ICENI Semantic Service Adaptation Framework

Jeffrey Hau

London e-Science Centre
Department of Computing, Imperial College London
Grid and Semantic Web

**Grid**
- OGSI
- Web Services
- JINI

Service Interoperability through standard syntactic interface

**Semantic Web**
- RDF + OWL

Resource interoperability
By semantic metadata description

Enable interoperable Grid service with semantic metadata description

Service adaptation
Semantic Services

• What are semantic services?
  - services with metadata expressing their ‘capabilities’
  - making the implicit information explicit
  - enable searching through capabilities rather than static interface definition
Semantic Metadata

Resource Description Framework (RDF)

A simple data model of labelled directed graph
• Nodes and arcs are name by URIs
• graph can be decompose into “subject predicate object” triples

http://www.doc.ic.ac.uk/~jh398/ahm2003-talk.ppt

http://purl.org/dc/1.1/creator

http://www.doc.ic.ac.uk/~jh398

subject

predicate

object
What is an ontology?

- definition “specification of conceptualisation” (Gruber)
- a controlled vocabulary
- a concept taxonomy

Ontology provides the shared vocabulary and concepts for describing services.

Ontology enables reasoning about a shared knowledge domain.
Once services are semantically matched, what do you do with them?
- semantic matching isn’t the end of the story

```
add3(int a, int b, int c)    sum(int[] a)
       1,2,0          int[] {1,2}
```

AddService.add(1,2)
Service Adaptation

- Semantically matched services have varying interface definition and implementation details.

Adaptation enables ‘fuzzy’ syntactic match.

- User has to manually adapt his requirement to the matched services.

Adaptation enables dynamic and autonomous service invocation selection.
• **User** publishes requirement through semantically annotated Java interface
• **Services** publishes capability through semantic metadata
• **Semantic matching services** matches capabilities with requirements
• **Adaptation services** adapt requirement interface to service implementations.
Adaptation Framework in Action

Semantic matching service

Semantic Metadata

Semantic Metadata

Semantic Metadata

Java Interface

Adapter service

Adapter Proxy

Service

Service

Service
Adaptation in more detail

Semantic service metadata expressed in RDF can be viewed as directed labelled graphs.

Syntactic View

public int add(int a, int b) 

Semantic View

<rdf:Description rdf:about="uri:method1/param/a"> 
  <rdf:type rdf:resource="&java;int"/> 
  <rdf:Description> 
</rdf:Description>

Graph View

uri:method1/param/a
  hasType
    java:int

uri:method1/param/b
  hasType
    java:int

public int sum(int[] nums) 

<rdf:Description rdf:about="uri:method2/param/nums"> 
  <rdf:type rdf:resource="&java;array"/> 
  <rdf:Description>
Adaptation – Graph Transformation
Adaptation Proxy enables the autonomous invocation of syntactically different services.

Java ➔ RDF ➔ Graph

Instantiate Java objects dynamically from their RDF descriptions

```xml
<rdf:Description resource="param1">
  <java:hasType resource="&java;array"/>
  <java:hasElementType="&java;int"/>
</rdf:Description>
```

int[] {}
Adaptation Proxy

Use Java Reflection and Invocation Handler API to dynamically generate adaptation proxy.

Client View
AddService.add(1,2)

Invocation Handler
1,2 → int[] {1,2}

Service Metadata

Adaptation Proxy

Service Metadata
SumService(int[] {1,2})

Service View
Semantically annotate JINI services with RDF and OWL

Semantically matching JINI services using the Euler inference engine

Service Adaptation using graph transformation rules
• Director: Professor John Darlington
• Technical Director: Dr Steven Newhouse
• Research Staff:
  – Anthony Mayer, Nathalie Furmento
  – Stephen McGough, James Stanton
  – Yong Xie, William Lee
  – Marko Krznaric, Murtaza Gulamali
  – Asif Saleem, Laurie Young, Gary Kong
• Contact:
  – http://www.lesc.ic.ac.uk/
  – e-mail: lesc@ic.ac.uk