Multi-agent Collaboration Engine for Supply Chain Management

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***Abstract*—To improve the performance of Supply chain decisions (SCM) , agents technology is slowly becoming the best alternative . In general , most of the components in SCM work in isolation and achieving coordination among SCM partners turns out to be a difficult proposition . But in a multi-agent system (MAS) , an agent while making a local optimal decision , it sees how it will effect the other agents and in case required it coordinates with other agents to workout for a new alternative . In SCM , what is required is how to improve the performance . Today SCM needs to work in coordination with various like minded organizations to produce and supply to multiple market . In such circumstance MAS ,with beneficial features like autonomous , collaborative , coordinate and intelligence with ability to work in a distributed environment provides a best platform to make SCM performing at its best . The project aims to propose an integrated frame work based on multi-agent collaboration and case-based reasoning that can resolve various collaboration issue in supply chain. To show the frame work's feasibility, we implement a prototype system(multi-agent collaboration Engine supply chain management) MACE-SCM.MACE-SCM provides more flexible and extensible solution to help address emerging uncertainties**

Keywords- Multi-agent; Case-Based Reasoning; RDQL (Retrieval Data Query Language);

I. INTRODUCTION

Easy availability of network access and a huge demand because of usefulness of agents , the agent technology is picking up fast . Also growing demand from electronic commerce and the web technology , it creates a big environment and challenge to developers for designing agents which ultimately reduce total SCM cost , faster and assist users or other agents .

MAS with multiple interacting agents aims for a perfect coordination among its members to solve complex problem . The autonomous agents with their flexibility , quick in collaboration with other agents to propose optimum solution in a difficult situation in any application , their robustness , scalability and reusability , MAS stands out to be a right choice for SCM . Today's requirement is to reduce inventory , add more product value , proper use of resources , quick in marketing and customer satisfaction . An integrated SCM based on MAS technology is really a great asset . Such SCM will keep the correct information flowing over the entire supply chain , help supplier selection process easier and a proper distribution system .A case based reasoning (CBR) system is an excellent option especially in a SCM environment where decisions have to be taken instantaneously . CBR system helps in providing solution to any problem from its case base . A problem is reduced to a case format and CBR system looks for a matching solution or near solution . This reduces time and effort enormously. New case with solution will be added to Case base once the solution is adapted .

Hence, this project aims to propose an integrated frame work based on multi-agent collaboration and case-based reasoning that can resolve various collaboration issue in supply chain. We propose a frame work multi-agent collaboration Engine supply chain management (MACE-SCM) which provides more flexible and extensible solution to help address emerging complex problems in SCM .

II. RELATED WORK CASE BASED REASONING

An agent is a physical or virtual entity Which is capable of acting in a environment , can communicate directly with other agents, capable of perceiving its environment , having only a partial representation of this environment , possessing skills and offering services. Agents are Autonomy that is able to do at least part of its functionality independently and follow goals autonomously. They are Intelligent in the sense that agents have some specialized knowledge in one or more application fields. The agents are able to collect information or to react on conditions of its environment. They are reactive so they react appropriately to inputs from its Environment . They are Pro-activity and goal orientated . The agents change its behavior based on its previous experience. They are mobile in the sense that agents to transport themselves from one node of a network to another. The crucial features are that agents are communicative and cooperative .

Multiagent systems are systems in which multiple interacting agents interact to solve problems . Agents in MAS know when and how to interact with whom . Common characteristics of multiagent systems are their inherent distribution and complexity . Distributed and flexible nature of multiagent systems leads to increased speed, robustness, scalability and reusability.

In a MAS ,

- Each agent has incomplete information
- Control is decentralized
- Data is decentralized
- Computation is asynchronous

At the time of designing MAS , several issues have to be addressed like when and how agents should interact – cooperate and compete – to successfully meet their design objectives , sometimes agents have to solve a subproblem collectively and in such case agents should understand other agents' capabilities , how to enable agents to decompose their tasks and goals (and allocate sub-goals and sub-tasks to other agents) and synthesize partial results , how to enable agents to communicate ,What languages and protocols to use , how to enable agents to represent and reason about the actions, plans, and knowledge of other agents in order to interact with them , how to enable agents to represent and reason about the state of their interactions , how to enable agents to recognize and handle conflicts between agents , how to ensure multiagent systems are correctly specified , how to realize agents intelligent processes such as problem solving, planning, decision making, and learning in a multiagent systems context , how to organize Multiagent systems and define roles of each agent

