Semantic Web, and Other W3C Technologies to Watch

Steve Bratt
Chief Executive Officer
World Wide Web Consortium

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http://www.w3.org/2007/Talks/0130-sb-W3CTechSemWeb/

http://www.w3.org/2007/Talks/0130-sb-W3CTechSemWeb/0130-sb-W3CTechSemWeb.pdf

Outline

- Evolution of the Web and the Role of Standards
- Emerging W3C Technologies
- Introduction to the Semantic Web
- Discussion
- Extra slides

Evolution of the Web

and the

Role of Standards

"Over 1 Billion Served"

WORLD INTERNET USAGE AND POPULATION STATISTICS						
World Regions	Population (2006 Est.)	Population % of World	Internet Usage, Latest Data	% Population Penetration	Usage % of World	Usage Growth 2000-2006
Africa	915,210,928	14.1 %	**32,765,700**	3.6 %	3.0 %	625.8 %
Asia	3,667,774,066	56.4 %	**378,593,457**	10.3 %	35.2 %	231.2 %
Europe	807,289,020	12.4 %	**311,406,751**	38.6 %	28.9 %	196.3 %
Middle East	190,084,161	2.9 %	**19,028,400**	10.0 %	1.8 %	479.3 %
North America	331,473,276	5.1 %	**231,001,921**	69.7 %	21.5 %	113.7 %
Latin America/Caribbean	553,908,632	8.5 %	**85,042,986**	15.4 %	7.9 %	370.7 %
Oceania / Australia	33,956,977	0.5 %	**18,364,772**	54.1 %	1.7 %	141.0 %
WORLD TOTAL	6,499,697,060	100.0 %	**1,076,203,987**	16.6 %	100.0 %	198.1 %

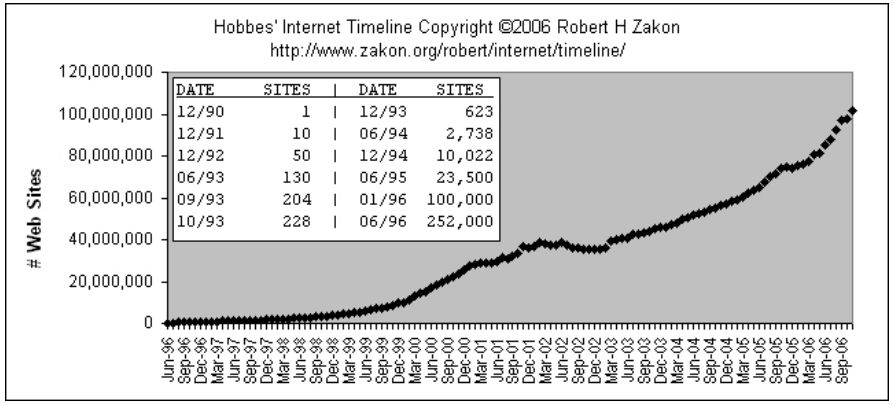
Source: http://www.internetworldstats.com/stats.htm

Note: in 1995, there were ~16,000,000 Internet users, or 0.4% of global population

(see also: Top languages on the Internet [graphic, link],
English 30% w/ 135% growth, Chinese 14% w/ 347% growth per year)

"Over 100 Million Serving"

