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Semantic Sensor Networks XG

Semantic Markup

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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

Type of semantic annotations	
Domain instance	
Domain class	
Object property	
Inverse object property	
Range instance	
Range class	
Datatype property	
Datatype property type	
Range value	

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
 - = 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
 - = 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
 - = 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

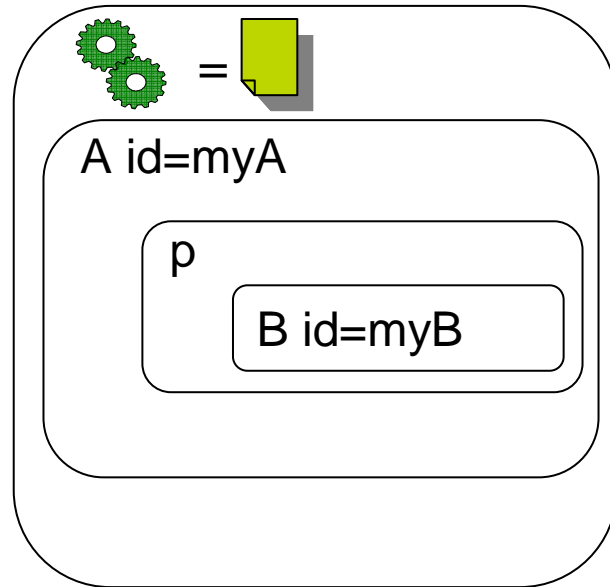
- Three families of standards
 - XML
 - HTML
 - RDF
- Risks with hybrid approaches
 - Difficulty for end users to differentiate the valid uses from the invalid ones
 - Validator tools become more complex to develop and to use
- See discussion in
 - Laurent Lefort Review of semantic enablement techniques 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 xlink to “semantic URNs”

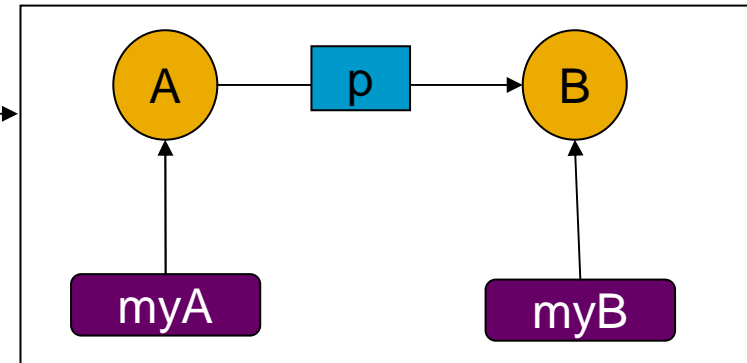
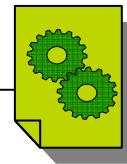
Lifting data into RDF from XML

XML data

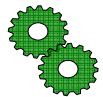


RDF data

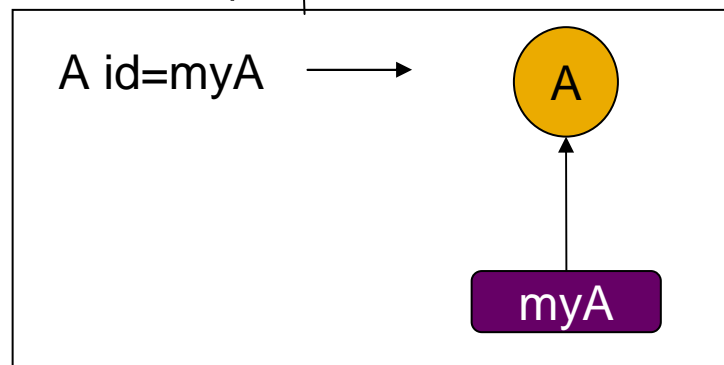
Custom-made lifting script



XSLT (or XSPARQL or ...)



