Contents

• Review of semantic annotation techniques
  • Types of annotations
  • “Compatibility” of existing approaches with past and present work
    • W3C: Semantic services e.g. SAWSDL
    • OGC: SensorML and other SWE standards

• Assessment of progress against SSN XG objectives
  • Mission: “to begin the formal process of producing ontologies that
    define the capabilities of sensors and sensor networks, and to
    develop semantic annotations of a key language used by
    services based sensor networks.”
    [Charter: http://www.w3.org/2005/Incubator/ssn/charter]

• Path to completion
  • Dependencies-linkages with work done elsewhere
    • W3C-led work
    • OGC-led work
Semantic annotation: a tentative definition

- **Semantic Annotation** (for a document containing text or data): a web annotation which adds information to a web resource that is described in an ontology
  - Can use any of the categories of definitions which can be included in an ontology (T-Box + A-Box)
- Such annotation may be added to different types of content
  - XML
  - Service descriptions
    - WSDL and XML Schemas
    - WADL and XML Schemas
    - HTML description of services
  - HTML
  - And even RDF

<table>
<thead>
<tr>
<th>Type of semantic annotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain instance</td>
</tr>
<tr>
<td>Domain class</td>
</tr>
<tr>
<td>Object property</td>
</tr>
<tr>
<td>Inverse object property</td>
</tr>
<tr>
<td>Range instance</td>
</tr>
<tr>
<td>Range class</td>
</tr>
<tr>
<td>Datatype property</td>
</tr>
<tr>
<td>Datatype property type</td>
</tr>
<tr>
<td>Range value</td>
</tr>
</tbody>
</table>
Three types of annotation techniques

- Provide links to content managed in external resources to allow local apps to access remote content to enrich the resource
  
  \[\text{Current use of XLink in OGC}\]

  - “Normal annotations”: the linked resource is not part of an ontology
  - Semantic annotations: the linked resource is part of an ontology
  - Special case: some plain resources can be converted into ontology elements (e.g. URNs)

- Provide “model reference to ontological descriptions” (and lifting script) to allow remote apps to lift content from a resource
  
  \[\text{SAWSDL / hRESTs}\]

  - Semantic annotations: the linked resource is part of an ontology
  - Provide embedded attributes to allow remote apps to lift content from a resource

  \[\text{RDFa}\]

  - Hybrid annotations: annotation fields may or may not correspond to ontology content. Special case: some plain fields can be converted into ontology elements (e.g. URNs)
Note: co-existence of multiple standard stacks

• Three families of standards
  • XML
  • HTML
  • RDF

• Risks with hybrid approaches
  • Difficulty for end users to differentiate the valid uses from the invalid ones
  • Validator tools become more complex to develop and to use

• See discussion in
  • Laurent Lefort Review of semantic enablement techniques used in geospatial and semantic standards for legacy and opportunistic mashups in Proc. of the 5th Australian Ontology Workshop (AOW 2009) paper and slides
Reviewed approaches

• Lifting data into RDF from XML
• SAWSDL
  • Data produced by the service
  • Service description itself
• hRESTs/RDFa
  • Data from service with custom script
  • Service description itself
• RDFa
• XML data containing xlinks to “semantic URNs”
Lifting data into RDF from XML

XML data

A id=myA

B id=myB

RDF data

A

B

@grddl:rel/href

Custom-made lifting script

XSLT (or XSPARQL or …)
Annotating a service using SAWSDL

(1) Lifting the data produced by the service

XML data

A id=myA
p
B id=myB

WSDL file or XML Schema:

xsd:element name=A

Custom-made lifting script

RDF data

A id=myA
p
B

@sawsdl:liftingSchemaMapping

myA

@sawsdl:modelReference

myB

XSLT (or XSPARQL or …)

A id=myA

myA

Same approach can be applied to WADL
Annotating a service using SAWSDL
(2) Lifting the service description itself

WSDL file or XML Schema:

```
wsdl:operation name=A
```

RDF data

```
“Standard” lifting script

@sawsd:modelReference
```

```
Operation

Class in the SAWSDL service ontology
```

```
modelRef

Property in the SAWSDL service ontology
```

```
A

Class in domain ontology
```

