

# Implementation of an Agent-Based Bidding Consortium in the Architecture of an Agent-Based Virtual Marketplace

Oliver Geibig, Martina Schnellenbach-Held

Institute of Concrete Structures and Materials, University of Duisburg-Essen

Universitaetsstrasse 15, 45177 Essen, Germany

{ geibig, m.schnellenbach-held }@uni-essen.de

## Summary

In this research project we intend to transfer the whole AEC-Bidding process to an agent-based virtual marketplace. Hereby, the existing legal regulations have to be considered. Important aspects in developing the virtual marketplace are to provide the possibility to realize an agent-based bidding consortium as well as to integrate subcontractors.

## 1 Introduction

Today's procedures for award of public construction work contracts are mainly paper-based. However, with the emergence of various virtual marketplaces, e.g. [1], in wide area networks, such as the internet, a trend towards the usage of electronic means is noticeable.

By applying software-agents to the architecture of virtual marketplaces a tremendous improvement can be reached. Software-agents are able to perform various tasks, such as to search for adequate calls for proposals, complete detailed estimates, negotiate about prices and special conditions of contracts with other agents and award public supply contracts. In this way the process of AEC-bidding can be facilitated and accelerated. In call for proposals (CFP), forming a bidding consortium and submitting a collaborative proposal is a very common way. Thereby, the corporate risk is shared by its participants.

To implement the possibility for software-agents to build and coordinate such a bidding consortium in the architecture of an agent-based virtual marketplace, several innovative steps from the technical as well as from the legal point of view have to be developed. Some of these aspects will be presented in this paper.

## 2 Legal Regulations for Bidding Consortia

According to the German contracting rules for award of public work contracts (VOB) [2], the members of a bidding consortium have to determine one of their participants to fulfill a coordination task and bear responsibility for the whole bidding consortium (pilot). This requirement has to be implemented in the architecture of the virtual marketplace in an adequate form (see chapter 3). For the case of unqualified or even failed agent-based bidding consortia in a virtual marketplace further research in the field of legal regulations were necessity. Hereby, special legal requests for the provable agent communication concerning the formation, coordination and realization of a bidding consortium had to be defined. Finally, security issues and legal obligation of all agent communication in the name of its user are analyzed.

## 3 Technical Realization of Bidding Consortia

In this research project, the bidding consortium is coordinated by a so-called BCA (**B**idding Consortium **C**oordination **A**gent) who is digitally signed by all participants of the bidding

consortium and is solely initiated for the period of the CFP to perform coordination tasks (see Fig. 1).

Scenario:

In Figure 1 the schematic procedure of forming an agent-based bidding consortium is depicted. A software-agent of the contractor *ReinforCon* is searching on the virtual marketplace for lucrative calls for proposals (CFP). Having found one, he first has to check the volume of the project and decide if it is possible to hand in a proposal solely. If not, he can decide to do the quotation processing within a bidding consortium. In this case the *ReinforCon*-agent builds a consortium with the company *Steel2*, which is included in the corporate local database. *Steel2* was chosen over *Steel1*, because of *Steel1*'s unqualified technical as well as personnel capacity for this project. To complete the consortium, a contractor specified for soil work is needed. Since there is not any soil company in the corporate local database, an unknown contractor has to be selected out of the General Server Pool (GSP) at SiReAM. A first selection criterion is the size and technical as well as the personnel capacity of the soil company, required for this project. For this reason the soil companies as well as all other companies are ranked in the GSP according to various classes. In the example in Fig.1, a soil engineering contractor with special knowledge in pile foundation is needed, which is a criterion for class 4 or higher. Therefore, *Soil1* is the only possible contractor for the bidding consortium and no further selection criteria are needed in this case. Consequently, the agents of *ReinforCon*, *Steel2* and *Soil1* form a bidding consortium and create a new agent (digitally signed by their initiators), the BCA, to coordinate the procedure of the whole quotation process.

