THALES	**WSDL 2.0 to UDDI mapping WSDL-S/SAWSDL to UDDI mapping**		
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Abstract	This document is a technical note that defines a new approach to using WSDL 2.0 and WSDL-S/SAWSDL in a UDDI registry.		
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Document evolution				
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1.1	Draft	14/06/06	Pierre Châtel	Document content and structural overhaul

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1. Introduction

1.1. Goal of the study

The WSDL-S mapping described in this technical note is in keeping with the general pattern of the global web-services and semantics effort: with the recent popularity increase of web-services, the ability to implement successful web processes by searching and using relevant services in a given domain will probably become the sinews of war in enterprise networks in the near future.

In this perspective, we wish to significantly improve the interoperability between web-service and raise their interpretability level. One approach is to develop semantic web-services by annotating this services with semantic information provided by ontologies.

How to semantically describe a web-service as already been, or is going to be, answered by several projects like OWL-S, DAML-S, WSDL-S or SAWSDL. But the first step toward obtaining a complete tooling of this approach consists of specifying a way to store, retrieve these descriptions and search for web-services based on these semantic descriptions.

We have chosen to ground our work on the WSDL-S service description language [see 6. WSDL-S] and we will define in this technical note how to map the syntactic and semantic information contained in a WSDL-S service description into UDDI.

The final goal of the study presented by this document is dual:

- First, by describing a mapping of WSDL-S into UDDI, giving web-service publishers a way to store their semantic service descriptions into any standard UDDI registry implementation.
- Secondly, by making this mapping expressive enough, to empower network clients to make efficient queries on UDDI registries based on a formal specification of their needs and a common knowledge background between publishers and clients.

1.2. Context of the study

The technological environment surrounding the study is composed of the following technologies:

- The WSDL v1.1 [WSDL1.1] and v2.0 [WSDL 2.0 Core Rec] specifications.
- The WSDL-S / SAWSDL specification [SAWSDL].
- The UDDI specification and its implementation: the juddi registry.

Three versions of WSDL-S are actually available: each one specifies how and when to annotate a WSDL service definition in order to add *references* to semantic elements (concepts in ontologies):

- One using the extensibility elements offered by the WSDL 1.1 standard which has been created as an interim step of defining the final WSDL-S specification.
- One based on the 2.0 version of the WSDL specification. It's the version that corresponds to the last W3C proposal of WSDL-S.
- At the time of the writing of this report, the future development of WSDL-S changed hands and is now being maintained by a specific W3C working group[1]. It was beforehand developed by the LSDID laboratory. Following this change, WSDL-S has been renamed to SAWSDL (« Semantic Annotations for WSDL »).

[1] http://www.w3.org/2002/ws/sawsdl/

See [SAWSDL] for more details on the subject.
We will continue to use the WSDL-S denomination in the rest of this technical note.

1.3. Document content

Although the current SAWSDL specification does not bring many appreciable change to the last WSDL-S technical note, the mapping described by this document is based on SAWSDL. Some elements from the last WSDL-S specification that were removed from the current SAWSDL extension-set are still mapped for compatibility reasons, see [7.2. Handled WSDL-].

Since WSDL-S has been defined as an extension to the WSDL 2.0 specification, a preliminary step to the WSDL-S to UDDI mapping will be to define a WSDL 2.0 to UDDI mapping [5. WSDL 2.0 to UDDI mapping]. It will keep all the mandatory elements from the previous WSDL 1.1 to UDDI mapping and will describe all the necessary syntactic and semantic aspects of a web service description.

The content of this document is organized as follows:

- A brief recap of the data models of both WSDL 2.0 and UDDI
- A brief recap on the WSDL 1.1 to UDDI mapping.
- A study of the correspondences between WSDL 1.1 and 2.0 structures.
- The development of a brand new WSDL 2.0 to UDDI mapping.
- The development of a WSDL-S to UDDI mapping as an extension to the WSDL 2.0 mapping.

2. WSDL 2.0

2.1. Goal and generalities

WSDL is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information. The operations and messages are described abstractly, and then bound to a concrete network protocol and message format to define an endpoint. Related concrete endpoints are combined into abstract endpoints (services). WSDL is extensible to allow description of endpoints and their messages regardless of what message formats or network protocols are used to communicate.

2.2. Data Model

This information comes from the [WSDL 2.0 Core Rec] W3C specification and is Copyright © 2006 W3C (MIT, ERCIM, Keio)

See [Appendix C: WSDL 2.0 Components hierarchical view] for a complete graphical view of the components containment hierarchy of WSDL 2.0.

2.2.1. Interface

An Interface component describes sequences of messages that a service sends and/or receives. It does this by grouping related messages into operations. An operation is a sequence of input and output messages, and an interface is a set of operations.

An interface can optionally extend one or more other interfaces. To avoid circular definitions, an interface MUST NOT appear as an element of the set of interfaces it extends, either directly or indirectly. The set of operations available in an interface includes all the

operations defined by the interfaces it extends, along with any operations it directly defines. The operations directly defined on an interface are referred to as the declared operations of the interface

2.2.2. Operation

An Interface Operation component describes an operation that a given interface supports. An operation is an interaction with the service consisting of a set of (ordinary and fault) messages exchanged between the service and the other parties involved in the interaction.

2.2.3. Binding

A Binding component describes a concrete message format and transmission protocol which may be used to define an endpoint. That is, a Binding component defines the implementation details necessary to access the service.

Binding components can be used to describe such information in a reusable manner for any interface or specifically for a given interface. Furthermore, binding information MAY be specified on a per-operation basis within an interface in addition to across all operations of an interface.

2.2.4. Service and endpoint

A Service component describes a set of endpoints at which a particular deployed implementation of the service is provided. The endpoints thus are in effect alternate places at which the service is provided.

An Endpoint component defines the particulars of a specific endpoint at which a given service is available. Endpoint components are local to a given Service component.

3. UDDI

3.1. Goal and generalities

UDDI is the specification of a multi-purpose web-service definition registry . It's an OASIS recommendation that empowers users to make queries about services available on a given network (there are public and private registries) and that let developers publish their services by specifying in the registry any information related to these services (like their operations, prerequisites or specification conformity). The registry itself is based on multiple standards like HTTP, XML, XML Schema and SOAP.

In this technical note, UDDI will be used to store the syntactic and semantic information related to a given service and expressed in a WSDL-S or WSDL 2.0 declaration.

3.2. Data Model

This information comes from the [UDDIMAP] OASIS technical note and is Copyright © OASIS Open 2002-2004.

3.2.1. tModels

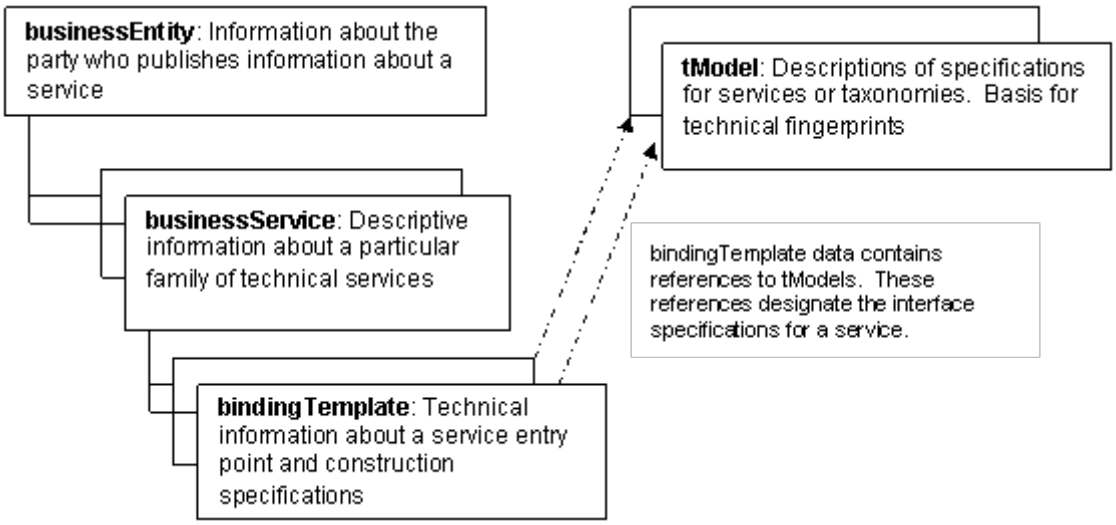
TModels are often referred to as service type definitions. TModels represent unique concepts or constructs. They are used to describe compliance with a specification, a concept, or a shared design. TModels have various uses in the UDDI registry. In the case of mapping WSDL-described Web services, tModels have two uses. First, tModels are used to represent technical specifications such as service types, bindings, and wire protocols. Second, tModels are used to implement category systems that are used to categorize technical specifications and services. This Technical Note defines a set of specification and category system tModels

that are used when mapping WSDL 2.0 and WSDL-S entities to UDDI entities. These tModels are defined in Appendix A.

