Introduction to Semantic Web

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Fraunhofer Gesellschaft

This Talk

- The Semantic Web Vision
- Languages of the Semantic Web
  - Dublin Core to RDF and Ontologies
- Semantic Web Applications
- Sources for this talk:
  - http://www.w3.org/2004/Talks/1013-semweb-em/talk
  - http://www.w3.org/2004/Talks/0120-semweb-umich/

The Semantic Web Vision

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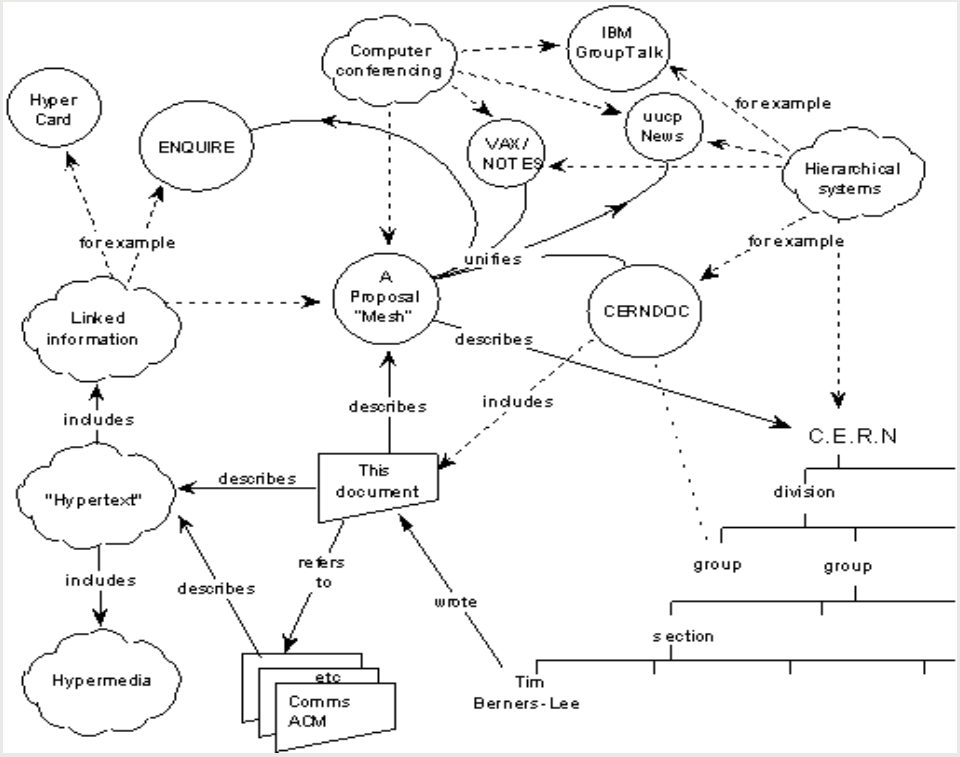
World Wide Web Consortium

- Directed by Tim Berners-Lee, “Inventor” of Web
- Mission: “Lead the Web to its full potential”
- Hosts: MIT, ERCIM, Keio University
- Develops Web Standards
  - HTML, CSS, XML, Security
  - Web Accessibility Initiative (WAI)
  - Web Services (SOAP, WSDL, etc.)
  - Semantic Web languages (RDF, OWL…)

World Wide Web Consortium

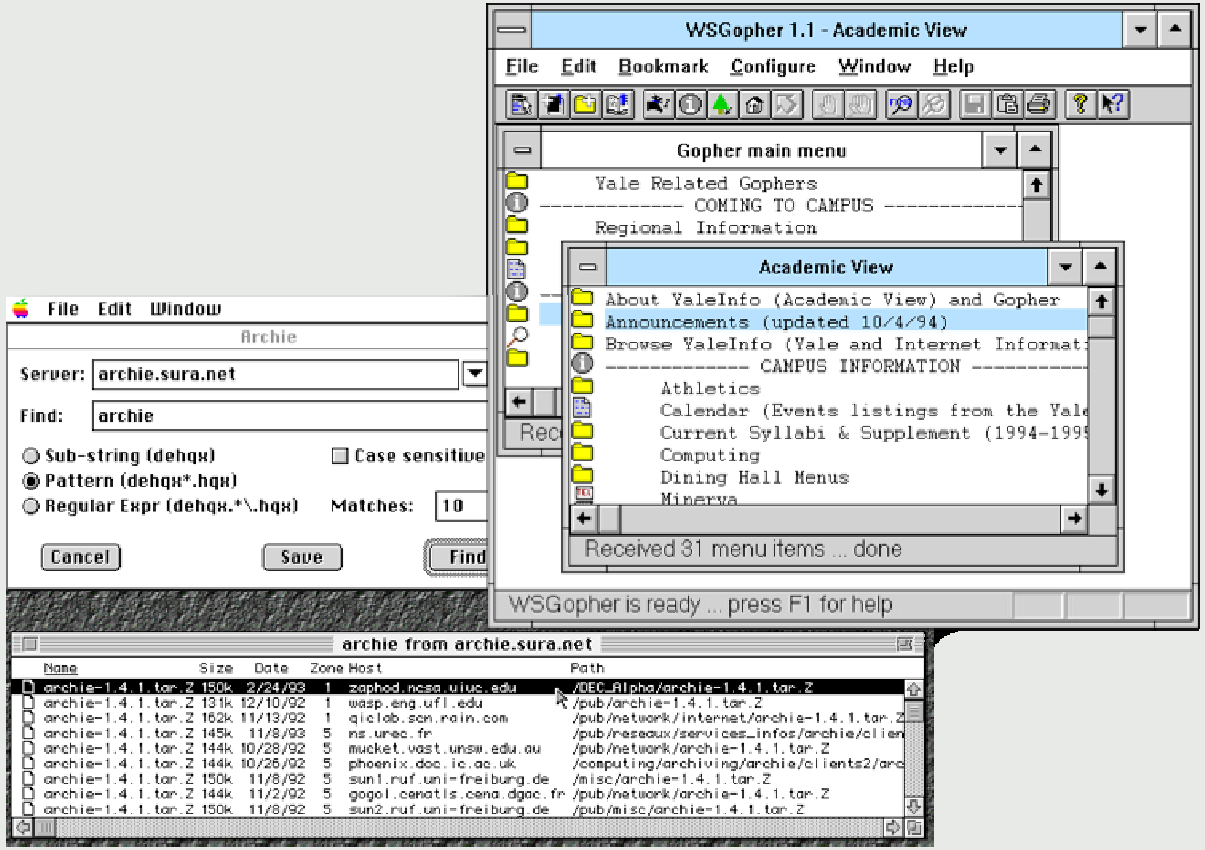
- Method
  - Technical specifications developed with Working Groups and extensive public review
  - Advanced Development to chart long term architectural directions
- Building infrastructure to address technical and social needs of the Web

