# Implementation of WPDL Conforming Workflow Model*

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**Abstract:** Workflow Process Definition Language (WPDL) facilitates the transfer of workflow process definitions between separate workflow products. However, much work is still needed to transfer the specific workflow model to a WPDL conforming model. CIMFlow is a workflow management system developed by the National CIMS Engineering Research Center. This paper discusses the methods by which the CIMFlow model conforms to the WPDL meta-model and the differences between the WPDL meta-model and the CIMFlow model. Some improvements are proposed for the WPDL specification. Finally, the mapping and translating methods between the entities and attributes are given for the two models. The proposed methods and improvements are valuable as a reference for other mapping applications and the WPDL specification.

**Keywords:** workflow process definition language; meta-model; workflow management systems; interface; process definition

## Introduction

Workflow Management Systems (WFMS) are a rapidly evolving class of software products being increasingly used by businesses in a variety of industries with a great variety of workflow management products. For any particular application domain, many different tools may be used to analyze, model and document the business process. To facilitate the integration requirements

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resulting from product specialization and market variety, the Workflow Management Coalition (WFMC) has identified 5 functional interfaces for a workflow service as part of its standardization program. Among these interfaces, Interface 1 is focused on defining the model specifications supporting process definition import and export.

The workflow process definition interface is used to define a common interchange format that supports the transfer of workflow process definitions between separate products. The principles of process definition interchange are illustrated in Fig. 1. Interface 1 includes a common meta-model for describing the process definition, a textual grammar for the interchange of process definitions (WPDL), and APIs for the manipulation of process definition data[1]. Interface 1 also defines a formal separation between the development and run-time environments, thus enabling the process definition generated by one modeling tool to be used as input to a number of different workflow run-time products. This format best meets the user's requirements for the independence of modeling and workflow run-time products.

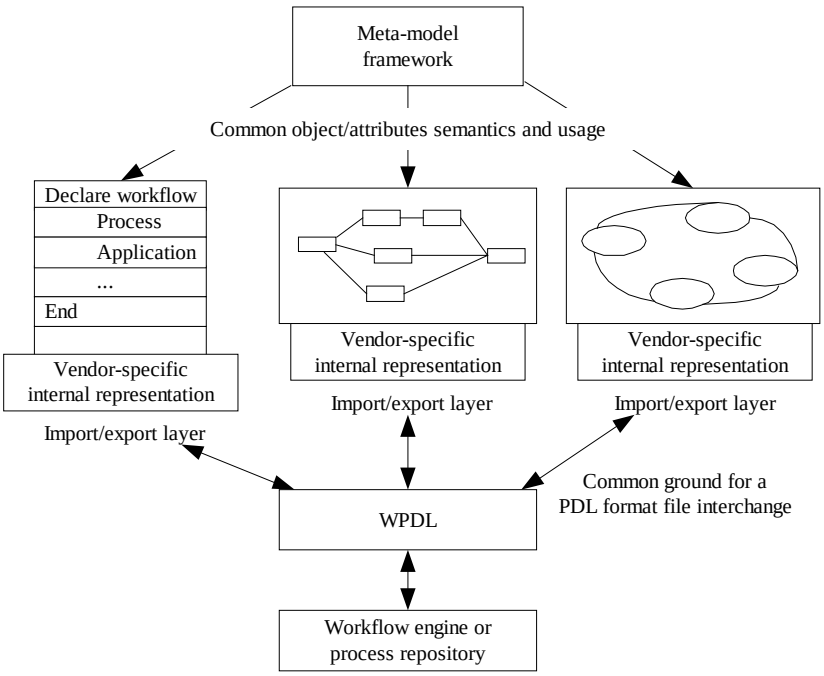

Fig. 1 Process definition interchange concept

CIMFlow is a workflow management system developed by the National CIMS Engineering Research Center as a software product to support implementation of business process management and reengineering. The CIMFlow model design references the common meta-model supported by WPDL. However, because the CIMFlow model is designed to meet the requirements of actual business process management and control of modern enterprises, there are many differences between the two models. To conform to the standards, the CIMFlow modeling tool includes interchange functions between the CIMFlow model and the common meta-model supported by WPDL. Thus, the workflow model built by CIMFlow is compatible with models built by other WPDL conforming modeling tools and can be easily used by workflow run-time products and BPR tools. The implementation will be described in the following sections with some proposed improvements to the WPDL specification.

