of MRP. Because of the agreement, OEM's supplier will produce the unique component for ESS KH and ESS KH has to buy 75% of supplier's buffer. And for not forecast on Standard module and without hub, there is no buffer flexibility so CTP level should be set as + or - 0% of MRP.

- Alert Monitor

Same as in Node level strategy, the alert monitor is also used to keep track of consumption of CTP on standard module level in near time planning.

B. Inside 8-week horizon: Critical Standard Module

The critical standard modules are the modules which ESS KH is always waiting for them to assemble on nodes. It takes the longest lead time among other parts on one node. Then it needs a unique CTP level according the suppliers' response. CTP level of critical standard module should be set rather low level.

Data from suppliers: Delivery time & Volume of Standard Module

AXE can be an example for this case. The bottleneck for AXE family now is the critical board GARP 2, which there is no buffer in ESS KH. These boards are used on lots of nodes and expansions of AXE family. There are 3 different part number of this board with different configurations: 1/ROJ 208 459/1 R4B, 2/ROJ 208 459/1 R4B, 3/ROJ 208 459/1 R4B.

There is not enough GARP 2 to build boards now, while other boards in AXE have too much in stock. Suppliers do not think the ESS KH' forecast is good.

Update parameters from Purchasing:

'Inventory Chart for Supplier Partial Bucket': (the only thing purchasing department can do to change the delivery time is changing transportation method, for example: via Express)

- Max Time
- Safety Time
- Critical Time

Delivery time is supposed to between Safety Time and Max Time - suppliers are going to deliver us within these days. The delivery time is the input from suppliers and it takes safety stock in ESS KH and Transportation Time into account as well.
Therefore, in near time plan, the purchasers can see the situation better and lower level to be close to what supplier can deliver.

8.2 Implementation

In this section, the actual ways of working and action plans will be described step by step to follow preliminary solutions. Regular meetings, further settings and simulation examples will be suggested so as to execute in comprehensive plan.

8.2.1 Regular Meetings

Internal Communication among stakeholders is the most significant way to transfer information in order to get the reliable data and work more efficiency. Regular meetings can visualize the process: communicate with different departments to get input from internal and external perspectives. The content of the meeting is related to near time planning (inside 8 weeks' horizon).

A. 11 o'clock meeting

11'o clock meeting already exists at ESS KH for twice a week on regular basis of Node level. It is between Dimensioning & Planning department and Production department. According to the solutions matrix in 8.1 sections, the discussion should include capacity flexibility, responsible people, and CTP consumption situation. Warning results of alert monitor should be the guideline of this meeting. Around 10-12 people are involved. Dimensioning & Planning department's CTP levels on node level are updated weekly, while production department should be updated too.

The reason for this 11o' clock meeting is keeping track of the production situation and CTP level. All people in the meeting should make the decision whether to increase the capability in a short time. In this way, there can be more accurate and flexible CTP inside 8-week horizon. The discussion can be test capacity. For example, this week's
test capacity is 350 per week, but this number varies for each week. Dimensioning & Planning department should discuss with production department that whether it is possible to raise capacity for the coming week or weeks. Capacity flexibility includes the assemble line and test (CTS, none CTS solution). Discussion should be mainly about whether production can increase the production capability in certain amount of time, what is the production baseline now, should Dimensioning & Planning department set more orders ahead in order to have buffer to cover all orders. Other situation like material supermarket, mount flow, CTS flexibility, outgoing good pack the nodes, standard module and warehouse worth mentioning too.

Then Master planners will set up the CTP limits to prevent receiving orders which production department cannot produce.

