MARKET MAKER AND MAS

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ABSTRACT: *In the last years, the research of multiagent systems for knowledge and information management has known a significant development. The interest for multiagent systems is in continuous growth due to the multitude of benefits associated with using these. The development of the architectures of mutiagents systems which facilitate information management, is an important direction in nowadays research. This paper presents the implementation of a multiagent system designed to perform the specific activities of a market maker in the Bucharest Stock Exchange. The system works in real time without an intervention from the operator and allows the insertion in the real market and/or the automatic cancelation of buy orders and stock exchange. The agents can be installed in one or more work stations and communicate through TCP/IP and UDP.*

KEY WORDS: *Multi-agent Systems, Information Management, Automatic Transactions, Bucharest Stock Exchange.*

JEL CLASSIFICATIONS: *C41, C81.*

1. INTRODUCTION

Developed as a new method of approach for the scalable organization of software systems, the multi agent systems (MaS) have become in the past years useful instruments in the evolution of software engineering. An agent is a software entity that searches actively for various ways of finalizing its tasks. Smart agents have the capacity to obtain knowledge by interaction with the environment and through learning and problem solving processes, that can be guided or not.

The agents of the multi agent system interact and cooperate to achieve their targets in an environment that isn't always predictable. The necessity of using agents comes from the complexity of large software systems that raise serious implementation and design problems. In a distributed dynamic system, self adjustment agents can

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simplify the architectural design of the system that can be extremely complicated in traditional architectures derived from object oriented design.

Agent oriented design allows the use of an unconventional approach of system design, approach that can be used including in the definition of components and in system integration**.** Different applications can impose different requirements in regards to the design and can lead to the implementation of different types of agents (Laklavic et al., 2006).

The autonomy is a distinct and extremely useful property of an agent. Autonomy represents the agent's capacity to survive in a changing environment. An agent has the capacity to detect changes in the environment and/or conditions in which it acts and to make decisions in regards the method used for the response (Bagnall and Toft, 2006).

Adaptability implies the adaptation of reactions and current decisions in relation to the past experiences while solidification implies that the system must react adequately whenever unexpected events occur.

Depending on their destination, the agents can be classified as cooperation agents, interface agents, reactive agents, mobile agents, information agents and so on. Each agent is designed in the best suited paradigm to resolve a part of a problem. A multi agent system is used to resolve a complex problem, which cannot be solved by a unique entity. The coordination between the behaviors of each agent represents a central part of the multi agent system design.

The multi agent systems are often used to adjust poorly linked distributed systems, with decentralized control and data allocation. Agents have the capacity to efficiently process local data and to communicate with other agents when needed, for example in case the tasks which they were given are beyond their field of knowledge or their processing capacity. Multi agent systems have been utilized in numerous applications such as e-commerce, e-learning, data mining, simulation, robotics transport systems and grid computing.

Multi agent systems are often classified in 2 categories – in relation to the agent characteristics: auto-interested agents and cooperation agents. The auto-interested agents are based on economic concepts in which an agent tries to maximize a utility function. Thus, researchers often use economical instruments and game theory instruments in order to model agents (Semsar-Kazerooni and Khorasani, 2009).

Auto-interested agents have the tendency to limit themselves to the information to which they have access and don't manage to react in case they don't detect any immediate benefit. Cooperation agents are built so they can engage into a cooperative behavior which most of the times brings additional benefits to the table.

Negotiation is one of the key subjects for multi agent systems. Due to their nature, agents must cooperate between themselves in order to fulfill their common tasks. Negotiations are often shaped as interactions between auto-interesting agents. At the moment, researchers are trying to build more complex and sophisticated protocols based on auctions. The simulation compatibility as well as the revenue optimization are crucial concepts for the construction of such mechanisms.

2. OBJECTIVES

Automation of dealer's activities was suggested more than four decades ago and is an important part of Market Microstructure – an area that has evolved into an independent subfield of Finance (Nevmyvaka, 2003).

This paper aims to present a multi agent system designed to generate, introduce and cancel buy and sell orders automatically in the Bucharest Stock Exchange system. The system is functional and is used to submit and cancel quotation pairs for intermediaries who act as market makers, in accordance to the rules of regulations provided by the Rulebook of Bucharest Stock Exchange and the current legislation of the Romanian capital market.

3. SYSTEM ANALYSIS

At the moment, BSE is trying to implement mechanisms and specific regulations which would allow it to pass to a new stage. One of the fundamental indicators of the stock market stature is liquidity. To increase this certain indicator, BSE has implemented the institution of the Market Maker.