As the demand for more powerful, efficient and versatile agents grows, so too does the pressure on developers. At the same time making agent perform too many tasks would lead to complexity of development and increase of maintenance Agents are generally designed with a specific purpose in mind. If agents must perform more tasks, we can either increase their complexity (which increases the development effort), or we can make them work co-operatively. The cooperation among agents is absolutely necessary and to succeed, effective communication is required. we need a common language and communication medium. The language and communication medium is critical for cooperation between agents/

III. CASE BASED REASONING SYSTEM

A case based reasoning (CBR) system is an excellent option especially in an application environment where decisions have to be taken instantaneously . CBR system helps in providing solution to any problem from its case base . A problem is reduced to a case format and CBR system looks for a matching solution or near solution . This reduces time and effort enormously. New case with solution will be added to Case base once the solution in adapted . The processes involved in CBR can be represented by a schematic cycle .CBR typically as a cyclical process comprising the four REs:

- RETRIEVE the most similar case(s).
- REUSE the case(s) to attempt to solve the problem.
- REVISE the proposed solution if necessary.

1. RETAIN the new solution as a part of a new case.

A new problem is matched against cases in the case base and one or more similar cases are *retrieved*. A solution suggested by the matching cases is then *reused* and tested for success. Unless the retrieved case is a close match the solution will probably have to be *revised* producing a new case that can be *retained*. This cycle currently rarely occurs without human intervention. The intention is introduce agents technology to perform the CBR cycle . CBR system will consist of the following agents .

1.Retriever Agent which When a new problem is entered into a case based system, a retriever decides on the features similar to the stored cases . Retrieval is done by using features of the new cases as indexes into the case base.

2.Adapter Agent examines the differences between these cases and the current problem .It then applies rules to modify the old solution to fit the new problem

3.Refiner Agent critiques the adapted solution against prior outcomes . One way to do this is to compare it to similar solutions of prior cases. If a known failure exists for a derived solution, the system then decides whether the similarities is sufficient to suspect that the new solution will fail .

4.Executer Agent acts Once a solution is critiqued, an executer applies the refined solution to the current problem.

CBR system consists of Case base and engine consisting of these agents ..Evaluator Agent does the following :

If the results are as expected, no further analysis is made, and the cases and its solution is stored or use in future problem solving. If not, the solution is repaired.

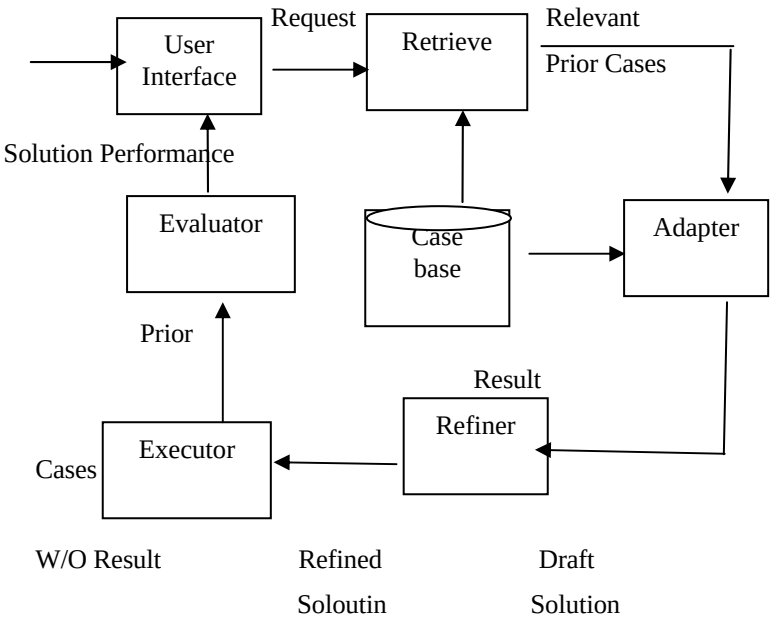

Figure 1 The CBR Cycle

IV. MULTI- AGENT (M-A) COLLABORATION ENGINE FOR SUPPLY CHAIN

In order to make SCM perform effectively , its function operates in a coordinate manner. But the fast change of the enterprise and the market make SCM facing several difficulties . Some of key problems are as follows :-

1. Materials not reach in time due shipment problem
2. Production facilities experience down-time
3. Man power problem
4. Customer change order or cancel.