**B. 10 o'clock meeting**

The 10 o'clock is the additional meeting that discuss about the near time planning for setting CTP level of Critical SM. This meeting recommends organizing once a week in order to improve the communication between the stakeholders in manufacturing. The super users will be assigned in each department for being in charge of CTP setting issues in this meeting. Any problem about CTP issues arises, super users will responsible for taking care of any problems. The table 7 below illustrates the role of stakeholders in CTP update process on standard module level:

<table>
<thead>
<tr>
<th>Supplier forecast</th>
<th>Supplier management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Updates the data</td>
<td>Purchasing</td>
</tr>
<tr>
<td>Uploads the data</td>
<td>Dimensioning &amp; Planning</td>
</tr>
</tbody>
</table>

Table 7: The role of stakeholders in CTP updated process on standard module level

In 10 o’clock meeting, the super user from each department should attend this meeting for discussing each of standard modules’ situations. The role of each stakeholder in CTP update process on standard module level from table 7 can be explained as follows:

- **Supplier management**: Supplier planners who have good knowledge and experience on supplier development should take the general setting of CTP level on purchased standard modules by considering the supplier capability regarding monthly basis.
- **Purchasing**: In near time, purchasers have first-hand information about suppliers’ weekly response. This means they know the material situation and each supplier’s various performances. That is why purchasers are the ones who update the CTP level of standard module on daily basis.
- **Capacity management (Dimensioning & Planning)**: Dimensioning & Planning should take responsible for updating CTP level in the SAP via communication with
purchasing on standard module level on weekly basis in order that it continuously connects weekly process of working.

After the super users of each department have discussed about the situations on standard module, the master planners can set the CTP level before 11 o'clock meeting which master planner can take some issues to discuss with production department.

8.2.2 Alert Monitor Setting
Alert Monitor as mentioned in section 8.1 is a very good monitoring tool. Master planners should set different percentages and early warnings among families and components. Different targets values should be set among different levels. On family level, different warning values should be set for different families. On component level on weekly buckets, different parameters like materials numbers should be adjusted for different components.

Moreover, taking different actions when the CTP consumption passes the warning line is a further development area. When the CTP consumption is higher than the actual customer order, actions consist of pulling orders, decreasing workload of production and etc. When the CTP consumption is lower than the actual customer order, actions include pushing orders ahead, raising capability and etc. Master planners should consider whether taking these actions on daily, weekly or even longer time base.

8.2.3 Simulation Example
This section will be described about the tool box and method of setting CTP level according to the solutions from the previous sections. The way of working like the format and template which will be used to handle the CTP level is explained in this part.

A. Node level
Since the node level's solution is a conceptual setting for outside 8-week horizon and a very flexible setting for inside 8-week horizon, it is very difficult to test node level's solution in this paper for limited time. With the effect of Alert Monitor, the final CTP decision is also based on the regular communication between production and Dimensioning & Planning, which adjusts the capability.

B. Standard Module level
After the solutions and implementation are mentioned, the section will be explained the way of working by taking some of standard modules in some commodities as the example. This simulation on standard module level can show whether the numbers on commodity list is reasonable.

The table 8 below is an example of simulation to get the action plan from setting CTP level via commodities. The first column is the product number of standard modules which belong to different commodities. Then the MRP and MRP adjustment which are as the baseline are put after the first column. The CTP level can be calculated from multiplication of MRP and MRP adjustment. MRP number is from 2-month ahead,
because it is simulated as outside 8-week's horizon. In real situation, it can be adjusted
to 1-month ahead, too. The last column is the action plan which is analysed by
comparing Actual order intake and CTP level.

<table>
<thead>
<tr>
<th>Product No.</th>
<th>Commodity</th>
<th>MRP (2 months ahead)</th>
<th>MRP Flexibility</th>
<th>Supplier (Weekly Adjustment)</th>
<th>CTP</th>
<th>Actual Order</th>
<th>Result</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/BMG 347/2</td>
<td>Power</td>
<td>144</td>
<td>20%</td>
<td></td>
<td>173</td>
<td>397</td>
<td>CTP is lower</td>
<td>Adjust in near time planning, CTP can be set a bit more.</td>
</tr>
<tr>
<td>1/BMG 663/014/31</td>
<td>Climate</td>
<td>42</td>
<td>20%</td>
<td></td>
<td>51</td>
<td>69</td>
<td>CTP is lower</td>
<td>Adjust in near time planning, CTP can be set a bit more.</td>
</tr>
<tr>
<td>1/ROJ 459/1</td>
<td>EMS</td>
<td>279</td>
<td>0</td>
<td></td>
<td>279</td>
<td>589</td>
<td>CTP is lower</td>
<td>Adjust in near time planning, CTP can be set a bit more.</td>
</tr>
<tr>
<td>KDU 0008/5</td>
<td>OEM - without hub / not forecast SM</td>
<td>65</td>
<td>0</td>
<td></td>
<td>65</td>
<td>108</td>
<td>CTP is lower</td>
<td>Adjust in near time planning, CTP can be set a bit more.</td>
</tr>
<tr>
<td>KDR 124/3</td>
<td>OEM - Hub</td>
<td>33</td>
<td>20%</td>
<td></td>
<td>40</td>
<td>34</td>
<td>CTP is higher</td>
<td>Adjust in near time planning, CTP can be set a bit less.</td>
</tr>
</tbody>
</table>

