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Wing Lok YEUNG
wlyeung@ln.edu.hk

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**Global Electronic Commerce through
ebXML and Service Oriented Architectures**

W. L. YEUNG
Assistant Professor
Department of Computing and Decision Sciences
Lingnan University

Tuen Mun, Hong Kong
Telephone: (852) 2616 8095
Fax: (852) 2892 2442
E-mail: wlyeung@ln.edu.hk

Global Electronic Commerce through ebXML and Service Oriented Architectures

W. L. Yeung

Lingnan University, Hong Kong

Abstract

Global electronic commerce has flourished following the commercialisation of the Internet. ebXML is a global business-to-business (B2B) electronic commerce standard which addresses not only the formats and vocabularies of electronic business documents exchanged between business partners, but also the choreography of business transactions during a collaborative process. On the other hand, the service-oriented architectures (SOA) together with web services promise a new era for B2B collaboration with dynamically created business partnerships transacting based on published choreographies, for which the ebXML BPSS (Business Process Specification Scheme) is a major specification language. This paper illustrates the approach with a contract negotiation process and identifies some implementation issues.

Keywords: collaborative processes, web services, choreography, orchestration

1 Introduction

Rapid growth in business-to-business (B2B) electronic commerce has been widely expected since we entered the 21st century. The US Census Bureau estimated that over 94% of all electronic commerce could be classified as business-to-business (B2B) in 2000. In 2001, the value of B2B e-commerce in the US was estimated to be 3% of GDP according to eMarketer. The U.S. B2B sector revenues had been expected to reach US\$2 trillion

in 2002. According to IDC Research, global B2B revenues were expected to rise from US\$282 billion in 2000 to US\$4.3 trillion by 2005.

Electronic Business XML (ebXML) (www.ebxml.org) is a global standard for electronic business processes developed and sponsored by UN/CEFACT and OASIS since 2001. The standard is built upon the Extensible Markup Language (XML) standard and is aimed at business-to-business (B2B) collaborative processes. ebXML relies on the Unified Modelling Language (UML) [5] for business process modelling and a major component of ebXML is the Business Process Specification Schema (BPSS) [4] which is for defining the *choreography* of business transactions involved in a collaborative process.

On the other hand, Service-Oriented Architectures (SOA) based on web services promise an unprecedented level of flexibility and interoperability between enterprise applications that are loosely coupled and can be dynamically bound together during execution. This is most relevant to B2B collaborative processes in which business partnerships are set up dynamically with enterprise applications running on diverse platforms and communicating through the Internet. This involves each partner packaging its enterprise applications as web services according to relevant standards and orchestrating them according to the needs of the collaborative process. The Web Service Business Process Execution Language (WS-BPEL) [1], also known previously as BPEL4WS, supports the orchestration of web services.

In this paper, we discuss and illustrate the use of ebXML within SOA in setting up collaborative processes among business partners. Our aim is to highlight the complementarity of the two technologies and identify issues for their successful implementation.

The next section provides some technology background on ebXML and SOA. Section 3 introduces the use of ebXML BPSS in specifying the choreography of a contract negotiation process example adapted from [6]. Section 4 describes an implementation of the collaborative process in which the two business partners orchestrate their web services using WS-BPEL. Section 5 discusses some implementation issues and Section 6 gives a conclusion.

2 Technology Background

Workflow management systems (WfMS) have been around since the 1980's providing computer-based handling of (electronic) documents and sequencing of processing tasks involved in a business process. This requires a so-called workflow model that specifies the process flow and details of document processing. A workflow model is often presented graphically as a directed graph in the style of a traditional program flowchart, which is deemed accessible to business analysts without any background in the technical implementation. Nevertheless, early WfMS often employed proprietary modelling notations and did not allow "on-the-fly" modification of workflow models.

Business process management systems (BPMS) extend WfMS with, among other things, a software architecture that supports "on-the-fly" modelling of entire end-to-end business processes involving multiple software applications at a highly user-accessible layer. In BPM terminology, this is known as orchestration.

The emergence of web services based on the World World Web Consortium (W3C) standards (XML, WSDL, SOAP, etc.) promises a service-oriented architecture for a new generation of BPMS in which software applications packaged and run as web services are loosely coupled and can be dynamically bound together during the execution of a business process. This is most relevant to business-to-business (B2B) collaboration in which business partnerships can dynamically be set up with software applications running on diverse platforms, communicating and collaborating through the Internet. At the same time, a business can make use of a standard process modelling language such as the Web Services Business Process Execution Language (WS-BPEL) in orchestrating software applications for its internal as well as collaborative processes.

