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Winter 12-5-2004

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# Research on Multi-Agent Based Information Management Platform for Enterprise Business Cooperation

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## ABSTRACT

The Enterprise Business Cooperation Mode is analyzed, as a result, an multi-agent based business cooperation framework is presented. The agent configuration in the framework is explained respectively, and a case of business process reengineering with multi-agent is discussed to prove the feasibility of the framework.

**Key words:** business cooperation; information integration; multi-agent technique; business process reengineering

## 1. INTRODUCTION

Looking back to the operation process of the well-known enterprises at home and abroad, it's easy to get a thought of enterprise' development in the future: internet provides more choice to the customer, customer's loyalty decides enterprise' survival and development in the age of internet economy, the enterprises will be sure to turn to pursuing the maximum of customer's satisfaction from simply pursuing the maximum of profit. In order to fulfill this goal, manufacture enterprise should make order-form-centered strategic cooperation with supplier, realizing interactivity, equity, win-win. Its core is to realize business cooperation including the information sharing and business cooperation of all the enterprises in the supply chain.

With the development of manufacturing industry mode and information technique especially, the enterprises are faced with a great amount of different distributing information resource. However, in the customer-oriented, rapidly changing and vehemently competitive market at present, enterprise's surviving room is tending to a state of "upper-flow" and "chaos"<sup>[1]</sup>. The information system in Enterprise Business Cooperation Mode presents a characteristic of intermixing huge system. Traditional calculation mode can't deal with the complicated tasks in function and in structure. The appearance of CSCW (computer supported cooperative work) provides a better method to solve the problem, while Agent and MAS (multi-agent system) is the base of CSCW. Starting with analyzing the technique means, management notion and method adopted in enterprise's operation, business cooperation mode is discussed in aspect of system engineering, and combined with the Agent theory, an integrated framework suitable for business cooperation mode is constructed, providing a new approach for the study on Enterprise Integration System.

## 2. ANALYSIS OF ENTERPRISES' OPERATION ENVOROMENT

The worldwide market economy is rapidly developing

and the competition among enterprises is becoming more and more vehement. Traditional manufacturing industry including process enterprise operation mode has changed ultimately, from traditionally long-time, orderly manufacturing in manufacture plan organization to contemporarily short-time, random manufacturing in order contract organization; from traditionally manufacturing characterized in large volume, single type, normative to contemporarily manufacturing in small volume, various types, non-normative, from traditionally emphasizing on guaranteeing the carrying out of the manufacture techniques during the manufacture operation control to contemporary gaining the maximum economic benefit under the condition that the manufacture resources such as the material ,energy, human resource, capital and storage are limited. Therefore, many research organizations and scholars at home and abroad are studying in the field of E-commerce supply chain. Some advanced enterprises are trying to optimize the product's design and manufacture by using PDM(Product Dada Management) and CPC (Cooperative Product Commerce) , reduce the internal cost by using ERP (Enterprise Resource Planning) , improve the whole supply chain's efficiency by using SCM(Supply Chain Management) , broaden the market and confirm the customer's loyalty by using CRM(Customer Relationship Management) , and operate from electron purchasing to solving problems in supply chain.

With the further studying of information technique and E-Business, the emphasis of supply chain's construction has been transferred from simply stressing on exchange to the whole transfer of business body (enterprise) and business activities in the network environment. To those enterprises that have adopted business cooperation mode, the application of "cooperation-trade" will bring the return of income and profit. The development of "cooperation-trade" will bring up highly agile dummy enterprises and bring change to some business models, such as material, the design and manufacture of products<sup>[2]</sup>.

### 3. ENTERPRISES BUSINESS COOPERATION MODE

#### 3.1 The Thought of Business Cooperation Mode

Business cooperation means not only the internal departments of the enterprise but also the associates including supplier, distributor, retailer and customers should be tied closely to exploit and meet the market's demand together, forming enterprise's dynamic union and cooperation. With unified plan and unified data mode, all the supply chain node enterprises make the product's cooperatively exploiting and material's cooperatively purchase, manufacture, distribution and delivery under the operation of unified plan. In a word, the cooperation among enterprises can be defined in three layers, one lies on operation layer, such as the purchase, promotion and order, etc, the second one lies on tactics layer, including the task-base forepart cooperation that work flow's upper-flow and down-flow enterprises make, and the third lies on strategic layer, that is, tight cooperation that work flow's upper and down. Enterprises start on phase of seeking for task. Enterprises involved the cooperation try their best to take advantage of the combination to form strong competition in addition to making use of their own advantage.