Table 8: A simulation example of setting CTP on standard module level

The limitation of this simulation is that it lacks of weekly response of suppliers and adjustment via Alert Monitor. The critical standard module is not pointed out in this simulation, since it is an ideal simulation which all suppliers can keep their promises. The number of CTP setting will be more accurate with above input.
9 Conclusions & Recommendations

In this section, there will be explanations of how the problem is solved by the solutions and how the targets are fulfilled. Also some recommendations are made to improve different processes and CTP setting.

9.1 Conclusion

The problem of ESS KH is that inaccurate CTP level leads to the low performance of first delivery precision. In this thesis, strategies are developed to solve this problem with keeping the response lead time and decreasing the manual work. The results are divided by 2 products levels and 2 time periods. As shown in the matrix in chapter 8, outside weeks' horizon, on the node level, CTP setting should base on a high MRP with consideration of bottlenecks. Inside 8 weeks' horizon, on the node level, CTP setting should work with the SAP Alert Monitor. For standard module level, grouping standard module into commodities to set CTP is the optimized solution. Inside 8 weeks' horizon, the CTP should be adjusted via SAP Alert Monitor. For critical standard module, the CTP should be adjusted via delivery time and amount in 8 weeks' window.

To answer the problems raised in section 1.3, the solutions for 2 levels match ESS KH's fluctuated demand and limited capacity. In order to get more orders, the CTP set is high outside 8-week's horizon. It is important to not have too many restrictions in that time period. The system can automatically confirm large volumes of orders, which decrease the manual work of order handling. With the monitoring tool, effective internal communication and updated external response, the CTP level is well controlled and adjusted inside 8-week's horizon. These monitoring parameters and input makes CTP level more flexible and visualized, also gives different departments have time react for the CTP consumption problems. The Alert Monitor makes orders go to the back order process which prevents them to become order past due. This effective tool makes ESS KH's first delivery precision to keep on a high percentage, which fulfills the promises for customers as well as response to them quickly.

In short, the solution keeps ESS KH’s response speed and raises the flexibility of capability to provide fast delivery with minimum risk. The figure 38 below summarizes how the proposed solutions achieve the three targets of this study:
9.2 Recommendations

In this section, 3 recommendations are suggested to ESS KH for setting more suitable CTP strategies.

9.2.1 CTP Decisions' History

It is good to keep track of CTP decision history to see the trend in historical data. The data could be how accurate of CTP consumption history compared to demand variation from week to week. It is good to follow the trend of the gap between these two numbers to make better CTP decision for the future.

9.2.2 Master Data Quality

From the two case studies of Volvo companies, the lesson learned from their experiences that Dimensioning & Planning department needs to work on the master data quality. The master data includes stock numbers, lead time synchronization and etc. For example the configuration could be wrong, like materials are missing. In this case, master planners can't build the structure what they want. Also master planners should update buffer stock in the system once a month to make the data correct. Dimensioning & Planning department also needs to clarify who and how to update these data, and make sure the data correspond with real situation.

Moreover, Dimensioning & Planning Department needs to be well prepared for
fluctuating demand by adding more safety planning lead time between suppliers and production.