# 1 WPDL Meta-Model and CIMFlow Model

## 1.1 WPDL meta-model

A workflow process definition meta-model was established to provide a common method to access and describe workflow definitions. The meta-model describes the top-level entities contained within a workflow process definition, their relationships and their attributes. The meta-model also defines various conventions for grouping process definitions into related process models and the use of common definition data across a number of different process definitions or models. The WPDL grammar is directly related to these objects and attributes. The top-level entities are shown in Fig. 2. The important entities are described here.

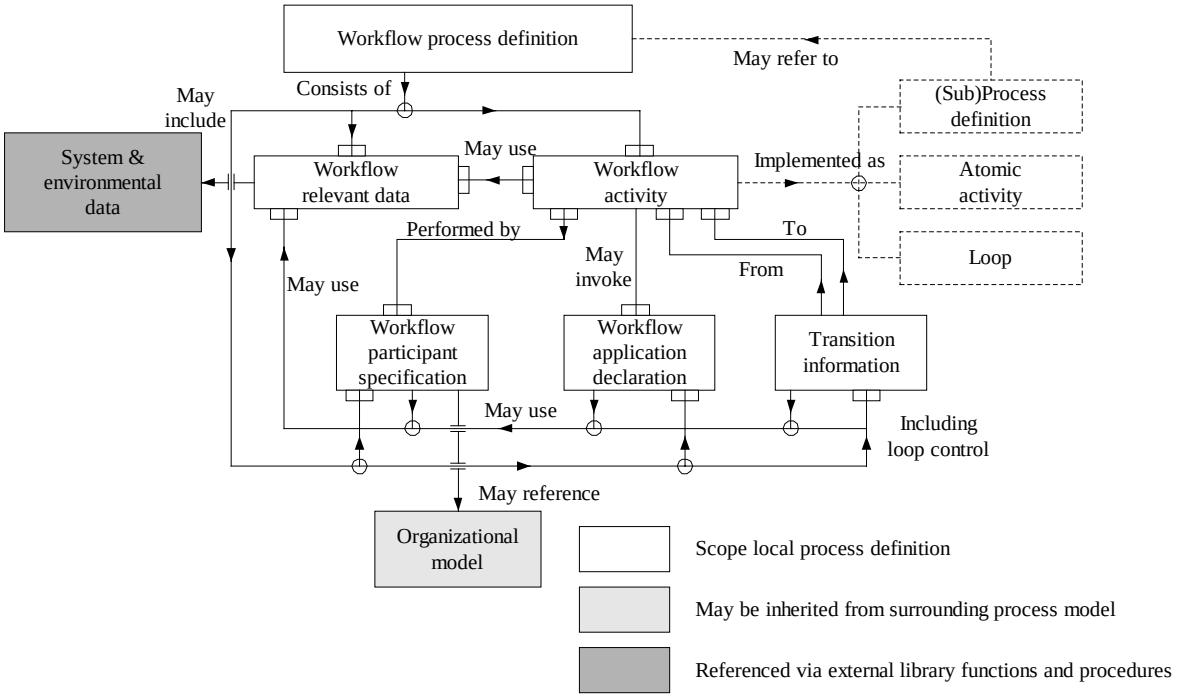


Fig. 2 Meta-model top-level entities

- Workflow process definition

This describes the process itself with an ID and textual description, and other optional information associated with the process.