Same approach can be applied to WADL
Annotating a RESTful service using hRESTs/RDFa
(1a) Lifting data from service with custom script

XML data
A id=myA
  p
    B id=myB

RDF data
A
  p
    B

myA
myB

Custom-made lifting script

HTML description
Form
  = typeOf
    A
  = about
    myA

span
  = property
    p

div
  = typeOf
    B
  = about
    myB

XSLT (or XSPARQL or …)
A id=myA
  →
    A

myA

@rel="lowering" href= 
Annotating a RESTful service using hRESTs/RDFa (1b) Lifting data from service with standard script

Possible area of improvement of existing W3C standards
Annotating a service using SAWSDL (2) Lifting the service description itself

**HTML description**

- Form: anchor = typeOf myA
- span = property p
- div = typeOf myB

**RDF data**

- Operation: modelRef
- "Standard" lifting script
- @sawsd:modelReference
- Class in the SAWSDL service ontology
- Property in the SAWSDL service ontology
- Class in domain ontology
Lifting data into RDF from HTML using RDFa

HTML document

```
<div anchor="myA" typeOf="A" about="A"> </div>
<br/>

<span anchor="p" property="property"> </span>
<br/>

<anchor="myB" typeOf="B" about="B"> </anchor>
```

RDF data

```
A
/premise Raf
myA

B
/premise Raf
myB
```

“Standard” lifting script

@rdfa annotations (different attributes for different purposes)

- For datatype properties
- For datatype range (xsd types)
- For RDF literals (values)
Lifting XML data containing xlinks to “semantic URNs”

**XML data**

```xml
A id=myA
  p
  xlink:role = C
  xlink:href = myC
  xlink:arcrole = q
```

**RDF data**

lifting script

Custom or standard?

```
A
  q
  C
```

@xlink annotations

**Technical area where guidance material for OGC standard users would be beneficial**

Note: in GML, XLink annotations can only be attached to properties!
XLink – RDFa comparison

- **RDFa complete specification:**
  - covers all the different aspects of the OWL language
- **RDFa lifting script fully specified**
  - Can be implemented in multiple ways
    - Javascript, XSLT, Python, Ruby

- **XLink is part of XML stack and well known of XML developers**
  - Upgrading XLink could be a convenient method to upgrade existing OGC standards
  - Possibility to extend XLink with a RDFa style?
    - Initial investigation: not easy to port the RDFa spec. on an XLink base if XLink only authorised in property / leaf elements
    - New features in XLink 1.1 ([http://www.w3.org/TR/xlink11/](http://www.w3.org/TR/xlink11/)) not targeting this specific usage
## XLink – RDFa comparison (details)

<table>
<thead>
<tr>
<th>RDF mapping</th>
<th>XLink</th>
<th>RDFa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain instance</td>
<td><img src="image" alt="Anchor" /></td>
<td>about or src</td>
</tr>
<tr>
<td>Domain class</td>
<td><img src="image" alt="Anchor" /></td>
<td>typeof</td>
</tr>
<tr>
<td>Object property</td>
<td><img src="image" alt="Anchor" /></td>
<td>arc role</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Anchor" /></td>
<td>rel</td>
</tr>
<tr>
<td>Inverse object property</td>
<td><img src="image" alt="Anchor" /></td>
<td>rev</td>
</tr>
<tr>
<td>Range instance</td>
<td><img src="image" alt="Anchor" /></td>
<td>href</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Anchor" /></td>
<td>href or resource</td>
</tr>
<tr>
<td>Range class</td>
<td><img src="image" alt="Anchor" /></td>
<td>role</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Anchor" /></td>
<td>typeof</td>
</tr>
<tr>
<td>Datatype property</td>
<td><img src="image" alt="Anchor" /></td>
<td>property</td>
</tr>
<tr>
<td>Datatype property type</td>
<td><img src="image" alt="Anchor" /></td>
<td>role</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Anchor" /></td>
<td>datatype</td>
</tr>
<tr>
<td>Range value</td>
<td><img src="image" alt="Anchor" /></td>
<td>content or element content</td>
</tr>
</tbody>
</table>
Current use of XLink in OGC