When a particular specification is registered in the UDDI registry as a tModel, it is assigned a unique key, called a tModelKey. This key is used by other UDDI entities to reference the tModel, for example to indicate compliance with the specification. Each specification tModel contains an overviewURL, which provides the address of the specification itself, for example, a WSDL document.

Additional metadata can be associated with a specification tModel using any number of identifier and category systems. Identifiers are grouped in a construct called an identifierBag, and categories are grouped in a construct called a categoryBag. These bags contain a set of keyedReference elements. Each keyedReference specifies the tModelKey of the category system tModel and a name/value pair that specifies the metadata. For example, a keyedReference referencing the namespace category system can be used to specify a WSDL namespace. The metadata values specified in keyedReference elements can be used as selection criteria when searching UDDI.

3.2.2. businessService & bindingTemplate



Services are represented in UDDI by the businessService data structure, and the details of how and where the service is accessed are provided by one or more bindingTemplate structures. The businessService might be thought of as a logical container of services. The bindingTemplate structure contains the accessPoint of the service, as well as references to the tModels it is said to implement.

4. WSDL 1.1 to UDDI mapping

There is an OASIS committee technical note [UDDIMAP] that specifies a simple implementation of a WSDL 1.1 to UDDI mapping. We are going to ground our own WSDL 2.0 mapping [5. WSDL 2.0 to UDDI mapping] on this technical note.

A WSDL web service definition can be decomposed in two main parts: one called the “abstract definition” of the service, the other focused on the implementation aspects. In the following table, we present a quick summary of the mapping concerning the two parts that was specified by the OASIS technical note:

WSDL Element	*Description*	*Corresponding UDDI element*	*Description*

WSDL Element	*Description*	*Corresponding UDDI element*	*Description*
Abstract definition			
PortType	A portType is an abstract collection of operations that may be supported by one or more Web services	TModel	tModels represent unique concepts or constructs. They are used to describe compliance with a specification, a concept, or a shared design.
Binding	A WSDL binding specifies a specific set of encoding and transport protocols that may be used to communicate with an implementation of a particular WSDL portType	tModel	tModels represent unique concepts or constructs. They are used to describe compliance with a specification, a concept, or a shared design.
Service implementation			
Service	WSDL defines a Web service implementation as a service with a collection of named ports	BusinessService	Descriptive information about a particular family of technical services
Port	Each port implements a particular portType using the protocols defined by a named binding	BindingTemplate	Technical information about a service entry point and construction specification

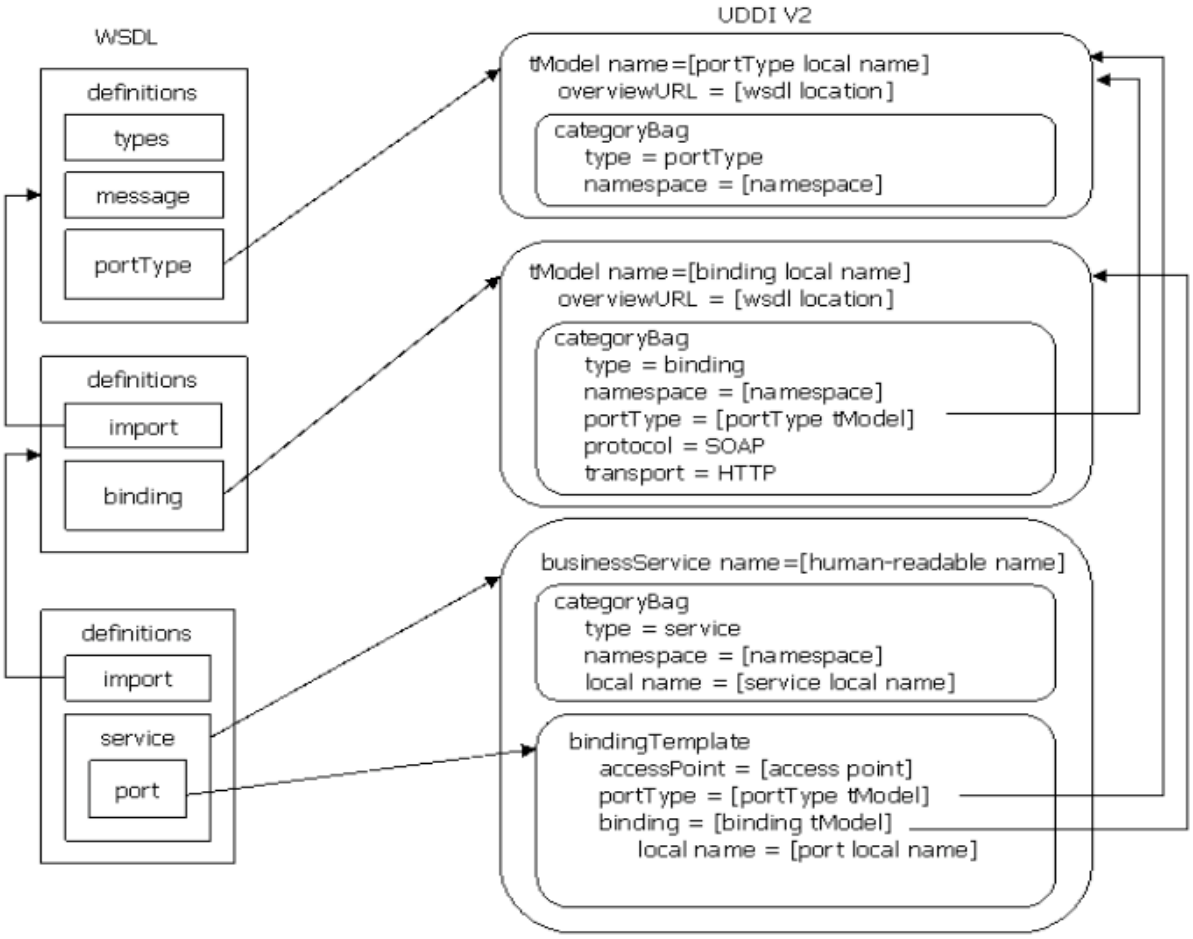


Figure 1 - Recapitulatory of the WSDL 1.1 to UDDI mapping

5. WSDL 2.0 to UDDI mapping

5.1. Goal

The primary goals of this mapping are:

1. To enable the automatic registration of WSDL 2.0 definitions in UDDI
2. To enable precise and flexible UDDI queries based on specific WSDL 2.0 artifacts and metadata.
3. To optimize the UDDI query processing performance by carefully choosing which WSDL 2.0 components will be mapped to UDDI.
4. To support any logical and physical structure of WSDL 2.0 description

5.2. Correspondences between WSDL 1.1 and 2.0 components

Refer to [Appendix B: Comparison between WSDL 1.1 and WSDL 2.0 component models] for more details.

WSDL 1.1 component	*WSDL 2.0 component*	*Note*
Message	N/A	The *message* element was removed from

WSDL 1.1 component	*WSDL 2.0 component*	*Note*
		the WSDL 2.0 specification. You now have to use xsd type declarations to format operations' inputs and outputs.
PortType	Interface	*PortType* was renamed to *interface* in WSDL 2.0. It is now possible to specify a set of declared *interface* components which a given *interface* extends.
Operation (from portType)	Operation (from interface)	A WSDL 2.0 *operation* is semantically equivalent to a WSDL 1.1 *operation*. But its syntax and implementation are slightly different. It is now required to specify a message exchange pattern and operations are now making direct references to xsd types without using a *message* construct.
Binding	Binding	The new *binding* component doesn't necessarily needs to be associated to a given *interface* element (it is now an optional attribute). This new king of *binding* can be used on multiple interfaces.
Service	Service	A major difference between the WSDL 1.1 and 2.0 version of the *service* component is that it is now required to specify the *interface* that the service is an instance of. That makes it possible to guarantee a logical bond between the various endpoints of a given *service*. Whereas, in the WSDL 1.1 specification, it was possible for a given *service* to bring together *ports* implementing different portTypes/interfaces.
Port	Endpoint	*Port* was renamed to *endpoint* in the WSDL 2.0 specification. There are some syntax variations compared to the WSDL 1.1 version.

