Trust-Based Facilitator for e-Partnerships

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ABSTRACT
In this paper, we propose a facilitator that finds capable and trustworthy partners on behalf of client users, which helps users form and maintain e-partnerships for electronic commerce and electronic collaboration. Unlike existing capability-based facilitators or matchmakers, the facilitator collects and maintains private "word-of-mouth" trust information as well as capabilities from each user and uses the information for personalized trust-based facilitation for each user, which is done through the facilitation protocols and trust propagation mechanism. Compared to other existing trust mechanisms, the characteristics of trust, which this facilitator handles, are personalized-collaborative-subjective-qualitative-private.

Keywords
Middle agents, facilitator, trust model, e-commerce, KQML

1. INTRODUCTION
The concept of facilitator and matchmaker for finding right partners in online communities has been proposed. Figure 1 shows a current form of facilitation [6].

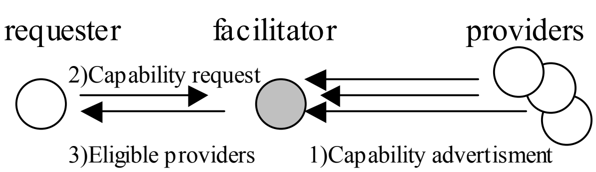

Figure 1. General mechanism of facilitator.

First, provider agents advertise their capabilities to a facilitator and the facilitator stores these advertisements. When a requester asks a facilitator whether it knows of providers with the desired capabilities, the facilitator matches the request against the stored advertisements and returns the result, a subset of stored advertisements. There are several standards that have facilitator-like servers for making dynamic e-partnerships such as Knowledge Query and Manipulation Language (KQML), the Foundation for Intelligent Physical Agents (FIPA), and the Common Object Request Broker Architecture (CORBA). In addition to these standards, there are some existing implementations, such as Matchmaker by CMU [6] and Kasbah by MIT [2]. Unfortunately, however, all of them perform facilitation based only on the registered capabilities of service providers and are not sufficient for making e-partnerships in online community. This is because requesters do not want to deal with bad providers. On the other hand, providers also do not want to deal with bad requesters. It is then necessary to filter and rank requests and responses according to trustworthiness for both requesters and providers.

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2. TRUST-BASED FACILITATOR
2.1 Trust for e-partnerships
"Trust" information, which we try to make use of in facilitation, has been defined and used differently in many applications and services such as rating systems and reputation systems. Roughly, we define trust as a general factor for deciding whether or not the facilitator can introduce the agents. As this definition is too vague, however, we define five categories of trustworthiness:

1. Commonality of trustworthiness of target agent: same for all participant agents (Standardized) or different from each source agent (Personalized)
2. Evaluator of target agent: third-party authority (Authoritative) or participants (Collaborative)
3. Objectivity of evaluation: based on common criteria (Objective) or based on different criteria (Subjective)
4. Complexity of trustworthiness: numeric values (Quantitative) or positive/negative (Qualitative)
5. Disclosures of reputation report: open to public (Public) or closed to public (Private)

Based on these categories, existing applications and services are classified as shown in Figure 2. The Better Business Bureau (BBB) and Dun & Bradstreet (D&B) rate companies and provide information to those who inquire about inquired companies, which include trustworthiness, management, and profit. eBay [3] runs an auction site to sell and buy various goods, which has more than 10

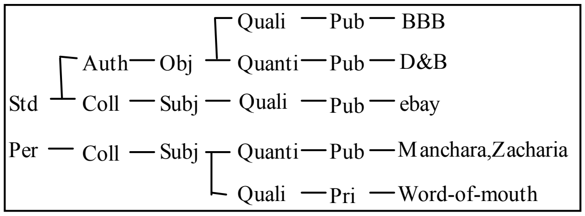

Figure 2. Categorization of application and services

million members. On eBay, sellers and buyers can check rating scores of potential partners before trading as they evaluate each other by providing feedback after their trades.