Semantic Web Vision



Web of Data – the file level

- Circa 1993
- FTP, Gopher, Archie: sharing resources on the Internet
- Stopped at file level

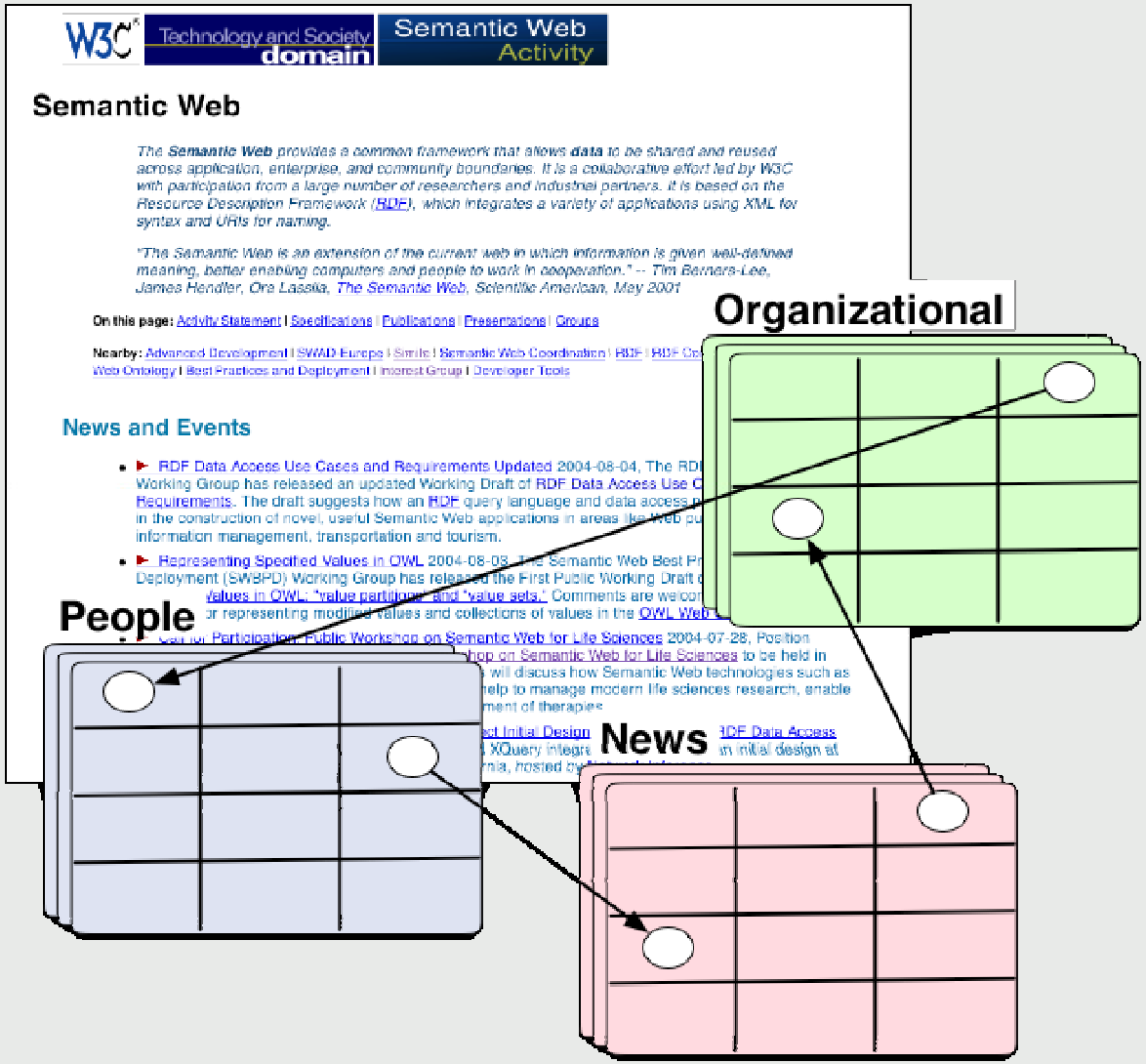


Web of Data – the text level

- Circa 1994
- HTML and URLs
- Below file level
- But stopped at text level

Semantic Web of Data

- And now
- XML, RDF, OWL, URI
- Below file level
- Below text level
- At data level



Semantic Web Vision

- Scenario: Someone needs to see a doctor.
  - Tim Berners-Lee, Scientific American 2001
  - Handheld devices with “agents” negotiate:
    - Doctor’s agent knows prescribed treatment
    - List of doctors, rated at least “very good”, within 20 miles, accepted by insurance plan.
    - Devices match calendars to fix appointment.