5.3. Mapping

This mapping **is not compatible** with the following WSDL 1.1 based mappings:

1. The basic mapping which is registered as a "Best Practice" by the OASIS committee. http://www.oasis-open.org/committees/uddi-spec/doc/bp/uddi-spec-tc-bp-using-wsdl-v108-20021110.htm
2. The second mapping type which is more elaborate but has not been validated yet. http://www.oasis-open.org/committees/uddi-spec/doc/tn/uddi-spec-tc-tn-wsdl-v2.htm

You can see in Figure 2 a simplified view of the mapping that is described in this section. It indicates the correspondences between the WSDL 2.0 model and the fixed UDDI structures.

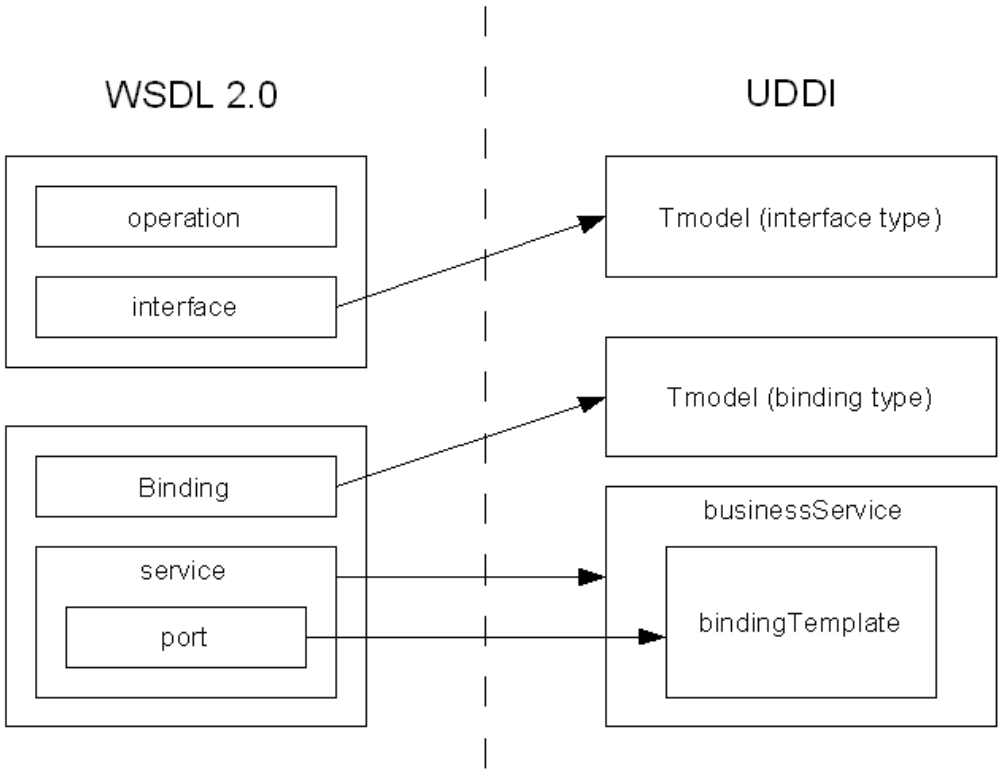


Figure 2 – Simplified representation of the correspondences between WSDL 2.0 and UDDI structures

5.3.1. New Canonical tModels

This mapping introduces a number of canonical tModels that are used to represent WSDL 2.0 metadata and relationships. These tModels MUST be registered in the UDDI registry to support this mapping. Only the V1/V2 keys are given for these tModels.

We reuse all the canonical tModels defined by [UDDIMAP] to which we add the following tModels (see [Appendix A: Canonical tModels] for more details):

- *WSDL Interface Reference* (based on the WSDL portType Reference tModel)

5.3.2. References to WSDL Components from UDDI

A UDDI entity normally references technical specifications using the overviewURL element. As noted above, in this mapping a single WSDL document maps to multiple tModels, and each tModel refers to a particular WSDL entity within the file.

The particular WSDL entity is uniquely identified by the combination of its local name and the target namespace of the definitions element that contains the WSDL entity. This identity information SHOULD be determined from the UDDI entity, using the particular mapping for the namespace name and local name applicable to the particular UDDI entity type..

To sum up, 3 values are captured when mapping to a UDDI entity:

- The local name of the originating WSDL element
- The target namespace of this element (a mandatory attribute of the service *description* since WSDL 2.0).

- The location of the service definition itself via the *overviewURL* attribute.

5.3.3. WSDL 2.0 Import and Include directives

The WSDL 2.0 specification is introducing a new dependencies handling mechanism which complements the *import* element already defined by WSDL 1.1:

- The *include* element allows you to assemble the contents of a given WSDL 2.0 namespace from several WSDL 2.0 documents that define components for that namespace. The components defined by a given WSDL 2.0 document consist of those whose definitions are contained in the document and those that are defined by any WSDL 2.0 documents that are included in it via the include element. The effect of the include element is cumulative so that if document A includes document B and document B includes document C, then the components defined by document A consist of those whose definitions are contained in documents A, B, and C.
- In contrast, the *import* element does not define any components. Instead, the import element declares that the components whose definitions are contained in a WSDL 2.0 document for a given WSDL 2.0 namespace refer to components that belong to a different WSDL 2.0 namespace. If a WSDL 2.0 document contains definitions of components that refer to other namespaces, then those namespaces must be declared via an import element. The import element also has an optional location attribute that is a hint to the processor where the definitions of the imported namespace can be found. However, the processor may find the definitions by other means, for example, by using a catalog.

The mapping described in this document does not handle directly the *import* and *include* directives. It's the responsibility of the preprocessor inside the tools based on this specification to assemble the various dependencies prior to publishing service definitions into UDDI. After processing any include elements and locating the components that belong to any imported namespaces, the WSDL 2.0 component model for a WSDL 2.0 document will contain a set of components that belong to the document's WSDL 2.0 namespace and any imported namespaces. These components will refer to each other, usually via QName references. A WSDL 2.0 document is invalid if any component reference cannot be resolved, whether or not the referenced component belongs to the same or a different namespace.

5.3.4. wsdl:interface->uddi:tModel

A wsdl:interface MUST be modeled as a uddi:tModel.

The minimum information that must be captured about an interface is its entity type, its local name, its namespace, and the location of the WSDL document that defines the interface.

Capturing the entity type enables users to search for tModels that represents interface artifacts. Capturing the local name, namespace, and WSDL locations enables users to locate the definition of the specified interface artifact.

IF the wsdl:interface extends one or multiple wsdl:interface (new in WSDL 2.0), the tModel MUST contains references to these parent interfaces.

As in the WSDL 1.1 mapping where the *operation* elements of a specified portType where skipped when mapping to UDDI, the *fault*, *operation*, *feature* and *property* elements of a wsdl :interface won't be mapped in UDDI.

The wsdl:interface information is captured as follows :

- The uddi:name element of the tModel MUST be the value of the name attribute of the

wsdl:interface.

- The tModel MUST contain an overviewDoc with an overviewURL containing the location of the WSDL document that describes the wsdl:interface.
- The tModel MUST contain a categoryBag:
  - the categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Entity Type category system and a keyValue of "interface".
  - the categoryBag MUST contain a keyedReference with a tModelKey of the XML Namespace category system and a keyValue of the target namespace of the wsdl:description element that contains the wsdl:interface.
  - IF the wsdl:interface contains an *extends* attribute THEN the categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Interface Reference relationship tModel FOR EACH parent wsdl:interface. And the keyValue MUST be the tModelKey of the specified parent interface.

WSDL 2.0	***UDDI***
Interface	**tModel** (categorized as an *interface*)
Namespace of interface	KeyedReference in categoryBag
Local name of interface	TModel name
Location of WSDL document	OverviewURL
Parent interface(s)	KeyedReference(s) in categoryBag

5.3.5. wsdl:binding->uddi:tModel

A wsdl:binding MUST be modeled as a uddi:tModel.

The minimum information that must be captured about an interface is its entity type, its local name, its namespace, the protocol of the binding, and the location of the WSDL document that defines the interface.

Capturing the entity type enables users to search for tModels that represents binding artifacts. Capturing the local name, namespace, and WSDL locations enables users to locate the definition of the specified binding artifact.

IF the wsdl:binding specify an implemented wsdl:interface THEN the tModel MUST contain a reference to the tModel representative of this interface (it was a mandatory indication in WSDL 1.1).

