BPMN 2.0 HANDBOOK SECOND EDITION

Robert Shapiro, Stephen A. White PhD, Conrad Bock, Nathaniel Palmer, Michael zur Muehlen PhD, Prof. Marco Brambilla, Denis Gagné et al.

Foreword by Dr. Bruce Silver

Published in collaboration with the Workflow Management Coalition (WfMC)

This book is for business people who want to understand the why and how of BPMN 2.0 in simple, non-legal terms and the strategy and motivation for its adoption within the corporation. It is also for the technical practitioner seeking current insights into the BPMN 2.0 standard and how to take advantage of its powerful capabilities.

BPMN 2.0 Handbook Second Edition assembles industry leading strategies, case studies, and best practices. Following the groundbreaking body of work in the BPMN 2.0 Handbook First Edition, this book is greatly expanded with substantial new content and chapters updated to the latest advances in this important standard.

The authors explore a variety of aspects that, start with an introduction of what, new and updated in BPMN and end with the business imperative for widespread adoption of the standard by examining BPMN 2.0 and look closely at new components and practices aspects of making BPMN models consumable and the basic uses.
BPMN 2.0 Handbook
Second Edition: Updated and Expanded
Methods, Concepts, Case Studies and Standards
in Business Process Modeling Notation (BPMN)

Foreword by
Dr. Bruce Silver

Published in association with the Workflow Management Coalition

Workflow Management Coalition

18 Years of Thought-Process Leadership

Edited by
Layna Fischer

Future Strategies Inc., Book Division
Lighthouse Point, Florida
Reference Guide—XPDL 2.2: 
Incorporating BPMN 2.0 Process Modeling Extensions\(^1\)

Robert M. Shapiro, WfMC Chair Technical Committee, USA

**INTRODUCTION**

In June 2009 the OMG\(^2\) voted to adopt the BPMN 2.0 specification which then entered the Finalization Task Force (FTF) phase. At that time the WfMC\(^3\) initiated work revising XPDL2.1. The new version, XPDL2.2, is described in this paper.

As of March 1, 2010 the FTF was still hard at work. Many issues in BPMN2.0 remain unresolved. If the FTF completes its task in June, the original objective, it will do so only by deferring a large number of issues. The principle reason for this is that many new ideas were introduced that extend or change what was in the previous version, BPMN1.2.

XPDL2.2 is intended as a preliminary release which supports the graphical extensions to process modeling contained in BPMN2.0. In fact, the BPMN specification addresses four different areas of modeling, referred to as:

- Process Modeling
- Process Execution
- BPEL Process Execution
- Choreography Modeling

We focus only on Process Modeling. Within that we define several sub-classes to support process interchange between tools. This is discussed in a later section of this paper.

For a review of XPDL we refer the reader to a prior paper which describes the historical development of XPDL and a review of the major elements in XPDL2.1\(^4\). Here we discuss significant additions in XPDL2.2.

Another part of the process interchange story is the serialization of a process diagram, which is used to persist a process model and to transport it to other tools. XPDL has been used for this purpose and XPDL2.1 is the only standardized way of serializing earlier versions of BPMN\(^5\). The OMG is committed to providing a serialization of BPMN2.0, but the draft specification contains a serialization only for the semantic portion of the specification; the graphical aspects of diagram inter-
change are being worked on by the Diagram Interchange subgroup of the FTF. We return to this topic in a later section of this paper.

OVERVIEW OF ADDITIONS AND CHANGES

In the next sections we discuss changes in the following areas:

• Pools and Lanes
• Call Activity/Re-usable Sub-Process
• Event Sub-Process
• Event Types
• Data Objects, Data Flow and Input/Output Specifications

For a complete description of BPMN2.0 refer to the OMG specification⁶. For a complete description of XPDL2.2 refer to the WfMC specification⁷.

POOLS AND LANES

In prior versions of BPMN all the process modeling elements pertaining to flow, i.e. Activities, Gateways, Events and SequenceFlow, were always contained in a Pool. All the flow elements in a Pool were part of the same process. Multiple processes were depicted using multiple pools. Message communication between processes was depicted by message flow between Pools. The Pool boundary was optional for a single Pool in the diagram. Lanes were a way of subdividing Pools.

