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Self-Organization and Learning in MultiAgent Based Brokerage Services

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Abstract. Electronic Commerce is based on the exchange of information between involved stakeholders, using the underlying telecommunication infrastructure. Business-to-Consumer applications enable providers to propagate their offers, and customers to find an offer, which matches their demand. A huge collection of frequently updated offers and customers, the electronic marketplace, reveals the task of matching the demand and supply processes in a commercial mediation environment. The aim of the Abrose¹ project (Agent based BROkerage SErvices for electronic commerce) launched by ACTS Domain V is to design a brokerage system based on adaptive multi-agent architecture.

The first part of this paper explains the reasons of using this technology and gives a brief survey of related works. The second part describes the broker architecture and examines the underlying basic self-organization and learning mechanisms used. The third part concerns a description of the main tasks the global system has to perform. Then how it provides advanced electronic brokerage services in three business domains (tourism, trading and teleworking) is described. The paper ends on the current state of the Abrose system development

1 Introduction

Internet is a system composed of many thousands of information sites. These sites are accessed by millions of users having very different points of interest. In electronic commerce application, for example, the customers wants to find somebody who provides a well-suited service for him, the content providers wants to find somebody who needs his service. Moreover, these user profiles and the site contents are generally highly dynamic. New content providers could appear, the offer of existing ones could evolve. The last important constraint is that it is fully based on distributed

¹ The full Abrose consortium comprises : DT-Berkom, FT-CNET, Univ. of Toulouse, Univ. of Athens, Univ. of Madrid, Univ. of Berlin, Infomures from Roumania, Onyx Ltd England, Dégriftour sa France.

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processes for accessing and managing this great amount of information. This set of characteristics is bound to the definition of a complex system.

Launched by ACTS Domain V in March 1998[7], for a duration of about two years, the Abrose project (Agent based BROkerage SErvices for electronic commerce) main objectives are the following:

- to design, implement and integrate the Abrose agent based brokerage system incorporating the following salient features:
 - matching of demand and supply*: a huge collection of frequently updated offers and of customers needs on an electronic marketplace, in a commercial mediation environment,
 - dynamic Knowledge Capture and Unified Knowledge Representation,
 - remembering of success and quality of past transactions (collective memory),
 - propagation of offers and demands,
 - request processing: using the knowledge on the customers and on providers,
- to improve the performance and the quality of mediation through usage of collaborative adaptive society of agents,
- to demonstrate and evaluate the Abrose system on technical aspects and on the economic suitability to existing commercial applications.

1.1 Brokerage Based on Agents

Agents, based on artificial intelligence like TopicTM (VerityTM), Internet Sleuth (MCC Carnot), allow one to search on the web in depth with a friendly interface. Autonomy (Cambridge University), is a search engine capable of a dynamic reasoning suggesting similar notions to reach the greatest possible precision. For more information see <http://www-sv.cict.fr/urfist>.

The collective filters represent a new mean to evaluate the resources on the Web.

- Metadata: Dublin Core Metadata and Warwick projects deal with automatic classification (<http://www.dlib.org/dlib/july96/07contents.html>) and define a set of metadata and methods to integrate them in the web pages: metatags (titles, authors, style, type of document).
- Boulder University has developed the program Harvest which indexes its own pages that are transmitted to the various search engines (<http://harvest.transarc.com>).
- Cooperative filtering systems, like Group Lens, Phoaks, or Firefly <http://www.firefly.com/> or YahooTM (at a lesser degree) are based on the favorite sites of groups of people sharing the same interests. Such systems carry the dangers of influencing the users (hiding marketing considerations under recommendations), which is not the case with multi-agents systems, like Abrose.

Many authors [14, 16, 13] have developed applications of agent in the field of Cooperative Information Systems. The basic assumption of these works is that an entity (for example a mediator) has the ability to link different terms or topics in order to find the right information source. In a dynamic world, this assumption must be replaced by some learning mechanisms about concept acquisition and relationships[3]. This is done in Abrose, when new knowledge about agent's skills are acquired cooperatively as the resulting process of their interactions (see part 2.2).

1.2 Dynamic and Personalized User Profiles

Current electronic marketplaces or brokerage services enable users to browse through a directory or a classification (textual, graphical or using virtual reality) until the user has found the appropriate category or shop. Then he may provide attribute / value pairs until he finally gets the information whether that good is available at all, and a set of globally suiting offers. A more flexible approach is now used by the way of personalised recommendations. Two great technical set of recommended systems are designed.

