



## NextGRID Workflow Language Profile

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# 1 Introduction

This document defines the NextGRID Workflow Language Profile 1.0 (hereafter, "the Profile"). This Profile is part of the NextGRID Generalized Specifications which aims to capture NextGRID architectural concepts in a set of composable profiles. These profiles are specified in such a way that they could be implemented in terms of other well known specifications. While overall consistency is achieved at the conceptual level, and captured through the motivating Use Cases accompanying each specification, the implementation in terms of other specifications may not be consistent between different profiles. Thus each profile defines an implementable realisation of the underlying concept, but implementers of the full NextGRID architecture may need to support multiple competing underlying specifications.

Section 1 introduces the Profile, and explains its relationships to other profiles.

Section 2, "Profile Conformance", explains what it means to be conformant to this Profile.

Each subsequent section addresses a component of the Profile, and consists of two parts: an overview detailing the component specifications and their extensibility points, followed by subsections that address individual parts of the component specifications. Note that there is no relationship between the section numbers in this document and those in the referenced specifications.

## 1.1 Profile Overview

This Profile is intended for use when using a workflow language for orchestrating services that are concerned with distributed computing in line with the concepts of the NextGRID project [1]. A component implementation that uses a workflow language in a manner conformant with the Profile may be said to be an "implementation of the NextGRID Workflow Language Profile 1.0".

The primary issues addressed in this Profile are as follows:

- *Process Model*. This specification profiles the process model from OWL-S Semantic Markup for Web Service [2] to support orchestration of distributed services that are inline with the concepts of the NextGRID project.
- *Abstract Process*. This specification extends the "Process" concept from OWL-S Semantic Markup for Web Service [2] to enable description in workflow of abstract processes and their requirements.
- *Query Profile*. This specification profiles the "Service Profile" from OWL-S to enable association of query constraints with Abstract Processes. The constraints contained in a Query Profile can include an expression for querying a registry in order to discover candidate realisations for the associated Abstract Process, for example.
- *Grounding*. This specification profiles the "Grounding" concept and specification from OWL-S Semantic Markup for Web Service [2], to enable description of bindings in workflow for orchestrating services that are inline with the concepts of the NextGRID project.
- *Expressions and Conditions*. This specification extends OWL-S with new mechanism for representing conditional expressions in a workflow.

## 1.2 Relationships to Other Profiles

This Profile is related to the NextGRID Basic Profile [3] concerning XML serialisation of `wsa:EndpointReference`. It is related to the NextGRID Registry Profile [4] with regard to the query language that may be used to discover candidate bindings for abstract processes in a workflow. It is also related to the NextGRID Security Profile [5], with regard to handling of security tokens.

## 1.3 Notational Conventions

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC2119 [6].

Normative statements of requirements in this Profile are presented in the manner detailed in the Conformance Requirements section of WS-I Basic Profile 1.1 [7].

Both requirement statements and extensibility statements can be considered namespace-qualified.

This specification uses a number of namespace prefixes throughout; their associated URIs are listed below. Note that the choice of any namespace prefix is arbitrary and not semantically significant.

Table 1 Namespaces used by NextGRID Workflow Language Profile 1.0

Prefix	Namespace
owl	<a href="http://www.w3.org/2002/07/owl#">http://www.w3.org/2002/07/owl#</a>
rdf	<a href="http://www.w3.org/1999/02/22-rdf-syntax-ns#">http://www.w3.org/1999/02/22-rdf-syntax-ns#</a>
rdfs	<a href="http://www.w3.org/2000/01/rdf-schema#">http://www.w3.org/2000/01/rdf-schema#</a>
ngowlws	<a href="http://www.nextgrid.org/owlws">http://www.nextgrid.org/owlws</a>
grounding	<a href="http://www.daml.org/services/owl-s/1.1/Grounding.owl#">http://www.daml.org/services/owl-s/1.1/Grounding.owl#</a>

## 1.4 Profile Identification and Versioning

Profile identification and versioning uses the style described in WS-I Basic Profile 1.1 [7] and abides by the normative descriptions contained therein. The name of this Profile is "NextGRID Workflow Language Profile" and the version number is "1.0".

## 2 Profile Conformance

Conformance to the Profile is defined normatively in WS-I Basic Profile 1.1 [7]. This Profile abides by those definitions.

### 2.1 Conformance Targets

The following conformance targets are used in this Profile:

- **ENDPOINTREFERENCE** – the serialisation of the `wsa:EndpointReference` element and its content (from OGSA WSRF Basic Profile [8]).