9.2.3 Material Visibility

In order to have good materials' visibility to set up better CTP, ESS KH should work on the information flow in the whole supply chain. Dimensioning & Planning department is planning orders 1-3 months ahead without good materials visibility. If the information of current stock level, raw materials or other related input get more accurate, the first confirmed delivery precision will get better. Having good material visibility means the material situation is visible, like suppliers buffer information. This means the problematic components won't limit the CTP and CTP can be set up more reasonable to get more orders. Purchasing department should cooperate better with suppliers to get better information and increase the low performance of suppliers' first delivery precision.
10 Validity & Future study

Because of the limitations of this thesis, this section will give some ideas and suggestions for future study by the company. It also need further research on the subject, both in terms of quantifying the effects of the implemented planning process and in terms of comparing to other cases where similar approaches are used in the capability of promise.

10.1 On validity of the results

In accordance with methodology of thesis, the subjects in the discussion were repeated in order to be valid. The solutions in this report were discussed with different stakeholders in order to get different aspects. For the CTP strategies on node level, the solutions are established as the concepts which need to be adjusted with real situation to get real figure. Flexibility and Neutrality are the prerequisites that the authors concerned. Another result on SM level, the CTP strategies come from the experienced estimation and involved people within ESS KH. This method could increase the creditability of the results.

About SAP APO which is used for setting CTP in ESS KH, this system is rather expensive and too complex for most companies. The researchers for the future study should seek for advice from experts or consulting company more according to the contact information list in the end of this thesis.

However, this thesis covers a developing area and the people involved are facing ever changing demands. These essential factors make it difficult to repeat this research exactly with similar conclusions. The research needs to conduct further study as following section.

10.2 Future studies

In order to get more validity and reliability on the results, there are some future studies which involve this setting CTP area and need to do further.

10.2.1 Pick from Stock (PFS) Flow

As described in section 7.5.3, PFS flow is one of the problems affects the CTP setting up. It consumes the standard module and influences the material availability and capacity of standard module level in Make to Order flow in ESS KH. In the future, Ericsson group probably can separate the consumption of standard modules of these two flows. This means PFS flow should consume materials in Ericsson Distribution Centre (EDC). Ericsson group should work on the feasibility to put PFS at EDC.

10.2.2 Production Flexibility

The production flexibility can be one of the issues in setting CTP strategy that is needed to be further study. The amount of product and the production lead-time will be concerned in order to get the most production flexibility. For instance, assume order come on day 8, 50 pieces. Keeping CTP 5 pieces per day and consume 10 days for this
order. If CTP level is increased to be 10 pieces per day and consume 5 days. The issue that should be discussed between master planning department and production is which one is more flexible for production in order to get the most efficient CTP level.

10.2.3 CTP leveling on SM level

From the CTP strategies on SM level, the results will be more reasonable on monthly basis by taking a SM with a large consumption. But in weekly, the SM consumption varies which causes the incorrect CTP. The future study of CTP strategy on SM level should concern the CTP level in weekly. For example, if CTP should be set +10% of MRP:

<table>
<thead>
<tr>
<th>Week</th>
<th>MRP</th>
<th>CTP (+10% of MRP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>75</td>
<td>82.5</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>77</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>77</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>88</td>
</tr>
</tbody>
</table>

Table 9: The example of MRP and CTP level weekly

The issue is that if the CTP level is set 88 pieces for each week in that month instead of setting in percentages, which method is more effective way.

10.2.4 Measurement of Suppliers' Performance

As described in section 6.7.2, the unpredictable suppliers' performances make the CTP setting hard to evaluate. Because of this reason, the solutions in this research do not use the supplier performance which is too fluctuated to be factor. It is important to develop an effective tool or method to measure the suppliers' performance: even they vary a lot on weekly or monthly basis. Therefore, setting CTP level on Standard Module (SM) level can be adjusted weekly based on supplier performance in order to get the most reliable CTP level as supplier capability.

10.2.5 Specified Setting CTP on Node level

Due to the limitation listed in section 8.2.3, the setting of CTP on node level and the test of it can be further topics to study. The CTP outside 8-week's horizon can probably be specified to numbers of MRP. Then it is possible to test this solution of how high MRP as a baseline to support customer request.

