An Architecture of Supply Chain Management Systems

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Abstract

Supply chain management (SCM) is the integration of business processes from end consumers through original suppliers that provides product, services and information. By this definition, we know that SCM is a series of management processes across firms forming a supply chain network. Cooper et al. [2] stated that those processes are customer relationship management, customer service management, demand management, order fulfillment, manufacturing flows management, procurement, product development and commercialization.

In this paper, we propose an architecture of SCM systems. The architecture contains three main components. The first one is "System Portal", which is an interface between users and the system objects. The second one named "Object Repository", which is used to store objects of the SCM system, makes the development, management and usage of these objects easier. The third one is "Database" which is a universal database to store all data of the SCM system. This architecture contains not only technique issues but also management issues, in order to solve the SCM implementation problems and provide a technology guide to combine the legacy systems with the SCM system.

In this paper, we will also use the object-oriented analysis and design methodology to model the proposed architecture of SCM systems, in order to view the whole phases in the systems and help the system developers to build their owned supply chain management systems.

1. Introduction

Recently, we usually heard that many enterprises said that they want to do supply chain management, or make a system to build a supply chain management environment. In fact, early in 1990s, supply chain management had been brought up. But until late of 1990s, many companies just started to do the supply chain management. And if it is too late to do it, what management issues we should mention, and how to build the real supply chain system. These two issues are the most important questions when do supply chain management. This paper is to focus on the framework of supply chain management system to be the first step of building supply chain management system.

In this paper, we will describe what supply chain management is, including definition, characteristics and architecture of supply chain management. Then, we will introduce object oriented analysis and design. In this part, the UML notation will be introduced.

At last, we combine the supply chain management and the latest object oriented technology, then propose an architecture of supply chain management systems. Base on this architecture, we use object-oriented analysis and design methodology to model the full architecture of supply chain management system.

2. Supply Chain Management

2.1 Definition of Supply Chain Management

A supply chain is a network of facilities that procures raw materials, transforms them into intermediate subassemblies and final products and then delivers the products to costumers through a distribution system [1].

According to the members of The International Center for Competitive Excellence in 1994: Supply chain management is the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers [4].

By this definition, we know that supply chain management is a serial management process across firms among the supply chain network. This network begins from material suppliers to product manufacture that is provided to end-user.

And supply chain network contains three flows through the network, which are information flow, mater flow and cash flow. The three flows to make the members among the network to exchange information, cash and material with each other.

2.2 Characteristics of Supply Chain Management

The most challenge of supply chain management is how to maintain a visible level of warehousing. In order to minimize the uncertainty among the supply chain, members in supply chain network would like to see information what they want. However, this kind of uncertainty will make firms to use safer amount of warehousing or other not ideal management method. For example, purchasing earlier. Using this point helps to compare the difference between traditional logistics management and modern enterprise-oriented supply chain management [3]. The difference between traditional logistics management and modern supply chain management is shown as Table 1.

Table 1

Effect factors	Traditional logistics management	Supply chain management
Warehousing Management	Enterprise oriented	Coordinate among supply chain
Flow of warehousing	Interrupted (base on unit of enterprise)	Seamless/Visible
Cost	Minimize in single enterprise	Base on end cost of product
Information	Controlled in enterprise	Shared by all members in supply chain
Risk	Enterprise oriented	Share
Planning	Enterprise oriented	All members in supply chain
Relationship among cross organizations	Enterprise focus on low lost	Companion relationship focus on end cost

2.3 Framework of Supply Chain Management

The SCM framework, shown as Fig. 1, consists of three major and closely related elements: business processes, management components, and the structure of the supply chain. Business processes are the activities that produce a specific output of value to the customer. The management components are the components by which the business processes are structured and managed. The supply chain structure is the configuration of companies within the supply chain [2].