- The first set uses an analysis based on natural language approach in order to select information to users. In return the users improve their profiles in evaluating information they received. We can find some system description in [1], [2].
- The second set uses syntactic collaborative filtering. For example, Firefly allows users to get advises from others users for buying books and CDs. From the technical viewpoint, the service creates communities of common interest. Arachnid <http://www-cse.ucsd.edu/users/fil/agents/> uses artificial life algorithms for information search. Agent based technologies are also used [4] or [10].

The operation of these user groups depends critically on a balancing between the number of users and providers, the view point of their interest and the algorithms used to decide similarity and dissimilarity between profiles. These grouping approaches reveal in fact the inability to manage a real dynamic users profile and to assume the true existence of a global functional adequacy as defined in [15].

Abrose aims to simplify this process of interactions. Users shall be enabled to ask directly in a text field, whether this marketplace has ever traded or mediated the good he is looking for, and which could be recommendations of the system, according to its experiences (see parts 3 and 4). The theory based on cooperative self-organisation leads to a concrete tool in order to create dynamically personal links for everybody. In this new approach a user can find relevant information or goods or services anywhere if they exist without any explicit search and a provider can contact similarly all potentially interested customers (and only them). This is supported by user profile management and by the learning process based on monitoring the customer's habits (see Section 2.2). The systems' recommendations are supposed to be an alternative approach to the "standard" searching and browsing, it will ease up the navigation and querying.

2 The Abrose Multi-agent Architecture

In general, a multi-agent system (MAS) is viewed as a system composed of many interacting agents. The technical approaches to implement individual agents or a society of agents can be similar, each can have an individual goal. The main difference is that the multi-agent system must also possess a global task to solve. For example, Abrose finds efficiently the better relevant matches between offers and demands. The global task is very difficult to solve in a dynamic environment in which unexpected events frequently occurs, under the constraint that no agent has a global view of the system. In order to overcome these unexpected events, the basic multi-agent principle is that agent communication is driven by "social conventions" [17].

As the global function of this kind of system is not well-defined, the consequence is that the classical approach based on a global top-down approach to design artificial systems is totally inappropriate for internet. Today no software devoted to access and management of internet information is able to assume coherence and completeness. Thus, a quite different approach is necessary to guarantee the functional adequacy. Functional adequacy is defined as the capability of a system to give all the time the right response expected by its environment [15]. Ideally in the Internet domain, functional adequacy relates to two properties:

- all existing information belonging to a given subject is obtained by an end-user requesting it, and only those,
- any offer made available by a content provider is broadcast to all the interested end-users, and only to them.

In these systems, the behaviour of an agent in its environment depends on some basic characteristics.

- **Autonomy.** This implies that the global system computation is distributed into separated smaller functions: the agents. There is no central management.
- **Partial environment representation.** Any agent knows the state of the world and the activity of others (beliefs). It works within a bounded rationality leading possibly to concurrent situations or conflicts with others.
- **Tasks realization.** Commonly an agent has not only skills (its competence domain) but also goal(s) to achieve.
- **Communication abilities.** An agent must interact with other agents locally or remotely in using protocols and speech acts.

These agent characteristics are well adapted to the customers and content providers. The dynamics of the market place domain is the main reason why we have oriented Abrose technical choices towards an adaptive multi-agent system. The global architecture of Abrose is composed of the user domain and the broker domain. The user domain consists in all software needed to connect and to communicate with the broker domain and the front-end of the content providers. In the broker domain, takes place the main functions of the brokerage service. This part is described in this paper.

2.1 Abrose Multi-agent Architecture

Abrose multi-agent architecture is a three-layer architecture, each layer is made of communicating agents following the same “social conventions”. An agent at a level is composed of cooperating agents at the sub-level.

Because the goal of Abrose is to be applied in many topics and with numerous users, it cannot be centralised on a single machine. Thus, the first role of the top layer agents is to add in a totally incremental fashion new users and services located anywhere in the world. These agents called Mediation Agents (MA) are distributed on interrelated computers. At the top layer, MA can be added or suppressed inside the system, so avoiding the need to maintain any global view. In their second role, these agents could also be associated with service or user domains such as the set of users registered in the same Internet Service Provider or a collection of services sharing the same topic. Their goal is to structure the set of users and services in order to decrease the complexity of locating them. The main difference of a MA and a shared memory

is in the fact that a MA learns from the transactions done in the system and it does not require an update by the system designer.