In BPMN2.0 a distinction is made between Collaboration diagrams and Process diagrams. A Collaboration diagram involves two or more Pools with Message flow between them. A Process diagram has no Pool. To support the Lane construct, a new element, LaneSet, was introduced. The Lane structure is contained in LaneSet. Both Pool and Process may have LaneSets.

Eliminating Pool from a process diagram creates an inconsistency between prior versions of BPMN and BPMN2.0 with little apparent benefit. Consequently in XPDL2.2 we retain the idea of a background Pool for a single process with no pool border displayed. Lanes remain a way of subdividing Pools.

CALL ACTIVITY/RE-USABLE SUB-PROCESS

BPMN2.0 introduces a graphical distinction between embedded Sub-Process and Re-Usable Sub-Process which is incorporated in XPDL2.2. However, the manner in which input and output parameters are passed between the caller process and the called process remains complicated and confusing. XPDL retains the mechanisms provided for accomplishing this: providing conventional parameter lists (actual and formal parameters) as well as straightforward data mapping between data fields in the two processes upon entry and exit.

EVENT SUB-PROCESS

An Event Sub-Process is similar to an Embedded Sub-Process. It shares the data environment of the Process or Sub-Process in which it is defined. The instantiation is different. Instead of being instantiated by a SequenceFlow, it is triggered by an Event. In XPDL both Event and Embedded Sub-Process are defined by Activity Sets within a Process. An Embedded Sub-Process is instantiated by execution of a Block Activity in the Sequence flow of the containing Process, whereas the Event

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⁶ OMG, BPMN (version 2.0 – June, 2009)
⁷ WfMC, XPDL 2.2 WFMC-TC-1025 (Version 1.0 April 2009)
Sub-Process is triggered by an Event. An attribute of Activity Set ‘TriggeredByEvent’ distinguishes between Event and Embedded.

**EVENT TYPES**

Event Types in BPMN2.0 are more complex for three reasons:

- Support for both interrupting and non-interrupting Events.
- Introduction of the Event Sub-Process.

Changes in XPDL to support this are minimal:

- A new attribute ‘Interrupting’ with a default value ‘true’ for the appropriate Start and Intermediate Events.
- Addition of Escalation Event for:
  - Interrupting or non-interrupting Start Event in Event Sub-Process.
  - Interrupting or non-interrupting Boundary Intermediate Event.
  - Intermediate or End Throw Event

The following chart (from the specification) portrays all the Event types and the contexts in which they may occur.

<table>
<thead>
<tr>
<th>Types</th>
<th>Start Intermediate</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top-Level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Event Sub-Process</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interrupting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Event Non-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interrupting</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escalation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parallel Multiple</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Data Objects, Data Flow and Input/Output Specifications**

Data and data flow, as represented in the diagram by the *data object* shape and *association*, were classified in BPMN 1.x as *artifacts*, meaning essentially annotations of the diagram with no defined semantics.

That has all changed in BPMN 2.0. Data has been elevated to a first-class semantic element. A data object, together with a handful of other types of *data-aware elements*, now signifies a *process variable*, defined with a specific schema. It is no longer connected to flow elements by a regular association, which still just applies to artifacts, but with a new type of connector, a *data association*. The details of the data association actually define the mapping of data from one flow element to the next.

The *data object* is the primary construct for modeling data within a process. Each data object is contained within a specific process or subprocess element, and its lifetime and visibility are constrained within that element. In other words, a data object could represent a *global variable* for the process or a *local variable* for a particular activity. The lifetime of a data object is limited to the lifetime of the process or activity instance.

A data object representing a *collection* of variables is depicted in the diagram with the multi-instance marker. A *data store* represents a data structure that the process can read or write but which persists beyond the lifetime of the process.

Processes, tasks, and global tasks specify their input and output parameters, or data requirements, as *data inputs* and *data outputs*. A data input represents information needed to start an activity, and each data input can be defined as required or optional; it cannot have incoming data associations. If a required data input is unavailable when a process or task is invoked, start is delayed until that data input becomes available. A data output represents information that may be output from an activity; it cannot have outgoing data associations.

**Data input (left) and data output (right)**

The collection of data inputs and data outputs required by a particular activity is called an *inputSet* and *outputSet*, respectively, and together these comprise the *ioSpecification* for the activity or process. It is possible to define multiple inputSets and outputSets, in which case the implementation determines which ones apply.