  - Semantic Web challenge: provide language that expresses both data and rules for reasoning about that data

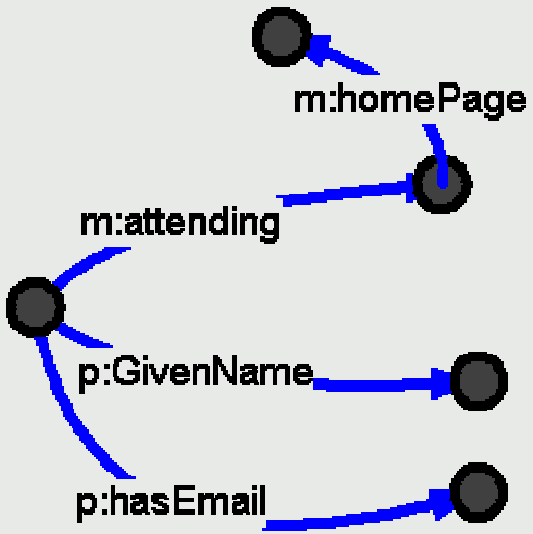
Semantic Web Vision

- Web of data
  - Integrating multiple sources to draw new conclusions
  - Architecture for describing all kinds of things (items, collections, services, processes, etc.)
  - Effective management and reuse of data at various scales (personal, group, enterprise, community, web)

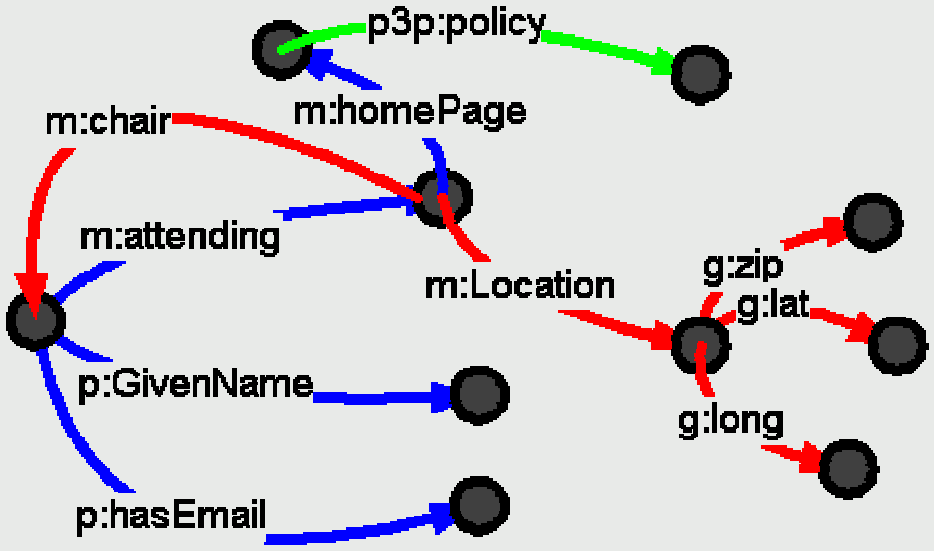
Semantic Web Vision

- URI – Foundation of Semantic Web
  - Identify **anything** distinctly and uniquely by an opaque string of characters in global URI space
    - physical things – books, cars, people…
    - digital objects – Web pages, digital images…
    - conceptual things – colors, subjects, metadata terms!

