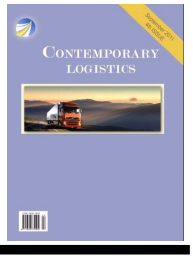
Contemporary Logistics 04 (2011) 1838-739X

Contents lists available at SEI

Contemporary Logistics

journal homepage: www.seiofbluemountain.com



Research on Intelligent Management Model in Distribution Service System: Based on Collaboration FPS Management

Qingmin Zhang*

School of Management Science& Engineering, Nanjing University of Finance& Economics, Nanjing 210046, China

KEYWORDS

Multi-agent,
Semantic web services,
Forecasting-planning-scheduling

ABSTRACT

To improve information management development, an intelligent operation management framework was presented in the distribution service system. An operation model of forecasting-planning-scheduling (FPS) was designed using Multi-agent and semantic web services, and the model compared with CPFR. A configuration model was composed of application layer, Agent constructing layer, semantic web services layer and data layer. An operational framework was established with Agent controlling modeling, simulation optimization model and software development. The cooperative management effectiveness was demonstrated by the optimization models based on Multi-Agent.

1 Introduction

Due to the distribution service system has the character of a multi-echelon and interactive features, therefore, many methods of solving cooperation operational problems were proposed recently, such as vendor managed inventory (VMI), quick response (QR), and collaborative planning, forecasting and replenishment (CPFR). Through the methods described the collaborative management concept from different aspects, the lag and distortion phenomena were still existed in the distribution / supply chain's logistics flow, information flow and capital flow, resulting in it was difficult to make a timely decision to the core business. CPFR as the collaborative management software provides software support for the supply chain management, but has been not designed from the view of web service, operation optimization, intelligent collaborative design and development, resulting in the management process need many managers involvement, the more complex workflow, the heavier workload. Therefore, this article discusses how to establish an intelligent operation management model of the Forecasting-Planning-Scheduling (FPS) in the distribution service system from the intelligence information and software components perspective based on CPFR. The model will be helpful to offer new thinking for the distribution service system management, and improve the overall operation efficiency in distribution services system. In this study, scholars have introduced Agent, web services and semantic web services theory, CPFR model was built by two types of Multi-Agent (MA) and simulated, but was not been taken into the semantic web services and web services issues [1,2]. A SSCIOBP was built and evaluated to enhance CPFR standard mode using semantic web services [3]. Currently, it has been needed to combine Agent and semantic web services to study CPFR, some scholars have already studied the intelligent manufacturing operations management model combining Agent and web services technology. The manufacturing control systems, design framework and

* Corresponding author.
Email: zqm1204@126.com

DOI:10.5503/J.CL.2011.04.020

manufacture model was discussed using Agent and web services and so on [4,5]. Since web services provide only a keyword-based search query matches or framework for human-computer interaction methods, precision and recall rate is not high and can not meet the Agent and other types of interaction of heterogeneous systems in the semantic layer, so it needs to study that combining the Agent and semantic web services making the Agent has a certain semantic processing to solve a more complex problem. Therefore, based on CPFR concept, the article builds the intelligent collaborative operation system of FPS to understand and deal with the Agent automatically using MA and the semantic web services in distribution service system.

2 Compared CPRF with IOMFPS

To achieve the intelligent management of manufacturing and services industries, CPFR is compared with the operations management model based on the MA and the semantic web service to improve operational management level and service level, as much as possible use the computer instead of people working to free the heavy labor. In the intelligent system, Agent can decide automatically and does not require managers' intervention to perceive the external environment. Semantic web services can achieve the automatic discovery, invocation, composition, execution and monitoring, and realize the web services' semantic annotating. As a result, it becomes a software entity of the computer-readable, Agent to handle and transparent to the user.

