Electronic Negotiation of Government Contracts through Transducers

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Abstract.

Business to Government (B2G) e-commerce has increased manifold the opportunities available for entrepreneurs for global trade. The entrepreneurs can deal with businesses around the world, evaluate offers, undertake complex negotiations and realize successful deals in the electronic marketplace. In this paper, we demonstrate how the use of transducers can be very effective for generation, negotiation and the finalization of these deals. We limit our focus to the application of the transducer in a one to many, multiple parameters based negotiation. We present some of the negotiating strategies to be utilized by the transducer. We also illustrate the application of this transducer in a B2G environment, motivated by the Brown Field development.

1. Introduction.

The B2G e-commerce is expected to grow exponentially in the coming years with entrepreneurs from multiple domains interacting on a global basis along the lines of B2B electronic commerce. Electronic market places provide a forum for bringing together buyers and sellers with the aim of enabling and supporting trade in a B2B or B2G environment.

Negotiation is a process in which two or more parties with different criteria, constraints, and preferences, jointly reach an agreement on the terms of a transaction (Rahwan, 2002). Human intermediaries through various forms of auctions, bidding systems for awarding contracts, and brokerages, currently conduct negotiations. Internet trading applications at a fraction of the cost can now perform the role of these intermediaries. Trading on the Internet allows a business to reach a larger number of potential customers and suppliers in a shorter time and a lower cost than possible by other modes of communication, and to settle business transactions with lower cost overhead in a shorter time. Existing projects have demonstrated that the current system solutions are lacking to solve the problems present in the area of B2G e-commerce, especially for the SMEs. It is a formidable challenge to automate decision-making processes humans typically get involved in as they conduct business transactions. Many current automated negotiation systems support one-to-one negotiation. One-to-Many negotiations describes a situation where one entity needs to negotiate with multiple entities about different issues, with the possibility of the negotiation over one issue influencing the negotiations over other issues. Many-to-Many negotiations depict a situation where multiple entities negotiate with multiple entities about multiple issues. The multivariable negotiation is based on deals involving multiple parameters beyond just price. In this paper we will present the transducer as an approach to efficiently negotiate the different phases of an e-government negotiation process. The goal of the transducer is to facilitate B2B or B2G e-commerce for small and medium sized enterprises (SMEs) by providing an effective and resourceful negotiating tool. This would enable the SMEs to compete with the larger business more competently. We will present a framework for one-to-many negotiation by means of conducting a number of concurrent coordinated one-to-one negotiations by means of the Transducer. The transducer conducts reasoning by using constraint-based techniques. The current technology focuses on interaction between software agents by themselves or between the human and the software agent. The transducer aims at developing a cross interface wherein either of the negotiating parties could be human or a software agent. The paper is structured as follows. Section 2 introduces an example of Brownfields, which is used throughout the paper. This section illustrates the challenges existing in brownfields negotiation and identifies the major issues. In section 3 we will discuss the transducer along with its various aspects. Section 4 will discuss the proposed transducer architecture. In section 5 we apply the transducer architecture to brownfields negotiation. Finally we identify the areas to pursue future work and conclude our paper in section 6. Due

to space limitations we have not included the details of the formalization in this paper. A detailed version of the paper is available (Adam, 2003).

2. Brownfields.

Many areas across the country that were once used for industrial and commercial purposes have been abandoned-some are contaminated. Because lenders, investors, and developers fear that involvement with these sites may make them liable for cleaning up contamination they did not create, they are more attracted to developing sites in pristine areas, called "greenfields." The term `brownfield site' means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. The Brownfields initiative will empower States, communities, and other stakeholders in economic development to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. The key constituents of the Brownfields initiative are as follows. ***Participants:*** Comprise of Sellers, Private parties or municipalities that own contaminated sites in need of reuse. Buyers, Developers or businesses in need of a site search for an appropriate brownfields location to meet individual needs. ***Preliminary Planning:*** Determine if contamination is an issue by conducting a preliminary assessment and, if necessary, site investigation and analyze the potential remedial costs. ***Final Planning***: If contamination is an issue, conduct a remedial investigation, Review varied mechanisms to provide certainty in cleanup costs. ***Redevelopment and Reuse:*** Involves the construction of residential, commercial or industrial facilities that allow reuse of a site for new ventures along with the creation of open space and recreational opportunities for community residents.