The later CTP setting should consider the stairs of production capability (see figure 35 & 36). The test should include whether this setting can meet most of the orders and how large the percentage will be fulfilled. The input parameters should conclude forecast, node demand, customer request date, actual order, action plan and whether it fits in production plan. Also in the detailed setting, monthly CTP setting can be driven into weekly bases to see the differences.
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(11. Appendix)

Appendix 1: Interview Questions with Volvo Penta

Contact Person: Process & Solution Manager, Christian Jensen, Phone: +46 31 3221691
Location: Gothenburg, Sweden

Product
1. What are the products of Volvo Penta?
2. How is the demand situation?

Process
1. Which kind of order fulfillment process (MTO, MTS, or others) do you use?
2. How about the lead time period for your products?
3. How is the production planning within Volvo Penta?

System
1. What is the system used within production planning?
2. How does it work with CTP setting?

CTP setting up
1. How do you set up CTP (Capability to Promise) level in general?
   - Is it based on forecast or demand?
   - How much manual work is involved?
   - Which kind of parameters or factors do you consider when you set up CTP levels?
2. Does Volvo Penta have any other concepts or solutions for order promise?
3. Do you have any suggestions for our thesis?
Appendix 2: Interview Questions with Volvo Construction Equipment:
Contact person: Production planner/ Logistics development, Christian Hallin, Phone: +46 16 541 6339
Location: Eskilstuna, Sweden

Product
1. What are the products of Volvo Construction Equipment?
2. How is the demand situation?

Process
1. Which kind of order fulfillment process (MTO, MTS, or others) do you use?
2. How about the lead time period for your products?
3. How is the production planning within Volvo Construction Equipment?

System
1. What is the system used within production planning?
2. How about the SAP Factory Master Module which will be implemented in October in VCE?

CTP setting
• How do you set up CTP (Capability to Promise) level in general?
  • Is it based on forecast or demand?
  • How much manual work is involved?
  • Which kind of parameters or factors do you consider when you set up CTP levels?
• Does Volvo Construction Equipment have any other concepts or solutions for order promise?
• Do you have any suggestions for our thesis?
Appendix 3: Contact information

**Company:**
1. Mölnlycke company is the potential company on SAP APO
2. EKA Company is the potential company on SAP APO
3. Wipro infrastructure engineering is the company which delivers hydraulic cylinders, components and solutions & truck hydraulics components to OEMs globally in the infrastructure and related industries. According to similar planning system consideration to this study, this company can be potential comparable company which uses SAP.
   Contact: information: +46 910 73 80 30 or http://www.wiproinfra.com/html/contact.html or mktg-wie@wipro.com

**Consultant:**
1. Call SAP Sweden
   Contact Information: +46 70 323 00 53 (Carina Nordqvist)
2. Roce consulting company
   The consulting company is the SAP APS & i2 technology expert.
3. APS Nordic:
   This is the community in SAP APS & i2 technology.
4. Optilan consulting company
   Contact: information: magnus.edberg@optilan.se or www.optilan.se
5. Shashi K Venkatesh, Yadukumar Chikkaiah and Apoorva Trivedi
   They are expert in ERP implementation (sales, purchasing, production planning, SAP APO) from IBM.
6. Niclas Hansson (System Designer)
7. Niclas Kullstam (ERP consultant)
8. The useful website about the SAP knowledge is provided on http://help.sap.com/

**Professor:**
1. Jens Wiren from www.plan.se
   Jens Wiren is one of the people from www.plan.se which website is of is the Swedish Production and Inventory Management Society. They could offer mailing list to do questionnaire.
   Contact information: Jens Wiren@ericsson.se
2. Joakim Wikner PhD. from Jönköping University:
   Joakim Wikner is the Professor of Logistics in industrial engineering and management at Jönköping University who may provide the the theoretical and concept of setting CTP level in resource planning system since he used to write a number of papers about product planning and system.
   Contact information: Joakim.Wikner@jth.hj.se
3. Ola Cederborg: from Linköping University
   Ola Cederborg conducted the thesis as part of the research project in Supply Chain and Advance planning Systems regarding single case study at SSAB Plate Company which use i2 technology system. He can be potential person to guideline about CTP setting
concept and lead to the right contact person at SSAB Plate Company.
Contact information: Tel. +46 013 28 15 16 or ola.cederborg@gmail.com