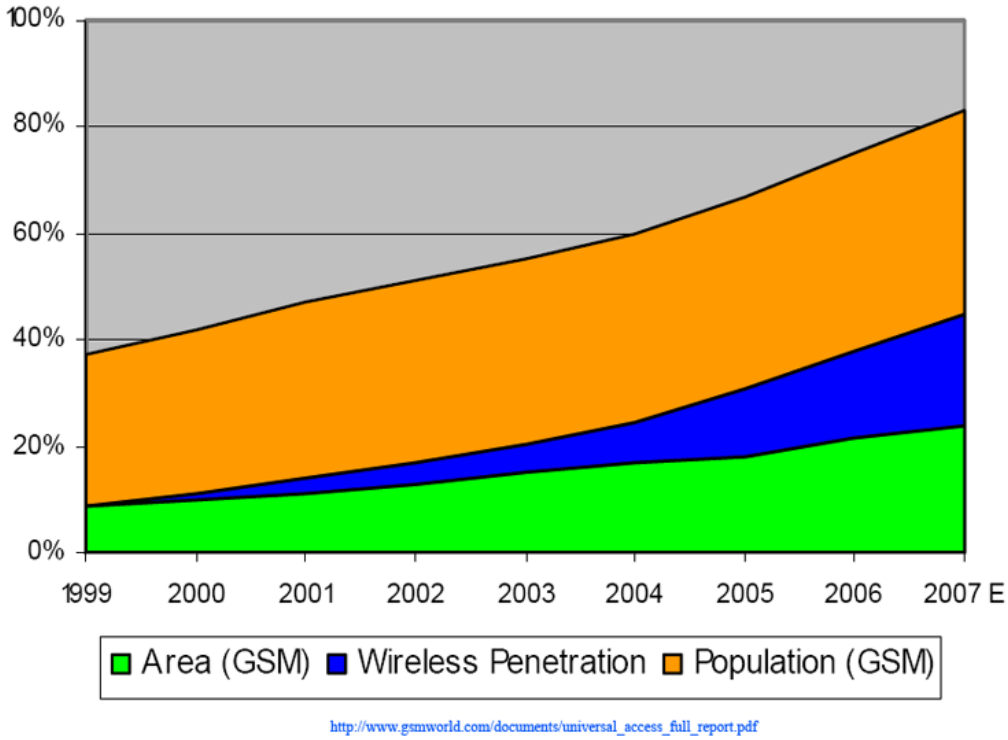
Number of Web Sites (domain names and content)



Source: http://www.zakon.org/robert/internet/timeline/, http://news.netcraft.com/archives/2006/11/01/november_2006_web_server_survey.html

(Users:Servers ratio ~ 1996 = 150:1. 2000 = 50:1. 2006 = 10:1)

Potential to Break the Digital Divide



http://www.gsmworld.com/documents/universal_access_full_report.pdf (2006)

What Led to the Web's Success?

- Simple architecture - HTML, URI, HTTP
- Networked - value grows with data, services, users
- Extensible - from Web of documents to ...
- Tolerant - even w/ imperfect mark-up, data, links, software
- Universal - independent of systems and people
- Free / cheap - browsers, information, services
- Simple / powerful / fun for users - text, graphics, links
- Open standards ...

Why are Open Standards Important?

- Broad industry agreement (if done right)
- Interoperability ... cross-application, -organization, -data
- Avoids vendor lock-in ... for providers and users
- Open access = no black boxes
- Mandated ... by customers, government
- Open, royalty-free standards = good business sense

Founded by Tim Berners-Lee in 1994, W3C is:

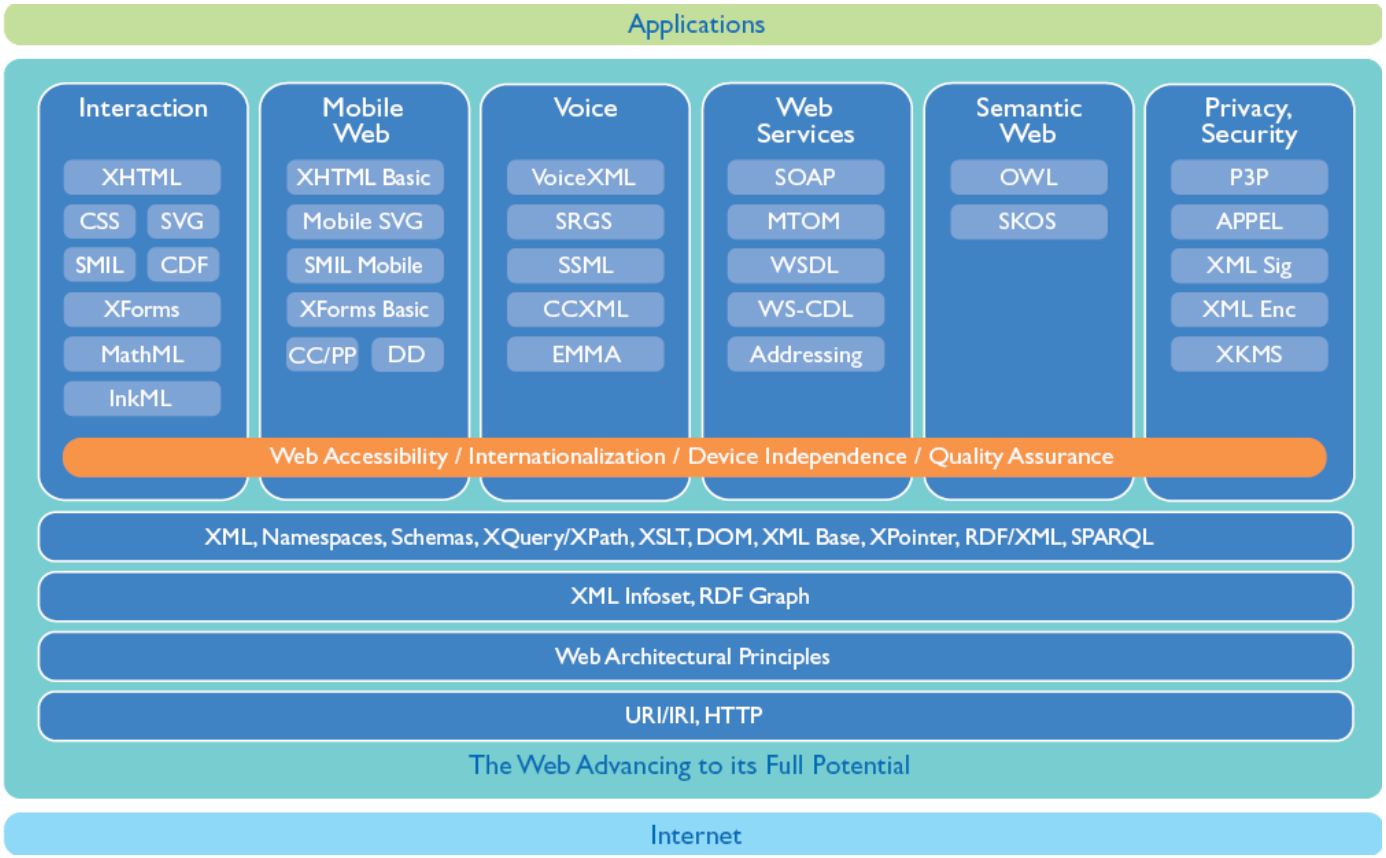
- Providing the **Vision** to Lead
- **Engineering** the **Open Standards** that Make the Web Work ...

... expanding ...

- From a Web of **Documents** ...
- Toward ***One Web*** ...
  - *... of **Data and Services***
  - *... on **Everything***
  - *... for **Everyone***
- -- think *Web 3.0*

Engineering an Interoperable Foundation of the Web

- Close to 100 Web Standards to date (list/svg-by-yr/translations/~60 groups svg)
  - *Including:* ***HTML, XML, CSS, SOAP, SVG, Voice XML, RDF*** *and more*



The Real Question

- Q: Which of these are relevant to you?
- A: All of them… ☺
- But let's look at W3C's *emerging* technologies, and focus on one

Emerging W3C Technologies

Web for Everyone

Universal Access ...