Ideally, business partners could orchestrate their respective sets of software applications to work together seamlessly according to a model of the overall end-to-end collaborative process. In reality, requiring such a comprehensive overall collaborative process model is unrealistic and unreasonable whenever business partnerships are supposed to be dynamically set up. Even in relatively stable partnerships, businesses have many reasons not to reveal their internal workflows to their partners—one typical reason is that the collabora-

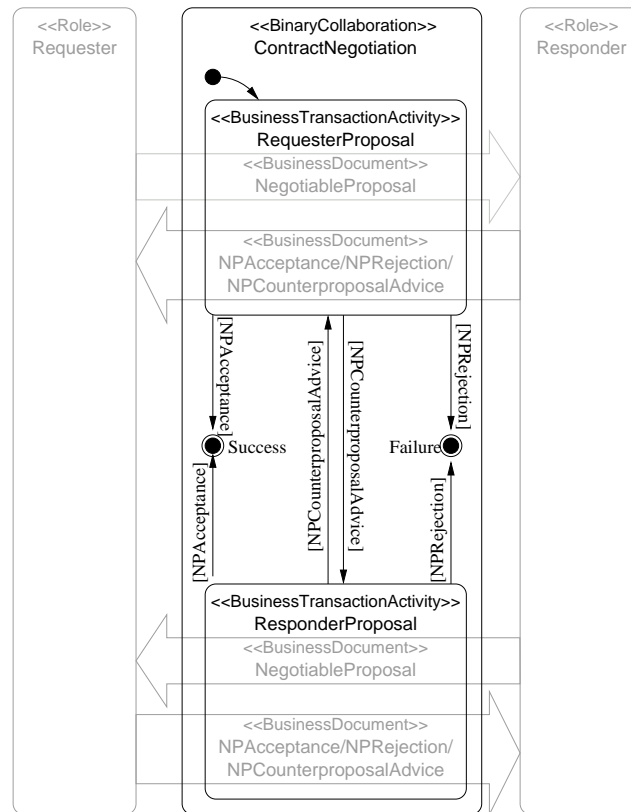


Figure 1: A choreography example

tion involves some sort of negotiation among the partners. Instead, partners orchestrate their own software applications according to their own agendas but at the same time adhering to some agreements on what and how documents are to be exchanged (electronically) in a collaborative process. The following sections illustrate such an approach based on the Electronic Business XML (ebXML).

3 A Contract Negotiation Protocol in ebXML

In ebXML BPSS, a *business transaction* is an atomic unit of work in a trading arrangement between two business partners. When a *business transaction activity* (the performance of a business transaction) is carried out, one partner initiates the transaction by sending a request to the other partner who may optionally send a response to the former. As a business process may involve several business transactions between two partners, the choreography of them is defined in a *binary collaboration*. Figure 1 shows a UML statechart diagram

which illustrates the choreography between two partners in a contract negotiation process.

The two partners take on specific *roles* involved in the negotiation, namely, the Requester and the Responder. The negotiation process begins with the Requester-Proposal business transaction which involves the Requester's sending of a proposal document to the Responder and then the Responder's sending a response to the Requester. Depending on the response, the negotiation process may end with either a success or a failure status, or it may continue with the Responder-Proposal interaction which mirrors the Requester-Proposal with the two roles reversed. The process ends as soon as a *NPAcceptance* or a *NPRejection* response is issued by either role. Also shown in light grey in Figure 1 (which is not a part of the statechart diagram proper) is the flow of documents involved in the business transactions. The corresponding segment (with some details omitted) of the ebXML BPSS for the choreography is shown in Figure 2

4 Web Service Orchestrations in WS-BPEL

Figure 3 illustrates an implementation of the contract negotiation process based on web services. The interactions between the Requester and Responder are driven by two WS-BPEL processes, one on each side, orchestrating the web services (realised by enterprise software applications and human operators). The WS-BPEL processes are also responsible for exchanging business documents according to the ebXML BPSS specification discussed in the preceding section and shown here in light grey.

