Conceptual Modeling and Specification Generation for B2B Business Processes based on ebXML

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Abstract

In order to support dynamic setup of business processes among independent organizations, a formal standard schema for describing the business processes is basically required. The ebXML framework provides such a specification schema called BPSS (Business Process Specification Schema) which is available in two stand-alone representations: a UML version, and an XML version. The former, however, is not intended for the direct creation of business process specifications, but for defining specification elements and their relationships required for creating an ebXML-compliant business process specification. For this reason, it is very important to support conceptual modeling that is well organized and directly matched with major modeling concepts. This paper deals with how to represent and manage B2B business processes using UML-compliant diagrams. The major challenge is to organize UML diagrams in a natural way that is well suited with the business process meta-model and then to transform the diagrams into an XML version. This paper demonstrates the usefulness of conceptually modeling business processes by prototyping a business process editor tool called ebDesigner.

1. Introduction

In order to support dynamic setup of business processes among independent organizations, a formal standard schema for describing the business processes is basically required for sharing their common semantics. With the rapid adoption of XML as the exchange format, it is the best candidate for defining such a specification schema because it is a meta-language on which business applications can be build. An issue closely related with the schema definition is how to compose a specification following the schema. Partly due to the textual form of the grammar, even the design of a simple specification may cause difficulties.

ebXML provides a modular suite of specifications that enables enterprises of any size and in any geographical location to conduct business over the Internet. Compared with other XML-based frameworks, ebXML specifications can be characterized by the fact that it emphasizes business processes rather than business documents. Analysis teams normally use methodologies and metamodels to specify the business processes in an electronic business community. The ebXML business process modeling language and methodology of choice is the UML-based UMM (UN/CEFACT Modeling Methodology) [8] and its supporting business process metamodel (UMM Metamodel). The UMM Metamodel specifies all the information that needs to be captured during the analysis of an electronic commerce based business process within the ebXML framework. An additional view of the UMM Metamodel, the ebXML business process specification schema (BPSS), is also provided to support the direct specification of the set of elements required to configure a runtime system in order to execute a set of ebXML business transactions. The schema lends sufficient functionality to model interactions between business partners [7]. The BPSS is available in two stand-alone representations, a UML version, and an XML version. The former, however, is not intended for the direct creation of business process specifications. Rather, it is a self-contained statement of all the specification elements and their relationships required for creating an ebXML-compliant business process specification [9]. It is merely a UML class diagram.

ebXML adopts worksheet-based approach for allowing users to capture all the information that is required to completely describe a business process without modeling and analysis expertise. The intent of the worksheets is to capture all the bits of information that are required to completely describe a business process so that it can be registered, classified, discovered, and reused. UML diagrams may be used instead of some worksheets. For example, UML activity diagrams can be interchangeably used with Business Transaction Transition Table worksheet. However, there is no explicit way about how to use UML diagrams for specifying business processes. Furthermore, it should be clearly defined how to generate business process specifications from the worksheets and UML diagrams.

For this reason, it is very important to support conceptual modeling that is well organized and directly matched with the major modeling concepts (i.e., meta-model). This paper deals with how to represent and manage ebXML business processes using UML-compliant diagrams. The major challenge is to re-organize some UML diagrams in a natural way that is well suited with the meta-model, and then to transform

instantiated diagrams into an XML-based specification. Conceptual modeling with UML helps to improve the understanding and design quality of business processes [3].

The rest of the paper is organized as follows. Section 2 describes how to conceptually model B2B business processes using UML-compliant diagrams. The usefulness of the conceptual modeling approach is demonstrated using a prototype editor tool for designing B2B business processes, ebDesigner, in Section 3. Finally, Section 4 concludes the paper with some future research directions.