URIs as anchors for merging data



URIs as anchors for merging data



Languages of the Semantic Web

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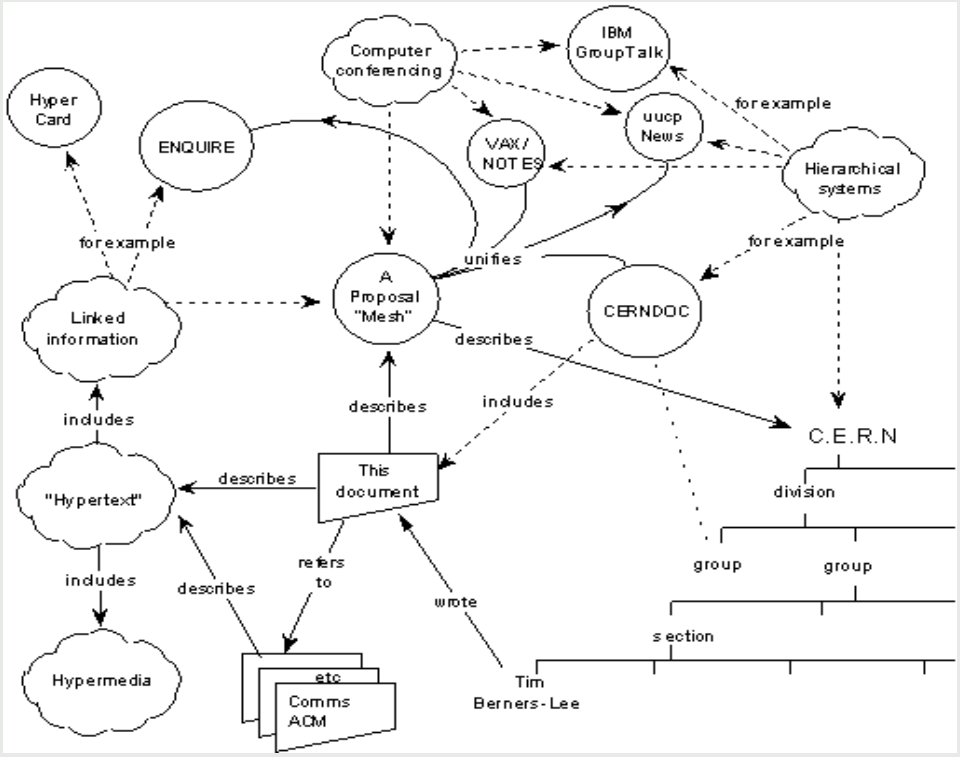
Simple Resource Description

- Mid-1990s: Web takes off – flood of information
  - "How can we describe this simply?"
- "Dublin Core": Title, Subject, Date…
  - Pidgin-like "metadata" for describing Web pages
- Library Science meets Computer Science
  - Not enough to agree on words – also need grammar!
  - Machine processing requires agreement on a simple data model

Simple Linked Data Model

Machine-processable statements about **things** (Web pages, organisations, people, concepts, products, etc) and the **links between them**

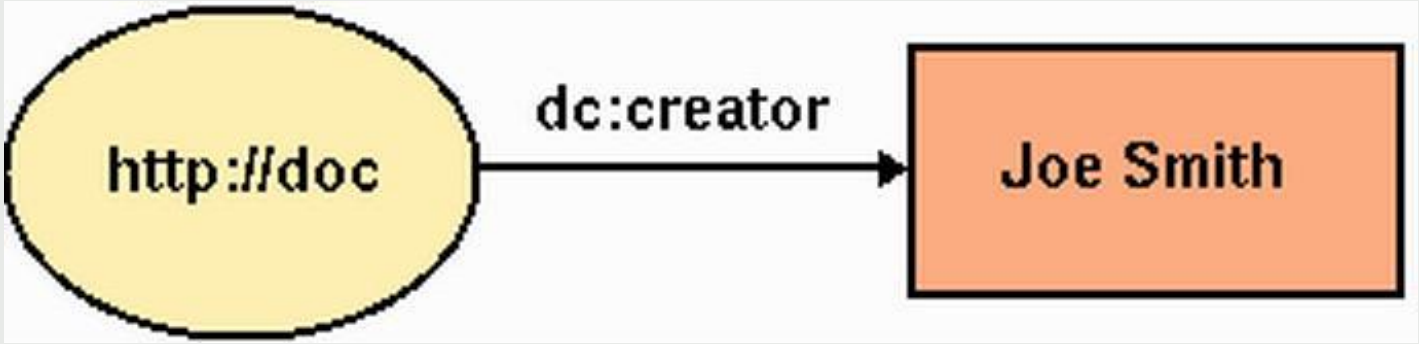


“Resource Description Framework”

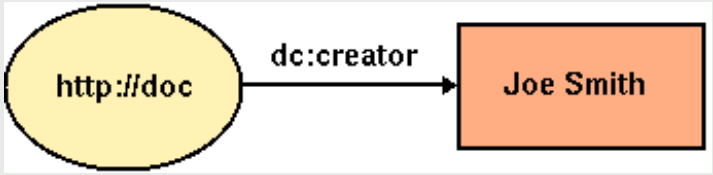
- 1997: Define metadata vocabularies (like Dublin Core) and use them to make statements
  - **Resource**: anything identifiable with a URI
  - **Description**: statements about properties of resources
  - **Framework**: a common model for statements using diverse vocabularies

RDF “triples”

- A simple model for “statements”
  - Subject: what the statement is about
  - Predicate: a property of the subject
  - Object: the value of the property
- “A natural way to describe the vast majority of the data processed by machines”



Statement about a document using Dublin Core in RDF/XML




```
<?xml version="1.0"?>
<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:dc="http://purl.org/dc/elements/1.1/" >
  <rdf:Description about="http://docs" >
    <dc:creator> Joe Smith </dc:creator>
  </rdf:Description>
</rdf:RDF>
```