- **WORKFLOW** – the serialisation of a workflow.
- **QUERYLANGUAGE** – the language and representation in workflow for querying registries.
- **TARGETSERVICE** – a NextGRID compliant service that is addressed within a WORKFLOW with the intention that an operation of the service will be invoked during workflow evaluation and execution.
- **WORKFLOWENGINE** – a software component that evaluates and executes a WORKFLOW to orchestrate one or more TARGETSERVICES.
- **SERVICE** – the workflow language (OWL-WS) construct representing a Web service, or a WORKFLOW that may compose many services.
- **PROFILE** – the workflow language (OWL-WS) construct that is used to express constraints and requirements associated with a SERVICE (e.g. Quality of Service and service interface details, or query constraints).
- **PROCESS** – the workflow language (OWL-WS) construct representing the operations and their sequencing constraints to correctly orchestrate a SERVICE.
- **GROUNDING** – the workflow language (OWL-WS) construct that defines binding information so that a WORKFLOWENGINE can bind to and execute a Web service.

## 2.2 Claiming Conformance

Claims of conformance to the Profile and are the same as normatively described in WS-I Basic Profile 1.1.

The conformance claim URI for this Profile is “<http://www.nextgrid.org/workflow-language-profile/v1>”.

## 3 Workflow language

This section of the Profile incorporates the following specification by reference:

- OWL-S: Semantic Markup for Web Services [2].

This document provides a Profile over OWL-S and extensions that generate a new semantic workflow language, referred to as OWL-WS.

### 3.1 Process Model

In the OWL-S specification the class `Service` provides an organizational point of reference for a declared Web service; one instance of `Service` will exist for each distinct published service. The properties `presents`, `describedBy`, and `supports` are properties of `Service`. The classes `ServiceProfile` (`Profile`), `ServiceModel`, and `ServiceGrounding` (`Grounding`) are the respective ranges of those properties. OWL-S also defines a sub-class of `ServiceModel` called `Process`, providing the specification of the ways a client may interact with the service.

The OWL-S upper ontology for services, depicted in Figure 1, specifies only two cardinality constraints:

- a `Service` can be described by at most one `ServiceModel`; and
- a `Grounding` must be associated with exactly one `Service`.

It does not specify any minimum cardinality for the properties `presents` or `describedBy`. Nor does the upper ontology specify any maximum cardinality for `presents` or `supports`.

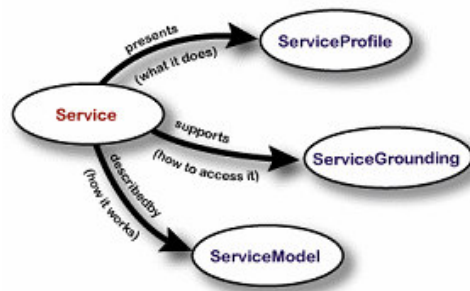


Figure 1: OWL-S Upper Ontology

In the OWL-WS process model in Figure 2 the class `Service` represents a service or workflow and it directly refers to `Process` instead of `ServiceModel`.

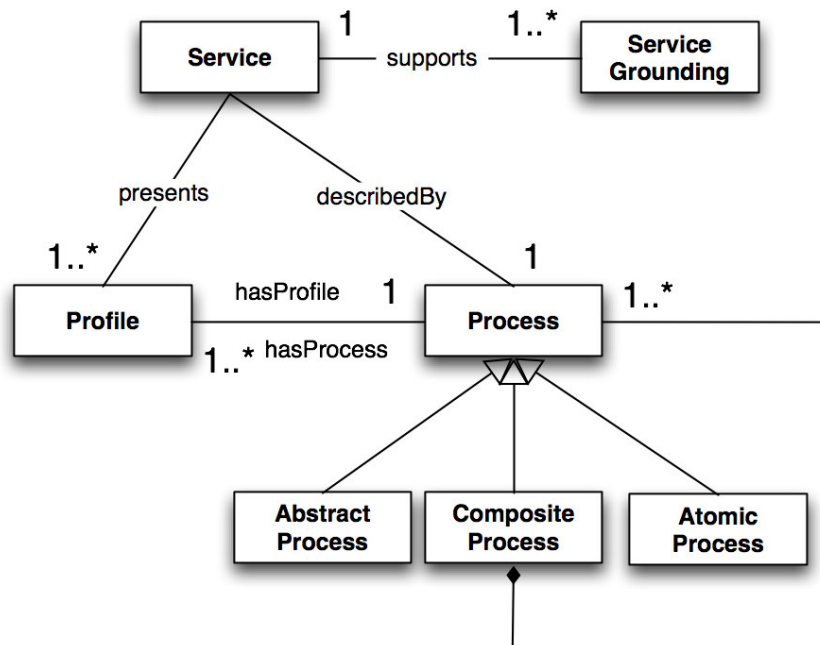


Figure 2: OWL-WS Process Model

OWL-WS also mandates that there must be at least one `Profile` and `Process` describing a service/workflow.

