USING UDDI REGISTRY AND WORKFLOW ENGINE FOR MANAGING E-PROCUREMENT PROCESSES

Juha Puustjärvi
Lappeenranta University of Technology, Skinnarilankatu 34, Lappeenranta, Finland

Keywords: B2B, e-procurement, e-auctions, Web Services, UDDI.

Abstract: In electronic business buyers and sellers should be able to interact with each others inside an architecture that is easy to use and maintain. Electronic auctions are an interesting approach to achieve this goal by bringing together business in the Web. Further the greatest benefits lie in cost reduction for buyers and sellers. Technically, an electronic marketplace is a virtual place that resides somewhere in the Internet. They can provide several types of business processes depending upon their target audience. A form of such processes is e-procurement. E-procurement technology is any technology designed to facilitate the acquisition of goods by a commercial or a government organization over the Internet. A form of e-procurement is reverse e-auctioning. In such auctions the supplier that made the lowest offer wins the auction. In this paper we describe the e-procurement system that we are developing. In particular we present how taxonomies and user profiles can be utilized in improving the effectiveness of the e-procurement process. From technological point of view we present how suppliers' Web services support e-procurement specific operations, and how BPEL4WS (Business Process Execution Language for Web Services) can be used in orchestrating these Web services. In addition, we present how UDDI (Universal Description, Discovery, and Integration) registry can be utilized in storing the used taxonomies and the profiles of the suppliers. In this way we can achieve high recall and precision fractions in searching relevant suppliers.

1 INTRODUCTION

E-procurement technology is any technology designed to facilitate the acquisition of goods by a commercial or a government organization over the Internet. Using such a technology we can achieve many advantages including:

- reducing administrative costs,
- shortening the order fulfilment cycle time, and
- lowering inventory levels and the price paid for goods.

A form of e-procurement is reverse e-auctioning. In reverse e-auctioning buyers buy goods by using Internet technology from a number of known or unknown suppliers. In such auctions the supplier that made the lowest offer wins the auction.

Most auction software developed for e-auctioning is based on advanced auction formats such as on combinatorial auctions and on multi-attribute auctions (Nissan, 200). In combinatorial auctions bidders are allowed to place offers on sets on items whereas in multi-attribute auction price is not the only negotiable parameter.

Auctions are usually defined by their rules. The rules are typically classified into three classes (Klein and Keefe, 1999): rules that control the admission of bids, rules that control the information revealed by the auction, and rules that control how the auction computes trades. The architectures of the auctions systems typically reflect these rules (Wurman et.al, 2001). Some architecture originates from workflow systems and contract management systems. There are also many research efforts concentrating on agent technology for electronic market transactions,e.g., (Wurman et.al, 2005).

A common problem of e-procurements systems is the retrieval of relevant suppliers. Ideally the system should be able to retrieve all the suppliers, which are relevant while retrieving as few non-relevant suppliers as possible. This kind of quality of supplier retrieval can be measured by the following fractions:

Puustjärvi J. (2007).
USING UDDI REGISTRY AND WORKFLOW ENGINE FOR MANAGING E-PROCUREMENT PROCESSES.
In *Proceedings of the Third International Conference on Web Information Systems and Technologies - Society, e-Business and e-Government / e-Learning*, pages 72-76
DOI: 10.5220/0001262700720076

• Recall: the fraction of the relevant suppliers, which has been retrieved.
• Precision: the fraction of the retrieved suppliers, which is relevant.

The values of these fractions are highly dependent on the way the suppliers and their products are modelled and how the searching of suppliers is done.

In this article we focus on e-procurement technology supporting reverse multi-attribute auctioning. In particular, we will consider the technical solutions of the e-procurement system that we are developing. A corner stone of the system is the private UDDI (Universal Description, Discovery, and Integration) -registry that is used for searching relevant suppliers. The registry supports a variety of taxonomies including industry taxonomy, product and service taxonomy and location taxonomy. Using these taxonomies in retrieving relevant suppliers we can achieve high recall and precision fractions.

The main ingredients of the e-procurement system are the private UDDI registry, workflow engine, and the Web services. The workflow engine coordinates the procurement processes. The UDDI registry also includes information supplier's Web services that support procurement specific operations such as "Request for Bid"- operation

The rest of the paper is organized as follows. First, in Section 2, we give a short introduction to Web services. Then, in Section 3, we first give an overview of the UDDI registries, and show how a private UDDI registry can prove services for the e-procurement broker. Then, in Section 4, we give an overview of BPEL4WS (Business Process Execution Language for Web Services) and show how it can be used for specifying the coordination requirement of the workflow engine which runs procurement processes. After this, in Section 5 we illustrate how the ingredients (private UDDI registry, suppliers Web services and the workflow engine) are put together to form a working e-procurement system. Finally, section 6 concludes the paper by discussing the advantages and limitations of our proposed technical solutions.

