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Research on multi-agent-based shipping information system

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Research on Multi-agent-based Shipping Information System

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me,

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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Abstract

Title of Dissertation: **Research on Multi-agent-based Shipping Information System**

Degree: **Master of Science in International Transport and Logistics**

The paper discusses the feasibility of using the multi-agent systems to improve the performance of current information systems in shipping industry.

The information technology has been used in the shipping industry recently. The function of these is limited in transmitting the information from one place to another rapidly, storing the information in a way that it is convenience for the company to query and manage simplifying the traditional manual documentation process etc.

In this dissertation, there are two multi-agent-based shipping information systems which are discussed in the multimodal transportation (especially liner services) and the tramp shipping, respectively.

The multimodal transportation is the collaboration transportation among different participants. It is regarded as the virtual enterprise and the organization in the multimodal transportation is the Professional Bureaucracy which focus on the core operation and the coordination is the major problem in this organization structure. And the independency of the different company leads to the difficulty of building one information system which has the capacity of covering all business in the multimodal transportation. However, the multi-agent technology has the advantage of integrating different distributed information system into one coordination

information system and reduces the complexity of building one information system for every participant.

The tramp shipping is a lack of information system. The e-mail, fax, telex and telephone used by charterers, brokers, agencies etc are just the channels of information exchange. The possibility of building an information system for tramp shipping will be covered by the discussion of implementing the multi-agent technology.

KEY WORDS: information coordination; agent; multi-agent;

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LIST OF ABBREVIATIONS

AI   Artificial Intelligence

AL   Artificial Life

ASM   Agent Management System

ABMS   Agent-Based Modeling and Simulation

BIMCO Baltic and International Maritime Council

B/S   Brower/Server

C/S   Client/Server

COA   Contract of Affreightment

CORBA Common Object Request Broker Architecture

DCOM Distributed Component Object Model

ERP   Enterprise Resource Planning

GPRS   General Packet Radio Service

GIS   Geographic Information System

IMTVE International Multimodal Transportation Virtual Enterprise

LAN   Local Area Network

MAS   Multi-Agent System

PDA   Personal Digital Assistant

RSS   RDF Site Summary

SN   Serial Number

SMS   Short Message Service

WCO   World Customs Organization

XML   Extensible Markup Language

CHAPTER 1

Introduction

The paper discusses the current information systems in shipping industry. And it discusses the possibility of using the multi-agent systems to improve the performance of current information systems in shipping industry.

1.1 The background and significance of the topic choosing

With the development of shipping industry, the informatization gradually appears its importance in the logistics. The lagged effect of information often leads to whipping effect (out of stock, the high inventory cost etc). Because of lack of sharing the information or coordinating with each other, it occurs that the shipment of raw material or finished product can't be transported from the original to the destination on time.

These problems are especially evident in shipping industry. The information technology has been used in the shipping industry recently. The function of these is limited in transmitting the information from one place to another rapidly, storing the information in a way that it is convenience for the company to query and manage simplifying the traditional manual documentation process etc.

As we all know, the information technology is booming and has changed beyond recognition.
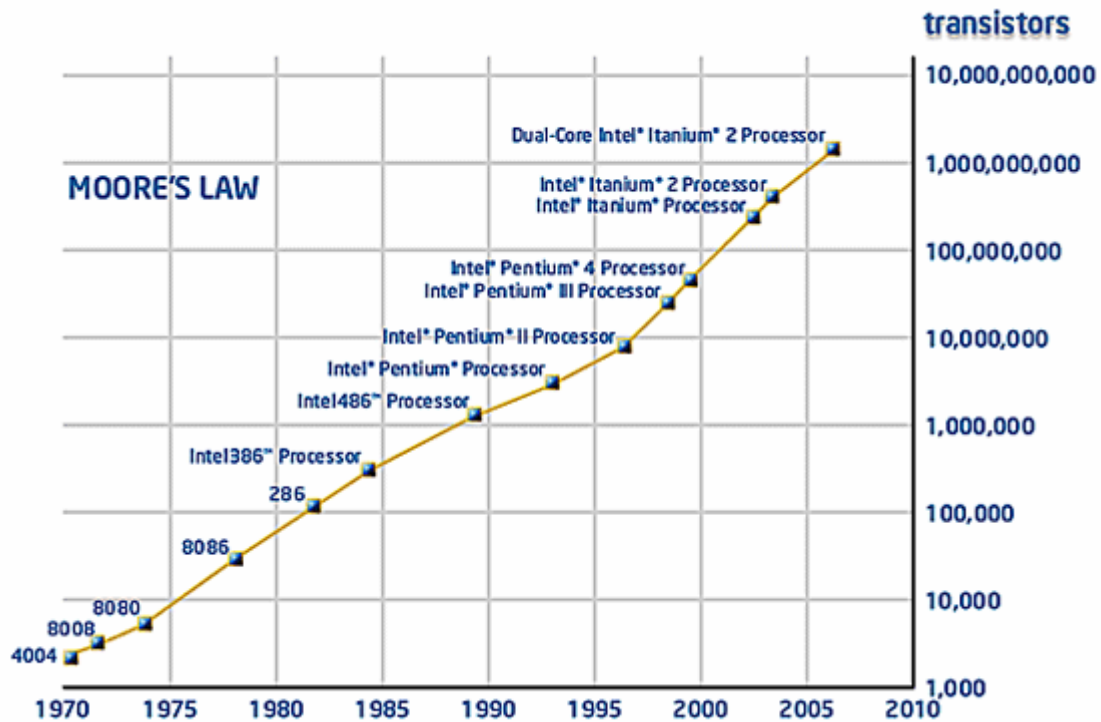
Figure Moore's Law-1

As the Moore's law (that the number of transistors per square inch on integrated circuits had doubled every year since the integrated circuit was invented, but data density has doubled approximately every 18 months) show us, the processor power has increased dramatically. Although the hardware has updated into the new generation in the shipping company, the software, especially those which focus on handling the information automatically, hasn't kept in touch with these tendency.

The implementation and problem of current shipping information system

Nowadays many shipping information systems have been developed or in progress in order to meet different requirements. They are based on the C/S or B/S design structure or other methods.

The discussion about C/S-based shipping information system

The advantage of C/S structure is the complete user interface and the ability to meet

the needs of shipping company. But the limitation and authority setting in C/S-based shipping information systems becomes the obstacle in the integration of new requirement. The shipping information is concerned not only by the shipping managers in the company but also by other participants. And the deployment in the C/S-based structure is complicated. It has special hardware and software requirements. Indirectly, it is inevitable for the companies to increase the cost related to information exchange. Another problem related to C/S-based shipping information system is the training of the employees. The information system which is based on C/S has the complex user interface and the business logic (the workflow in operation of information). It requires extra cost to make the employees skillful in using the information systems. But in practices not every workflow in the shipping information system is useful for every employees or users. The third problem of C/S-based shipping information systems is the updating problem. The updating problem is caused by the new requirement in practices or new services. That is to say, the C/S-based systems haven't the ability to meet the increasing demands although it is still well-performed in the past services. The updating problem will be solved by two solutions. The first one is integration between the current C/S-based information systems and new information systems. The compatibility between the new and the old one is faced with the provider of information services. The potential issue will occur at the data exchange in different information systems. And furthermore, it may have the result of 1+1<2 (The efficiency of integration will be lower than we expected because of dependency between each systems. For example, the delay of dealing with, transferring, or confirming one specific information which is provided by the current information systems will have the bullet-effect in the whole information systems). The next solution is using the new system instead of old one completely. The cost of replacement of the old one is the obvious problem not only in the purchasing hardware and software but also in the training. The awful situation

may be that the new problem occurs at the service workflow which is excellent in the old system. And after that, there is the complaint from the employees or customers. The operators (employees or customers) will have to accommodate themselves to the new systems.

The discussion about the B/S-based shipping information system

The advantage of B/S-based shipping information system, compared with C/S-based one, is the lower requirement of client machine. The requirement of client is the browsers. The B/S-based shipping information systems decrease the cost of hardware not only in maintenance but also in update. In software, the information processing is in the server side. The B/S-based system has less integration problem than the C/S system has. The updating in server side means the updating for the whole information system. But the problem in B/S-based shipping information systems is obvious. It has the high requirement of server machine. Any error or delay in server-side will have side-effect on the service-level in client. Another problem in B/S-based system (also in C/S-based system), I think, is the idle machine. A lot of power of information processing is wasted. With the development of hardware, the client (it may be Personal Computer or handhold device) has more well-performed than ever before. The function of browser in B/S-based system makes these clients idle.

The discussion about other methods

In the shipping systems, the email-based system is common used in shipping industry especially in tramp shipping. The participants in the tramp shipping use email to exchange their information. The email-based system in tramps has the advantage. Compared with phone-call, the email-based system won't interrupt the user frequently. For example, if the brokers have a phone-call with customers, they must

stop their current work and talk with the customers. And exchange the information by email doesn't interrupt the current work of brokers. The emails form a queue in the email client (Outlook Express, or Firebird etc) and are ready for broker to read. The problem in email-based system, I think, is dependency on users. The users have to read every email and reply every sender. Some reply is over-duplicated. For example, the information about the tramp shipping such as the current location of vessel, the plan of loading and discharging, and the notice to the clients, etc is exchanged frequently among the participants (shipowers, brokers, shippers/charters). And the brokers or intermediators just transfer the information from one side to another manually. The inconvenience in this process is obvious.

Multi-Agent technology

Since 1985, the study of Artificial Intelligence has boom.

There is a traditional belief in the computability of nature and society, but it has run into severe difficulties. Computability is only simple for linear problems. But most problems in the world are nonlinear and complex—from the biological evolution of life to the ecological, economic, and social dynamics of human society.

The multi-agent technology is formed initially in the distributed artificial life (the subset of artificial intelligence). It is created in solving problems of the nonlinear complex distributed systems. It has not only the property of AI such as learning, autonomy but also the property of transmitting the information according to the prepared schedule. The AI in multi-agent technology represents the processing the information in one terminal and the transmitting the information in schedule is in the exchanging the information. So it has the potential capacity that makes the current shipping information system well-performed.

1.2 Dissertation's contents and methodology

The concept of agent and multi-agent technology is introduced in the chapter two. The aim of the chapter two is to make a general understanding of the agent and multi-agent technology and show the advantage of the multi-agent technology in developing the coordination information system. The further discussion about the meaning of multi-agent technology in the shipping industry is also included.

The multi-agent based information system in the international multimodal transportation is in the chapter three. Because the liner service is key service in the international multimodal transportation, the international multimodal transportation is sea-borne transportation. Its aim is to discuss the information coordination in the international multimodal transportation. The international multimodal transportation is regarded as the virtual enterprise. Using the concept of the virtual enterprise introduces the organization structure into the international multimodal transportation in order to understand the importance of coordination and collaboration in the international multimodal transportation. In additional, the framework of multi-agent information system in the IMTVE is discussed.

In chapter four, the tramp shipping information system is discussed. Its aim is to show the mechanism of current information exchange in the tramp shipping and discuss the feasibility of implementation of multi-agent technology in the tramp shipping.

In chapter five, the simple case is implemented by the multi-agent technology. The

case is the ship supplement between the shipowner and intermediaries (operator, or the supplement company). The case show us the feasibility of multi-agent based information system in the shipping industry. The case study is implemented and analyzed by one person (the writer of the dissertation).

1.3 Literature review

The views of the existed research in the information coordination and multi-agent related to transportation are as follows.

In ZHOU Yan-jie, WANG Meng "The System Design of Management of Third Party Logistics" 2005, it mentions that The logistics appropriation costs of the business enterprise lead high, the management level fall behind, so the logistics market's potential is very big. The emergence of the logistics management software is inevitable to the logistics industry. However, various logistics management software now exist the irregularity or limit of itself. It introduces the basic components in the logistics information system. The system design is based on customers' demand and separates the information system into different function components.

In HUANG ming qian, LI ming shen "the knowledge-based 3PL management (from information-centralization to knowledge-centralization)" it mentions the importance of information in the 3PL management and the knowledge-based 3PL management. In the paper, it divided the meaning of logistics knowledge into three: 1. statement knowledge (the basic knowledge or understanding of the logistics) 2. Technical knowledge (legal, regulation, workflow of process) 3. Operational knowledge (related more to the practical management of logistics). And the framework of knowledge-based 3PL management is mentioned in detail. It covers the knowledge

acquisition, knowledge recognition, knowledge management and benchmark of the management.

In DING Yong "A study of the logistics distribution decision support system on agent technology" The paper explores the design of the logistics distribution decision support system based on the agent technology, then introduces that the learning mechanism in the agent model of this system. It mentions establishing a logistics distribution decision support system that has the feathers of expert system.

In ZHOU Liang, WANG Tie-ning "Research on Logistics Information Platform Model Based on Agent Technology" It mentions that the initial discussion about the application of agent technology in the logistics information management. And the function of the agent is separated into five parts 1.function of acquisition of information in logistics 2.function of organization of information 3.function of management of data related to information 4.function of coordination with customers 5.function of supporting the design of enterprise strategy.

In HUO Liang "Research on Integration strategies of GIS Techniques based on Agent technology" it mentions the dependency of Geographic Information System and logistics is very vital. The cargo flow in the logistics covers from one region to another. So the tracking and tracing is the first problem. And Agent information system is based on distributed network computing. The multi-layers of agent information system provide the new solution about the tracking tracing monitoring etc.

In "Agents in traffic and transportation: Exploring autonomy in logistics, management, simulation, and cooperative driving" it mentions that "all these

characteristics relate directly to traffic and transportation systems, especially the social ability, which is a key factor. Therefore, agent-based modeling and simulation (ABMS) is becoming a popular tool. ABMS is intended to facilitate two tasks: understanding the system (account for past observation), and making qualitative and quantitative predictions about the future." [1] It suggests that the agent-based simulation model can consist of a set of agents which encapsulates the behavior of the various individuals. The execution of the model emulates the entire behavior of the system.

