# ABROSE: Multi Agent Systems for Adaptive Brokerage

Marie-Pierre Gleizes, Pierre Glize

Institut de Recherche en Informatique de Toulouse
Université Paul Sabatier
31062 Toulouse, Cedex 4, France
{gleizes, glize}@irit.fr
http://www.irit/SMAC

## 1. Context of the Project

A market place is composed of an important amount of content providers and customers who have very dynamic offers and requests. ABROSE[1] (Agent based BROkerage SErvices in electronic commerce) is an agent-based electronic commerce tool. The principal idea is to use an agent-based collective memory between content providers and customers which contains the users' individual experiments results. ABROSE manages this collective memory to improve the exchanges quality. The principal functions offered by ABROSE are:

- for the customers, simplified interactions, a personalized assistant, spontaneous notification of new offers, a navigation and requests formalisation tool , a list of relevant content providers which answer to a request given by the customer.
- for the content providers, a target diffusion of the offers towards relevant customers, a collection of information about the customer's interests and about market offers.

## 2. The Architecture of ABROSE

The prototype ABROSE V2.0 is implemented in Java with JWS1.1.3, the communication between the multi-agent system and the other parts of the system is supported by OrbixWeb3.1™. The brokerage software, which includes the multi-agent systems, runs on Solaris 2.6. The customer is a Personal Computer with the standard browser Netscape™. ABROSE is composed of two main parts: the broker domain and the user domain assuming the access to information and the displaying abilities for a user. The part of the system which realises the brokerage in ABROSE is constituted of several adaptive multi-agent systems: the multi-agent system of transaction agents and multi-

[1] European ACTS project with nine partners: Deutsche Telekom Berkom, InfoMures SA Roumanie, France Telecom CNET, Universidad Polytechnica de Madrid, Onyx Ltd Angleterre., Dégriftour SA Paris , National Technical University of Athens, Technical University of Berlin, IRIT Université Paul Sabatier of Toulouse.

agent systems of belief agents. At the most general level, there is the Mediation Agent (MA) representing the site where ABROSE is located. A MA knows all the Transaction Agents (TA) present on the site. The MA has beliefs on the TAs which evolve in an independent way from the evolution of the beliefs of TAs. The beliefs of the MA are not a simple aggregation of the belief of all TAs, but rather a synthetic view.

At the middle level, the system is composed of an adaptive multi-agent system of the TAs present on the site. A TA represents a customer or a content provider and belongs to him. It knows other TAs that are on its site, but has no global view.

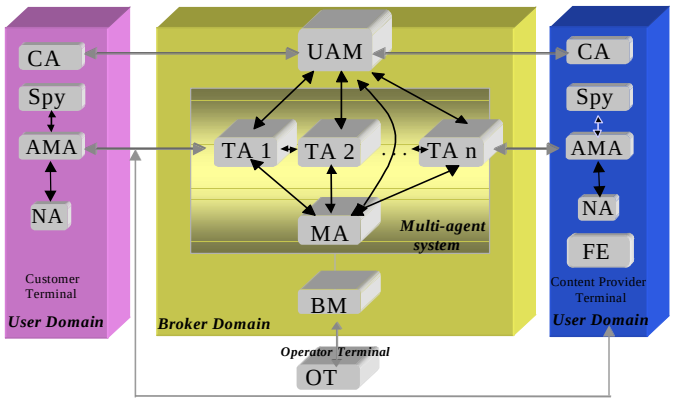


Figure 1: ABROSE global architecture

At the lowest level, the beliefs possessed by the MA about itself and those possessed by a TA about itself and about other TAs are implemented in an adaptive multi-agent system called Belief Network (BN). There is a BN per TA and the MA also has a BN.