In the global market place with shortening life cycle ,fast changing consumers' choice , the need for real time supply chain coordination , collaboration among various functions , sharing of correct information among SCM partners is vital. Information technology and information sharing make coordination possible. Collaboration in supply chain in any single company in a one-directional way will not make the SCM successful but need to be coordinated by all like minded companies who are in business autonomous participation of companies. For these reasons, multi agent system technology and case-based reasoning are regarded as best candidate for supply chain management. To optimize supply chain decisions, an agent can not by itself make a local optimal decision but it has to coordinate with others to choose correct method and execute that is optimal over the entire supply chain.

Multi-agent technology has many beneficial features for autonomous, collaborative and intelligent system in distributed environment, which make it one of the best candidates for complex supply chain management. Agent send and receive messages concerning their current situation to agent in other related or same system and display evolutionary behavior in response to change. With in MAS, different types of agents have different degree of problem solving capabilities with in different problem domains. MAS architectures vary according to the

complexity of problem domains (number of agents, system design and the number of variables determining agents, decision making behavior). Effective coordination mechanisms perfecting agent interaction are particularly needed in any application especially SCM . These should be taken care of at the design of the system itself .The proposed model is given below. The agents are goal oriented. In the proposed models, Goals are defiled for each agent with their roles.

Manager Agent:- Goal of this agent is Maximum profit providing to the company and its function is Import game parameters , BOM and Component Catalogue , Get supplier offers, Customer RFQs and orders, Send and register, Customer offers, suppliers' RFQs etc

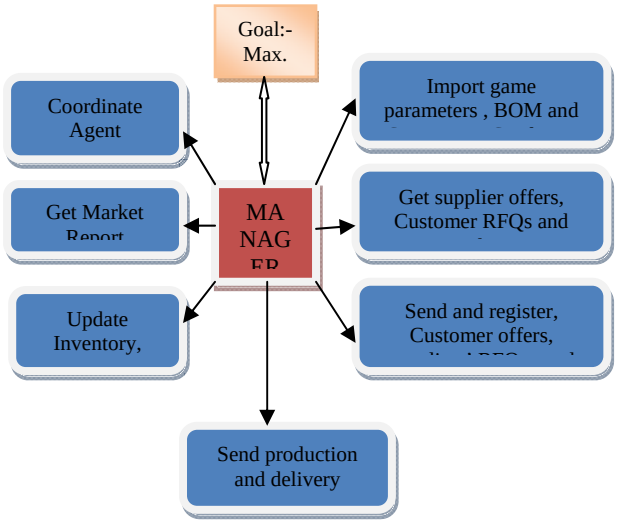

Figure 2:- Manger Agent

Demand Agent:- Goal of this agent is Revenues(Decision times) and Max Production utility (Production capacity)(Component stock) function is Generate future demands, Process new customer Orders, Predict customer order prices, Process new customer RFQs, Product Production, Manage Late Production, Generate production Schedule

Figure 3:- Demand Agent1

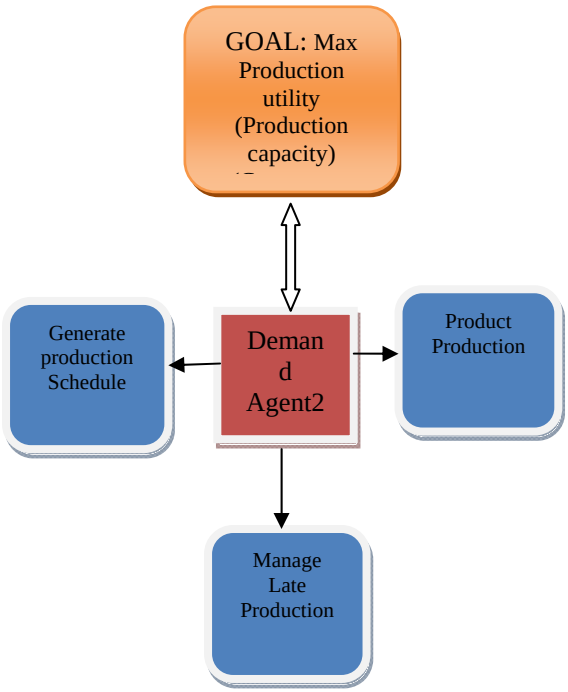

Figure 4:- Demand Agent2

Inventory Agent:- GOAL of this agent is Min component holding cost and function is Manage component, Product arrival & consumption, Manage Component Demand, Tune Component Stock Thresholds, Tune Component Critical levels, Predict customer order prices

