

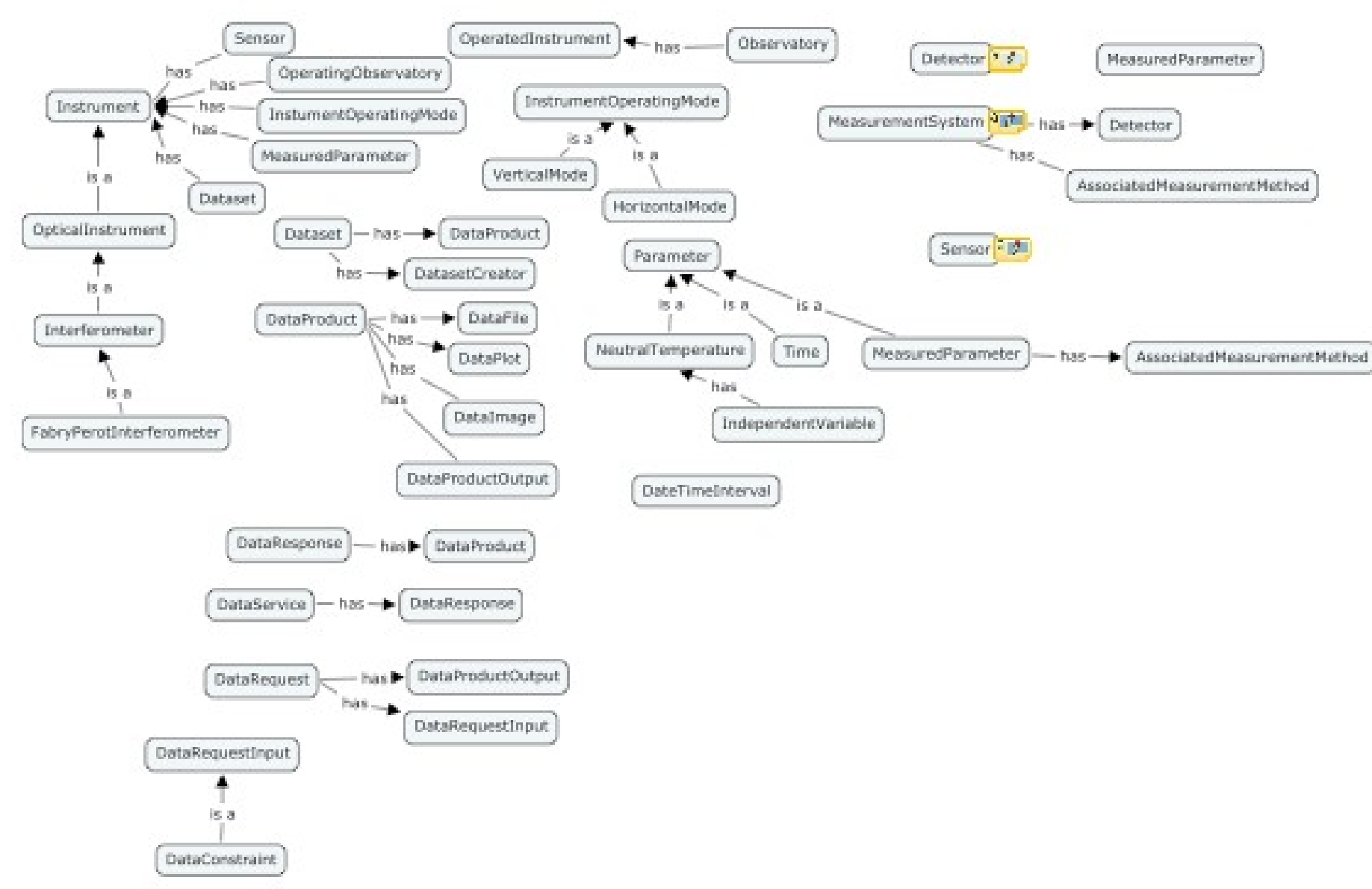
Current and future uses of OWL for Earth and Space science data frameworks: successes and limitations (IN53B-1207)