2.1 Challenges in Brownfields Re-development.

Acquiring, cleaning, and redeveloping older, often abandoned, industrial sites can be very expensive. Creatively crafted and carefully targeted incentives and assistance can help advance cleanup and reuse activities and achieve significant economic, social, and aesthetic benefits. It would involve undertaking the various aspects of the redevelopment process and also to aid the buyer in negotiating different business processes with various service providers. The key areas of expertise in Brownfield Development are: ***Real Estate Negotiation:*** Among the challenges in addressing the brownfields issue is the difficulty in conducting real estate transactions due to the complication of real or perceived environmental contamination. There is a need to develop resources, which can facilitate the real estate transactions and provide an avenue for the return of these properties to productive use. ***Project Financing:*** Financing is a key component of brownfields cleanup and redevelopment. This involves development of a number of financial assistance programs to facilitate brownfields redevelopment. They include grants, low-interest loans and varying degrees of tax breaks, among others.

The Brownfields development initiative involves complex business processes. The various agencies and businesses involved along with the multitude of negotiations make it very challenging to frame the best possible deal. In this paper we propose a transducer-based model would assist the buyer with the simplification of the various business processes. It helps the buyer understand the business rules and the constraints. Entrepreneurs as well as the various government agencies involved could utilize the power of the transducer to effectively search and negotiate the business process.

3. Transducer.

Transducers are applications that assist in the negotiation of business transactions between the buyer and the seller, acting on the behalf of humans. The transducer achieves this by processing a sequence of input relations, interactions with the outside world to generate a sequence of output relations, the application response. The transducer supports a database approach that can provide the backbone for a wide range of electronic commerce applications (Yesha, 1998). Transducers are software entities that may have the following characteristics (Griggs, 2000); 1) Independence - Operate without the direct intercession of humans or others, 2) Social Order - Interact with other agents and/or humans, 3) Responsiveness -

Identify their environment and react in a timely fashion to changes that occur in it, 4) Pro-activeness - Exhibit goal-directed behavior by taking the lead, 5) Portability - Move to other environments, 6) Temporal continuity - Continuously running processes.

3.1 Transducer aided Negotiation.

We view negotiation as a process of collaborative and competitive decision making between self-interested participants in the presence of incomplete information. They make decisions according to available limited information about private preferences, constraints and individual negotiation strategies. An *offer* is a complete solution, which is currently put forth by a participant given its preferences, constraints and the negotiation history of offers and counteroffers. *Conformity* takes place when all negotiating parties accept a particular offer. During the negotiation process, the range of possible offers of each party changes according to the current information available. These ranges typically reduce to the final conformity, or if they become empty, a deal does not materialize and the negotiation ends unsuccessfully. Therefore, negotiation is typically an iterative process of evaluating the offers, updating the available options, and making the counteroffers according to the individual negotiation strategies. The transducer involves the two main parts in a negotiation. ***Offer Estimation:*** The transducer uses multiple attributes and constraint-based reasoning for the estimation and generation of offers and counteroffers. For an offer received by the government from an entrepreneur to be considered, it has to satisfy all constraints, that is, the proposed value of each variable must belong to its domain as specified by the rules governing the reasoning of the transducer. (Rahwan, 2002). ***Offer Initiation:*** Initiating offers is the main decision making process that directs the progress of negotiation and its outcomes. The transducer uses constraint-based analysis in order to search for a possible solution as a feature of the negotiation. This involves reducing the domain of variables to one that consists of viable solutions satisfying the constraints of the party. Initiating offers involves both constraint consistency maintenance and searching for the values of attributes to be offered. Constraint consistency maintenance involves posting new constraints as new information becomes available so they can be publicized during the search process in order to ensure the individual area of interest is consistent with the constraints of the party. This process takes place before and during the negotiation process. Searching for new offers involves selecting a particular value for the overall utility, and then performing constraint propagation in order to find the corresponding values of the attribute variables. Selecting new utility values is specified by the negotiation strategy. A tradeoff only takes place if there are different instantiations of attribute variables for the same total utility (Rahwan, 2002).

3.2 Transducer as a FSM.

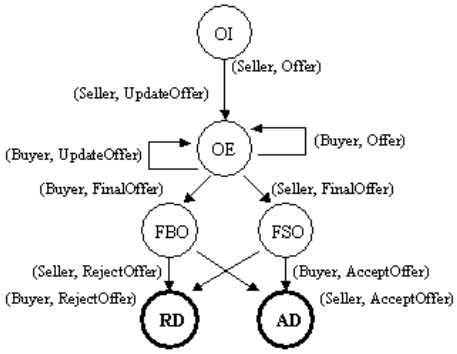

Fig.1 Transducer as a FSM

A Transducer can be modeled as a finite state machine (FSM). The states of the transducer would be the states of the deal. While 'negotiable' or 'nonnegotiable' are different states of the deal, different bid or asking prices do not create different states of the deal. The input alphabet of the FSM is the set of messages that can be possibly sent by the participants, expressed as a pair where participant is the sender of the message. The output alphabet of the FSM is the power set of the set of messages sent to participants. The process flow of the negotiation maps into the state transition rules of the FSM (Kumar, 1998).