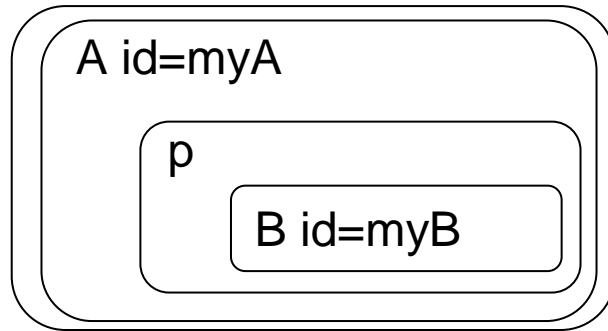
@grddl:rel/href



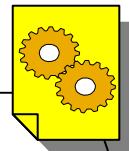
Annotating a service using SAWSDL

(1) Lifting the data produced by the service

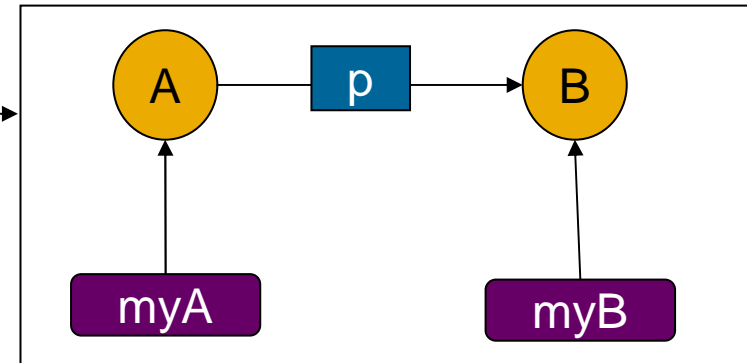
XML data



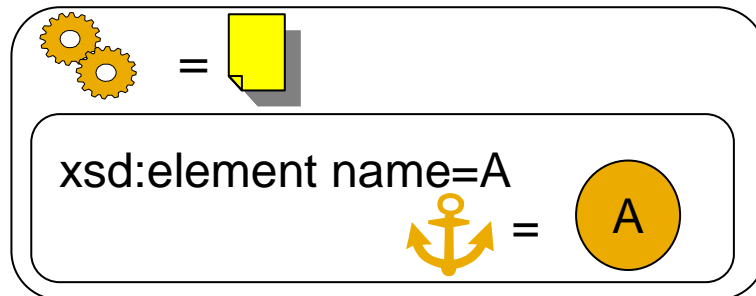
Custom-made lifting script



RDF data



WSDL file or XML Schema:

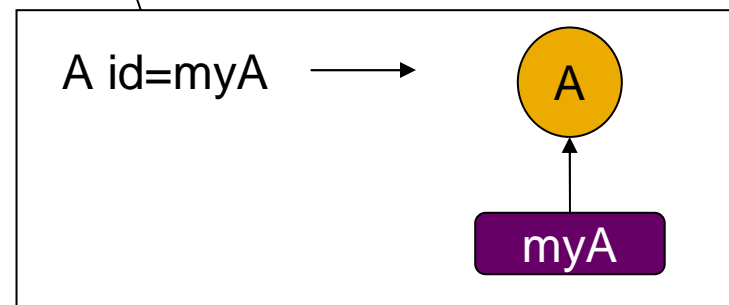


@sawSDL:liftingSchemaMapping



@sawSDL:modelReference

XSLT (or XSPARQL or ...)

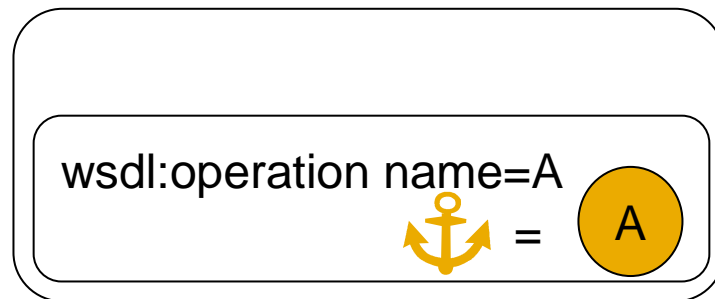


Same approach can be applied to WADL

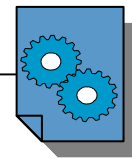
Annotating a service using SAWSDL

(2) Lifting the service description itself

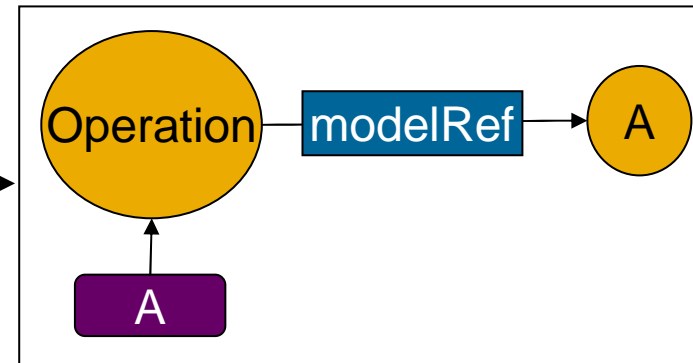
WSDL file or XML Schema:



“Standard”
lifting script



RDF data



@sawsd:modelReference



Class in the SAWSDL service ontology



Property in the SAWSDL service ontology



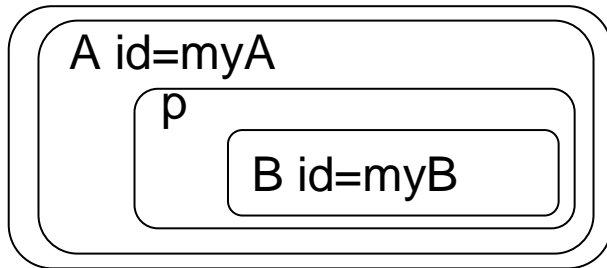
Class in domain ontology

Same approach can be applied to WADL

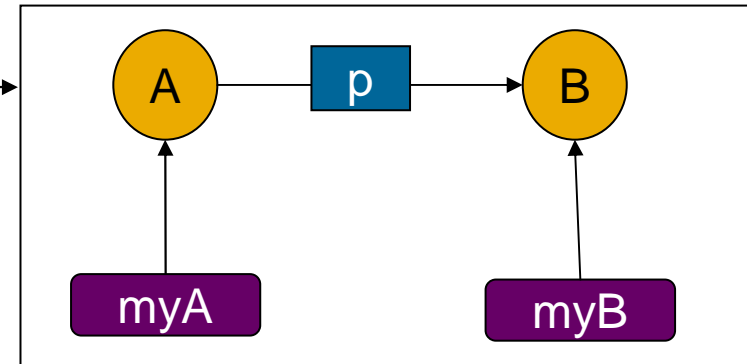
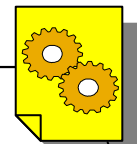
Annotating a RESTful service using hRESTs/RDFa

(1a) Lifting data from service with custom script

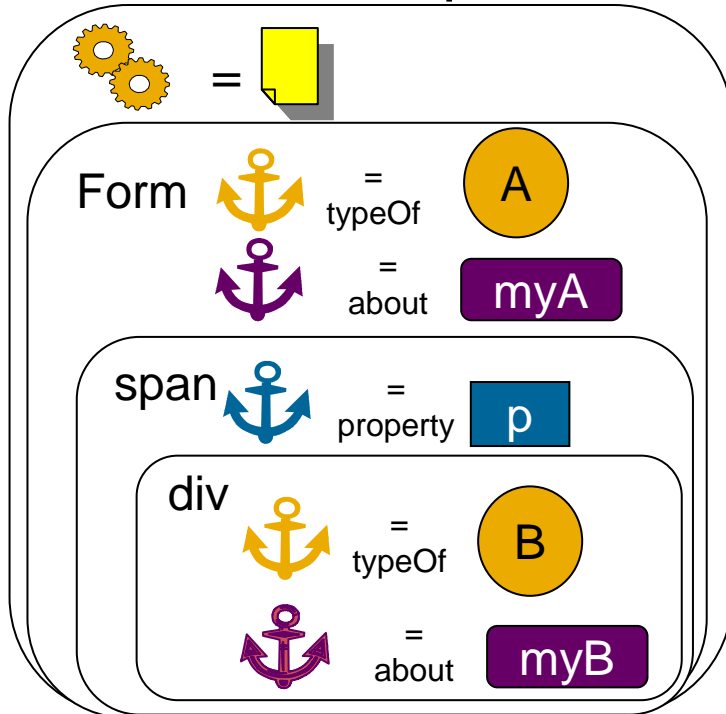
XML data



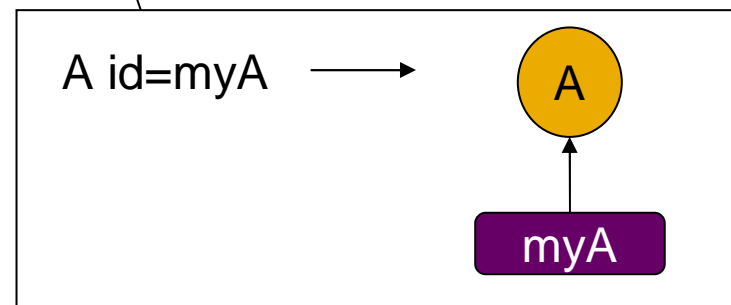
Custom-made RDF data lifting script



HTML description



XSLT (or XSPARQL or ...)

