Mobile Agent for Sales and Stock Control in a Supply Chain System

T.M.A. Ari Samadhi [†]
Manufacturing Research Group, Bandung Institute Technology
Bandung, INDONESIA
Email: asamadhi@mail.ti.itb.ac.id

Muhammad Ali
Department of Electrical Engineering Education
Yogyakarta State University, Yogyakarta, Indonesia
Email: muhal.uny@gmail.com

Rajesri Govidaraju
Department of Industrial Engineering
Bandung Institute of Technology, Bandung, INDONESIA

Iman Sudirman
Department of Industrial Engineering
Bandung Institute of Technology, Bandung, INDONESIA

Abstract. *Collaboration among manufacturer and its distributors as well its supplier needs information system that can integrates all functions within the supply chain for controlling stock. A mobile agent technology that works on the web is an ideal solution for making the integration of geographically dispersed of various parties in a supply chain. This research develop a mobile agent for monitoring stock position at distribution points and simultaneously report the stock position to manufacturer. Therefore the manufacturer will be able to anticipate the production planning for replenishing the stock. A prototype is built and simulated in the laboratory environment and it is shown that the mobile agent performance is adequate for meeting the monitoring system.*

Keywords: *mobile agent, supply chain, stock control.*

1. INTRODUCTION

Collaboration among manufacturers, suppliers and distributor in a supply chain needs information system that is able to integrate all functions within the supply chain. Information technology used for realizing the system has developed rapidly from computer technology up to the global network system such as the web system.

Researches on the design of information system for integrating supply chain had been conducted by several researchers. Ellram (1995) describes the importance of data sharing for manufacturer, supplier and distributor to control stock or inventory in a supply chain. Relationship and cooperation among manufacturer, supplier, and distributor must be made properly to ensure the smooth flow of material. Cooperation must be made for the sake of providing good service to customers and supplying good quality product at minimum cost.

Verwijmeren (1998) emphasized the importance of information technology for controlling stock in a distributed environment such as a supply chain. The geographic distance of parties involve in a supply chain is the main problem of integrating them and thus the advancement of information technology provides opportunity for establishing effective and efficient stock control along the supply chain.

Au & Ho (2002) proposed a model of stock control

---

† : **Corresponding Author**

using an electronic transaction for managing fashion industry that form a supply chain in Honking. Using this web information infrastructure communication process among producers, suppliers and customers can be made vastly and easily, thus the responses to customer demand can be made shorter. In this model, web technology such as electronic data exchange and e-mail are employed. Cooperation among the parties is facilitated by providing data access to each suppliers and distributors.

Due to the increase complexity of the control process in the supply chain, the approach to integrate the system using web based client/server is not adequate anymore. This fact that in turn drives the motivation toward research and implementation on distributed system. A distributed system is a development of client/server system. In a distributed system several of autonomous agents connected with network and equipped with distributed system software works together in performing specified tasks such as stock control.

Several developments on a distributed system have been made. Swaminathan (1998) has developed a multi-agent model for supply chain. In this model several agents are developed such as manufacturer agent, distributor agent, and transportation agent using the inventory policy as the control mechanism for agents' interaction in managing supply chain.

Shen & Norrie (1999) introduced Collaborative Agents System Architecture (CASA) and Infrastructure for Collaborative Agent System (ICAS) for integrating manufacturer, supplier and distributor in a virtual enterprise. The virtual enterprise here, possessing the similar characteristic to a supply chain system.

Lange (1998) in his research is using mobile agent system in a distributed system. By using this approach, cooperation among agent that is able to work autonomously can be made effectively since the agent is moving in the global network.

2. SALES AND STOCK CONTROL

Stock of product in distributor is dynamically changing due to the sales activities. This change on stock position should be known simultaneously by the manufacturer so that the manufacturer is able to make a production plan in anticipating the change effectively. The manufacturer must make a decision on how much to produce and when to produce to replenish the sold stock at the distribution side. The key is the provision of real time

information to manufacturer that can be easily presented by effective information technology.