2 WEB SERVICES

Web services are XML-based (Newcomer, 2002) self-describing applications that can be published and invoked across the Internet. Web services use a loosely coupled integration model to allow flexible integration of heterogeneous systems. A nice feature of web services is that new and more complex Web services can be composed of other web services.

Our distributed architectural model of Web services is comprised of three types of participants: service provider, service brokers, and service requesters. This architectural model presupposes that services can be first found from the UDDI registry, and then used. This in turn requires exact descriptions of the services. WSDL (Web Service Description Language) (WSDL, 2001) is an XML-based language (Harold and Scott, 2002) for describing a programmatic interface to a Web service. It includes for example input and output message formats and the operations provided by the service.

For example, in our e-procurement model supplier's Web services support the operation "Request_for_Bid", which has the parameters product_id and quantity. Accordingly e-procurement broker's Web service supports operation "Response _for_Bid", which has the parameters "Suplier_Name" and "Bid. This information is passed between Web services by the SOAP protocol (SOAP, 2002). It is a protocol specification for invoking Web services and defining a uniform way of passing XML-encoded data

The SOAP-envelope for passing the "Request_for_Bid"-operation is presented above in Figure 1.

```
<SOAP-ENV: Envelope
   xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
   SOAP-ENV:encodingStyle=
                  "http://schemas.xmlsoap.org/soap/encodig/">
      <SOAP-ENV:Body>
          <os:request_for_bid
                  xmlns:="http://www.it.lut.fi/transaction/ontology/">
              <product_id_name>Nokia E 90</product_id>
              <quantity>500</quantity>
                  </os:request_for_bid>
       </SOAP-ENV: Body>
</SOAP-ENV: Envelope>
```

Figure 1: A SOAP-message for a "request-for-bid" operation.

3 UDDI REGISTRY

Basically UDDI registry describes a mechanism for registering and locating Web services (Daconta et. al, 2003). This in turn requires that in UDDI service providers describe their organization and register their Web services.

The information in UDDI consists of three parts white pages, yellow pages and green pages. White pages include company's contact information. It may also include description of the company or links

to external documents that describe the business in more detail.

In our private UDDI registry yellow pages consist of business categories organized according to following taxonomies:

- Industry: Classification of the industry supported by the e-procurement system.
- Products and services: Classification of the products and services of the suppliers of the e-procurement system.
- Geographical location: Classification of the country and region codes.

So, searching on yellow pages can be performed to locate business that service particular industry or product category, or are located in a particular geographic region.

Green pages consist of the information businesses use to describe how other businesses conduct electronic commerce with them. In particular, green pages include technical information of the exposed services. For example, the WSDL descriptions of the Web services are included in green pages.

UDDI specifies also two APIs for programmatic access to UDDI registry. The inquiry API is used for retrieving information from a registry and the Publishing API is used for storing information.

For our purpose we use UDDI for storing information (Publishing API) and for retrieving information (Inquiry API). To illustrate this let us consider the structure of a taxonomy presented in Figure 2. For example, in the case of classifying ICT-devices, the correspondence of symbols could be the following: P= ICT device, P1=memory unit, P2=laptop, P3=mobile device, and so on.

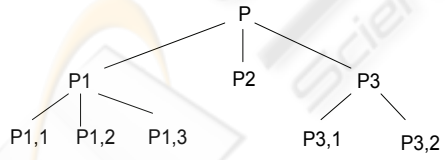

Figure 2: The structure of the product taxonomy.

Now, when a supplier makes registration (using the Publishing API) the supplier specifies using the taxonomy which kind of products it can provide, e.g., if it specifies P1, it means that also provides products of its descendants, i.e., P1,1, P1,2 and P1,3. Then when a buyer (or the e-procurement broker) retrieves products or services (using the Inquiry API) it specifies one or more nodes from the taxonomy. For example, in the case of P2 (laptop), the UDDI registry returns the Web services of the suppliers which sell laptops.