3.1 Market Maker

At the beginning of this year, BSE has defined new rules as well as offered additional facilities to the intermediaries which act as market makers. As a result, most of the large issuers listed on our capital market have benefited of the liquidity offered by one or more market makers. The task of a market maker consists of the contractual obligation to maintain daily, for a large period of the trade session (generally up to a minimum of 75% from its duration), a pair of opposing quotations (one to buy and one to sell) for the significant stock packages of an issuer, at a maximum distance imposed by regulations. The minimum volume corresponding to the buy and sell order is applied to each limit order in the offer.

The maximum spread between the buy and sell prices listed by the market maker is given by the following formula: [(MMAsk – MMBid) / MMBid] * 100 where:

MMBid = the buy order price from the firm buy and sell offer, which fulfils all the requirements (symbol, indicated account, minimum volume etc)

MMAsk = the price of the sell order from the firm buy and sell offer, which fulfills all the requirements (symbol, indicated account, minimum volume etc)

If an Intermediary has in the market, simultaneously, several buy and sell orders on the indicated account, that fulfil all the applicable conditions, firm buy offer, respectively firm sell order corresponding to the maintaining of the liquidity is built from the buy order with highest price among the buy orders, respectively from the sell order with the lowest price among the sell orders administered by the Intermediary on the indicated account. During the trading session, minimum period of time for maintaining the bid and ask offer during one trading session is determined by reference to trading period corresponding to the Continuous Trading (Open stage of the market),

considering the total trading period from the Continuous Trading where the financial instrument was available for trading and the fact that the obligations of the Intermediary were not suspended during that period.

Due to the fact that stocks offered for sale, respectively the stocks to be purchased can not belong to a client, the intermediary which acts as a market maker must have a large enough capital to be able to trade on its own and to assume the risks affiliated to that certain activity. In fact, the interest of the intermediary which acts as a Market Maker is not to execute transactions, but to abide to the contractual rules and regulations, respectively to offer quotations in the given conditions.

When the best quotations on the market disadvantage them, respectively there's a chance that the buy or sell order is going to be partially or totally executed, the market maker must cancel the introduced quotations and reposition on another price level. Since analyzing the market, canceling orders, calculating new quotations and reintroducing them requires a great execution speed, the tasks had to be taken over by an automatic application. At this time, all the market makers of BVB introduce the quotations automatically.

3.2 The multi agent system

The specific tasks which a Market Maker must execute as well as the necessity of scalability of the system naturally led to the implementation of a multi agent system. BSE offers intermediaries a system formed of transaction servers linked by a secured VPN based on fixed address, on different access points called Gateways. The secure communication between the transaction applications and the dedicated stock market servers is done through these Gateways. A Gateway connects to the users app, negotiates the connection to the system and ensures the bidirectional data flux required by the transaction via sockets. Each application linked to the stock market has its own connection, thus two or more users can not connect to the same Gateway. The classic connection diagram between client and server is shown in the figure 1.

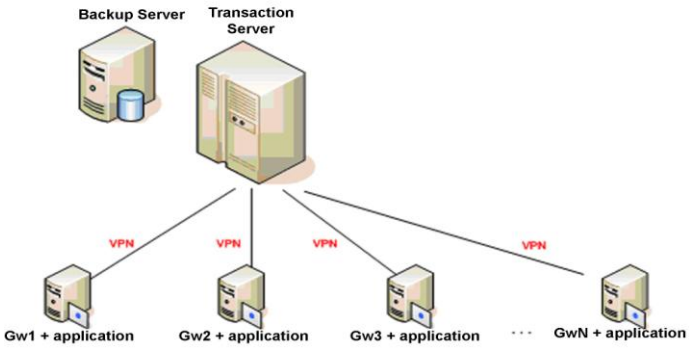

Figure 1. BSE transaction system

Generally, the classic Market Maker application is installed on one of the computer stations linked to a gateway and it is supervised by a trader which executes manual transactions for the intermediary clients which is also a market maker.

The architecture of the application based on MaS, implemented as an alternative, has an even more complex structure, made out of four types of agents which interact. The system allows easy scaling as well as adding new real time data analysis methods.

Thus we have:

The dispatcher agent which ensures the gateway connection for the application. It can authenticate to the BSE system and ensure the coherence of the data stream between the transaction server and the agent system. It is always active and its actions are triggered by data from a gateway or the coordination agent. It periodically generates HeartBeat signals to the the gateway and coordinator to ensure the data uplink. It can be placed on any of the internal network computers.