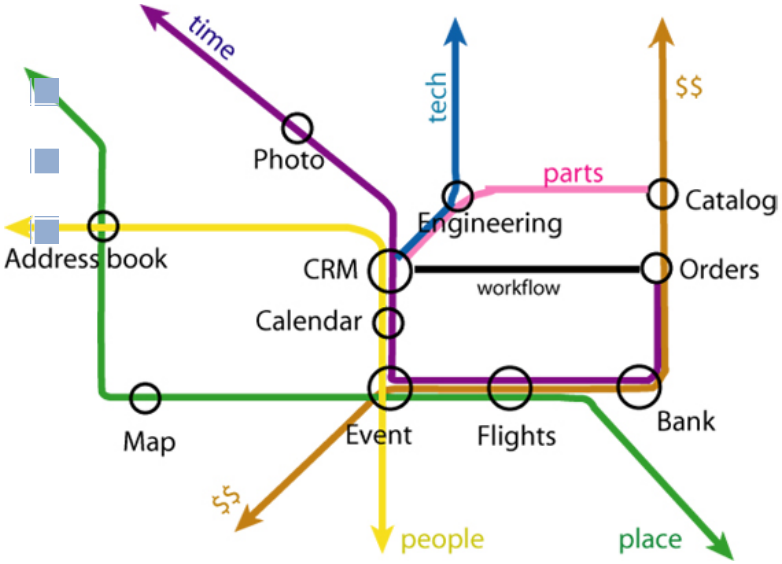
- Global participation (Offices, translations, etc.)
- Internationalization Activity *(overview talk)*
- Web Accessibility Initiative
- New Web security work
- Future objective: "Trust"

Web on Everything

***The* User Interface, everywhere ...**

- Interaction Technologies: HTML, XForms, CSS, MathML, Voice, Graphics, Multimedia, Multimodal
- Web 2.0 <= Rich Web Clients: Compound Doc Formats, Web Apps APIs (AJAX) and Formats
- Mobile Web Initiative
- Device Independence
- Ubiquitous Web (workshop, slides)

Web of Data & Services



Interoperable information and programs ...

- XML: Binary, Processing Model
- Web of Services: Performance, Addressing, SemWeb Services, Policy *(overview slides)*
- Web of Data = Semantic Web: Deployment, Query, Rules, Health Care/Life Sciences, Content Labeling, Geospatial, Multimedia Semantics

Introduction to the Semantic Web

What is the Semantic Web?

"The Semantic Web is an

... extension of the current web in which

... information is given well-defined meaning,

... better enabling computers and people to work in cooperation."

The Semantic Web

Tim Berners-Lee, James Hendler and Ora Lassila

Scientific American, May 2001

Semantic Web: Why?

- Tasks often require *combining* data across the Internet, e.g.:
  - *Integrating data across the enterprise*
  - *Hotel, transport, meeting, personal info come from different sites*
  - *Mining data from biochemical, genetic, pharmaceutical, patient databases*
  - *Cross-referencing disparate digital libraries*
- Humans understand how to combine this information ...
  - *Not always easy (different vocabularies, languages, formats)*
- Machines aren't smart enough :-)

Why Can't Machines "Understand"?

Analogy:

What We Say to Dogs

- "*Stay out of the garbage! Understand, Ginger? Stay out of the garbage!*"

What Dogs Understand

- "... blah blah blah blah **GINGER** blah blah blah blah ..."

What Machines "Understand"

" ... blah blah ****** ***text-link*** ****** blah blah . . . ."*

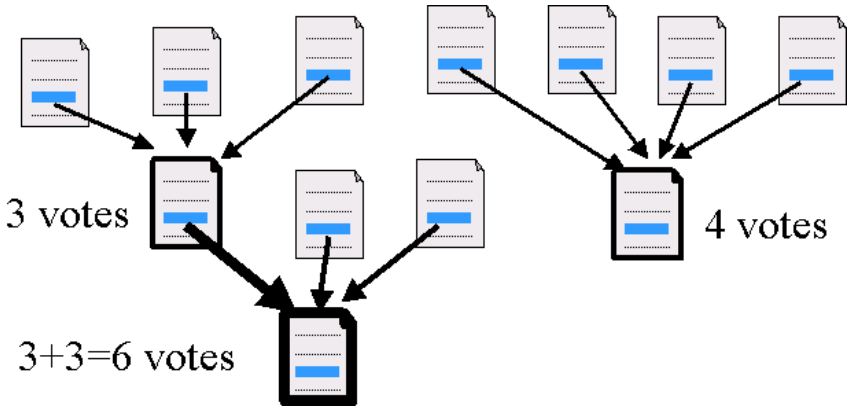
- Computers must "**understand**" more:
  - *Not human concept of "understanding"*
  - *Just useful machine processing, for example, capturing the nature of*
    - the "link-text" object
    - the thing at the other end of the link ("http://www.xwz.com/foo.html")
    - the relationship between the two (why are they linked?)

