Outline

- Services and Services Science (beyond SE, CS)
- Our focus in Services Science research
- Service Ontologies: an analysis
- Challenges
- Future Work

Services Spectrum

- On an average day, we use around 40 services
- Utility Services (Potable water, Drainage, Transport, Electricity...)
- Information Service (News, Information Content, Analysis)
- Communication Services (Telecom, Internet...)
- Government Services (Health, Security, Education, Welfare...)
- Professional Services (Finance, Health, Legal Consultation.)
- Web Services and * as a Service

Services vs. Products

- Few observations
  - Interactions and Exchange (or not)
  - Customization (or not)
  - Value Co-creation (or not)
  - Skill-based and/or Knowledge-based (or not)

Growing Complexities: Multiple Players

Growing Complexities: Automation
Growing Complexities
Ratings, Compliance, Governance...

Growing Complexities: Mediation beyond registry

Internet of Services (IoS)...
Service Marketplace Requirements

- Legal and community aspects, and business models
- Service search based on advance service description
- Negotiation of service level description
- Service monitoring
- Billing and payment
- Service governance
- Service delivery platform
- Service engineering

(Carboso et al., 2003)

Service Operations

- Typical operations during service life cycle
  - Service Identification
  - Service Design
  - Service Offering
  - Service Discovery
  - Service Consumption
  - Service Governance
  - Service Evaluation
  - Service Regulation
  - Service Innovation
  - Service Monitoring

Discipline Spectrum

- Service activities can benefit from different discipline point-of-views
  - Science (Social, legal..)
  - Management (Marketing, Finance, Operations, ...)
  - Engineering (Telecom, Software, ...)
  - Arts (Performing arts, creativity..)
The Services Science Challenge

- How to realize vision of Services Science
  - By covering
    - Full Service Spectrum
    - Full Service Life Cycle
    - Full Discipline Spectrum

Our Focus

- To address issues of
  - Complexity
  - Heterogeneity
- With help of effective knowledge management
  - Modeling concepts and their inter-relationships
    - Ontology Development
    - Integrating with practice
    - Unified Process for Service Knowledge Management

Ontology and Ontology Engineering For Services

- Ontology
  - A formal specification of a shared conceptualization
- Ontology Engineering
  - Formal approach
  - Standard based tooling
  - Advantage
  - Sharing and Reuse
  - Reasoning on the runtime

Semantic Web Community- A Survey

Service Ontology Development: Issues

- Some practical issues
  - Few Service Ontologies already exist
  - Can not be ignored (being outcome of standardization process)
  - May not be compatible as is (designed for different purposes)
  - Competing Standards/Legislations
  - No General / unifying theories exist
  - Difficult to build multi-disciplinary team of knowledge engineers.

Service Ontology Development: Requirements

- An appropriate methodology to
  - Evaluate existing Ontologies
  - Establish gaps and overlaps
Method Appropriate for Evaluation

- A formal approach to ontology design and evaluation
  - [Step 1] A motivating Application Scenario
  - [Step 2] Informal Competency Questions
  - [Step 3] Terminology
  - [Step 4] Formal Competency Questions
  - [Step 5] Specification of Formal Axioms
  - [Step 6] Completeness Theorems

(Uschold and Grüninger, 1996).

Our Approach for Systematic Analysis

- Selection of Ontologies
  - Literature Survey (Research Papers, Standards, Theses)
- Selection Criteria
  - Initial grouping (Business, Computation, Quality, Classification)
- Formal Approach
  - [Step 1] Terminology
  - [Step 2] Informal Competency Questions
  - [Step 3] Internet of Service (IoS) Scenario
- Coverage Analysis

Service Ontologies focusing on Service Concepts

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Development goals</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:ecl@ss.owl">ecl@ss.owl</a></td>
<td>Service concept</td>
</tr>
<tr>
<td>GoodRelations</td>
<td>Functional properties</td>
</tr>
<tr>
<td>OBELIX</td>
<td>Non-functional properties</td>
</tr>
<tr>
<td>Serviguration</td>
<td>Configuration of service bundles</td>
</tr>
</tbody>
</table>

