ADMIT: Agent-Based Distributed Market Place Architecture for Integrate Trading on the Internet

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1 Introduction

In a community of agents providing a broad kind of services, the capability to trade and negotiate about products and services is an essential issue. This paper presents a generic architecture (ADMIT) for trading among groups of agents to be integrated in a world wide distributed agent platform developed in the EC funded Agentcities.RTD research project. The central part of ADMIT is the possibility to trade via participation in multiple auctions and multi-attribute negotiation held by a set of e-markets. These e-markets can be loosely federated to form an integrated e-market. Integration bases in particular on the use of a common shared ontology of products and trading. ADMIT becomes a wide trading space, where users access in a transparent fashion and locally using his habitual e-markets interface.

Negotiation process within ADMIT can be performed using several complementary mechanisms. One of them are auctions, that have very small transaction cost and allow the participation of a large number of bidders. Auctions are the most popular and also efficient trading mechanism [4, 2] but there are some limitation, only one attribute can be negotiated and only one part manages the negotiation process. In order to avoid these limitations a multi-attribute negotiation is also included in ADMIT. A negotiation is more time consuming and requires more effort from the parts than an auction but it covers the main problems of auctions. Using negotiation several attributes can be considered instead of only one, so the result agreement can be integrative, where all the parts win because the interest of one part are not necessary in conflict with the other one [4, 6]. On the other hand there is the distributive process where the benefits of one part affects the benefits of the other, such as a auction does. Each trading mechanism has advantages compared with the other but they are not incompatible but complementary, so ADMIT integrates both in order to offer and integrated trading space where agents has the chance of choosing the most suitable mechanism.

ADMIT also allow the integration of different external services in order to create a complete e-market. One of these services is an agent payment service that is developed by a third party in the frame of Agentcities.RTD research project, another service is a logistic service that offers the possibility to take into account the shipping information in the matchmaking and also in the negotiation process.

The remaining paper is structured as follows. We briefly introduce the AD-MIT architecture, its agent-based service components for auction and trade houses, generic ontologies, and distributed search in an ADMIT e-market in section 2. An example of a distributed ADMIT e-market and its use is outlined in section 3. Section 4 concludes with some details about the implementation and future work.

2 ADMIT Market Place Architecture

In subsequent sections we briefly outline the generic ADMIT e-market architecture.

2.1 Overview: ADMIT E-Market and Agents

An ADMIT e-market is a collection of networked ADMIT e-market houses for trading via auctions and multi-attribute negotiations on items of a given product domain as well as providers for secure payment and logistics. This collection may be considered as a loose "federation" in that all members are fully interconnected, and commonly agreed on ontologies for products and trading mechanisms (§2.3) to enable meaningful interaction and communication between them. In addition, collaborations between members of an ADMIT e-market are assumed to be benevolent. We envision any ADMIT e-market to consist of a set of two types

of trading houses. Customers may trade commodities on an relevant ADMIT e-market via participation in multiple auctions and one-to-one multi-attribute negotiations in auction or trade houses of this market, respectively. Thus, the generic component-based architecture of both types of houses mainly differs in the kind of trading mechanism (auctions or negotiations) it provides to the users by either an auction or trade engine (see figure 1).

Users may access to and trade on any ADMIT market via a convenient ADMIT user interface such that the structure and functionality of the e-market remains transparent to them. The ADMIT user interface is knowledgeable of the set of ADMIT e-markets which are available to its users, and able to create and manage personal user profiles and agents for assisting users in trading on these markets. In particular, each user is represented in ADMIT e-markets by its personal ADMIT user agent.