2. Conceptual Modeling of B2B Business Processes based on ebXML

In this section, five facets of describing business processes are discussed for conceptual modeling. An ebXML business transaction represents an atomic unit of work in a trading arrangement between two business partners in modeling business processes. Each business transaction consists of one or two predefined business document flows and additional business signals. A business collaboration consists of a set of roles collaborating through a set of choreographed business transactions by exchanging business documents. Two or more business partners participate in the business collaboration through roles. The roles interact with each other through business transactions. The business transactions are sequenced relative to each other in a choreography. Please refer to ebXML specifications [9,10] for further details.

2.1 Business Transaction Modeling

A business transaction consists of a requesting business activity, a responding business activity, one or two document flows between them and additionally business signals. Implicitly there is a requesting role performing the requesting business activity and a responding role performing the responding business activity. These roles become explicit when the transaction is used within a business transaction activity in a binary collaboration. A request document flow is required for all business transactions. Whether a response document is required is part of the definition of the business transaction. Associated with each document flow can be one or more business signals acknowledging the document flow. These acknowledgment signals are not modeled explicitly but parameters associated with the transaction specify whether the signals are required or not. Figure 1 illustrates the meta model, composed of classes and relationships, for defining business transactions. Note that the meta-model is not intended for the direct creation of ebXML business process specifications. Rather, it is a self-contained statement of all the specification elements and relationships required to be able to create an ebXML-compliant business process specification. Any methodologies and/or meta-models used for the creation of ebXML-compliant business process specifications must at minimum support these elements and relationships. For efficient and effective modeling of business processes, we need other diagrams that organize and match well with the major modeling concepts. In this respect, we adopt the UML sequence diagram as the best candidate for the conceptual modeling of business transactions. Figure 2 shows such a UML sequence diagram that includes all the possible document flows and business signals. In the diagram, solid lines represent document flows while dotted lines identify business signals. We call such a diagram as BP Transaction Diagram, where document flows and business signals are modeled as an asynchronous message.

While some business transactions need a pair of a request and a response, typically for the formation of a contract or agreement, other business transactions are more like notifications, and have only a request document flow. Logically, there could be eleven patterns following the semantics of business transactions. These patterns could be employed by modeling tools to enhance reusing business transactions.

2.2 Document Flow Modeling

Request document flows and response document flows contain business documents that pertain to the business transaction. A document flow is not modeled directly. Rather it is modeled indirectly as a document envelope sent by one role and received by the other. The document envelope is always associated with one requesting business activity and one responding business activity to model the flow. There is always only one named document envelope for a requesting activity. There may be zero, one, or many mutually exclusive, named document envelopes for a responding activity. The document envelope represents the flow of documents between the activities. Each document envelope carries exactly one primary business document. A document envelope can optionally have one or more attachments, all related to the primary business document.

For conceptual modeling, business documents and attachments are modeled as objects. In the case of document envelopes, this paper chooses another way. A document envelope is defined as a property value of its document flow since each document envelope just belongs to one document flow. Relationships between document envelopes and business documents (or attachments) are then modeled as property values of business documents.

2.3 Binary Collaboration Modeling

A binary collaboration is always between two roles, which are called authorized roles. Authorized roles represent the actors that are authorized to participate in the collaboration. A binary collaboration consists of one or more business activities conducted between the two authorized roles of the binary collaboration. For each activity one of two roles is assigned to be the initiating role (from) and the other to be the responding role (to). A business activity can be either a business transaction activity or a collaboration activity. A business transaction activity is the execution of a business transaction. Business transactions are re-useable relative to business transaction activity. A collaboration activity is the performance of a binary collaboration, possibly within another binary collaboration. Binary collaborations are re-useable relative to collaboration activity.