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Abstract

Based on almost three years of experience in developing and deploying scientific data frameworks built using semantic technologies, we now have a production virtual observatory in operation, serving two broad communities: solar physics and terrestrial upper atmospheric physics. Within this application, a data framework provides online location, retrieval, and analysis services to a variety of heterogeneous scientific data sources distributed over the internet. We describe selected current and planned uses of our ontologies in OWL-DL, and tools involved in development and deployment. We describe both successes and limitations we have found to date using OWL-based technologies, especially tool support. We also indicate the important components we require from a robust technical infrastructure as we move forward with expanding the functionality of the frameworks. This expansion includes additional semantic representation and reasoning/query services as well as broadening the scope of our scientific disciplines.

Ontology in CMAP (left) and some OWL code



```
<owl:Class
rdf:about="http://www.vsto.org/DataPlot">
<owl:disjointWith>
<owl:Class
rdf:about="http://www.vsto.org/DataImage"/>
</owl:disjointWith>
<owl:disjointWith>
<owl:Class
rdf:about="http://www.vsto.org/DataFile"/>
</owl:disjointWith>
<rdfs:subClassOf>
<owl:Class
rdf:about="http://www.vsto.org/DataProduct"/>
</rdfs:subClassOf>
</owl:Class>
```

```
<owl:Class rdf:about="http://www.vsto.org/FabryPerot">
<rdfs:subClassOf rdf:resource="http://www.vsto.org/Interferometer"/>
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A multiple-beam
interferometer, usually consisting of two flat plates, with high reflective ability. The plates are set parallel
to one another by spacers so that light waves may bounce back and forth between them several times.
The requirements for constructive interference of reflected light waves of a given wavelength can be
fulfilled only at particular angles, relative to the normal to the plates. Therefore, Fabry-Perot
interferometers can be used as spectrometers with high resolution. Used as a laser resonator, the
Fabry-Perot reinforces only light of specific frequencies traveling perpendicular to the mirror surfaces,
and its successive reflections and amplifications form the oscillating mode.</rdfs:comment>
</owl:Class>
<owl:Class rdf:about="http://www.vsto.org/GroundBasedRadar">
<rdfs:subClassOf rdf:resource="http://www.vsto.org/Radar"/>
</owl:Class>
```