4 BPEL4WS

The BPEL4WS (BPEL, 2004) processes are XML-based grammars that can be executed by workflow engine (orchestration engine), e.g., by IBM's BPWS4J (BPWS4J, 2004). The engine reads the BPEL4WS document and invokes the necessary Web services in the order required by the process.

A nice feature of BPEL4WS is that we can generate executable BMEL4WS code from the BPMN (Business Process Modeling Notation). The reason for using BPMN is that the BPMN notation is readily understandable for the buyers and sellers of the system. It is also readily understandable for the business analyst that create the drafts of e-procurement processes as well as for the technical developers responsible for implementing the technology that will perform those processes.

We now give an overview of the BPMN. First we describe the types of graphical objects that comprise the notation, and then we show how they work together as part of a Business Process Diagram (BPD) (BPMN, 2004). After it we give a simple reverse e-auction description using BPD.

In BPD there are tree Flow Objects: Event, Activity and Gateway. An *Event* is represented by a circle and it represents something that happens during the business process, and usually has a cause or impact. An *Activity* is represented by a rounded corner rectangle and it is a generic term for a work that is performed in companies. The types of tasks are *Task* and *Sub-Process*. So, activities can be presented as hierarchical structures. A *Gateway* is represented by a diamond shape, and it is used for controlling the divergence and convergence of sequence flow.

In BPD there are also three kind of connecting objects: *Sequence Flow, Message Flow* and *Association*. A *Sequence Flow* is represented by a solid line with a solid arrowhead. A *Message Flow* is represented by a dashed line with an open arrowhead and it is used to show the flow of messages between two separate process participants. An *Association* is represented by a dotted line with a line arrowhead, and it used to associate data and text with flow objects.

We now consider how a reverse electronic auction can be represented by a BPD. In this example, the auction system runs an auction which is comprised of time rounds where an offer is

required from each supplier before the auction can proceed. Such auctions can be conceptualized as having four Activities (Figure 3):

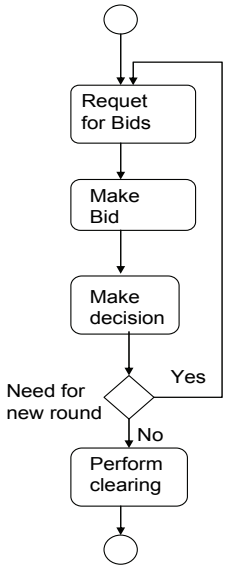

Figure 3: An example of a BPD in e-procurement.

- Request for Bids: The broker requests the suppliers to make an offer of certain products or services.
- Make Bid: The suppliers make bids and send them to the broker.
- Make decision: The broker makes the decision which bids are accepted and which bids are rejected and sends a message to each supplier. In addition, if the broker did not make deal of all products it needs, then the broker may request the suppliers to make additional offers.
- Perform clearing activity, where the agreed-upon contract is executed and payments are made.

5 E-PROCUREMENT BROKER

In this section we describe the main functional components of the e-procurement server (Figure 4). Essentially the e-procurement broker brings together various companies. An important feature is that it can simultaneously support a set of procurement processes which may be based on different e-procurement formats (e.g., whether the bids are sealed or not).

The Buyer' application registers new users and collects their preferences in Web forms and forwards this information (through Web services) to the E-procurement broker, which in turns stores the information to the private UDDI registry, which is part of the brokers database.

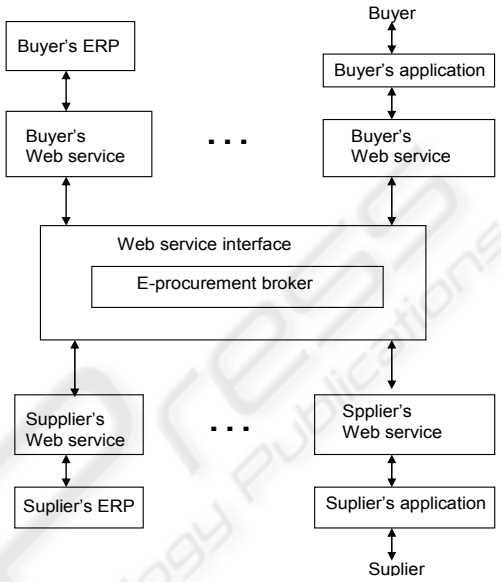

Figure 4: The architecture of the system.

Basically, there are two approaches how companies (in the role of buyer or supplier) can integrate their system with the e-procurement broker.

- A person of company (in the role of a buyer or a supplier) communicates with the e-procurement broker through an application (buyer's application or server's application) and Web service interface.
- A company integrates its ERP-system with the e-procurement broker.