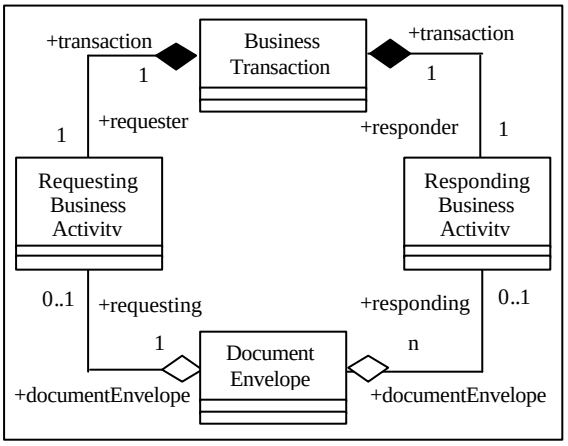

Figure 1. Class Diagram for Business Transaction Modeling [9]

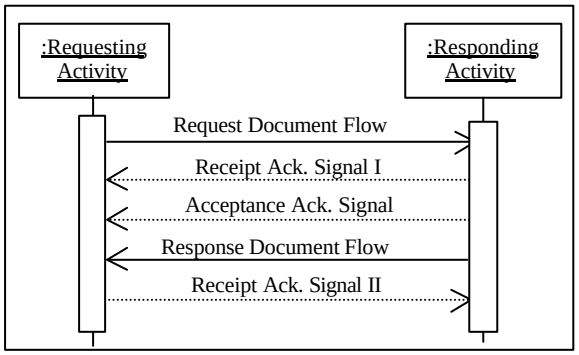

Figure 2. BP Transaction Diagram

Since binary collaborations represent interactions between two authorized roles, a UML sequence diagram can also be employed for conceptual modeling. We call the diagram as a BP Binary Collaboration Diagram, where business transaction activities and binary collaboration activities are represented as a kind of asynchronous message. In the diagram, two authorized roles (an initiating role and a responding role) are modeled as two participating objects. As an example, figure 3 describes how two business transactions are integrated into a binary collaboration using business transaction activities. The buyer is the initiating role and seller is the responding role. CreateOrder and NotifyOfAdvanceShipment are business transaction activities that contain a business transaction respectively.

2.4 Multiparty Collaboration Modeling

A multiparty collaboration is an integration of binary collaborations, which consists of a number of business partner roles. Each business partner role performs one authorized role in one of the binary collaborations, or perhaps one authorized role in each of several binary collaborations. Implicitly the multiparty collaboration consists of all the binary collaborations in which its business partner roles play authorized roles.

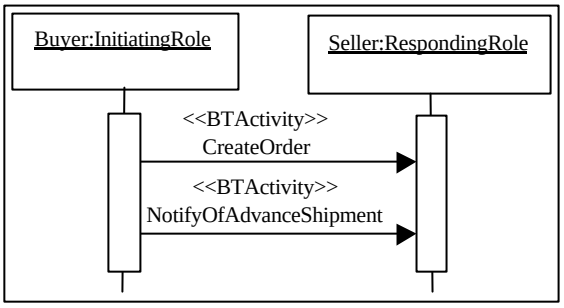

Figure 3. BP Binary Collaboration Diagram

Likewise binary collaborations, multiparty collaborations can be represented as a UML sequence diagram. We call the diagram as a BP Multiparty Collaboration Diagram, where binary collaboration activities are represented as a kind of asynchronous message. Note that we are using binary collaboration activities instead of 'performs' relationships between business partner roles and authorized roles. Those relationships can be deduced from the implicit matching between business partner roles and authorized roles through binary collaboration activities. For example, figure 4 shows how two binary collaboration transactions are integrated into a multiparty collaboration using binary collaboration activities. In the example, a business collaboration activity A is linked with the binary collaboration A, whose initiating role is the Buyer. So, we can conjecture that a business partner role Customer corresponds to the authorized role of Buyer in the binary collaboration A.

2.5 Choreography Modeling

The purpose of a choreography is to order and sequence business transaction activity and/or collaboration activity within a binary collaboration, or

across binary collaborations within a multiparty collaboration. The choreography is specified in terms of business states, and transitions between those business states. A business activity is an abstract kind of business state. Its two subtypes, business transaction activity and collaboration activity, are concrete business states. There are a number of auxiliary kinds of business states that facilitate the choreographing of business activities. These include a start state, a completion state, a fork state and a synchronization state. Transitions are between business states. Transitions can be gated by guards. Guards can refer to the status of the document envelope that caused the transition, the type of document sent, the content of the document, or postconditions on the prior state.

