Supply Chain Simulation: Collaborative Design System based on SOA - A Case Study in Logistics Industry -

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***Abstract*—**The paper proposes a new concept in developing collaborative design system. The concept framework involves applying simulation of supply chain management to collaborative design called – '*SCM–Based Design Tool*'. The system is aimed to increase design productivity and creativity. Therefore, user can collaborate by the system since conceptual design. *SCG: Supply Chain Generator* based on service-oriented architecture. It helps you make sure that every dollar invested in IT, every resource allocated and every application in development or production meets your business goals. Unlike software offerings and methodologies that focus on internal IT processes, SCM optimizes the strategic functions between technology and business. Moreover, the proposed system can support users as decision tool and data propagation. Data management and sharing information are visually supported to designers and customers via webservice interface. The system is developed on Web–assisted product development environment. The prototype system is presented for Logistics industry system prototype demonstration, but applicable for other industry.

***Keywords*—**Collaborative design, SOA, logistics, supply chain management.

I. Introduction

THE service-oriented architecture (SOA) approach has attracted the interest of companies worldwide because it is the most promising technology strategy for meeting the business imperative to increase agility while lowering total operating costs. Business and IT executives at many companies are focused on SOA because they realize there is a monumental mismatch between their current competitive and market pressures and the ability of their existing software and systems to deliver improved bottom-line results. In today's hyper-competitive global business environment, companies have to sense and respond to demand "real-time" across a network of customers, suppliers and their own employees while managing the risks associated with compliance requirements. In most companies, the installed software is incapable of supporting the fast and easy communications across the enterprise and value chain that business needs dictate.

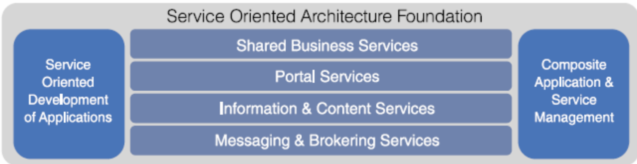

Fig. 1 Service-Oriented Architecture Foundation

Supply Chain Management (SCM) was designed to offer more effective methodologies for various logistics industries and businesses. SCM is a collaborative effort that provide more holistic supply chain management services to clients from supply chain consulting, good packing loading, through to the delivery of integrated logistics services such as warehousing, freight forwarding and transportation. All these are integrated through cutting edge technology applications and the management of the information supply chain or electronic transfer of information, either via the EDI, API, web services and so on. The availability of information on a more timely basis provides for better planning and decision making, thereby enhancing supply chain efficiency.

Therefore, the goal of this research is with service-oriented architecture (SOA) to analyze and identify the fundamental elements or objects that are necessary for modeling supply chain framework used in collaborative design and manufacturing. The resulting analyses is to develop a SCM-based design tool integrated with an intelligence design system using in collaborative design and manufacturing to support increase efficiency in logistics management.

II. Review

A. Supply Chain Management

Several definitions of supply chain and SCM are presented by researchers and practitioners from various points of views. This paper summarizes here in the general concept of them, which can be applied to work in collaborative design and manufacturing.

Supply chain is a network of enterprises linking flows since raw material supply to final products and interacting to deliver/distribute products or services to end customers. A streamlined SCM is the network of facilities and distribution options to support an association of vendors, suppliers, manufacturers, distributors, retailers, and other trading partners. Effective management of supply chain systems can be achieved by identifying customer service requirements, determining inventory placement and levels, and creating effective policies and procedures for the coordination of supply chain activities. The coordination of logistics functions into the integrated supply chain systems has increased the need for improving the process quality. Improving the quality of all supply chain processes results in reduced utilization, and improved process efficiency.

Enterprise Resource Planning (ERP) is technologically said to be the backbone of SCM, because they both rely on very similar framework, such as intranet, extranet and electronic data interchange.

The web-based part library used in collaborative design, concurrent engineering, virtual enterprise and supply chain management system is developed. The part library is integrated into SCM systems to share part/product data and information among enterprises. Thus it is necessary to develop system under standard data and systems.