URIs to identify properties

- Connecting information to its definitions and its context
  - Dublin Core element Creator is denoted by a URI
    - http://purl.org/dc/elements/1.1/creator
  - Not just any concept of “color”, but one defined in an identifiable context:
    - http://pantone.example.com/2004/std#color

Statements defining the Dublin Core property itself on the Web

<rdf:Property rdf:about="http://purl.org/dc/elements/1.1/creator">
<rdfs:label xml:lang="en-US">Creator</rdfs:label>
<rdfs:comment xml:lang="en-US">An entity primarily responsible for making the content of the resource.</rdfs:comment>
<dc:description xml:lang="en-US">Examples of a Creator include a person, an organisation, or a service. Typically, the name of a Creator should be used to indicate the entity.</dc:description>
<rdfs:isDefinedBy rdf:resource="http://purl.org/dc/elements/1.1/"/>
<dcterms:issued>1999-07-02</dcterms:issued>
<dcterms:modified>2002-10-04</dcterms:modified>
</rdf:Property>

Semantic Web languages today

- RDF – Resource Description Framework
  - See http://www.w3.org/TR/rdf-primer/
- OWL Web Ontology Language
  - See http://www.w3.org/TR/owl-features/
- Core specifications are W3C Recommendations as of February 2004:
  - See http://www.w3.org/2001/sw/

Challenge: Independent vocabularies working together

- Need to formally declare how vocabularies relate to each other
  - "MARC:illustrator refines DC:contributor"
  - "RRS:title refines DC:title"
  - Relationships can be declared in RDF on Web
- Will require well-understood conventions for declaring and managing vocabularies

Defining Best Practice for Vocabulary Management

- Identify terms with URI references
- Articulate maintenance policies for your vocabulary (semantic stability, persistence)
- Identify historical versions
- Declare your terms using a formal, machine-processable schema language

Semantic Web Applications

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Evolution towards a Semantic Web

- Not revolution
- Emphasis on methods for extracting existing data from documents, servers and databases
- Translate into common form using Semantic Web languages

D2RQ
DBVIEW

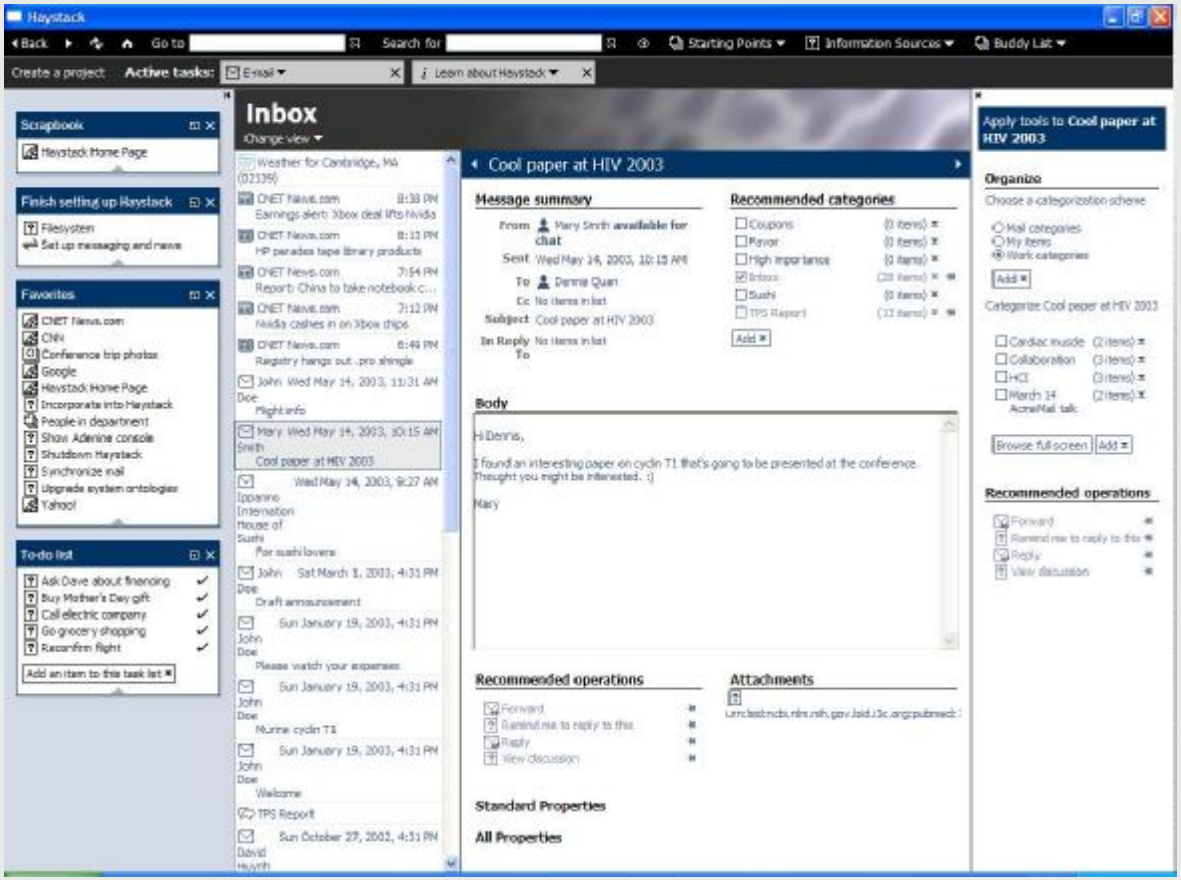
XSLT
GRDDL
Schema Annotation

XSLT
GRDDL

Joseki
DAWG

Personal Information Environments

- Haystack - User configurable universal information client
  - benefits from RDF's universal information model
- Uses RDF for personalization, data, layout, preferences, etc.



