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A Methodology to Integrate Public Processes with Private Processes for B2B e-Commerce

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B2B 전자거래를 위한 공개 및 내부 프로세스의 통합 방법론

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The inter-organizational business process is one of the hot issues in B2B e-commerce. In this paper, through the survey of the inter-organizational business process integration and the analysis of B2Bi related standards, e.g., BPML, WSDL, WSCI, and BPSS, we propose a method of linking BPML and BPSS specifications that can be used to integrate private processes with the public processes among enterprises. We also suggest an application example of the method by redefining a PIP of RosettaNet to the BPSS specification. The basic principle of the method is to maintain the independency of the existing BPML and BPSS applications and to construct an intermediary transformation module between the two applications.

Keywords: private processes, public processes, e-business, BPML, BPSS, B2B

1. Introduction

With a tremendous potential of e-commerce for modern enterprises, business processes composed of business transactions among enterprises become a matter of primary concern. In e-commerce, business processes can be classified into public process and private process. Public process is defined as business transactions being exchanged among business partners. However, private process is defined as business processes implemented within an organization. To date, many initiatives for B2B e-commerce standards, e.g., RosettaNet, ebXML, BizTalk and so on, are working on standardizing public processes in order to allow organizations to inter-operate by defining business contents based on XML. However, these standards include only the specifics of public processes but not the specifics of private processes. From the business perspectives, business transactions often require interactions with internal processes which implement back-end applications such as ERP in order to drive some decisions for trading between partners. Unfortunately, current B2B e-commerce standards basically do not take the internal implementations into account. In order to make a seamless implementation among business partners, public processes should be integrated with internal processes Chen 2001(Li, 2002).

In order to resolve this issue, BPMI.org has proposed the Business Process Modeling Language (BPML) in June, 2002(Arkin, 2002), which is dedicated to the modeling of transactional and collaborative business processes. BPML provides a

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formal model for expressing abstract and executable processes that address all aspects of enterprise business processes, and also leverage the Web Service Choreography Interface (WSCI) for the definition of public interfaces between partners (W3C, 2002). The WSCI is in fact used as an interoperability layer in the BPML 1.0 specification. In addition, BPML provides an end-to-end view that depicts the role of each individual business process in the overall choreography, and the business activities performed by each role. However, BPML does not have specifications in detail for public processes between business partners. Therefore, for the purpose of B2B e-commerce, the business process modeled by BPML is desirable to comply with B2B e-commerce standards which have specifications well defined for public processes.

As one of B2B e-commerce standards, the Business Process Specification Schema (BPSS), part of ebXML, describes interoperable public processes that allow business partners to collaborate each other. Moreover, BPSS provides the nominal set of specification elements necessary to specify a collaboration between business partners, and configuration parameters for partners' runtime system to execute the collaboration between business service interfaces (ebXML.org 2002). Therefore, BPSS can be used for the definition of semantics for the collaboration between business partners. In other words, it defines the commercial transactions between business partners and provides full commercial semantics.

Based on B2B standards, reference (Sayal, 2002) proposes a practical method to integrate a private process with a public process. However, in this method all B2B conversation logics need to be redefined with XMI which generates corresponding process templates from the XMI definitions. Then, it uses an existing WFMS to model the whole interaction as a workflow type.

As another effort to integrate public and private processes, inter-organizational workflow models have been developed (Chen, 2002, Hoffner, 2000; Aalst, 2001). Reference (Chen, 2001) discusses about a peer-to-peer inter-enterprise business process execution mode. In the ESPRIT project (www.crossflow.org, Hoffner, 2000) they proposed CrossFlow, a inter-organizational workflow management model in virtual enterprises. It is characterized by fine-grained contract based cooperation. Both organizations have a common view on the contract level and do not want to show the details of their core business processes. But as all enterprises involved are required to use the same software for the contract enforcement, this does not fit loosely coupled B2B business process integrations between business partners. Reference (Aalst, 2001) proposes the Public-to-Private (P2P) approach to inter-organizational workflow. This method needs to first define a common public workflow that serves as a contract between involved organizations, and then partition it into several public parts according to organizations and allow to refine the part privately by the organization. This is based on a notion of inheritance that a private workflow is a subclass of its public part. The problem with this method is that the private workflow contains all the messaging logics, thus, a high number of programs have to be written to satisfy all demands of messaging logics.