A *data association*, depicted in the diagram using the dotted line connector, represents a mapping between a data object, property, or data store (i.e., persisted data) on one end and a data input or data output (i.e., parameter) on the other end. A data association connected to an activity or event in the process diagram represents a visual shorthand for connection to the data input or output of that activity.

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8 This section is taken from BPMN Method and Style, Bruce Silver 2009
or event. Activities have two types of data association, *dataInputAssociation* and *dataOutputAssociation*, respectively. A catching or throwing event has only one, as appropriate.

A data association defines a *source* and a *target*, and optionally a *transformation*. When a data association is executed, data is copied from the source to the target, and possibly transformed in the process.

The example shown above illustrates the use of data objects and data associations in executable BPMN.

For non-executable modeling,
- Data Input and Data Output are typically omitted from the model.
- Data Object is used in the same way as the Data Object artifact of XPDL2.1.
- DataStore is used to graphically emphasize **persistent data**.

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The meta-model depicts the relationships between all the elements in a Process. The shaded elements represent new graphical elements added to XPDL.
This meta-model describes the relationship between elements on the Package or Business Process Diagram level. The shaded elements represent new graphical elements added to XPDL.

**PROCESS INTERCHANGE**

Common meta-model allows tools to exchange models

Type of tools:
- Simulation tools
- Monitoring tools
- Execution tools
- Modeling tools
- Repository tools

The following diagram illustrates the use of process interchange in a BPM suite.
**BPMN Model Portability Conformance**

BPMN can be used for both “abstract” activity flow modeling and for complete executable design. Many tools, however, make use of BPMN for the abstract modeling but add executable detail in tool-specific activity properties. One goal of XPDL 2.2 is to promote portability of abstract activity flow models between tools. This requires separating the elements and attributes of BPMN related to activity flow modeling from those related to executable design. The BPMN2.0 spec does not define this separation, but a proposal being considered by the OMG BPMN2.0 Finalization Task Force would add Conformance sub-classes for this. XPDL2.1 did this, in the form of BPMN Model Portability conformance classes. XPDL2.2 modifies and extends the conformance classes.

In broad terms, the “abstract model” elements are those that represent BPMN constructs that are printable in the business process diagram, such as those defining the flow object type or subtype (e.g., looping User task, collapsed subprocess, exclusive gateway, timer event), including only attributes specifying the subtype, label (Name attribute), and unique identifiers for the object itself and pointers to other identifiers in the diagram. Elements and attributes representing data, messages, or other implementation detail are omitted from the abstract process model. In other words, the model describes the "what" and the "when" of process activity flow, but not the "how" of flow object implementation.

There are three conformance sub-classes defined:

- SIMPLE
- DESCRIPTIVE
- ANALYTIC

SIMPLE is contained in DESCRIPTIVE, which is, in turn, contained in ANALYTIC.
## SIMPLE

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>sequenceFlow (unconditional)</td>
<td>id, name, sourceRef, targetRef</td>
</tr>
<tr>
<td>task (None)</td>
<td>id, name</td>
</tr>
<tr>
<td>subProcess (expanded)</td>
<td>id, name, flowElement</td>
</tr>
<tr>
<td>subProcess (collapsed)</td>
<td>id, name, flowElement</td>
</tr>
<tr>
<td>exclusiveGateway</td>
<td>id, name</td>
</tr>
<tr>
<td>parallelGateway</td>
<td>id, name</td>
</tr>
<tr>
<td>startEvent (None)</td>
<td>id, name</td>
</tr>
<tr>
<td>endEvent (None)</td>
<td>id, name</td>
</tr>
</tbody>
</table>