Integration using the web system proves its advantage in transfer speed, wide span and reliability. However, in the web based integration system, an operator is required to collect data and retrieve information, which it is often a cumbersome task. It is better if there is a system that can handling the information automatically and presents information directly for decision making process. This provision is an advantage for a complex system such as a supply chain system.

This paper will discuss the control system based on a mobile agent system. The system will be able to monitor and update stock position at remote distribution point from the manufacturer side as a result of sales activities simultaneously and in a real time way. It is also discussing the development of stock/sales prediction system in a supply chain system as an additional feature for the monitoring system.

Mobile agent is an agent that has a capability of traveling in a global network such as web; make an interaction with outside host, collect data based on the specified task and return back to its host after completing the task (Lange, 1998).

3. SYSTEM SPECIFICATION

System which has been developed here id design to meet several requirements such as:
a. Manufacturing company will be able to monitor the product stock level and sales activity in several distributor simultaneously and in a real time way.
b. In each distributor side, there will be an agent that be able to monitor the stock level of a certain product maintain by the distributor. In case of sales transaction occurred in the distribution point, the agent will creating a messenger agent that travels through network to manufacturing company side, informing the current status of stock level.
c. In the manufacturing company's server, there will be an agent that have its capability to receive the information from the messenger agent and subsequently activates the agent for updating stock data base at the manufacturing company.
d. Using the transaction of stock stored in data base, manufacturing company may perform stock level prediction to enhance the stock level information, thus enabling the manufacturing company to anticipate production in advance.

e. Mechanism to replenish the stock by the manufacturing company is using Q method, where, the manufacturing company will send the order in a fixed quantity.

4. SYSTEM DESIGN

The system will utilize a web system as the platform. The manufacturing company will have a server and terminal, while at each distributor there will be server and terminal. The system architecture, in general can be seen in the block diagram as shown in figure 1.
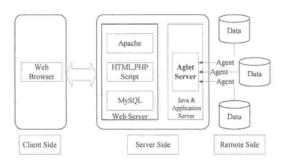

Figure 1. System Architecture

In brief the architecture consists of:
a. Aglet server is a home for agents or placed where agent is created, work and exchanging information with other agents.
b. Apache is a HTTP server that has a capability to handle the browsing demand and showing web page in html or php format.
c. MySQL is the data base server in the web server where the data stored and can be accessed by the users using the web browser
d. Web browser is the interface for user as well as the access

5. AGENT DESIGN

The agents created for the purpose of sales and stock control consists of:
a. Agent for receiving information on stock position at the manufacturing server called as **AgenPengawas**. The agent is created in the Aglet Server. This agent is also capable of creating mobile agent that can be dispatched to distributor side and looking at the online transaction made by distributor. The last agent is called AgenPengawasMobile.
b. Monitoring agent in the distributor side which is

the **AgenPeangawasMobile.** After created by the AgenPengawas, this AgenPengawasMobile will be dispatched to distributor side and stay at the distributor server to monitor stock transaction as a result of sales transaction. This agent will be disposed if the distributor server is not available (see figure 2).
c. AgenMessenger is a mobile agent that is created by AgenPengawasMobile if there is stock transactions which reduce the level of stock or if stock replenishment happened. The AgenMessenger will move to manufacturing server to inform the transaction.
d. BasisData RetrievalAgen is the mobile agent that perform the function to examine the stock level in the distributor side. This agent must have an access to read the stock database of the distributor. The agent will move to examine the stock database at the distributor side if there is a dispatch command from AgenPengawas. The dispatching command from AgenPengawas is trigger by the arrival of AgenMessenger before, which indicating the existence of transaction at the distributor side.
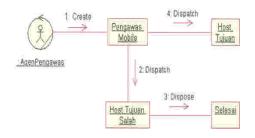

Figure 2. Collaboration Diagram of Displacement of mobile agent to Distributor

6. SYSTEM PROTOTYPE

A prototype of the system is developed using Java programming language, that is JDK 1.1.8 from SUN Microsystems. Platforms for creating mobile agents uses aglet application called Aglet API Development Kit version 1.1.0 (ASDK1.1.0) developed by IBM.