As a new subject, "cooperation" has been widely used as a crossing subject to study the common essential characteristics among different things. The notion of cooperation can be explained by simple mathematic symbols. The combination of any kind of product and market will have influence on enterprise's whole profit level. Suppose the price of some product is  $¥S$ , the expense on manpower, material, management and so on is  $¥O$ , and the investment on research and development, tools, workshop, inventory and etc. is  $¥I$ . The investment income per year on  $P_1$  can be expressed as follows:

$$ROI = \frac{S_1}{O_1 - I_1} \quad (1)$$

As to other products  $P_2, P_3, \dots, P_n$ , the same expression can be got. If there's no relativity among products, the income of enterprise can be expressed as follows:

$$S_T = S_1 + S_2 + \dots + S_n \quad (2)$$

The whole operation cost and investment can be expressed as follows.

$$O_T = O_1 + O_2 + \dots + O_n \quad (3)$$

$$I_T = I_1 + I_2 + \dots + I_n \quad (4)$$

Therefore, the whole investment efficiency of enterprise is,

$$(ROI)_T = \frac{S_T - O_T}{I_T} \quad (5)$$

As long as the income, operation cost and investment of different products are irrelevant, all of the above relations will exist<sup>[3]</sup>. Most enterprises have scale benefit. To a big company whose income is equal to the sum of

several small enterprises, its operation cost may be less than the sum of the small enterprises', or its total investment is less than the sum of theirs, which can be expressed as follows:

$$S_S = S_T; S_S \leq S_T; I_S \leq I_T; \quad (6)$$

In which, index  $s$  represents an enterprise, index  $t$  represents the aggregation of several single small enterprises. Therefore, when the income is equal, the investment income of the company is higher than that of the aggregation of several single small enterprises, that is:

$$(ROI)_S > (ROI)_T \quad (7)$$

When the total investment amount is equal, we can get the similar conclusion:

$$S_S \geq S_T; O_S \geq O_T; I_S = I_T \quad (8)$$

So we can know, manufacturing cooperatively can create higher income and/or lower operation cost. Taking advantage of cooperation can achieve all kinds of operating goal. If an enterprise has the ability to make use of the combination of products and market to increase the cooperation effect, the competition means offered will be very amplitude.

#### 3.2 The Signification of Information Management Platform for Enterprise Business Cooperation

The information management platform for enterprises business cooperation integrates all the application and data into one platform, and supply the unitary user interface, which make enterprises build the information platform quickly between business to business, and business to its own employees. This platform is a comprehensive implementation mode of electronic business, and also a web based application system, which makes enterprises delivers all kinds of information stored inside or outside to employee, customer, suppliers and the firm comates, as a result, the information accessed by them is customization. The characteristics of the information platform can be summarized as the following, using unitary information access canal form which user can access their need information in order to optimize business operation and heighten productivity of company; using uninterrupted services through network and secure mechanism to make user access information anywhere and anytime; using strong content management capability to support almost all structure and non-structure data, identify the data from variant of data bases and collect and dispose all kinds of document; using individuation application services to set and supply the customization data and application such as enterprises portal in order to heighten the working efficiency of employee, intensify the affinity and attractive force; using integration with existing system to make the existing data and application be integrated together; using strong expansibility to adapt to new readjustment and change of enterprises, so to meet the need of business readjustment and expanding; using infallible and secure indemnity to guarantee the privacy and integrity of data; using collaboration and share to make user access and supply information for special

organization including individual.