## DESCRIPTIVE

All the elements in SIMPLE plus:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>participant (pool)</td>
<td>id, name, processRef</td>
</tr>
<tr>
<td>laneSet</td>
<td>id, name, partitionElement, childLaneSet, flowElementRef</td>
</tr>
<tr>
<td>messageFlow</td>
<td>id, name, sourceRef, targetRef</td>
</tr>
<tr>
<td>userTask</td>
<td>id, name</td>
</tr>
<tr>
<td>serviceTask</td>
<td>id, name</td>
</tr>
<tr>
<td>callActivity</td>
<td>id, name, calledElement</td>
</tr>
<tr>
<td>dataObject</td>
<td>id, name</td>
</tr>
</tbody>
</table>
**textAnnotation** | id, text
---|---
**association/dataAssociation** | id, name, sourceRef, targetRef, associationDirection*
**dataStoreReference** | id, name, dataStoreRef
**messageStartEvent** | id, name, messageEventDefinition
**messageEndEvent** | id, name, messageEventDefinition
**timerStartEvent** | id, name, timerEventDefinition
**terminateEndEvent** | id, name, terminateEventDefinition

*associationDirection* not specified for dataAssociation

**ANALYTIC**

All the elements in **DESCRIPTIVE** plus:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>sequenceFlow (conditional)</td>
<td>id, name, sourceRef, targetRef, conditionExpression*</td>
</tr>
<tr>
<td>sequenceFlow (default)</td>
<td>id, name, sourceRef, targetRef, default**</td>
</tr>
<tr>
<td>sendTask</td>
<td>id, name</td>
</tr>
<tr>
<td>receiveTask</td>
<td>id, name</td>
</tr>
<tr>
<td>Looping Activity</td>
<td>standardLoopCharacteristics</td>
</tr>
<tr>
<td>MultiInstance Activity</td>
<td>multiInstanceLoopCharacteristics</td>
</tr>
<tr>
<td>exclusiveGateway</td>
<td>Add default attribute</td>
</tr>
<tr>
<td>inclusiveGateway</td>
<td>id, name, eventGatewayType</td>
</tr>
<tr>
<td>eventBasedGateway</td>
<td>id, name, eventGatewayType</td>
</tr>
<tr>
<td>signalStartEvent</td>
<td>id, name, signalEventDefinition</td>
</tr>
<tr>
<td>signalEndEvent</td>
<td>id, name, signalEventDefinition</td>
</tr>
<tr>
<td>Catching message IE***</td>
<td>id, name, messageEventDefinition</td>
</tr>
<tr>
<td>Throwing message IE</td>
<td>id, name, messageEventDefinition</td>
</tr>
<tr>
<td>Boundary message IE</td>
<td>id, name, attachedToRef, timerEventDefinition</td>
</tr>
<tr>
<td>Non-int Boundary message IE</td>
<td>id, name, attachedToRef, cancelActivity=false, messageEventDefinition</td>
</tr>
<tr>
<td>Catching time rIE</td>
<td>id, name, timerEventDefinition</td>
</tr>
<tr>
<td>Boundary timer IE</td>
<td>id, name, attachedToRef, timerEventDefinition</td>
</tr>
<tr>
<td>Non-int**** Boundary timer IE</td>
<td>id, name, attachedToRef, cancelActivity=false, timerEventDefinition</td>
</tr>
<tr>
<td>Boundary error IE</td>
<td>id, name, attachedToRef, errorEventDefinition</td>
</tr>
<tr>
<td>errorEndEvent</td>
<td>id, name, errorEventDefinition</td>
</tr>
<tr>
<td>Non-int Boundary escalation IE</td>
<td>id, name, attachedToRef, cancelActivity=false, escalationEventDefinition</td>
</tr>
<tr>
<td>Throwing escalation IE</td>
<td>id, name, escalationEventDefinition</td>
</tr>
<tr>
<td>escalationEndEvent</td>
<td>id, name, escalationEventDefinition</td>
</tr>
<tr>
<td>Catching signal IE</td>
<td>id, name, signalEventDefinition</td>
</tr>
<tr>
<td>Event Type</td>
<td>Attributes</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Throwing signal IE</td>
<td>id, name, signalEventDefinition</td>
</tr>
<tr>
<td>Boundary signal IE</td>
<td>id, name, attachedToRef, signalEventDefinition</td>
</tr>
<tr>
<td>Non-int Boundary signal IE</td>
<td>id, name, attachedToRef, cancelActivity=false, signalEventDefinition</td>
</tr>
<tr>
<td>conditionalStartEvent</td>
<td>id, name, conditionalEventDefinition</td>
</tr>
<tr>
<td>Catching conditional IE</td>
<td>id, name, conditionalEventDefinition</td>
</tr>
<tr>
<td>Boundary conditional IE</td>
<td>id, name, conditionalEventDefinition</td>
</tr>
<tr>
<td>Non-int Boundary conditional IE</td>
<td>id, name, cancelActivity=false, conditionalEventDefinition</td>
</tr>
<tr>
<td>message</td>
<td>id, name</td>
</tr>
</tbody>
</table>

