

# Agent-Based Electronic Market With Ontology-Services

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## Abstract

*This paper proposes a semantic information integration approach for agent-based electronic markets based on ontology-based technology, improved by the application and exploitation of the trust relationships captured by the social networks. We intent face the problem of the growth of e-commerce using software agents to support both customers and suppliers in buying and selling products. The diversity of the involved actors leads to different conceptualizations of the needs and capabilities, giving rise to semantic incompatibilities between them. It is hard to find two agents using precisely the same vocabulary. They usually have a heterogeneous private vocabulary defined in their own private ontology. In order to provide help in the conversation among different agents, we are proposing what we call ontology-services to facilitate agents' interoperability. More specifically, this work proposes an ontology-based information integration approach, exploiting the ontology mapping paradigm, by aligning consumer needs and the market capacities, in a semi-automatic mode, improved by the application and exploitation of the trust relationships captured by the social networks.*

## 1. Introduction

In an efficient agent-mediated electronic market, where all the partners, both sending and receiving messages have to lead to acceptable and meaningful agreements, it is necessary to have common standards, like an interaction protocol to achieve deals, a language for describing the messages' content and ontologies for describing the domain's knowledge.

The need for these standards emerges due to the nature of the goods/services traded in business transactions. The goods/services are described through multiple attributes (e.g. price, features and quality), which imply that negotiation processes and final agreements between seller and buyers must be enhanced with the capability to both understand the terms and conditions of the transaction (e.g. vocabulary semantics, currencies to denote different prices, different units to represent measures or mutual dependencies of products). A critical factor for the efficiency of the future negotiation processes and the success of the potential settlements is an agreement

among the negotiating parties about how the issues of a negotiation are represented and what this representation means to each of the negotiating parties. This problem is referred to as the ontology problem of electronic negotiations [1]. Distributors, manufactures, and service providers may have radically different ontologies that differ significantly in format, structure, and meaning. Given the increasingly complex requirements of applications, the need for rich, consistent and reusable semantics, the growth of semantically interoperable enterprises into knowledge-based communities; and the evolution; and adoption of semantic web technologies need to be addressed.

Ontologies represent the best answer to the demand for intelligent systems that operate closer to the human conceptual level [2].

To achieve this degree of automation and move to new generation e-commerce applications, we believe that a new model of software is needed.

In order to provide help in the conversation among different agents, we are proposing what we call ontology-services to facilitate agents' interoperability. More specifically, this work proposes an ontology-based information integration approach, exploiting the ontology mapping paradigm, by aligning consumer needs and the market capacities, in a semi-automatic mode, improved by the application and exploitation of the trust relationships captured by the social networks.

In this paper we present an ontology-mapping service which is aligned with a negotiation mediation service, allowing negotiation to take place between entities using different domain ontologies. Although the negotiation process of the ontology mapping is not a part of the business negotiation (B2C), the same infrastructure can be applied, minimizing the development effort.

One the other hand ontologies are perceived as socially evolving descriptive artifacts of a domain of discourse, namely that of B2C which can be used as a social information and web-of-trust source of information to support the ontology-services.

The paper is organized as follows. This section makes an introduction. Section 2 contextualizes the usage of an ontology-mapping service in agent-based automated negotiations. Section 3 details the service itself. Section 4 illustrates an Ontology Mapping Negotiation Example and section 5 makes some conclusions.

## 2. The Marketplace Ontology Services Model

To study our proposal we combine the use of two tools, developed at our Research Group, namely ISEM [3] and MAFRA Toolkit [4] into a novel electronic marketplace approach, together with the exploitation of social semantic network services.

ISEM (Intelligent System for Electronic MarketPlaces) is a multi-agent market simulator, designed for analysing agent market strategies. The main characteristics of ISEM are: first, ISEM addresses the complexities of on-line buyer's behaviour by providing a rich set of behaviour parameters; second, ISEM provides available market information that allows sellers to make assumptions about buyers' behaviour and preference models; third, the different agents customise their behaviour adaptively, by learning each user's preference models and business strategies.