A generic methodology to design production-distribution network of divergent process industry companies in multinational context is presented. In this research, a mathematical programming model for mapping the industry manufacturing process onto potential production-distribution facility locations and capacity options is developed. A directed multi-graph of production and storage activities is applied to represent the industrial process. Associating One-to-many recipes to production activities is to model the divergent nature of the process. The divergent nature of the process is modeled by associating one-to-many recipes to each of its production activities. The manufacturing process is mapped onto the potential network nodes is shown Fig. 2.

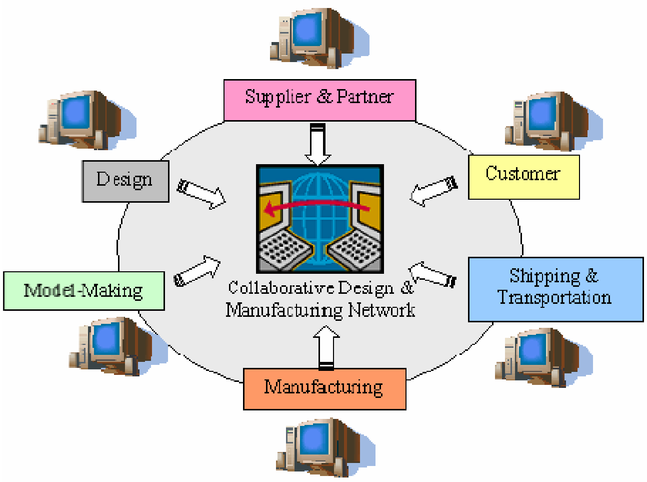

Fig. 2 Web-based integration for collaborative design & extended enterprise network space

B. Electronic Data Interchange (EDI)

An inter company, application-to-application communication of data in standard format for business transactions, Electronic Data Interchange (EDI) is a set of standards for structuring information that is to be electronically exchanged between and within businesses, organizations, government entities and other groups. The standards describe structures that emulate documents, for example purchase orders to automate purchasing. The term EDI is also used to refer to the implementation and operation of systems and processes for creating, transmitting, and receiving EDI documents. So EDI have interface provide partner for data intercommunion shown Fig. 3.

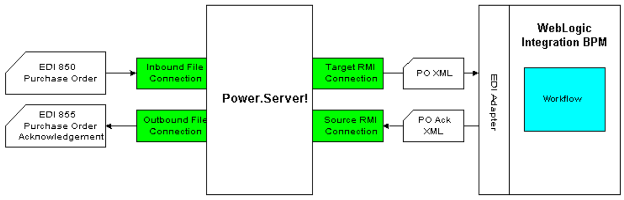

Fig. 3 EDI transact Processing

C. Service Data Objects (SDO)

Service Data Objects (SDO) is a new concept that helps enable an SOA by simplifying data transfer between a wide variety of service and resource types (such as an ERP system and a relational database). SDO provides loose coupling via disconnected data graphs that allow data browsing and updates while the application is disconnected from the data source (see Fig. 4). Using the disconnected data graphs architecture, a client retrieves a data graph from a data source, makes changes to the data graph, and can then apply the data graph changes back to the data source utilizing a Data Mediator Service (DMS). The data graphs can be dynamically created from just about any data source, including XML files, Enterprise Java Beans (EJBs), XML databases and relational databases—or from Web services, Java Connector Architecture resource adapters and Java Message Service packages.

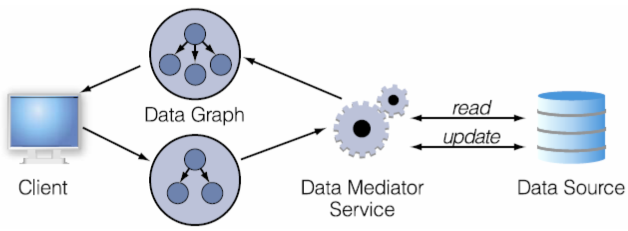

Fig. 4 Service Data Objects architecture

The Service Data Objects framework provides a unified framework for data application development. With SDO, you do not need to be familiar with a technology-specific API in order to access and utilize data. You need to know only one API, the SDO API, which lets you work with data from multiple data sources, including relational databases, entity EJB components, XML pages, Web services, the Java Connector Architecture, JavaServer Pages pages, and more.