• Conventions defined by the GML standard (Portele 2007)

• GML specification: xlink can only be used on properties
  • Reference to an object element in the same GML document
    <myProperty xlink:href="#o1"/>
  • Reference to an object element in a remote XML document using the gml:id value of that object: <myProperty xlink:href="http://my.big.org/test.xml#o1"/>
  • Reference to an object element with a uniform resource name may be encoded as follows (a URN resolver is required): <myProperty xlink:href="urn:x-ogc:def:crs:EPSG:6.3:4326"/>
Current use of URNs in OGC

- **ISSUE**: URN is a generic resource naming mechanism
  - Cannot tell if a URN is expected to be mappable to a class, property or to an individual
- **ISSUE**: the rules/conventions for the URN usage in SWE are not documented for the SWE examples below
  - @definition
  - @uom
  - @xlink:href in element
    - `<process name="thermometer" xlink:href="urn:vast:sensor:davisTemperature:1.0:001"/>
  - @xlink:role in swe:field
    - `<swe:field name="Battery Current" xlink:role="urn:ogc:def:property:powerSupply"/>
  - Literal in sml:value
- **ISSUE**: if we want to add an annotation to @uom
  - Tougher to define annotation mechanism applicable to attributes
XLink used for “semantic annotations”

- Sheth [Semantic Sensor Markup of Data and Services](#) SSN-XG briefing
  - XLink @href pointing to individual
- Luis Bermudez [Enriching SOS services with Ontologies - OOSTethys/OceansIE and MMI](#) SSN-XG briefing
  - XLink @href pointing to individual
- Janowicz et al. (2009; forthcoming): [Semantic Enablement for Spatial Data Infrastructures](#). Transactions in GIS.
  - XLink @href pointing to individual with @role pointing to sawsdl:modelReference (should be arcrole)
  - Correct use of sawsdl:modelReference in XML schema but does not define the associated lifting script
  - XLink @href pointing to #AirTemperature – assumed to be
Issues with XLink (and its usage in OGC)

• ISSUE: URNs can point to an individual, a class or a property
  • No guidelines on these three types of URN
  • `<swe:Quantity definition="urn:ogc:def:property:SBE:batteryCurrent">`
• Confusion between XLink @role vs. @arcrole
  • Ex of a property URN (here, @arcrole should be used): `<swe:field name="Battery Current" xlink:role="urn:ogc:def:property:powerSupply">`
  • Same issue with the @definition attribute
• Usage of @href (to an individual) generally correct
  • Because the majority of the community developing and using OGC standard plans to use SKOS to manage vocabulary elements
• Possible conflicts between current usage and new usage
  • Conventions needed for simple transposition from XML data (including semantically convertible URNs) into RDF
  • Conventions needed for annotations which ~ SAWSDL (model references)
  • Other cases identified by University of Muenster
Progress assessment & proposed courses of actions

• Charter extract
  • Mission: “[..] to develop semantic annotations of a key language used by services based sensor networks.”

• Findings
  • Possible areas of improvement of existing service annotations standards (follow-up work on SAWSDL/hRESTs)
    • Proposed course of action: feedback to the W3C Web Service Activity
    • Multi-standard stack issues not limited to SSN XG: feedback to TAG
    • Disruptive innovations (RDFa-inspired) beyond the scope of the XG?
  • Lack of guidance for current OGC standards users wishing to adopt Semantic Web technologies (XLink and URNs usage)
    • Open issues: relative values of approaches using existing standards “as is” vs. approaches requiring (non-disruptive) changes
    • Proposed course of action: OGC Discussion paper issued by individual members of the XG according to OGC process (see next slide)
  • Lack of Semantic Markup examples to illustrate use of the SSN ontology in real world apps \( \rightarrow \) PRIORITY for completion of work
Wanted: guidance material directed at OGC users

- **Objective:** fill gaps in current practice and go beyond current use of SAWSDL or hRESTs and of XLink / URNs pointing at individuals