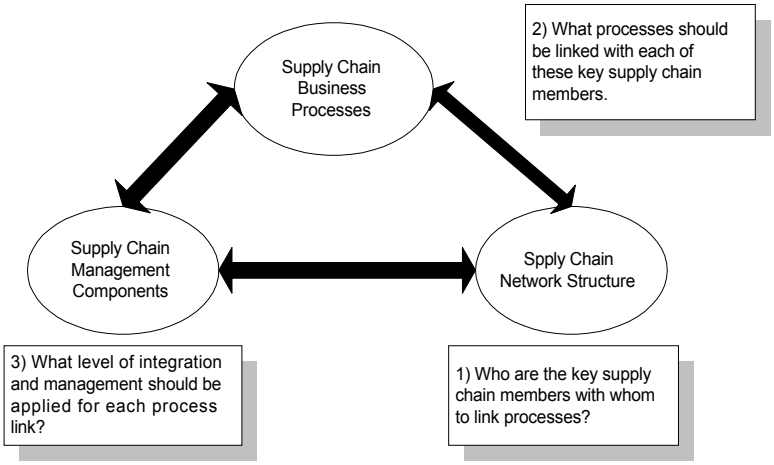

Fig. 1

By this framework, we could view what is included in the supply chain management, the supply chain business processes is processes through the supply chain, this enables three flows, material flow, cash flow, and material flow, could be active, visible through the supply chain. Supply chain structure could view the members and relationships among the supply chain network.

3. Object Oriented Analysis and Design

3.1 Object Oriented Development Life Cycle

The object-oriented development life cycle, depicted in Fig. 2, consists of progress developing an object representation through three phases-analysis, design, and implementation. In the early stage of development, the model is abstract, focusing on external qualities of the application system. As the model evolves, which becomes more and more detailed, shifting the focus to how the system will be built and how it should function-system architecture, data structures, and algorithms. Ultimately, the system developer must generate code and database access routines. The emphasis in modeling should be on analysis and design, focusing on front-end conceptual issues, rather than back-end implementation issues. [6]

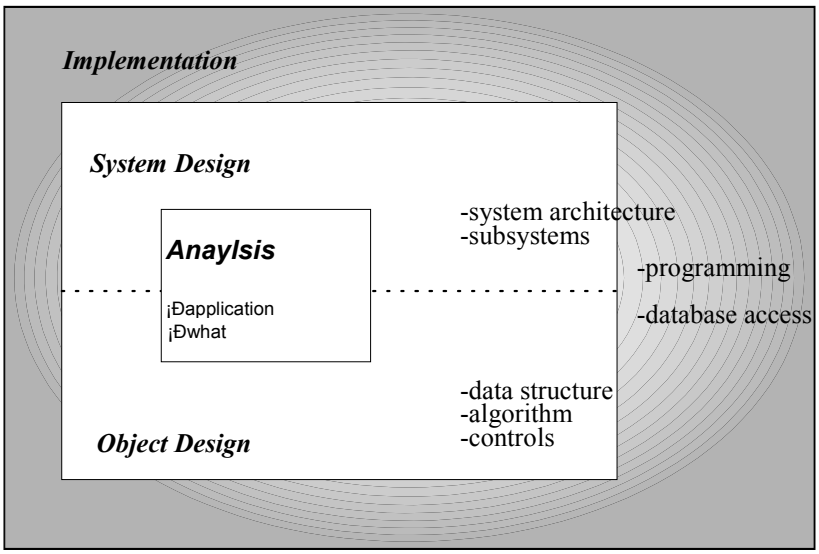

Fig. 2

3.2 Unified Modeling Language

The Unified Modeling Language (UML) is "a language for specifying, visualizing, and constructing the artifacts of software systems, as well as for business modeling" [7]. The UML notation is useful for graphically depicting object-oriented analysis and design models. It not only allows you to specify the requirements of a system and capture the design decisions, but it also promotes communication among key persons involved in the development effort.

In analysis model, we would use four types of notations-use-case diagram, class diagram, state diagram, and sequence diagram. The first two diagrams is static diagram to describe the system architecture, and the last two diagrams is dynamic diagram to describe the dynamic behavior of the objects.