- Workflow process activity

A process definition consists of one or more activities, each comprising a logical, self-contained work unit within the process definition. An activity represents a piece of work that will be processed by a combination of resources and/or computer applications. An activity may be atomic, which is the smallest self-contained work or sub-flow unit which in this case is a container for the execution of a process definition.

- Transition information

Activities are related to one another via flow control conditions which are transition information. Each individual transition has three elementary properties, the from-activity, the to-activity and the

condition under which the transition is made.

- Workflow participant declaration

This provides descriptions of resources that can perform the various activities in the process definition.

- Workflow application declaration

This provides descriptions of the IT applications which may be invoked by the workflow service to support, or wholly automate, the processing associated with each activity. The descriptions are identified within the activity by application assignment attributes.

- Workflow relevant data

This defines the data that is created and used within each process instance during process execution.

## 1.2 CIMFlow model

CIMFlow modeling tool provides a graphical interface to help users easily and quickly develop their workflow model. The CIMFlow model framework and the internal structure of the CIMFlow activity are depicted in Fig. 3 and Fig. 4. The elements in the CIMFlow modeling tool can be classified into two categories as nodes and directional arcs. These two kinds of elements represent the basic activities and the relationships between activities in the business process. The node stands for an executable activity that can run automatically or manually. The directional arc from one node to another represents the execution sequence and the relationship between the two activities. Completeness and correctness of the model requires subdivisions of the two primary elements. The node elements are classified into manual activities, automatic activities,

sub-processes, start marks, end marks, synchronization marks and nop marks. The directional arcs are classified into non-conditional links, conditional links and data links. These elements are described as follows:

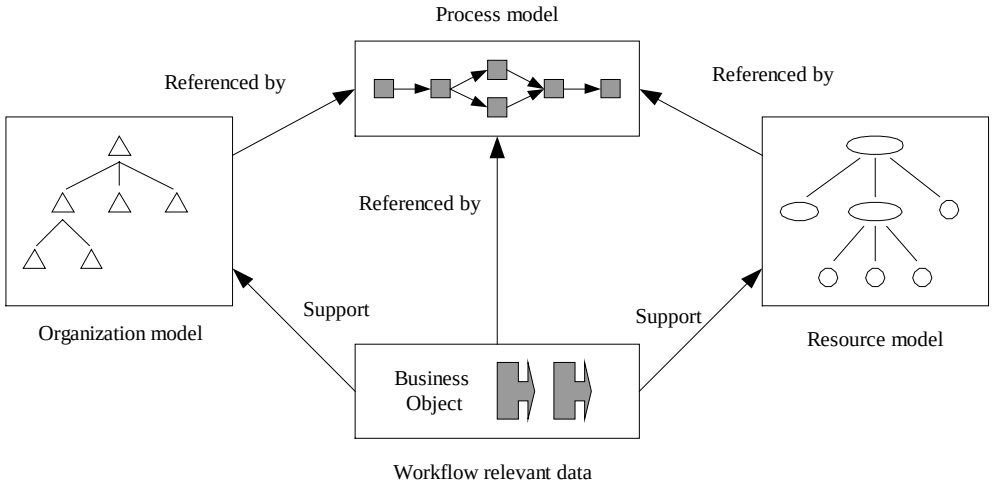


Fig. 3 CIMFlow model framework

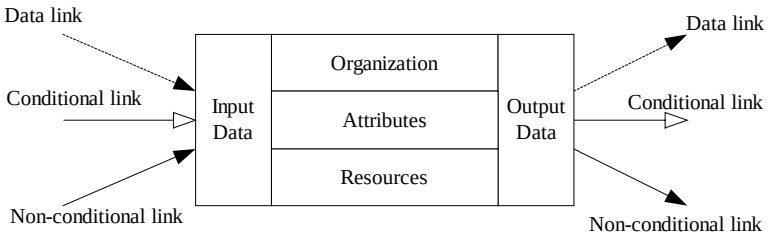


Fig. 4 Internal CIMFlow activity structure

- Manual activity

A task performed by the participants assigned to complete the task in a continuous period of time. The manual activity is the basic model unit with the attributes of priority, model status, time configuration, condition configuration, role list, resource list, and so on.