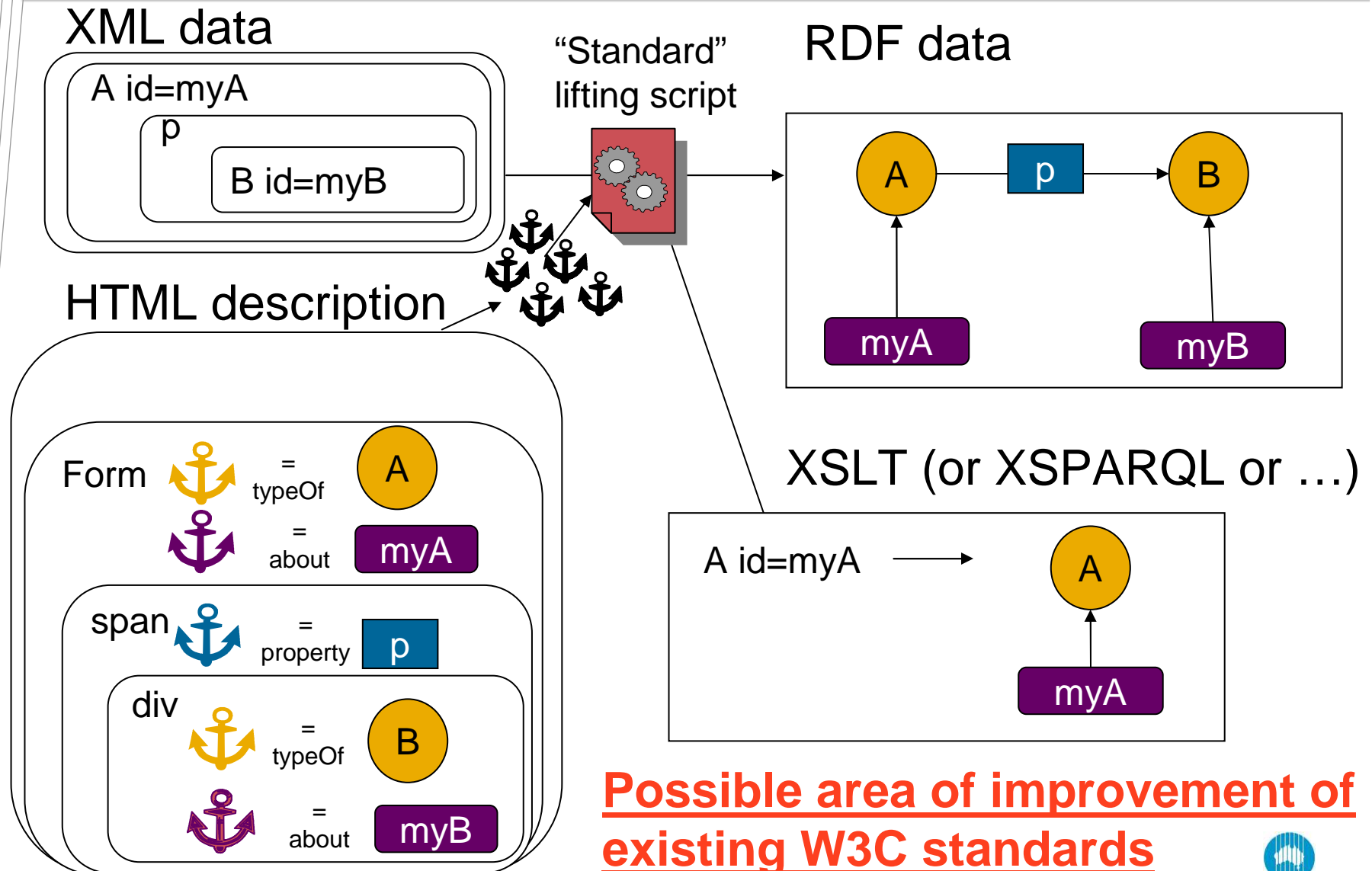


@rel="lowering" href=



Annotating a RESTful service using hRESTs/RDFa

(1b) Lifting data from service with standard script

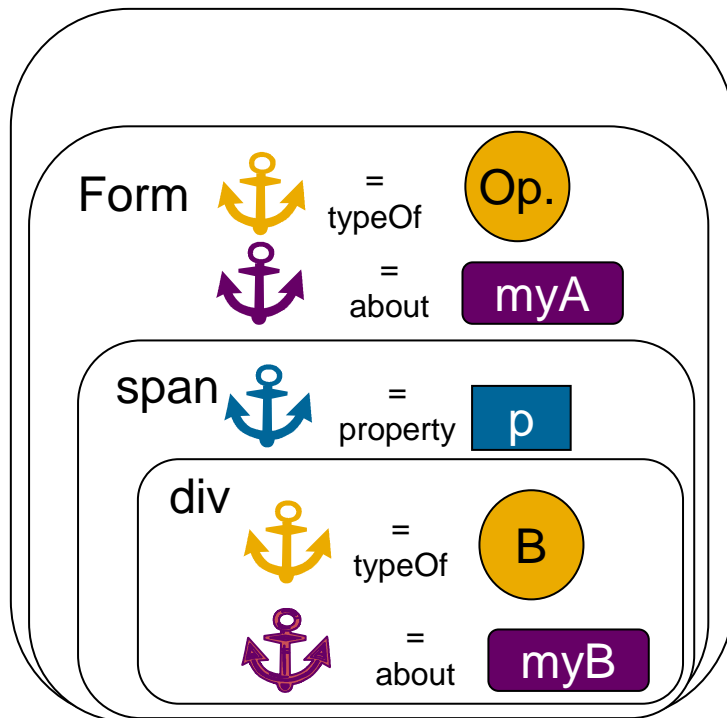


Possible area of improvement of existing W3C standards

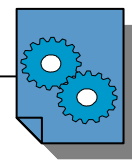
Annotating a service using SAWSDL