**R0311** a SERVICE MUST be described by exactly one PROCESS.

**R0312** a SERVICE MUST present one or more PROFILES.

There is no constraint on maximum cardinality for `presents` or `supports`: a `Service` can have one or more `Profiles` and `Groundings`.

In the OWL-WS model, each `Profile` and `Grounding` is associated with a `Process`. Therefore, `Process` and `Profile` need to be explicitly linked to each other. To this end the `hasProcess` property, from the OWL-S `Profile` schema is used to associate `Profile` and `Process`. A new property, `hasProfile`, is defined by OWL-WS to model the inverse of `hasProcess`.

**E0311** a *PROFILE MUST use the hasProcess property to identify its PROCESS.*

**E0312** a *PROCESS MUST use the hasProfile property to identify one or more associated PROFILES.*

Association of an `AbstractProcess` with its corresponding binding process is specified using the property `realizedBy` (see Section 3.2 below). The link between the `AtomicProcess` and the corresponding `Grounding` is implemented through the `Service` entity and the `Service Grounding` [9].

OWL-S does not specify any constraints between `Profile` and `Process` models. Consequently the two descriptions may be inconsistent for a `Service`. However, this situation could cause failures when OWL-WS processes are executed by compliant implementations. To avoid this, OWL-WS mandates that `Profile` and `Process` specification for the same `Service` MUST be consistent with each other.

**E0313** all *PROFILES associated with a PROCESS must be consistent with the constraints and descriptions expressed in the PROCESS.*

### 3.2 Abstract Process

An `AbstractProcess` is a `Process` that does not have a `Grounding` and therefore is not executable. The basic schema for an `AbstractProcess` is:

```
<owl:Class rdf:ID="AbstractProcess">
  <rdfs:subClassOf rdf:resource="#Process"/>
  <owl:disjointWith rdf:resource="#AtomicProcess"/>
  <owl:disjointWith rdf:resource="#SimpleProcess"/>
</owl:Class>
```

An `AbstractProcess` is associated with a *query profile* that specifies constraints that should be applied when discovering and selecting a *realisation*.

```
<owl:ObjectProperty rdf:ID="hasProfile">
  <rdfs:domain rdf:resource="#AbstractProcess"/>
  <rdfs:range rdf:resource="&profile;#Profile"/>
  <owl:inverseOf rdf:resource="&profile;#hasProcess"/>
</owl:ObjectProperty>
```

An `AbstractProcess` MAY be assigned an evaluation *priority* so that evaluation of `AbstractProcesses` can be ordered and co-ordinated during `PROCESS` enactment. If a priority is not specified for an `AbstractProcess`, a compliant implementation SHOULD consider the effective evaluation priority to be lower than the lowest priority specified in the workflow. In this case, the effective priority for the `AbstractProcess` MUST be considered equal to the evaluation priority of each `AbstractProcess` for which a priority was not specified.

**R0321** an *AbstractProcess MAY be associated with an evaluation priority. Interpretation of the value of an evaluation priority is implementation specific.*

**R0322** if an *AbstractProcess is not associated with an evaluation priority, the WORKFLOWENGINE SHOULD consider the evaluation priority to be lower than the lowest explicitly defined evaluation priority in the WORKFLOW, and*

*equal to the evaluation priority for all AbstractProcesses for which an evaluation priority was not specified.*

The schema for the `hasPriority` property and associated `Priority` class is provided below.

```
<owl:ObjectProperty rdf:ID="hasPriority">
  <rdfs:domain rdf:resource="#Process"/>
  <rdfs:range rdf:resource="#Priority"/>
</owl:ObjectProperty>

<owl:Class rdf:ID="#Priority">
  <rdfs:subClassOf rdf:resource="#Parameter"/>
  <owl:disjointWith rdf:resource="#Input"/>
  <owl:disjointWith rdf:resource="#Output"/>
  <owl:disjointWith rdf:resource="#Local"/>
  <owl:disjointWith rdf:resource="#Result"/>
</owl:Class>
```