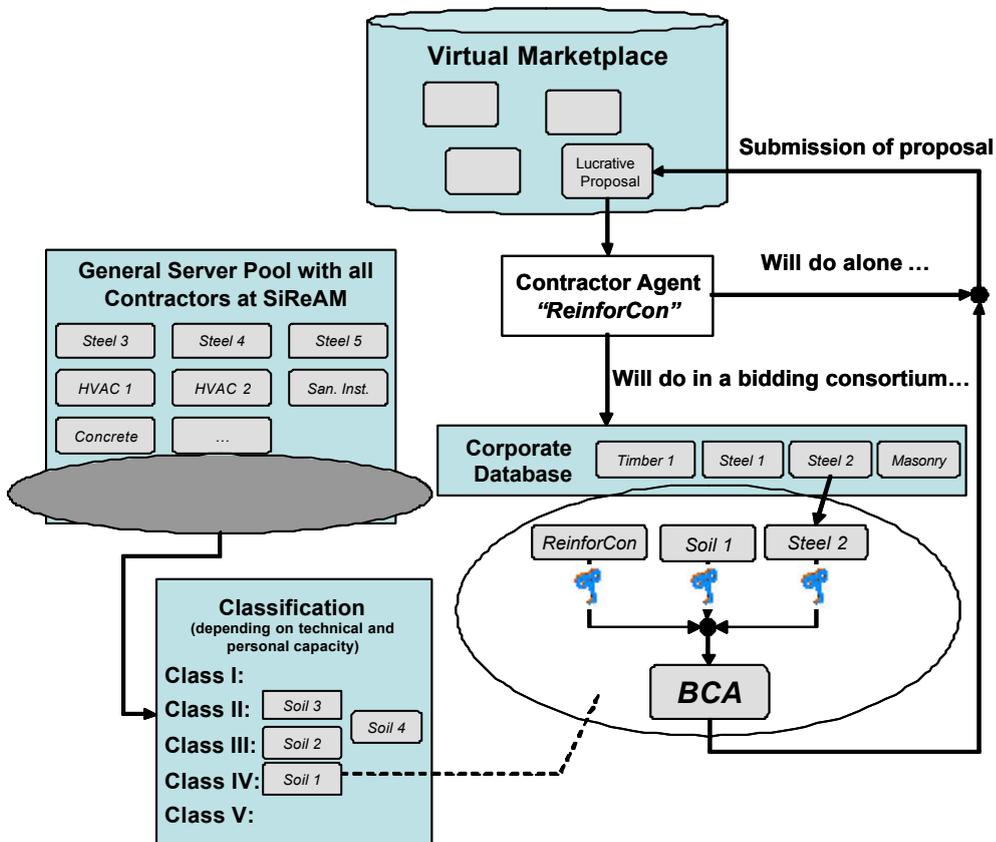


Fig. 1: Forming a Bidding Consortium

The classification of all Contractors in a GSP, as described above, serves two main advantages:

- It enables the contractor's agent to identify and evaluate qualified subcontractors and
- It reduces significantly, if not even eliminates, problems of rejection associated with unqualified subcontractors of doubtful capability.

As shown in the scenario, in many cases the corporate local database available to the initiating agent of a bidding consortium does not include every company required for a successful proposal. Therefore, he has to refer to reliable sources. These can be:

1. Contractors, registered and classified, according to their abilities, at the virtual marketplace SiReAM (see Fig.1)
2. Contractors, who have received a positive rating profile by other reliable contractors, e.g. those, registered at SiReAM

#### Detailed information for No.1

In Fig.1 the size of the GSP is manageable and in this case for the soil works specified in the contract to be proposed, only one contractor - *Soill* - is capable of executing the project. While working with GSPs with large amounts of registered companies who seem to be capable of joining a bidding consortium for a certain project, further preliminary selection criteria are required. The following are proposed:

##### **1. Eligibility**

- 1.1 Existence of Conflict of Interest
- 1.2 Existence of Arbitration Awards
- 1.3 Existence of Client Ineligibility

##### **2. Historical Contract Non-Performance**

- 2.1 History of Non-Performing Contracts (in years)
- 2.2 Pending Litigation (in %)

##### **3. Financial Situation**

- 3.1 Financial Performance (in years and Euros)
- 3.2 Average Annual Construction Turnover (in years and Euros)