The integration issue of public and private processes is being expanded even to web services. IBM and Microsoft recently released a new business process modeling standard called Business Process Execution Language for Web Services (BPEL4WS) (Cubera, 2002). Compared with the BPML, BPEL4WS shares similar roots in web services such as SOAP, WSDL, and UDDI, and uses the same XML technology of Xpath and XSDL. Both languages are designed to leverage other specifications. From the viewpoint that BPML supports nested processes and complex compensated transactions which BPEL4WS has yet to address, BPML is a strict superset of BPEL4WS.

In this paper, we propose a method to integrate public and private processes using current business process modeling standards, BPSS and BPML. In this method, BPML makes a role to define the private (or internal) processes within an enterprise and BPSS to define the public processes between enterprises. In addition, a solution model is suggested to interface between the private business processes of BPML compliant and enterprise-to-enterprise public processes of BPSS compliant in order to realize the binding of the two processes together. The proposed solution can be used to implement both the development of new business processes that support B2B operations and the enhancement of the existing business processes by adding B2B operations. An example of the solution model is also provided redefining PIP 3A1 (the Request Quote process in RosettNet) into the BPSS specification.

2. The Analysis of BPML and BPSS

As mentioned above, B2B e-commerce standards are emerging and they all provide specifications which can achieve interoperability among business partners. However, through the analysis of these standards, it has been found that till now these standards lack a comprehensive model of e-business processes. Therefore, the development of such a model would be of considerable significance.

Suppose that we have an e-business process for purchase order. The e-business process is anatomized in Figure 1. It includes private implementations of business partners A and B, and common public interface between the two business partners participating in interaction.

A private implementation can be represented as a private process, and similarly a public interface can be represented as a public process. In this example, the private processes of partners A and B correspond to the procurement process and the fulfillment process, respectively. In the same way the public process corresponds to the purchase order management process. Therefore, the terms "implementation" and "process" are often used interchangeably in this paper.

BPMLas a specification of business process modeling within an enterprise can be used to represent private processes. BPSS as a specification of B2B transactions can be used to represent public processes. Hence, BPML and BPSS specifications can be linked together to integrate private processes with the public processes among enterprises.

BPSS is part of the comprehensive ebXML specifications, which also include messaging, collaboration agreements and profiles, registry/repository, and core components. It is a simple but effective schema that describes public processes only. In a BPSS model different roles, i.e., seller, buyer, collaborate to implement a group of business transactions. The choreography of business transactions is defined by means of a control flow based on UML activity diagram semantics. But there is no explicit description of how data flows among business transactions. BPSS assumes that every transaction is a series of requesting and or responding documents. So it is almost impossible to express complex business scenarios. In a BPSS processes, a choreography of business transaction activities is only based on the business states (start, success, failure, fork, join, and business activity) and transition between them. Therefore, it is similarly difficult to assemble complex choreography with these business states.

Business transactions in a BPSS model are based on a proven robust transaction model used by B2B standards such as RosettaNet. Also BPSS provides explicit support for specifying quality-of-service semantics for business transactions, for instances, authentication, acknowledgements, non-repudiation, and timeouts. But BPSS can not use or access the back-end data in order to derive business decisions, while real business process scenarios do involve the interaction with back-end system to derive business decisions.

BPML has been developed to provide a comprehensive means of specifying the processes of an enterprise. As mentioned in the web site of BPMI.org, "BPMI.org and ebXML are addressing complementary aspects of e-Business processes, BPMI.org provides a standard way to describe their private implementation." BPML describes comprehensive control flow and data flow constructs. It

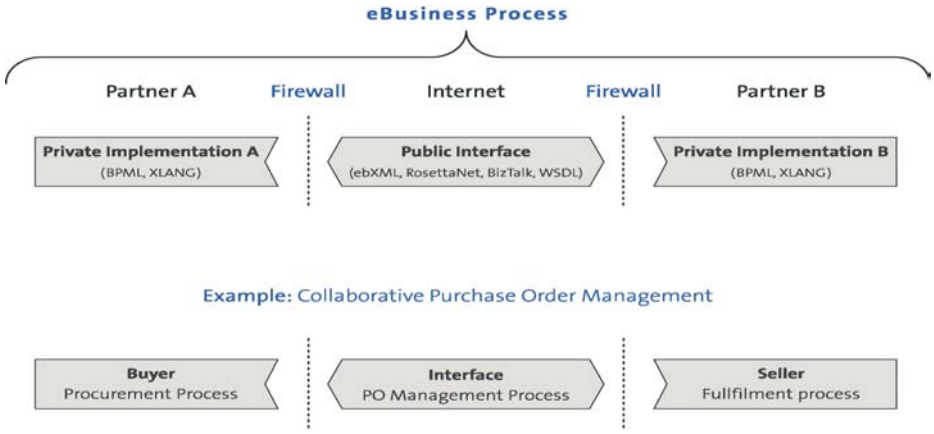

Figure 1. Anatomy of an e-business process (Smith, 2001).