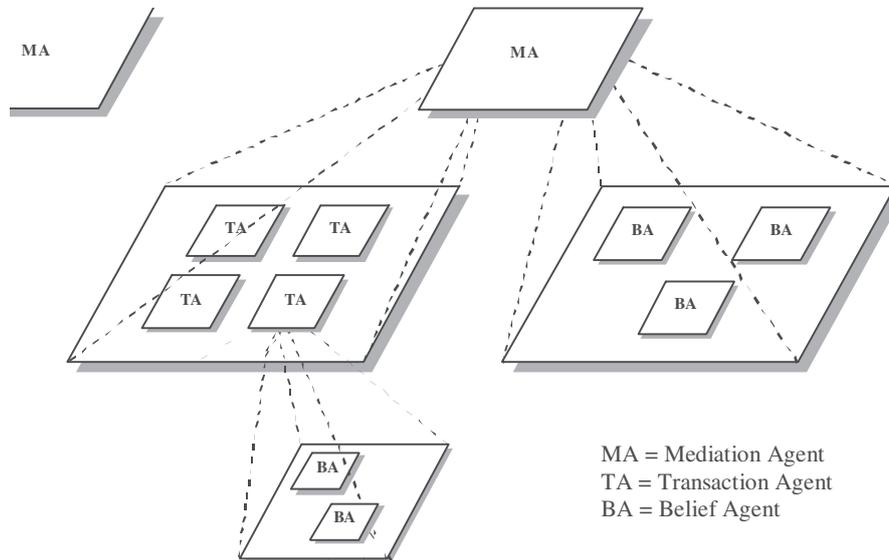


Fig. 1. Abrose : The three layered Multi-agent Architecture

The second layer is made of Transaction Agents (TA), each customer or content provider in a domain is associated with such an agent. They are built when a new service is created or when a customer registers. TA's have beliefs on the skills of itself and of other TA's which are hosted by the same MA. The TA is in charge of exchanging autonomously requests or answers with other TA's. The TA should also communicate with the customer or content provider it is associated with.

All agents of the two previous types possess beliefs on themselves and on some agents belonging to the same level. These beliefs describe the organisation of the agent society. They constitute the third layer of multi-agent system in Abrose called the Belief Network (BN) and is composed of Belief Agents (BA). A BA expresses the viewpoint that an agent (MA or TA) can have about itself or another one. A BA links the common concepts of two agents and confers on an agent the possibility to reason upon others. It gives the possible interaction links between the agents of the society.

The knowledge of an agent on others agents is continuously updated on the basis of the transactions flow. Thus, each layer improves its internal organization in order to give efficiently and all the time relevant information. The next section of the paper explains this learning mechanism.

2.2 Learning Activities

Generally speaking, a system is composed of interacting parts: the agents. Designing an artificial system consists in finding the good function realised by the system. In a

highly dynamic environment, such as internet, this good function cannot be predefined at the conception phase. Thus, we must give to the system learning capabilities in order to adapt itself when it is necessary.

In Abrose, this is done by a self-organisation process. Self-organisation allows learning because each part of a system performs a partial function, and their composition gives the resulting global function of the whole system. The composition is the result of the internal organisation between parts; thus modifying this internal organisation is equivalent to transform the global function. Self-organisation is an autonomous modification of this organisation by the system itself. Each agent of Abrose wants to find the right place at the right time: this is obtained when it has cooperative interactions with others. In our theory [8], we have shown that a system where each parts are in cooperative interactions, guarantee its functional adequacy, and this without knowing the global function of the system. To assume that the agents in a system are in cooperative interactions, it is necessary to give them the abilities to use uncooperative situations to return to functionally adequacy. The notion of cooperation guides the learning activity which is performed in the three types of Abrose multi-agent systems.