1) Use-Case: Jacobson et al. [5] pioneered the application of use-case modeling for analyzing the functional requirements of a system. Because it focuses on what an existing system does or a new system should do, as opposed to how the system delivers or should deliver those functions, a use-case model is developed in the analysis phase of the object-oriented system development life cycle.
2) Class Diagram: A class diagram shows the static structure of an object-oriented model: the object classes, their internal structure, and the relationships in which they participate.
3) State Diagram: State transitions are shown using state diagrams. A state diagram depicts the various state transitions or changes an object can experience during its lifetime, along with the events that cause those transitions.
4) Sequence Diagram: A sequence diagram depicts the interactions among objects during a certain period of time. Because the pattern of interactions varies from one use case to another, each sequence diagram shows only the interactions pertinent to a specific use case.

4. System Architecture

According to the discussion of supply chain system components and system requirements, we propose a simple architecture as Fig. 3.

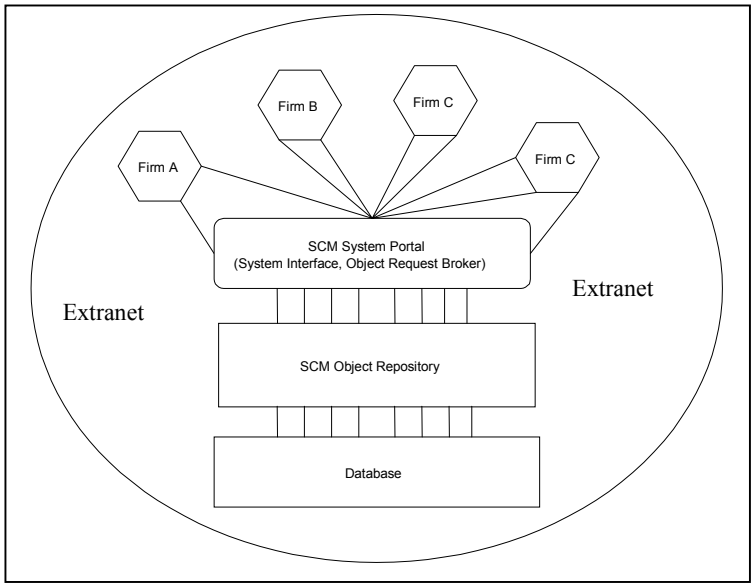

Fig. 3

This architecture consists of three components. They are system portal, Object Repository, and database.

1) SCM System Portal: This interface between supply chain management system and environment. It has two main functions. First, the function receiving and retrieving external data sources, and making system to process and deal with the data in right way. Second, providing data or information for other system or system users.
2) SCM Object Repository: This is the primary part of the SCM system. All processes are stored in this repository, and logically designed in object-oriented architecture.
3) Database: This component provides the functionality of storage of various data format. Including the supply chain network member data, product, and production information, etc.

5. Components Design

According to the above description and discussion of supply chain management process, this study combines the management processes as well as basic system architecture, and proposes an abstract supply chain management system architecture and its components as Fig. 4.

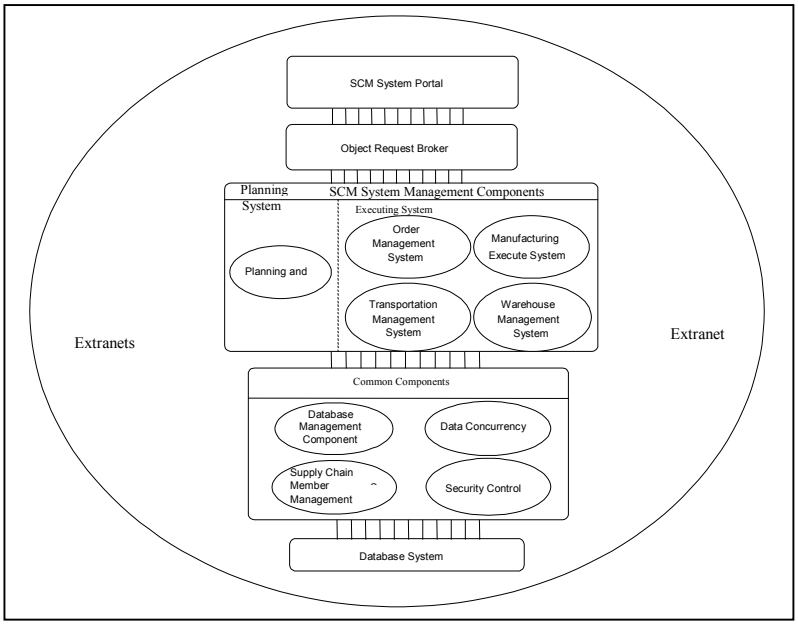

Fig. 4

5.1 Portal System

Portal system includes two components, “Outer Information Access” and “Inner Information Access”. Follows are details of the two components.