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[1] "Agents in traffic and transportation: Exploring autonomy in logistics, management, simulation, and cooperative driving" (2005) 251-254 Transportation Research Part C www.sciencedirect.com

CHAPTER2

Methodology of multi-agent technology

The multi-agent technology is derived from the artificial life. It is different from the traditional artificial intelligence methodology. The traditional artificial intelligence methodology focuses on the expression of knowledge, machine learning, deduction etc. The main achievement is knowledge-based expert system which integrates the professional knowledge in some field with the algorithm of highly developed AI programming and provides users with a practical solution for the pervious problems. As the branch of AI, the knowledge-based system is the problem-oriented planning. Another focus of AI is the strategy theory which means that the applications have the capacity of self-judgment and selection.

With the development of network technology, the pattern of coordination among multi-applications changes from the single integration system to the distributed integration system. The communication and coordination on the network infrastructure can be established on the physical distributed systems. The distributed object (such as CORBA or DCOM) has the capacity of integrating the isolated system into one distributed system in order to break the boundary between each information systems.

Combing with the AI technology and network technology, the multi-agent technology appears. The multi-agent technology is a new methodology through which people can deal with complex, dynamic, distributed problems.

2.1 The agent concept
2.1.1 The definition of agent

The word "Agent" is a person whose job is to represent another person in English dictionary. In general, it covers the instance which has the intelligence such as human being, intelligent hardware (robot) and intelligent software.

These definitions range from the simple to the lengthy and demanding. Here, only two are listed below.

The MuBot Agent   [http://www.crystaliz.com/logicware/mubot.html] "The term agent is used to represent two orthogonal concepts. The first is the agent's ability for autonomous execution. The second is the agent's ability to perform domain oriented reasoning." [2]

The IBM Agent [http://activist.gpl.ibm.com:81/WhitePaper/ptc2.htm] "Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user's goals or desires." [3]

So far, many researchers have their own definition (as listed above), but there is no uniform definition about agent. Different researchers in the different field give their own understanding which involved in their technology.

Although it is lack of the accurate definition about agent, the understanding of agent may be based on as follows:

A. Agent is an entity which lives in the surrounding and has the capacity of gaining the information and explaining the phenomenon in the environment and has

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[2] http://www.crystaliz.com/logicware/mubot.html
[3] http://activist.gpl.ibm.com:81/WhitePaper/ptc2.htm

impact on the environment where it lives. In this understanding, the agent is regarded as the live in the real world, not only robot but also the software.

B. Intelligent agent is a special software which finish the task the user deploy and , to some extent, has the intelligence and self-execution in order to adjust itself to the environment. It comes from the understanding of agent software designer.

On one hand, researchers in many fields always define the agent as the distributed instance which has the AI and can interoperate among agents. Human being, robot, embedded intelligent device, personal computer and intelligence software can also be seen as the agent. On the other hand, agent represents automated distributed intelligence software.

2.1.2 The feature of agent
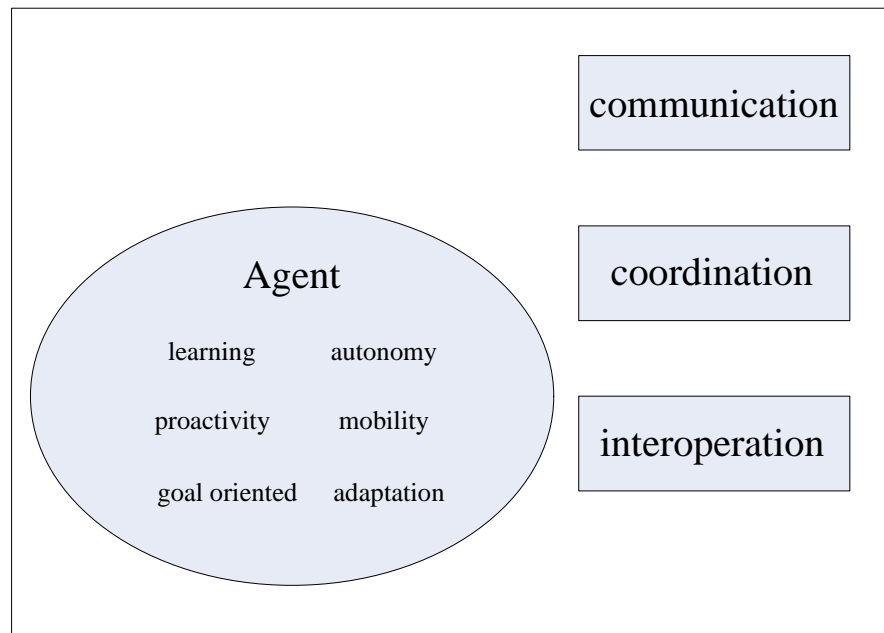
Figure Agent's features-2

As the diagram shows, agent has six features.

Learning

The agent should control its behavior based on its pervious experience.

Autonomy

Agent should have the ability to control itself even if there is no command.

Proactivity/goal-oriented

Agent doesn't simply act when some problem occurs in the environment. It has the goal-oriented behavior.

Mobility

Agent can move in the network system according to the schedule.

Adaptation

Agent has the intelligence which covers the internal knowledge (or pervious experience), learning, deduction and so on in order to adapt itself to the new situation.

Three function of agent covers communication, coordination, interoperation in the agent information systems. All these functions will be based on the features listed above.

2.1.3 Classification of agent in software

Researchers in many fields classify the agents into different groups according their functions. In order to clarify the specific meaning of the agent, there are some ways in which the agent can be classified.
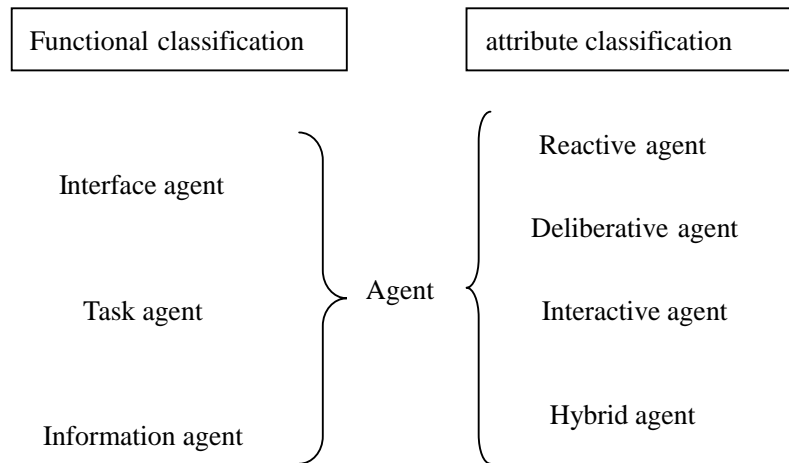
Figure agent classification-3

According to functional classification there are three main agents.

Interface Agent

Its major function is to assistant user to finish overlap work. The interface agent can monitor how the users do their specific work. It can provide the support or notification to the users.

Task Agent

The business logic is in the task agent. The task agents have some specific work flow in their body and focus on their task. It can be an expert-support function which can analyze the data and make the possible strategy or plan.

Information agent

Its function is to collect the information which the user wants in the distributed systems. It has the ability to search the information and manage the information intelligently. The information the information agent collect may be used by the people to analyze or to be provided to the task agent or interface agent in the multi-agent systems.

Another classification in response to the attribute can give us a clear picture of agent itself.

Reactive agent

It is reactive when there are several changes in the environment. It may have some pre-schedule or pre-strategy for the predicated situation in the agents system.

Deliberative agent

It has the autonomous capacity when the task is deployed to them. It knows what to do and how to do.

Interactive agent

It is intermediate among the agent system. It may be a information agent which can convert one type of the information in one agent to another type of that in order to break the boundary between different agents which need to communicate or coordinate with each other.

Hybrid agent

It combines other agents' function into one agent which has the overall capacity according to the requirement.

2.1.4 What the agent's point of view means in shipping information system?

The agent concept and function has been stated in the pervious section. It shows another view on the current shipping information system. We can regard the current shipping information system as the different agents, for the agent concept covers human being, robot, or software.

In the first chapter, the different types of shipping information systems have been discussed in details and most of them are based on the network. The current system have well-perform in their work. However, they are lack of intelligence or automate, for the solution of the shipping information system is complicated.

End-user attitude to ERP system

Time to implement another ERP-system

A new ERP-system is implemented
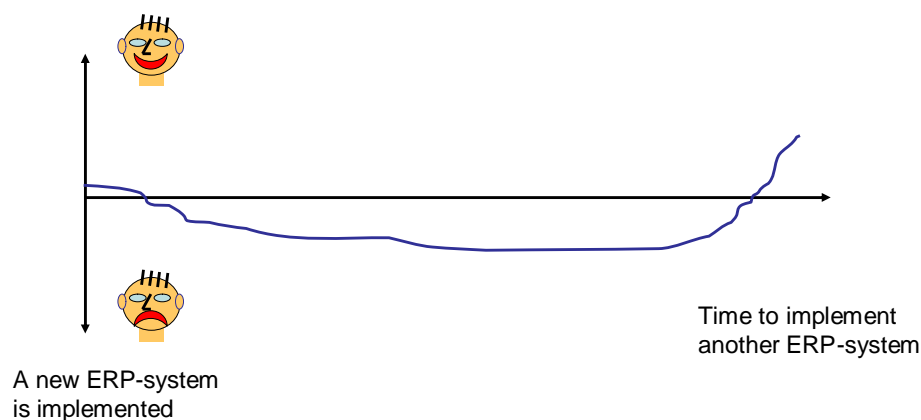
Figure End-user attitude to ERP-4

(Gunnar Stefansson ERP modules and Implementation 2.ppt)

The design and implementation of shipping information systems is the form of ERP systems. As the End-user attitude to ERP diagram shows, the end-users are satisfied at the beginning of the new ERP systems. And then the end-users have the unpleasant experience in using the current ERP systems for a quite long period. Finally, it's the time to implement another ERP-system. It throws light on the difficulty of the design and implementation. Because the ERP users know what they need but they don't know what they want, it is difficult for the ERP designer to meet the needs of the

end-user. The ERP system designers have tried their best to cover all the customers' need although the demand of the end-users is changed rapidly. The current ERP system in use can satisfy the end-users partially. From the agent's point of view, the long period of end-users' tolerance for current system can be reduced. The current system is regarded as an agent or an integrated agent who has a good performance on some work. It is convenience for the designer to improve or re-design the current systems in order to meet the new demand of the end-users. The current system won't be rejected and it becomes the agent of the new systems.

2.2 The multi-agent technology

In pervious chapter, the agent technology is stated. The agent technology is a lack of focus on how to coordinate among the agents themselves, although the functions and responsibilities have been classified into different agents. However, multi-agent technology can team the agents and play an important role in communication-coordination and cooperation among agents themselves.

The multi-agent technology is to integrate different types of agent into one information systems. The fundamental goal of the multi-agent is communication coordination and cooperation between different agents.

2.2.1Communication-coordination in multi-agent systems

The understanding of communication-coordination

"Without coordination, agents are capable of conflict, wasting effort and squandering resources thus failing to accomplish their required objectives" (Durfee, 2004)[4]. The

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[4] Durfee EH(2004). Challenges to scaling-up agent coordination strategies. In: Wagner T, editor. Multi-agent systems: an application science. *Dordrecht: Kluwer Academic Publishers*;,1–20.

advantage of the MAS is to have the capacity of using the distributed resources in the information system in order to finish the communication tasks by different agents instead of by phone-call or any other ways. So the communication-coordination is the essential requirement for the MAS.

What is coordination?

The coordination is "As the managing of dependencies between activities" (Omicini and Ossowski, 2003)[5]. The activities in the MAS are the different functions of different agents. And the managing of dependencies is the key characteristic of the MAS which includes schedule tasks; coordinate each agent in the systems and so on.

In order to accomplish the goal that communication-coordination in the multi-agent technology is seamless, there is a high requirement for well-defined interface between different agents. Take the human communication for example. The language is the intermediate between people and the same language in one society is another key factor which has the influence on the efficient communication. Chinese is a language and it have both simplified Chinese and traditional Chinese in the characters. The goal of using simplified Chinese is to simplify the representation of intermediate. That is to say, the selection of intermediate is also important. However, the interpretation is necessary, for there are different languages in different area. The work of interpretation provides a buffer for exchange the information among different agents without obstacles. In short, the MAS like the human communication are the intermediate and the interpreter within different agents. "Coherency is an essential property of a MAS and coordination for the reason that it ensures an agent

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[5] Ominici A, OssowskiS. Objective versus subjective coordination in the engineering of agent systems. In: OssowskiS, editor. Intelligent information agents: the AgentLink perspective, vol. 2586/2003. Berlin: Springer; 2003. 179–202.

or system of agents behaves as a unit" (Nwana, 1996).[6]

2.2.2 What the MAS means in the shipping industry?

As I mention above, the MAS is a ready-made system which can be used to make the information exchange more flexible than ever before. In the first chapter, several problems about current information systems in shipping industry have been discussed in details. All these design of information system in the shipping industry is to meet the needs of information coordination that make the related person or company know about the related information without any delay.

In the past or even nowadays, the information coordination is a lack of "pull" process. As we all know, pull and push is two driven in the logistics. It also exits in the shipping information system.

2.2.2.1 "Push" process in Information

In the marketing and advertising world, the "push" is defined that the consumer does not request the product to be developed. The product is pushed at the end-user by promotion.   The push strategy in logistics has some features as follows:

- Based on past orders received from retailer's warehouse (may lead to Bullwhip effect)
- Inability to meet changing demand patterns
- Large and variable production batches
- Unacceptable service levels

An example of "push" process is PDA (Personal Digital Assistant), where the major manufacturers such as Palm or HP promote their products via retailers. Personal

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[6] Nwana HS.(1996.) Knowledge engineering review, vol. 11(1). *Cambridge: Cambridge University Press*; 1996. 1–40.

selling and trade promotions are often the most effective promotional tools for companies such as Palm or HP. For example, exhibition of their product and introduction of new function of their products will encourage the customers to consume their products. So the promotion is key factor in the successful "push" strategy.