An adaptive multi-agent system is a system composed of agents which are in interaction with the environment, and which modifies their interactions in a self-organising process. In a general way, the system-environment exchanges imply reciprocal influences which bring about a mutual adjustment due to their structural coupling. The unexpected happenings were inherent to the life of these systems. It is why the self-organisation which is an autonomously change becomes a way to arrive to overcome the perturbations of the environment. For a system S learning consists in autonomously modifying its actual function, noted $f_S$, in order to adapt itself to its environment. The environment is considered as a constraint given to the system. Each part pi of the system S realises a partial function fpi. The environment of a part pi is composed of the other parts of the system and the environment of S. The global function fs is the result of the composition of these fpi. The composition is determined by the relations - i.e. the organisation - that connect the parts. So, without changing the parts, transforming the internal organisation of the system leads to a change of the composition between the partial functions and consequently leads to a change of the global function fs. The theory of AMAS (Adaptive Multi-Agent Systems) that we have studied and used, asserts that a permanent cooperation state between the parts of the system guarantees the functional adequacy of the whole system. A system which is functionally adequate realises the right activity. And we have shown that for any functionally adequate system in a given environment there is at least a system having its parts

(or agents) in cooperative interactions, which realises an equivalent function. The concrete implication of this theory allows a system to adapt itself when faced with a dynamic environment and gives us a guide to design multi-agent systems. For the design phase, we focus on cooperative agents and on finding local criteria from the point of view of an agent in order to determine non cooperative interactions and to remove them. The self-organisation based on cooperation implies that the system and its environment try to mutually adjust themselves to be in cooperative interactions, and implies at a different level that all the agents of the system try also to be in cooperative interactions.

## 3. Transaction Agents

TAs are built when a new service is created or when a customer registers to ABROSE. TAs co-operate with each other to answer to a request or to propagate an offer. Each TA consists in beliefs, skills, an interaction language and social attitudes. The skills of a TA are the skills of the user it represents. When a TA receives a message, it interprets it and acts. The beliefs describe the knowledge a TA possesses about the others and about its own skills. The social attitude is cooperation; it is guiding its behaviour. TAs interact with others by messages exchanges. They use protocols and speech acts, as a subset according to FIPA definition. TAs represent the parts of an adaptive multi-agent system. They try to maintain all the time, cooperative interactions between themselves. In order to do this, each TA is endowed with a cooperative social attitude that gives it three properties: *Sincerity*: an agent says the truth about something it knows. *Willingness*: an agent tries to satisfy a received request if it is coherent with its own skills. *Reciprocity*: an agent knows that the others belonging to the same society have the same social attitude as itself. An agent cannot act if it has no belief about others. In consequence, a cooperative agent sends spontaneously information to another agent, if it believes it is useful to the receiver. If an agent is unable to satisfy a given request, it automatically recruits other agents that have relevant skills on the subject. A TA which does not know to answer to a received request (or offer) can request assistance of known TAs if it thinks they are relevant, or of the MA which has a global point of view about the market place. When a TA represents a customer (respectively a content provider), the trigger conditions for learning and the moment when the belief of this TA evolves, are the following one:

1- When a new request (respectively offer) is given to the TA, it learns that the customer is interested by the request (respectively that the content provider could answer to the offer),

2- when he evaluates the received offer or when he evaluates the realised transaction, it learns on itself and on the content provider who has given the offer or who has answered to the request,

3- if it has requested assistance of the MA, the TA learns on the content providers (respectively on potential customers) communicated by the MA,

4- if it receives an answer from a content provider (respectively from a customer) by an other TA, it learns on the content provider (respectively from a customer).

During the lifetime of the system, the interactions between TAs evolve: the self-organisation process is responsible of the evolution of the mutual belief. Consequently, the organisation between the TAs evolves too.

## 4. Conclusion

The European project is ended; the final software version was tested in real connection to the electronic commerce server of Tradezone. Using it has shown that the multi-agent technology is useful to solve problems in a dynamic environment like a market place and that the brokerage service quality was improved because of the use of a collaborative, adaptive and altruistic society. Nevertheless, ABROSE has some shortcomings. It was never used with a huge collection of products; we evaluated it only in using approximately five hundred products descriptions. The response time was really correct for the end-user with the configuration used but we have no test with thousands of users yet. Because of privacy reasons on users' personal information, a user needs to subscribe to have a password to access private information.The essential properties of the ABROSE system could be summed up in five points. Firstly, the system is modular and reusable because the code of the communication between agents, the code of the BN could be reused in others applications. Secondly, it is generic: ABROSE could be used for selling or promoting any products or service. Thirdly, in ABROSE several languages could be used. The content providers could describe their products or services in any language (perhaps in several); it is implicit that the requests may be done in the same language. Fourthly, ABROSE is an open system because the creation or the removal of transaction agents is dynamically done without any human intervention. Fifthly, ABROSE adapts itself by taking into account in real time and automatically the evolution of its environment (the users' preferences and the content providers' services).

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