(1) Outer Information Access

This part, the object model shown in Fig. 5, is to receive or retrieve data out of the supply chain system. So there must be three primary function of this component, and they are:

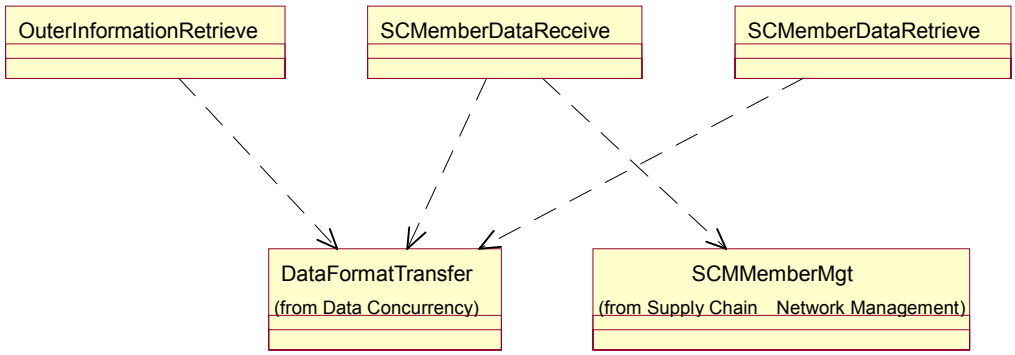

Fig. 5

1) Outer Information Retrieve: to retrieve data out of the supply chain network, these data might be the market information or other competitor’s information. The supply chain members could refer these kinds of information.
2) Supply Chain Member Data Receive: to receive data from members of supply chain network. These members could be suppliers or customers, even end users. Using these kinds of information, the firm can make their production planning, capacity planning and other management requirements.
3) Supply Chain Member Data Retrieve: to retrieve data from supply chain members actively, not passive like supply chain member data receive. This is because sometimes some future information that the suppliers or customers do not send to the company. But the company could get the information early to help to make better management processes.

(2) Inner Information Access

This part, the object model shown in Fig. 6, is to provide the members of supply chain network to access the information of this system. Three components will be included in this part.

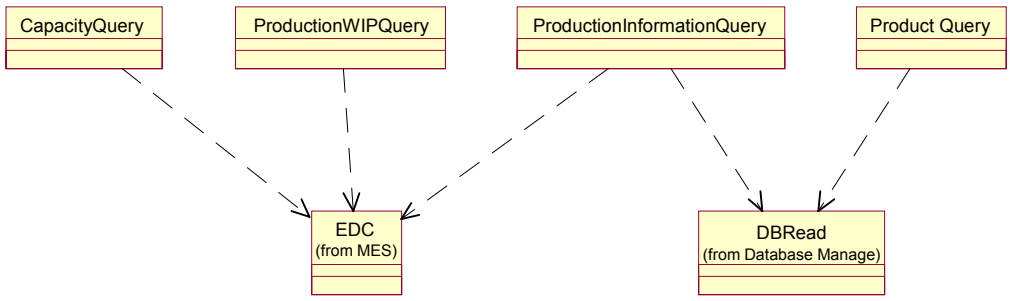

Fig. 6

1) Product Query: When customers want to know how about the product catalog or product specification information, etc. they would have to use this component to get the production information.
2) Production Information Query: The supplier or the customer can get the production planning and control or other associated with the production information. Using these information supplier and customer can make the production planning more compatible with their business partner.
3) Capacity Query: This is to get the company’s capacity planning. By this information, the supplier could determine whether to send the order to the company.
4) WIP status Query: The customer could use this to get the manufactured production information. These data could help the customers to predetermine their production-planning schedule or other production

related management process.