In the shipping information system, there also exists the "push" process. The understanding of it is that those who concern about some shipping information can't find out the specific or related information and the related information will be pushed at the information-demanders by information creators. So the feature listed about the logistics may be in shipping information system.

- Based on past information-demanders received from information creator
- Inability to meet changing demand patterns(It forms the imbalance of information in shipping industry)
- Large and variable information batches(for example there is much information in the shipping website which are ready for the information-demander to search the information they concern)
- Unacceptable information service levels (for example the information delay in the one step of the sea-transport may cause the problem of the international trade.)

An example of "push" process in shipping information system is the international multimodal transportation. If equipment which contains ten set is transported by tween-deck vessels, two-set of the equipment have to be left in the original port because of the cargo-jam. There may be a problem which means that the plan in the whole international multimodal transportation has been changed. The prompt information exchange is inevitable. The notification of the information is the liability

to the sea-carrier. He, coordinator of the sea-carrier, will have to make a phone call to other sides which may be in another country or another time zone. And the next notifications of that will be the liability to the next carrier. It forms the process of pushing information from one to another in order to coordinate the information and make the related parties know what had happened in the sea-transport and prepare the re-planning in their schedule. The promotion by the suppliers in the marketing or advertising industry becomes the notification by the information creators. The flexible information exchange or notification is the key factor in the international multimodal transportation.

2.2.2.2 "Pull" process in information

The "pull" process the consumer requests the product and "pulls" it through the delivery channel. The production is driven by the demand of market. The pull strategy in logistics has some feature as follows:

- Applied to that portion of the supply chain where demand uncertainty is high
- Production and distribution are demand driven
- No inventory, response to specific orders
- Decrease in lead time
- Difficult to implement

A good example of "Pull" process is the DELL Company. It may be Push-Pull integration strategy but the Pull process is the major effort in the DELL business. DELL has two mechanisms in the Pull process. The first one is to manufacture the production according to order. The next is to lower inventory level by means of rapid information exchange.
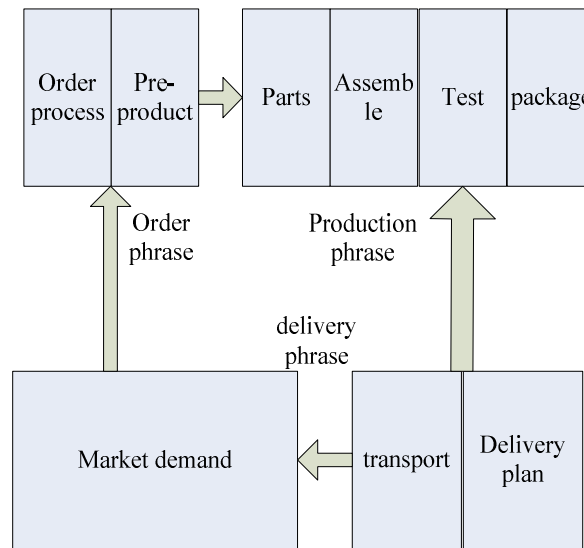
Figure pull process in DELL-5

The diagram above shows the Pull process in Dell's business. However, the difficulty of the pull process is obvious. Any delay of the information about the marker demand or feedback will break the balance in the whole business.

In the shipping information system the "pull" also exists. It means that the shipping information provider is the information-demander-driven mechanism. The feature about the pull process in shipping information system is as follows

- Information-Production and distribution are demand driven (Who needs the information? Who is the key information-demander? What value the information-provider create for the information-demander)
- Decrease in lead time(reduce the delay of information exchange or delivery)
- Difficult to implement(In traditional way it may be a difficult for the parties to implement the "pull" process in the shipping information system because of not only the time-zone problem but also poor information-coordination tools or method)

An example of "pull" process in shipping information system is the market report. The information-demander subscribe the market report .The publisher of the market report can get the feedback of the readers and improve the related information in the market report.

2.2.2.3 The meaning of coordination in multi-agent-based shipping information system

The shipping is the work of communication-coordination or cooperation. We can't imagine what the shipping will be without communication-coordination or cooperation in the shipping industry. Most of the shipping information system such as C/S, B/S, or email-based system is the "push" process.

However, the advantage of the "pull" process in shipping information system is obvious. Any information will be provided to the information-demander promptly. The current shipping information systems focus on the information organization and transmission. They are lack of the active form and the designer is also lack of thinking in information "pull" process.

In the next chapters, the implementation and design will be covered according to the different shipping information system.

2.3 Common framework of the multi-agent information system
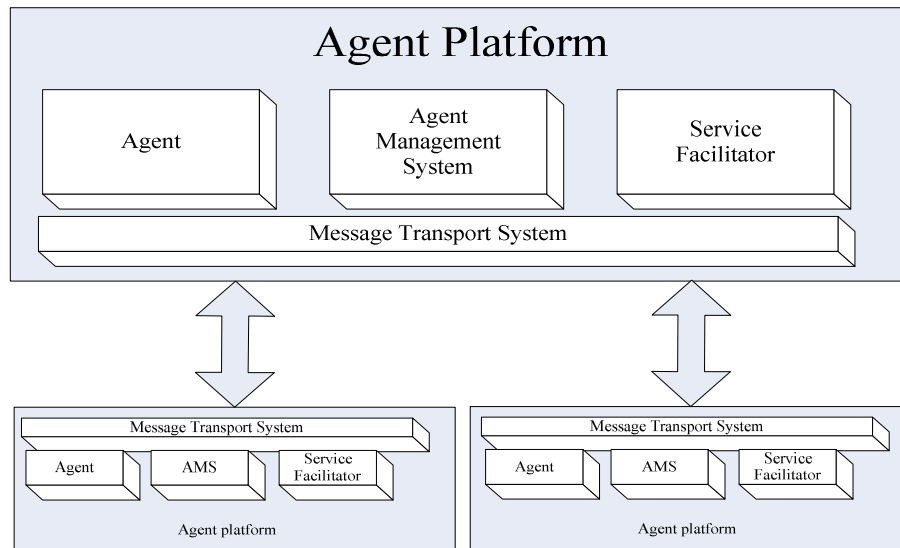
Figure multi-agent platform-6

2.3.1 The elements in the multi-agent information system

Agent

Though the multi-agent information system is software or middleware, the agent is not only an instance in the computer but also a hardware or person.

First, the agent is a utility which can be integrated with the existed application. It have one or more service capabilities which means that the agent should provide the other application with functions or services in order to collaborate with other agents. It must have identification which defines who the agent belongs to, where the agent comes from, and so on. In additional, it contains the features of "learning, autonomy, pro-activity, mobility, adaptation". And features' implementation depends on behaviors of the agent. (In the common framework, all these features should be defined as interfaces whether they are used or not)

Second, the agent is a hardware or person. The information flow in the information

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system begins from the information collection. And the information collection can be done by the hardware such as the webcam, or the CCTV, etc. Person also can also be the agent in the agent platform, for the computer can't take the place of the human being completely.

Agent Management System

As the name shows, AMS is the manager of the agents which manage the agent and provide agents with a pool in order to make every agent under the control. The AMS maintains a list of agents' identification mentioned above. In addition, the AMS offers the services list and the lookup to other agents (local agent or remote agent). There is only one AMS in one agent platform.

Service facilitator

It is an optional component of the MAS (multi-agent system) which is used as yellow pages services by other agents. The difference between the AMS and the Service facilitator is focus. The focus of the AMS is the agents' management. The service facilitator focuses on the service which the AMS or agents offer.

2.3.2 The basic workflow in the multi-agent information system

The basic workflow in the multi-agent information system covers many parts from the life cycle of the agent, the mechanism of the management of the multi-agent system to the cooperation among the multi-agent system. The cooperation workflow among the multi-agent system will be introduced below, for the aim of the dissertation focus on the cooperation and collaboration among many different participants (companies, organizations, etc).

Message Transport System
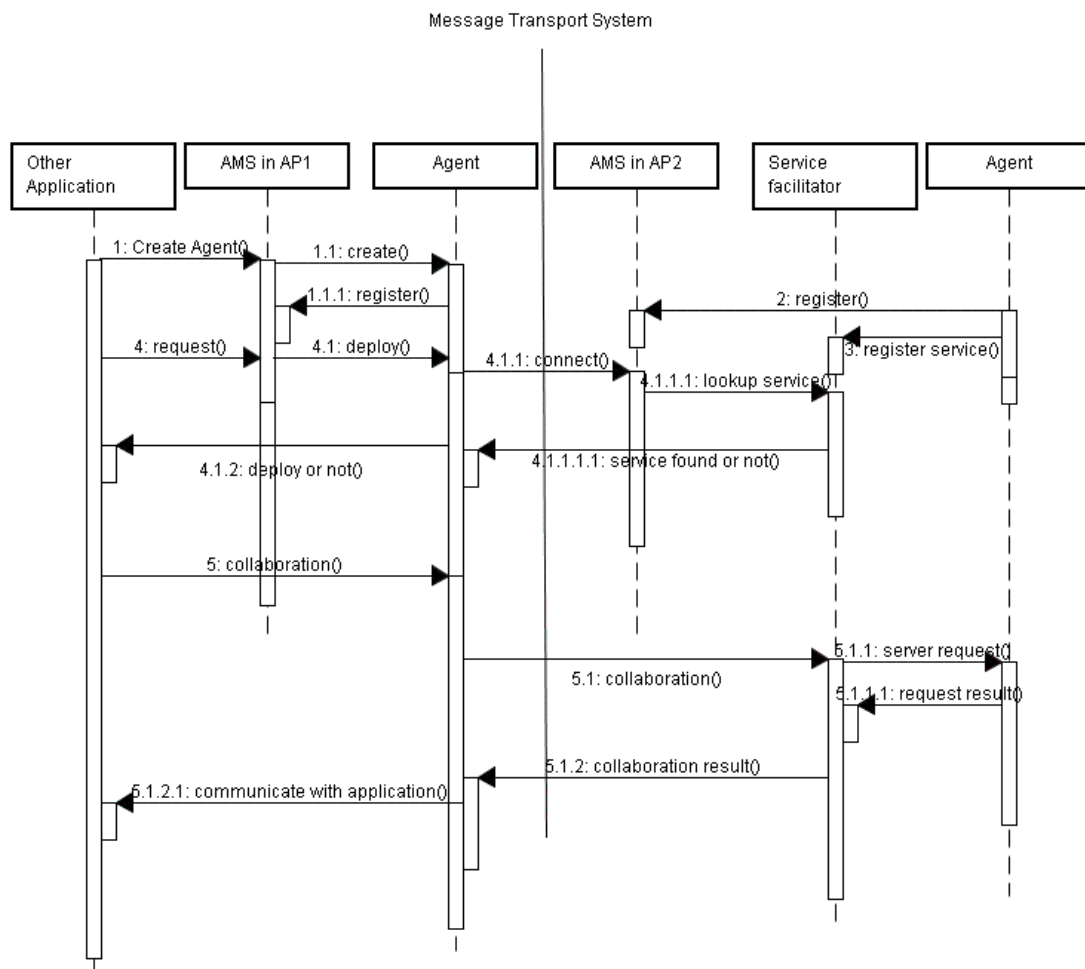
Figure multi-agent workflow-7

1. Create agent

The other application send the request to the AMS in the AP1 to create the agent in the Agent platform.

1.1 create

The AMS will create the agent according to the requirement of the application such as the task definition, the required feature and so on.

1.1.1/ 2 Register

The defined agent will register itself in the AMS and make it under the AMS control. The agent life cycle and the authority of the access will be managed by the AMS.

The work related to the external application is done by the agent directly.

3. Register service

On the other side of the multi-agent system, services are registered by other agents.

4. Request

After the required agent is ready, the request of the external application can be sent to the AMS. In 4.1 Deploy, the task definition is deployed to the agent and the agent knows its task or responsibility. In 4.1.1 Connect, the agent makes a connection with the remote AMS in AP2 by means of the Message transport System. That work is the basis of the cooperation or collaboration. In 4.1.1 lookup services, the AMS can search the defined service request according to the agent in the AP1. After that 4.1.1.1 and 4.1.1.1.1 and 4.2, the result of the communication and cooperation will be sent to the external application.

5. Collaboration

After the preparation (1- 4), the collaboration is setup between the external application and agent. In 5.1, 5.1.1, 5.1.1.1, the collaboration on the other side of the multi-agent system is deployed to the other agent. The agent in the AP2 offers the services to the agent in the AP1. In 5.1.2, 5.1.2.1, the result of the collaboration will be returned to the agent in the AP1 and also the information which is explained by the agent in the AP1 is sent to the external application.

The 5.Collaboration is done repeatedly in the multi-agent system until the work in the multi-agent system is finished.

CHAPTER 3

The multi-agent based information system in the international multimodal transportation

3.1 The virtual enterprise concept in the international multimodal transportation

3.1.1 The virtual enterprise and the international multimodal transportation

The virtual enterprise concept is a new organization and management pattern with the modern development in the information technology. The definition of the virtual enterprise is a temporary alliance whose aim is to share the cost and technology and which have the ability of hunt for the opportunity promptly.

What is the international multimodal transportation?

The international multimodal transportation is "to provide intermodal freight transportation, which is coordinated, seamless, flexible, and continuous from door to door on two or more transportation modes"[7] From the definition, we can find that the international multimodal transportation put emphasis on confidence, cooperation, coordination with each participants in order to reach the goal of "win-win" patterns in all parties.

In short, the attributes of "alliance" include cooperation and coordination within different parties and the basis of "share the cost" is on the confidence among the parties. So the international multimodal transportation tightly clings to the concept and target of the virtual enterprise.