MAFRA Toolkit is the instantiation of the MAFRA - Mapping FRAMework, addressing the fundamental phases of the ontology mapping process. In particular, it allows the identification, specification and representation of semantic relations between two different ontologies. These semantic relations are further applied in the execution phase of the interoperation, by transforming the data as understood by one of the actors into the data understood by the other. In this sense, ontology mapping allows actors to keep their knowledge bases unchanged while supporting the semantic alignment between their conceptualizations (ontologies).

### 2.1. The Marketplace Model

The Marketplace facilitates agent meeting and matching, besides supporting the negotiation model. In order to have results and feedback to improve the negotiation models and consequently the behaviour of user agents, we simulate a series of negotiation periods,  $D = \{1, 2, \dots, n\}$ , where each one is composed by a fixed interval of time  $T = \{0, 1, \dots, m\}$ . Furthermore, each agent has a deadline  $D_{max}^{Agent} \in D$  to achieve its business objectives. At a particular negotiation period, each agent has an objective that specifies its intention to buy or sell a particular good or service and on what conditions. The available agents can establish their own objectives and decision rules. Moreover, they can adapt their strategies as the simulation progresses on the basis of previous efforts' successes or failures. The simulator probes the conditions and the effects of market rules, by simulating the participant's strategic behaviour.

ISEM is flexible; the user completely defines the model he or she wants to simulate, including the number of agents, each agent's type and strategies.

### 2.2. The Negotiation Model and Protocol

The negotiation model used in ISEM is bilateral contracting where buyer agents are looking for sellers that can provide them with the desired products at the best conditions, Figure 1.

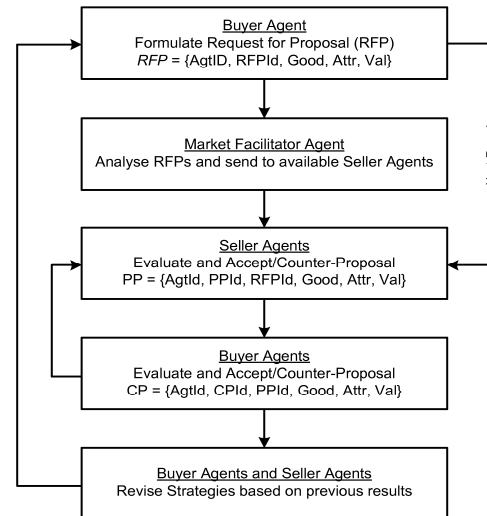


Figure 1. Sequence of Bilateral Contracts

Negotiation starts when a buyer agent sends a request for proposal (RFP) (Figure 1). In response, a seller agent analyses its own capabilities, current availability, and past experiences and formulates a proposal (PP).

Sellers can formulate two kinds of proposals: a proposal for the product requested or a proposal for a related product, according to the buyer preference model.

On the basis of the bilateral agreements made among market players and lessons learned from previous bid rounds, both agents revise their strategies for the next negotiation round and update their individual knowledge module.

The negotiation protocol of the ISEM simulator has three main actors (Figure 2):

- Buyer (B), is the agent that represents a consumer or a buyer coalition. Multiple Buyers normally exist in the marketplace in an instant;
- Seller (S), is the agent that represents a supplier. Multiple Sellers normally exist in the marketplace in an instant;
- Market Facilitator agent (MF), usually one per marketplace, coordinates the market and ensures that it works correctly. MF identifies all the agents in the market, regulates negotiation, and assures that the market operates according to established rules. Before entering the market, agents must first register with the MF agent.

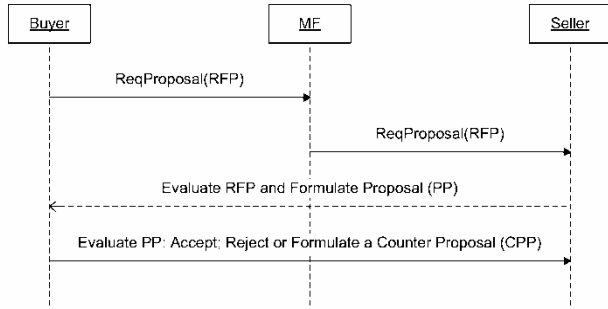


Figure 2. ISEM Bilateral Contract Protocol

### 2.3. The Ontology Service Model

While the use of ontologies allows e-commerce actors to describe their needs and capabilities into proprietary repositories, the use of the ontology-mapping paradigm allows transparent semantic interoperability between them. This is the technological basis for the alignment between needs and capabilities of consumer and supplier, even when they use different ontologies. Based on this approach we can obtain the essential requirements to support our proposed solution and a new system infrastructure is proposed, recognizing two new types of actors:

- Ontology Mapping Intermediary (OM-i), is the agent that supports the information integration process during the market interoperability, typically one per marketplace;
- Social Networks Intermediary (SN-i), is the agent that provides trust relationship information holding between B, S and other agents that undertake similar experiences (e.g. a trader agent), typically one per marketplace.

These actors deploy a set of relationship types whose goal is to automate and improve the quality of the results achieved in the e-commerce transactions. Figure 3 depicts the types of interactions between the marketplace supporting agents (i.e. MF, OM-i and SN-i agents) and the operational agents (i.e. B and S).

1. The Registration phase is initiated by the B or S agent, and allows these agents to identify themselves to the marketplace and specify their roles and services;
2. The Ontology Publication phase is the set of transactions allowing B and S to specify their ontologies to the marketplace;
3. The Mapping phase is the set of transactions driven by OM-i to align the ontologies of B and S;
4. The Transformation phase is the set of information transactions through OM-i that transforms (i.e. converts) the interaction data described in two different ontologies.

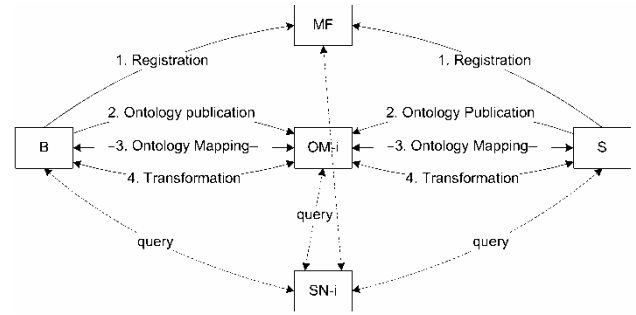


Figure 3. Marketplace's Actors and Interactions

Considering the previous descriptions, a more complete and complex protocol is now detailed, including the OM-i and SN-i agents in the system (Figure 4).

The integration starts when the B agent sends a request for proposal message (ReqProposal) to the MF agent. In response, the MF sends to the OM-i a request for mapping message (ReqMapping) between B and S's ontologies.

Once OM-i receives the ReqMapping message, it will start the ontology mapping specification process, with the support of other entities, including matching agents, ontology mapping repositories and SN-i. SN-i is responsible for retrieving the relevant information from ontology mapping repositories and social networks. Past similar ontology mapping experiences undertaken by agents with trust relationships with B and S will be used by SN-i to compile the social network repository information (i.e. SNInf(Inf)). Because the ReqSNInf is the exclusive responsibility of OM-i, both B and S are advised to perform a similar verification (eventually using other SN-i) once the ontology mapping is submitted for acceptance (i.e. ReqAcceptance(M)). Despite the fact that figure 4 represents only the acceptance scenario, a rejection scenario is also possible, in which case no further interaction will occur between B and S. In case the mapping is accepted, MF resumes the protocol by requesting to OM-i the RFP data transformation. Using the ontology mapping document, RFP data represented according to B's ontology is transformed into data represented according to S's ontology. The transformed data (RFP') is forwarded to S, which will process it and will reply to MF. MF will then request the transformation of the proposal data (P) and will forward P' to B. B processes it and will accept or formulate a counter-proposal (CP). As can be seen, once a mutually acceptable ontology mapping is established between B's ontology and S's ontology, all messages exchanged between B and S through MF are forwarded to OM-i for transformation.

Notice that Figure 4 represents one single S in the system, but in fact multiple S's capable of replying to the request may exist in the marketplace. In such case, the protocol would replicate the previous protocol for as many capable S's. In order to decide which S's are

capable of answering the request, a simple approach based on a keyword matching algorithm is taken. The B agent specifies a few keywords along with its formal request (RFP). The MF, with the aid of SN-i, matches this list against every S's publicized keyword list. In case the match succeeds to a certain level, the S is classified as capable.