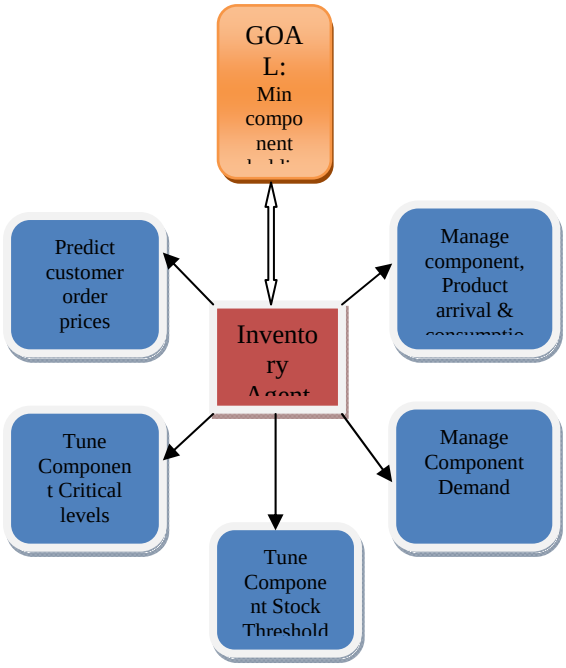

Figure 5:- Inventory Agent

Supply Agent :- GOAL of this agent is Min component Cost and function of this agent is Generate Supplier RFQs, Decide on quantity And future date for supplier, Track Supplier Prices and Deliveries, Generate Supplier Orders, Process Supplier Offers

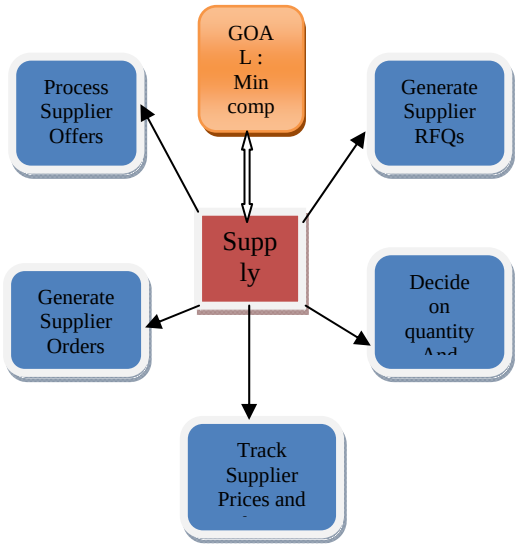

Figure 6:- Supply Agent

Delivery Agent:- GOAL of this agent is Min Component Holding Cost and Function of this agent is Generate Deliver Schedule, Manage Late Customer Orders.

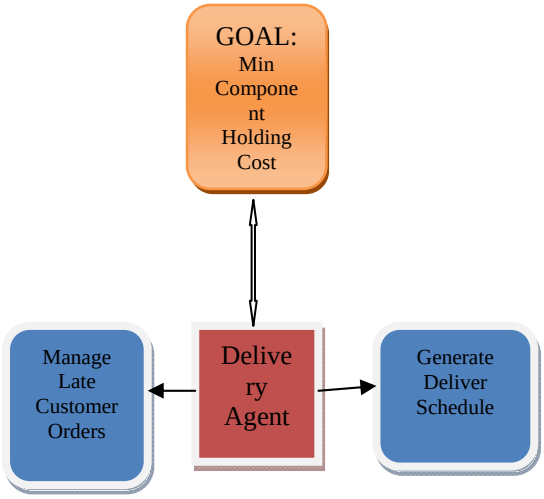

Figure 7:- Delivery Agent

Scheduling Agent:- GOAL of this agent is Each process is completed within a reasonable time framework and Function of this agent is Customer service management process, Procurement process, Manufacturing flow management process etc.