As in the WSDL 1.1 mapping where the *operation* elements of a specified wsdl:binding where skipped when mapping to UDDI, the *fault*, *operation*, *feature* and *property* elements of a wsdl:binding won't be mapped in UDDI.

The wsdl:binding information is captured as follows :

- The uddi:name element of the tModel MUST be the value of the name attribute of the wsdl:binding.
- The tModel MUST contain an overviewDoc with an overviewURL containing the location of the WSDL document that describes the wsdl:binding.
- The tModel MUST contain a categoryBag:
  - the categoryBag MUST contain a keyedReference with a tModelKey of the WSDL

Entity Type category system and a keyValue of “binding”.

- the categoryBag MUST contain a keyedReference with a tModelKey of the XML Namespace category system and a keyValue of the target namespace of the wsdl:description element that contains the wsdl:binding.
- the categoryBag MUST include a keyedReference with a tModelKey of the Protocol Categorization category system and a keyValue of the tModelKey of the protocol tModel indicated by the *type* attribute of the wsdl:binding.

  As specified by par [[WSDLADJ] – 5.2 Identifying the use of the SOAP binding] and [[WSDLADJ] – 6.1 Identifying the use of the HTTP binding], this indication is sufficient to distinguish between various binding types. The client of a web-service will need to check the full WSDL service definition in order to gather enough information to conduct a dialog with the service.

  - IF the value of the *type* attribute of the wsdl:binding is “http://www.w3.org/2006/01/wsdl/soap” THEN we will use the tModelKey of the « SOAP Protocol » tModel.

    Also, we need to add a keyedReference in the categoryBag with a tModelKey of the « Transport Categorization » canonical tModel and a keyValue of the tModelKey of the tModel standing for the transport type indicated by the *protocol* attribute defined in the SOAP namespace “http://www.w3.org/2003/O5/soap-envelope”.
  - IF the value of the type attribute of the wsdl:binding is “http://www.w3.org/2006/01/wsdl/http” THEN we will use the tModelKey of the “HTTP Protocol” tModel. In this case, there is no need to specify the transport type.
  - Other values are handled in a similar fashion. It is assumed that vendors who provide other protocol or transport types will provide the appropriate tModels.
- IF the wsdl:binding has an interface attribute, THEN the categoryBag MUST contain a keyedReference keyedReference with a tModelKey of the WSDL Interface Reference relationship tModel and a keyValue of the tModelKey of the tModel standing for this interface.

WSDL 2.0	*UDDI*
Binding	**tModel** (categorized as a *binding*)
Namespace of binding	KeyedReference(s) in categoryBag
Local name of binding	TModel name
Location of WSDL document	OverviewURL
Protocol of binding	KeyedReference(s) in categoryBag
Transport implemented by this binding (opt)	KeyedReference(s) in categoryBag
Interface linked to the binding (opt)	KeyedReference(s) in categoryBag

5.3.6. wsdl:service->uddi:businessService

A wsdl:service MUST be modeled as a uddi:businessService.

Since a service MUST implement an interface in WSDL 2.0, we can guarantee that there is a direct link between a wsdl:service and a given uddi:businessService in the mapping (1:1 relation).

The minimum information that must be captured about a wsdl:service is its entity type, its local name, its namespace, its implemented interface and the list of endpoints that it supports.

1. Capturing the entity type enables users to search for services that are described by a WSDL definition.
2. Capturing the interface inside the businessService enables users to search for the various implementations of a specified interface in a single instruction.
3. The list of ports provide access to the technical information required to consume the service.

The wsdl:service information is captured as follows :

- The uddi:name element of the businessService MUST be the value of the name attribute of the wsdl:service.
- The businessService MUST contain a categoryBag:
  - The categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Entity Type category system and a keyValue of “service”.
  - The categoryBag MUST contain a keyedReference with a tModelKey of the XML Namespace category system and a keyValue of the target namespace of the wsdl:description element that contains the wsdl:service.
  - The categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Interface Reference relationship tModel and a keyValue of the tModelKey of the interface tModel implemented by this wsdl:service.

Each endpoint defined by this service is automatically mapped into a uddi:bindingTemplate inside the corresponding uddi:businessService. [5.3.7 wsdl:endpoint->uddi:bindingTemplate]

WSDL 2.0	***UDDI***
Service	**BusinessService**
Namespace of service	KeyedReference(s) in categoryBag
Local name of service	BusinessService name
Interface implemented by this service	KeyedReference(s) in categoryBag
Endpoint(s) defined by this service	*bindingTemplate* inside the *bindingTemplates* element of the businessService.

5.3.7. wsdl:endpoint->uddi:bindingTemplate

A wsdl:endpoint MUST be modeled as a uddi:bindingTemplate inside the uddi:businessService element defining this particular endpoint.

The minimum information that must be captured about an endpoint is its local name, the *binding* that it implements and the *interface* that it implements.

By capturing the binding, users can search for services that implement a specific binding. By capturing the interface, users can search for services that implement a particular interface without necessarily knowing the specific binding implemented by the service.

The wsdl:endpoint information is captured as follows :

The bindingTemplate MUST contain a tModelInstanceDetails element:

- This tModelInstanceDetails MUST contain a tModelInstanceInfo with a tModelKey of the tModel that models the wsdl:binding that this endpoint implements. The instanceParms of this tModelInstanceInfo MUST contain the wsdl:endpoint local name.
- This tModelInstanceDetails MUST contain a tModelInstanceInfo with a tModelKey of the tModel that models the wsdl:interface implemented by this endpoint. The tModelKey is the value of the mandatory *interface* attribute of the *service* element defining this endpoint (if specified, it can also be obtained by the *interface* attribute of the wsdl:binding associated to this endpoint)

WSDL 2.0	***UDDI***
Endpoint	**BindingTemplate**
Namespace of endpoint	Captured in keyedReference of the containing businessService
Local name of endpoint	InstanceParms of the tModelInstanceInfo related to the tModel for the binding.
Binding implemented by endpoint	tModelInstanceInfo with tModelKey of the tModel corresponding to the binding.
Interface implemented by endpoint	tModelInstanceInfo with tModelKey of the tModel corresponding to the interface.

The uddi:bindingTemplate MUST store address information for the Web service in its accessPoint element. In WSDL 2.0 this information can come from various locations whereas it was only located in the extensibility elements of WSDL 1.1.

- IF the endpoint has an *address* attribute:
  - The value of the accessPoint MUST be the value of this attribute
  - The value of the URLType attribute in the accessPoint element MUST correspond to the transport type specified by the binding linked to this endpoint or “other” if no correspondence exists. In the case of the HTTP transport, for example, the URLType attribute MUST be "http".
  - If "other" is used then a tModelInstanceInfo element referencing the appropriate vendor-defined transport tModel MUST be added to the bindingTemplate.
- IF the endpoint does not have an address attribute BUT possesses an *Endpoint Reference* [WSA 1.0 Core]: in thise case, we can use the value of the *address* element of this particular endpoint reference.
- IF the endpoint does not have an *address* attribute NOR *endpoint reference* THEN this case is not specified by the WSDL 2.0 recommendation [WSDL 2.0 Core Rec], it will not be treated by this specification.

5.3.8. WSDL 2.0 Components not mapped to UDDI

The following components are optional in a WSDL description and don’t carry any particular semantic annotations. It was decided not to map them to UDDI elements in the WSDL-S to UDDI mapping

current version of this specification. In order to consult them, one must first access to the full WSDL 2.0 definition of a given service stored in the UDDI registry. A direct consequence is that they cannot be used as criterions in a (semantic) UDDI query.

- The "feature" component describes an abstract piece of functionality typically associated with the exchange of messages between communicating parties. The presence of a Feature component in a WSDL 2.0 description indicates that the service supports the feature and may require that a client that interacts with the service use that feature.
- The "property" component in the Features and Properties architecture represents a named runtime value which affects the behavior of some aspect of a Web service interaction, much like an environment variable.
- The optional "documentation" element information item used by WSDL 2.0 as a container for human readable or machine processable documentation. The content of the element information item is arbitrary character information items and element information items and is allowed inside any WSDL 2.0 element information item.
- All the "fault" handling element of WSDL 2.0.

6. WSDL-S

6.1. Goal

The Web Services Description Language (WSDL) specifies a way to describe the abstract functionalities of a service and concretely how and where to invoke it. But the WSDL 1.1/2.0 specification does not include semantics in the description**,** thus two services can have similar descriptions while totally different meanings.