supports both short and long-living business transactions with compensating activities. It also supports exception handling and timeouts. On the other hand, for the application to the web service-based business process, BPML supports WSCI and WSDL specifications. The WSCI is used as an interoperability layer and the WSDL is used to describe web service-based interoperations in the BPML 1.0 specification. But BPML does not provide a means to specify B2B semantics that are important to B2B business processes, such as authentication and non-repudiation.

Through the analysis, characteristics between BPSS and BPML specifications are compared in several aspects and summarized in Table 1.

As for collaboration based modeling, BPSS provides two kinds of collaborations; binary collaborations between two roles, and multi-party collaborations between three or more roles. In a BPML process, the participants can be assigned statically or determined dynamically, and interact with business processes through a set of collaborations. As for workflow, BPSS only provides simple control flows and does not support data flows. The data flow means how information flows between activities in a process. In transaction management, a BPSS compliant process needs to specify receipt and (or) acceptance acknowledgements for each request or response in addition to time constraints. However, there is no support for nested transaction and compensation when a business transaction fails on either side. Comparatively, BPML provides a comprehensive transaction management. In the ACID or coordinated transactional model, BPML completely supports traditional transactional properties, and in the open nested or extended transactional model, it relaxes the transactional isolation property and supports nested transactions and compensations for a long-living business transaction. As for exception handling, BPSS only causes business transactions to fail when exceptions occur, while BPML provides flexible exception handling facilities and explicit recovery actions. As for web services, till now there is no explicit support for web services in the BPSS specification. BPML does not support the message security/reliability and audit trail/agreements. As for execution, BPSS only specifies the external execution semantics, while BPML specifies the internal detailed implementation steps.

Through above analysis we can conclude that BPML and BPSS are complementary each other. Therefore, in the next section, we suggest a methodology to integrate public and private processes by interfacing BPML and BPSS specifications.

Table 1. The feature comparison between BPSS and BPML specifications

Features	BPSS	BPML
Collaboration based modeling	Describes public processes as collaborations between roles.	Expresses abstract and executable processes that address all aspects of enterprise business processes.
Workflow	Describes the sequencing of business transactions between roles.	Provides comprehensive support for control flows and data flows.
Transaction Management	Supports long-running business transactions based on proven e-commerce transaction patterns.	Supports both ACID transactions and open nested transactions.
Exception Handling	Defines a number of possible exceptions, but only cause the transaction to fail.	Provide flexible exception handling facilities and recovery actions.
Web Service	Does not supports WSDL.	Supports WSDL.
Message Security and Reliability	Specifies the identity, security, guaranteed delivery and etc.	Does not supports security and reliability semantics.
Audit Trail	Provides transactional non-repudiation.	Does not support non-repudiation semantics.
Agreement	Supports the collaboration protocol agreement (CPA) .	Does not support B2B agreement.
Execution	There is no support for internal execution semantics.	Specify detailed implementations steps of a process, but lack of B2B semantics.

3. A Method to Integrate Public and Private Processes

In this section, we propose a solution model to integrate the private process complying with BPML and the public process complying with BPSS. In the model, we assume that there exist solutions which manage BPSS compliant public processes and BPML compliant private processes, and these solutions are being operated independently. In this situation, an intermediary transformation mechanism between them can be suggested. The proposed solution model is depicted in Figure 2.

The proposed solution model includes the following main components:

- Business Process Designer: It is responsible for the design of internal or private processes in buildtime. This designer can embed the predefined B2B operations to private processes through accessing the B2B operation repository. Herein, theB2B operations refer to the WSDL compliant operations for the business-to-business interaction and they are derived from the definitions of BPSS compliant processes.
- B2B Operations Repository: It can be used to support the designer of private processes for implementing B2B interactions, who does not concern with the details of the B2B interactions.
- Business Process Engine(or BPML engine): It provides a run-time execution environment for a process instance complying with BPML specification.
- Transformation Manager: It can be used for binding the private process and public process. It is responsible for mapping and packaging of input/ output data, sending messages to the BPSS/BPML engine, receiving replies, and extracting data.
- BPSS Engine: It provides a run-time execution environment for all B2B operations complying with BPSS specification. This has the ability interacting with private processes through Transformation Manager.