At the MA level, the right organisation is reached if all messages sent by any of them find a relevant receiver. When a MA believes that it is relevant for a received message, it passes it to TA's composing it. On the opposite, when it is unable to solve a problem (i.e. no internal TA is able to find a solution) it sends it to other MA's and later learns about this action. At the TA level, the right organisation comes up when each TA is able to solve requests or to answer an offer received in messages and to know always partners able to help it. In order to find these partners, it uses its own beliefs. Each BA of a BN encapsulates strings employed by end-users during their communications. The goal of each small BA is to create a network of others linked terms in the similar view of generic and specific links in a thesaurus. A BA or a TA or a MA modifies the organisation of the system it belongs, in changing its way of interacting with others. This implies a modification of the knowledge about the others agents. The learning concerns at this stage, the beliefs of an agent on itself and on the other agents. The learning mechanism proposed has the following properties, it is:

- distributed in each agent of the system,
- autonomous: each agent decides when they have to learn,
- asynchronous: each agent can learn at a different time from others,
- generic in principle: it is based on cooperation.

2.3 Messages Interpretation

The theory used in Abrose [8] explains why a system having cooperative interactions between its parts (here the agents) gives the good results for the environment (users and services in Abrose). Thus, the aim of the agents in Abrose is to correct non-collaborative situations. "Incompetence" is an example of non-collaborative situation where a request cannot be properly interpreted by the receiver. A cooperative way to correct this situation is for the receiver to send this request to agents assumed to be competent. Eventually, the request will reach a competent agent. When an agent receives an answer it can correct its beliefs on other agent skills. Conflict, redundancy or ambiguity are other non-collaborative situations.

Whatever its granularity may be, an agent interprets all messages it receives. Interpretation consists of a matching between the message received and the skills of the receiving agent. Four cases can appear after interpretation, this for the TA or MA agent:

- complete lack of understanding: the agent can associate no meaning to the received message,
- partial lack of understanding: the message is only partly meaningful for the agent ,
- ambiguity : received message has several meanings for the agent,
- conflict: two agents want to access to a service which proposes a limited resource and their demand exceeds the offer,
- full understanding: agent associates a single meaning to the received message.

The four first situations are called uncooperative because they damage the collective activity of the society. They occur often because agents have an incomplete, and may be erroneous knowledge of the society and of the others. They can be suppressed, thanks to knowledge owned by the collectivity and by the cooperation between agents [15]. For that, we have to endow agents with social attitudes which allow them, in such situations, to detect and to act in the world to attempt to come back to cooperative situations. To face up to uncooperative situations, each individual act is simultaneously guided by the own objective of the agent and by the cooperation with others. In Abrose, agents will react in the following manners:

- when a complete incomprehension occurs, receiver agent brings the message to a more relevant agent,
- when a partial comprehension occurs, receiver agent brings to the sender the partial answer associated to the understood part of the message. It sends the other part of the request to a more competent agent,
- when an ambiguity occurs, the receiver agent turns up the message to the sender for clarification. If it cannot answer, it turns it up to its own sender,
- when a conflict occurs, one of the two agents or the two agents have to relax constraints,
- when a total comprehension occurs, the receiver agent has to give the answer to the full request and turn it up to the sender agent.

Two kinds of communication allow one to maintain a cooperative state between each agent of a multi-agent society. Firstly, the spontaneous communication [5] is an altruistic behaviour resulting from the reasoning process using each agent's knowledge on the other agents of the society. An agent communicates in a spontaneous way the change of state of a shared information to agents with which it shares it. This communication occurs when the reasoning of the sender is stable in order to guarantee (in its viewpoint and in a temporary way) that messages it will transmit will have a non-erroneous content. Spontaneous communication allows one to guarantee the consistence management of the shared information between agents. Secondly, the restricted relaxation allows the dissemination of knowledge to particular neighbours, in order to satisfy an agent's request or to provide result to relevant agents. Each agent, according to its beliefs, will provide results to agents which are likely to use it or will ask help to agents which are likely to help. Restricted relaxation is the method we used to localise relevant services.

2.4 Structure of Agents

Each agent of Abrose, whatever its level is, consists of beliefs, skills, abilities, interaction language and social attitudes. The social attitude is always cooperation.