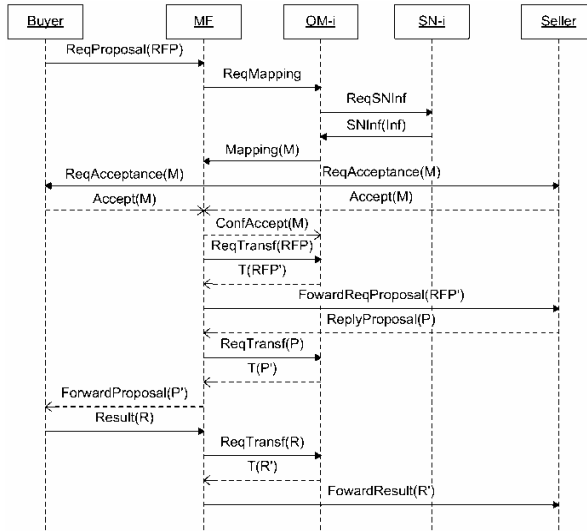


Figure 4. The Integration Protocol

An important goal is to maintain the identification stage of the CBB model by using ontologies, the main idea is to construct the most accurate model of the consumer's needs. Moreover, at the product brokering, buyer coalition formation, merchant brokering and negotiation CBB stages, the ontology mapping process will provide the integration of the seller and consumer's models. In fact, in every stage of the CBB model, both the SN-i and OM-i are major players in the proposed solution. Notice that the social network information and trust component of the system is orthogonal to previous processes, as depicted in Figure 5. Also notice that the trust component of the system is orthogonal to previous processes, as depicted in Figure 3.

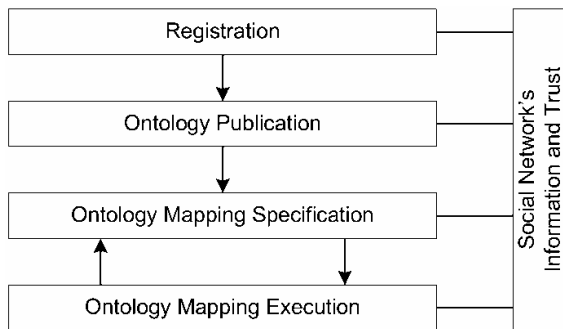


Figure 5. Marketplace's Ontology-Based Services

Complementarily, the repository of relationships provided by emergent social networks will support establishing more accurate trust relationships between businesses and customers, as well as providing a better alignment (mapping) between their models. This new information is very important to feed the agents' knowledge bases to improve their strategic behaviour. Market participant's strategic behaviour is very significant in the context of competition.

In particular, the Social Network component is envisaged as a source of information for disambiguation and decision-making to the other processes, along with trust relationships between users and groups:

- The Registration process will profit from the Trust component in several ways. For example, the S agents can better decide which Services to provide in a marketplace, depending on the segment of customers traditionally found in specific marketplace. This is achieved by the social characterization of the B agents according to the social networks they belong to. In the same sense, B agents can more accurately choose the marketplaces to register to, depending on the social network advice, based on a social characterization of the other marketplace participants (i.e. Buyers and Sellers);

- During the Ontology Publication process, agents need to decide which ontologies are advisable in that particular marketplace (e.g. simple or more detailed). The agent is able to choose the ontology that conveniently describes the semantics of its data in a certain context. In order to decide the more convenient ontology, S agents require a social characterization of the marketplace. Similar decisions are taken by B agents. Notice however, that the agent's published ontology should not be understood as the complete representation of its internal data, but the semantics the agent intends to exteriorize through the Ontology Publication process. As a consequence, the agent should encompass the mechanisms allowing the internal transformation between the internal data semantics (e.g. data schema) and the external semantics (ontology), and vice-versa;

- The Ontology Mapping Specification process is typically very ambiguous, thus it can potentially profit from the social characterisation and social trust relationships provided by SN-i. This process is understood as a negotiation process, in which B and S try achieving a consensus about the ontology mapping. The SN-i agent participates in this process as an information provider to the OM-i in order to disambiguate the ontology mapping achieved through automatic mechanisms and protocols. The rest of the paper addresses this dimension;

- The Ontology Mapping Execution process is very systemic (in accordance to the ontology mapping specification document). Yet, the resulting messages' data may be inconsistent in respect to the B's and S's data repository. In such cases, social knowledge is often

required in order to decide/correct the consistency of the data. Through the use of social relationships, SN-i is a facilitator of this process.