Three main modules are developed in the prototype. The first module is the monitoring module which has a function to do the monitoring of stock and sales transaction. The second module has a function to perform the updating of stock position information. The third module is the module for performing stock-sales prediction using the neural network. The last module is the off-line module that

is useful for predicting stock level or sales activity for enhancing the decision maker capability to anticipate the demand for production.

The prototype is also equipped with additional module that is the on-line sales transaction system since the AgenPengawasMobile will only functioning if there is an electronic transaction occurred. Thus, if there is a transaction made by distributor which is the operation of this on-line sales transaction module, the AgenPengawasMobile will reacts by creating AgenMessenger.

A simulation of sales transaction is performed to test the system. The simulation experiment shows that the agents are able to perform the required task. Figure 3 shows the movement of mobile agent from manufacturing side and distributor side.
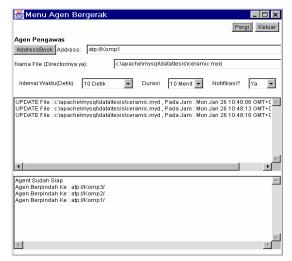

Figure 3. Test results

7. DISCUSSION AND CONCLUSION

The prototype developed here is only at the laboratory level. Simulation is perform using only three terminal, where one terminal functioning as manufacturer, the second terminal functioning as distributor while the last terminal is performing retail or customer who make the transaction through the on-line sales transaction module.

Simulation shows that the agent are able to work in a real time way, where the mobile agent is moving to inform the reduction of stock as the result of a sales transaction activity. The simulation also indicates that the agent is able to inform the decision maker about the current stock position at the distributor side.

The off-line prediction module is still in its infancy state. Matlab is used to perform the prediction using neural

network, based on transaction data provided by the agent. In the future this module will be developed so that it can be smoothly access data from the database of stock level.

Testing the system to a real supply chain system is also a need to be completed in the next plan. Operational condition of both the supply chain system as well as the telecommunication problem must be studied to make this system applicable in the real world.

REFERENCES

Ellram, L.M., Hendrick, T.E., (1995), Partnering characteristics: a dyadic perspective, *Journal of Business Logistics* 16 (1), 41–64.

Verwijmeren, M.A.A.P., (1998), "Networked Inventory Management by Distributed Object Technology" Koninklijke KPN NV, KPN Research, Leidschendam, the Netherlands.

Au, K.F., Ho, D.C.K., (2002), Electronic Commerce and Supply Chain Management Value Adding service for Clothing Manufacturing, *Integrated Manufacturing Systems*, 13 (4), 247-255

Swaminathan, J.M, Smith, S.F, Sadeh, N.M, (1998), Modelling Supply Chain Dynamics : A Multi Agents Approach, *Decision Sciences* 29 (3),

Shen, W and Norie, D. H, (1999), "An Agent-based Approach for Manufacturing Enterprise Integration and Supply Chain Management", In Jacucci, G. (ed.), Globalization of Manufacturing in the Digital Communications Era of the 21st Century: Innovation, Agility and the Virtual Enterprise, Kluwer Academic Publisher, pp. 579-590.

Lange, Danny and M. Oshima, (1999), Seven good reasons for mobile agents, *Communications of the ACM* 42, 88-89.

AUTHOR BIOGRAPHIES

TMA Ari Samadhi. is a lecturer in Department of Industrial Engineering, Bandung Institute of Technology. He is graduated from Bandung Institute of Technology in Industrial Engineering. He completed his master and doctor of philosophy from School of Mechanical and Manufacturing Engineering, The University of New South Wales, Sydney Australia. His research area is in production network, manufacturing information system and lean manufacturing.

Muhamad Ali is a lecturer in Department of Electrical Engineering Education, Yogyakarta State University. He is graduated from Gadjah Mada University in Electrical Engineering and completed his master from Bandung Institute of Technology. His research area is in Electrical Engineering, Industrial Engineering, production network, manufacturing information system and Education of Engineering.