### 3.3 Construct the Framework of Business Cooperation Model based on MAS technique

With introduction of mutual communication, distributed self-government agent, advanced enterprises cooperation business can be regarded as a heterogeneous multi-agent system which integrates all kinds of manufacturing action such as order, design, manufacturing and marketing together. This heterogeneous multi-agent is a polyphyletic cooperative system, in which each agent

team works for the same aims. We build the interactive enterprises cooperative business information management platform using object-oriented methods and MAS technology of artificial intelligence (see figure 1). From view of function realization, Agent is classified into two kinds, transaction agent and intra agent, the former take charge of information and communication between the key company in enterprises cooperative supply chain and the other node companies, while the latter is responsible for the information interflow and data commutation of different department within a enterprise.

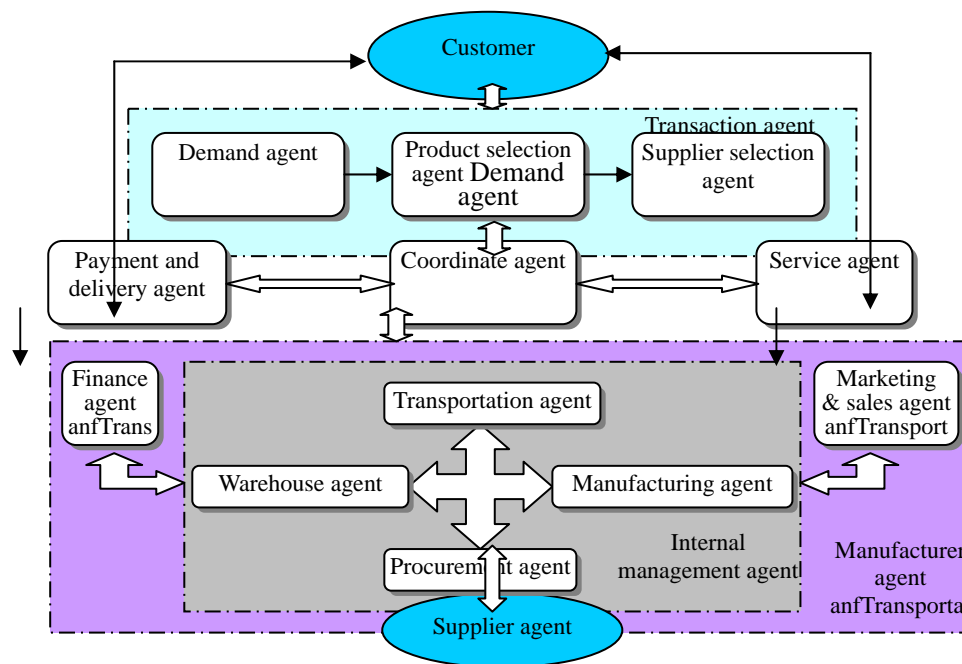


Fig.1 Enterprises business cooperative information management platform

## 4. CSASE STUDY

### 4.1 Design and implementation of MAS

Agent has the ability of manipulating multi-dimension information real time, impacting and communicating each other, which adapts to requirement of manipulation real time and concurrent for software development. On the other hand, development of internet technique make it possible for each agent unite to resolve problem cooperatively by teamwork in internet, with space distributed intelligence, information and technical resource. An integrated agent unite includes information model, resource model, organization model and cooperation model. Agents between upper layer and subordinate layer coordinate besides those in same layer. I.e., the original equal relationship is combined with the upper layer and subordinate layer relationship to form hierarchical relationship. The whole agents comprise an association in which agents are divided into several programmer teams according to task scope of agent. In a programmer team, agent is divided into three types

including management agent, function agent and service agent. The three type of agent lies in deferent layer and forms an agent tree, in which type and hierarchical relationship defines the status and power of the agent. Management and function agent comprise the key layer of programmer team, and all the agent association comprise the forest showed in figure2.

At different stage of design and development including view building and process flow model building, and agent model design and information support flat building of implementation stage, different modeling tool system and information integration techniques is needed. At requirement analysis stage there are all kinds of modeling tool software for function view and information view developed by IDEF0 and IDEF1 standard<sup>[4]</sup>, e.g., CASE and ARIS At design stage object modeling tool based on agent can be adopted such as ABE of IBM Co. Ltd. At implementation stage practical execution system is built in light of process flow model, the key to which is designing and packaging agent, building the information integrated flat for the object and

agents.