http://haystack.lcs.mit.edu/

Integrating Enterprise Data

- Tucana - Enterprise Information Integration
- Expose diverse data sources as RDF
- Scalable back-end storage

http://www.tucanatech.com/

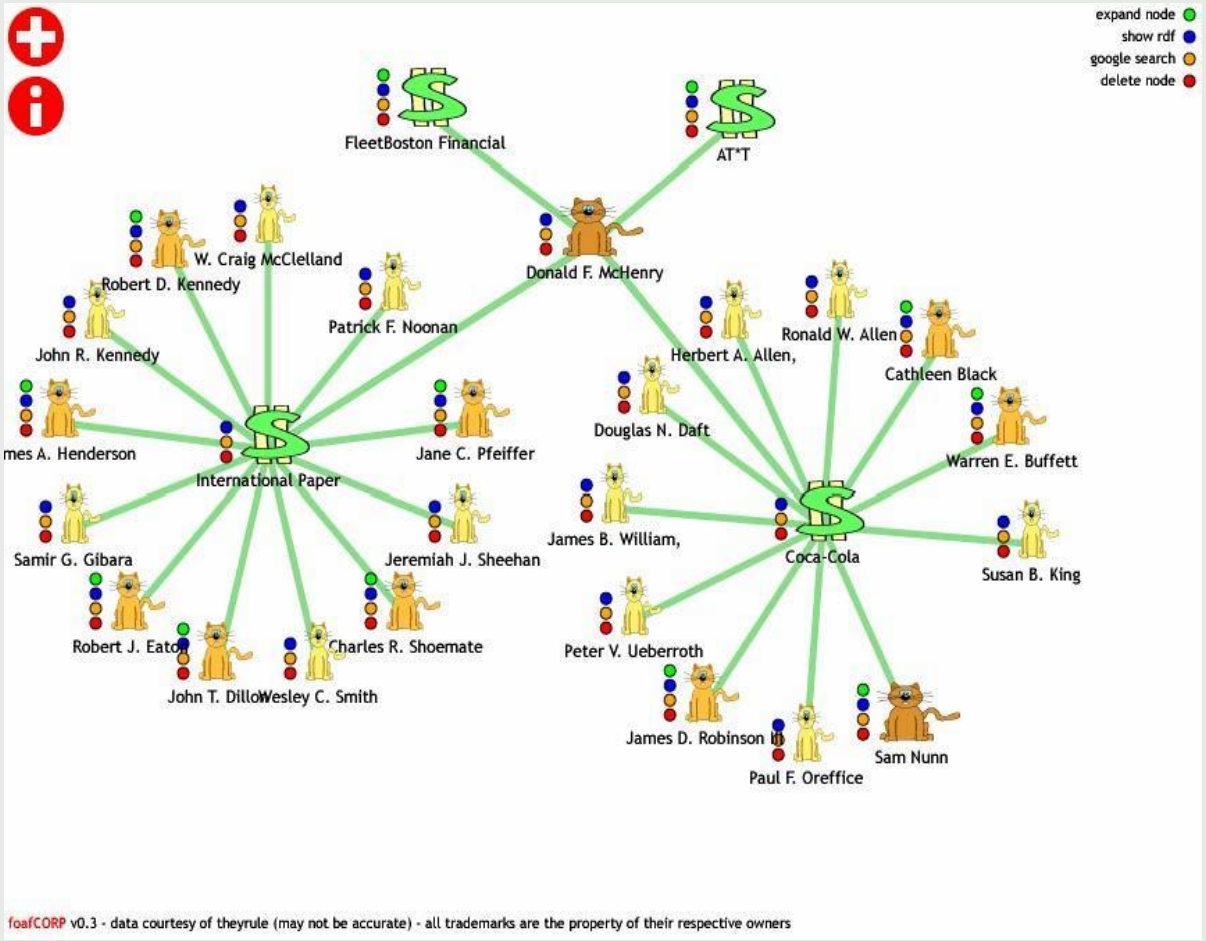
Aggregating Knowledge Bases

- TAP
- Simple tools that treats the Web a giant distributed database.
- Local, independently managed knowledge bases can be aggregated