After *discovery* and before *selection* during workflow enactment, an `AbstractProcess` may be associated with zero or more candidate realisations.

```
<owl:Class rdf:ID="CandidateProcessList">
  <rdfs:subClassOf rdf:resource="#shadow-rdf;#List"/>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#shadow-rdf;#first"/>
      <owl:allValuesFrom rdf:resource="#Process"/>
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#shadow-rdf;#rest"/>
      <owl:allValuesFrom rdf:resource="#Process"/>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

<owl:ObjectProperty rdf:ID="hasCandidates">
  <rdfs:domain rdf:resource="#AbstractProcess"/>
  <rdfs:range rdf:resource="#CandidateProcessList"/>
</owl:ObjectProperty>
```

If the *selection* phase of workflow enactment is successful for an `AbstractProcess` it will be associated with a realisation that is an executable `Process`.

```
<owl:ObjectProperty rdf:ID="realizedBy">
  <rdfs:domain rdf:resource="#AbstractProcess"/>
  <rdfs:range rdf:resource="#Process"/>
  <owl:inverseOf rdf:resource="#realizes"/>
</owl:ObjectProperty>

<owl:ObjectProperty rdf:ID="realizes">
  <rdfs:domain rdf:resource="#Process"/>
```

```

<rdfs:range rdf:resource="#AbstractProcess"/>
<owl:inverseOf rdf:resource="#realizedBy"/>
</owl:ObjectProperty>

```

### 3.3 Query Profile

A query Profile is a Profile used for providing constraints for an AbstractProcess. Constraints expressed in a query Profile SHOULD be taken into account when discovering and selecting a realization.

**R0331** the OWL-S ServiceParameter MAY be used in OWL-WS to provide a mechanism for specifying query Profile constraints.

A ServiceParameter includes a serviceParameterName, which is the name of the parameter, and a value. The value can be represented by a sParameter, that references a value within some OWL ontology, or it can be a spDataValue, when the value is a simple literal. The ServiceParameter schema is as follows.

```

<!--
  ServiceParameter describes service parameters.
-->
<owl:Class rdf:ID="ServiceParameter"/>

<!-- serviceParameterName is the name of the actual parameter,
  which could be just a literal, or perhaps the uri of the process
  parameter (a property)
-->

<owl:DatatypeProperty rdf:ID="serviceParameterName">
  <rdfs:domain rdf:resource="#ServiceParameter"/>
</owl:DatatypeProperty>
<owl:Class rdf:about="#ServiceParameter">
  <rdfs:comment>
    A ServiceParameter should have at most 1 name (more precisely only
    one serviceParameterName)
  </rdfs:comment>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#serviceParameterName"/>
      <owl:cardinality rdf:datatype="&xsd;#nonNegativeInteger"> 1
      </owl:cardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

<!-- sParameter points to the value of the parameter within some
  OWL ontology -->
<owl:ObjectProperty rdf:ID="sParameter">
  <rdfs:domain rdf:resource="#ServiceParameter"/>
  <rdfs:range rdf:resource="#owl;#Thing"/>
</owl:ObjectProperty>

```

```

<owl:Class rdf:about="#ServiceParameter">
  <rdfs:comment>
    a Parameter is restricted to refer to only one concept in some
    ontology
  </rdfs:comment>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#sParameter"/>
      <owl:cardinality rdf:datatype="&xsd;#nonNegativeInteger">1
    </owl:cardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

<!-- spDataValue is the value of the parameter in case it is a literal,
-->
<owl:DatatypeProperty rdf:ID="spDataValue">
  <rdfs:domain rdf:resource="#ServiceParameter"/>
</owl:DatatypeProperty>

```

An example of `ServiceParameter` usage within a query Profile, is provided below. The example shows a *query* specification within the query Profile. In this case, a `ServiceParameter` is specified in which:

- the `serviceParameterName` is a URI specifying the QUERYLANGUAGE; and
- the `spDataValue` is literal value for the query expression.

```

<profile:ServiceParameter>
  <profile:serviceParameterName>http://profile/application/xpathQuery/
</profile:serviceParameterName>

  <profile:spDataValue>/*/*[local-name()='Entry' and
  ./*[local-name()='spDataValue' and
  .='http://dataService/save']]</profile:spDataValue>
</profile:ServiceParameter>

```

**R0332** if a `profile:ServiceParameter` is used to specify a registry query, the `profile:serviceParameterName` element MUST contain a URI for a query language that is supported in the NextGRID Registry Profile.

