cse@buffalo

Semantic Grids

Arun Mirpuri
amirpuri@cse.buffalo.edu

Contents

- Introduction
- Why Semantic Grids?
- Semantic Web Overview
- RDF and Ontologies (OWL)
- Mapping Semantic Web onto Grid
- Key requirements and Capabilities
- Architecture
- Applications
- Final Words

Introduction

- Analogous to Power Grid
- "Virtual Organizations" – a dynamic collection of individuals, institutions and resources bundled together in order to share resources as they tackle common goals
- Middleware used for efficient utilization of resources

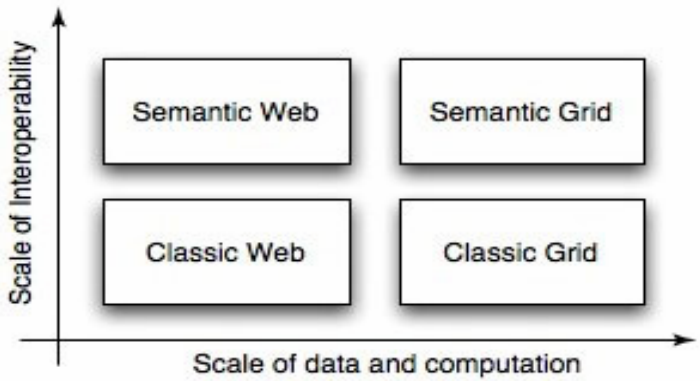
Why Semantic Grids?

- Meta-data for locating resources managed in adhoc manner
- Prone to syntactic changes
- Less interoperable
- Manual deployment, maintenance and configuration

Why Semantic Grids? (continued…)

- "An extension of the current grid in which information and services are given well-defined meaning, better enabling computers and people to work in cooperation."
- Maximizes the reuse of software, services, information and knowledge

Why Semantic Grids? (continued…)



- Semantic Grid combines higher inter-operability with greater computational facilities
- Extends existing grids by providing richer semantics

Semantic Web Overview

- *"…an extension of the current Web in which information is given well defined meaning, better enabling computers and people to work in cooperation. It is the idea of having data on the Web defined and linked in a way that it can be used for more effective discovery, automation, integration, and reuse across various applications… data can be shared and processed by automated tools as well as by people." World Wide Web Consortium*

- Describe what it is *about* and what it is *for*.

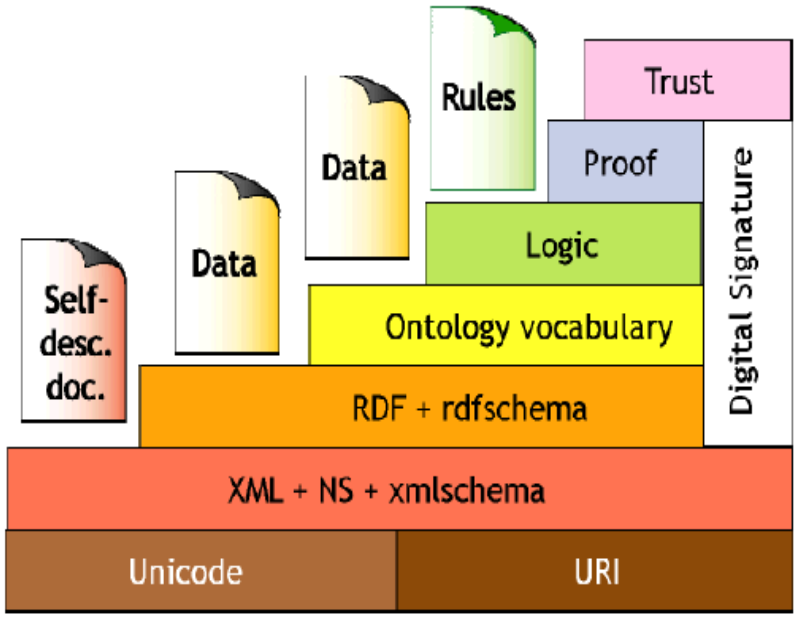
Semantic Web Overview (continued…)

- Example 1 - search for “pharmacy selling paracetamol"
  - Returns pharmacy/pharmacies closest to you, that is open and selling the cheapest pain relief.
- Example 2 – search for “flight to New York City (specify address) from Christmas to New Year
  - Returns the best deals available for return trips across airline sites for (window?) seat from Buffalo to an NYC airport closest to the destination address (JFK/La Guardia/Newark)

Semantic Web Overview (continued…)