- **Work to be completed**
  - Issue guidance on the use of sawsdl:modelReference in XLink-based annotations
  - Issue guidance material on the use of xlink:role and xlink:arcrole
  - Issue guidance material on “Semantic URNs”
  - Evaluation of “as-is” use of existing standards vs. “non-disruptive changes”
    - Check W3C standards compliance and OGC-standards compliance of proposed approaches

- **Linkage – Dependencies**
  - Work by University of Münster
    - Patrick Maué (ed.): OGC Discussion Paper "Semantic Annotations in OGC Standards OGC 08-167r1"
    - SAPIENCE: http://my-trac.assembla.com/sapience/
    - ENVISION http://www.envision-project.eu/

- **Proposed target:**
  - OGC discussion paper: call for contribution from OGC experts (even if they are external to the group – if everyone agrees to this idea)
Semantic Markup examples: status

- Many examples on the SSN XG wiki
  - Semantic_Markup_Draft_Deliverable#Motivating_Use-cases

- Based on sawsdl:modelReference!

- `= xlink:role C`
- `= xlink:href myC`
- `= xlink:arcrole sawsdl:modelReference`
Issue to be discussed: different implementation strategies “as-is” vs. “non-disruptive changes”

- Different assumptions to clarify within the XG between
  - “as is” strategy: no change to the existing specs
    - Assumption: new OGC services specialised in the management of semantic web definitions are created to avoid change in existing ones
    - Check if 52 North (and partners) are following this path
  - “non-disruptive changes” strategy: find right trade off to create more flexible specs.
    - Modify the existing services at a cost as low as possible to allow new usages (no extra services required)
    - (if possible) put all the annotations together and automate their processing

- Type of benefits to aim for (trade offs)
  - Reduce custom-made development
  - Provide extra validation opportunities compared to existing spec.

- Further investigations required
  - The presence of hidden changes (or unacceptable non-compliance)
  - The risks of confusions / conflicts between different usages
Wanted: more semantic markup examples

• To answer the following questions:
  • Choice of one specific semantic markup techniques or combination of several approaches?
  • arcroles:
    • limited to sawsdl:modelReference?
    • sawsdl:modelReference plus domainReference?
    • unrestricted (q in the figure below)?
  • Part of the SSN XG to be used in annotations
  • Part of the OGC schemas where annotations will be allowed

• To provide feedback to:
  • SSN ontology developers
  • Writers of guidance material
Summary

• Defining what a semantic annotation is a challenging task
  • The difference between non-semantic and semantic annotation is hard to define
    • Some type of content can sit on both sides of the boundary (e.g. URNs)

• Need for guidance material specifically targeting users of OGC standards
  • Decide if this type of documents should be published as an OGC or as an W3C “discussion paper”
    • In the latter case, it would be good to have some sorts of OGC endorsement
  • Need to further discuss “as-is” vs. “non-disruptive-changes”

• Need for concrete semantic markup examples

• Resolve dependencies-linkages with work done on the ontology and also with work done outside the working group
CSIRO ICT Centre
Laurent Lefort
Ontologist

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• **Resource Description Framework (RDF)** The Resource Description Framework (RDF) is a language for representing information about resources in the World Wide Web. RDF is a W3C recommendation. RDF is based on the idea of identifying things using Web identifiers (called Uniform Resource Identifiers, or URIs), and describing resources in terms of simple properties and property values. This enables RDF to represent simple statements about resources as a graph of nodes and arcs representing the resources, and their properties and values. [more info]
Alphabet soup (2)

- **GRDDL** - A markup format for Gleaning Resource Descriptions from Dialects of Languages. It is a W3C Recommendation, and enables users to obtain RDF triples out of XML documents, including XHTML. [more info]
  - It defines the syntax to include a reference to a lifting script in a source document - the lifting script can then be used to transform the document to RDF

- **SAWSDL** - A set of extension attributes for the Web Services Description Language and XML Schema definition language that allows description of additional semantics of WSDL components. [more info]
  - Allows the user to record the mapping of WSDL elements to concepts defined in a reference ontology and to specify the lifting scripts which can be applied to the output of a service to transform it into a RDF file using the reference ontology concepts
• **hRESTs** - A microformat to add additional meta-data to REST API descriptions in HTML and XHTML. Developers can directly embed meta-data from various models such as an ontology, taxonomy or a tag cloud into their API descriptions. The embedded meta-data can be used to improve search (for example: perform faceted search for APIs), data mediation (in conjunction with XML annotation) as well as help in easier integration of services to create mashups.