(2) Lifting the service description itself

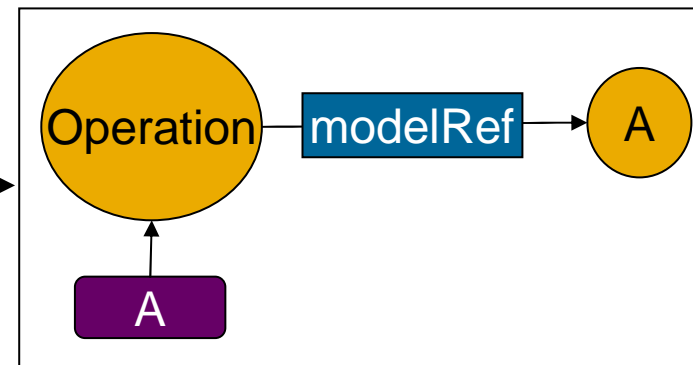
HTML description



"Standard"
lifting script



RDF data



@sawsd:modelReference



*Class in the SAWSDL
service ontology*



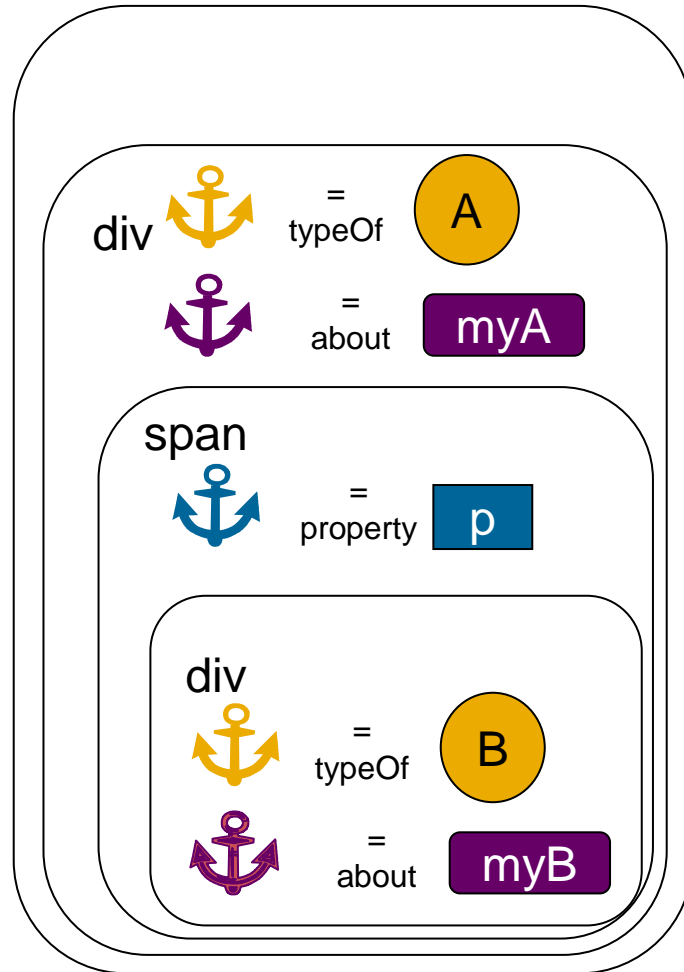
*Property in the SAWSDL
service ontology*



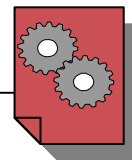
Class in domain ontology