Based on management thinking of CPFR, and operations management of the traditional FPS, a new operation and management mode is proposed using MA and semantic web services, which is called intelligent FPS operations management, and abbreviated intelligence operation management for FPS (IOMFPS). IOMFPS is composed of management Agents, forecasting Agents, planning Agents, scheduling Agents, cooperation Agents and ontology Agents. Each Agent has different features. Management Agents take charge the internal management system which coordinates information communication and access registration between the Agent and managers through knowledge exchange. Forecast Agents take charge interaction and communication tasks; planning Agents adjustment results of forecast Agents according to the demand fluctuations or internal punishment incentives, and finish generation of planning, coordinating and summing orders; Scheduling Agents take on the orders scheduling and replenishment; Cooperation Agents implement coordination, collaboration and consultation mechanisms to resolve the conflict through the contract net, bidder and auction contracts and optimization theory; Ontology Agents is responsible for data analysis and extraction to achieve information sharing in the systems, reduce ambiguity and terminological ambiguity using of ontology learning functions, then provide a unified information framework.

Based on the existing information system, IOMFPS achieves business process integration in accordance with the collaborative operation, translates the heterogeneous system and database data into a web application program which is used easily through the intelligent technology, as a result, realizing the transformation of management information system (MIS) to management intelligence system (MIS). Based on this idea, CPFR and IOMFPS are compared, as shown in table 1. Table 1 shows the same point and different points of CPFR and IOMFPS. The same points are analysed from the purpose of information sharing, coordination, consultation and collaboration, the joint prediction scheme, planning and scheduling aspects. At the same time, the different points are compared from the intelligence point, management participation, joint forecasting, planning, scheduling and rescheduling aspects, et al.

Table 1 Comparison of CPFR and IOMFPS

		CPFR	IOMFPS
The same point	Propose	Through the joint prediction, planning and replenishment (scheduling), ultimately improving distribution / supply chain management efficiency, reducing inventory, improving the consumer satisfactory degree.	
	Information shaing	They need use the iInternet and information software (ERP, CPFR) to obtain the company inside information, including stock information, shortage, sales, unit cost, market demand.	
	Coordination and cooperation and consultation	When the multilayer company faces the market, the company is facing its own interests and the interests inconsistent phenomenon in the whole chain, so cooperation can improve the whole efficiency. When existing the conflict, consultation or negotiation can exchange information and data.	
	Joint prediction program	uncertain market demand forecast is all need the existing prediction, optimization method.	
	Planning and scheduling	Need to consider each company exists the constraint conditions when planning and replenishment. In the constraint , how to maximize the meet the market needs.	
Different points	The intelligent degree		Using Multi-Agent to establish the collaborative FPS function is operated by the management model with reactively and intelligent.
	Participate	Many collaboration is completed through interaction, negotiations via various managers, which is larger workload, more trifles phenomenon, slow real-time corresponding.	In the intelligent system, most collaborative problem is completed by MAS itself, when it only requires managers to participate to trigger the action.
	Joint forecasting	The joint forecasting problem exists two layer companies, the predictive order quantity distribution is determined according to POS data and programs.	Due to the joint forecasting is mainly directed against the market demand change, so the collaborative forecasting problems are considered by the multi game under the condition of from the entire chain optimization and multilayer inventory management point view.
	Planned order	The various cooperation plannings are achieved by managers between company, such as the business plan.	According to the company inventory status, intelligent order plan process is completed mainly through the Agent using optimization theory.
	Scheduling and rescheduling		The company's current inventory situations are real-time monitored and orders redistributionin is carried out in supply chain management based on the joint forecast and planning replenishment through Agent intelligent learning ability.

3 Operation System of FPS

3.1 IOMFPS structural model

Figure 1 shows the intelligence operation structure model that divided into the application layer, Agent building layer, semantic web services layer and data layer. Application layer provides an interface that the manager (external environment) and this model, which is the effective interaction interface between this model and the manager, including forecasting, planning, scheduling, collaboration, and data display interface. The application layer can achieve seamlessly connect between distribution services operating and a financial system module. Agent intelligent building layer is the main operational part which is composed of forecasting Agent, planning Agent, scheduling Agent, cooperation Agents and ontology Agents. Each Agent should be able to perform some information from external sensors, intelligent learning, optimization and decision-making and other activities. External information includes the dynamic system data and static information, such as the communication information, inventory information, varieties operating parameters. This information is achieved through ACL communication interaction and the semantic web services to achieve operational functions. The semantic web services layer is responsible for transferring the existence information and knowledge to semantic description. The ontology provides a clear conceptual vocabulary for knowledge sharing and reuse as the fourth layer structure, which can shield the complex grammatical structure, but also provide some background knowledge to realize the semantic layer access.