Unlike some of the other data integration models, SDO doesn't stop at data abstraction. The SDO framework also incorporates a good number of J2EE patterns and best practices, making it easy to incorporate proven architecture and designs into your applications. For example, the majority of Web applications today are not (and cannot) be connected to backend systems 100 percent of the time; so SDO supports a disconnected programming model. Likewise, today's applications tend to be remarkably complex, comprising many layers of concern. How will data be stored? Sent? Presented to end users in a GUI framework? The SDO programming model prescribes patterns of usage that allow clean separation of each of these concerns.

Data objects are the fundamental components of SDO. In fact, they are the service data objects found in the name of the specification itself. Data objects are the SDO representation of structured data. Data objects are generic and provide a common view of structured data built by a DMS. While a JDBC DMS, for instance, needs to know about the persistence technology (for example, relational databases) and how to configure and access it, SDO clients need not know anything about it. Data objects hold their "data" in properties (more on properties in a moment). Data objects provide convenience creation and deletion methods (createDataObject() with various signatures and delete()) and reflective methods to get their types (instance class, name, properties, and namespaces). Data objects are linked together and contained in data graphs.

III. Solution

A. System Architecture: Overview

The main objective of this research is to develop a robust supply chain management system, which results the efficient, easy to maintain and reliable application. Therefore, the approach to construct the collaborative design and manufacturing network is based on Service-Oriented Architecture (SOA).

The system is created based on Web platform to support communications, collaborations and sharing data/information among users in the supply chain. The activities within the framework are viewed as dynamic actions that make up as a dynamic system.

Data repository is accessed and utilized by inside and outside clients. The data flow at work is dynamic to fulfill decision making and to propagate to the requests. The Web based tool provides secure, reliability and easy-to-access, and multiple access methods.

B. Service-Orientation Architecture

The traditional three tiers (presentation, business logic, data) were enriched by service-orientation through the introduction of a service layer and a business model layer, both of which resided within the business logic layer. Moreover, the overall data tier was enhanced by the separation of the data access layer from the data store layer. The layers are depicted in Fig. 5 along with the techniques and technologies used for their implementation.

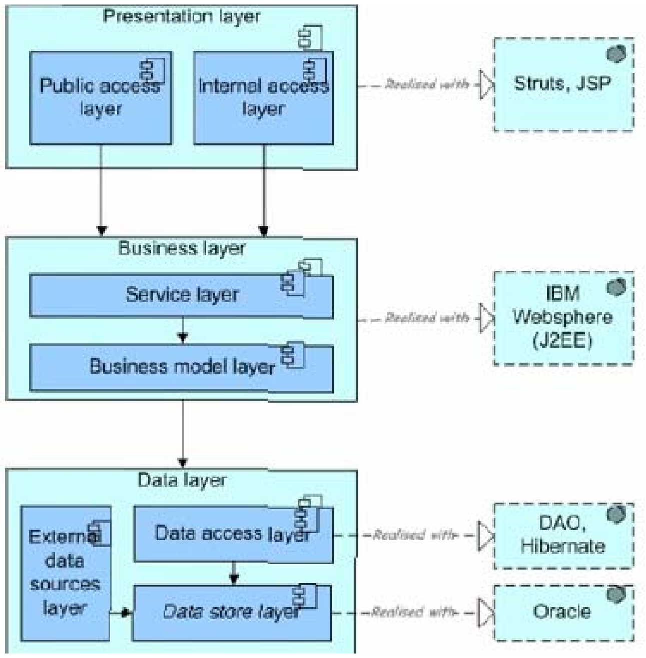

Fig. 5 The layered architecture of SCM

In accordance with the layered architecture principle, the business layer is only accessible through the presentation layer. This enables the screen designs to be independent of the business logic. The business model layer is in turn accessible only through the service layer. Services are functions that are meaningful to the business. Services do not execute these functions themselves, they are just a shell or facade, behind which the real function is executed by the business model layer.