Moreover, we can provide concrete modeling constructs for this method on the conceptual level. These modeling constructs include BPML compliant processes, B2B operations, transformation processes, and BPSS compliant processes.

The meaning of the constructs is explained as follows:

- BPML compliant processes refer to the private processes that comply with BPML specifications and may be embedded in B2B operations.
- BPSS compliant processes refer to the public processes that comply with BPSS specifications and may include redefined PIPs of RosettaNet (we have redefined a PIP in the format of BPSS as an example in Section 4).
- B2B operations is defined in the form of WSDL operations for the business-to-business interaction in order to comply with BPML specification. They can be invoked in design time and derived from the definitions of BPSS compliant processes.
- Transformation processes refer to data mapping, packaging, sending, and receiving message from or to BPSS/BPML engines.

The implementation procedure of the proposed method is as follows:

First, construct a B2B operations repository according to B2B standards. In this paper, these operations are restricted to BPSS specifications. However, they can be completely extended to other B2B standards when necessary. All B2B operations

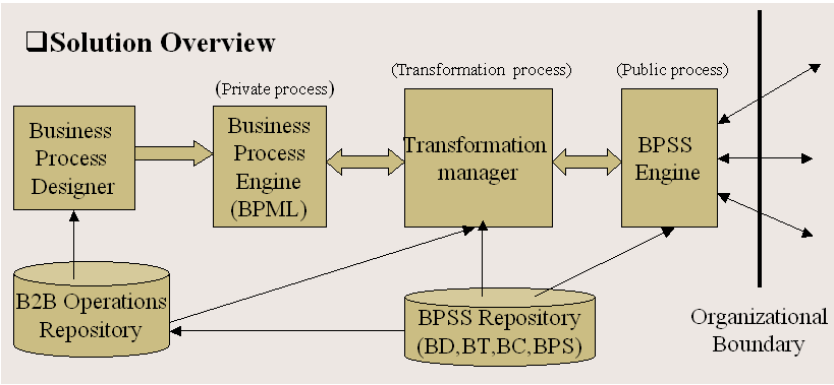

Figure 2. The solution model to integrate private and public processes.

are constructed from the predefined business process specifications in a BPSS repository.

Second, construct or modify private processes of BPML compliant by embedding B2B operations taken from the B2B operations repository when B2B interactions is needed in the definition of business processes. The B2B operations embedded in the definitions of private processes will be transmitted to the Transformation Manager. Then, through the transformation of data formats and the packaging of instance data, they are sent to the BPSS engine.

Third, extend public processes of BPSS compliant through the enhancement of the BPSS engine by adding business event handling ability to activate private processes. For instance, when an interaction occurs with private processes in order to derive a business decision, the BPSS engine would transmit the business data to the Transformation Manager through the business event handler. Then, the Transformation Manager would extract data from the business data received before sending it to the private processes. In this case, the Transformation Manager is also instructed to activate a predefined process for the business decision. Hence, from the viewpoint of private processes, there exist two kinds of messages received from the Transformation Manager; the response message and the instantiation message.

Forth, build the intermediary Transformation Manager. Similarly, from the viewpoint of the Transformation Manager, there also exist two kinds of messages received from the BPSS engine; the response message and the instantiation message. In addition, there is one message received from the BPML engine, i.e., the B2B operations message. Thus, the Transformation Manager is capable of mapping, packaging and extracting the received messages, and sending them to the BPSS or BPML engine.

4. B2B Operations and Transformation

In order to minimize manual involvement in business process design and enactment, a set of B2B operations is made available in advance in the B2B operations repository. These operations are derived from concrete public process or interaction that complies with BPSS or other B2B standards.

There are two kinds of B2B operations in the B2B operations repository: simple and complex operations. The simple operations can be associated with WSDL operations that include four atomic- transmission operations, i.e., 1) request-response operation which has both input and output messages listed in that order, 2) one-way operation which has only an input message, 3) solicit-response operation which has both output and input messages listed in that order, and 4) notification operation which has only an output message. The complex operations can be associated with WSCI interfaces that describe how WSDL operations can be choreographed in message exchange.