The virtual enterprise concept in the international multimodal transportation, in general, is a enterprise pattern of international multimodal transportation ,which

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[7] Gerhardt Muller(1995),Intermodal freight transportation, *Intermodal Association of North America*,1

unite the carriers of different parts in transportation, the port authorities, the customs, the quarantine, the ship agencies, the tallies, the banks, the insurances together ,whose aim is to finish the intermodal freight transportation from door to door safely, promptly, efficiently, whose costs and risks will be shared by the parties and under the authority of a single freight bill. The virtual enterprise in the international multimodal transportation is the resource integration which optimizes the functionality of the whole chain of the transportation and takes advantage of every party in the international multimodal transportation. It shows the effectiveness of 1+1>2.

3.1.2 The problems about information in the international multimodal transportation virtual enterprise

As we all know, every parties which take part in the international multimodal transportation is professionalized highly. They have a lot of experiences and specialized knowledge in their own business. And some parties may have the knowledge which relate to their patterns in business, for it is convenient for them to coordinate with each other.

The internal problem related to the coordination in the enterprise should be known clearly. "Most important, the Professional Bureaucracy relies for coordination on the standardization of skills and its associated design parameter, training and indoctrination. It hires duly trained and indoctrinated specialists—professionals— for the operating core, and then give them considerable control over their own work."[8] The professional bureaucracy structure exists most commonly in the different parties in the international multimodal transportation. From the description of the professional bureaucracy, we can conclude that the coordination is based on the

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[8] Henry Mintzberg(1992).Structure in fives –designing effective organizations. *Prentice Hall*, 190

standardization of skills and standardization of skills form the operating core. In other words, the standardization of skills becomes the interface between the coordination and the operating core.

The problem of standardization

The standardization is mandatory in the organization. In the international multimodal transportation, the representation of the standardizations is the agreements or regulations which are signed or obeyed between the parties such as carriers, shippers, customs, tally companies, agencies and so on. In these standardizations, it is necessary for every party to exchange the information just in time according to the agreements or regulations. "The professional bureaucracy emphasizes authority of a professional nature—the power of expertise"[9] It implies that there are different types of bilateral standards in the international multimodal transportation, for every parties has the power of expertise. For instance, in the world customs organization, there is a list as follow:

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[9] Henry Mintzberg(1992).Structure in fives –designing effective organizations. *Prentice Hall*, 192

Information Technology

► The Recommendations on the UNIQUE CONSIGNMENT REFERENCE (UCR) FOR CUSTOMS PURPOSES
(26 June 2004)

► THE USE OF WORLD WIDE WEB SITES BY CUSTOMS ADMINISTRATIONS
(26 June 1999)

► THE USE OF THE WCO DATA MAPPING GUIDE FOR CUSTOMS UN/EDIFACT
(21 June 1995)

► ADHERENCE TO STANDARDS IN RELATION TO DATA REQUIREMENTS FOR ADVANCE PASSENGER INFORMATION (API)
(6 July 1993)

► THE USE OF THE UN/EDIFACT RULES FOR ELECTRONIC DATA INTERCHANGE
(26 June 1990)

► THE USE OF THE UNITED NATIONS TRADE DATA ELEMENTS DIRECTORY (UNTDED)
(26 June 1990)

► THE USE OF THE CCC/IATA DATA INTERCHANGE STANDARDS
(21 June 1988)

► THE USE OF CODES FOR THE REPRESENTATION OF DATA ELEMENTS
(22 May 1984)

Figure WCO information technology-8

These recommendations are designed or implemented for the international exchange of data between Customs administrations and between Customs administrations and trade users.

Another example is electronic booking system in the liner company or documentation standards. There also exist the information data and format.

For these standards is bilateral and the related information is multilateral, the problem occurs. The basic information provided by the shippers or generated in the procedures is reused in different parties according to the different bilateral standards. It increase s the information handling cost and complexities, for the information coordination is inclined to the paper work manually.

The problem of the coordination
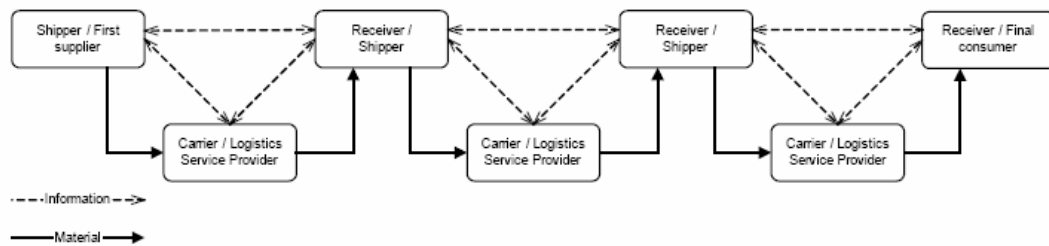
Interfaces in collaboration-9

(Interfaces in collaborative logistics management P2)

"It is a challenge to coordinate the operation throughout the supply chain shown in the figure above and many attempts fall short"[10](Gunnar Stefansson 2005). The IMTVE has the similar situation.
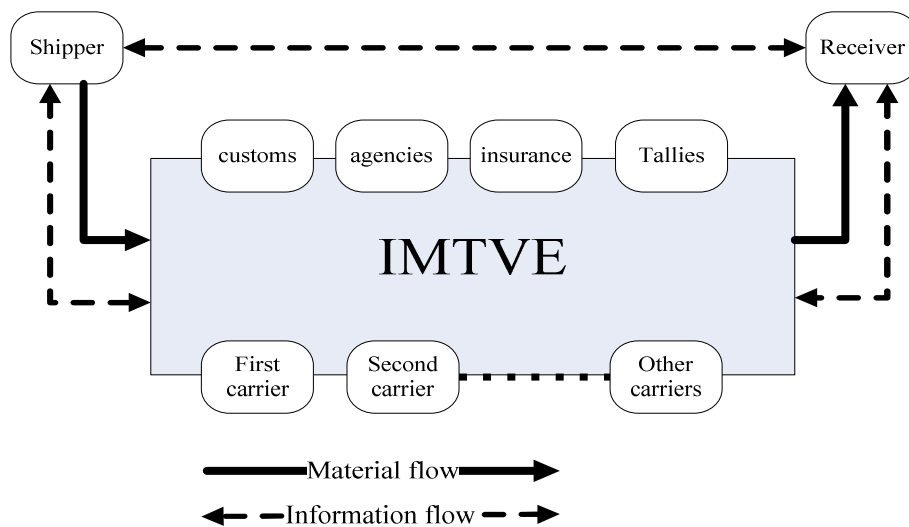
Figure IMTVE diagram-10

But the coordination between each part is converted into internal problem. The coordination events in the IMTVE, in the shipper and receiver points of view, are the

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[10]

Gunnar Stefansson(2005). Interfaces in collaborative logistics management. Unpublished lecture handout, World Maritime University, Malmo,Sweden

vertical flows. It is different from the pervious that both the vertical flows and horizontal flows are in the whole logistic setups.

The problem of building the information system in the IMTVE The IMTVE isn't like the real enterprise. Firstly, the specific needs of the information system can be known easier in the real enterprise than in the IMTVE. It is difficult for the designer or architecture to know about or understand what information system in the IMTVE should be. Secondly, the work of building the information system for the IMTVE may be unbelievable.

Figure Information dependency-11

As the diagram shows, the information dependency or exchange relation is too complex.

3.1.3 What does the changed understanding of the coordination in the IMTVE mean?

It is necessary for the every parties in the IMTVE to closer their coordination. The aim of coordination is to deal with some unpredictable situation. If some delay occurs at the first transportation under the first carrier because of the unpredictable reasons or human factors, there is always phone-call between the first carrier and the second carrier or other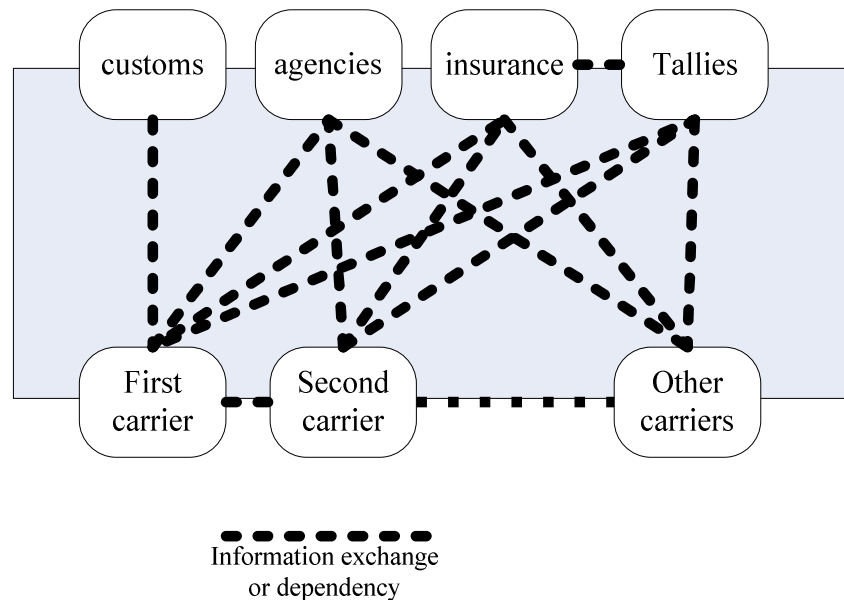s in order to make sure that other parties have the abilities to adjust themselves to new re-schedules or re-planning. The re-schedules or re-planning, another problem which is oriented from delay, is usually done manually. The re-schedules or re-planning may cover the existed planning among parties. It also needs further coordination among parties. For example, the container which is late for the first schedule in the liner company will be moved to the next schedule in the liner company or will be transshipped into another modal of transportation. The closer coordination in the process is obvious.

"In lateral coordination an organization employs lateral (i.e. horizontal) forms of communication and joint decision-making processes which cut across vertical lines of authority (see e.g. [17]). This strategy moves the level of decision making down to where information exists instead of referring a problem upward in the hierarchy."[11] It states that the re-schedules or re-planning, as a strategy, should focus on where the information related to the problem is. From the vertical and horizontal flows point of view, it is difficult for the parties to coordinate the information among them, for the information must have both the vertical direction and horizontal direction by means of manpower. From the vertical flow in IMTVE, without advanced information technology, it is also complex for the parties in the IMTVE to coordinate them promptly.

3.2 The feature of IMTVE in information vs. the multi-agent technology

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[11] Janne Huiskonen*, Timo PirttilaK(2002), Lateral coordination in a logistics outsourcing relationship, Department of Industrial Engineering and Management, Lappeenranta University of Technology

The international modal transportation, as mentioned above, is similar to the virtual enterprise. Much effort to coordination among parties should be made in the different carriers or parties. And the relationship and collaboration among them have great impact on the efficiency in the IMTVE. Otherwise, the seamless connections among different parties have the high requirement of information coordination among them. Furthermore, the focus on the feature of IMTVE is important.

3.2.1 The feature of IMTVE in information

The involved information has the variety sources and wide range among parties, for the different carriers or parties have their own characteristics and working flow. As an IMTVE, the complexity of gaining the related information just in time is another obstacle among participants.

The bilateral standard among parties implies that there are many differences in the information system among different parties. So it is very important for the IMTVE to ensure the compatibilities and inter-operations among the parties.

The requirement of information exchange among subsystems, legacy systems or existed systems is key feature in the IMTVE. The existed system in isolated party may be well-designed and well-performed for its own business. However, the integration of every system in the IMTVE becomes another difficulty, for the every system is parallel in the IMTVE and sharing information among parties under the bilateral standard is also difficult.

The support for the high-efficient information network is another feature in the IMTVE, for the participants is located in different countries or regions. Without the information network in the transportation, the IMTVE has inability of collaboration

among parties in the material flow and fund flow.

3.2.2 The feature of IMTVE in the multi-agent technology

As I state in the pervious chapter about the multi-agent technology in details, the multi-agent technology can provide a further solution.

The variety source of information can be regarded as an agent (or information agent) whose task is to collect the information for every participant. Different participant in IMTVE has their different core operation and they put different emphasis on different types of information.

Firstly, how the information agent in IMTVE gains the information?

Here, the behaviors of gaining the related information are two types. First type is that the work is done by manual, for the concept of agent has various meanings, it may be human. In this type, collecting the information may be documentary work or marks on the lists and finally all these information should be e-type. Second type is that the work is done by the software agent. It can collect the information dynamically and automatically in order to show the physical situation of the cargo in the IMTVE. The classification of the information can be done by the participant or the work process in the IMTVE.

Secondly, what meanings of information agent in the IMTVE is?

The information agent can be mapped to an entity which records every physical operation in international multimodal transportation. That is to say, the information agent can be used as the utility of tracking and tracing which covers the whole work in the IMTVE. Furthermore, it is useful for the manager of IMTVE to analyze the pervious information agents and make their works better, for the information agent

has well-performed in the structure of information.

The problem of standard in IMTVE which is related to bilateral and multilateral in the information can be seen as the combination between the task agent and information agent. The information agent knows the different types of standards and task agent knows how to digest the information which has already exist in the information agent and is also useful for the next participant. What's more, it is convenient for the task agent to convert the information in the multilateral standards.

Why it is the combination of both types of agent?

Suppose that the work is only done by the task agent, the function of the task agent is complex and it is not easy for software designer to update the task agent. For example, the standard has a new revision. The software designers have to adjust the task agent to meet the new requirement of compatibility in the IMTVE. It increases the complexity of maintenance and system updating. If the standard is seen as the information agent, the work is obviously simplified, for collecting and classifying the information are the major functions of the information agent and the revision of the standard is just the work of recollecting and reclassifying the information. And the task agent keeps the coordination correct in the IMTVE in compliance with the regular process.

The requirement of information exchange and network support can also be implemented in the multi-agent technology, for the distribution computing is the significant feature in the multi-agent technology. The information transmission can faster by the internet than by the phone-call. As we mention above that "This strategy moves the level of decision making down to where information exists instead of

referring a problem upward in the hierarchy,"[12] the agent technology can have a good performance in the "where the information exists". The problem related to the cargo flow in the IMTVE can be just-in-time for the manager, for the multi-agent can be automatic and dynamic in monitoring the condition of cargo.