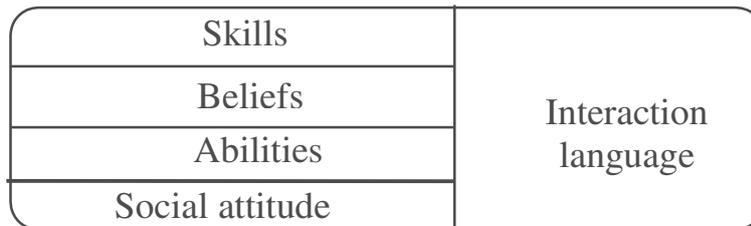


Fig. 2. Components of an agent

The skill of BA is composed of a term. It communicates with some other BA's by sending signals. The beliefs on other BA's are represented by weights linking them. New BA's are created – or previous BA's suppressed – when an end-user gives the evaluation of a transaction result. When a BA receives signals about other BA's, it interprets them and acts.

A TA has beliefs on itself and on the skills of other TA's which are hosted by the same MA. So, it only has a local view on other TA's. A TA contains and manipulates users' and services' knowledge they represent. It communicates by exchanging information about the knowledge domain of the whole Abrose system. When a TA receives a message, it interprets it (see section 2.3) and acts.

An MA controls creations, suppressions and migrations of TA's which compose it. Its skill consists of the skill of the TA inside it. Its beliefs on itself are composed of the beliefs it has of its TA's. An MA has a local view and cannot have beliefs on TA's which are in other MA's. It has a corpus of beliefs on other MA's which is initially fixed in order to guarantee the connectivity of the system. It knows other MA's with which it exchanges information. This exchange is carried out by messages passing. The communication between MA is then performed by the migration of TA's. An MA has the capability to help one of its TA's which is blocked, in getting in touch with a local TA which is able to solve the blocking. If it does not possess such TA's, it gets in touch with an other MA which is able to suppress the blocking state. A MA has also the capability to modify the specified itinerary of a TA which came in it, specially when it is not the relevant itinerary for the current request. A MA interprets each message that it receives (see section 2.3) and acts.

3 The Broker Operation

When a user is connected to its TA, he can do a request or an offer to the broker. In the case of an offer, the content provider wants to propagate his offer towards only relevant users. This scenario is shown on an example in the next section.

In the case of a request, a customer wants to know (and perhaps access) to all the relevant content providers. This protocol between the customer and the broker is given in the sequence below. The hypotheses are:

- a relevant content provider relevant for the initial request exists in the system,
- the customer does not know the relevant content provider.

The steps are the following :

Request formulation

1. The customer selects the request service
2. The customer writes his request in a textual form

Search of relevant content providers

3. A message which includes the request is sent by the customer to the broker, more precisely towards the customer TA in the MAS.
4. The customer TA analyses its beliefs in order to find the relevant providers' TA
5. Because the customer TA doesn't know any other TA, it asks the MA for beliefs on relevant providers TA's. (Note: The MA has knowledge of all the "experiences" made by the system.)
6. The MA returns to the customer TA the beliefs on providers relevant for this work

Displaying relevant content providers

7. The list of probably relevant providers is sent to the customer

Connection to some content providers

8. The user selects the desired service(s).
9. The interface of the service(s) is displayed to the user screen.
10. The user specifies its request. Generally, it fills the fields of the interface.

Note: -a spy stores the requests corresponding to each selected Provider.

11. Some service(s) receive the customer request.
12. Results are directly given to the user in using the URL of the Provider databases.

Evaluation and learning phase

13. At the end of the transaction with the content provider, the user gives his evaluation of content provider 's results.
14. The knowledge spied and user's evaluation is sent to the customer TA
15. The customer TA learns the evaluation for enhancement of its TA beliefs about the content provider TA and on itself.
16. The user TA sends the knowledge spied to the content provider TA's and to its MA
17. The content provider TA's learns : the knowledge spied is used for enhancement of Provider TA's beliefs about themselves and about the customer TA.
18. The MA learns : the beliefs of MA's are also updated with information coming from involved TA's.