The objective of the WSDL-S/SAWSDL specification is to develop a mechanism to enable annotation of Web services descriptions with semantic concepts extracted from ontologies representing common knowledge in a specific domain. This mechanism takes advantage of the WSDL 2.0 extension mechanisms to build a simple and generic support for semantics in Web services.

Since the current WSDL standard operates at the syntactic level, it lacks the semantic expressivity needed to represent the requirements and capabilities of Web Services. Semantics can improve software reuse and discovery, significantly facilitate composition of Web services and enable integrating legacy applications as part of business process integration.

To solve this issue, WSDL-S offers an evolutionary and compatible upgrade of existing web-services standards by providing support for rich mapping mechanisms between most aspects of an service declaration and ontologies, and also by externalizing the semantic domain models (agnostic to semantic and ontology representation languages).

6.2. Semantic annotations defined by WSDL-S

In WSDL-S a semantic information can be associated to a WSDL element by using an annotation based on the standard service description extension mechanism of WSDL 2.0.

Conceptually, WSDL 2.0 has the following constructs to represent service descriptions: interface, operation, binding, service and endpoint. Of these, the first two, namely interface and operation, deal with the abstract definition of a service while the remaining three given by binding, service and endpoint constructs deal with service implementation. WSDL-S focus on semantically annotating the abstract definition of a service to enable dynamic discovery, composition and invocation of services. It provides URI reference mechanisms via

extensibility elements to the WSDL interface and operation constructs to point to the semantic constructs defined in the domain models.

It is possible to semantically annotate the following WSDL 2.0 components:

- **XML Schema declarations** (complex type, element), using *modelReference* and *schemaMapping* attributes.
- **Operations**, using the *modelReference* attribute*, precondition* and *effect* elements.
- **Interfaces**, using the *category* element. This one differs from the other elements since it is used to reference taxonomy concepts not ontologies.

7. WSDL-S to UDDI Mapping

7.1. Goal

The primary goals of this mapping are the same that the ones that were defined for the WSDL to UDDI mapping, except that semantic and performance concerns were added:

1. To enable the automatic registration of WSDL-S definitions in UDDI including the necessary semantic information.
2. To enable precise and flexible UDDI queries based on specific syntactic and semantic artifacts and metadata.
3. To maintain compatibility with the previous WSDL 2.0 to UDDI mapping [see 5. WSDL 2.0 to UDDI mapping]
4. To optimize the UDDI query processing performance by carefully choosing which WSDL-S components will be mapped to UDDI.
5. To support any logical and physical structure of WSDL-S description

7.2. Handled WSDL-S version

Since SAWSDL is in the early stages of the normalization process, **we decided to maintain in our binding some elements that were removed from the WSDL-S specification. Like *precondition* and *effect*** [see 6.2. Semantic annotations defined by WSDL-S].

There is, at the time of the writing of this report, some controversy around precondition and effect since the charter for the SAWSDL working group rules them out of scope, but the concept has already been validated by previous works on the subject and seems to correspond to the need to distinguish between services that change the “world” and those that don't.

In fact, the STRIPS operator (AI planning) defined state as a set of prepositional variables. In this scenario, an action would be eligible to be executed if the current state satisfied the preconditions, and the effect of the operation would create a new state by modifying the values of some propositional variables.

You can refer to all the work done by Kunal Verma at the LSDIS Lab for more information on the subject. Especially in [COMPSWS] where they defined state as a two tuple consisting of an expression of propositional variables and the data available to the service.

7.3. Mapped semantic information

Compared to the mapping described by "Adding Semantics to Web Services Standards", the approach adopted by this specification should allow greater expressibility when composing UDDI request using semantic criterions.

In this early paper by the LSDID Lab, not all the semantic annotations currently available were mapped to UDDI structures. In particular, we add the mapping for the precondition and effect elements as defined by the current WSDL-S specification.

The semantic information attached to an operation input and output will also be mapped into UDDI. This will allow richer queries to be made and should significantly improve the performance when searching for a particular web-service in a UDDI registry (i.e. it will not be necessary to gather the full wsdl description of a service stored in UDDI in order to match and rank it based on the semantic similarity with the query being made).

The following semantic elements will be mapped to UDDI :

- Operation inputs
- Operation outputs
- Operation preconditions
- Operation effects
- Operation functional concept
- Interface categorization information

7.4. WSDL 2.0 to UDDI mapping extensions

Semantic annotations of WSDL-S are limited to the "abstract" part of a service declaration. As such, extensions will only be made on the operation and interface mapping specifications. Concerning the service implementation part, we will use the previously defined mapping [see 5. WSDL 2.0 to UDDI mapping].

Since WSDL-S stores input/output related semantic information in the XML Schema types declarations we will also need to extract the needed ontological references from this structures in order to map them into UDDI.

WSDL 2.0 Element	*Extension*
Operation	Was not mapped in the WSDL 2.0 to UDDI mapping. In WSDL-S they are annoted with semantic elements so we need to map them to UDDI. This mapping will convert them to tModels.
Interface	The mapping that was specified in 5.3.4 need to be modified in order to create a link between a given interface and the operations that it defines.
Type	The "message" construct was removed from WSDL 2.0. As such, the semantic information that was added to the message elements is now directly appended to the xsd types themselves. We need to build a mapping to store this semantic elements inside the operation tModels.

7.5. Mapping

Figure 3 shows a synthetic view of the extensions that were above-mentioned. The following sections will explain in details the implementation of these mappings.

The semantic additions made by WSDL-S/SAWSDL to the WSDL 2.0 model and their mapping to UDDI are shown in blue.

The logical links between interfaces and operations, operations and types, are figured in red.

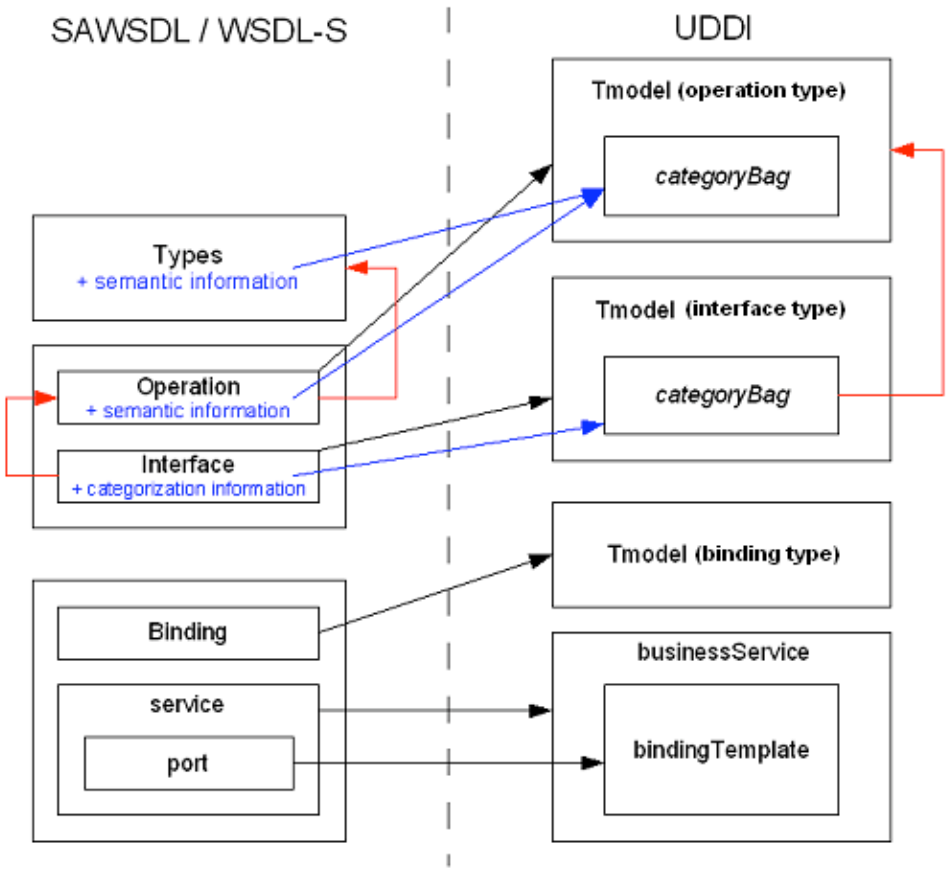


Figure 3 - WSDL 2.0 to UDDI mapping extensions

7.5.1. New Canonical tModels

This mapping introduces a number of canonical tModels that are used to represent WSDL-S/SAWSDL 2.0 semantic metadata and relationships. These tModels MUST be registered in the UDDI registry to support this mapping. Only the V1/V2 keys are given for these tModels.