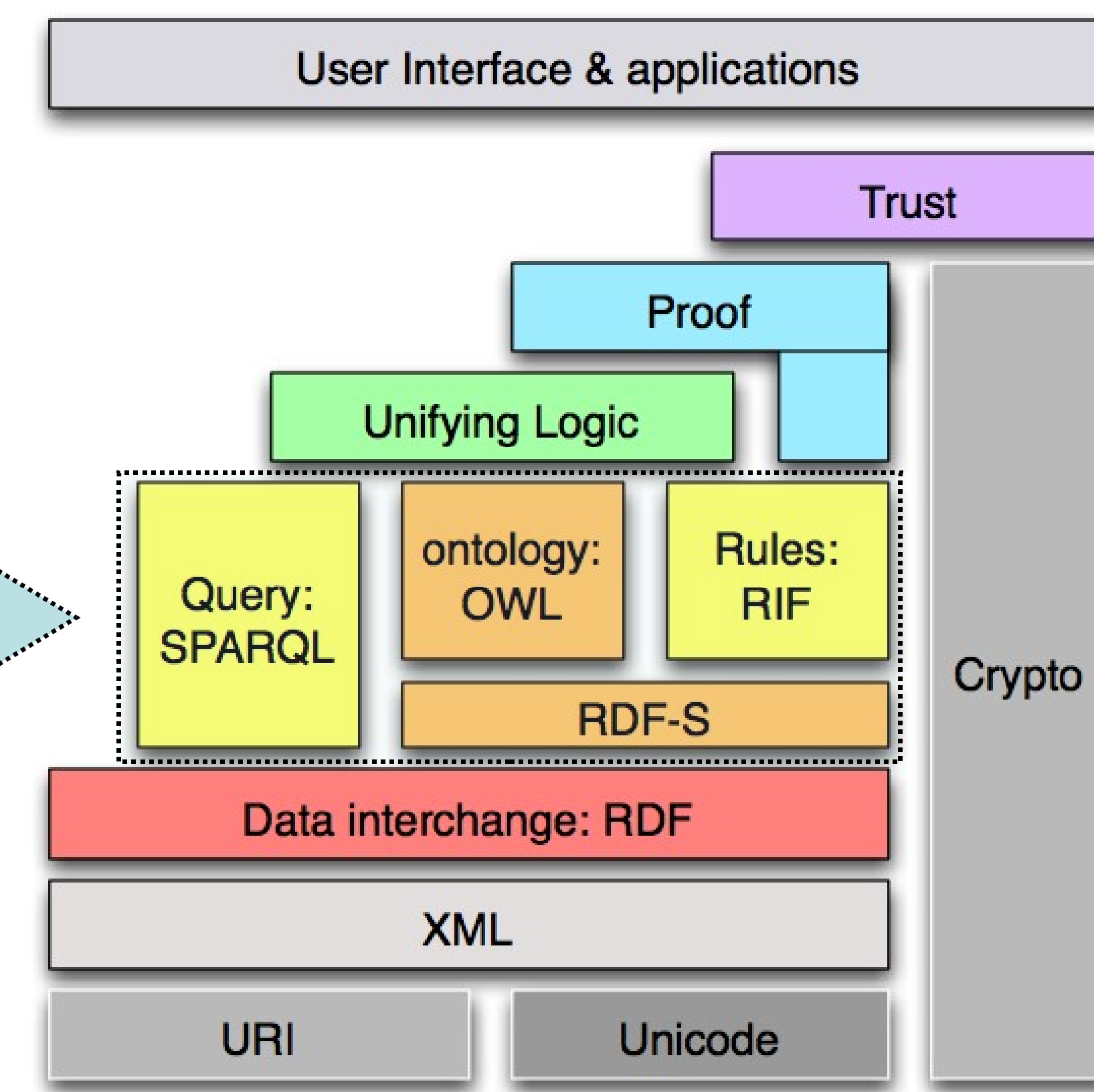
Successes

- ❖ Now: excellent tools for writing and reading OWL code with many plug-ins and capabilities (open source, free, and commercial)
- ❖ Support for storage of triples, developing software, reasoners are very accessible for rapid implementation of developed ontologies
- ❖ Very good technical support infrastructure to implement code
- ❖ Necessary expressivity to capture the key concepts, relations, and instances of the underlying knowledge we needed to represent
- ❖ Combines with other RDF-based knowledge encodings
- ❖ Stable 1.0 W3 recommendation

Limitations

- ❖ Visual representation of ontologies is essential but the tools for writing, reading and presenting OWL code are very limited.
- ❖ Alternate forms of the OWL - such as a plain English translation of OWL code have only been implemented in a few cases (e.g. SWOOP - which is no longer undergoing development).
- ❖ Expressivity for numerical quantities is absent and is currently handled outside the OWL and reasoning
- ❖ OWL language elements for supporting imports, as well as inadequate tool support make it very difficult to create modules, understanding dependencies, and ingrate modules into flexible packages.
- ❖ No OWL-specific query language recommended (SPARQL is temporary solution)

Semantic Web Architecture Layers



Layer at which declarative languages are important

Editors for OWL: write, read, display

- Protégé (<http://protégé.stanford.edu>)
- SWOOP (<http://mindswap.org/2004/SWOOP>; see also <http://www.mindswap.org/downloads/>)
- Altova SemanticWorks (<http://www.altova.com/download/semanticworks>)
- SWeDE (<http://owl-eclipse.projects.semwebcentral.org/In>), goes with Eclipse
- Medius
- TopBraid Composer and other commercial tools
- CMAP Ontology Editor (COE) (<http://cmap.ihmc.us/coe>)

Tools for OWL: plugins, APIs, etc.