5.2 SCM Components

This is the core part of supply chain system. The whole business processes are modeled in the SCM components. From the framework of supply chain management, there are five components are described here, and these five components can also be separated two pars. One is planning system; include advanced planning and scheduling system. Another is executing system; include order management system, manufacturing execution system, warehouse management system, and transportation management system

(1) Advanced Planning and Scheduling (APS)

APS, the object model shown in Fig. 7, forecasts demand at various points in the supply chain. Managers can plan for inventory, equipment, and personnel needed to process future order. So we could find out APS could interact with the all execution systems. APS also have to request or receive data from outer information access, and have to be accessed by inner information access.

APS have two main classes capacity planning and production planning.

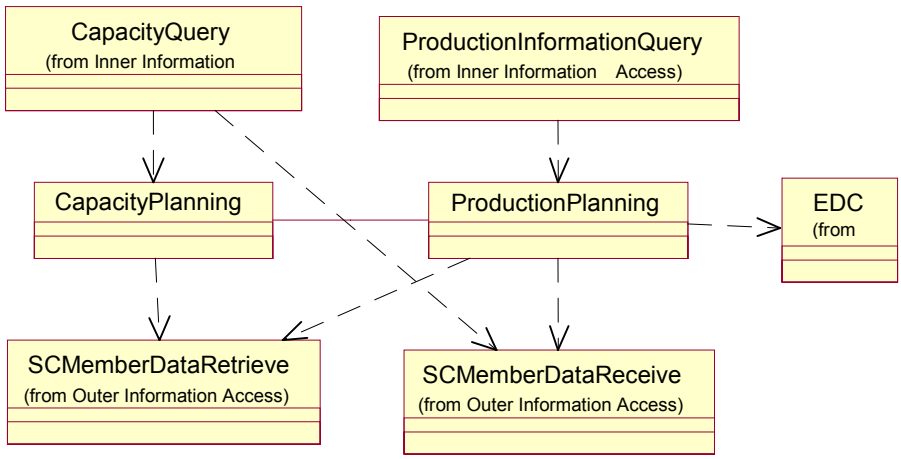

Fig. 7

Capacity Planning: Capacity planning is finite capacity constraint. And the finite constraint directly influences the production planning. It also could be query by the inner information query to be accessed by other company to get the capacity planning information. Besides, APS could get information from supply chain member. According to these data it could make the capacity more detailed and precise.

Production Planning: Production planning get capacity planning data from Capacity Planning, and get the WIP status in the factory and other information like raw material status from the supplier or the order due date from customer. Therefore, production planning has to request data from outer information receive and retrieve. Also, it has to request data from MES system. Gathering these kinds of information, then it could make the production plan and schedule.

(2) Manufacturing Execution System (MES)

MES, the object model shown in Fig. 8, is to control the manufacturing process and monitor the factory status, in order to be referenced by the capacity and production planning. MES contains five main classes, and they are dispatching, electronic data collection (EDC), material management, tracking, and processing control.

1) Dispatching: When product flow will be entered into a station and the product might wait in queue, dispatching will dispatch all the products in queue by some product properties.
2) Tracking: When a product is worked in a station, before the product into the station, we could record the track in time. After it is worked over, record the track out time.
3) Material Management: To management the resource of manufacturing, including the status of raw material, and semi-manufactured goods. This data is provided for Dispatching and EDC and is received from tracking system.
4) EDC: This class is to record status of all objects in factory. These data could provide Production Planning to plan the production schedule.