4 Experiment: A Marketplace for Tourism, Trading, and Telework

The Abrose service paradigm is informally best illustrated with the metaphor of a marketplace. A marketplace "... is a small area in a town or city where there are no buildings and where goods are bought and sold... ". On a more abstract level "... a marketplace is the activity of buying and selling and the places where this occurs... " (Collins Co-build, English Dictionary). When entering a physical marketplace, one realizes visually, in front of which shops people are queuing up, which restaurants are

empty and which are always full, which magazines are bigger and more fashionable than others. When acting on an "abstract" marketplace, one may experience which goods create turnover on that special market, and which companies are successful. In fact, marketplaces have a kind of "collective memory", the market "remembers" success and quality, and this "success" is visible to customers and providers. This collective memory is composed of individual experiences or recommendations received by other customers. This knowledge influences the decisions of customers and providers. The underlying idea of the Abrose service is, to introduce, model, represent and process this kind of "collective" and "individual" memory to electronic marketplaces. The system remembers what was successfully dealt with, what the users' requests really have been. It has a kind of track record of interactions between different actors on the marketplace. Users and Providers are enabled to use this knowledge, in order to improve the quality of the mediation for both parties.

One service idea is to enable Users to ask implicitly questions as:

- "Tell me, what is really being dealt successfully here on this marketplace?"
- "Which are the goods really mostly requested?"
- "Which are the successful shops, and what are they dealing with?"
- "What have been the experiences with the good xxxxx?"
- "Tell me if there is something new related to yyyy!"

Providers shall be enabled to understand:

- Which have been the customers requests regarding the entities he offers?
- Which have been the things customers have shown interest in general?
- And how to propagate offers towards potentially interested customers.

The overall operational paradigm that the customer could imagine of the service offered is the following. Customer Agents (user and provider) are delegated tasks. They move to the broker domain, where they meet alter ego specialised in different business domains (here Tourism, Telemarketing and business to business Electronic Commerce), in order to find the most appropriate answer to their tasks. This fully mimics human beings co-operating through forum, excepted that their agent counterparts are endowed with the appropriate societal behaviour of openness and co-operation. In addition, as human beings do, they observe and learn, and so capitalise the knowledge passing through the broker domain, from very specific knowledge in the Customer's Agents (profiles) to more global knowledge in the MA (facilitating agents).

Application in TradeZone of ONYX

This scenario is drawn from a business domain of Onyx™ Ltd. called TradeZone™ (Business-to-Business Electronic Commerce). Traditionally, suppliers have relied on paper catalogues, literature and price lists to market their products, however, the shortfalls of this method are increasingly apparent. Paper and postage costs are high, it is not financially viable to send the information to every potential purchaser, and personalising the product range and price for each customer is virtually impossible.

TradeZone (<https://www.tradezone.onyx.net>) provides the secure electronic commerce services to help companies reach a global marketplace via the Internet, increase sales and sales margins, improve customer service and reduce costs. The TradeZone service comprises three main components: a catalogue service, a secure order processing service, and a secure payment processing service. Anyone can buy

through TradeZone, and will see a standard catalogue and prices. Companies who want certain customers to see personalised catalogues and prices can arrange this via TradeZone; those customers are issued with smart cards and PIN numbers, and when they enter TradeZone they are recognised and see only the catalogue and prices specific to them. Currently there are three main methods of payment within