3.2.3 Further discussion about the multi-agent information system in the IMTVE

The IMTVE has the "professional bureaucracy" structure. Every participant in the IMTVE has their own core operation. And information is often created with the core operation in the participant of the IMTVE. So the information security is major problem in the framework of the multi-agent information system in the IMTVE.

What the security about information is in the IMTVE?

The security about the information in the IMTVE surrounds the core operations. And the problem in every core operations will influence the quality of the coordination or collaboration in the IMTVE. "This strategy moves the level of decision making down to where information exists instead of referring a problem upward in the hierarchy."[13] The generated information may cause the problem. It may lead to the side-effect such as the Bullwhip but how the information is generated is not visible or helpful to others. How the information is generated is helpful to how to solve the problem inside or how to avoid the similar problems in the future. The information about the side effect is the secure information in the IMTVE. For example, the container is under the check of the customs and it will take a long time. It is not the problem but may change the schedule in the IMTVE. The waiting time in the customs will

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[12]Janne Huiskonen*, Timo PirttilaK(2002), Lateral coordination in a logistics outsourcing relationship, Department of Industrial Engineering and Management, Lappeenranta University of Technology
[13]Janne Huiskonen*, Timo PirttilaK(2002), Lateral coordination in a logistics outsourcing relationship, Department of Industrial Engineering and Management, Lappeenranta University of Technology

influence the inland transportation service. In the example, why the container must be checked in detail at the customs and how the container is checked is not important information for the inland carriers. The estimated time when the cargo in the containers can be released is the focus of the inland carriers. The synchronization of the information about the estimated time of releasing the container is the key information for both the inland carriers and the buyers or sellers. So the secure information is the estimated time.

In the IMTVE the document-process may be e-version. And in the traditional document-process, contents in the document must be checked carefully by the people.

This is overlap work for the people and the fault about the information on the document is inevitable. In the multi-agent information system in the IMTVE, the checking or matching document can be done in an effective way.

The digital signature service

The original information created by the information provider can setup a digital signature service. The every document can have an only-one signature sequence number. Moreover, a list of the sequence number for contents in the document can be created by the digital signature service.

The agent of the information creator signatures the information and transit the information and the SN to the other side of the multi-agent information system. The agent of the information receiver can signatures the information in the same way and compare the SN with the original SN. Any modification of the information will caused the difference between the original SN and destination SN. The paper

verification work can be simplified by the multi-agent information system.

3.3 The framework of multi-agent based information system in IMTVE

The multi-agent system is a system, which contains many types of agents and self-control these agents and provide the agents with a coordination platform. It can integrate the current agent-like system into one flexible system in order to improve the performance of the current system.

3.3.1 Agents in the multi-agent information system in IMTVE

In the pervious section, there are two types of defined agents as follows

Agent Type	tasks & meaning	Where it is
information agent	gain information, tracking and tracing, used for analysis	information creator
Task+information agents	digest the information and transit the useful information to another users	between information-user and information creator

Table agents in the IMTVE1

These types of agents are classified according to the function of the information system in the participants of the IMTVE. The function of these two is to create the information and locate where the information comes from and translate one format of information into anther which can be understood or useful to users. However, it is not enough to integrate the different information systems into one stable, flexible, robust multi-agents information systems in IMTVE.

The coordination agent is one type of significant agent in the IMTVE which focus on the coordination work in the IMTVE. The one function is to locate where

information-users are according to the information properties or values for the information users. For example, when the quantities of cargo may have some changes, the coordination agent can notify the information to the carriers according to the transportation planning in time. Another function is to make a plan or schedule according to the current resources of different participants in the IMTVE and to provide the operator of the international intermodal transportation with a feasible scheme or solution. The example may be the transportation for the project such as the project of building a power station. The coordination agent knows the target of the transportation such as time-priority or cost-priority or combination between time and cost. And then the coordination agent can have a clear picture of what the transportation-related resources in the IMTVE are, for it have the access to authorized-information in the IMTVE. For the AI algorithm is in the coordination agent, the coordination agent can separate the target into some small different targets and utilize the limited-resources in the IMTVE in order to get a better service-level for the project. Besides, in the implementation of the transportation, the coordination agent can give a modified, optimized solution for any situation. Last but not least, the coordination is the key function of the coordination agent. The just-in-time in the information coordination makes every participant know what have happened in other participants of the IMTVE without any delay. The presentation of just-in-time coordination may be e-mail, SMS and so on.

3.3.2 Framework of the multi-agent information system in IMTVE
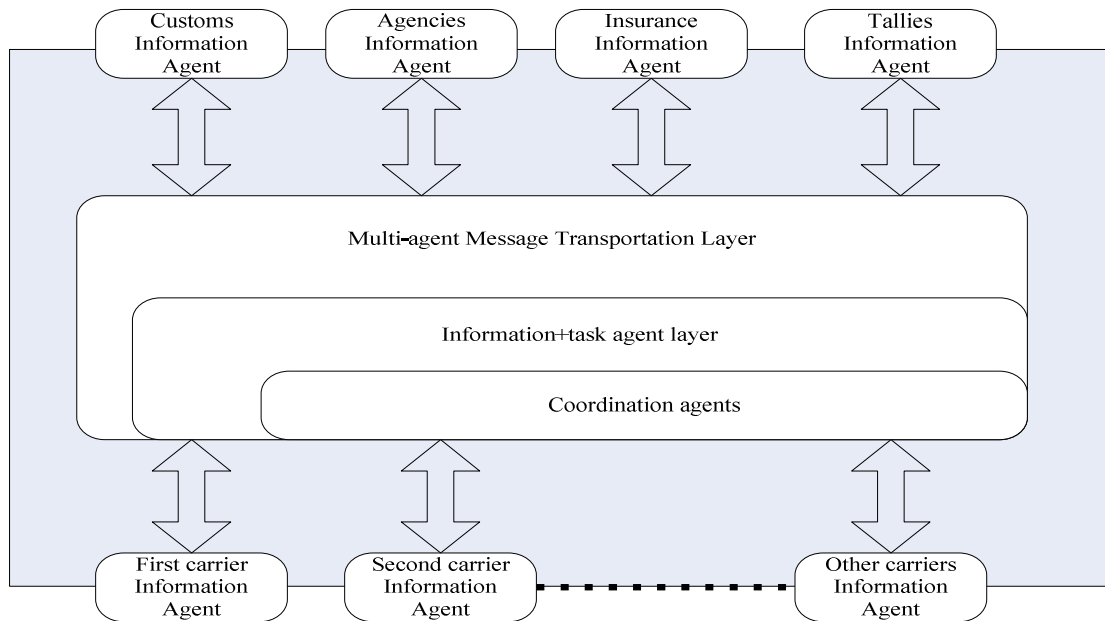
Framework of mult-agent based information system in the IMTVE

Figure Framework of MAS in the IMTVE-12

Where the agents are?

Where the information agents are?

In the framework diagram, the information agents are obvious in the every participant. From the agent's concept point of view, they are combination of different feature of agent. The format of information may be html, excel, or whatever and depends on the different existed information system in the participants, for the existed information system which is called subsystem in the multi-agent based information system may be legacy system or updated system and have different presentation in the information.

Where the information+task agents are?

Every participant has its own information+task agent whose work is to interpret the information which the information agents in every participant collect into the understandable data for the coordination agents or to interpret the data with which

the coordination agents provide the every participant into the understandable information for the information agents.

Where the coordination agents are?

"This strategy moves the level of decision making down to where information exists instead of referring a problem upward in the hierarchy,"[14] "decision making" is the goal of the coordination agent. "Where information exists" implies that the coordination agents are information-driven and are located at the position of decision making.

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[14] Janne Huiskonen*, Timo PirttilaK(2002), Lateral coordination in a logistics outsourcing relationship, Department of Industrial Engineering and Management, Lappeenranta University of Technology

CHAPTER 4

The conception of tramp shipping information system based on multi-agent technology

Tramp shipping is one types of sea transportation which have not fixed schedule, line and loading/discharge port, is suitable to the cargo demand. The sea transportation in the tramp shipping is managed by the carrier according to the requirement of the shipper.

4.1 The business flow in tramp shipping

4.1.1 The participants in the tramp shipping

Shipper is the person who needs the transportation to move his cargo from one place to another. Under the tramp shipping, he may be the charterer who charters a vessel to finish the transportation. Shippers form the demand of the tramp shipping services. The quantities of their cargo influence the capacities of the vessels. If both of them are not the same, the shippers have the cargo such as coal, iron, etc and need the sea transportation. For shippers, they want to find a vessel which is not only suitable for their cargo but also reasonable freight rate. They focus on the information about the tramp shipping market. They may have a good relationship with the intermediary such as agencies, or brokers (which are discussed below) in order to make it easy to get a better vessel for their cargo. If both the shipper and charterer are the same person who have both cargo and vessel, the charterer/shipper may charter a vessel (time charter, voyage charter, COA, etc) to finish their transportation. The problem at the very beginning is how to charter a vessel in a reasonable market level. The analysis of the tramp shipping market is inevitable. The information about the tramp shipping market is very significant for them.

The carrier in the tramp shipping is the person who may be the shipowner or ship

operator and wants to find the proper cargo for their vessel. They focus on the cargo flow in the world which implies the routing of shipment. The ideal situation for the carrier or shipowner is that their vessels can be deployed on the routing where there are ample cargoes and no ballast voyage. The information about the cargo flow or the trend of development in the world economic is quite important for them. However, they can have a good performance of their vessels with the intermediary's help.

The broker (intermediary) is the person who gives a hand to negotiation between the charterer and shipowner. He (owner's broker) can act on behalf of the shipowner and negotiate the transportation contract (charter party) with the charterer. Or He(charterer's broker) can act in the name of the charterer and charter a vessel for the charterer. "Brokers and agents have informative, intermediary and coordinating functions along the transportation chain. Due to their different work areas one may distinguish between shipbrokers in general and those concerned with sale and purchase, port agency and liner or loading agency."[15] In tramp shipping the major broker is the shipbroker. "In chartering, an owner and a charterer have an interest in the broker's sources of information, his particular knowledge, and his skill at negotiation"[16] The shipbroker, from the owner's or charterer's point view, is the information source. For the shipbrokers themselves, it is very important for the shipbroker to gain the information about a certain market or a sector of the market. The successful shipbrokers have the special sensitive to information, the potential meanings especially. For example, the Indian duties for export of the iron and ore have increased. It is significant signal for the sea transportation of the iron and ore. The freight rate for exporting iron or ore from India will have the fluctuation. The

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[15] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping series*, 39-40

[16] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping serie*s,39,40

side-effect is that demand of iron or ore from other exporters will be increased and the export from Brails or Australia will increase and in the short term there may be lack of vessel in Brails or Australia line. How the brokers gain this information? Traditionally, the newspapers are one channel. The next may be the TV news report or the Internet. Frequently, chatting with the business partners by telephone is another channel. All these are the channels of shipbroker to get the information. In other words, it spends much time and effort for shipbrokers to gain the related information about their business.

4.1.2 Business in the tramp shipping

Inquiry/Quote is that the charterer wants to charter a vessel with expected condition through the intermediary in the tramp shipping. The content of the inquiry/quote from charterers includes the type, quantity of cargo, loading and discharging ports, laycan, the form of chartering, expected freight, and the requirement of the specific vessels etc. Also, the inquiry can be sent by the shipowners' brokers in order to find the available cargo proposal in the tramp shipping. The inquiry from shipowners covers the name, nationality, type, gross capacity and bale capacity of the vessel, the time or voyage for the vessel, the expected available cargo and etc.

The second is offer that the shipowners' broker provides the charterer with the specific description of the vessel and other conditions after the shipowners get the inquiries, estimate the cost of the voyage and make a decision among some inquiries. Also, the offer can come from charterers when the inquiry is from the shipowners' side. The content of the offer, beside the reply for the inquiry, includes the freight level, selected formal of the charter party and some fix clauses, or additional clauses.

The third is the counter offer that charterers or shipowners will make some

modification in the contents of offer or add/delete some contents. The counter offer means that the new round of the inquiry starts and refuses the past inquiry/offer. When the charterers or shipowners get the counter offer, they must reply the inquirer whether they accept the content in the counter offer or make a new inquiry. It calls the recounter offer. The charterer and shipowner will make an agreement or suspend negotiation after several counter offers and recounter offers.

If the charterer and shipowner make an agreement, the firm offer and the fixture note will be sent to the charterer or the shipowner in order to firm the shipping agreement. If both the charterer and shipowner accept the contract, the charter party will be prepared for the charterer and shipowner to sign.

4.2 The information sharing in tramp shipping

The information source includes the information centre, the Baltic exchange, BIMCO. In tramp shipping the business through the intermediaries is commonly used. Now that the imbalance in the information leads to the existence of the intermediaries, it is necessary for intermediaries to share their information which covers the available cargo proposals, shipment possibilities.

4.2.1 The information source

The market reports may be the information source in tramp shipping. It covers comments on different markets, such as the dry cargo and tanker, the sale and purchase of ships, analysis of market and so on. The information provided by the market reports has the several features. The information delay is the first feature. In the market report, the information is a snapshot in the pervious market and is a lack of real-time. That is to say, the information on the market report has more advantage for the macro-understanding of the market than the micro-understanding of the

specific business. Another is the semi-close. The market reports are published by not only the famous consultations or information centre but also some big shipbroking companies etc. And most of them are not free of charge. In addition, the participants in the tramp shipping focus on the information they concerned about. The information demanders can't get the complete information from one market report and have to do their best to scan several market reports.

Information centers such as London, New York and Tokyo play an important role in the distribution of shipping information. "Brokers and charterers' representatives used to meet there regularly for a few hours around noon to distribute cargo circulars and to exchange information in confidence. The prevailing state of the market was discussed- formal freight negotiations could take place and fixtures were sometimes concluded on "the floor". Today this part of the work relating to the Baltic is normally done via the new tele- and internet media systems, while the important personal contacts are developed and maintained in other forms and by other means"[17] From the description in the book (the shipibroking and chartering practice), the internet media systems is used to simplify the process of providing the information related to the cargo flow and exchange. No doubt that it is convenient for the participant to communicate with each and exchange the information. The Information center can be regarded as a database which can be updated dynamically. But the function of that is an information pool.