http://tap.stanford.edu/

Visualizing Social Networks

- FoafCorp: visualizing corporate boards of directors



http://rdfweb.org/foafcorp/intro.html

Web'ifying Thesauri

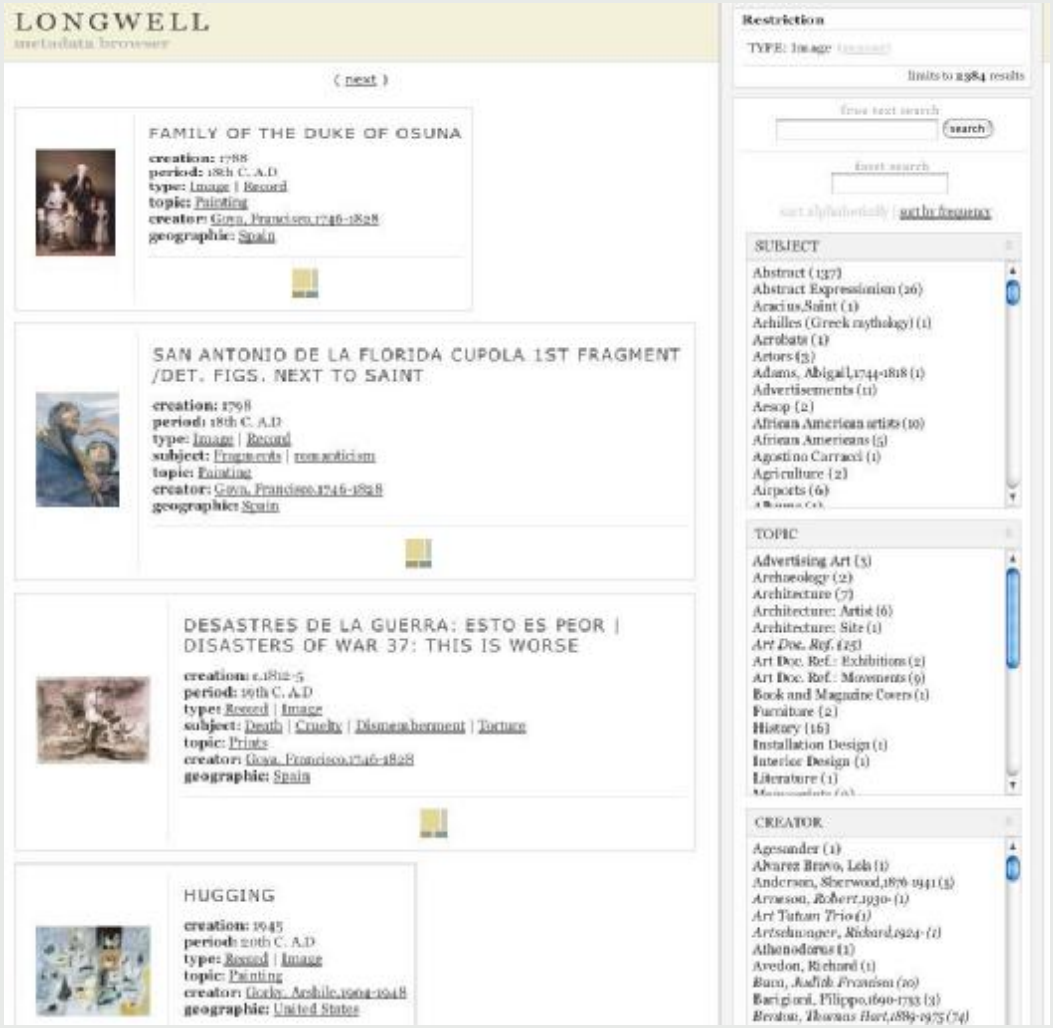
- SKOS – an RDF vocabulary for thesauri
  - Encoding and mapping of thesauri, controlled vocabularies
  - Bridges library classification and Web technologies
  - http://www.w3.org/2004/02/skos/core/guide/
- A product of SWAD-Europe - Supporting Semantic Web standards in Europe
  - Targeted research, software applications, outreach
  - Topics: calendaring, social networks, images, geospatial, internationalization, RDF storage, etc.

Bridging Institutional Repositories

- Project Simile - Semantic Web meets Digital libraries and personal information management
  - Partners: W3C, HP, MIT Libraries, MIT CSAIL
- Implement a digital asset management architecture based on Web standards
  - Add useful “views” to a digital artifact and bind those views to consuming services
- Leverage and extend DSPACE, enhancing its support for managing heterogeneous data

“RDF Browsers”

- Common interface, framework for navigation
- Architecture supports integration of heterogeneous data sources
- Tools for exposing content collections in RDF
- http://simile.mit.edu/



Integrating Life Science Data

- Connecting information: gene, diseases, cures
- Scientists in different locations, working on different problems, integrating results into coherent whole
- Recognized need for effective data integration from heterogeneous collections
- Increasingly available datasets in RDF
- Increasing scientific / vendor interest
  - Semantic Web and Life Sciences Workshop, Oct 27-28, Cambridge MA, http://www.w3.org/2004/07/swls-ws.html

W3C Semantic Web Activity

Phase 2

- Feb 2004: Core specs are W3C Recommendations
  - Open Standards and Open Source tools, technologies for modeling real world resources; sharing these models across the Web.
- Mar 2004: Phase 2 launched
  - RDF Data Access - “Joining the Web”
  - Best Practices and Deployment
  - Advanced Development
- Deployment / Facilitating 'Network Effect'

W3C Semantic Web Activity

RDF Data Access (DAWG)