- Annotate semantically every bit of web resource
- Express information to enable processing by machines
- Results in a web of formally and semantically interlinked data

Semantic Web Overview (continued…)



- Layer cake model for Semantic Web proposed by Tim Berners-Lee
- RDFs represent the meta-data required to describe any resource
- Ontologies use RDFs to express meanings of key terms, for easier interpretation of resource meta-data

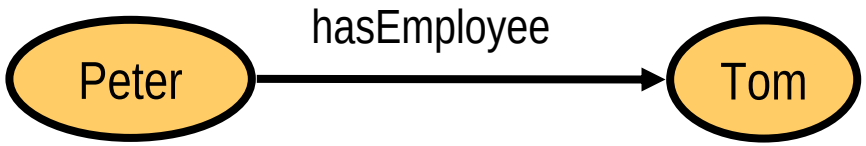
Semantic Web Overview (continued…)

- Semantic web search engine developed by University of Maryland, Baltimore County for semantic web documents, terms and data on the web
- Employs a system of crawlers to discover RDF documents and HTML documents with embedded RDF content.
- Any guesses on the name??

Semantic Web Overview (continued…)

RDF and Ontologies

- RDF Data Model
  - Statements are <subject, predicate, object> triples:
    - <Peter,hasEmployee,Tom>
  - Can be represented as a graph:



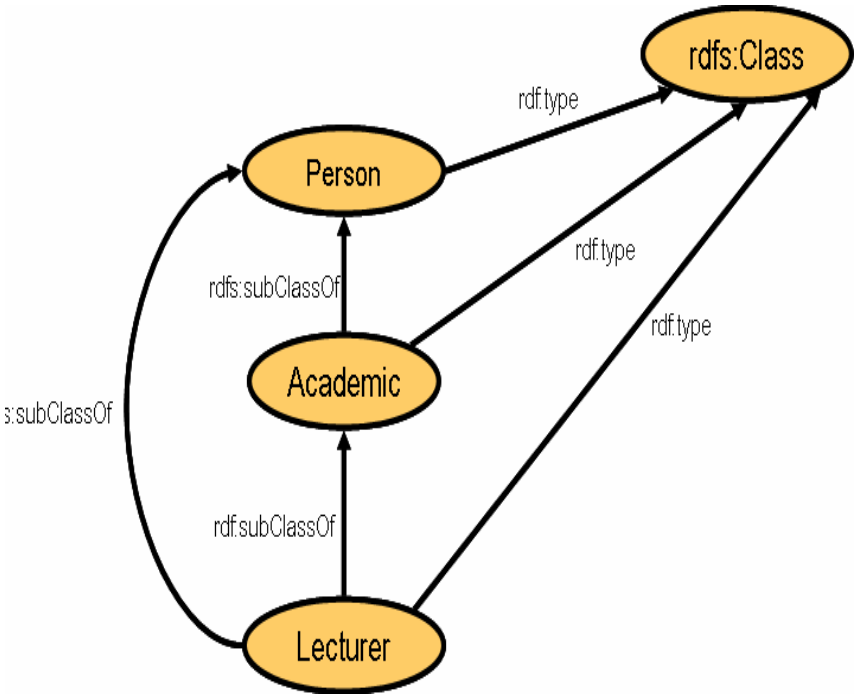
  - Statements describe properties of resources
  - A resource is any object that can be pointed to by a URI

RDF and Ontologies (continued…)

- RDF Syntax

```
<rdf:Description rdf:about="S23SD/person/peter">
  <o:hasEmployee resource="S23SD/person/Tom"/>
  <o:hasName rdf:datatype="&xsd;string">Peter Andrews</o:hasName>
</rdf:Description>
<rdf:Description rdf:about="S23SD/person/tom">
  <o:hasCar>Honda Civic</o:hasCar>
</rdf:Description>
```

RDF and Ontologies (continued…)



- RDF Schema
  - RDF Schema extends RDF with a schema vocabulary with-
    - Class, type, subClassOf,
    - Property, subPropertyOf,
  - Associates different RDF resources and assigns meaning to them

RDF and Ontologies (continued…)