### 3. The Ontology Mapping Process

There are several ontology mapping formats but only a few are able to thoroughly describe the semantic relations established between any two ontologies as required in the B2C and B2B contexts. SBO is one of the most thorough formats, as its building blocks semantically constrain the relevant and useful relationships between ontologies for data integration in B2B and B2C contexts.

As in any negotiation process, the ontology mapping negotiation problem is mainly characterized by the type of object to negotiate. In this case, the negotiation objects are part of the ontology mapping domain. According to the SBO, several types of objects might be considered in the negotiation:

- The ontology mapping document, when the whole specification is subject of negotiation;
- The semantic bridges, when each of the semantic bridges composing the mapping are subject of negotiation;
- Parameters of the semantic bridges (e.g. the set of related entities).

However, the more elements are subject to negotiation, the longer and more difficult it is to achieve a consensus among agents. Notice that a coarse grained negotiation (upon the mapping) is very fast, but a consensus is very hard to achieve, due to the lack of negotiation parameters. On the other hand, a fine grained negotiation (e.g. about the semantic bridges parameters) is easier to achieve, but it might be too long and therefore computationally inefficient.

Another important dimension to consider is the value associated to the object of negotiation. In the ontology mapping negotiation scenario, the value of the object (i.e. the semantic bridge) is a function relating:

- The correctness of the object, either the correction of the mapping, of the semantic bridges or of their parameters;
- Pertinence of the object in respect to its envisaged application. In fact, the ontologies might be larger than it is necessary for the transaction, thus the focus on the relevant parts.

Other dimensions are also relevant for the negotiation process, but in order to reduce the negotiation space, the following constraints have been decided and stated:

- The negotiation always occurs between two honest, non-bluffing agents;
- The ontology mapping to agree on is unidirectional, which means that for a bi-directional conversation, two ontology mapping negotiation processes are required. This is especially due to the fact

that many semantic bridges represent non bijective relations;

- The negotiation objects are the semantic bridges only. It means that no internal parameter of the semantic bridge is independently negotiable.

#### 3.1. Hypothesis

The proposed negotiation process bases on the idea that each agent is able to derive the correct semantic bridges and decide which semantic bridges are required in order to interoperate with the other entity.

The suggested approach aims to further exploit the multidimensional service-oriented architecture adopted in the semi-automatic semantic bridging process [5]. In this process, a confidence value is evaluated for every candidate semantic bridge. This evaluation aggregates different similarity values resulting from the analysis carried out upon different dimensions of ontologies (e.g. lexical, structural and semantic). Different evaluation functions are applied depending on the most relevant dimensions of the ontologies and required semantic relations. I.e. the semantic heterogeneity arising from different ontologies requires different semantic relations. These are referred as confidence functions. Yet, an agent might not know the other's evaluation of the same semantic relation.

Based on these confidence functions, semantic bridges are categorized as:

- Rejected semantic bridges (i.e. whose confidence value is smaller than the rejection threshold  $t_r$ );
- Accepted semantic bridges (i.e. whose confidence value is greater or equal the rejection threshold  $t_r$ ).

As referred previously, one of the major problems faced in negotiation scenarios relates to the difficulty in determining and supplying convergence mechanisms to the agents. Negotiation suggests the relaxation of the goals to be achieved by one (or both) agents, so that both achieve an acceptable contract, and an as good as possible one. This introduces two distinct concepts:

- The goals of the negotiation (the features of the contract to achieve);
- The relaxation mechanisms.