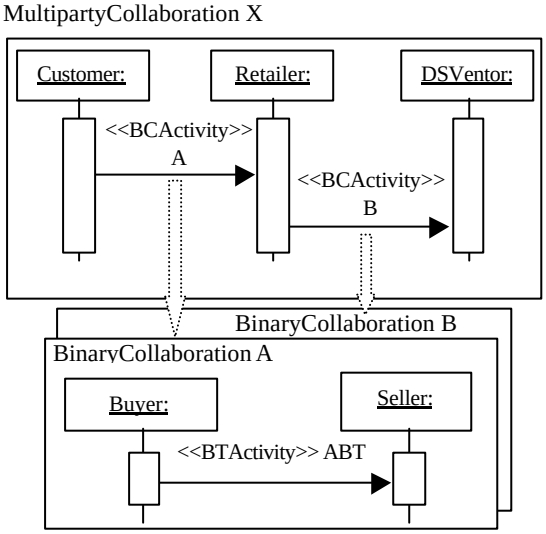

Figure 4. An Example Multiparty Collaboration Diagram and Related Binary Collaboration Diagrams

These are all equivalent to diagramming artifacts on a UML activity diagram. So, it is more natural that activity diagrams are used for conceptual modeling of choreography. We call such a diagram as a BP Choreography Diagram. Figure 5 demonstrates an example BP Choreography Diagram related with the BP Binary Collaboration Diagram of figure 3.

3. ebDesigner: A Prototype Support Tool for Conceptual Modeling of B2B Business Processes

Support tools such as business process editors and document / information editors are instrumental in enabling ebXML based e-business. ebXML is composed of two basic layers, i.e. design-time and run-time. Business process (BP) and business information is usually analyzed in the design-time which deals with the procedures for creating an application of the ebXML infrastructure, as well as the actual discovery and arrangements of ebXML-related resources required for business transactions to take place. The run-time layer covers the execution of an ebXML scenario with the actual associated ebXML transactions. Those support tools in the design-time layer will support discovery, user friendly forms-based modeling, business process and business information comparison, documentation and help on the analysis process, and capabilities for submitting specifications to ebXML registries.

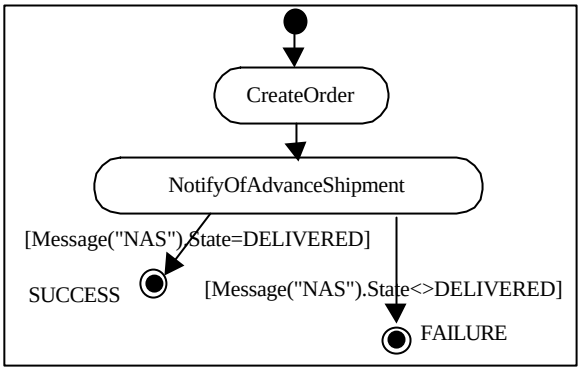

Figure 5. BP Choreography Diagram

This section demonstrates the usefulness of conceptually modeling business processes by prototyping a business process editor tool called ebDesigner. The prototype has been developed using Java and ArgoUML [1]. Figure 6 shows the general architecture of ebDesigner, where UML diagrams and related data for modeling B2B business processes are stored as local XMI [6] and PGML [11] files. ebDesigner uses the internal diagrams and data for generating a business process specification (BPS) because the direct generation is more efficient than that from stored files represented in XMI. From a business process specification, ebDesigner can generate a default CPP (Collaboration Protocol Profile) file for each binary collaboration. It is also supported in ebDesigner to register all the contents for reuse on an ebXML registry.