We reuse all the canonical tModels that were defined by [5.3.1 New Canonical tModels] to which we add all the following tModels (see [Appendix A: Canonical tModels] for more details):

- WSDL Operation Reference
- Functional Concept
- Input
- Output
- Precondition

- Effect

7.5.2. wsdl-s:category-> uddi:tModel (interface type) [extension]

We base this mapping on the one specified by [5.3.4 wsdl:interface->uddi:tModel] to which we add the categorization information specified by the *category* extension element. This information consist of references to taxonomies elements, Users can choose any categorization of their choice such as NAICS, UNSPSC and GICS. This aids in service discovery by narrowing the range of candidate services.

Multiple *category* elements can be used to specify that the service falls into multiple categories. A *category* element specifies one categorization. As such we need to map each and every *category* element individually.

The information associated to a given wsdl-s:category element is added to the categoryBag of the associated interface tModel as such:

- For each wsdl-s:category element defined in a wsdl:interface:
  - IF the value of the *taxonomyURI* attribute of the wsdl-s:category element is an URI associated in the UDDI registry to a valid taxonomy tModel (NAICS and UNSPSC tModels are bundled with juddi)

    THEN the categoryBag MUST contain a keyedReference with a tModelKey of the corresponding taxonomy tModel and the value of the *taxonomyCode* attribute of the wsdl-s:category element as the keyValue
  - ELSE IF the value of the value of the *taxonomyCode* attribute of the wsdl-s:category element is unknown in the UDDI registry

    THEN we must register a new taxonomy tModel to the UDDI registry PRIOR TO the mapping of this wsdl-s:category element.

WSDL 2.0	*UDDI*
Interface	**Tmodel** (categorized as an *interface*)
Namespace of interface	KeyedReference in categoryBag
Local name of interface	TModel name
Location of WSDL document	OverviewURL
Parent interface(s)	KeyedReference(s) in categoryBag
Interface category(s)	**KeyedReference(s) in categoryBag**

7.5.3. wsdl:interface->uddi:tModel [extension]

We base this mapping on the one specified by [7.5.2 wsdl-s:category-> uddi:tModel (interface type) [extension]] to which we add the ability to link an interface to the operation it defines.

We do not add to the mapping of a given interface the operations that may have been defined by extended interfaces (as allowed by the new WSDL 2.0 specification), they will be mapped when these interfaces will be analyzed. It is possible to indirectly access these operations using the "WSDL Interface Reference" keyedReferences defined by [5.3.4 wsdl:interface->uddi:tModel].

We add the following elements to the categoryBag of the tModel modeling a given interface:

- For each wsdl:operation defined by this wsdl:interface:
  - The categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Operation Reference relationship tModel and a keyValue of the tModelKey of the operation tModel.

WSDL 2.0	*UDDI*
Interface	**tModel** (categorized as an *interface*)
Namespace of interface	KeyedReference in categoryBag
Local name of interface	tModel name
Location of WSDL document	OverviewURL
Parent interface(s)	KeyedReference(s) in categoryBag
Interface category(s)	KeyedReference(s) in categoryBag
Interface defined operation(s)	**KeyedReference(s) in categoryBag**

7.5.4. wsdl:operation->uddi:tModel

A wsdl:operation MUST be modeled as a uddi:tModel.

The minimum information that must be captured about an operation is its entity type, its local name, its namespace, the location of the WSDL document that defines the interface and the interface that defines this operation. To which we add the following semantic information:

- If specified, the functional concept of the operation(also known as “action”).
- If specified, the bottom-level ontological concepts (see [SAWSDL] section 2.2.1 for more details) associated with the types of this operation’s inputs.
- If specified, the bottom-level ontological concepts associated with the types of this operation’s outputs.
- If a precondition is specified for this operation, the ontological concept associated to this precondition.
- If an effect is specified for this operation, the ontological concept associated to this effect. If a functional concept is specified for this operation then it must specify an effect.

Capturing the entity type enables users to search for tModels that represents operation artifacts. Capturing the local name, namespace, and WSDL locations enables users to locate the definition of the specified binding artifact. Capturing the semantic information enables users to search for a service based on ontological concepts associated to its operations.

The wsdl:operation information is captured as follows :

- The uddi:name element of the tModel MUST be the value of the name attribute of the wsdl:operation.
- The tModel MUST contain an overviewDoc with an overviewURL containing the location of the WSDL document that describes the wsdl:operation.
- The tModel MUST contain a categoryBag:

- The categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Entity Type category system and a keyValue of “operation”.
- The categoryBag MUST contain a keyedReference with a tModelKey of the XML Namespace category system and a keyValue of the target namespace of the wsdl:description element that contains the wsdl:operation.
- The categoryBag MUST contain a keyedReference with a tModelKey of the WSDL Interface Reference relationship tModel and a keyValue of the tModelKey of the interface tModel implementing this operation.
- IF the wsdl:operation has a wsdl-s:modelReference attribute THEN the categoryBag MUST contain a keyedReference with a tModelKey of the Functional Concept category system and the value of the wsdl-s:modelReference attribute as a keyValue. The SAWSDL technical note specify that this value is an URI.
- IF the wsdl:operation has a wsdl-s:precondition element THEN the categoryBag MUST contain a keyedReference with a tModelKey of the Precondition category system and, as keyValue, the value of the *modelReference* attribute of the wsdl-s:precondition element. The WSDL-S last proposal specify that this value is an URI.
- FOR EACH wsdl-s:effect element of the wsdl:operation the categoryBag MUST contain a keyedReference with a tModelKey of the Effect category system and, as keyValue, the value of the *modelReference* attribute of the wsdl-s:effect element. The WSDL-S last proposal specify that this value is an URI.
- FOR EACH wsdl:input element of the wsdl:operation :
  - IF this input has an *element* attribute,
  - AND IF this attribute is referencing a XML Schema type,
  - AND IF this type has a bottom-level wsdl-s:modelReference attribute,
  - THEN the categoryBag MUST contain a keyedReference with a tModelKey of the Input category system and, as keyValue, the value of the *modelReference* attribute of the type element. The WSDL-S last proposal specify that this value is an URI.
- FOR EACH wsdl:output element of the wsdl:operation :
  - IF this output has an *element* attribute,
  - AND IF this attribute is referencing a XML Schema type,
  - AND IF this type has a bottom-level wsdl-s:modelReference attribute,
  - THEN the categoryBag MUST contain a keyedReference with a tModelKey of the Output category system and, as keyValue, the value of the *modelReference* attribute of the type element. The WSDL-S last proposal specify that this value is an URI.

WSDL 2.0	***UDDI***

WSDL 2.0	*UDDI*
Operation	**tModel** (categorized as an *operation*)
Namespace of operation	KeyedReference in categoryBag
Local name of operation	TModel name
Location of WSDL document	OverviewURL
Functional Concept	KeyedReference in categoryBag
Input(s)	KeyedReference(s) in categoryBag
Output(s)	KeyedReference(s) in categoryBag
Precondition	KeyedReference in categoryBag
Effect(s)	KeyedReference(s) in categoryBag

8. A complete example

[TODO: A complete and useful example of a WSDL-S service declaration mapped into the UDDI v2 component model and sample queries based on this mapping]

8.1. WSDL-S/SAWSDL Sample

8.2. UDDI V2 Model

8.3. Sample V2 Queries

References

[UDDIMAP] - OASIS - Using WSDL in a UDDI Registry, Version 2.0.2 - Technical Note - http://www.oasis-open.org/committees/uddi-spec/doc/tn/uddi-spec-tc-tn-wsdl-v202-20040631.htm
[WSDLADJ] - W3C - Web Services Description Language (WSDL) Version 2.0 Part 2: Adjuncts - http://www.w3.org/TR/2006/CR-wsdl20-adjuncts-20060327
[WSA 1.0 Core] - W3C - Web Services Addressing 1.0 - Core - http://www.w3.org/TR/2005/CR-ws-addr-core-20050817
[WSDL 2.0 Core Rec] - W3C - Web Services Description Language (WSDL) Version 2.0 Part 1: Core Language - http://www.w3.org/TR/2006/CR-wsdl20-20060327
[SAWSDL] - W3C – Semantic Annotations for WSDL - http://www.w3.org/2002/ws/sawsdl/spec/
[COMPSWS] - LSDID Lab - Zixin Wu, Kunal Verma, John A.Miller and Amit P.Sheth - Composing Semantic Web Services with Interaction Protocol
[WSDL1.1] - W3C - Web Services Description Language (WSDL) 1.1 - http://www.w3.org/TR/wsdl

9. Appendix A: Canonical tModels

9.1. WSDL Interface Reference

9.1.1. Design Goals

WSDL Entities exhibit many relationships. Specifically, a wsdl:port describes an implementation of a wsdl:binding, and a wsdl:binding describes a binding of a particular wsdl:insterface. These same relationships must be expressed in the UDDI mapping. UDDI provides a built-in mechanism, via the tModelInstanceInfo structure, to associate a bindingTemplate with a tModel. But UDDI does not provide a built-in mechanism to describe a relationship between two tModels. The WSDL Interface Reference relationship tModel provides a mechanism to indicate that a UDDI entity has a relationship with a certain wsdl:interface tModel. This can be applied, for example, to indicate that a wsdl:binding tModel is a binding of a specific wsdl:interface tModel.