The coordinator agent is equiped with a graphic interface (GUI) which allows the tracking of the quota evolution and the overall behaviour of the system.
Placed usually on the trader's work station, it allows him the easy supervise of the whole process. The critical elements are sound signaled and transmitted through messages into the system. For this reason, the coordinator agents can be placed on either one of the work stations that belong to the local network of the intermediary. The coordinator receives a part of the data stream which transits the dispatcher by communicating via ports with the other agents of the system and can send the trade orders to the dispatcher.

The coordinator agent knows the market status at any moment through permanent updates of the lists which contain the active market orders for the issuers selected by the user. The list of orders is updated automatically on account of the data received from the dispatcher and the operation does not require express demands. The coordinator agent completely resets the lists of quotations only when the dispatcher signals the connection with the trade server stopped and resends the data. It is remotely linked to a data base which permits stocking market information in real time and automatic operations. For reasons which involve the risk management that can appear in a system, the coordinator agent has both an internal protection mechanism as well as a external one, managed by the risk evaluating agent. Based on the received signals from the data analysis agents, the coordinator agent determines when to introduce, maintain or cancel trade orders.

The risk evaluating agent is to supervise all transactions made in the system. Being part of an automated system the role of this agent is to minimise all uncontrolled trading risk. The risk evaluating agent has access to the data concerning all the finished transactions and verifies the volume of boght of sold stocks so that the net transitioned quantity during a trading session does not go beyond the limits set by the user.

The limitations target the sock volume and invested sums or obtained as a result of trading. After the interruptions generated by this agent the system must be manually restarted by the user.

The data analysis agents are specialized agents which receive information from the market through the dispatcher agents, then analyze the quotations and volume

of the transactions in real time and send signals to the dispatcher. They're equipped with an internal evaluation mechanism which determines the degree of data uploads and quantify the necessary time required for the completion of the tasks. When it exceeds a determined threshold, they emit to the dispatcher an overloading signal. In this situation, the coordinator agent activates another analysis agent, which was previously in a dormant state on another work station, and eases the work load of the overloaded agent on the current station by transferring it to the new agent. The dispatcher agent is also involved in the operation and has to actualize the connection list and transfer the initiation data to the new agent. Nevertheless, transfer from an agent to another agent is fast enough, the total connection time being always less than half a second. The work load and the trust degree given to each analysis agent are predefined and stocked on the data base of the agent system.

4. IMPLEMENTATION AND RESULTS

The previously mentioned system was done in Java and works in a real time environment from the beginning of the year 2015. Up to this date, it suffered various modifications only in regards to the administration mechanism of the data analysis agents. The main board of the application, integrated in the coordinator agent is shown in Figure 2.

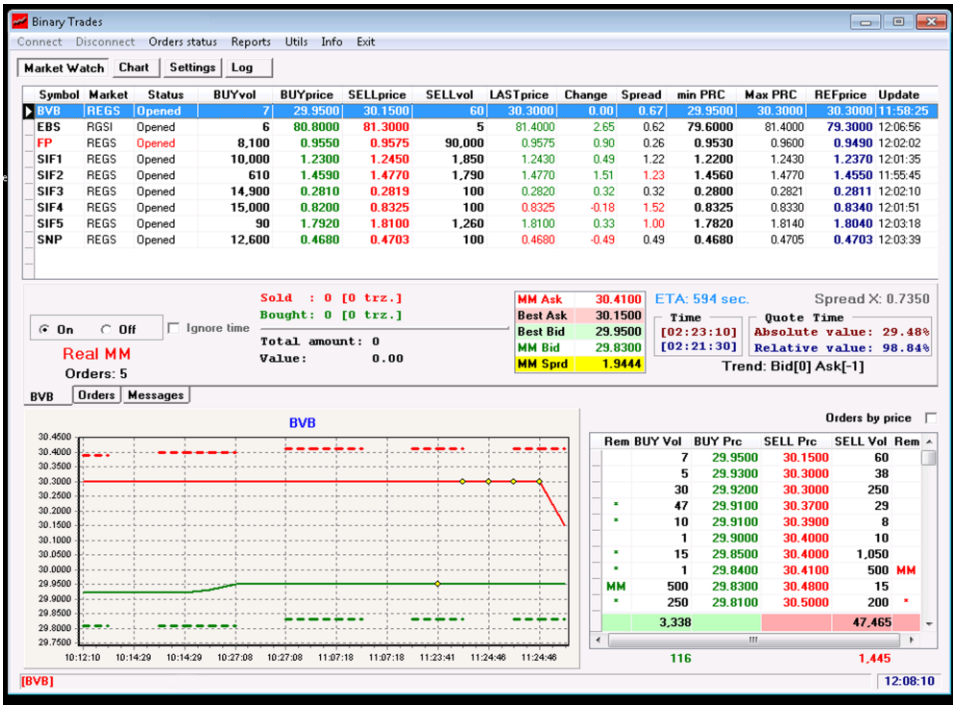

Figure 2. The interface of the coordinator agent

The upper side of the window shows the evolution of the issuer's quotations which are of interest. The information in regards to the market status, the best buy and sell prices as well as the available quantities, the last known price, medium, minimum and maxim price and the spread between offers are shown as a table.