The model is a combination where either the buyer or seller can start a negotiable deal, OI (Offer Initiation). The deal would contain both the seller's asking price and the buyers bid, and either party can modify their position, OE (Offer Estimation). From this state either the buyer or seller can create his final offer, FBO and FSO

respectively. On basis of agreement the buyer or seller would have the option to either accept the deal, AD or reject the deal RD.

RUN of the Transducer: A typical negotiation cycle is as follows. First, the transducer creates and initializes a number of sub-negotiating threads according to the bids for the development project. Initially, all these are identical. The negotiation engine provides each negotiating thread with the main decision making functionality during a negotiation cycle, namely offer evaluation and generation. A negotiation cycle consists of one exchange of offers and counter offers by each pair. After each cycle, the sub-buyers report back their results to the transducer. The first buyer managed to get an acceptable deal, while the others where asked by the transducer to terminate the negotiation. Notice that the same negotiation may be viewed and recorded very differently by the negotiating buyer and seller. This is because they have different preferences and constraints and because they evaluate offers differently.

3.3 Transducer Negotiation Strategies.

During the design of the transducer we assume two levels of negotiation strategies, namely strategies exercised by individual buyer or seller participants in their one-to-one encounters, and strategies exercised by the transducer in organizing and issuing commands to its sub-negotiating threads. Negotiation strategies of individual sub-negotiating threads include (Bui, 2000): 1) Seize it or dump it, 2) No compromise, 3) Preset compromise, 4) Enhanced follow-up deal. We outline a few simple coordination strategies that can be exercised by the transducer (Rahwan, 2002). ***Speedy Strategy:*** This is a very simple strategy in which the time constraints may be important and the party wants a rapid conclusion of a deal. In this strategy, as soon as a sub-negotiating thread finds an acceptable offer, the transducer accepts it and sends messages to all other sub-negotiating threads to cease their negotiation. If more than one sub-negotiating thread comes up with an acceptable offer, the one with the highest utility is chosen while the rest are also ceased.

Deliberate Strategy: In this strategy, even if one or more sub-negotiating threads find an acceptable deal, those parties are asked to wait while all other parties are asked to resume their negotiations. Once all sub-negotiators complete their negotiation process, the best offer is chosen. This strategy guarantees that the best possible deal can be reached, but does not give regard to time constraints. One variation of the deliberate strategy is one in which a time limit is be set by the user, within which if no better deal was found, the negotiation terminates and the best deal yet wins. ***Feedback Deliberate Strategy:*** In this strategy, the transducer uses information about one negotiation thread result to impact the performance of other sub-negotiating threads. The constraints on the utility for the other sub-negotiating threads is updated in order to avoid unnecessary deals which are not as good as the one already found. The constraint on that particular utility for all remaining sub-negotiating threads is also updated causing any deal below that margin to be unacceptable. This also ensures that no sub-negotiator offers an offer that is worse than an offer submitted by another sub negotiating thread.

4. Architecture.

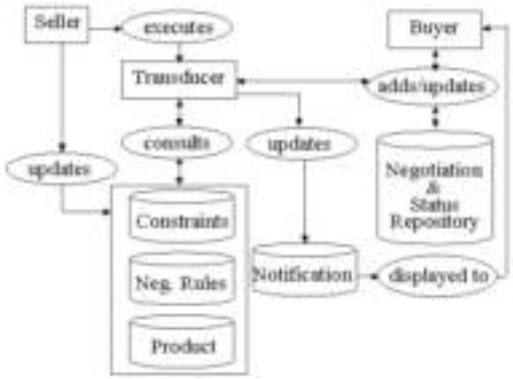

Fig 2 Transducer Architecture.

The key elements and their functionalities of the system are: ***Transducer:*** 1) Interacts with the one/many buyers or sellers, 2) Invokes negotiation rules, 3) Invokes the negotiation constraints, 4) Matches requests, 5) Records the transaction into the repository, 6) Maintains the bid and adds to the log, 7) Notifies potential buyers or sellers of the negotiation, 8) Performs analysis using the data from the repository. ***Database:*** 1) Notification: contains names and interest information about the potential buyers or sellers. 2) Negotiation and Status Repository: The central store for all negotiation activity. Contains all current and archived trades, current bids

and negotiation information etc. ***Knowledge Bases:*** 1) Negotiation Rules: A rule based expert system that contains rules that determine allowable trading behavior, 2) Constraints: Contains the various constraints the various negotiations would be subject to, 3) Product: Contains the various product details the negotiating process is about.