- Automatic activity

A task performed by IT applications assigned to automatically perform the task. The attributes

include the application name and a parameters list.

- Sub-process

A compound task consists of a set of activities as well as other sub-processes. The sub-process provides a mechanism for building a hierarchical workflow model and supports the top-down modeling process.

- Start mark (End mark)

A mark serving as the entry (exit) point of the model or sub-process.

- Synchronization mark

A mark implementing the "AND" function which requires that all of its preceding activities be finished before activating its subsequent activities.

- Nop mark

A routing mark without any actual function.

- Non-conditional link

An arc without any transition condition which is a simple sequential relationship.

- Conditional link

An arc with a transition function that can return values of "True" and "False". The transition is enabled only when the function returns "True". The condition of expression is defined in its attributes.

- Data link

A link to enable data flow between two entities that have no direct sequential relationship in the model.

## 1.3 Differences between two models

The differences between the CIMFlow model and the WPDL meta-model are:

- Some attributes in the CIMFlow model are not defined in the WPDL meta-model, so some extended attributes must be defined.
- The content in the two models is represented in different ways, for example, the activity definition methods differ, so a translation methodology is needed.
- In the WPDL meta-model, the workflow relevant data is defined as process global data, with no data flow described in a sub-process. In the CIMFlow model, workflow relevant data is described as data flow for the attributes, as each activity through the input and output data lists. The CIMFlow model also includes global data for the whole model and every sub-process.
- In the WPDL meta-model, the performers and resources to execute a particular activity are defined together as participants, but in the CIMFlow model, performers and resources are defined separately in the organization model and the resource model.

# 2 WPDL Specification Improvements

This section describes some inconsistencies in the WPDL grammar definition and proposes some modifications to the WPDL specifications. In the grammar to define formal parameters used in the attribute sequence in the workflow process definition and workflow application, the generic form of formal parameters is defined as:

<formal parameters> ::=

[IN_PARAMETERS <parameter list>]

//call input parameters (1)

[OUT_PARAMETERS <parameter list>]

//call output parameters (2)

<parameter list> ::= <parameter> [<parameter list>]

<parameter> ::= <data id> // workflow relevant data

In this definition, the formal parameter is defined as a particular piece of data in the workflow relevant data. However, in general, a formal parameter is a data type, not a particular piece of data. Only after the formal-actual parameter mapping is the actual parameter that is a particular piece of data used in an instance of the application or process.

This inconsistency is also found in an example in the WFMC document [6]. In the example, the formal parameters are fixed to a particular piece of data in the workflow relevant data when the workflow application is declared with no formal-actual parameter mapping for usage of the instance of workflow application in activities to which the application is designated.

The inconsistency can be corrected by defining a new data type. The WPDL grammar has a complex data type which contains the common complex data type and workflow relevant types. This definition can be used to define the generic form of formal parameters as:

<formal parameters> ::=

[IN_PARAMETERS <parameter list>]

//call input parameters (1)

[OUT_PARAMETERS <parameter list>]

//call output parameters (2)

<parameter list> ::= <parameter> [<parameter list>]

<parameter> ::=

PARAMETER

[NAME <name>]

[DESCRIPTION <description>]

TYPE <complex data type>

[LENGTH <cardinal>]

[<extended attribute list>]

END_PARAMETER

# 3 Implementation

Because of the differences between the two models, the most important challenges in the implementation lie in mapping and translating the entities and attributes. The modified data type can be used to implement mapping and translation of the entities and attributes between the CIMFlow and the WPDL meta-model. This section introduces the mapping of process and activity definitions.

