OWL-S

José M. Vidal

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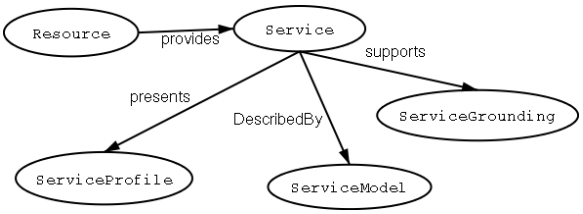
We introduce OWL-S. This talk is based on:

- The OWL Services Coalition. OWL-S Technical Overview[1]
- Unknown tag=Massimo Paolucci and Katia Sycara. Autonomous Semantic Web Services.[2] *IEEE Internet Computing,* 7(5):34–41, 2003.

1 Introduction

- WSDL is a simple standard for describing webservices. It provides functionality similar to an API.
- If we hope to have agent compose just-in-time services from individual components, we will need more semantically-rich descriptions of services.
- That is, an agent needs to have some understanding of what `getStockQuote (string symbol)` does.
- OWL-Services is a set of ontologies, written in OWL, which can be used to describe (at a higher/more detailed semantic level) what a service does.
- Previously known as DAML-S.

2 Upper Ontology for Services

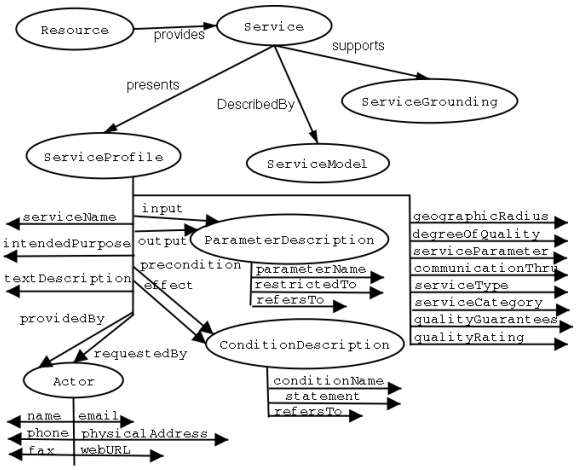


- `Resource`s are available out in the net.
- The OWL-S ontology defines a `Service` as the central class for describing interfaces, part of the OWL-S Service Ontology[3].
- *What does the service require and provide for the users?* This is given by the `ServiceProfile`. An agent uses it to determine whether the service meets it's needs.
- *How does it work?* Given by the `ServiceModel`. Gives details.
- *How is it used?* Given by the `Service Grounding`. It tells how to access the service.

3 Service Profiles

- The ServiceProfile ontology[4] supports the use of three types of information.
  1. A human readable description of the service and its provider.
  2. A specification of the functionalities that are provided by the service.
  3. Attributes which provide additional information and requirements (e.g., quality guarantees, expected response, geographic constraints, etc.)
- The functionalities are specified by declaring the IOPEs:
  - The *I*nputs the service expects.
  - The *O*utput information returned.
  - The *P*reconditions that have to be satisfied in order to use the service.
  - The expected *E*ffects from running the service.

3.1 ServiceProfile Ontology



3.2 Profile Description Attributes

- **serviceName** is the name (ID).
- **intendedPurpose** tells what constitutes successful accomplishment of service execution.
- **textDescription** English description.
- **providedBy** who provides it.
- **requestedBy** who requests this service.

3.3 Functional Description Attributes

- These attributes describe the interface.
- **input** describes the input(s) the service can receive.
- **output**
- **precondition** describes what must be true in order to use the service.
- **effect** what will happen when the service runs.

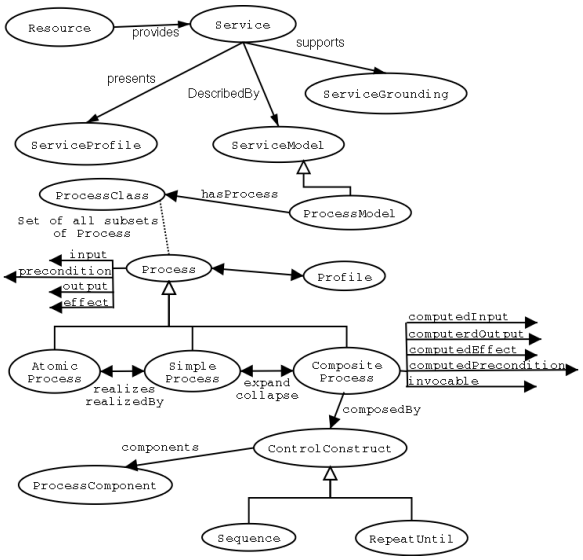
3.4 Functional Attributes

- A collection of other attributes that the service might have which do not deal with the process that the service implements.
- **geographicRadius**
- **degreeOfQuality**
- **serviceParameter**
- **communicationThru**
- **serviceType**
- **serviceCategory**
- **qualityGuarantees**
- **qualityRating**

4 Service Model

- Services are viewed as *processes* which are defined using a Process Ontology[5].
- A process can have any number of inputs.
- It can have any number of outputs.
- It has a parameter that specifies the participants in the process.
- It can have any number of preconditions that must hold for the process to be invoked.
- It can have any number of effects.
- Outputs and effects can have conditions associated with them.