* conditionExpression allowed only for sequenceFlow out of gateways, may be null.
**default is an attribute of a sourceRef (exclusive or inclusive) DecisionGateway.
***IE= intermediateEvent
****Non-int=nonInterrupting

For a tool to claim support for a sub-class the following criteria must be satisfied:
- All the elements in the sub-class must be supported.
- For each element, all the listed attributes must be supported.

The tool must be able to read and write syntactically correct serializations that include any other elements and attributes. In particular, if a tool reads in such a serialization and edits it, when writing it out all elements and attributes not in the supported sub-class must also be written out.

**Simple Persona**

A common situation for use of the SIMPLE class is *process capture*.
- A business analyst is sitting in a room with a group of process owners.
- The session is attempting to map out a currently deployed set of processes that have never been suitably documented.
- Technology for such a session may range from a low-tech whiteboard to a laptop and projector.
- A process map is drawn by the business analyst as the process owners describe their operations step by step.
**SIMPLE Example**

**Descriptive Persona**
A common situation for use of the descriptive class is fleshing out the details omitted in a process capture session.

Using elements familiar from traditional flowcharting, the business modeler

- extends the routing logic to include the more critical exceptions (such as time-outs) and special cases,
- adds information about resource or role requirements for performing activities,
- adds some basic information about data flow
- and provides an overview of communications between participants/processes pertaining to the start and end of processes.
**CONCLUSION**

XPDL 2.2 provides a standard graphical approach to Business Process Definition based on BPMN graphics. XPDL 2.2 provides a standard file format for persisting BPMN diagrams and interchanging Process definitions. The file format is based on the WfMC meta-model which establishes a framework for defining, importing and exporting process definitions for numerous products including execution engines, simulators, BPA modeling tools, Business Activity Monitoring and reporting tools. The schema defining the format is extensible and provides vendor and user extension capabilities as well as a natural path for future versions of the standard. Mappings to specific execution languages (e.g. BPEL) and other XML-based specifications (e.g. ebXML) are possible. Finally, BPMN Model Portability conformance classes greatly increase the likelihood of true portability at the design level among a significant number of different vendor tools.
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- BPM and Workflow online news, research, forums
  http://bpm.com

- BPM Research at Stevens Institute of Technology
  http://www.bpm-research.com

- Business Process Management Initiative
  http://www.bpmi.org see Object Management Group

- IEEE (Electrical and Electronics Engineers, Inc.)
  http://www.ieee.org

- Institute for Information Management (IIM)
  http://www.iim.org

- ISO (International Organization for Standardization)
  http://www.iso.ch

- Object Management Group
  http://www.omg.org

- Open Document Management Association
  http://nfocentrale.net/dmware

- Organization for the Advancement of Structured Information Standards
  http://www.oasis-open.org

- Society for Human Resource Management
  http://www.shrm.org

- Society for Information Management
  http://www.simnet.org

- Wesley J. Howe School of Technology Management
  http://howe.stevens.edu/research/research-centers/business-process-innovation

- Workflow And Reengineering International Association (WARIA)
  http://www.waria.com

- Workflow Management Coalition (WFMC)
  http://www.wfmc.org

- Workflow Portal
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Robert Shapiro, Stephen A. White PhD., Nathaniel Palmer, Michael zur Muehlen PhD., Thomas Allweyer, Denis Gagné et al

Authored by members of WfMC, OMG and other key participants in the development of BPMN 2.0, the BPMN 2.0 Handbook brings together worldwide thought-leaders and experts in this space. Exclusive and unique contributions examine a variety of aspects that start with an introduction of what’s new in BPMN 2.0, and look closely at interchange, analytics, conformance, optimization, simulation and more. **Retail $75.00**

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Keith D. Swenson, Nathaniel Palmer, Sandy Kemsley, Keith Harrison-Broninski, Max Pucher, Manoj Das, et al

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Keith D Swenson, Nathaniel Palmer, Bruce Silver, et al with foreword by Thomas Koulopoulos

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