Last but not least, Shipping organization or specialized website are significant information source. "BIMCO in Copenhagen is an organization dealing with various matters of interest to international shipping"[18] BIMCO have a good work on the

[17] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping series*,32
[18] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth

formal of the shipping documents. And also BIMCO also can provide the information demander with the port information such as the congestion, port dues and charges, port regulations and practice etc. The www.lloydslist.com is a website which contains the shipping information. "But Lloyd's List is not solely about shipping. On this internet site and in the pages of our daily newspaper you will also find in-depth coverage of marine insurance, offshore energy, logistics, global trade and law."[19]
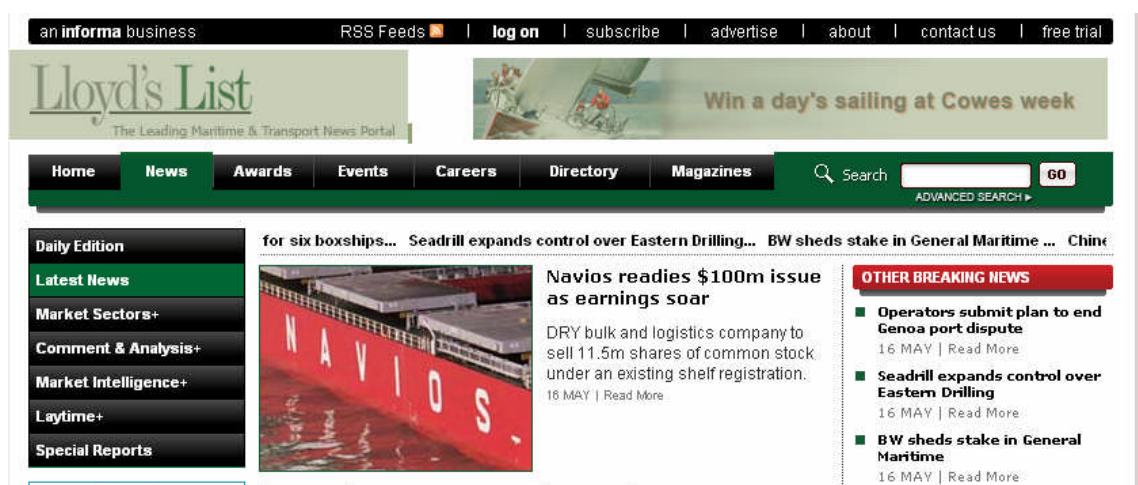
Figure Lloyd's list website-13

On this website, the RSS feed is a good feature for the information demander. And the other website about the shipping industry is a lack of that feature. It is based on XML technology.

4.2.2 The information sharing among the participants

The information sharing among the shipowner, charterers, brokers and agents is very important. They establish a network of contacts which can find the potential opportunities and adequate information.

edition, *Business of shipping series*, 33
[19] http://www.lloydslist.com/ll/home/about.htm;jsessionid=7AB94654F8ED7E2DD86DBAF54F251875

Sharing information between the shipowners and brokers

The brokers may keep in contact with some specific shipowners frequently. And they may have a good command of the position of the vessels owned by the shipowners. The shipowners may establish several contacts with several trusted brokers in order to maximize the utility of the shipment capacity. So the information about where and when the tonnages open often is exchanged between the shipowners and brokers. Otherwise, the open tonnage may be also sent to the potential charterers or charterers' brokers.

Sharing information between the charterers and brokers

Compared with sharing information between the shipowners and brokers, the information between charterers and brokers is also significant. It stands for the other side of the shipping marker—demand. The experienced brokers may have a long-term and good relationship with the charterers who often have available cargo for sea transportation. These brokers will communicate with the charterers/shippers in order to clarify the cargo flow.

Sharing information between the intermediaries

Different intermediaries focus on different markets or different sectors. By communicating within intermediaries who are specialists in the different sectors, the related information can be shared. For example, the brokers who are specialists in the panamax vessels may communicate with the brokers who are specialists in the cape-size vessels. They can understand the supply of the open tonnage. Brokers can keep well abreast of the availability of open tonnage of panamax and cape-size and the freight levels about different vessel types. If the freight level of the cape-size increases and that of the panamax reduces, the brokers may separate the available cargo for cape-size vessel into two for panamax. The precondition of it is the

information sharing among the brokers who have the firm information about open tonnage.

4.2.3 Means of communication

There are many means of communication in tramp shipping. "The shipping community has been fast in adopting and gearing up with modern IT tools and techniques."[20] In the past, telex is the popular tools to exchange information. Nowadays, the e-mail is commonly used. The material is scanned as a e-version and send as an e-mail on the internet. In additional, the instant messenger is another popular tool. The participants can chat with each other on the instant messenger without knowing where he or she is. The business can be done easier than ever before. The telephone remains the most popular tool. The telephone can also be a face-to-face contact.

"But the safety factors and the legal implications still remain to be fully defined and ascertained"[21] It may be the problem of exchanging information through internet. "Information about orders, position lists, market reports and various other matters are primarily received by e-mail"[22] The e-mail is used as the communication channel. "for example contract forms and pro forma charter-parties are frequently transmitted from one place to another by e-mail, but unfortunately today's situation is such that the offices at times feel nearly drowned by information of little relevance or usefulness" It is a lack of filter about the little relevance or usefulness.

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[20] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping series*,37
[21] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping series*,37
[22] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping series*,37

4.3 The discussion about the tramp shipping information system based on multi-agent technology

In the pervious section, the contents of information are discussed and the channel of exchange information has been listed. Nowadays, the information technology is developed rapidly. It is convenient for participants in the tramp shipping to simplify their works by means of multi-agent technology.

4.3.1 The business assistants

In tramp shipping, inquiry, offer, counter offer, recounter offer, acceptance, fixture note and etc is the basic business flow. All these are sent by e-mail. The e-mail is just a client for the users and its function is like the mail system, just e-implementation of the mail. It is obvious that the e-mail system can speed up the exchanging information in the tramp shipping. And the auto-check-mail option can check the e-mailbox at regular intervals.

The e-mail is designed for the common users, but it is a lack of the assistance for the business in the tramp shipping. From the agent's point of view, the e-mail clients (Outlook, foxmail, Thunderbird) can be regarded as the task agent whose function is to transit the information to the others. The business flow can be controlled by other types of agents. For example, based on the e-mail clients or e-mail packages, the special designed agents can monitor the inquiries and find the suitable vessels in the many inquiries and recommend them to the brokers and then trace the whole business. This work is done by brokers manually. Another potential advantage of this implementation of agents is that the tracing of every business flow can be used for establishing a long-term customer-relationship and locating the key customers (shipowners/charterers). In additional, as we all know, the experience in the tramp shipping is very significant. The special designed agents for business flow can be

historical records or cases from which the new-comers can accumulate the experience.

Where the business flow agents are?

They are in the different participants of the tramp shipping such as shipowners, charterers, and intermediaries. Because the contents or focuses of every participant in the business of tramp shipping are different, it is necessary for the every participant to have their own special designed agents for business flow.

What the contents of the business flow agents focus on?

The different information in the business of tramp shipping, I think, is the key focus. The information about the specific vessel is commonly unchanged such as the gross capacity, DWT, nationality etc. The meaning of different information is different information of every business in the tramp shipping. Take the shipowner for example. The vessel owned by the shipowner is the same. The difference for the vessel is the type, quantity of the cargo, loading and discharging ports, lay/can and so on. And the difference in the business implies the space for the negotiation or bargaining. The manifestation of the difference in every business may be the specific additional clauses, or some special terms. These manifestations can be recorded by the business flow agents.

4.3.2 The information sharing on the multi-agent technology
In the 4.2.1 and 4.2.2, sharing information is inevitable in the tramp shipping.

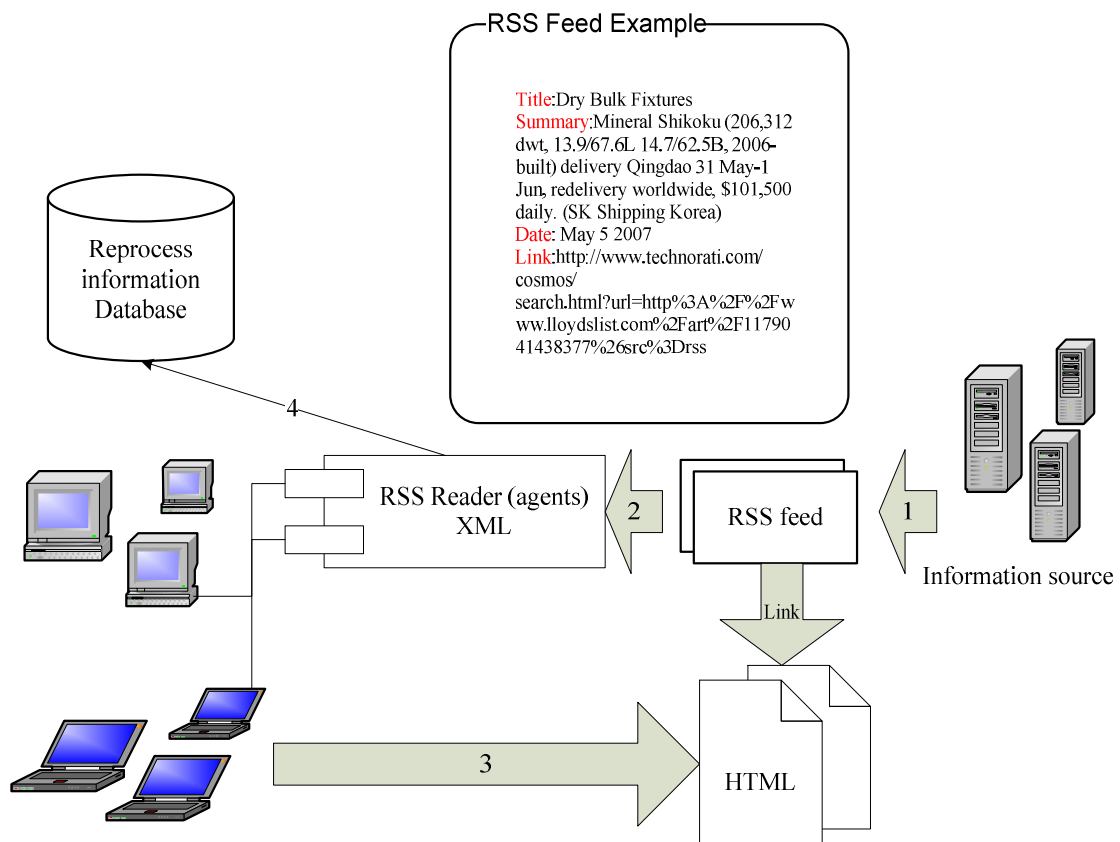### 4.3.2.1 Improvement for the information source
The information source mentioned above includes market report of which problem is time-delay in information, the information centers of which problem may be limitation as an information pool, the website (B/S structure) which put their

information on the net. And the market report and the information centers also have their website. There exist the improvements of the information source.

From the multi-agents' point of view, every participant is regarded as an information creator or demander. And the multi-agents can make the pull process in the information source. Every participant in the information source has their own agent whose task is to generate, evaluate and process the information.

"RSS 1.0 ("RDF Site Summary") is an RDF Vocabulary that provides a lightweight multipurpose extensible metadata description and syndication format. In short, it's a means for describing news and events so that they can be shared across the web." [23] (Description from w3c) The information provider makes their information as the RSS feed which is subscribed by the users. The RSS reader (which is a type of agent) can collect and show the information according to the preference of the users and introduced to provide personalized one-stop service. For the users, they book the RSS feed which they focus on such as the Baltic Exchange Index, the fixtures of example. Users can set the options about the filter of RSS reader which can list the important information for the users. The information described by the RSS can be processed easily, for the RSS is based the XML (the self-described markup language). Users can reprocess the information (for example source of their own market report) and find potential opportunities. For information publishers, they can publish their RSS feed on the website and add the information into the RSS feed as a tag which contains the title, the description, the link etc.

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[23] http://www.w3.org/2001/10/glance/doc/howto

RSS Feed Example

Title:Dry Bulk Fixtures
Summary:Mineral Shikoku (206,312 dwt, 13.9/67.6L 14.7/62.5B, 2006-built) delivery Qingdao 31 May-1 Jun, redelivery worldwide, $101,500 daily. (SK Shipping Korea)
Date: May 5 2007
Link:http://www.technorati.com/cosmos/search.html?url=http%3A%2F%2Fwww.lloydslist.com%2Fart%2F1179041438377%26src%3Drss

Reprocess information Database

4

RSS Reader (agents) XML

2

RSS feed

1

Information source

Link

3

HTML

RSS workflow-14

1. create the RSS feed about the information

2. RSS Reader (agent) updates the contents according to the RSS feed. Here, the example of RSS feed covers a Dry bulk Fixtures.

3. Users read the title and summary of the RSS information. If they are interested in the Dry bulk Fixtures, they can click the link of html on the information source.

4. The RSS Reader (especially designed for the brokers, shipowners, or charterers) reprocesses the information. For example, the Dry bulk fixtures may be important information for the brokers. Brokers can track and trace the vessel. And from the further analysis of the reprocess information database, they can clarify the supply and demand of vessels or available cargo in the specific trade area.

Last but not least, all the work can be done automatically by the agent technology. The information which is based on the XML RSS file can be reprocessed easily, but the method of reprocessing the information is the Data mining or knowledge discovery in the agent technology.

The multi-agents based on the RSS make the information demander book what they are interested in and reprocess the information according to their goal. Compared with "push" in the traditional website, the pull process can be implemented.