Any user agent may register itself at one or multiple e-market houses in which it is then represented by a proxy, called user interface agent (IA). This user agent proxy may spawn multiple agents each for pro-actively performing one process of trading in-house to accomplish its goal. Thus, an IA may concurrently participate via appropriate clones in relevant auctions and negotiations in different auction and trade houses, respectively. These clones are called A-servant agents or T-servant agents depending on the type of the e-market house they are running in. Each servant agent acts pro-actively and returns its results to its user agent proxy, which in turn delivers a compiled summary of results to its user agent at a given point in time.
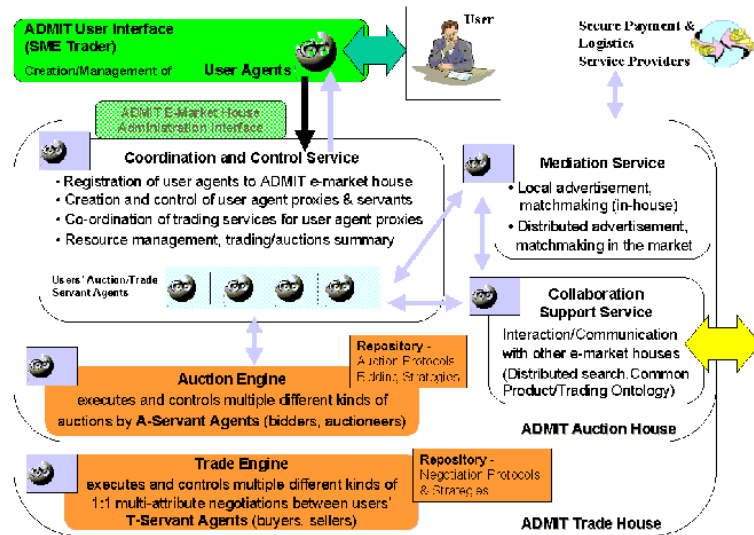

Fig. 1. Overview of ADMIT e-market architecture

Both user interface and servant agents are created, executed and controlled by an agent-based co-ordination and control module (CCM) of an ADMIT house. The CCM agent co-ordinates the services requested by the servants including local and distributed advertisement or search of products offered by other houses in the e-market. On demand by the user interface agent, the CCM agent supports its servant agents in providing integrated services for trading, secure payments and logistics.

For the purpose of interaction with the external world each house is equipped with an agent-based collaboration support module (CSM) managing communication and semantically meaningful information exchange based on commonly agreed specific product and trading mechanisms ontologies for the e-market. The CSM agent co-operates with both the mediation service and the CMM agent on demand. Each user agent proxy may request the CSM of other houses in the considered ADMIT e-market for relevant co-operation services.

The mediation service module provides local and distributed matchmaking services. This allows user interface agents to take all beneficial trading opportunities in-house and in other houses of the e-market into account for their decision-making. The distributed search for relevant providers is performed collaboratively with other mediation service agents in other houses of the considered market via support of the respective CSM agents (§2.4).

Agent-based distributed trading in an ADMIT e-market may be relatively tolerant against, for example, temporary network faults and delayed agent executions. We distinguish between matchmaking or weak brokerage based trading tasks of user agents. In the first case of matchmaking based trading, the user agent registers itself at the nearest house in the e-market. The user agent proxy then acts like a matchmaker by initiating a local in-house and distributed search for relevant trading opportunities across the whole e-market. The proxy returns the result of this search, i.e. the set of relevant houses, to the user agent which then is in charge to register itself at the relevant houses to trade via appropriately created (or already existing) user agent proxies. In the second case of weak brokerage based trading, the user agent proxy performs a distributed search and registers the user agent at the relevant houses, if not already done in the past. All cloned proxies return a compilation of their trading results to its original user agent.

Other e-market systems which do not conform to the ADMIT architecture may also become part of an ADMIT e-market. This could be achieved via appropriate integration of a CSM service module which is properly networked with others in the ADMIT e-market. This module then provides an interface mapping requests of trading services to proprietary in-house services. The mapping may be performed by matching relevant service descriptions using commonly agreed product and trading mechanisms, and transforming the in-house service results into the format required by CSM agents for collaboration in an ADMIT e-market.

2.2 ADMIT Houses: Service Components

As mentioned in previous section, both types of ADMIT e-market houses provide sets of agent-based generic services for integrated trading to the customer but essentially differ in the kind of trading they support. We briefly outline the functionality of the main generic service components of an ADMIT auction and trade house.