- To define an HTTP and/or SOAP protocol for selecting instances of RDF
  - ‘Join’ Web data as easily as merging tables in a local relational database.
- Use Cases
  - Personal Information Management, transportation, tourism, product life-cycle data management, publishing…
- Outputs
  - Use Cases and Requirements - Aug 2004
  - SPARQL - Query Language Specification - Oct 2004

W3C Semantic Web Activity

Best Practices and Deployment

- To provide guidance for developers of Semantic Web applications.
- Best Practice notes for ontology engineering, vocabulary development…
- Educational material and demo applications.
- Support transformation of ontologies and thesauri to RDF/OWL
- http://www.w3.org/2001/sw/BestPractices/

W3C Semantic Web Activity

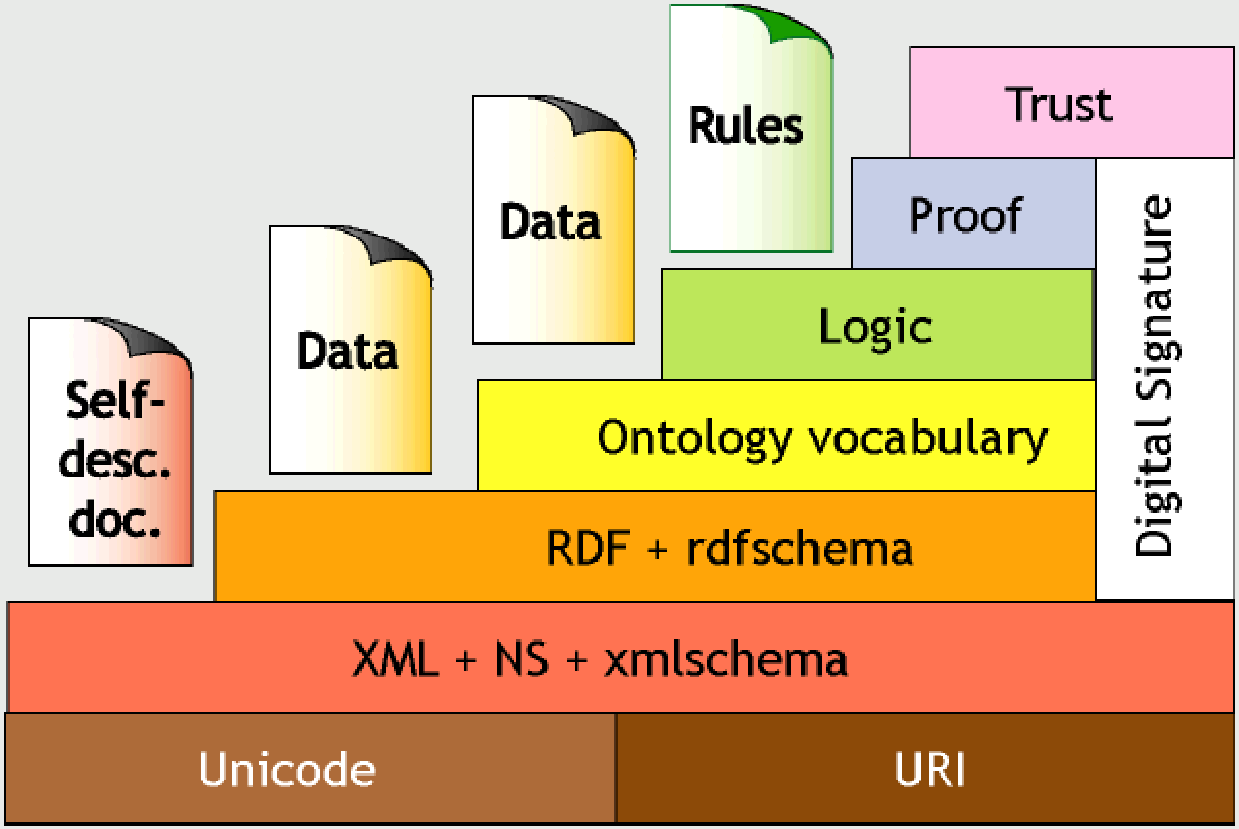
Advanced Development

- Collaborative development
  - Creation of core components (e.g. libwww) that will form the basis for the Semantic Web.
- Facilitate Semantic Web deployment and identify futures areas of standardization
- http://www.w3.org/2000/01/sw/

A Common Framework

- Many organizations are starting to realize they need ‘digital libraries’
  - Even if they don’t call it that
- Common data representation
  - Common description framework and architecture reduces (technical / social) costs and is more efficient
  - Everyone benefits

Towards the technology of trust



Conclusions

- Core Specifications in place
- More applications / toolkits / software every day
- A new class of Semantic Web applications at individual, enterprise, and Web scale
- Semantic Web based on a new type of human and machine language

Additional Information

- W3C World Wide Web Consortium
  - http://www.w3.org
- Semantic Web Initiative Home Page
  - http://www.w3.org/2001/sw/
- Dublin Core Metadata Initiative
  - http://dublincore.org/
- Eric Miller, W3C Semantic Web Activity Lead
  - http://www.w3.org/People/EM/
- W3C Semantic Web Best Practices and Deployment Working Group
  - http://www.w3.org/2001/sw/BestPractices/

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