Mathematically, these concepts might be represented respectively as:

- An utility function ( $u$ ), representing the overall goal of the negotiation of the semantic bridge, in which each parameter of the function is a sub-goal of the negotiation:

$$u(p_1, p_2, \dots, p_n)$$

- A meta-utility function ( $U$ ) defining the conditions in which the parameters may vary:

$$U(p_1, p_2, \dots, p_n)$$

It is fundamental to identify the ontology mapping concepts that are able play these role in the negotiation process.

### 3.2 Negotiation phase

The confidence evaluation function applied in the generation of the ontology mapping is a good candidate to play the role of the utility function ( $u$ ). This function plays a major role in the negotiation process and reusing it reduces the efforts of parameterization and customization, two hard, time-consuming and human demanding tasks of the ontology mapping process. However, it is our proposal to distinguish the semantic bridging from the negotiation phase, i.e. both phases occur consecutively. First, each agent performs its own semantic bridging process, generating a valid and meaningful document mapping. After that, the set of semantic bridges composing the mapping are subject to the negotiation between both agents.

The confidence value evaluated for each semantic bridge ( $csb$ ) is then used as the negotiation value of the semantic bridge, corresponding to the agent confidence in proposing the semantic bridge to the other agent.

Several situations might occur when negotiating a specific semantic bridge:

- Both agents propose the semantic bridge;
- Only one of the agents proposes the semantic bridge.

In case last situation arises, one of two situations occurs:

- The other agent relaxes the confidence value and accepts the semantic bridge;
- The other agent is not able to relax the confidence value and rejects the semantic bridge.

In case last situation occurs, one of two situations occurs:

- The agent proposing the semantic bridge cannot accept the rejection. In this case, the proposed semantic bridge is considered mandatory;
- The agent proposing the semantic bridge can accept the rejection (i.e. the semantic bridge is not mandatory).

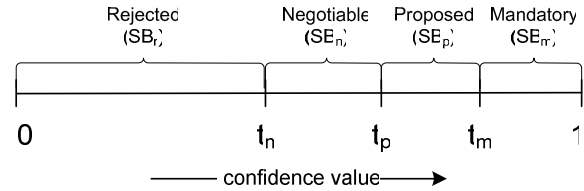
Since the goal of the process is to negotiate, it is important to provide the mechanisms so that the agents are able to revise their proposals about the semantic bridges, relaxing their sub-goals (i.e. individual semantic bridges) in favor of a larger goal, i.e. a valid, agreed mapping document. In this sense, the agent should not decide a priori on the acceptance/rejection of the semantic bridge.

Instead, it should admit that certain semantic bridges are neither accepted nor rejected: they are negotiable. Confidence categories account for the pertinence of the semantic bridge to the mapping and to the interoperability according to the agent. As a consequence, the rejection

threshold borderline ( $tr$ ) defined for the generation of the agent's mapping is insufficient and should be replaced by a multi-threshold approach:

- Mandatory threshold ( $t_m$ ) that determines the utility function value above which it is fundamental that the semantic bridge is accepted by the other agent;
- Proposal threshold ( $t_p$ ), above which the semantic bridge is proposed to the other agent;
- Negotiation threshold ( $t_n$ ), above which the semantic bridge is negotiable.

Therefore, four distinct categories of semantic bridges are defined according to the confidence value and the previously identified thresholds (Figure 6). Both Buyer and Seller classify their semantic bridges according to these categories (i.e.  $SB_n^x, SB_p^x, SB_m^x, SB_r^x: x \in \{Buyer, Seller\}$ ).



**Figure 6. Semantic bridges classified according to the utility function  $u(p_1, p_2, \dots, p_n)$  and the thresholds**

Furthermore, it is necessary to provide the mechanisms so that the agent is able to revise its perception of the negotiable semantic bridges. These mechanisms should be embodied in the meta-utility function, as defined in the hypothesis, but not yet contemplated in the applied ontology mapping process [5].

The meta-utility function ( $U$ ) is responsible for the definition of:

- The parameters variation possibilities;
- The priorities over parameters variation;
- The conditions under which the variation may take place.