ADMIT Auction House Service Components Any user agent may register at an ADMIT auction house (figure 2) using the house's agent-based CCM service for registration and login service provided by the registration agent. The coordination agent (CoA) provides services for load-balancing tasks inside the house, creates for each user agent its in-house proxy, called user agent proxy (UAP). In addition, the CoA is performing also tasks for tracking UAP activities for audit purposes, and provides information on available services on demand. Integrated services are provided by general integrated service agents (GISA) maintaining communication between in-house agents and external service providers such as providers for secure payment and logistics.
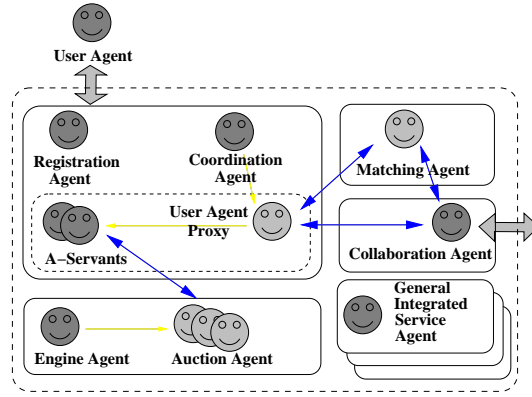

Fig. 2. ADMIT Auction house components, agents, and services

The mediation service module inside the ADMIT auction house is maintained by the matching agent (MA). The MA takes care of requests for local in-house and remote advertisements within the e-market. For this purpose it provides its matchmaking services to local and remotely UAP on demand. CSM service tasks are performed by the collaboration agent (CA), that is collaborating on demand with the MA and UAPs which are involved in co-operation tasks such as distributed search for relevant items to trade in the e-market houses. The auction engine agent (EA) maintains the core of the auction house, the auction engine, offering different types of auctions including English, Dutch, and Vickrey auctions ([8]). As mentioned in the previous section, each UAP may concurrently

participate in multiple auctions. For each auction the UAP wants to participate in or start an auction servant agent (A-Serv) or auctioneer agent (AA), respectively, is created. All servant agents report their results to their UAP which returns a compiled summary to its user agent residing on the potentially remote host of the user's ADMIT e-market interface.

ADMIT Trade House Service Components As mentioned above, any user agent may register at an ADMIT trade house (figure 3) via the house's agent-based CCM services for login and registration. The gate agent (GA) of the trade house's CCM provides these services. In addition, the gate agent pursues local load-balancing tasks, and creates for each user agent its proxy, called user interface agent (IA). The control agent (CA) provides services for tracking and agent introspection useful not only for the human administrator but also for extracting social measures of the underlying community composed by the agents. Through the relations among the agents several measures such as reputation and trust can be inferred using feedback processes [11, 7] or analysing the topology of interaction graphs and social networks [5].
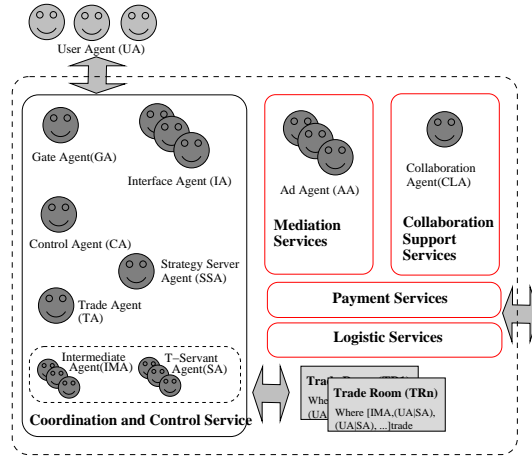

Fig. 3. ADMIT Trade house components, agents, and services

Similar to the mediation service agents in ADMIT auction houses, the ad agents (AA) in ADMIT trade houses take care of local and distributed advertisement and matchmaking services. The AA manages the local matchmaking and also the distributed, forwarding the local request and performing the integration with results yelled by the federated houses. To perform this task the AA collaborates with the Collaboration Agent (CLA) that is the responsible of the interaction with the federated houses. A strategy server agent (SSA) maintains the repository of negotiation strategies. Each user agent proxy may negotiate with different providers in one or multiple trade rooms concurrently by means of

customized servant agents (SA) following a given strategy. Thus the user agent proxy can avoid implementing difficult negotiation strategies. The user agent proxy can obtain from the SSA a customized servant agent (SA) choosing the desired strategy and defining the interests. The SSA on demand of the user agent proxy appropriately creates each SA that will act in behalf of the user agent maximizing his interests. The trade house offers one or multiple environments, called trade rooms, where multiple 1:1 multi-attribute negotiations between user agent proxies may take place. Each trade room is under control of a intermediate agent (IMA) that is created on demand by the trade agent (TH), which takes care of the setting up and the shutdown processes while the negotiation process itself is managed by an IMA.