The results of the current activity of the Market Maker are shown in the central part of the window.

The recent price evolution is shown graphically in the lower part of the main window, while users have access to the real time quotations of the interest symbol on the right side. To facilitate identification, the quotations of the Market Maker are marked distinctively.

The total volume of the orders placed between the Market Maker quotation and Best Bid respectively Best Ask are calculated and shown at any moment in real time in the lower part of the window.

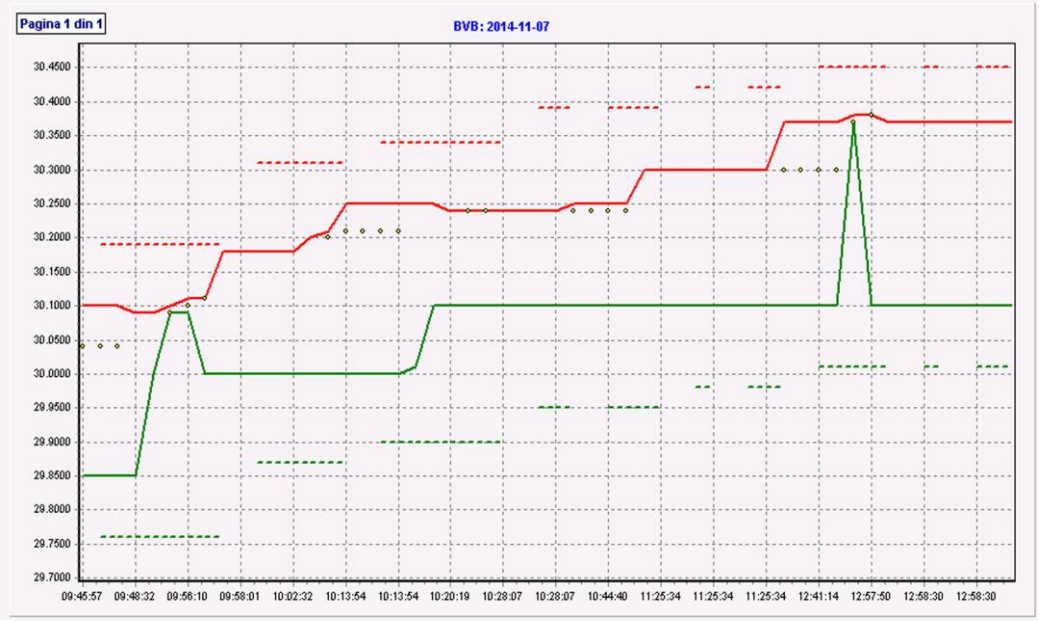

Figure 3. Issuer's quotations

The evolution of quotations can be tracked by the user in a special window shown in figure 3. The continuous lines represent the evolution of the best quotations of the market for Bid (green line) and for Ask (red line). The transactions are marked graphically through yellow dots and the dotted lines represent quotations of the market maker, automatically introduced by the system of agents.

The MaS reaction to the market conditions can be seen on the graphic of Fig. 3 when around 09:57:00 due to the upward evolution of the market sell quotation, the system canceled the quotations from 29.7500 and 30.2000 and reintroduced them at 29.8500 and 30.3000.

As previously stated the system is implemented and works in real time since the begining of this year. Untill this moment the system worked flawlessly, without the risk evaluation agent having to intervene. During the last year, the difference between the stocks bought by the Market Maker and the ones which were sold was under 7% of the total volume, and the net result of the activities was always positive. The positive outcome of this activity is due to the fact that the system inclines to make purchases at minimum prices and sells at maximum prices.

5. CONCLUSION

The mobile agent systems can be successfully used in practice. The scalability and reliability of such a system was proven by its implementation in a real and strongly competitive environment such as the one of the Bucharest Stock Market. The distribution of the tasks on more than one calculus system facilitates getting the performances due to the uniform loading and global reliability of such a system.

The current challenge is to implement more efficient detection techniques of the trend change of quotations at the analysis agent level.

Greater attention will be paid to the implementation of an automatic share system that allows the quantification and evaluation of the level of trust which can be given to the data offered by either one of the analysis agents within the cooperation agent. Right now, the quotas are statically assigned by the user, based on previous results, they are analysed offline after the closing of the trading day.

6. ACKNOWLEDGEMENTS

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