There are several algorithms for handling Personalized Distributed Subjective trustworthiness [5][7], which propose trust metrics and models for e-commerce by calculating over a chain of numerical trust values when there is a public intermediary.

2.2 Handling word-of-mouth trust

When we think of trust information in the real world, "word-of-mouth" trust information is considered to be very important [1]. For taking advantage of word-of-mouth trust information and existing facilitators, which collect capabilities registered by provider agents and do facilitation based on that information, we propose a facilitator that collects word-of-mouth trust from participants as well as capabilities, and uses both of them for facilitation.

Requirements for word-of-mouth trust-based facilitation are private-collaborative-subjective-qualitative-private in Figure 2. In addition to these: (1) Trustworthiness should be transitive. That is, if agentA directly trusts agentB and agentB directly trusts agentC, agentA can indirectly trust agentC. (2) Trustworthiness should be kept different by capabilities. That is, the trustworthiness of one agent concerning car sales could be different from that of the same agent concerning car repair.

2.3 Representation and maintenance of trust

The way of representing trustworthiness has the following types based on the requirements described in 2.2.

First, cases in which an agent evaluates the target agent directly based on its own previous experience with requested capabilities include direct positive (DP) and direct negative (DN) reputation. Second, cases in which an agent evaluates the target agent by using chain of trustworthiness from the source agent to the target agent include indirect positive (IP) and indirect negative (IN) reputation. Finally, the case in which an agent has no information about the target agent includes unknown (UN).

	AA	AB	AC	AD	AE	AF
AgentA		DP	IP	IP	DP	UN
AgentB	DP		DP	UN	DP	UN
AgentC	IN	DN		DN	DP	UN
AgentD	IP	DP	IP		IP	DP
AgentE	DN	IP	DP	DP		UN
AgentF	UN	IP	UN	DP	UN	

Figure 3. Example of Trust Table

Thus, trustworthiness can be represented by any of five types and they are kept in n*n table for each capability, as shown in Figure 3. In this example, an agentA directly trusts agentE, but agentE distrusts agentA. Inside the facilitator, filtering potential partners is performed based on requested capabilities and trustworthiness. For maintaining registration in the facilitator, capabilities and trustworthiness are stored in a dynamic database inside the facilitator. In the database, trustworthiness values are stored by an n*n matrix, in which the n is the number of registered agents, for each capability type. Trustworthiness registered by users could be either DP or DN. When a facilitator receives data, cells of the matrix that remain blank or UN are converted into IP or IN.

Every time the facilitator receives new data, it recalculates all of IP, IN, UN data. Calculating indirect reputation (IP or IN) from one agent (X1) to another agent (Xn), is done by the following two steps:

1) Find paths from X1 to Xn

2) Use a tie-breaking rule if more than one path exists.

The policies of step 1 are as follows (Figure 4):

- An agent can use only the direct reputation of other agents
- From Xj to Xj+1 (1 < j < n-2), only DP can be used.
- From Xn-1 to Xn, both DP and DN can be used.

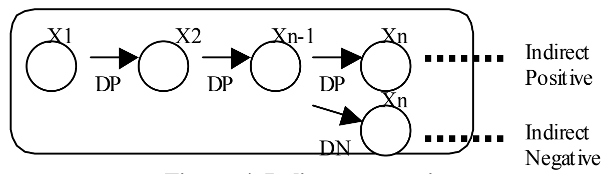

Figure 4. Indirect reputation.

3. CONCLUSION

We have implemented the facilitator as a JATLite-based multi-agent system, developed at Stanford University [4]. For communication among requesters, providers and a facilitator, we use KQML, which provides protocols for facilitation: *broker*, *recruit*, *recommend*, and *subscribe*. Both capabilities and trustworthiness are described in the "content" parameter of KQML. We believe that the facilitator is the first trust-based facilitator that uses private-distributed-subjective-qualitative trust information.

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