4.3.2.2 Sharing information among participants

The information sharing in the tramp shipping covers the shipowner, the charterer, the intermediary. The intermediaries reduce the complexity of imbalance of information between the supply (shipowner) and the demand (charterer).

The information sharing between the intermediary and the shipowner/charterer focus on the vessel information and available cargo, such as the position of the vessel, the ETA of the destination, quantity of cargo, so on. All these information is exchanged by the e-mail between the shipowner/charterer and the intermediary. The e-mail is just an agent which has the capacity of transiting the data from one side to another. The e-mail client is not designed for the sharing information in shipping business and limits the computing power of the present PC.
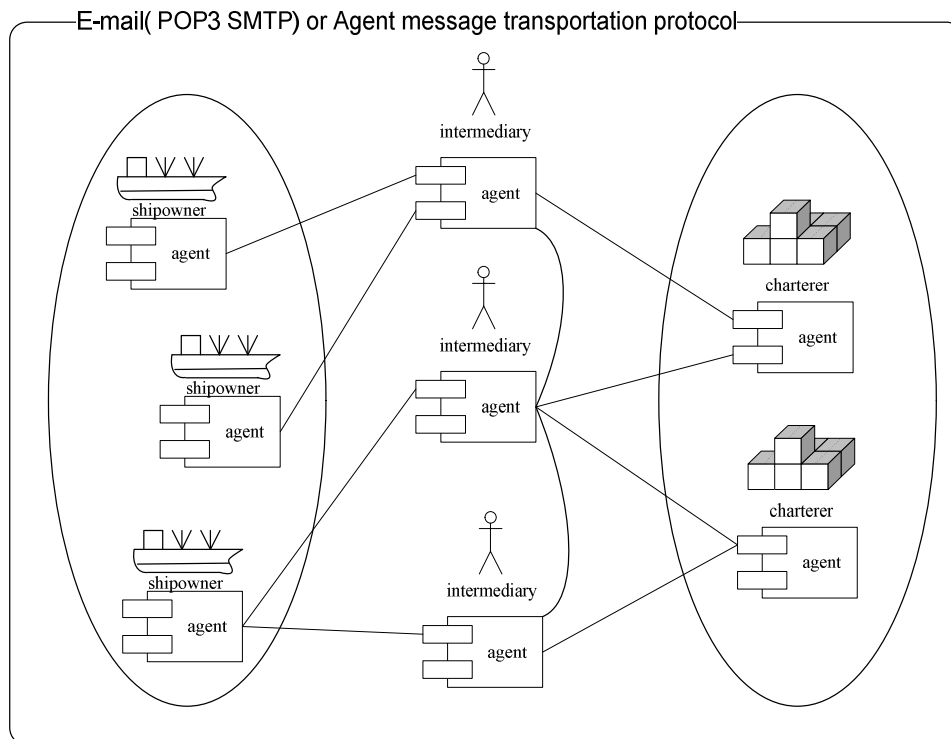
MAS in tramp shipping-15

1. The agent in the shipowner's side

   The work of collecting information which is related to the shipment may be done by the seafarers or operator of the vessel. For example, the agents in the shipowner may be a manager of the vessel. He prepares the next voyage for the specific vessel and creates the information about the open tonnage such as location of the vessel, delivery or redelivery, and expected cargo for the vessel etc. This is, to some extent, a repetitive work for the manager.

   However, the agent can translate the information into the pre-organized e-mail (which means that it is not only for people's reading but also for computer process) and finish the repetitive work for the manager. In addition, the reply from the intermediary can also under the monitoring of the agents. When the intermediary has the reply, the agent can list them according to the special order

such as the received date, the name of the intermediary and so on. The agent of the shipowner's side can also be on the vessel if the vessel has the semi-automatic system. The real-time information can be transmitted to the intermediary's agent without any delay.

2. The agent in the intermediary's side

The agent in the intermediary's side gains the information of the shipowner from the shipowner's agent and the intermediary can know the related information just in time. For example, the intermediary (port agent) wants to know the ETA of the vessel and the loading schedule. The intermediary may make a phone-call to the shipowner. One possible situation is that loading schedule may not be prepared. And the intermediary may wait and contact with the shipowner until the loading schedule is ready. The intermediary's agent can communicate with the shipowner's agent automatically. When the loading schedule is ready, the intermediary's agent can gain that information just in time and the intermediary is informed by means of the highlight title in the PC or SMS. Compared with the phone-call contact, the multi-agents' contact make the coordination between the shipowner and the intermediary fluent without and delay. And the intermediary won't be tolerant that he can't get the information they concerned about in time, for the multi-agents can coordinate with each other and exchange the information if the information exist. The time and position about the open tonnage can also be estimated through the coordination among multi-agents. The intermediary can also find the next available cargo for the vessel. The intermediary's agent also has the contact with the charterer's agent. The information from the charterer can be gained in the coordination among the intermediary's agent and the charterer's agent. In the intermediary's side, the agents can list some solutions for the certain available cargo and the certain open tonnage according to the setting of the

intermediary.

Here, some one may ask "Does the intermediary lose their job or opportunity in the business of tramp shipping since the multi-agents among the participants of the tramp shipping can coordinate with each other, exchange information and even give a solution for the available cargo and the open tonnage?" The answer is No. It is necessary for the intermediary to enter into the communication among participants, for the intermediary can make a decision in a suitable way. "The broker may not withhold any information from his principal nor give him wrong information. Nor may he reveal his principal's business secrets and may not act to the advantage of the counter party in the negotiations in order to reach an agreement."[24] However, the multi-agents can give a hand to the business of the tramp shipping and make the participants' work easier than ever before.

Last but not least, the inter-communication between the intermediaries is another key function of the agent of the intermediaries. The multi-agent in different intermediaries just like the multi-agent in the IMTVE can coordinate different agents in the tramp shipping business flow. The operator of the vessels can communicate with the port agents and the ship owner by means of the multi-agent coordination. Agents can assist chartering brokers which specialized in different market section to exchange the related information.

3. The agent in the charterer's side

The agent in the charterer's side has the function of communication with other agents. In addition, the track and trace of the charterer behavior may be another

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[24] Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), Shipbroking and Chartering practice sixth edition, *Business of shipping series*, 40

function. The charterer/shipper can be a merchant. Under the transportation agreement, there is always a trade agreement. In order to achieve the business goal, the merchant may face with the dilemma between the transportation agreement and the trade agreement. The merchant/shipper and the intermediaries or shipowners needs the well-time cooperation by means of exchanging information in time. And the charterer's agent can track and trace the trade agreement such as the manufacturing plan, the quantity of the cargo which is prepared for one voyage and so on. The charterer's agent can notify the intermediary's agent according to the business goal of the charterer.

CHAPTER 5

The Demo of the multi-agent information in the shipping industry

In this chapter the demo of the multi-agent information in the shipping industry has the simple implementation. And the matured multi-agent platform will be introduced. The aim of the demo is to explain the feasibility of the multi-agent information system. The coordination among different agents is the focus. And the demo will show us how easily the coordination among different agents implements. However, the demo of the multi-agent information system is powerful although the whole demo application and multi-agent platform environment debugging and testing is done by the writer.

5.1 The case description

The goal of the demo is to implement the concepts and functions of the multi-agent in the shipping industry. The ship supplement is common work between the shipowner and the intermediaries (the operator, the supplement company).
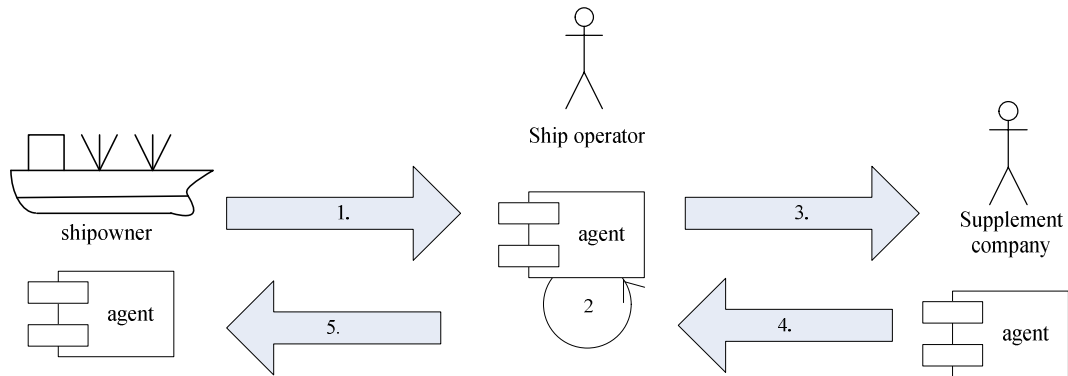
The content of the case is as follows

Figure Demo Case-16

1. The vessel or the captain sends its ship situation message to the agent of the ship operator in the shipowner or the operator company.

2. The agent of the ship operator analyzes and explains the message, after getting the ship situation message.

3. And then the agent of the ship operator coordinates with the agent of the supplement company in order to prepare the supplement of the fuel oil, the diesel oil, and the fresh water for the vessel.

4. The agent in the supplement company gets a reply to the agent of the ship operator and confirms the supplement request.

5. After getting the confirmation from the supplement company, the agent of the ship operator sends the message to the vessel or the captain.

5.2 The case is simulation

In practice, the supplement is the coordination and collaboration among the captain, the ship operator and the supplement company. This is a academic research of the feasibility of implement the multi-agent technology in the supplement work. So the agents of the ship (vessel), the operator, the supplement company will be simulated.
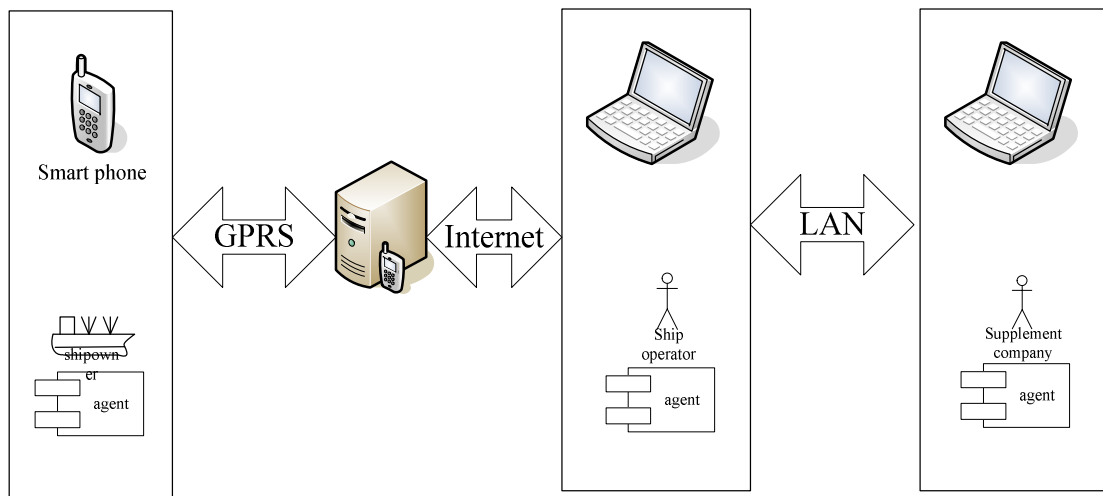
Figure Simulation structure-17

In the shipowner side, the smart phone represents the agent of the vessel or captain. The smart phone has the access to the GPRS network and sends the message to the smart phone server. And the smart phone server transmits the information (ship situation report) to the agent of ship operator by means of the internet. The agent of the ship operator is run on a laptop. The agent of the ship operator coordinates its information with the agent of the supplement agent by means of the local network.

5.3 The multi-agent implementation

5.3.1 The platform

There are some multi-agent platforms as follows:

Aglets

http://aglets.sourceforge.net/

"Aglets is a Java mobile agent platform and library that eases the development of agent based applications. An aglet is a Java agent able to autonomously and spontaneously move from one host to another. Originally developed at the IBM Tokio Research Laboratory, the Aglets technology is now hosted at sourceforge.net

as open source project, where it is distributed under the IBM Public License. Aglets is completely made in Java, granting an high portability of both the agents and the platform"[25]

JADE

"JADE (Java Agent DEvelopment Framework) is a software framework to develop agent-based applications in compliance with the FIPA specifications for interoperable intelligent multi-agent systems. The goal is to simplify the development while ensuring standard compliance through a comprehensive set of system services and agents. JADE can then be considered an agent middle-ware that implements an Agent Platform and a development framework. It deals with all those aspects that are not peculiar of the agent internals and that are independent of the applications, such as message transport, encoding and parsing, or agent life-cycle. The version 2.X of the JADE framework complies with the latest FIPA specs, also called FIPA2000 specs."[26] http://jade.tilab.com/

Also there are some other multi-agent platforms. I have some study on the aglet which was designed, implemented by the IBM and specialized in the mobility. The aglet is not a mature multi-agent platform. However, the JADE is mature multi-agent platform. The JADE can be easily developed and integrated with other information system. And it has been widely used in some fields such as Telecom Italia LAB(http://www.telecomitalialab.com/), Whitestein Technologies AG http://www.whitestein.com/ and so on (http://jade.tilab.com/ for details). So I build the demo on the JADE.

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[25] http://aglets.sourceforge.net/

[26] http://jade.tilab.com/

In addition, in order to simulate the wireless application, the incesoft msnrobot has been selected. "Incesoft is committed long term to the mission of offering the best technical products to users with our artificial intelligence technology base. At present we have had our own core patent technology -- artificial intelligence information interactive platform, and persisting in exploring new Internet technology and business modes. Our goal is to provide high-quality network service for Internet users through our excellent technology and interactive intelligent products." [27] http://www.incesoft.com/English/

The integration between JADE and Incesoft's robot in the demo can show us the flexibility in developing the multi-agent application.
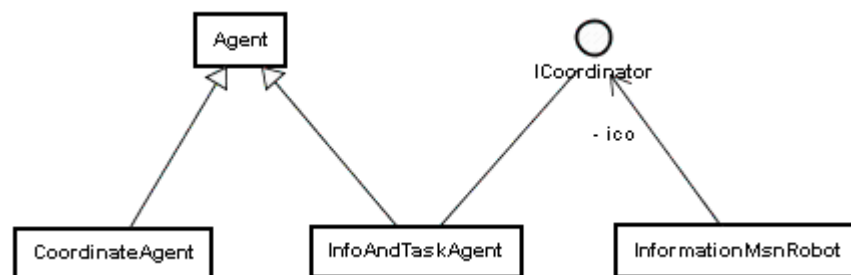
5.3.2 The basic design

Figure Demo Basic Agent Design -18

In the simulation, there are three agents in the multi-agent system.