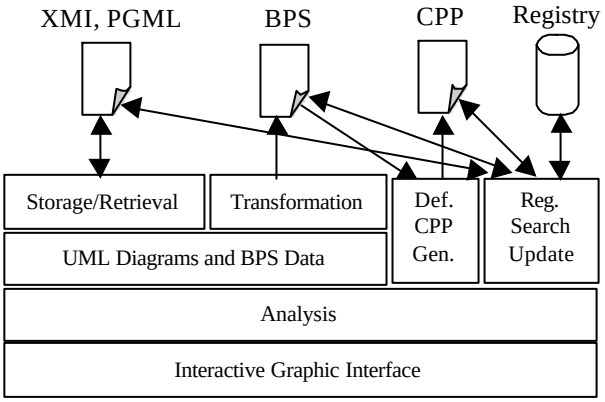

Figure 6. General Architecture of ebDesigner

Following the technical report [10] on the ebXML business process worksheets, ebDesigner supports four kinds of constructs for refining and reusing business processes: business reference model, business area, process area, and business process. A business reference model defines the frame of reference of the rest of the worksheets. This frame of reference might define basic terms accepted by the given industry segment. Typically a business reference model would define a canonical set of process areas which are to group business processes according to the primary business function. But, there are no concrete and fast rules for how to divide up the model into different business areas. A process area consists of a sequence of processes that are combined to form the "value chain" of the given business area. A business process is to define the smallest exchange of signals between stakeholders that has an identifiable economic value.

Figure 7 shows a capture screen of the ebDesigner, where the main window contains two panes, one for navigation, and the other for drawing diagrams. In the figure, two authorized roles, buyer and supplier, are modeled using a BP Collaboration Diagram, which is a specialized version of the UML sequence diagram. The buyer is the initiator in the business collaboration. Such properties can be interactively specified using a dialog box as figure 8. Between the two roles, two business transactions are defined as a message from the buyer to the supplier (figure 9). ebDesigner currently provides 8 patterns (8 arrow-style buttons at the top of the drawing pane) for modeling business transaction activities. The first business transaction of figure 9 follows the pattern 1 (including the request document flow), while the second one the pattern 8 (including all the document flows and business signals).

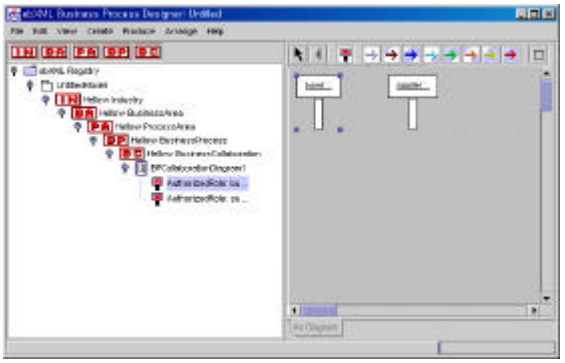

Figure 7. ebDesigner Main Window

Figure 10 demonstrates how business transactions are modeled in ebDesigner. A BP Transaction Diagram is used to define the interactions between two collaborating partners. Note that BP Transaction Diagrams are automatically generated by ebDesigner, following the selected pattern. The business transaction defined in the figure follows the eighth pattern. The only thing users have to do in this stage is just completing the dialog forms for requesting/responding roles, business documents, and business signals. The right bottom corner of the figure shows a dialog form for modeling the requesting role of the business transaction.