A WS-BPEL process is defined in terms of activities which can be primitive or structured. Primitive activities include: *invoke* for calling a Web service's operation; *receive* for waiting for a message; *reply* for sending a message; *wait* for pausing for a period of time; *assign* for assigning value of one variable to another; *throw* for initiating an exception; *terminate* for terminating the service; *empty* for doing nothing. Structured activities are structuring constructs including *sequence*, *repeatUntil*, *if*, *while*, which correspond to the usual programming constructs, as well as *pick* (selection based on timing or incoming triggers), *flow* (parallel fork), *scope* (for exception handler), and *links* (parallel join).

```

<BinaryCollaboration name="ContractNegotiation">
  <Role name="Requester" ... />
  <Role name="Responder" ... />
  <start toBusinessState="RequesterProposal" ... />
  <BusinessTransactionActivity
    name="RequesterProposal"
    fromRole="Requester" toRole="Responder" ... />
  <BusinessTransactionActivity
    name="ResponderProposal"
    fromRole="Responder" toRole="Requester" ... />
  <Transition
    fromBusinessState="RequesterProposal"
    toBusinessState="Test Reply" ... />
  <Transition
    fromBusinessState="ResponderProposal"
    toBusinessState="Test Reply" ... />
  <Decision name="Test Reply" ... />
  <Success fromBusinessState="Test Reply" ... >
    <ConditionExpression ...
      conditionExpression="NPAcceptance" />
  </Success>
  <Failure fromBusinessState="Test Reply" ... >
    <ConditionExpression ...
      conditionExpression="NPRejection" />
  </Failure>
  <Transition
    fromBusinessState="RequesterProposal"
    toBusinessState="ResponderProposal" ... >
    <ConditionExpression ...
      conditionExpression="NPCounterProposalAdvice" />
  </Transition>
  <Transition
    fromBusinessState="ResponderProposal"
    toBusinessState="RequesterProposal" ... >
    <ConditionExpression ...
      conditionExpression="NPCounterProposalAdvice" />
  </Transition>
</BinaryCollaboration>

```

Figure 2: Segment of the ebXML BPSS choreography for the negotiation process

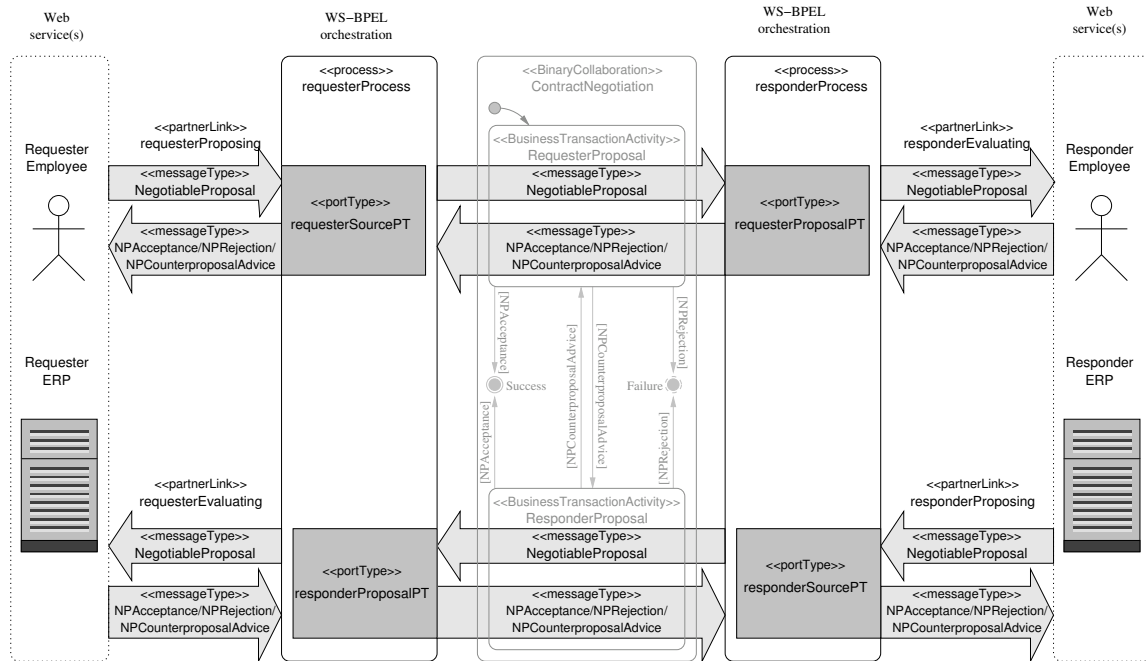


Figure 3: WS-BPEL processes and web services for the contract negotiation process

Figure 5 shows a UML activity diagram of the Requester's web service orchestration. The corresponding WS-BPEL process is specified in Figure 4

5 Implementation Issues

Both ebXML and WS-BPEL are based on the XML syntax which is mainly designed for machine processing as seen in the examples above. Software developers rely on software tools that provide graphical interfaces and modelling capabilities based on visual notations such as UML (see Figure 5) for designing business processes and their implementations. Such software tools are available from software vendors such as IBM and Microsoft which are behind these B2B standards, although there is the issue of platform dependency, i.e. a software tool may be tied to a particular vendor's implementation platform.