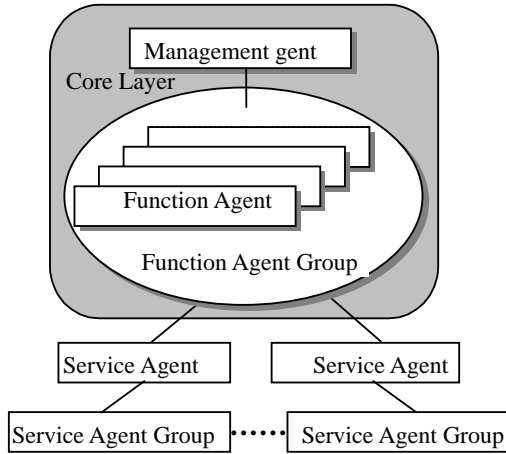


Fig. 2 Programmer organization model based on multi-agents

For the aim of inter-manipulation, multi-agent system needs support of standard and operation system. One is KQML standard, a language and protocol for exchanging information and knowledge. It supports the information share among agents as a language standard and information management protocol; meanwhile it is used as an interface among multi-agent system for resolving protocol problem as application programming language. Another is CORBA standard, provides service from abstract distributed object model and coincidence depiction of language, shields isomer of operation flats and data resource, to make different application transplant and manipulate each other. The third is COM/DCOM standard, a binary unit model defined for inter-manipulation of units, is a basement unit model which is irrespective of programming language and suitable for application and system development of units.

**4.2. Application in sales workflow of cooperative business information platform**

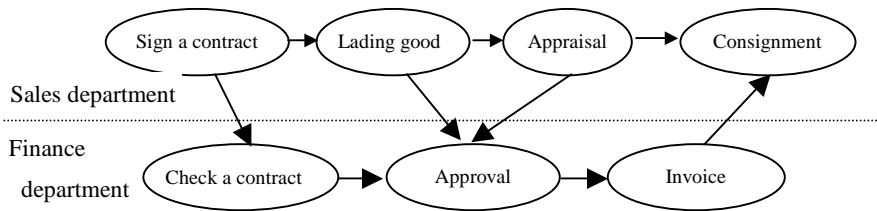


Fig.3 Sales and consignment process of a company

**5. CONCLUSION**

Today in the world, the enterprise is up against new challenging from the tendency of economy globalization and the enterprises development idea of centering on customer service. It is seems very necessary and important for corporations to reengineering the business process, integrated the forthcoming application, data and

The process flow modeling based on Agent expresses all the process flow activities and their relations by Agent model. Agent's characteristics of autonomy, agility, interaction and cooperation facility enterprise to restructure and reengineer the manufacture and operating process and to combine tightly with the information supporting flat during the implementation. The topological structure and incidence relation of agent Network in the Cooperation Layer are the reflection of the model of enterprise business disposal process. Every agent in cooperation layer corresponds coarse grain business disposal process in real life and has certain stability and atomicity. According to the value chain transitive theory, there is some un-value added action in figure 3. Suppose each business disposal spot corresponds to an agent in cooperation layer, in order to support business dynamic adjustment, every knowledge base of business disposal agent should include the knowledge on dynamic business disposal. For instance, if the following rules are added to the knowledge base of consignment agent, the consignment flow can be decides according to the priority of the contract.

```

If contract data agent.priority (contract number)>xx
then
consignment agent.consignment (bill of lading number)
else
If invoice agent.completion (contract number) =Ture
then consignment agent.consignment (bill of lading
number) else consignment agent.hanging
End if
End if
    
```

Every agent has the unitive expression about its own information and the interface information of the related agent (which composes the topological structure of agent network and reflects the enterprise business model), invoke of methods between different agents can be fulfilled naturally and conveniently, as a result, it can support the dynamic enterprise model strongly.

frames, to achieve the business cooperation by dependent on information technology, especially by network technique. This paper builds the enterprise integrated system model by means of multi-agent technique belonging to knowledge engineering. This model has high flexibility, distribution, concurrent, self-compatibility, and self-corroborate ability. As a result, such agent will have a direct effect on improving

the performance of enterprises integrated flexibility.

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