Lifting data into RDF from HTML using RDFa

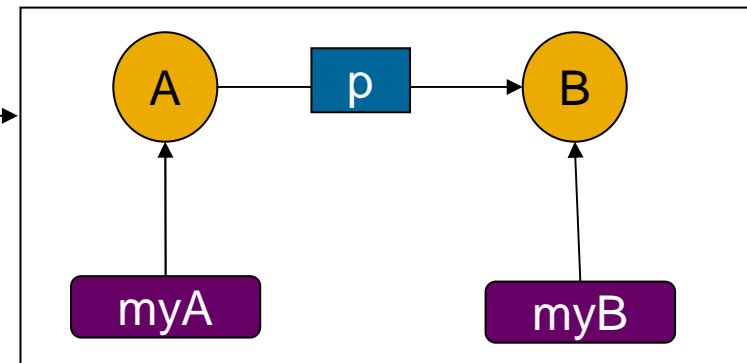
HTML document



"Standard"
lifting script



RDF data



*@rdfa annotations
(different attributes for different purposes)*

For datatype properties



For datatype range (xsd types)

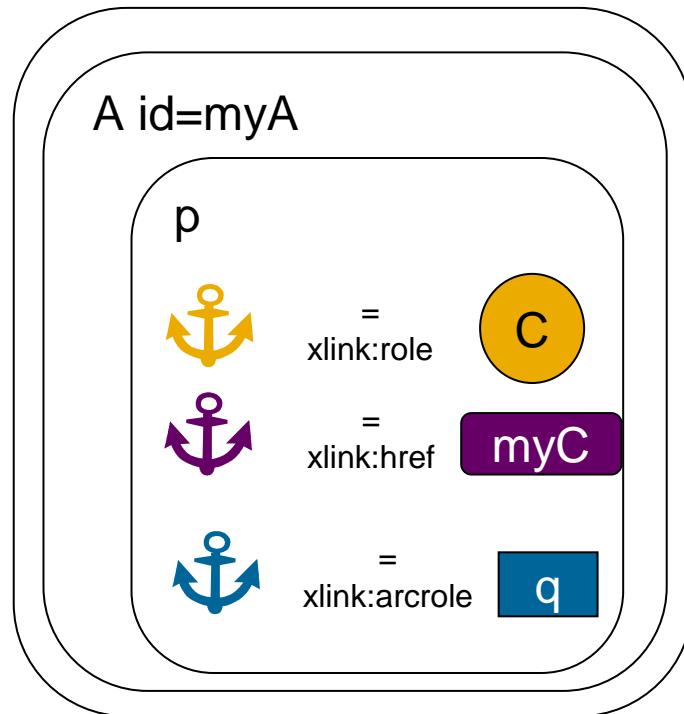


For RDF literals (values)