C. Decomposing the Interaction Model

Whereas visibility introduces the possibilities for matching needs to capabilities (and vice versa), interaction is the act of actually using a capability via the service. Typically mediated by the exchange of messages, an interaction proceeds through a series of information exchanges and invoked actions. There are many facets of interaction; but they are all grounded in a particular execution context – the set of technical and business elements that form a path between those with needs and those with capabilities. Architects building Rich Internet Applications (RIAs), are faced with special considerations when designing their systems from this perspective. The concept of “Mashups” surrounds a model whereby a single client RIA may actually provide a view composed by binding data from multiple sources persisting in multiple domains across many tiers.

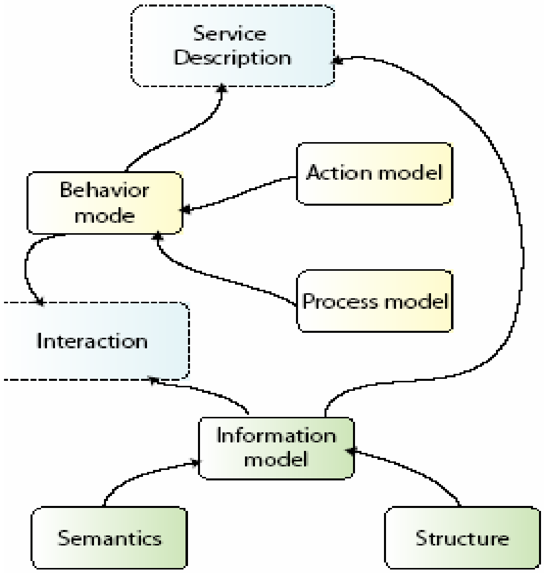

Fig. 6 Interaction model

As depicted in Fig. 6, the interaction model can be further decomposed into a data model and behavior model. The data model is present in all service instances. Even if the value is “null”, the service is still deemed to have a data model. The data models are strongly linked to the behavior models. For example, in a Request-Response behavior model, the corresponding data model would have two components – the input (service Request) data model and the output (service Response) data model. Data models may be further specialized to match the behavior model if it is other than “Request-Response”.

The behavior model is decomposable into the action model and the process model. The sequence of messages flowing into and out of the service is captured in the action model while the service’s processing of those signals is captured in the processing model. The processing model is potentially confusing as some aspects of it may remain invisible to external entities and its inner working known only to the service provider.

IV. Conclusion and Future Works

Service-orientation is a distinct construction method. Therefore, the concepts behind SOA can be applied to just one system, particularly when this system needs to share functionality with other systems or presentation layers. Service-orientation follows component-based design as the next generation of distributing computing. Services can be positioned to provide a shell or facade that is meaningful to the business, while abstracting technical components and implementation details. Applying service orientation can help organizations attain the flexibility and agility they require, as was proven in the case of Logistics industry.

In this research, SCM play the key role to link stages in the entire process including customers and suppliers. The prototype is developed based on Object-Oriented Modeling by using the Unified Modeling Language. The primary entities required for supply chain simulations is represented via UML use case diagrams and sequence diagram for illustrating relationships and interactions among these entities and for describing the flow of activities in the entire process. The results indicate that the framework can easily model the simple circumstances. This simple scenario can be easily expanded to include multiple products and multi echelons. SCM: Supply Chain Management based on ES and EDI is integrated into the SCM-based design tool for supporting the design activities. The proposed system can reduce processing time in transportation and manufacturing. This SCM based design tool then can be viewed as one of the solvers in the design bottleneck.

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