##### **4. Experience**

- 4.1 General Construction Experience (in years)
- 4.2 Specific Construction Experience (in number of contracts, years and Euros)
- 4.3 Key Activity Construction Experience (description, if applicable)

#### Detailed information for No.2

To gather information about the reliability of contractors, a rating system has to be implemented and accessible for every registered participant on SiReAM. After completing a project, similar to various existing rating systems in the C2C-Commerce, the participants have to rate each other. In the rating system of B2B-Commerce, however, the catalogue of aspects is extended [3]. The following aspects have to be considered:

- Total costs of the preliminary building work
- Constellation of the contractor: solely, bidding consortium, main/sub contractor
- Who is the rater, is he reliable?

Finally, every participant of a project has to give a short rating for each other. Table 1 shows an example for a client to rate a contractor. The rating criterion can differ depending on who is the rater and who gets the rating, e.g. a contractor rating a client certainly will have to rate the criterion “payment schedule”. Different ratings certainly have different assessments, such as that it differs if either one small sub-contractor or the client rates the main contractor positively.

Table 1: Rating Scheme for a Client

Project Description	Housing – 17.000.000 Euro – 23.500 m <sup>2</sup>				
Rater	Client				
Recipient	Contractor				
	1	2	3	4	5
Quality Assurance		x			
Time scheduling	x				
Adherence		x			
Key site management and technical personnel			x		
Financial soundness/ cash flow	x				
Collaboration		x			

During this process, the rater will assign each criterion a whole number score from 1 to 5, where 5 means that the criterion is absent, and 1 to 4 represent predefined values for an objective way of rating. For example, the scoring will be 4 for the criterion being fulfilled but showing many deficiencies; 3 for meeting the requirements; 2 for marginally exceeding the requirements; and 1 for significantly exceeding the requirements.

The rating scores will be combined in a weighted sum to form the Total Rating Score (TRS):

$$TRS \equiv \sum_{j=1}^n S_j * W_j$$

,where: S<sub>j</sub> = the rating score of criteria “j”,

n = the number of criteria and

W<sub>j</sub> = the weight of criteria “j” with  $\sum_{j=1}^n W_j = 1$ .

As shown above, submitting a proposal within a bidding consortium is a risk-reducing variant for the participating contractors as well as for the client-side. However, especially when CFP is conducted for turnkey projects, it is hardly possible that the members of the bidding consortium can execute every item of the estimate. According to this, some or even all participants have to work with several sub-contractors.

#### **4 Legal Regulations for Working with Sub-Contractors**

According to the German contracting rules for award of public work contracts (VOB) [2] and the German federal manual of awarding (VHB) [4], a general contractor is defined as the main contractor who is responsible for the execution of the major part of the proposal, or of his part of the proposal in a bidding consortium. It is assumed that the general contractor will award parts of the proposal to subcontractors. However, without agreement of the client, a general contractor is only allowed to transfer item works to subcontractors, for which he is not specialized. Furthermore the general contractor is particularly responsible for the work and the guarantee of his subcontractors. All these legal requirements have to be analyzed and implemented in the architecture of the agent-based virtual marketplace in an adequate form.

As seen above, the one part of this research project investigates the consideration, transfer and implementation of legal regulations and restrictions into SiReAM. Therefore, we work together in close cooperation with Prof. Dr. jur. A. Rossnagel (Kassel University).

#### **5 Technical Realization of Integrating Sub-Contractors in the Architecture of SiReAM**

The process of searching for subcontractors as well as negotiating and awarding their contracts is depicted in Fig.2. The following scenario will give a small insight of this process.

##### Scenario:

A general contractor agent (GCA) gets the names of potential subcontractors from the facilitator who has access to the GSP. After verifying the integrity of the subcontractor at the GC, the agent contacts the other utility agents to get all necessary information, e.g. IP-address and certificate, in order to establish a secure communication via SSL-connection with the subcontractor agents. In the following, the GCA starts negotiating the boundary conditions as well as the price of the proposal with the subcontractor agents. As the final legally binding decision is not and even not intended to be transferred to the agents, each agent has to get the agreement of its initiator before making the contract. After obtaining the acceptable proposals of all subcontractors, the GCA can continue with the quotation processing and submit a complete proposal.