- Triple stores:
- Jena (<http://jena.sourceforge.net/>)
- SeSAME/SAIL (<http://www.openrdf.org/>)
- KOWARI (<http://www.kowari.org/>)
- Mulgara (<http://www.mulgara.org/>)
- Redland (<http://librdf.org/index.html>)
- Oracle (<http://www.oracle.com>)
- Many others (relational, object-relational)

Reasoners for OWL

- Pellet (<http://pellet.owldl.com/>)
- Racer (<http://www.sts.tu-harburg.de/~r.f.moeller>)
- Racer Pro (<http://www.racer-systems.com/>)
- Medius KBS
- FACT++ - (<http://owl.man.ac.uk/factplusplus/>)
- fuzzyDL - (<https://dl.kr.org/pipermail/dl/2006/000774>)
- KAON2 (<http://kaon2.semanticweb.org/>)
- MSPASS - (<http://www.cs.man.ac.uk/~schmidt/mspa>)
- /QuOnto - (<http://www.dis.uniroma1.it/~quonto/>)
- Jess (for Rules) - (<http://herzberg.ca.sandia.gov/>)

Query for OWL

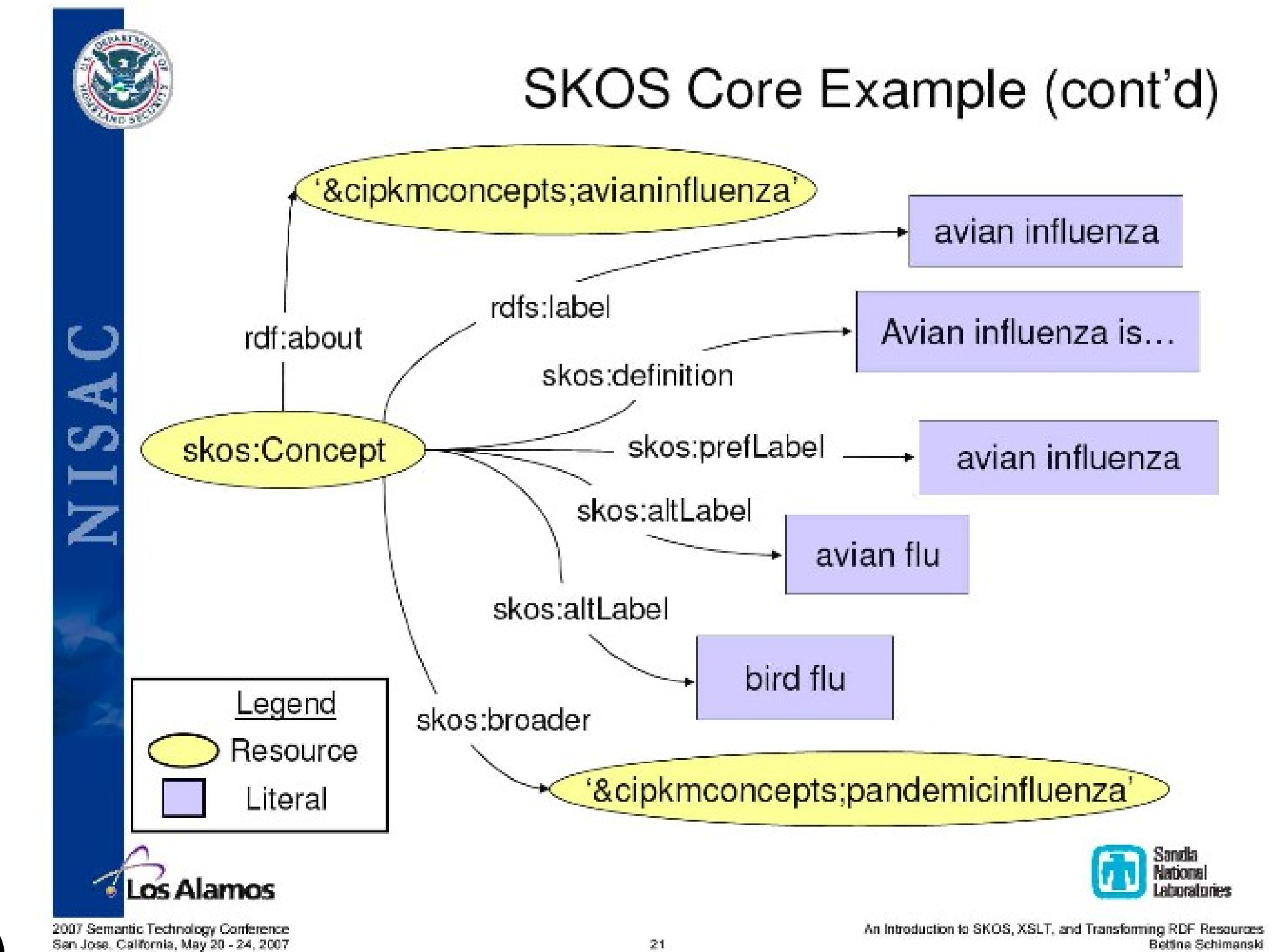
- OWL-QL (for OWL) <http://projects.semwebcentral.org/project>
- SPARQL for RDF <http://www.sparql.org/> and <http://www.w3.org/TR/rdf-sparql-query/> **Now a W3C Candidate Recommendation 14 June 2007!**
- XQUERY (for XML)
- SeRQL (for SeSAME)
- RDFQuery (RDF)
- E-QuOnto (English Query for Ontologies)
- None as yet for natural language representations