The gain of the first approach is that it has minimal initial costs but has high operational cost as it requires duplication of procurement management effort. In the second approach the costs are other way around. However this approach is extremely fascinating as it allows (through a Web service) the integration of the ERP-system (Enterprise resource Planning system) with the e-procurement broker. In particular, this approach nicely matches with the third wave ERP-systems which are based on Web service technology.

The internal components of the e-procurement broker are presented in Figure 5.

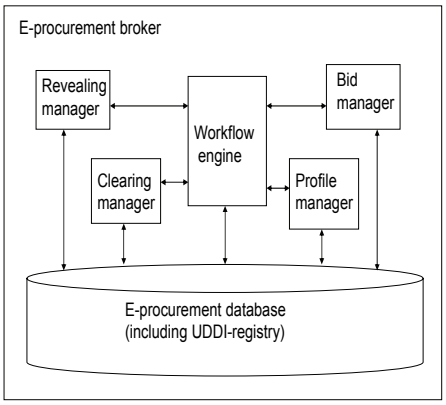

Figure 5: The components of the e-procurement broker.

The Bid manager controls the admission of bids, i.e., control that all the bids are done according to the bid rules. The Revealing manager governs the revealing of the information of an auction. The Clearing manger computes the trades. The Profile manager maintains the user profiles that are stored in the database (i.e., in UDDI registry). The profiles include preferences, which are collected at user registration

The Auction database contains the UDDI-registry, user profiles and the BPEL4WS specifications of various auction protocols. The Workflow engine (orchestration engine) loads BPEL4WS specifications from the e-procurement database and then runs the processes. The Workflow engine reads the BPEL4WS document and invokes the necessary Web services in the order required by the process.

6 CONCLUSIONS

In electronic business buyers and sellers should be able to interact with each others inside an architecture that is easy to use and maintain. Electronic auctions are an interesting approach to achieve this goal by bringing together business in the Web.

E-procurement technology is any technology designed to facilitate the acquisition of goods by a commercial or a government organization over the Internet. Using such a technology we can achieve many advantages including reducing administrative costs, shortening the order fulfilment cycle time, and lowering inventory levels and the price paid for goods.

A problem of e-procurements systems is how the system can find relevant suppliers. Ideally the system should be able to retrieve all the suppliers, which are relevant while retrieving as few non-relevant suppliers as possible

In this article we have described the e-procurement system that we are developing. A salient feature of the system is the private UDDI-registry which is used for finding relevant suppliers. The registry uses many taxonomies including industry taxonomy, product-taxonomy and location taxonomy. Using these taxonomies we aim to achieve high recall and precision fractions in searching relevant suppliers.

In future we aim to extend the e-procurement system by mobility features such that buyers and suppliers can interact with the e-procurement system by their mobile devices. From technology point of view we will use mobile Web services in implementing mobile interaction. Probably mobile Web services will allow the development of many new auction formats also for B2C.

REFERENCES

BPEL, 2004. BPEL4WS – Business Process Language for Web Sevices. http://www.w.ibm.com/developersworks/webservices/library/ws-bpel/

BPWS4J, 2004, A platform for creating and executing BPEL4WS processes. http://alphaworks.ibm.com/aw.nsf/download/bpws4j

BPMN, 2004. Business Process Modeling Notation (BPMN), http://www.bpmn.org/

Daconta, M., Obrst, L. & Smith, K. (2003). The semantic web. Indianapolis: John Wiley & Sons.

Harold E. and W. Scott W (2002) . XML in a nutshell. O'Relly & Associates.

Klein S, and R. O'Keefe R. (1999). The Impact of Web on Auctions, International Journal of Electronic Commerce, 3(3).

Newcomer E. (2002) Understanding Web Services. Boston: Addison-Wesley.

Nissan, N, (2000). Bidding and allocation in combinatioral auction. In proc Second ACM Conference on Electronic Commerce.

SOAP, (2002). SOAP – Simple Object Access Protocol. http://www.w3.org/TR/SOAP/

WSDL, 2001. WSDL- Web Services Description Language. http://www.w3.org/TR/2001/NOTE-wsdl-20010315

Wurman, P. Wellman W. and Walsh. A (2001)parametrization of the auction design space. Games and Economic Behavior. 35(1-2).

Wurman P. (2005), Online Auction Site Management. http://www.csc.ncsu.edu/faculty/wurman/Papers/Wurman-article.pdf.