2.3 ADMIT E-Market Ontologies

As mentioned above, we assume that all members of an ADMIT e-market share a set of domain-specific ontologies each of which may be derived from an appropriate generic ontology. The generic ADMIT e-market implementation includes such generic ontologies for describing the concepts and semantics of products and trading mechanisms for each type of ADMIT e-market house. A part of the generic product ontology in RDFS is shown in figure 4 (a). Part of a domain-specific instantiation of this generic ontology is shown in figure 4 (b). This specific ontology refers to the set of real-world concepts commonly shared and reused by ticket providers.
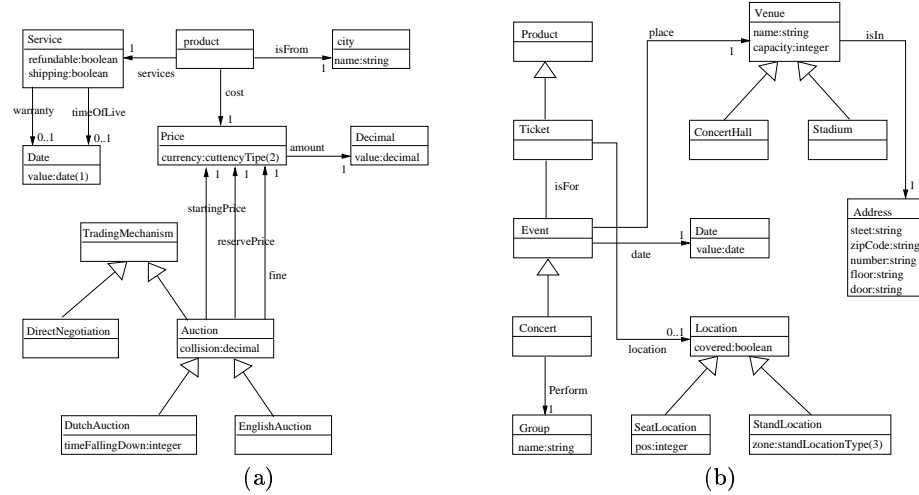

(a)   (b)

Fig. 4. Part of a generic product ontology (a) and a specific ticket ontology (b)

2.4 Distributed Search in ADMIT E-Markets

As mentioned in §2.1 any user agent proxy may initiate a distributed search for relevant items to purchase matching given preferences. This search is collaboratively performed between the user agent proxy, the mediation service and CSM agents of all houses of the e-market.

The idea behind the distributed search is the same that in peer-to-peer systems such as Gnutella or FreeNet. Once a search request is received it is forwarded to the directly connected houses. Thus, the search request will be spread among all the houses. Obviously, some controls in the broadcast process will be performed by the servant agent: diminishing the request time of live of the request, controlling the repeated request using a cache in order to cut the cycles. Not all the request will be automatically forwarded because a request could have some restrictions, for example, geographical scope.

For large-scale ADMIT e-markets with potentially hundreds of members world-wide we intend to adopt efficient methods for distributed search and data access in peer-to-peer networks [10, 1]. The result of the search is returned to the user agent (proxy) for further processing.

3 Example: ADMIT Ticket Market

Consider, for example, one distributed ADMIT ticket market as sketched in figure 5. This e-market consists of four ADMIT e-market houses, in particular two auction and two trade houses. Users may purchase tickets for pop concerts, for example, via relevant auctions in London and Saarbrücken as well as direct negotiations with relevant ticket providers in the trade house in Barcelona. In this example, the trade house in Lausanne does not offer tickets for pop concerts. Tickets for soccer games are offered for sale by all houses in this distributed ADMIT ticket market.