Every business deal may have its set of unique business constraints, negotiation rules and the characteristics of the product being negotiated in the deal. The entrepreneur, who could either be represented as a buyer or a seller, would implement the transducer. The seller would update the knowledge database; the constraint database, the negotiation rule database and the product database are updated to meet the requirements of an individual business deal. The transducer also updates the notification database. The notification database holds information about the notification of the business deal to be negotiated. In addition it also holds the information to whom the specific notification is being sent. The transducer adds and updates the notification table on a regular and incremental basis. During the various stages of the negotiation the transducer as well as the buyer update the negotiation and status repository. This repository would maintain a log of the negotiation process including its parameters and the status and progress of the negotiation. Once the transducer and the buyer reach a successful negotiation, the final parameters would be stored in the backend.

5. Brownfield Negotiations and Transducer.

We now present our approach to implement the transducer. The scenario of the example involves a successful project undertaken by the company involving a steel foundry site established before the turn of the 20th century. Recycling and reuse were key components of site cleanup. A key strategy for the success of the project was early communication with the public regarding the development and design of the site. *SITE CONDITION*: 1) Highly contaminated site containing creosote, foundry sand, hydrocarbons, etc., and 2) Substantial amount of surface waste. *SITE AREA*: 72 acres. *PROPOSED USE*: 1) 398 residential units, 100 retirement units, 2) Clubhouse and community center facilities, 3) Hotel/Mall/Medical services, and 4) Golf Course. *BENEFITS*: 1) Increased property taxes and about 70 construction jobs per year, 2) Estimated $2.1 million to be generated annually through local spending, 3) Elimination of contaminated soils, 4) New public walkways, large open space to be conveyed to the town, 5) Additional housing units and use of existing infrastructure, and 6) Increase in downtown population by more than 1,000 people.

On the basis of the business rules and constraints, represented in the knowledge database, the seller decides the various negotiation strategies to be followed by the transducer along the entire negotiation process. The entrepreneur is notified of the various attributes and issues associated with the property by the notification module. The seller has set certain minimum requirements in terms of the proposed use. These requirements are however negotiable. In addition the benefits and the proposed use are linked issues. The negotiation could switch back and forth between the benefits and the proposed use for a particular buyer. The entrepreneur would then submit his offer in terms of the price, the parameters of the proposed use and the time involved in developing the project. The transducer evaluates the various offers it receives. It then makes counter offers in terms of the benefits and other services, i.e. in its counter offer the transducer increases the number of permitted residential units to 450 if the entrepreneur would agree to building 110 retirement units. The entrepreneur would be interested if the seller agrees to certain conditions in the clean up process. The transducer may now take on the role of a buyer when it may negotiate the part of the development process involving clean up with the businesses offering these services. The entrepreneur evaluates the offer presented, evaluates and makes a counter offer. This is an ongoing process. At a certain stage either the seller or the developer may make a final offer on the basis of the entire negotiation process. If the offer is acceptable to the other party the deal is registered and stored. If either the buyer or the seller turns down the offer, the seller then pursues the negotiation with the other developers. The *run* of the transducer is as follows

Database: area, location, uses, available, price, transaction, available; *Input:* userselect, user_offer, user_evaluate; *State:* past-bid, past-offer;

Output: agency_evaluate, reject-offer, unavailable, agency_accept
Output rules:
Agency_evaluate (area, price, uses, benefits): - UserSelect(area) NOT past-user_offer
Reject-offer (area): - user_offer (area, price, uses, benefits)
Unavailable: - UserSelect (area), NOT available (area)
Agency_accept: - user_offer (area, price, uses, benefits), Past user_evaluate ()

6. Conclusions and Future Work.

The transducer is an efficient tool that aids SMEs for negotiation. The transducer is a resourceful tool that understands the business model, business rules and constraints and helps the entrepreneur to compete with larger businesses that employ professionals to negotiate the business deals. In this paper we have presented the transducer and its implementation as an approach to efficiently negotiate the different phases of an e-government negotiation process.

One of the crucial success factors for a multivariable multiparty negotiation is to bring the maximum number of interested buyers/sellers the negotiation event. Two simple means of furthering this goal are negotiating with buyers/ sellers with a common interest together, and to set up a regular schedule and publicizing it well in advance to these potential buyers/sellers. Security mechanisms are needed to ensure that an outsider does not sabotage the site announcing the negotiation process and its rules. Cryptographic tools will be very useful in transducer-aided e-negotiations. *Multiple Transducers:* The transducer can automatically be extended to support many-to-many negotiations in a B2B/B2G environment. In this scenario, each self-interested entrepreneur-buyer negotiates with many sellers in order to find the best deal, and each self-interested entrepreneur-seller negotiates with many buyers in order to get the highest profit.

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