9.1.2. Definition

Name:	thalesgroup-com:sc2:wsdl:interfaceReference
Description:	A relationship tModel used to reference a wsdl:interface tModel
V1,V2 format key:	uuid:9FC8E760-F7C6-11DA-A760-E48CBDDD8628
Categorization:	relationship
Checked:	no

9.1.3. V2 tModel Structure

```
<tModel tModelKey="uuid:9FC8E760-F7C6-11DA-A760-E48CBDDD8628">
      <name> thalesgroup-com:sc2:wsdl:interfaceReference </name>
      <description xml:lang="en">A relationship tModel used to reference
a wsdl:interface tModel</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-
            s_mapping.htm#interfaceReference
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="relationship"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
      </categoryBag>
```

9.1.4. Valid values

Valid values for this relationship tModel are tModelKeys. The content of the keyValue attribute in a keyedReference that refers to this tModel is the tModelKey of the wsdl:interface tModel being referenced.

9.1.5. Example of Use

One would add the following keyedReference to signify that a wsdl:binding implements a specific interface:

```
<categoryBag>
    <keyedReference
        tModelKey="uuid:9FC8E760-F7C6-11DA-A760-E48CBDDD8628"
        keyName="wsdl:interface Reference"
        keyValue="uuid:e8cf1163-8234-4b35-865f-94a7322e40c3"/>
…
</categoryBag>
```

Note that the keyValue is a tModelKey, which, if queried for using get_tModelDetail, would return the tModel that represents the portType.

9.2. WSDL Operation Reference

9.2.1. Design Goals

WSDL Entities exhibit many relationships. Specifically, a wsdl:interface describes multiple wsdl:operation. This same relationship must be expressed in the UDDI mapping. UDDI provides a built-in mechanism, via the tModelInstanceInfo structure, to associate a bindingTemplate with a tModel. But UDDI does not provide a built-in mechanism to describe a relationship between two tModels. The WSDL Operation Reference relationship tModel provides a mechanism to indicate that a UDDI entity has a relationship with a certain wsdl:operation tModel.

9.2.2. Definition

Name: thalesgroup-com:sc2:wsdl:operationReference
Description: A relationship tModel used to reference a wsdl:operation tModel
V1,V2 format key: uuid:F7893D50-F7C7-11DA-BD50-F1F106FBFEDE
Categorization: relationship
Checked: no

9.2.3. V2 tModel Structure

```
<tModel tModelKey="uuid:F7893D50-F7C7-11DA-BD50-F1F106FBFEDE">
      <name> thalesgroup-com:sc2:wsdl:operationReference </name>
      <description xml:lang="en">A relationship tModel used to reference
a wsdl:operation tModel</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-
            s_mapping.htm#operationReference
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="relationship"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
      </categoryBag>
```

9.2.4. Valid values

Valid values for this relationship tModel are tModelKeys. The content of the keyValue attribute in a keyedReference that refers to this tModel is the tModelKey of the wsdl:operation tModel being referenced.

9.2.5. Example of Use

```
<categoryBag>
      <keyedReference
            tModelKey="uuid:F7893D50-F7C7-11DA-BD50-F1F106FBFEDE"
            keyName="wsdl:operation Reference"
            keyValue="uuid:e8cf1163-8234-4b35-865f-94a7322e40d4"/>
…
</categoryBag>
```

9.3. Functionnal Concept

9.3.1. Design Goals

As needed by 7.5.4, this tModel is used to express a relation between an operation and a functional concept from a specific ontology. It is to be used with operation tModels.

9.3.2. Definition

Name: thalesgroup-com:sc2:wsdl:functionnalConcept
Description: A category system used to associate a concept from a specific semantic domain to an operation tModel.
V1,V2 format key: uuid:15D03F20-F7C8-11DA-BF20-C3F48481A023
Categorization: categorization
Checked: no

9.3.3. V2 tModel Structure

```
<tModel tModelKey="uuid:15D03F20-F7C8-11DA-BF20-C3F48481A023">
      <name> thalesgroup-com:sc2:wsdl:functionnalConcept </name>
      <description xml:lang="en"> A category system used to associate a
concept from a specific semantic domain to an operation tModel
</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-
            s_mapping.htm#functionnalConcept
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="categorization"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
```

9.3.4. Valid values

Valid values for this category system are URIs. The content of the keyValue attribute in a keyedReference that refers to this tModel is the value of the *modelReference* attribute of the wsdl-s:modelReference element of this specific operation.

9.3.5. Example of Use

```
<categoryBag>
      keyedReference
            tModelKey="uuid:15D03F20-F7C8-11DA-BF20-C3F48481A023"
            keyName="Functional Concept"
            keyValue="http://example.org/rosetta#RequestPurchaseOrder"
…
</categoryBag>
```

9.4. Input

9.4.1. Design Goals

As needed by 7.5.4, this tModel is used to express a relation between an operation's input element and a concept from a specific ontology. It is to be used with operation tModels.

9.4.2. Definition

Name: thalesgroup-com:sc2:wsdl:input
Description: A category system used to associate an input related concept from a specific semantic domain to an operation tModel.
V1,V2 format key: uuid:349CC4A0-F7C8-11DA-84A0-90AE920025E6
Categorization: categorization
Checked: no

9.4.3. V2 tModel Structure

```
<tModel tModelKey="uuid:349CC4A0-F7C8-11DA-84A0-90AE920025E6">
      <name> thalesgroup-com:sc2:wsdl:input </name>
      <description xml:lang="en">A category system used to associate an
input related concept from a specific semantic domain to an operation
tModel</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-s_mapping.htm#input
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="categorization"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
      </categoryBag>
```

9.4.4. Valid values

Valid values for this category system are URIs. The content of the keyValue attribute in a keyedReference that refers to this tModel is the value of the *modelReference* attribute of the type system element associated to this specific input.

9.4.5. Example of Use

```
<categoryBag>
      keyedReference
            tModelKey="uuid:349CC4A0-F7C8-11DA-84A0-90AE920025E6"
            keyName="Input"
            keyValue="http://example.org/rosetta#PurchaseOrderRequest"
…
</categoryBag>
```

9.5. Output

9.5.1. Design Goals

As needed by 7.5.4, this tModel is used to express a relation between an operation's output element and a concept from a specific ontology. It is to be used with operation tModels.

9.5.2. Definition

Name: thalesgroup-com:sc2:wsdl:output
Description: A category system used to associate an output related concept from a specific semantic domain to an operation tModel.
V1,V2 format key: uuid:72CBF520-F7C8-11DA-B520-E08563B732CC
Categorization: categorization
Checked: no

9.5.3. V2 tModel Structure

```
<tModel tModelKey="uuid:72CBF520-F7C8-11DA-B520-E08563B732CC">
      <name> thalesgroup-com:sc2:wsdl:output </name>
      <description xml:lang="en">A category system used to associate an
output related concept from a specific semantic domain to an operation
tModel</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-s_mapping.htm#output
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="categorization"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
      </categoryBag>
```

9.5.4. Valid values

Valid values for this category system are URIs. The content of the keyValue attribute in a keyedReference that refers to this tModel is the value of the *modelReference* attribute of the type system element associated to this specific output.

9.5.5. Example of Use

```
<categoryBag>
      keyedReference
            tModelKey="uuid:72CBF520-F7C8-11DA-B520-E08563B732CC"
            keyName="Output"
            keyValue="http://example.org/rosetta#PurchaseConfirmation"
…
</categoryBag>
```

9.6. Precondition

9.6.1. Design Goals

As needed by 7.5.4, this tModel is used to express a relation between an operation's precondition element and a concept from a specific ontology. It is to be used with operation tModels.