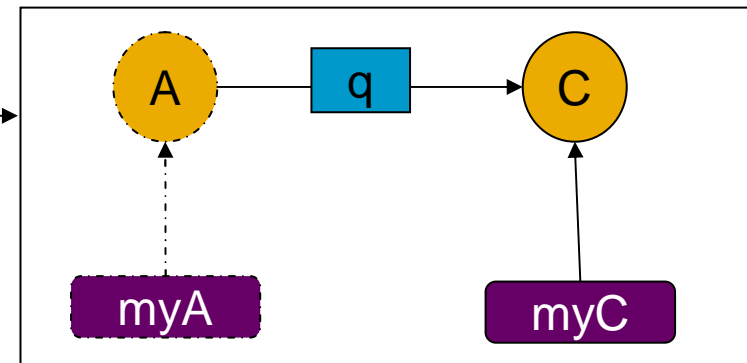
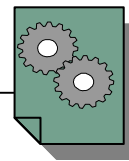
Lifting XML data containing xlink to “semantic URNs”

XML data



RDF data

lifting script
Custom or standard?



@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/>) not targeting this specific usage

XLink – RDFa comparison (details)

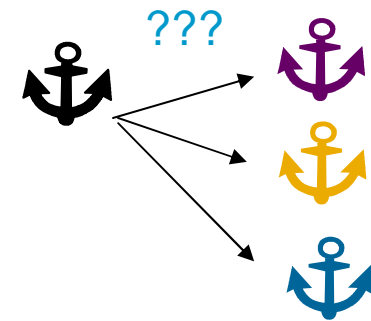
RDF mapping		XLink	RDFa
Domain instance			about or src
Domain class			typeof
Object property		arc role	rel
Inverse object property			rev
Range instance		href	href or resource
Range class		role	typeof
Datatype property			property
Datatype property type		role	datatype
Range value			content or element content

Current use of XLink in OGC






- Conventions defined by the GML standard (Portele 2007)
 - Portele C. (2007): OpenGIS® Geography Markup Language (GML) Encoding Standard version 3.2.1 [OGC 07-036](#) Open Geospatial Consortium 2007-08-27
- 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
 - `<swe:Quantity definition="urn:ogc:def:property:SBE:batteryCurrent">`
 - @uom
 - `<Quantity definition="urn:ogc:def:phenomenon:temperature" uom="urn:ogc:def:unit:celsius"/>`
 - @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
 - `<sml:Term definition="urn:x-ogc:def:identifier:OGC:uuid"> <sml:value>urn:x-ogc:object:sensor:MBARI:GPS:17:HVS</sml:value> </sml:Term>`
- **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
- Compton et al. (2009) [A Survey of the Semantic Specification of Sensors](#), in Proc. International Workshop on Semantic Sensor Networks SSN'09 CEUR-WS Vol. 552
 - 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 → **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` !
 - `<sos:observedProperty`
`xlink:href="http://knoesis.wright.edu/ssw/ont/weather.owl%23AirTemperature"` `xlink:role="http://www.w3.org/2009/SSN-XG/Ontologies/SensorBasis.owl#Property"`
`xlink:arcrole="http://www.w3.org/ns/sawSDL#modelReference"/>`



=
xlink:role



=
xlink:href



=
xlink:arcrole

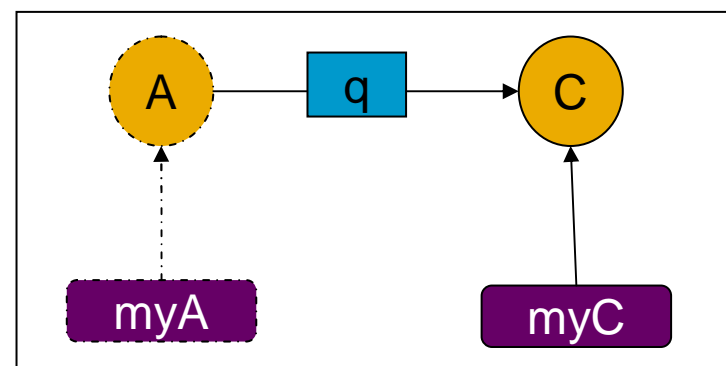
`sawSDL:modelReference`

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?
 - acroles:
 - 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