## 3.1 Workflow process definition attributes mapping

Workflow process definition attributes mapping is depicted in Table 1 including the domain attribute. In the Computer Integrated Manufacture Open System Architecture (CIMOSA), the function view reflects the functional structure that includes domain, domain process, business process and enterprise activity. Domain is an important concept in CIMOSA which represents new enterprise organizations that are customer and market oriented. Different domains will fulfill different goals and will coordinate with each other through events and messages. The domain

attribute enables the workflow model to bind each run-time workflow engine with the proper function domain.

Table 1 Workflow process definition attributes mapping

| CIMFlow model process attribute | WPDL workflow process definition header attribute | Description |
|---|---|---|
| ID | Process ID | Workflow process attribute |
| Create time | Creation date | |
| Name | Name | |
| Description | Description | |
| Author | Author | |
| Version | Version | |
| Modify time | | An extended attribute, date type |
| Domain | | An extended attribute, string type |
| Parameters | Formal parameters | Defined with the modified generic form of formal parameters |

In the CIMFlow model, the input list attributes of start mark and the output list attributes of end mark in a sub-process define parameters used in the sub-process. So, the input list attributes of start mark and the output list attributes of end mark in a sub-process will be mapped to the formal parameters attribute of the workflow process definition of the WPDL meta-model.

## 3.2 Activity attributes mapping

Each type of extended node in the CIMFlow model has a special activity type information

definition. The WPDL forms of the definition are depicted in Table 2. In the activity type information definition of a sub-process, the parameter map list attribute will realize the mapping of formal to actual parameters during invocation of the model.

Table 2 WPDL forms for activity type information definition

| Extended node type | WPDL form of definition | Description |
|---|---|---|
| Sub-process | IMPLEMENTATION<br>WORKFLOW<br>SYNCHR id [<parameter map list>] | ID referring to the process ID attribute in the workflow process definition |
| Manual activity | IMPLEMENTATION NO<br>PERFORMER<br>performerlist<br>PRIORITY priority | Performerlist is a expression containing the roles and resources assigned to an activity |
| Automatic activity | IMPLEMENTATION<br>APPLICATIONS id [<parameter map list>] | ID refer to the generic tool ID attribute in the workflow application list |
| Start mark | ROUTE | |
| End mark | ROUTE | |
| Synchronization mark | ROUTE<br>JOIN AND | Enable the synchronization function |
| Nop mark | ROUTE | |

## 3.3 Other attributes mapping

The attributes of the workflow model, transition information, workflow relevant data, workflow participant specification and workflow application definition in the two models are similar, so these attributes can be mapped directly. Some mapping descriptions are given below.

- In workflow relevant data mapping, the global data attributes of the CIMFlow model can be directly mapped to the workflow relevant data attribute of the WPDL meta-model, as can the sub-process global data attribute of the CIMFlow model. However, a sub-process of the CIMFlow model has not only the sub-process global data attribute, but also three kinds of workflow relevant data that are defined in the output list attribute of activities in the sub-process. The first is the manual activity output data. The second is the automatic activity output data. In addition, there may be another sub-process in the current sub-process which also has some output data defined in the output list attribute of end mark in the sub-process. So, the workflow relevant data attribute of the workflow process definition of the WPDL meta-model should include all the four data types.
- The transition attributes mapping ignores the data link.
- The CIMFlow organization model has four types of participants including department, role, person and resource. The mapping relationships are department to ORGANISATIONAL_UNIT, role to ROLE, person to HUMAN and resource to SYSTEM.
- In the workflow application definition mapping, the formal parameters should be defined with the modified generic form of the formal parameters.

# 4 Conclusions

This paper describe implementation of a typical WPDL conforming application example which makes the CIMFlow model compatible with other models built by other WPDL conforming modeling tools, so the CIMFlow model can be used by workflow run-time products and BPR tools. Because of the differences between the two models, the implementation must carefully consider

what should be included. Although some mapping and translating problems between the two models were resolved, some of the methods are just for convenience. Further work should consider more necessary aspects.

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