**R0333** the `profile:spDataValue` property MUST contain a valid query expression for the query language specified by the `profile:ServiceParameterName` element.

### 3.4 Grounding

In OWL-WS a `Grounding` specifies binding information for a service. This specification profiles the OWL-S `Grounding` and defines additional properties that are relevant to binding to NextGRID compliant services.

An example OWL-WS `Grounding` is provided below. In this example, ellipses (“...”) are used in place of application specific values.

```

<ngowlws:Grounding rdf:about="...">

```

```
<grounding:wSDLOperation>
  <grounding:WSDLOperationRef>
    <grounding:operation
rdf:datatype="http://www.w3.org/2001/XMLSchema#anyURI">
      ...
    </grounding:operation>
  </grounding:WSDLOperationRef>
</grounding:wSDLOperation>

<ngowlws:serviceEndpoint>...</ngowlws:serviceEndpoint>
<ngowlws:federationContext>...</ngowlws:federationContext>
<ngowlws:securityContext>...</ngowlws:securityContext>

<grounding:owlsProcess rdf:resource="...">
  <grounding:wSDLDocument
    rdf:datatype="http://www.w3.org/2001/XMLSchema#anyURI">
    </grounding:wSDLDocument>
  </grounding:owlsProcess>
</ngowlws:Grounding>
```

OWL-WS extends OWL-S with a number of properties that are relevant to binding to NextGRID compliant services. Each property is considered in turn below.

### 3.4.1 Service Endpoint

The `ngowlws:serviceEndpoint` property is used to specify the `ENDPOINTREFERENCE` for the `TARGETSERVICE`.

**R0341** *the `ngowlws:serviceEndpoint` property of a `GROUNDING` MUST contain a valid `ENDPOINTREFERENCE` for the `TARGETSERVICE`.*

### 3.4.2 Federation Context

The NextGRID Security Profile [5] specifies how Federation Context headers should be included in SOAP messages.

The value of the `ngowlws:federationContext` parameter should be an `ENDPOINTREFERENCE` representing the federation context. In NextGRID federations are achieved using a Service Level Agreement (SLA) and consequently the value of the `ngowlws:federationContext` parameter is an `ENDPOINTREFERENCE` for an SLA.

**R0342** *the `ngowlws:federationContext` property of a `GROUNDING` MUST contain a valid `ENDPOINTREFERENCE` for an SLA.*

### 3.4.3 Security Context

The `ngowlws:securityContext` parameter is used to hold the `ENDPOINTREFERENCE` for a Security Token Service from which security tokens can be obtained.

In cases where security tokens are required to access a particular resource (for example an SLA or service), the security tokens obtained from the STS are placed in the `ENDPOINTREFERENCE` for the resource. This is done in accordance with the mechanisms specified in the NextGRID Security Profile [5].

**R0343** the `ngowlws:securityContext` property of a `GROUNDING` MAY contain a valid `ENDPOINTREFERENCE` for a Security Token Service.

**R0344** if the `ENDPOINTREFERENCE` for a Security Token Service is present, a `WORKFLOWENGINE` MUST obtain security tokens and insert them in messages addressed to a `TARGETSERVICE`, in accordance with the NextGRID Security Profile.

### 3.5 Expressions and Conditions

This section of the Profile concerns the way conditions can be specified in OWL-WS. In the OWL-S specification, ontology elements for capturing conditions can be expressed in a number of logical languages such as SWRL, DRS, RDQL, SPARQL, and KIF. OWL-WS extends these with the addition of XPath [10] for expressing conditions.

**E0351** XPath 1.0 MAY be used in a `WORKFLOW` to specify conditional expressions.

The ontology schema for these extensions is provided below.

```
<LogicLanguage rdf:ID="XPATH">
  <refURI rdf:datatype="http://www.w3.org/2001/XMLSchema#anyURI">
    http://www.w3.org/TR/xpath (</refURI>
</LogicLanguage>

<owl:Class rdf:ID="XPATH-Expression">
  <rdfs:subClassOf rdf:resource="#Expression" />
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#expressionLanguage" />
      <owl:hasValue rdf:resource="#XPATH" />
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#expressionBody" />
      <owl:allValuesFrom rdf:resource=
        "http://www.w3.org/1999/02/22-rdf-syntax-ns#XMLLiteral" />
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

<owl:Class rdf:ID="XPATH-Condition">
  <rdfs:subClassOf rdf:resource="#XPATH-Expression" />
  <rdfs:subClassOf rdf:resource="#Condition" />
</owl:Class>
```

## 4 References

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