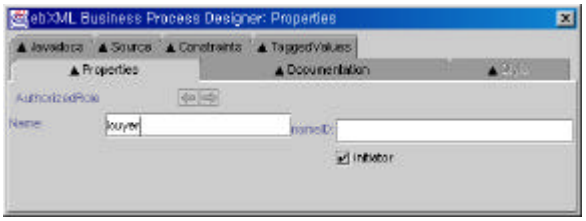

Figure 8. Property Dialog Box

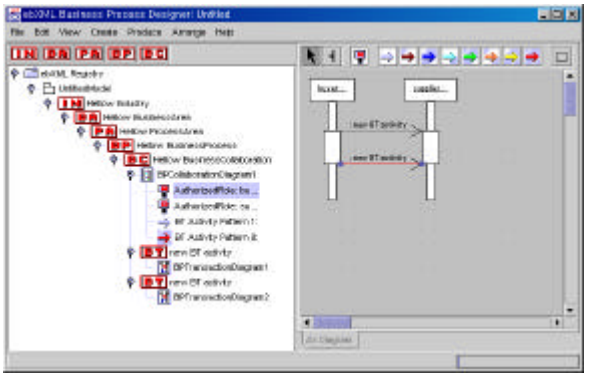

Figure 9. BP Collaboration Diagram

After modeling business collaborations contained in a business process, we need to generate a BPS in order to manage and carry out business processes. The XML version of the ebXML BPSS provides the specification for XML-based instances of ebXML BPS's, and as a target for production rules from other representations. ebDesigner supports the automatic generation of BPS's from the UML-based conceptual modeling. Figure 11 shows a sample output generated from the model defined above. Figure 12 demonstrates the process for registering a BPS on an ebXML registry [5] with some classification schemes such as geographic location and UN/SPSC.

4. Concluding Remarks

A UML version of the ebXML BPSS is not adequate for the direct creation of business process specifications. The focal point of our approach is to support conceptual modeling that is well organized and directly matched with major modeling concepts. Using UML-compliant diagrams organized in a natural way that is well suited with the business process metamodel, the conceptual modeling approach improves the understanding and design quality of B2B business processes. A business process editor tool called ebDesigner has been prototyped to demonstrate the

usefulness of the conceptual modeling approach to B2B business process design. The prototype supports the automatic generation of XML-based business process specifications directly from the conceptual models. It is also possible to generate them from the models stored in the format of XMI [6], but the generation process is more complex and time-consuming than the direct generation from the internal model.

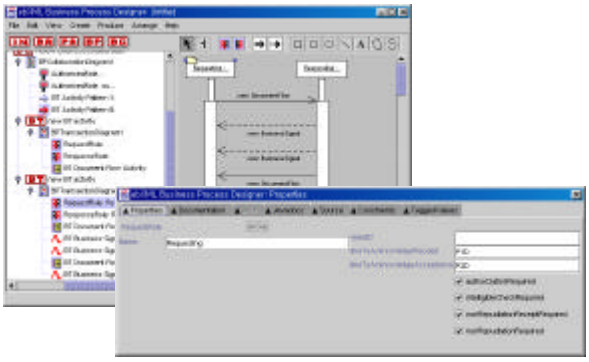

Figure 10. Business Transaction Modeling

Figure 11. A BPS Sample Generated

Among the products and implementations listed in the ebXML web site [3], BindPartner [2] is the only one that provides a graphical modeling environment built for capturing collaborative process semantics within the ebXML framework. It permits the generation and output of ebXML BP specifications in XML format. However, it does not support constructs for refining and reusing business processes such as business areas. While it just uses an activity diagram for the graphical modeling of a business collaboration, ebDesigner employs sequence diagrams for its hierarchical decompositions. Furthermore, ebDesigner emphasizes reusing patterns.

For future work, the prototype support tool is currently being used as a test bed for finding a good conceptual modeling framework. Of course, improving its functionality and performance is required. For more consistent and complete specification, research is in progress about specifying constraints such as timing and security using OCL. Based on the conceptual modeling and specification transformation, other support tools such as document / information modeling and collaboration protocol selection/design need to be developed and integrated to create synergy.

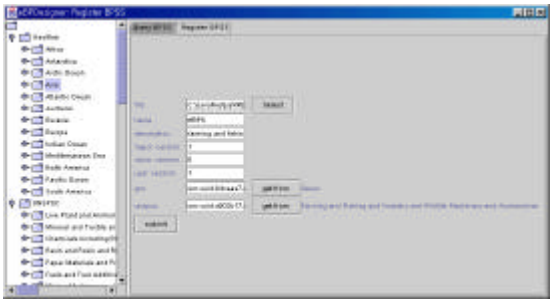

Figure 12. Registration of a Business Process Spec.

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