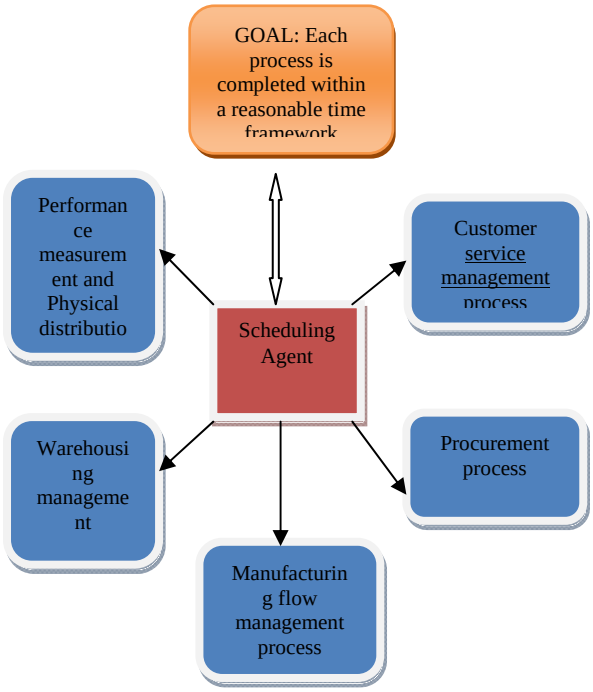

Figure 8:- Scheduling Agent

Order processing Agent:- GOAL of this agent is Each process is complete process from point of sales inquiry to delivery and Function of this agent is The nature of the orders, Availability and cost and productivity of workforce , The nature of the orders, Predictability of future volume, product and order profiles, Seasonality variations in outbound volume

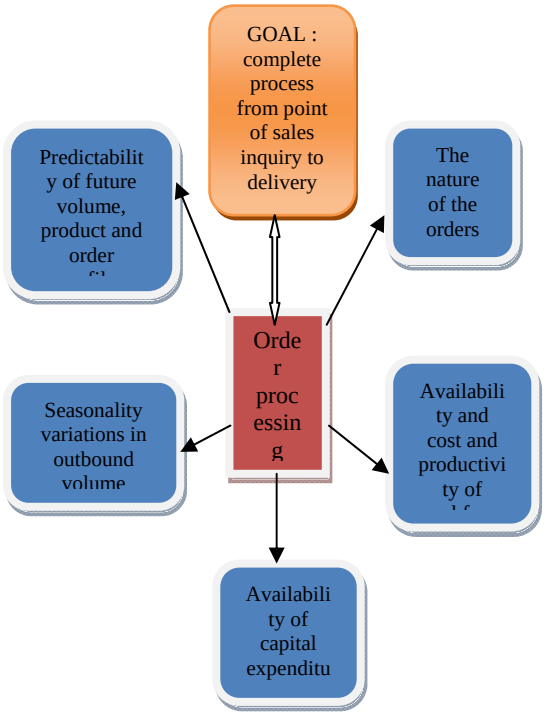

Figure 9:- Order processing Agent

Relation between agent and the information and controlling of processes in particular order in this system which is purposed

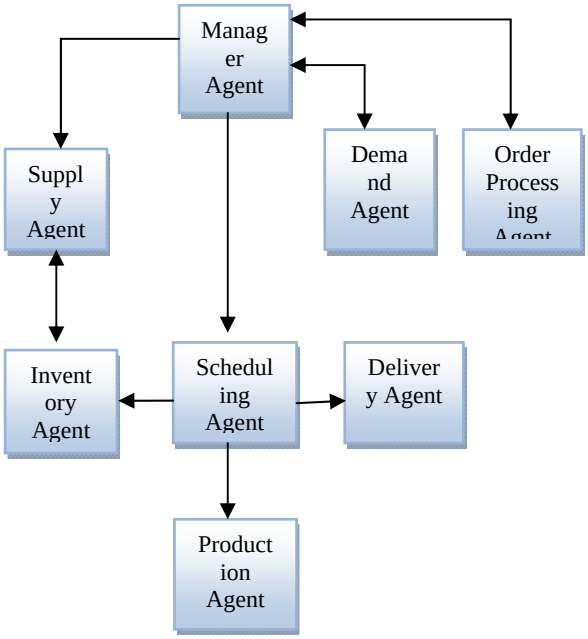

Figure 10:- Flow of information and control

FRAME WORK

In this Frame work the original case is check out by the RDQL (Retrieval Data Query Language) if this case exist then directly reach the result of previous case other wise move on adapted case and Check out by RDQL again if its find then show result directly other wise move on similar Assessment