Through these elements, an updated confidence value is evaluated ( $c_{sb}^x$ ) for the negotiable semantic bridges that were proposed by the other agent. If  $c_{sb}^x \geq t_p$ , the negotiable semantic bridge is categorized as tentatively agreed ( $SB_p^x$ ). Since the meta-utility function determines priorities and conditions for the variation of the parameters, it is possible that, for some variations,  $c_{sb}^x < t_p$ . It is therefore necessary to iterate across the different variation possibilities, following the defined priorities and conditions. In case it is impossible to evaluate  $c_{sb}^x \geq t_p$ , the semantic bridge is not re-categorized and is therefore rejected.

As result of this process three groups of semantic bridges are generated:

- The Accepted Semantic Bridges ( $SB_a$ ), those that were proposed by one of the agents and accepted by the other without any relaxation;
- Tentative Semantic Bridges ( $SB_t$ ), those that were proposed by one of the agents, and negotiated and successfully relaxed its confidence value. Tentatively agreed semantic bridges are subject of the definitive decision phase;
- Backup Semantic Bridges ( $SB_b$ ), those that were negotiable for both agents or those that were negotiable for one of the agents but the relaxation was not successful.

The effort made by the agent to re-categorize a semantic bridge varies according to the priorities conditions and values of the parameters. The meta-utility function is also responsible for the evaluation of this effort, named convergence effort ( $e_{sb}$ ). In its simplest form, the convergence effort may account for  $e_{sb} = c_{sb} - e_{sb}$ , but it can be arbitrarily complex depending on the several parameters of the (meta-) utility function(s).

### 3.3 Decision phase

In order to ensure that the proposed agreement is advantageous for both agents, it is necessary to decide if the is globally advantageous and not only locally advantageous.

The problem arises due to the convergence efforts made during the negotiation process. For every  $sb \in SB_t$  re-categorized as  $SB_a$ , a convergence effort  $e_{sb}$  is evaluated by the meta-utility function. Convergence efforts should be considered inconvenient to the agent and treated as a loss. Instead, the agreement upon the same semantic bridge provided some profit for the agent when it is re-categorized. This profit is denoted by the confidence value (csb). In that sense, the balance between profits and losses is a function such:

$$balance = \sum c_{sb} - \sum e_{sb} : sb \in SB_t$$

Depending on the balance value the entity decides to agree on the negotiation agreement or to propose a revision of the mapping.

### 3.4 Completion phase

While the  $SB_a$  is the minimum agreed semantic bridge set, it does not necessarily correspond to a valid ontology mapping. This is primarily due to the semantic constraints holding between semantic bridges. For example, a semantic bridge between properties (i.e. a property bridge) should be enclosed in the scope of a semantic bridge that relates the domain concepts (i.e. a concept bridge) of the properties. I.e. because a property value

exists in the context of a concept instance, a property bridge only makes sense in the scope of a concept bridge.

This leads to the necessity of a completion phase in which logically required semantic bridges are identified and negotiated. Yet, these semantic bridges are taken only from those that belong to  $SB_t \cup SB_b$ . For that a flooding algorithm is applied, emphasizing the similarity/dissimilarity of neighbor semantic bridges. Through this, a high confidence semantic bridge is able to positively affect a “near” semantic bridge, and a low-confidence semantic bridge will negatively affect a “near” semantic bridge.

Yet, because the completion phase potentially affects the negotiation balance, the cyclic decision-completion process runs until no change occurs in one of the phases.

## 4. An Ontology Mapping Negotiation Example

Consider the e-commerce scenario where the Buyer uses ontology O1 and the Seller uses ontology O2. The correct ontology mapping between O1 and O2 is depicted in Figure 7.

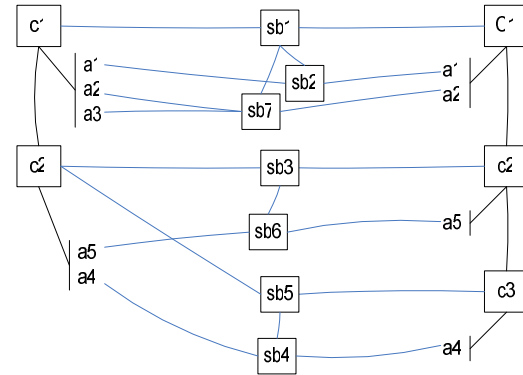


Figure 7. Perfect ontology mapping

Buyer and Seller internally generate their ontology mappings, further classifying the semantic bridges. The first negotiation phase deals with synchronizing these sets in the MF. As result, semantic bridges are grouped according to the accepted, tentative and backup categories, Figure 8. Notice that sb7 was proposed by the Seller but rejected by the Buyer. During the decision phase, the OM-i supports Buyer and Seller achieving a consensus about tentative semantic bridges.