The ontology requires web ontology language for services (OWL-S) to represent this knowledge or data, so that improving Agent internal and external knowledge sharing, integration and interoperability. The concepts which have many synonyms need to be able to map only concept, so that formal knowledge representation, a clear vocabulary and semantic are established which makes MA build the consensus domain knowledge through formal knowledge representation. The ontology model includes resource ontology, task ontology and method ontology. It has mapping and ontology learning functions which can realize information mapping, extraction and mining operations, and obtain statistical and clustering information. It completes the operation and management of the underlying information system interaction through statistics and clustering process.

3.2 IOMFPS operational model

IOMFPS operational model is composed of Agent operational controlling models, simulation and optimization models and software development parts, shown in figure 2. Agent operational controlling model is divided into the organizational level, planning and forecasting level, coordination layer, scheduling layer and underlying data layer, whose purpose is to obtain the timely and accurate demand information, reduce the inventory costs and maximize the consumer demand satisfaction. Planning Agent exists both the bond between forecasting Agent and scheduling Agent. Ontology Agent translates underlying heterogeneous data into sharing

knowledge. If existing conflict or inconsistent results in the operational process, cooperation Agent is triggered. The simulation optimization model provides the simulation results for Agent operational control, it provides simulation function through the initial inventory parameters, product parameters and various optimization parameters according to the design process conditions and needing verified results based on Matlab / Simulink, GATBX1 and the Super Decision software systems. Software development parts provides an effective way to achieve the intelligent operation through Agent development software, architecture or platform (JADE, Swarm and Repast, etc.), using Agent development methods, Java and other languages or environments to achieve intelligent operational systems software development.

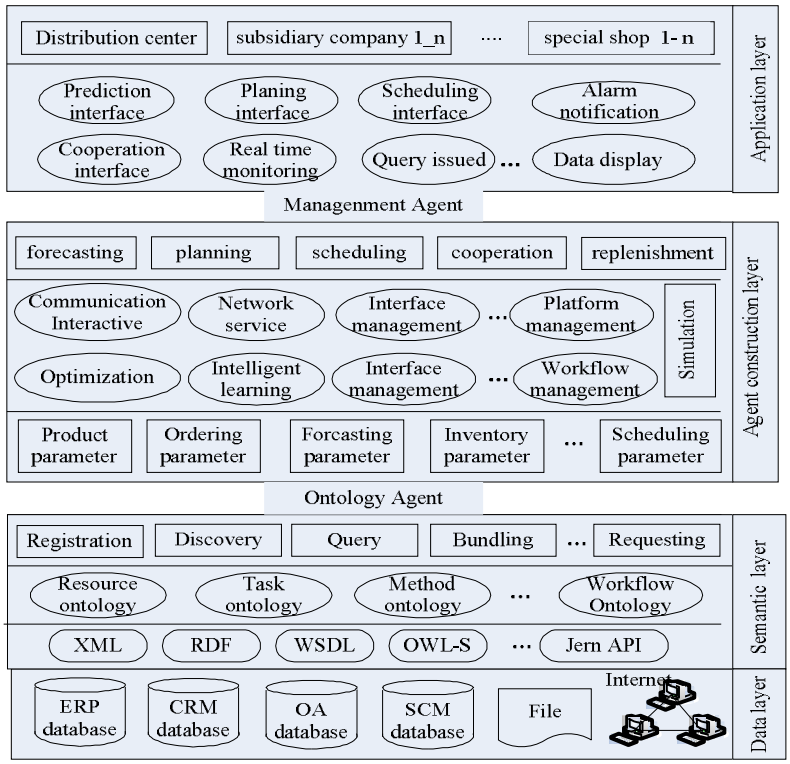


Figure 1 Intelligent Operation Structure Model

3.3 IOMFPS design

As management software, CPFR is not related to intelligence, optimization and simulation functions. An intelligent development platform is designed based on Matlab \ Simulink, JADE, Jena and Protégé according to the literature [6]. The platform uses SQL Server 2000 database, Eclipse IDE as programming and debugging tools, Java EE as the development, deployment and management the underlying architecture of distribution services system. In order to solve the interaction and communication problem, the information exchange and negotiations are achieved by Agent platform and Agent communication language (ACL), such as knowledge query and manipulation language / knowledge interchange format (KQML / KIF).