Suppose that an user in Stockholm wants to buy some tickets for, say, a champions league soccer game played in the city of Barcelona for a given price and time of delivery. The user contacts its SME trader residing on a host in Stockholm to select and access the relevant ADMIT ticket market(s).

Its personal ADMIT user agent decides to perform a brokerage-based trading of the tickets taking the given user preferences into account. Thus, the agent registers itself only at the nearest house per ticket market, for example, the auction house in London, and awaits a list of buying options to be confirmed by the user. The user agent proxy in the auction house in London decides if, when, and how to spawn auction servants for its participation in multiple relevant and concurrently running ticket auctions in-house. At the same time, as a result of distributed matchmaking in the market, it gets informed that tickets for this game are available in all other houses of the e-market. Therefore, the proxy registers the user agent at each of these houses in Barcelona, Saarbrcken, and Lausanne, to purchase 3 tickets each. All user agent proxies return their ticket buying options including payment and shipment to the waiting user agent. The
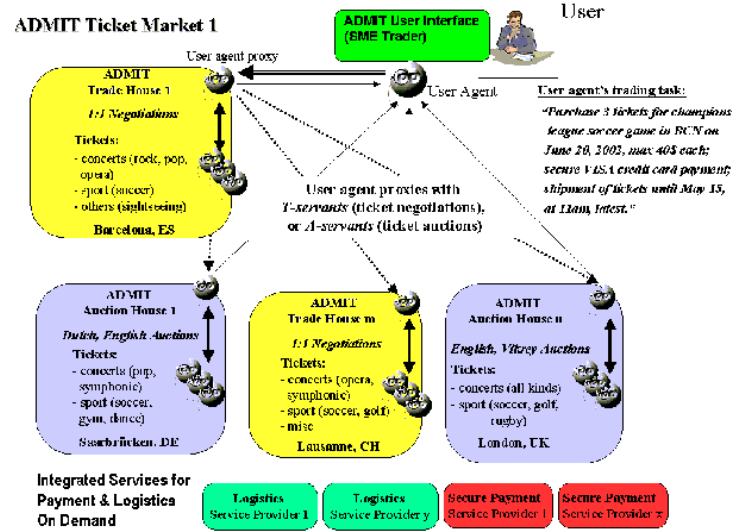
Fig. 5. A distributed ADMIT ticket market place

user agent may then decide on how to proceed in the trading in co-operation with its proxies in the relevant houses. As soon as the user confirms one option, the respective servants will be notified such that they may complete the deal for the user according to the pre-contracts made between the relevant trading agents.

4 Implementation and Future Work

The ADMIT architecture is currently under joint development between UPC and DFKI in the EC-funded Agentcities.RTD research project. As a result we expect to implement a suite of generic service providing components of ADMIT auction and trade houses. These components are basically implemented in Java; the underlying agent system development platform is FIPA-OS 2.1 and JADE, respectively. The ADMIT implementation includes tools for administering and monitoring ADMIT houses.

We intend to utilize the implemented ADMIT architecture for building and demonstrating one simple, geographically distributed ADMIT ticket market. This example of an ADMIT e-market consists of one ADMIT auction and trade house hosted at DFKI in Saarbrcken, Germany, and at UPC in Barcelona, Spain, respectively. The auction house will provide services allowing customer agents to concurrently auction tickets on relevant English and Dutch auctions. In addition, agents can purchase tickets via one-to-one multi-attribute negotiation [3, 8, 9] with relevant ticket provider agents following different strategies at the ADMIT trade house in Barcelona.

Future work includes, in particular, the development of methods for a distributed brokerage based trading within one and across multiple ADMIT e-markets. In this case, the first contacted user agent proxy may act as a full-fledged broker by collaborating with relevant proxies in other houses to accomplish the goal given by its user agent to which it reports a compilation of the approximately optimal results only. More work to be developed is the incorporation of social measures such as reputation or trust in the negotiation process. These information is vital in order to create a more realistic market place where agents social dimension are also taken into account in the negotiation process.

5 Acknowledgements

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