The coordinateAgent is an agent whose work is to accept the request of the supplement and reply the confirmation of the supply's preparation. It runs on the supplement company machine.

The InfoAndTaskAgent is an agent whose task is to analyze the receiving message

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[27] http://www.incesoft.com/English/

from the vessel or captain and coordinate the information of supplement with the agent of the supplement company. It runs on the ship operator's machine.

The InformaitonMsnRobot is an special agent which is based on the third party software package(I mentioned above the Incesoft robot). The Incesoft robot server works between the GPRS and internet. And the Incesoft robot transit the information from the vessel or captain into the InfoAndTaskAgent.

5.3.3 The demo snapshot

1. MSN Agent (the vessel or captain)

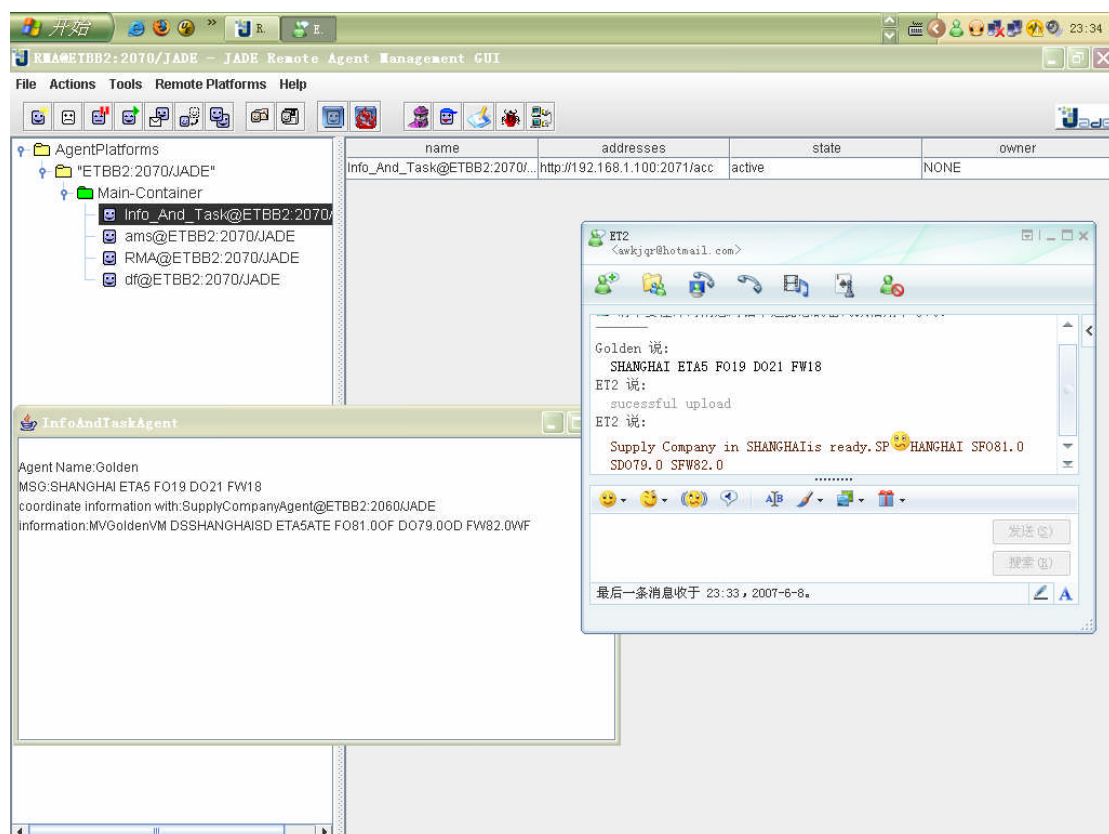It sends the ship situation of "SHANGHAI ETA5 FO19 DO21 FW18"

Figure Demo snapshot-19

2. The InfoAndTaskAgent(the ship operator or agency)

It coordinate the information ("Agent Name:Golden

MSG: SHANGHAI ETA5 FO19 DO21 FW18

Coordinate information with:SupplyCompanyAgent@ETBB2:2060/JADE

information:MVGoldenVM DSSHANGHAISD ETA5ATE FO81.0OF DO79.0OD

FW82.0WF") with the agent of the supplement company.

3. The SupplyCompanyAgent

It prepares the supplement for the information coordination from the agent of ship operator. It sends the reply to the agent of the ship operator. The agent of the ship operator sends the confirmation of supplement request to the agent of the vessel or captain.
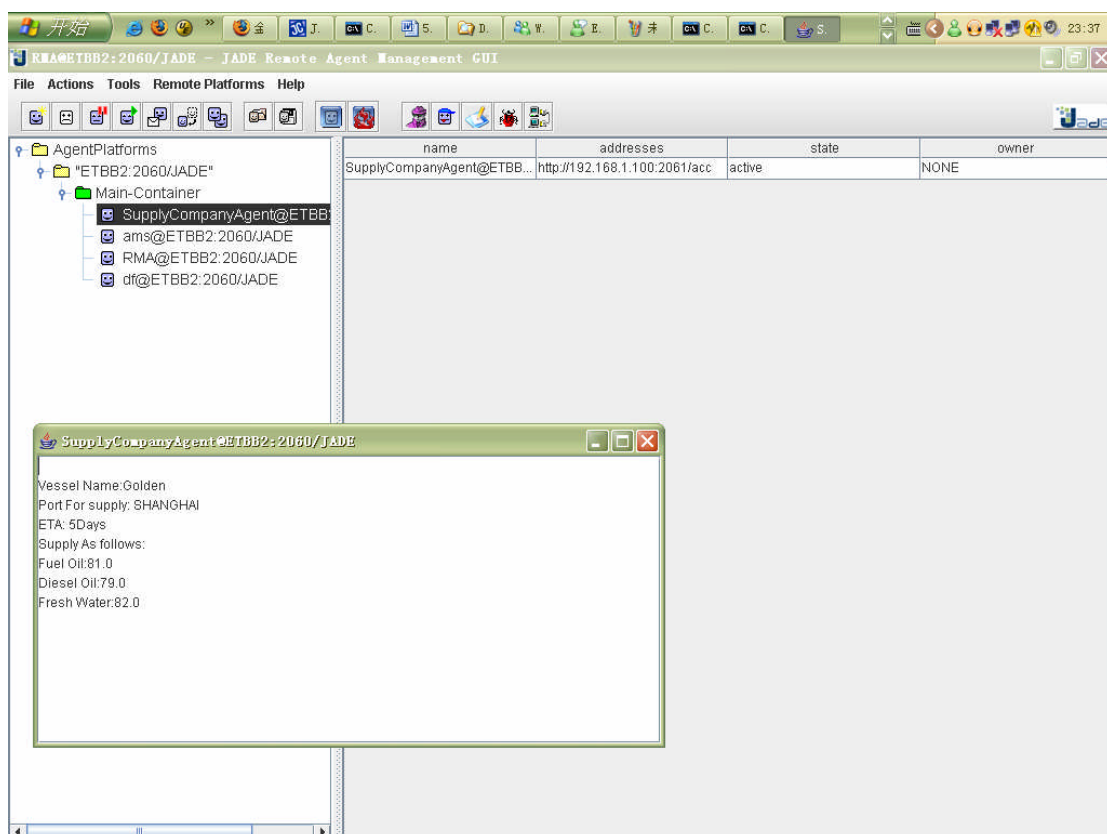

Figure Demo snapshot 2-20

CONCLUSION OF THE DISSERTATION

Nowadays sea-borne transportation is collaboration among many participants. The coordination among the different participants becomes the most important element in the sea-borne transportation. The service of sea-borne transportation is not only related to the supply and demand in the transportation's market but also related to the degree of the collaboration in the transportation which influences the service level. So the information sharing is the key factor which means that the greater the ability to share related information with the most important supplier (the participants in the IMTVE, or the shipowners, the charterers, the intermediaries), the greater the degree of transportation services.

Information sharing is the fundamental requirement for the sea-borne transportation. One company provides others with the information. But mostly the dependency on the information is not just sharing information. The information coordination is further step of the information sharing. Just gaining the information is not enough. The information can drive the internal wok in one company and the feedback's information of that work is another driver for another company. Any problem in one side may generate the information which is also important for others to change the work promptly.

Computers have been widely used. The computing power of the computer is increased dramatically, but making the utmost of the computing power can't keep in step with the tendency of increasing computing power. The multi-agent technology focuses on how to integrate different information system into one coordinate, synchronized, sharing information system. It can reduce the complexity of building one information system for everyone. Instead, it has the capacity of combine

different existed information systems into one and makes them well-performed in the information coordination.

REFERENCE

ZHOU Yan-jie, WANG Meng(2006), *The System Design of Management of Third Party Logistics* China storage & transport magazine

Nirupam Julka, I. Karimi, Rajagopalan Srinivasan (2002), *Agent-based supply chain management—2:a refinery application*

A.V. Smirnov, M.Pashkin, N.Chilov, T.Levashova, *Agent-based support of mass customization for corporate knowledge management*, Engineering Application of Artificial Intelligence

XU Li; CAO Yuan-da; LIAO Le-jian; HU Jing-jing(2002), *Planning for Logistic Management System Based on Multi-agent*, Microcomputer Development

HAO Peng-fei; HE Shi-wei; CHEN Yan-qing(2001), *Logistics Dispatch Decision Support System Based on Multi-Agent*, Logistics Management

ZHOU Liang; WANG Tie-ning; LI Sheng-li; PEI Shuai, *Research on Logistics Information Platform Model Based on Agent Technology*, Logistics Management

YANG Run-ping, DU Shi-min(2003), *Research on workflow of commerce model for collaborative logistics*, Information Technology

Ding Yong(2002), *A Study of the Logistics Distribution Decision Support System on Agent Technology*, Logistics Management

ZHANG Jin, YANG Dong-yuan, WANG Xiao-kun, XU Jun, GUAN Zhi-chao(2005), *Development of Logistics Public Information Platform*, Communication and Transportati0n Systems Engineering and Information

DONG Qian li(2002), *Regional logistics information platform and resource planning*, Journal of Traffic and Transportation Engineering

DONG Qian-li; ZHU Chang-zhenghaina(2004), *Research on Industry Supply Chain and its Logistics Informatization*, Logistics Technology

Chen Jun'an Huang Jinguo(2003), *Model of material flow management for manufacture enterprise based on multi-agent technology*, Journal of Huazhong University of Science and Technology

Yu ming(2003), *The Design of Logistic Management Information System Based on ERP and the Study on Production Scheduling*

LIU Xing -jing; DAI He; YANG Dong – yuan(2001), *Analysis on the Frame of Logistics Information System*, Logistics Technology

Jonathan Bredin and David Kotz and Daniela Rus(1997). *Market-based Resource Control for Mobile Agents.* Technical Report PCS-TR97-326, Dept. of Computer Science, Dartmouth College

Andreas Gerber, Christian Russ, Matthias Klusch (2003), *Supply web co-ordination by an agent-based trading network with integrated logistics services*, Electronic Commerce Research and Application 2(2003) 133-146

Leonid B.Sheremetov, Miguel Contreras, Cesar Valencia(2004), *Intelligent multi-agent support for the contingency management system*, Expert Systems with Applications 26(2004) 57-71

Ana L.C. Bazzan, Franziska Klugl, Sascha Ossowski (2005) *Agents in traffic and transportation: Exploring autonomy in logistics, management, simulation, and cooperative driving* Science direct Transportation research Part C

Schleiffer,R. 2002. Intelligent agents in traffic and transportation(editorial). Transportation Research C

Paul Davidsson, Lawrence Henesey, Linda Ramstedt(2005), *An analysis of agent-based approaches to transport logistics* science direct Transport Research

JADE website gives further information on courses
(http://jade.tilab.com/)

Incesoft website gives further information
http://www.incesoft.com/English/

Lars gorton, Patrick hillenius,Rolf ihre, Arne sandevarn (2004), *Shipbroking and Chartering practice sixth edition*, Business of shipping series,

Henry Mintzberg(1992).*Structure in fives –designing effective organizations*. Prentice Hall

Gunnar Stefansson(2005).*Interfaces in collaborative logistics management.* Unpublished lecture handout, World Maritime University, Malmo, Sweden

LIANG Shi-xiang(2005), *Research on Synergetic Logistics Based on MAS*, Logistics Technology publication No11,2005

Xu Shujun(2006), *An Online Prediction Grey Modeling Jump Series on Reverse Logistics Based on Agent,* Computer Engineer,Vol32 No8

LIANG Dengpan, ZHAO Yifei(2006), *Problems and Developing Tactics for Constructing the Port Logistics Information Platform in China*, Industrial Engineering and Management No1.2006

LIU Xiaoqun, MA Shihua(2006), *Planning and designing of logistics outsourcing information support system*, Computer Application, Vol26 No2

Klaus Mainzer(1998), *Computer technology and evolution: from artificial intelligence to artificial life*, Computer Technology and Evolution105 PHIL&TECH

Benoit Leloup(2003), P*ricing with local interactions on agent-based electronic marketplaces*, Electronic Commerce Research and Application 2(2003),187-198

Alexander Smirnov, Mikhail Pashkin, Nikolai Chilov, Tatiana Levashova (2004), *Knowledge logistics in information grid environment*, Future Generation Computer Systems 20(2004)61-79