Ontology-based semantic web service is described using Protégé software. It is described with the Owls-Editor and OWL-S description service is operated with OWL-S API using Jena to parse OWL file. Ontology is generated and edited via the Protégé class, class hierarchy, attributes, attribute relationship, values constraints, and relationships between the classes and attributes. All Agents are built with Java and UML in JADE. The management Agent, forecasting Agent, planning Agent, scheduling Agent, cooperation Agent and body ontology Agent are designed in the development platform.

OWLS-Editor is used to the semantic web service editor, which allows the user to manually create an OWL-S service description or automatic generation OWL-S services description from the existing WSDL documents, thus the web service OWL-S description and web service semantics are realized.

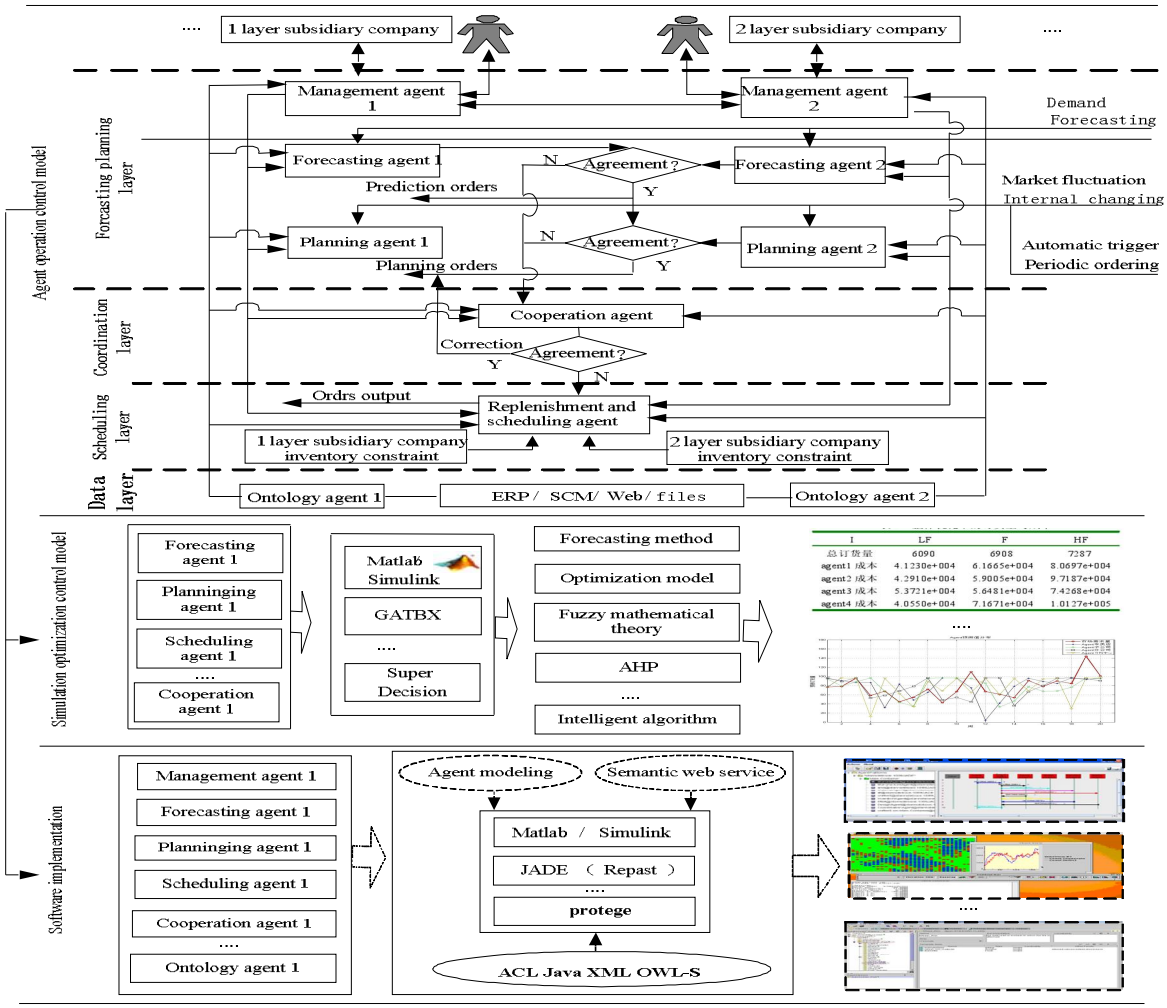


Figure 2 Executive Functioning Model

Finally, the semantic features are matched using the analysis of OWL-S API on OWL-S files, so all intelligent operation results are reflected to the application layer. All Agents need follow FIPA standards, which defines communication ACL between Agents. The standards have basic setup including the message purpose, message sender, message recipient, message content, using language, message ontology etc.

For this intelligent operations management model, various functional modules are analysed. The article [7] built and simulated an optimization model based on MA in distribution chain, and then further considered the forecasting problems in the uncertainty in the literature [8] by fuzzy theory. A cooperation ordering model based on MA was established through the fuzzy control theory and Bayesian learning method according to the actual inventory and demand situation planning orders in the article [9]. In order to solve the global distribution, the company needed to optimize and complete intelligent scheduling by case-based reasoning (CBR). CBR scheduling Agent based on MA and semantic web service obtained related cases by scheduling precise feature items in case library, evaluated the similar cases and deposited into the scheduling cases. The article [10] simulated MA-based intelligent replenishment, and established coordinated replenishment models using multi-layer decomposition method. The studies analysed intelligent FPS optimization problems in the distribution service system.

4 Conclusion