--

* *where* **<a href=...>** *is HTML for a "link"*

Toward Processable Search Semantics

Google:



- Web links are machine processable
- Minimal semantics assumed: "This" refers to "that" = popularity
- Amazing results from minimal semantics

What if Web pages had more semantics?

(See Article by Bijan Parsia)

Ways to Enable Machine Processing

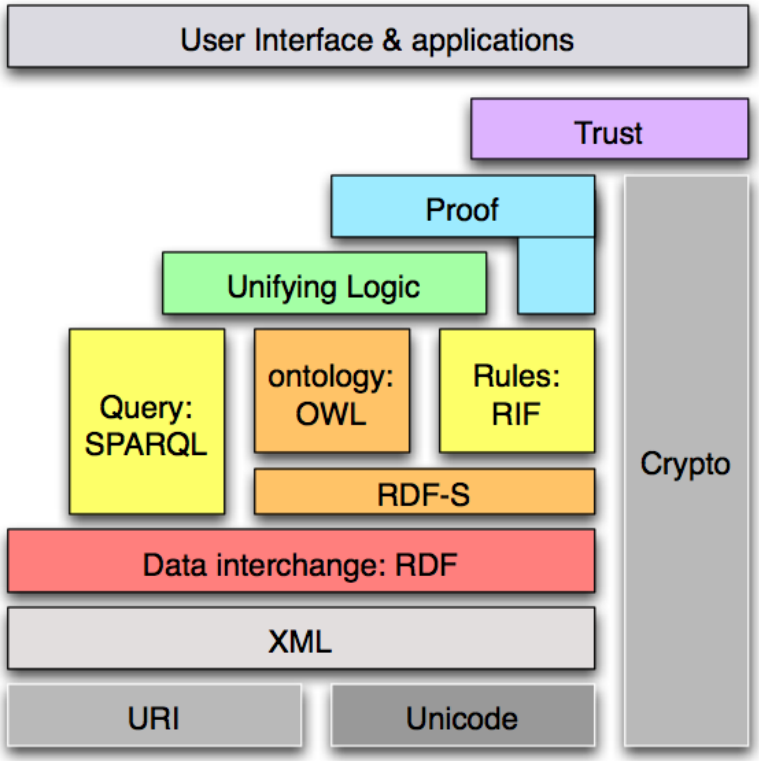
Smarter Machines

- Teach computers to infer the *meaning* of Web data
  - *Natural language, image recognition, etc.*
- ... this is the Artificial Intelligence approach
  - ***WARNING**: Hard problem!*

Smarter Data

- Make data *easier* for machines to find, access and process
  - *Express data and meaning in standard machine-readable format*
  - *Support decentralized definition and management, across the network*
- ... this is the ***Semantic Web*** approach

Semantic Web: Linked Data on the Web



Machine-processable, global **Web** standards:

- Assigning unambiguous names (URI)
- Expressing and linking data, including metadata (RDF)
- Capturing ontologies (OWL)
- Query, rules, transformations, deployment, application spaces (in progress) logic, proofs, trust

Semantic Web = Web 3.0? (Markoff, NYT, Nov 2006)

(W3C's Semantic Web Activity / Semantic Web overview slides / example)

Uniform Resource Identifiers (URI)