As mentioned before, BPML supports WSDL and

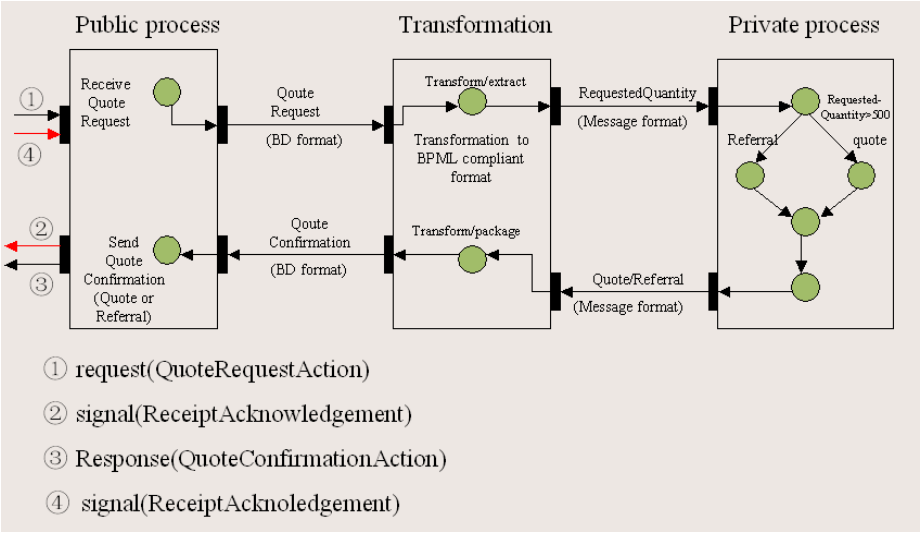

Figure 3. A scenario of B2B interactions among public processes, transformation processes and private processes.

WSCI, thus, it can also support these two kinds of B2B operations.

In fact, a B2B operation substantially represents a public implementation between business partners. When needed to define a business process that involves conversations with another organization, the designer of business processes can simply create an activity in the business process definition and make the activity bound to a predefined B2B operation in the B2B operation repository, such that we can make B2B operations embedded into private process definitions. The transformation manager deals with the mapping/packaging between B2B operations and corresponding public implementations, and the delivery/receipt from/to BPSS engine and BPML engine.

5. An Application Example of the Proposed Method

An example is given for better understanding of the proposed method. In this example, a PIP blueprint of RosettaNet is used; that is, PIP3A1 Request Quote. It is a public process that is connected to internal processes in order to derive whether to quote. The whole procedure of the scenario is depicted diagrammatically in Figure 3.

In this scenario, the DTD specified by '3A1_MS_R02_00_QuoteRequest.dtd' is used for the Quote Request document, and the DTD specified by '3A1_MS_R02_00_QuoteConfimation.dtd' is used for the Quote Confirmation document (www.rosettanet.org).

The application example of the proposed method can be implemented through the following steps:

First, the PIP3A1 is redefined in the form of the BPSS specification for the interpretation by the BPSS engine. The BPSS format of redefined PIP3A1 is given as follows:

```
<?xml version="1.0" encoding="UTF-8" ?>
<ProcessSpecification name="RN-Quote" uuid="" version="R02_00_00">
<Documentation>
Expressing simple PIP3A1 in XML against ebBPSS.
</Documentation>
-<DocumentSpecification name="3A1_MS_R02_00_QuoteRequest"
        location="http://www.rosettanet.org/.../3A1_MS_R02_00_QuoteRequest.dtd">
-<BusinessDocument name="QuoteRequest" />
-</DocumentSpecification>-
-<DocumentSpecification name="3A1_MS_R02_00_QuoteConfimation"
        location="http://www.rosettanet.org/.../3A1_MS_R02_00_QuoteConfirmation.dtd">
-<BusinessDocument name="QuoteConfirmation" />
-</DocumentSpecification>
<BusinessTransaction name="3A1_RequestQuote" isGuaranteedDeliveryRequired="false">-
<RequestingBusinessActivity name="RequestQuoteActivity"
        isNonRepudiationReceiptRequired="true"
        timeToAcknowledgeReceipt="PT2H"
        isAuthorizationRequired="true"
        isNonRepudiationRequired="true"
        isIntelligibleCheckRequired="true">
<DocumentEnvelope businessDocument="QuoteRequest"
        isAuthenticated="true"
        isConfidential="true"
        isTamperProof="true" />
</RequestingBusinessActivity>-
<RespondingBusinessActivity name="ConfirmQuoteActivity"
        isNonRepudiationReceiptRequired="true"
        timeToAcknowledgeReceipt="PT2H"
        isAuthorizationRequired="true"
        isNonRepudiationRequired="true"
```

```
        isIntelligibleCheckRequired="true">
<DocumentEnvelope businessDocument="QuoteConfirmation"
        isAuthenticated="true"
        isConfidential="true"
        isTamperProof="true">
</RespondingBusinessActivity>
</BusinessTransaction>-
<BinaryCollaboration name="Request Quote"
        timeToPerform="P24H">
<AuthorizedRole name="Buyer" />
<AuthorizedRole name="Seller" />
<BusinessTransactionActivity name="RequestQuoteBTA"
        businessTransaction="3A1_RequestQuote"
        fromAuthorizedRole="Buyer"
        toAuthorizedRole="Seller"
        isConcurrent="true"
        isLegallyBinding="true"
        timeToPerform="P24H" />
<Start toBusinessState="RequestQuoteBTA" />
<Success fromBusinessState="RequestQuoteBTA" guardCondition="Success" />
<Failure fromBusinessState="RequestQuoteBTA" guardCondition="AnyFailure " />
</BinaryCollaboration>
</ProcessSpecification>
```

Then, the redefined public process specification is registered in the BPSS repository. At the same time, the corresponding B2B operations of PIP 3A1 should be derived in the form of WDSL operations that the BPML supports (W3C, 2002), and then registered in the B2B operations repository. The B2B operations of BPML compliant are expressed as follows:

```
<wsdl:definitions>
  <wsdl:portType name="RN-Quote">
    <wsdl:operation name="3A1_RequestQuote" >
      <wsdl:output name="RequestQuoteActivity"  message="QuoteRequest"/>
      <wsdl:input name="ConfirmQuoteActivity" message="QuoteConfirmation"/>
    </wsdl:operation>
  </wsdl:portType >
</wsdl:definitions>
```

Next, we build mapping information items into a mapping table of the intermediary Transformation Manager in order to set up a relationship between BPML message elements and BPSS business document elements. In this example, 'Quote-Request' and 'QuoteConfirmation' respectively have corresponding XML DTDs provided by Rosetta-Net.org. Hence, when receiving the 'Quote- Request' from the BPSS engine, the Transformation Manager transforms the received 'QuoteRequest' business document in the format of 'http://www.rosettanet.org/.../ 3A1_MS_R02_00_Quote-Request.dtd' into the BPML message format that complies with the predefined XML schema in BPML documents. Then it extracts theitem of 'RequestedQuantity' from it. 'RequestedQuantity' is required by the internal business process engine, or alternatively, directly sent to the internal business process engine for further processing .

And then, based on the value of 'Requested-Quantity', 'Quote' or 'Referral' will be determined from the corresponding private process according to

relevant internal business rules. The result of business decision will be sent back to the Transformation Manager. The Transformation Manager packages the resultinto the BPML compliant form, i.e., the 'QuoteConfirmation' that complies with 'http://www.rosettanet.org/.../ 3A1_MS_R02_00_ Quote-Confirmation.dtd', and then transmits back to the BPSS engine.

6. Conclusion

Through the survey of the inter-organizational business process and the analysis of B2Bi related standards, e.g., BPML and BPSS, we have proposed a method of linking BPML and BPSS specifications that can be used to integrate the private process with the public process among business partners. In fact, BPML can support modeling not only the private executable abstract processes that span all business processes of an enterprise but also public interfaces to other enterprises by leveraging WSDL and WSCI. However, BPML lacks semantics about business transactions among business partners. Therefore, for the integration of public and private processes, BPML needs to combine with other B2B e-commerce standards, such as BPSS of ebXML, PIP of RosettaNet, and so on. In this method, BPSS is used to represent public processes of B2B transactions and BPML is used to represent private processes within an enterprise. We have also presented an implementation example of the method to help understanding. The basic principle of this method is to maintain the independency of existing BPML and BPSS applications and to add an intermediary transformation module between the two applications for integration.

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http://www.crossflow.org

http://www.rosettanet.org

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