Modeling and Application of Semantic Constraints for ebXML Business Process Specification

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Research Objectives

Electronic Document Standardization based on EDI

Needs for Business Process Modeling Standard for Electronic Commerce

- ebXML BPSS (Business Process Specification Schema)
  - XML-based BP Modeling

Correctness Validation of Business Process Model
- Formal Modeling and Application of BPSS Semantic Constraint
ebXML and BPSS

- **ebXML**
  - Electronic Business using eXtensible Markup Language
  - OASIS & UN/CEFACT
  - To provide global EC environment based on XML-based message exchange

- **BPSS**
  - Business Process Specification Schema
  - To specify business scenarios (BPS, Business Process Specification)
B2B Transaction based on ebXML

1. Request Business Details
2. Build Local System Implementation
3. Register Implementation Details
   - Register COMPANY A Profile
4. Download Scenarios and Profiles
5. Agree on Business Arrangement
6. DO BUSINESS TRANSACTIONS

Source: ebXML Technical Architecture Specification
Creating ebXML Business Process Specification

1. **Business Process and Information Model**
   - ebXML Metamodel
   - Semantic Subset

2. **Extract/Transfer**
   - BPS(UML)
   - BPS Transformation Rules

3. **Register**
   - BPS(XML)
   - BPSS (XML)
   - BPSS (UML)

4. **Output**
   - Standard
   - Tool
   - flow use validate

5. **Registry**

Diagram flows:
- From Business Process and Information Model to ebXML Metamodel
- From Extract/Transfer to BPS(UML)
- From BPS(UML) to BPS Transformation Rules
- From BPS Transformation Rules to BPS(XML)
- From BPS(XML) to BPSS (XML)
- From BPSS (XML) to BPSS (UML)
- From BPSS (UML) to BPSS Transformation Rules
- From BPSS Transformation Rules to ebXML Metamodel
- From ebXML Metamodel to Semantic Subset
Overall ebXML Business Process Specification Schema as UML Class Diagram
An Example of BPSS Semantic Description in Standard Document

- **Document Envelope**
  - A Document Envelope is what conveys business information between the two roles in a business transaction. ...
  - **Subtype of**
    - ......
  - **Tagged Values**
    - ......
  - **Associations**
    - ......
- **Wellformedness Rule**
  - A Document Envelope is associated with exactly one requesting and one responding activity. ....
Research Motivation

Current BPSS Standard
- UML-based BPSS
- XML-based BPSS

Informal Semantic Description

Future BPSS Standard
- UML-based BPSS
- XML-based BPSS
- OCL-based Semantic Spec.
- Schematron (or XCSL)-based Semantic Spec.

BPS Design Tool
- UML-based Tool
- XML-based Tool
- Rule-based Semantic Constraint Verifier
- Schematron (or XCSL)-based Semantic Constraint Verifier

Reference Model
- BPS Tool Developer
- BPS Designer

Equi.

Equi.

Equi.

Equi.
OCL

- UML (Unified Modeling Language)
- OCL (Object Constraint Language)
  - As business constraint modeling language by IBM
  - Used for formal representation of semantics in UML meta model

**Context** Person
inv: self.age > 0
There are 28 Wellformedness rules in ebXML BPSS formal document

[WFR 19]
- If non-repudiation is required at the requesting business activity, then there must be a responding business document

[WFR 27]
- There must be zero or one output transition to a document flow that in turn has an output transition to a requesting business activity
Classification of ebXML
BPSS Semantic Constraint

Simple constraints

Pattern matching against a regular expression

Complex constraints

Attribute value

Multiplicity of Associations

Type: SAT
Range: SAR

Minimal: SMM
Exact: SME
Maximum: SMA

Single instance’s attribute value: CAS

Multiple instances’ Attribute value: CAM

Instance cardinality

Minimal: CIM
Exact: CIE
Maximum: CIA
Non-existential: CIN
BPSS Semantic Constraint Modeling Using OCL (cont.)

[ WFR 19]
**content** RespondingBusinessActivity **inv:**
self.BusinessTransaction.RequestingBusinessActivity.isNonRepudiationRequired='true'
implies
self.DocumentEnvelope->size > 0

[ WFR 24- 1]
**content** DocumentEnvelope **inv:**
self.respondingBusinessActivity->size <= 1
[ WFR 24- 2]
**content** RequestingBusinessActivity **inv:**
self.documentEnvelope->size = 1
Application to Constraint Validation

- Rule-based Validation
  - Using CLIPS
- XML-based Validation
  - Schematron
    - An XML Structure Validation Language using Patterns in Trees
    - Rick Jelliffe, Academia Sinica Computing Centre, Taipei, 2002
- XCSL (XML Constraint Specification Language)

Constraint Specification and Process Framework in XCSL
Rule-based Validation using CLIPS

- **BPSS Class Template**
- **BPSS Rule-based Representation**
- **BPSS Semantic Constraints**
  - Simple Constraints
  - Complex Constraints
- **Common sense model**
  - Time Specification Rules
  - OCL Predefined Functions
- **Forward Inference Engine**

* BPS specific part
Class Template Example

( defeftemplate DocumentEnvelope
   ( slot id)
   ( slot isPositiveResponse)
 )

; Requesting Business Activity to Document Envelope
( defeftemplate ReqBA- DE
   ( slot ReqBA)
   ( slot DE)
 )

; Responding Business Activity to Document Envelope
( defeftemplate ResBA- DE
   ( slot ResBA)
   ( slot DE)
 )
CreateOrder: BusinessTransaction
Name: Create Order