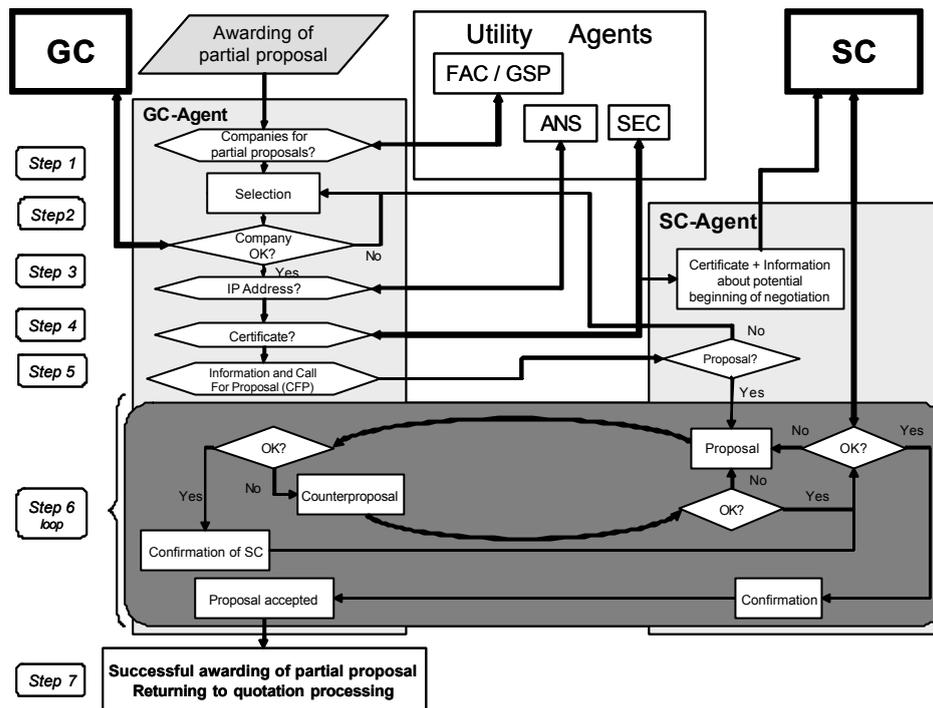


Figure 2: Awarding of a partial proposal

This research project is sponsored by the German Science Foundation (DFG).

## 6 Endnotes

As shown in this paper, there are several sectors in the complex quotation process where the implementation of software agents gives rise to its facilitation and acceleration. However, very important aspects to reach acceptance among possible users of the agent-based virtual marketplace, as to ensure confidentiality, integrity, non-repudiation and authentication, must not be neglected. These demands have been satisfied by the implementation and adaptation of a reliable and trustworthy public key infrastructure [5]. In order to execute legally effective actions on the agent-based virtual marketplace, the requirements of the German Digital Signature Act had to be considered. By the application of the ISIS-MTT Standard, these requirements have been fulfilled.

## 7 References

- [1] My-Con im WWW: <http://www.my-con.com/>
- [2] Vergabe- und Vertragsordnung für Bauleistungen (VOB), Bundesanzeiger Verlagsgesellschaft mbH, September 2002.
- [3] Björnsson, H., Ekström, M.: A rating system for of AEC e-bidding that accounts for rater credibility, Forthcoming in CIB W65 Symposium September 2002, Cincinnati, Ohio, USA
- [4] Vergabehandbuch für die Durchführung von Bauaufgaben des Bundes im Zuständigkeitsbereich der Finanzbauverwaltungen (VHB), Deutscher Bundes-Verlag GmbH, Ausgabe 2002
- [5] Denk, H.: Softwaremodelle für einen rechtsgemäßen, agentenbasierten virtuellen Marktplatz für Ausschreibung, Angebotsbearbeitung und Vergabe von Bauleistungen, Dissertation, VDI Fortschrittsberichte – Reihe 4, Darmstadt, 2002