9.6.2. Definition

Name:	thalesgroup-com:sc2:wsdl:precondition
Description:	A category system used to associate a precondition related concept from a specific semantic domain to an operation tModel.
V1,V2 format key:	uuid:A05DC270-F7C8-11DA-8270-ABAD25871E16
Categorization:	categorization
Checked:	no

9.6.3. V2 tModel Structure

```
<tModel tModelKey="uuid:A05DC270-F7C8-11DA-8270-ABAD25871E16">
      <name> thalesgroup-com:sc2:wsdl:precondition </name>
      <description xml:lang="en">A category system used to associate a
precondition related concept from a specific semantic domain to an
operation tModel</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-
            s_mapping.htm#precondition
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="categorization"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
```

9.6.4. Valid values

Valid values for this category system are URIs. The content of the keyValue attribute in a keyedReference that refers to this tModel is the value of the *modelReference* attribute of the precondition element defined by a specific operation.

9.6.5. Example of Use

```
<categoryBag>
      keyedReference
            tModelKey="uuid:A05DC270-F7C8-11DA-8270-ABAD25871E16"
            keyName="Precondition"
            keyValue="http://example.org/rosetta#ValidCreditCard"
…
</categoryBag>
```

9.7. Effect

9.7.1. Design Goals

As needed by 7.5.4, this tModel is used to express a relation between an operation's effect element and a concept from a specific ontology. It is to be used with operation tModels.

9.7.2. Definition

Name:	thalesgroup-com:sc2:wsdl:effect
Description:	A category system used to associate an effect related concept from a specific semantic domain to an operation tModel.
V1,V2 format key:	uuid:D87CD330-F7C8-11DA-9330-E5D46D2020A1
Categorization:	categorization
Checked:	no

9.7.3. V2 tModel Structure

```
<tModel tModelKey="uuid:D87CD330-F7C8-11DA-9330-E5D46D2020A1">
      <name> thalesgroup-com:sc2:wsdl:effect </name>
      <description xml:lang="en">A category system used to associate an
effect related concept from a specific semantic domain to an operation
tModel</description>
      <overviewDoc>
            <overviewURL>
                  http://www.thalesgroup.com/sc2/wsdl-s_mapping.htm#effect
            </overviewURL>
      </overviewDoc>
      <categoryBag>
            <keyedReference tModelKey="uuid:c1acf26d-9672-4404-9d70-
            39b756e62ab4"
            keyName="uddi-org:types" keyValue="categorization"/>
            <keyedReference
            tModelKey="uuid:c1acf26d-9672-4404-9d70-39b756e62ab4"
            keyName="uddi-org:types" keyValue="unchecked"/>
      </categoryBag>
```

9.7.4. Valid values

Valid values for this category system are URIs. The content of the keyValue attribute in a keyedReference that refers to this tModel is the value of the *modelReference* attribute of the effect element defined by a specific operation.

9.7.5. Example of Use

```
<categoryBag>
      keyedReference
            tModelKey="uuid:D87CD330-F7C8-11DA-9330-E5D46D2020A1"
            keyName="Effect"
            keyValue="http://example.org/rosetta#AccountDebited"
…
</categoryBag>
```

10. Appendix B: Comparison between WSDL 1.1 and WSDL 2.0 component models

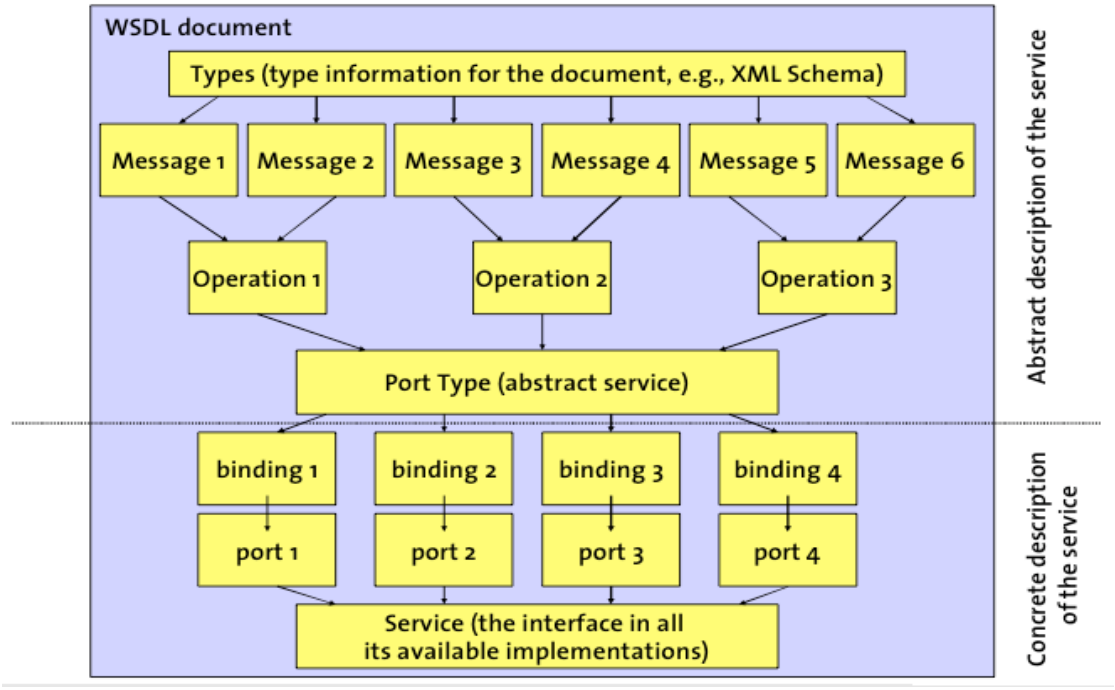


Figure 4 - WSDL 1.1

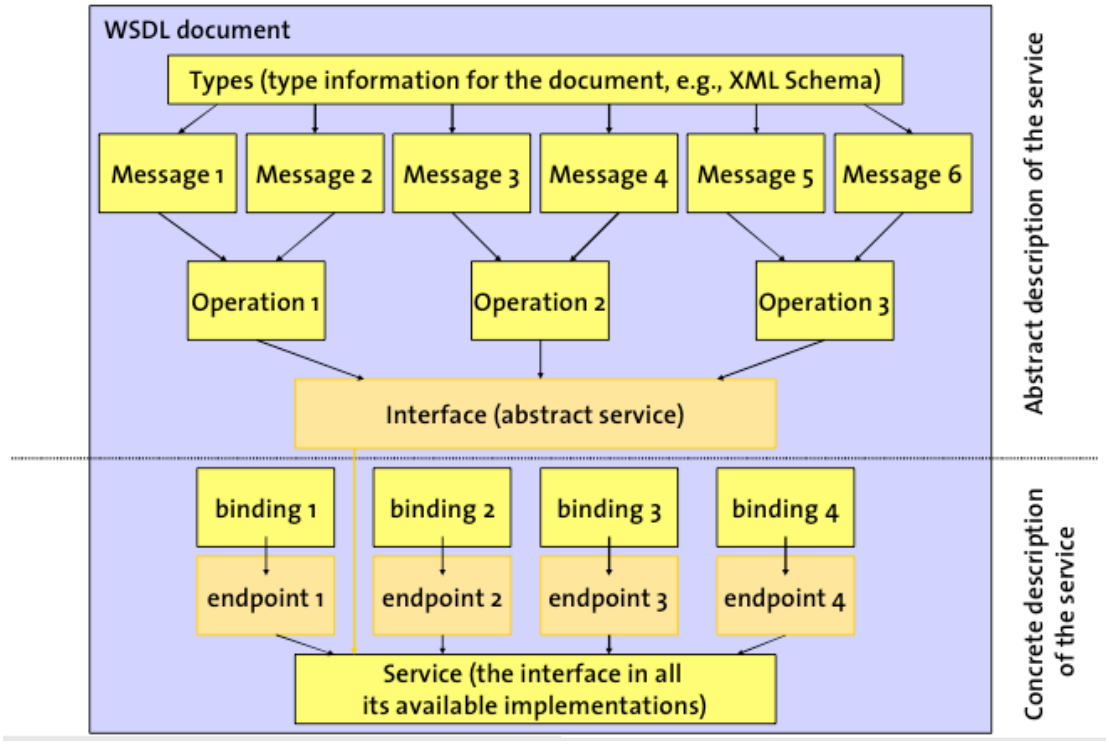


Figure 5 - WSDL 2.0

Errata: this diagram comes from an old WSDL 2.0 specification. The message component was removed from the last specification.

11. Appendix C: WSDL 2.0 Components hierarchical view