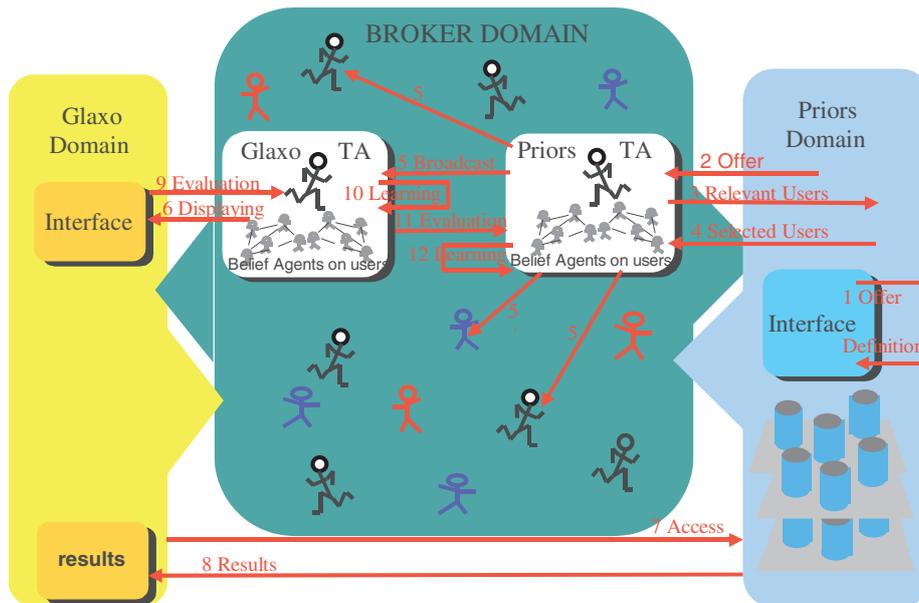


Fig. 3. An offer registration scenario in electronic commerce using Abrose

TradeZone: cheque or bank transfer, credit card payment using SSL, and credit/debit/corporate purchasing card using SET. This scenario corresponds to a supplier who wants to reach existing customers with individually tailored special offers.

Priors fine arts supplies high quality paintings and prints to consumers and businesses. The company has a product catalogue on TradeZone. From time to time, the company is able to acquire art of specific interest, such as line drawings of old coal mining villages in northern England. Now that they have an on-line catalogue, they want to target specific previous customers with special information when this type of product is acquired. There are two specific actors and their corresponding Transaction agents inside the broker domain (see Figure 2):

- the Glaxo company (called Glaxo)
 - Priors Fine Arts (called Priors)
1. Priors defines his offer using the available Interface. The aim of Abrose is to find customers who have previously shown an interest in this type of line drawing. For example, he might type: "Mining, northern England, line drawings, charcoal, (artist's name)"
 2. A message, which includes the offer, is sent to the TradeZone broker domain.

3. The Abrose broker creates a goal corresponding to this offer and analyses its beliefs in order to find the relevant customers in this particular application domain, being previous customers of Priors who have bought similar types of picture before). The Abrose broker has knowledge of all the experiences of the system. In particular it knows Glaxo because they have previously purchased through TradeZone. The Abrose broker presents to the Priors user the list of probably relevant customers with information about the previous buying.
4. Priors selects the desired customer(s) and sends the offer information to the selected customers. The User interface notifies the MAS about the experiences and selections made.
5. The offer is sent to all selected users by the Transaction Agent of Priors
6. The Glaxo TA which has received the Priors offer send it to Glaxo when it is logged in.
7. Interested by this subject, Glaxo connects to the Priors Provider in using the address contained in the offer.
8. Glaxo accepts the transaction about paintings with Glaxo.
9. Satisfied by the result Glaxo sends to Abrose a positive evaluation.
10. This evaluation is learnt by the Glaxo Transaction Agent. This means that now Priors has relevant offers about paintings, and Glaxo customer is interested by.
11. The evaluation is sent to the Priors TA.
12. Priors TA updates the profiles users about itself and Glaxo.

The only steps explicitly done by customers are those corresponding inside the users domains (Glaxo and Priors) corresponding to the steps 1, 4, 7 and 9. All those communications and treatments are managed by the multi-agent systems of Abrose.

5. Conclusion

The Abrose platform V 1 is implemented in Java with JWS1.1.3, the communication between the Broker and the User domains is developed with OrbixWeb3.1. The brokers runs under Solaris 2.6. All the specifications have been made in UML under Rational™ Rose98™. The client is a standard PC equipped of a standard browser.

In addition, as active members of the FIPA consortium (Foundation for Intelligent Physical Agents), and as the FIPA'97 and FIPA'98 specifications are available [9], we are partly evaluating and we will report results to FIPA during 1999. More precisely, on the need to implement the full set of ACL to the specific case of cooperative and self-organised multi-agent system, namely number of speech acts, protocols and ontology services. In 1998, we have presented the specificity of the Abrose project to FIPA (9th meeting, Osaka, April, 98) and we acted as the editor of the "Methodology to build an ontology" (Annex B, FIPA98-part 10) published in fall 1998.

The experimental service described in this paper showed that multi-agent system brings intrinsic innovations for:

- convergence towards maximal satisfaction of the clients (final users and service offers) of the mediation service ("win-win" approach),
- great flexibility to follow the dynamic evolution of the offers-demands context,
- contextual and personalized help of the clients (e.g. information pushing according to the user profile).

Extensions to others applications are foreseen in the tourism and job research domains. These extensions to new data fields should prove the robustness of the approach, in other words the genericity of the basic functions provided by the multi-agent architecture, and above all, the added-value of the Abrose multi-agent service to new business domains.

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