4.1 Process Ontology



- An `AtomicProcess` is directly invocable, has not sub-processes, and executed in a single step.

- A `SimpleProcess` is not invocable (not associated with a grounding). Its executed in a single step. Used as an element of abstraction.
- A `CompositeProcess` is decomposable into other process using control constructs. It is `composedOf` a `ControlConstruct` which, in turn, has a `components` property that indicates the ordering and conditional execution of the sub-processes.

4.2 Control Constructs

- A `Sequence` is a list of `Processes` to be done in order.
- A `Split` contains a bag of process components to be executed concurrently.
- `Unordered` specifies a bag of process components that can be executed in any order.
- `Split+Join` consists of concurrent execution of process components with barrier synchronization.
- A `Choice` has further properties `chosen` and `chooseFrom` which let you create customized subsets.
- The `If-Then-Else` class has properties `ifCondition`, `then`, and `else`, which implement the statement.
- `Iterate` does just that until the `whileCondition` or `untilCondition` are met.
- **Repeat-Until** does a similar job.

4.3 Process Control Ontology

- Its an ontology that represent methods for monitoring and controlling the progress of an executing process.
- It does not exist yet.

4.4 Time Ontology

- OWL-S also defines a simple Time Ontology[6].
- It has two main classes: `Instants` and `Intervals`.
- It has three properties that go from Interval to Instant:
  - `start-of`
  - `end-of`
  - `inside`

5 Resources

- There is also a Resource Ontology[7].
- Processes generally require(consume) resources.
- `Resources` have an `AllocationType` property which can be used to tell if the resource is consumable (e.g., time) or reusable (e.g., paint).

6 Congo Example

- This example is from the walkthru.
- Congo is a website that sells books.
- Their services are LocateBook, PutInCart, SignIn, CreateAcct, CreateProfile, LoadProfile, SpecifyDeliveryDetails, FinalizeBuy.
- You cat get the complete Congo example file set[8].

6.1 Describe the Program

- Congo offers the CongoBuy service which is composed of smaller programs.
- You should describe these programs first.
- These individual programs are defined as `Process`.

6.2 Process Input and Output

- The process ontology shows the various types of processes we can have.
- The `LocateBook` service is atomic, so we declare it as such:

```
<process:AtomicProcess rdf:ID="LocateBook">
 <process:hasInput>
  <process:Input rdf:ID="BookName">
   <process:parameterType rdf:resource="&xsd;#string"/>
  </process:Input>
 </process:hasInput>
 <process:hasOutput>
  <process:ConditionalOutput rdf:ID="LocateBookOutput">
   <process:coCondition rdf:resource="#InCatalogueBookInstance"/>
                <process:parameterType rdf:resource="LocatedBookOutput"/>
  </process:ConditionalOutput>
 </process:hasOutput>
</process:AtomicProcess>
```

- This also says that `LocateBook` takes as input a BookName, which is a string
- The output is conditional. If `#InCatalogueBookInstance` then return `LocatedBookOutput`.

6.3 Process Preconditions and Effects

- In order to tie a bunch of processes together (compose) we also need to know their preconditions for execution and any side-effects they might have.
- So, OWL-S also has `precondition` and `effect` (yes, like AI planner operators. 1970's AI research might yet find an application :-).
- `ExpressCongoBuy` service has two preconditions: you must have an account and credit:

```
<process:AtomicProcess rdf:ID="ExpressCongoBuy">
 <process:hasInput>
  <process:Input rdf:ID="ExpressCongoBuyBookISBN">
```

```
    <process:parameterType rdf:resource="&xsd;#string"/>
   </process:Input>
     </process:hasInput>
     <process:hasInput>
  <process:Input rdf:ID="CongoBuySignInInfo">
    <process:parameterType rdf:resource="#SignInData"/>
   </process:Input>
 </process:hasInput>
 <process:hasPrecondition rdf:resource="#AcctExists"/>
 <process:hasPrecondition rdf:resource="#CreditExists"/>
 <process:hasEffect>
  <process:ConditionalEffect rdf:ID="CongoOrderShippedEffect">
    <process:ceCondition rdf:resource="#BookInStock"/>
    <process:ceEffect rdf:resource="#OrderShippedEffect"/>
  </process:ConditionalEffect>
 </process:hasEffect>

 <process:hasOutput>
  <process:ConditionalOutput rdf:ID="CongoOrderShippedOutput">
    <process:coCondition rdf:resource="#BookInStock"/>
    <process:parameterType rdf:resource="#OrderShippedOutput"/>
  </process:ConditionalOutput>
 </process:hasOutput>

 <process:hasOutput>
  <process:ConditionalOutput rdf:ID="CongoOutOfStockOutput">
    <process:coCondition rdf:resource="#BookOutOfStock"/>
    <process:parameterType rdf:resource="#BookOutOfStockOutput"/>
  </process:ConditionalOutput>
 </process:hasOutput>

</process:AtomicProcess>
```