ReqBA1
: RequestingBusinessActivity
Name: ""
isNonRepudiationRequired: true
timeToAcknowledgeRequired: P2D
timeToAcknowledgeAccepted: P1D

DE1
: DocumentEnvelope
isPositiveResponse: true

BD1
: BusinessDocument
name: PurchaseOrder

ResBA1
: RespondingBusinessActivity
Name: ""
isNonRepudiationRequired: true
timeToAcknowledgeRequired: P5D

DE2
: DocumentEnvelope
isPositiveResponse: true

BD2
: BusinessDocument
name: POAcknowledgement
<BusinessTransaction name="CreateOrder">
  <RequestingBusinessActivity name="" isNonRepudiationRequired="true"
    timeToAcknowledgeReceive="P2D"
    timeToAcknowledgeAcceptance="P1D">
    <DocumentEnvelope isPositiveResponse="true"
      businessDocument="PurchaseOrder"/>
  </RequestingBusinessActivity>
  <DocumentEnvelope isPositiveResponse="true"
    businessDocument="POAcknowledgement"/>
</BusinessTransaction>
BPS Rule-based Representation

(deffacts RequestingBusinessActivities
  (RequestingBusinessActivity (id ReqBA1)
    (name CreateOrderRequesting)
    (isNonRepudiationOfReceiptRequired true)
    (timeToAcknowledgeReceipt P2D)
    (timeToAcknowledgeAcceptance P1D) ; P3D
  )
)

......

(deffacts ResBA-DEs
  ; (ResBA-DE (ResBA BA1) (DE DE2))
)
(deffacts ReqBA-DEs
  (ReqBA-DE (ReqBA ReqBA1) (DE DE1))
  (ReqBA-DE (ReqBA ReqBA1) (DE DE2))
)

;WFR 14
(defrule checkWFR14
  (RequestingBusinessActivity (name ?name)
    (timeToAcknowledgeReceipt ?TimeToReceipt)
    (timeToAcknowledgeAcceptance ?TimeToAcceptance))
  (previous ?TimeToAcceptance ?TimeToReceipt))
=>
  (printout outfile "WFR14 Validation Error ! : RequestingBusinessActivity " ?name crlf)
)
(defrule checkWFR19
  (RespondingBusinessActivity (id ?ResBA))
  (BT- ResBA (transaction ?BT) (responder ?ResBA))
  (BT- ReqBA (transaction ?BT) (requester ?ReqBA))
  (RequestingBusinessActivity (id ?ReqBA)
    (isNonRepudiationOfReceiptRequired true))
  (not (exists (ResBA-DE (ResBA ?ResBA)))))
=>
(printout outfile "WFR19 Validation Error! :
  RespondingBusinessActivity " ?ResBA " must have a
  DocumentEnvelope." crlf)
(load "BPSSTemplate.bat")
(load "ExampleBPS.bat")
(load "BPSSRule.bat")
(reset)
(open "check.txt" outfile "w")
(run)
(close outfile)

WFR24- 2 Validation Error ! : RequestingBusinessActivity ReqBA1 has more than two DocumentEnvelope DE1, DE2
WFR19 Validation Error ! : RespondingBusinessActivity ResBA1 must have a DocumentEnvelope.
WFR14 Validation Error ! : RequestingBusinessActivity CreateOrderRequesting TimeToReceipt P2D is not previous TimeToAcceptance P1D
<schema xmlns="http://www.ascc.net/xml/schematron">
  <pattern name="WFR19">
    <rule context="// BusinessTransaction">
      <assert test="RequestingBusinessActivity/@isNonRepudiationRequired and RespondingBusinessActivity/DocumentEnvelope">
        This BPS violates WFR19 (If non-repudiation is required at the requesting business activity, then there must be a responding business document.)
      </assert>
    </rule>
  </pattern>
  <pattern name="WFR24">
    <rule context="// BusinessTransaction/RequestingBusinessActivity">
      <assert test="count(DocumentEnvelope)=1">
        This BPS violates WFR24 (There must be one output document flow from a requesting business activity that in turn is the input to a responding business activity.)
      </assert>
    </rule>
  </pattern>
</schema>
Constraint Validation using Schematron

Schematron Report

WFR19

This BPS violates WFR19 (if non-repudiation is required at the requesting business activity, then there must be a responding business document.)

```xml
<ProcessSpecification>
  <BusinessTransaction name="CreateOrder">
    <RequestingBusinessActivity name="RequestOrder"/>
    <DocumentEnvelope />
    <RespondingBusinessActivity name="RespondOrder">
      <DocumentEnvelope />
    </RespondingBusinessActivity>
  </BusinessTransaction>
</ProcessSpecification>
```

WFR24

This BPS violates WFR24 (There must be one output document flow from a requesting business activity that in turn is the input to a responding business activity.)

```xml
<ProcessSpecification>
  <BusinessTransaction name="CreateOrder">
    <RequestingBusinessActivity name="CreateOrder"/>
    <DocumentEnvelope />
    <RespondingBusinessActivity name="RespondOrder">
      <DocumentEnvelope />
    </RespondingBusinessActivity>
  </BusinessTransaction>
</ProcessSpecification>
```
Conclusion

- ebXML BPSS semantic specification using OCL
- BPS correctness validation using CLIPS
  - Validation using Schematron
- Further research issues
  - Identification and specification of other constraints which are not included in current Well-Formed Rules.
  - Automatic translation among OCL representation, CLIPS specification, XML constraint language specification