An ebXML BPSS specification lays down the a pattern of message interaction to which the orchestration of web services must conform by all partners. Ensuring such conformance is necessary for the successful implementation of a B2B process. From a given ebXML BPSS document, it is possible to *partially* generate WS-BPEL documents with the help of

```

<process name="requesterProcess" ...>
  <partnerLinks>
    <partnerLink name="requesterProposing" ... />
    <partnerLink name="requesting" ... />
    <partnerLink name="responding" ... />
    <partnerLink name="requesterEvaluating" ... />
  </partnerLinks>
  <variables>
    <variable name="proposal" messageType="proposalType"/>
    <variable name="response" messageType="responseType"/>
  </variables>
  <repeatUntil>
    <sequence>
      <receive partnerLink="requesterProposing"
        operation="requesterPropose"
        variable="proposal">
      </receive>
      <invoke partnerLink="requesting"
        operation="requesterRequest"
        inputVariable="proposal"
        outputVariable="response">
      </invoke>
      <reply partnerLink="requesterProposing"
        operation="requesterPropose"
        variable="response">
      </reply>
      <if>
        <condition>
          $response = "NPCCounterProposalAdvice"
        </condition>
        <sequence>
          <receive partnerLink="responding"
            operation="responderRequest"
            variable="proposal">
          </receive>
          <invoke partnerLink="requesterEvaluating"
            operation="requesterEvaluate"
            inputVariable="proposal"
            outputVariable="response">
          </invoke>
          <reply partnerLink="requesterProposing"
            operation="requesterPropose"
            variable="response">
          </reply>
        </sequence>
      </if>
    </sequence>
    <condition>
      $response != "NPCCounterProposalAdvice"
    </condition>
  </repeatUntil>
</process>

```

Figure 4: WS-BPEL process for the Requester's web services

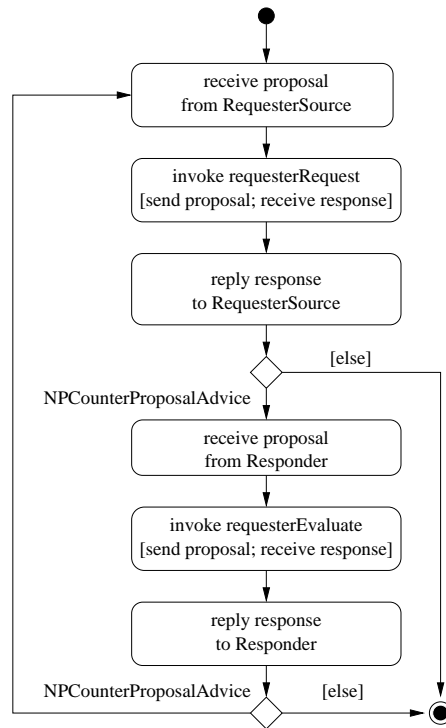


Figure 5: The Requester WS-BPEL (executable) process

software tools for individual participants to orchestrate their respective web services [3]. This approach would in principle guarantee conformance of the orchestration processes, although the generated WS-BPEL documents are not complete and therefore still require further development by individual partners.

A different approach is to allow the WS-BPEL processes to be developed independently by partners but their conformance is formally verified using logic-based model checking [2, 7]. This requires the translation of both ebXML BPSS and WS-BPEL into some formal modelling notations and using a software tool to check conformance automatically.

Further work is needed develop the software tools mentioned above and integrate them into the development process in order to facilitate the use of ebXML and WS-BPEL in B2B e-commerce.

6 Conclusion

We have considered the use of ebXML BPSS in specifying the choreography of business transactions for a collaborative process. We have also illustrated the implementation of such a process in web services based on WS-BPEL. Together they provide a systematic approach to enabling global electronic commerce based on established technology standards.

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