- It has the effect of shipping the order, the the output tells if the book was in stock or not.

6.4 Composite Processes

- A `CompositeProcess` is `composedOf` a bunch of `ControlConstruct`s which can be things like `sequence`, `if-then-else`, `fork`, `while`, etc.
- Build them in a top-down manner.
- `FullCongoBuy` has two steps: locating the book and then buying the book.

```
<process:CompositeProcess rdf:ID="FullCongoBuy">
 <process:composedOf>
  <process:Sequence>
   <process:components rdf:parseType="Collection">
                          <process:AtomicProcess rdf:about="#LocateBook"/>
                         <process:CompositeProcess rdf:about="#CongoBuyBook"/>
   </process:components>
  </process:Sequence>
 </process:composedOf>
```

```
<!-- All of the inputs and outputs of this composite process are
derived from the corresponding inputs and outputs of its atomic
processes and will normally be computed automatically by OWL-S tools. -->

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyBookName">
   <process:parameterType rdf:resource="&xsd;#string"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuySignInInfo">
   <process:parameterType rdf:resource="#SignInData"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyCreateAcctInfo">
   <process:parameterType rdf:resource="#AcctInfo"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyCreditCardNumber">
   <process:parameterType rdf:resource="&xsd;#decimal"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyCreditCardType">
   <process:parameterType rdf:resource="#CreditCardType"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyCreditCardExpirationDate">
   <process:parameterType rdf:resource="&xsd;#string"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyCreditCardDeliveryAddress">
   <process:parameterType rdf:resource="&xsd;#string"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyPackagingSelection">
   <process:parameterType rdf:resource="&xsd;#string"/>
  </process:Input>
 </process:hasInput>

 <process:hasInput>
  <process:Input rdf:ID="FullCongoBuyDeliveryTypeSelection">
```

```
  <process:parameterType rdf:resource="#DeliveryType"/>
 </process:Input>
</process:hasInput>

<process:hasOutput>
 <process:ConditionalOutput rdf:ID="FullCongoBuyBookISBNOutput">
  <process:coCondition rdf:resource="#InCatalogueBookInstance"/>
          <process:parameterType rdf:resource="&xsd;#string"/>
 </process:ConditionalOutput>
</process:hasOutput>

<process:hasOutput>
 <process:UnConditionalOutput rdf:ID="FullCongoBuyCreateAcctOutput">
     <process:parameterType rdf:resource="#CreateAcctOutputType"/>
 </process:UnConditionalOutput>
</process:hasOutput>
</process:CompositeProcess>  <!-- End of Full Congo Buy -->
```

7 Conclusion

- OWL-S is more complex than WSDL.
- OWL-S gives a lot more details about how a process is composed of other process, what sequence they must execute, etc.
- It's processes are akin to AI-planning operators.
- Just-in-time service composition will be much more likely if services are described using OWL-S. Unfortunately that will require extra effort on the programmer's part (WSDL can be generated automatically).
- OWL-S is sits righ between web-services (RPCs over HTTP) and the Semantic Web vision.

Notes

[1] http://www.daml.org/services/owl-s/1.0/owl-s.html
[2] http://jmvidal.cse.sc.edu/library/paolucci03a.pdf
[3] http://www.daml.org/services/owl-s/1.0/Service.owl
[4] http://www.daml.org/services/owl-s/1.0/Profile.owl
[5] http://www.daml.org/services/owl-s/1.0/Process.owl
[6] http://www.isi.edu/ pan/damltime/time-entry.owl
[7] http://www.daml.org/services/owl-s/1.0/Resource.owl
[8] http://www.daml.org/services/owl-s/1.0/examples.html

This talk is available at `http://jmvidal.cse.sc.edu/talks/owls`