Based on the CPFR management philosophy, the FPS managements are realized using the MA and the semantic web services technology in the distribution service system. The article described semantic by ontology, and built collaborative FPS optimization problems in the operational and management process based on MA. Finally, the system feasibility was verified through modeling and simulating. From the information perspective, the system architecture will help promote upgrade from a distribution / supply chain system to an intelligent management.

References

[1]. Cadidi M, CigoliniI R, DE Marco D. Improving supply-chain collaboration by linking intelligent agents to CPFR [J]. International Journal of Production Research, 2005, 43 (20): 4101-4218

[2]. Cadidi M, CigoliniI R, DE Marco D. Linking autonomous agents to CPFR to improve SCM [J]. Journal of Enterprise Information Management 2006, 19 (5): 465-482

[3]. D'Aubeterre F, Singh R, Iyer L. A Semantic Approach to Secure Collaborative Inter- Organizational e-Business Processes [J]. Journal of the Association for Information Systems, 2008, 9 (3/4): 231-266.

[4]. FU Chuang, YE Luqing, LIU Yongqian, et al. Intelligent control-maintenance-management system (ICMMS) based on multi-agent system [J]. Control and Decision, 2003, 18 (3): 371-374 (in Chinese)

[5]. Sun Jianjun, Feng Shan, Zhou Jianlan. Intelligent agent architecture based on manufacture/storage plan, scheduling and controlling system [J]. Journal of wut (information & management engineering), 2005, 27 (4): 165-168 (in Chinese)

[6]. Govindu R. Multi-agent systems for supply chain modeling: methodological frameworks [D]. School of Wayne State University, 2006

[7]. ZHANG Qingmin, XUE Hengxin, LIU Mingzhong, et al. Multi-agent based forecasting optimization model in distribution chain [J].Computer integrated manufacturing systems, 2007, 13 (12): 2388- 2394 (in Chinese)

[8]. ZHANG Qingmin, XUE Hengxin, LIU Mingzhong. Fuzzy forecasting optimization based on Multi-agent under uncertainty [J]. Journal of System Simulation, 2009, 21 (16): 5247-5250 (in Chinese)

[9]. ZHANG Qingmin, XUE Hengxin, WU Chunmei, et al. Cooperation ordering plan simulation based on Multi-agent in distribution chain. Journal of wut (information & management engineering), 2009, 31 (4): 555-558, 561 (in Chinese)

[10]. XUE Hengxin, ZHANG Qingmin, CHEN Cheng. Dynamic and intelligent replenishment model based on multi-echelon decomposition method and genetic algorithm [J]. Computer integrated manufacturing systems, 2009, 15 (6): 1088-1097 (in Chinese)