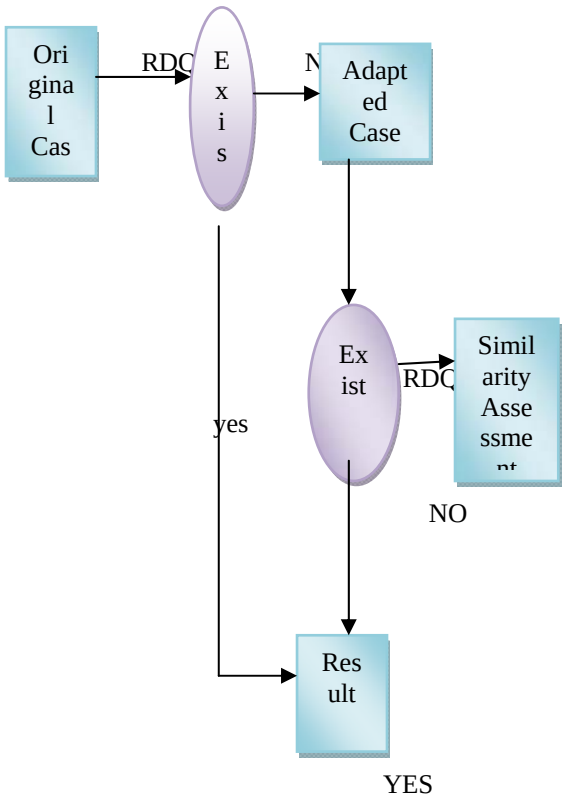

Figure 11:- Framework.

CONCLUSION & FUTURE WORK

Supply Chain Management (SCM) has become a vital issue for manufacturers, professionals and researchers. It is felt that to manage the supply chain effectively entire structure of supply chain must be understood properly. It presents a state of art on SCM by systematically arranging main activities in supply chain. supply chain management is to integrate. SCM needs integration of all activities like sourcing, procurement, production scheduling, order processing, inventory management, transportation, manufacturing, warehousing, and customer services. Research suggests that integration of several functions at different organizational levels could give above average financial and performance results. There is a continuous need to interact with supply chain partners to achieve the basic objective of organization. MACE-SCM provides more flexible and extensible solutions to help address emerging uncertainties in Supply Chain Management. The importance of collaboration in the supply chain has led researchers to suggest diverse approaches for problems in the collaboration process. Questions still remain about which technology is best when coordinating and sharing information in the presence of various supply and demand uncertainties. Given a complexities of supply chains we propose a frame work based on case based reasoning approach to build a complete comprehensive multi agent system to understand, manage and make informed decision to minimize disruption in SCM . This paper will enable Next-Gen computing especially in the software field which requires much attention in the computer field . Building Autonomous Agents is a challenging task which is essential for our main project MACE-SCM. The main problem in the industry is to reduce the cost of production and increase the revenue . This aim of the project is to provide a solution to the industry so that the industry will grow on at faster speed.

REFERENCES

[1] Gerhard Weiss (1999) Multiagent System A Modern Approach to Distributed Artificial Intellegence The NIT Press Cambridge , Massachusetts London

[2] Aamodt, A. & Plaza, E. (1994). Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. *AI Communications*, 7(i): pp 39-59.

[3] Ashley, K.D. (1988). Arguing by Analogy in Law: A Case-Based Model. In D.H. Helman (Ed.), *Analogical Reasoning: Perspectives of Artificial Intelligence, Cognitive Science, and Philosophy*. D. Reidel.

[4] Barletta, R., (1991). An introduction to case-based reasoning. *AI Expert*, August 1991, pp.42-49.

[5] Branting, K. (1991). Exploiting the complementarity of rules and precedents with reciprocity and fairness. In, *Proceedings of the Case-Bases Reasoning Workshop 1991, Washington, DC, May 1991*. Sponsored by DARPA. Morgan Kaufmann, pp.39-50.

[6] M. Wooldridge “Agent-based software engineering” IEE Proc. on Software Engineering, 144 (1) 26-37, 1997.

[7] M. Wooldridge and N. R. Jennings “Intelligent agents: theory and practice” The Knowledge Engineering Review 10 (2) 115-152, 1995

[8] P. R. Cohen, A. Cheyer, M. Wang, S. C. Baeg “OAA: An Open Agent Architecture”, AAAI Spring Symposium, 1994.

[9] Wooldridge M “Agent-based software engineering”, IEE Proc. Software Eng. 144(1): 26–37,1997.