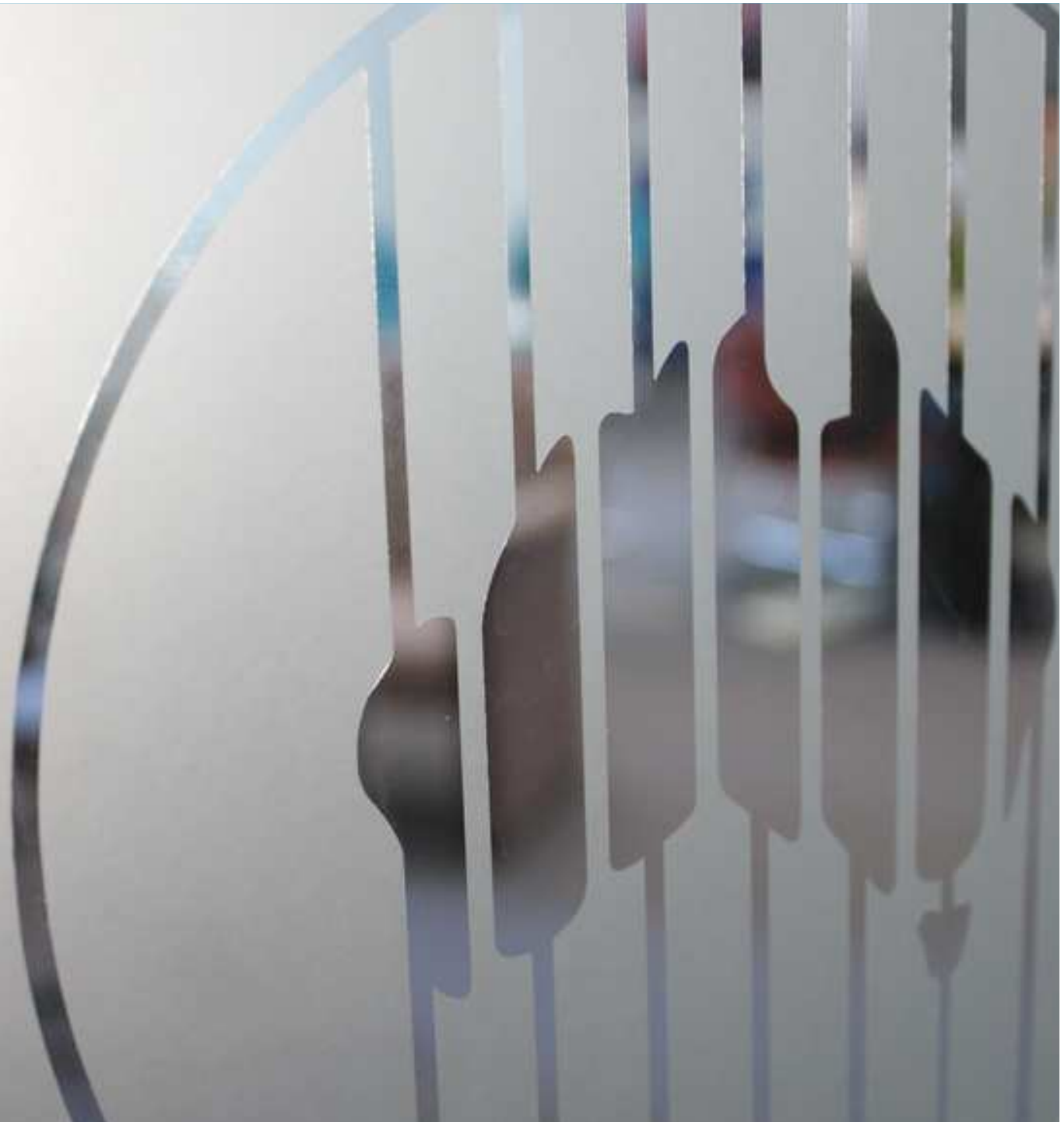
- Defining what a semantic annotation is a challenging task
 - The difference between non semantic and semantic annotation is hard to define
 - Some type of content can sit on both sides of the boundary (e.g. URNs)
- Need for guidance material specifically targeting users of OGC standards
 - Decide if 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

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Alphabet soup (1)

- **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*

Alphabet soup (3)

- **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 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. [\[more info\]](#)

Alphabet soup (4)

- **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](#).
 - *Example: `urn:x-ogc:def:crs:EPSG:6.3:4326"/>`*

RDFa attributes

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

XLINK

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