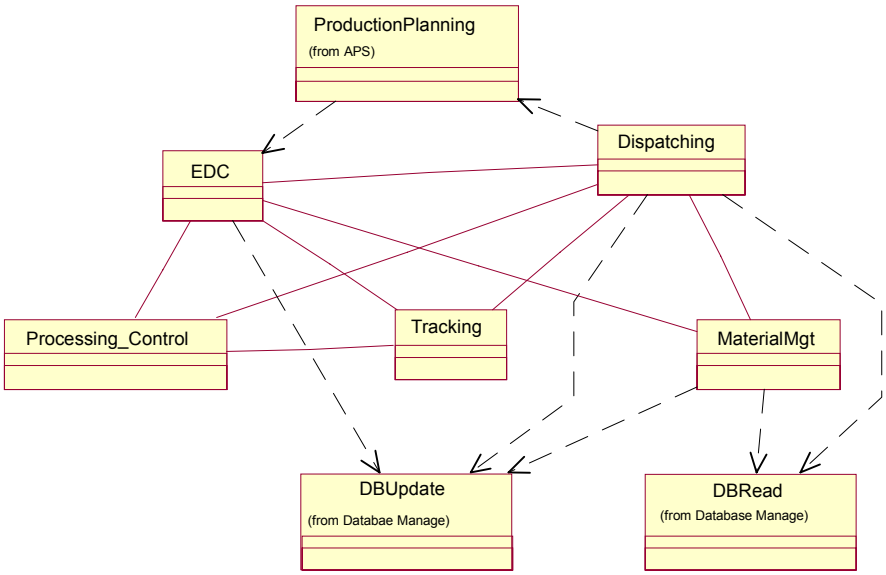

Fig. 8

5.3 Common Components

This part consists of four components, which are Database Management, Data Concurrency, Supply Chain Network Management, and Security Control. The relationships among those components are shown in Fig. 9. These components provide an infrastructure for the SCM system, and make the supply chain members use system in a consistent, solid, and security way.

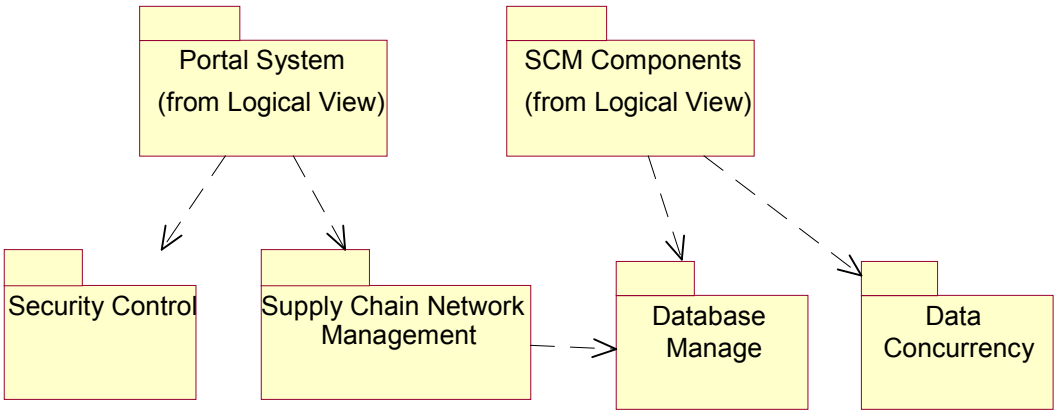

Fig. 9

(1) Security Control

This component confirms the security of transferring data of supply chain network or external access to other system. Therefore, when portal system accesses the internal data, the portal system has to request the security control to ensure the data access is safety.

(2) Data Concurrency

This component provides the ability to transform multipurpose data format to the unified format of the supply chain management system. In order to provide concurrent data for every firm which use these data to communicate with each other.

(3) Supply Chain Network Management

The members and relationship of the supply chain network construct the structure of the supply chain. This structure is the view of the supply chain, and maintains the relationship of members. So, this component is the

management of this structure and the members of supply chain network.

(4) Database Management

When messages are transferred among members of the supply chain network, users and the SCM system, the data will be accessed (read, insert, or update) by the Database Management. So this component is the interface between the SCM system and other components to access the database.

6. Summary

Further, we propose an architecture of supply chain management. Through this architecture we could view relationships of components of supply chain management system. This is the first step for building the supply chain management system. This architecture gets the whole functionality of supply chain management. The basic concept of this architecture hopes to make the system flexible enough to connect with other system, and transform data automatically.

7. Reference

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