Is OWL the only option?

- RDF - Resource Description Framework
- SKOS - Simple Knowledge Organization System
- CLCE - Common Logic Controlled English
- Peng - Processible English
- Rabbit - "Smarter than OWL" controlled English vocabulary
- Other natural language forms
- Atom - Generalization of RSS
- FOAF - Friend-of-a-Friend

OWL (Web Ontology Language)	SKOS (Simple Knowledge Organization System)
W3C Recommendation	W3C Working Draft
Several IDEs Available (Protégé, SWOOP, ...)	Lacking in IDEs (ThManager, ...?)
• Class-oriented	• Less strict constraints over the domain
• Logically precise	• Becoming de facto standard for XML-based representations of controlled vocabulary:
• Ideal for reasoning over a domain that can be completely partitioned into disjoint classes which exhaustively segment the space	• simple thesauri
• Cost: time, effort, expertise	• simple taxonomic hierarchies
	• glossaries
Conclusion: Too heavyweight	Conclusion: Flexible

OWL and SKOS are both RDF-based, therefore both can link to the CIP KM OWL Ontology



CLCE - example

CLCE: If a set x is the set of (a cat, a dog, and an elephant), then the cat is an element of x, the dog is an element of x, and the elephant is an element of x.

PC: $\sim(\exists x:\text{Set})(\exists x1:\text{Cat})(\exists x2:\text{Dog})(\exists x3:\text{Elephant})(\text{Set}(x,x1,x2,x3) \wedge \sim(x1 \in x \wedge x2 \in x \wedge x3 \in x))$

PENG - example

- If X is a research programmer then X is a programmer.
- 2. Bil I Smith is a research programmer who works at the CLT.
- 3. Who is a programmer and works at the CLT?

Sydney - example

If X has Y as a father then Y is the only father of X. The class person is equivalent to male or female, and male and female are mutually exclusive. equivalent to The classes male and female are mutually exclusive. The class person is fully defined as anything that is a male or a female.