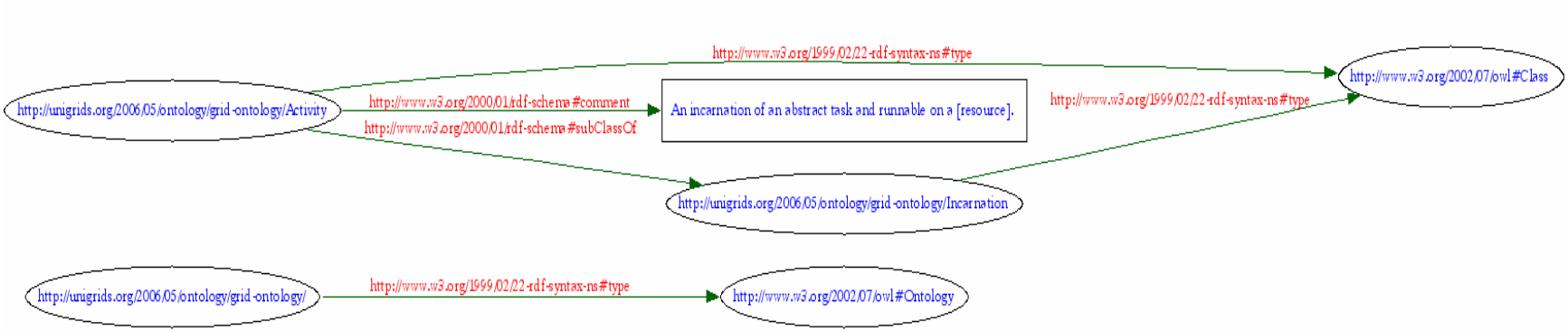
- Why Ontologies are required along with RDF?
  - RDFs do not contain range and domain constraints
    - E.g. not possible to describe **hasEmployee** to contain only persons. It can contain animals, birds along with persons
  - RDFs do not contain cardinality constraints
    - E.g. not possible to specify **how many** employees would resource Peter have
  - RDFs cannot express symmetric, inverse or transitive properties
    - E.g. **IsEmployeeOf** property (if existed!) could not have been expressed as a inverse of **hasEmployee** property (that exists!)

RDF and Ontologies (continued…)

- Web Ontology Language (OWL) Taxonomy

Classes	- Way of describing the world. - Collection of Individuals	e.g. – person, professor, student
Property	- Means of describing relationships between Individuals	e.g.has_student, is_male, person_no
Individuals	- Objects in the world. - Related to other objects, data values via properties	e.g. Individual(pp:Rex type(pp:dog) value(pp:is_pet_of pp:Mick))

RDF and Ontologies (continued…)




```
<rdf:RDF
   xmlns="http://unigrids.org/2006/05/ontology/grid-ontology/"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
  xml:base="http://unigrids.org/2006/05/ontology/grid-ontology/">
  <owl:Ontology rdf:about=""/>
  <owl:Class rdf:about="http://unigrids.org/2006/05/ontology/grid-ontology/Activity">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >An incarnation of an abstract task and runnable on a [resource].</rdfs:comment>
    <rdfs:subClassOf>
      <owl:Class rdf:about="http://unigrids.org/2006/05/ontology/grid-ontology/Incarnation"/>
    </rdfs:subClassOf>
  </owl:Class>
</rdf:RDF>
```

Mapping Semantic Web onto Grid

Semantic Web	Grid
Operating in global distributed and changeable environment Computationally accessible and sharable metadata needed Complexity hidden	
Small number of hosts	Large number of interacting processes
Enables communication	Enables full collaboration
Static provider of metadata	Dynamic user of metadata
Persisting web services	Appearing and disappearing grid services
Stateless web services	Transient and stateful grid services