The effort for sb3 is acceptable for Seller, thus the process follows for the completion phase with  $SB_a = \{sb1, sb2, sb4, sb3\}$ . OM-i detects that sb4 requires sb5, thus it proposes the re-classification of sb5 to  $SB_t$ , so it can be decided by both agents. At this point  $SB_t = \{sb5\}$ . Because this phase changed the sets, the decision phase takes places once again. Now, agents have to decide if  $SB_a$  is acceptable for both agents. In fact, the

resulting balance is even more near zero than previous and therefore  $SB_c = \{sb1, sb2, sb4, sb3, sb5\}$ . According to  $SB_c$ , no completion changes are required and the process ends.

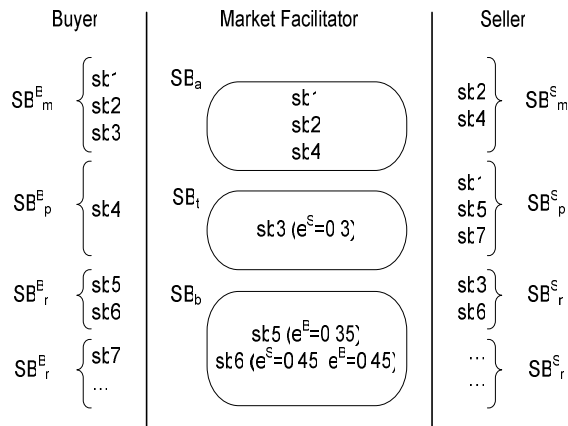


Figure 8. Earlier negotiation state

## 5. Conclusions and Future Work

A big challenge for communicating software agents is to resolve the problem of interoperability. Through the use of a common ontology it is possible to have a consistent and compatible communication. However, we maintain that each different actor involved in the marketplace must be able to independently describe their universe of discourse, while the market has the responsibility of providing a technological framework that promotes the semantic integration between parties through the use of ontology mapping. In addition, we think that the solution to overcome these problems has to take into consideration the technological support already existent, namely a well-proven e-commerce platform, where agents with strategic behaviour represent consumers and suppliers.

The proposed ontology mapping negotiation mechanism suggested in this paper is our effort in that direction. This approach is being applied and tested in our ISEM+MAFRA platform as a larger effort to provide support for the overall e-commerce interoperability. Earlier experiences show that this mechanism provides a considerable mitigation of interoperability risks and substantially reduces the human participation in the interoperability setup phase.

The hardest part of the described ontology mapping negotiation process is the specification, configuration, adaptation and evolution tasks of the utility and meta-utility functions. These tasks are very complex and recurring so they adapt the negotiation to past experiences, both from the agent itself as well from other “friend” agents. There is where social relationships and past experiences reports are useful. In fact, as occurring in human-driven negotiations of physical goods, experience,

reputation and trust play a fundamental role in the process. With the emergence of social web in general and of social networks in particular, users frenetically started producing experience classifications and reports of their experiences. It is our conviction that the established infrastructure is a starting point for the automation and quality improvement of the e-commerce negotiation in general and of ontology mapping negotiation in particular. Trust providers might emerge from this infrastructure, collecting agents’ experiences and providing their insights in an aggregated, concise and useful format to the market facilitator and the buyer and seller agents.

Market facilitator (MF) would play this role, as it manages and therefore collects and evaluates the business results. MF is then called to actively participate in the negotiation process, integrating information from different sources, including social networks and tagging repositories. Furthermore, MF must collect (in a legal way) relevant information respecting the negotiation, including the established ontology mapping contracts and relate these with the success measures of the interaction.

## ACKNOWLEDGEMENTS

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