• **SA-REST** and **Micro-WSMO**: two similar methods to semantically annotate REST services using the same microformat (hRESTs) and a different target ontology. Similar basis than SAWSDL (including the possibility to include a reference to a lifting script) but applicable to an HTML-based description of a service). [more info]

• The **Web Application Description Language (WADL)** is an XML-based file format that provides a machine-readable description of HTTP-based web applications. These applications are typically **REST web services**. WADL is a W3C Member Submission. [more info]
• **XSPARQL**: a hybrid language derived from XQuery and SPARQL which provides a solution for mapping between XML and RDF in either direction, addressing both the use cases of GRDDL and SAWSDL. As a side effect, XSPARQL may also be used for RDF to RDF transformations beyond the capabilities of "pure" SPARQL.[more info]

  - **XSPARQL is a W3C Member submission and may also be considered as a use case for future work on XQuery extensibility.**
Alphabet soup (5)

- **Resource Description Framework -in- attributes (RDFa)** RDFa is a W3C Recommendation that adds a set of attribute level extensions to XHTML for embedding rich metadata within Web documents. [more info]
Alphabet soup (6)

• **XML Linking Language (XLink)** XLink is an XML markup language for creating hyperlinks in XML documents. XLink is a W3C recommendation and outlines methods of describing links between resources in XML documents.[more info]

• **Uniform Resource Name (URN)** is a Uniform Resource Identifier (URI) that uses the *urn* scheme, and does not imply availability of the identified resource. The Functional Requirements for Uniform Resource Names are described in RFC 1737.
## RDFa attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Intended RDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>about</td>
<td>The identification of the resource (to state what the data is about)</td>
<td>rdf:about of domain resource</td>
</tr>
<tr>
<td>typeof</td>
<td>RDF type(s) to associate with a resource</td>
<td>rdf:about of class of a resource</td>
</tr>
<tr>
<td>href</td>
<td>Partner resource of a relationship ('resource object')</td>
<td>rdf:about of range resource</td>
</tr>
<tr>
<td>property</td>
<td>Relationship between a subject and some literal text ('predicate')</td>
<td>rdf:about of datatype property</td>
</tr>
<tr>
<td>rel</td>
<td>Relationship between two resources ('predicate')</td>
<td>rdf:about of object property</td>
</tr>
<tr>
<td>rev</td>
<td>Reverse relationship between two resources ('predicate')</td>
<td>rdf:about of (inverse) object property</td>
</tr>
<tr>
<td>src</td>
<td>Base resource of a relationship when the resource is embedded 'resource object')</td>
<td>rdf:about of domain resource</td>
</tr>
<tr>
<td>resource</td>
<td>Partner resource of a relationship that is not intended to be 'clickable' ('object')</td>
<td>rdf:about of range resource</td>
</tr>
<tr>
<td>datatype</td>
<td>Datatype of a property</td>
<td>XML type range of datatype property</td>
</tr>
<tr>
<td>content</td>
<td>Machine-readable content ('plain literal object')</td>
<td>Value for datatype property</td>
</tr>
</tbody>
</table>
### XLINK

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Intended RDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>xlink:href</td>
<td>Identifier of the resource which is the target of the association, given as a URI</td>
<td>rdf:about of range resource</td>
</tr>
<tr>
<td>xlink:role</td>
<td>Nature of the target resource, given as a URI</td>
<td>rdf:about of class of range resource</td>
</tr>
<tr>
<td>xlink:arcrole</td>
<td>Role or purpose of the target resource in relation to the present resource, given as a URI</td>
<td>rdf:about of object property linking domain element to range resource</td>
</tr>
<tr>
<td>xlink:title</td>
<td>Text describing the association or the target resource</td>
<td>rdfs:comment</td>
</tr>
</tbody>
</table>