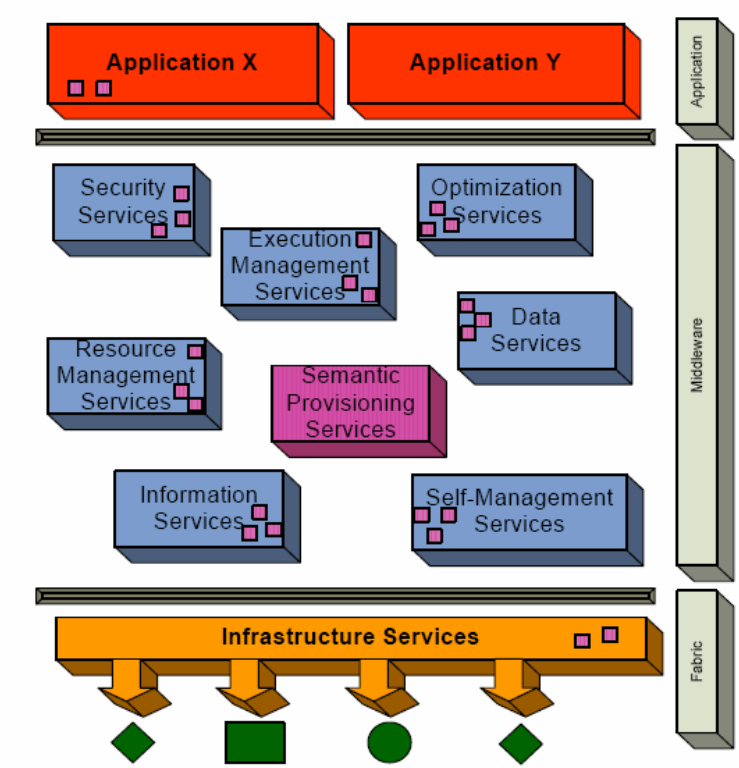
Key Requirements and Capabilities

- What is expected from Semantic Grids?
  - Resource description, delivery and re-use
  - Process description and enactment
  - Autonomic behavior
  - Annotation
  - Information Integration
  - Synchronous information streams
  - Context-aware decision support
  - Community Support
  - Ease of configuration and deployment
  - Integration with legacy systems

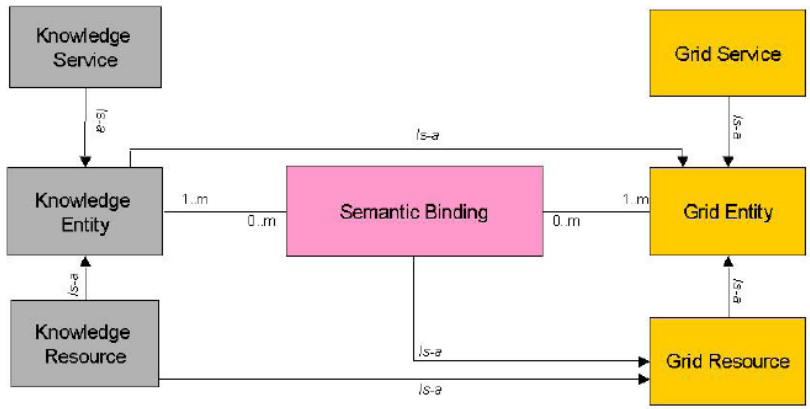
Key Requirements and Capabilities (continued…)

- What do Semantic Grids provide?
  - Web services – Provides on-the-fly software composition through the use of loosely coupled, reusable software components
  - Software agents - bring the dynamic decision making, decentralization, coordination, and autonomous behavior needed to realize virtual organizations. Results in autonomy of systems
  - Metadata – Can be used to label Grid services. Extended by sharing and linking of machine readable content
  - Ontologies and Reasoning – Provide descriptions of resource capabilities. Help in inter-operability and reuse
  - Semantic Web Services – Provide detailed semantic description for indicating capabilities of services

Architecture



Modified OGSA model (S-OGSA)



Entities in S-OGSA and their relationships

Applications

- In Enterprise Grids
  - Insurance Grids - economize the process of insurance claims handling by chain integration of parties involved
- caBIG – build a network that will freely connect researchers, physicians, and patients to promote information sharing for prevention and treatment of cancer.
- BBC Climate Change Initiative – Use the idle processing power of home PCs to building computer models for climate change

Final Words

- Use of semantic grids would allow large scale integration of resources
- Automation of creating, managing and maintaining meta-data required
- Encouraging and promoting use of more machine readable documents on the web
- Scalability and reliability of Semantic Grids need to further improved
- People need to think beyond organizational boundaries and share resources

References

- Article by Martin Brown on IBM Developerworks entitled *What is the semantic grid?*, published September 2005
- Oscar Corcho, Pinar Alper, Ioannis Kotsiopoulos, Paolo Missier, Sean Bechhofer and Carole Goble. *An overview of S-OGSA: A Reference Semantic Grid Architecture.* Web Semantics: Science, Services and Agents on the World Wide Web, Volume 4, Issue 2, June 2006, Pages 102-115
- De Roure, D. Jennings, N.R. Shadbolt, N.R. *The Semantic Grid: Past, Present, and Future*, Proceedings of the IEEE, Volume 93, Issue 3, March 2005, Pages 669-681, ISSN: 0018-9219
- Introduction to Grid Computing, IBM Redbooks
- C. A. Goble and D. De Roure, "The Grid: an application of the semantic web," ACM SIGMOD Record, vol. 31, pp. 65-70, 2002
- Semantic Grid presentations given at the DMTF 2006 Alliance Partners Technical Summit in Portland, Oregon, July 2006.
- W3C.ORG RDF Primer

Any Questions?