Service Ontologies focusing on Business Aspects

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:ecl@ss.owl">ecl@ss.owl</a></td>
<td>Industry, competitive advantage</td>
</tr>
<tr>
<td>ecl@ss</td>
<td>Industry, competitive advantage</td>
</tr>
<tr>
<td>OBELIX</td>
<td>Bundling, re-serviceable services</td>
</tr>
<tr>
<td>Serviguration</td>
<td>Configuration of service bundles</td>
</tr>
</tbody>
</table>
**Service Ontologies focusing on Computational Aspects**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Concepts</th>
<th>Properties</th>
<th>DL Exp.</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>ToG</td>
<td>50</td>
<td>71</td>
<td>ALCHIN</td>
<td></td>
</tr>
<tr>
<td>OASIS</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>SQA</td>
</tr>
<tr>
<td>WSDL</td>
<td>60</td>
<td>69</td>
<td>ALCHIN</td>
<td></td>
</tr>
<tr>
<td>OWL-S</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Service mediation</td>
</tr>
<tr>
<td>WS-AF</td>
<td>93</td>
<td>69</td>
<td>ALCHIN</td>
<td>Agent mediation</td>
</tr>
</tbody>
</table>

**Business Aspects**

- CQ: What is the business value offered by a service?
- CQ: Who are the partners of a given service instance?
- CQ: What are the Service Level Agreement (SLA) parameters of a service?
- CQ: Is a certain service an atomic offering or a service bundle?

**The Open Group**

**Service Ontologies focusing on Quality Aspects**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Concepts</th>
<th>Properties</th>
<th>DL Exp.</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoSOnt</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>WS-QoSOnt</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SL-Ontology</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>FIPA</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>WSAF</td>
<td>93</td>
<td>69</td>
<td>ALCHIN</td>
<td>Agent mediation</td>
</tr>
<tr>
<td>MQO (Kim et al., 2007)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Conceptualization of quality parameters</td>
</tr>
</tbody>
</table>
WSAF

Quality Aspects

- CQ: What types of QoS parameters are relevant for a given service type?
- CQ: What are the QoS properties of a certain service instance?
- CQ: What is the quality of a certain service?
- CQ: What conversions are known for some given quality parameter?
- CQ: What is the agreed value of a service parameter?
- CQ: What types of exceptions are possible for a service instance?

Service Ontologies focusing on Classification Aspects

<table>
<thead>
<tr>
<th>Ontology</th>
<th>Example</th>
<th>Properties</th>
<th>Role</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAICS.owl</td>
<td>2341</td>
<td>0</td>
<td>A1</td>
<td>Industry classification</td>
</tr>
<tr>
<td>UNSPSC.owl</td>
<td>2548</td>
<td>0</td>
<td>A1</td>
<td>Industry classification</td>
</tr>
<tr>
<td>ISIC.owl</td>
<td>538</td>
<td>0</td>
<td>A1</td>
<td>Industry classification</td>
</tr>
<tr>
<td>CPC.owl</td>
<td>3650</td>
<td>0</td>
<td>A1</td>
<td>Industry classification</td>
</tr>
<tr>
<td><a href="mailto:ecl@ss.owl">ecl@ss.owl</a></td>
<td>76976</td>
<td>5525</td>
<td>A1(D)</td>
<td>Industry classification with e-commerce</td>
</tr>
</tbody>
</table>

UNSPSC

Classification Aspects

- CQ: Which standard service industry class a certain service belongs to?

Proposed Classification of Service Aspects: Based on Issues and Conceptual Gaps identified
Current Status

- Developing Service Ontology
- Exploring possibilities of reuse
- Addressing identified gaps
- Designing a proof-of-concept
- Setting up consortium of multi-disciplinary experts
- Developing joint research proposal

Outcomes

- Journal Article
  - "An Analysis of Service Ontologies"Accepted for publication in PALIS special issue on Research Directions and Issues of Service Research, A Perspective of Business Information Systems, 2010. Co-authored with Luís Ferreira Pires and Marten van Sinderen.
- Conference/Workshop paper