- URIs have two, very powerful, functions:
  1. *Unique, unambiguous name for something*
  2. *Where to find that something*
- URIs can be used to identify definitions for concepts
  - *Especially useful for ontologies & metadata*
- Examples:
  - *http://www.w3.org/People/Berners-Lee/*
  - *mailto:steve@w3.org*
  - *ftp://ftp.is.co.za/rfc/rfc1808.txt*
  - *See also Internationalized Resource Identifier standard (RFC 3987)*

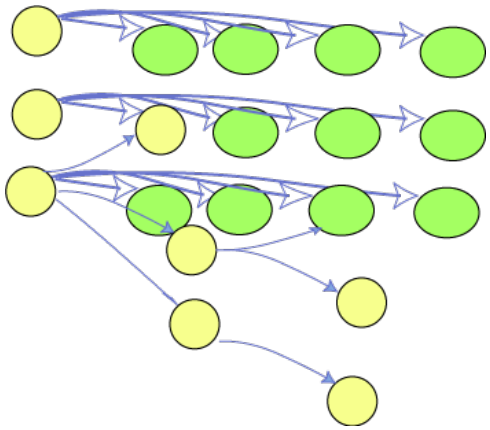
Resource Description Framework (RDF)

- Semantic Web's Resource Description Framework: a W3C standard (Primer)
  - *Statements linking data so as to describe things (concepts, objects, etc.)*
  - ***RDF : Data :: HTML link : Documents***
- Descriptive statements expressed as triples:
  - *(Subject, Predicate, Object) or (Subject, Property, Value)*

- Most useful, Web-wise, when these are URIs, e.g. for this presentation:
  - *http://www.w3.org/2006/Talks/0811-sb-W3Cemergingtech/Overview.html as the subject*
  - *http://purl.org/dc/elements/1.1/creator as the property*
  - *http://www.w3.org/People/Bratt/stevenrbratt.rdf#SB as the value*

RDF: Flexible Representation

Linking table and tree data ...



Web Ontology Language (OWL) +

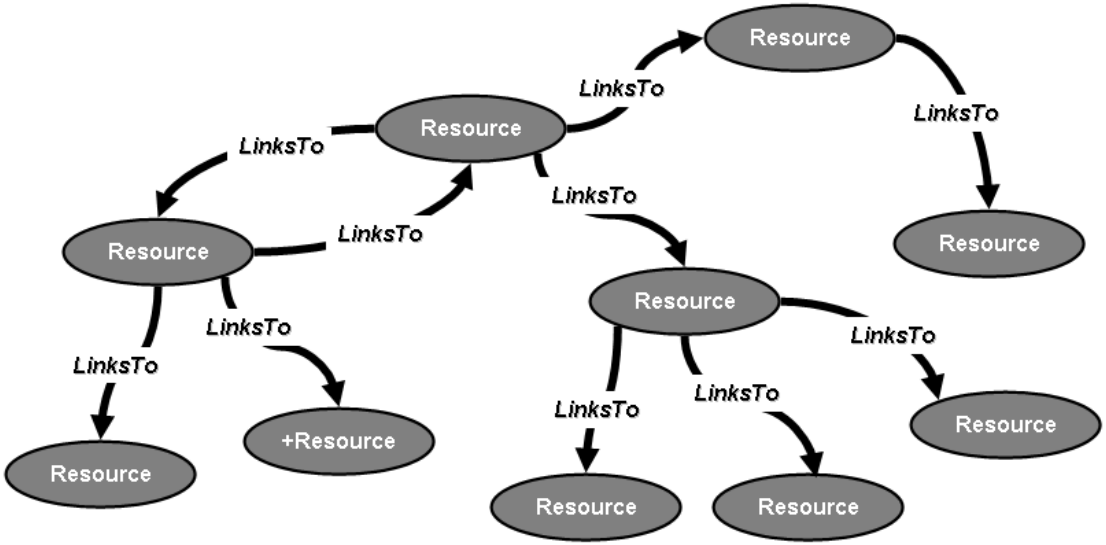
- W3C standard (Guide, *Overview*)
  - *Defining concepts & relationships within area of knowledge*
- Like DBMS data dictionary or schema, *but* ..
  - *Global, standard syntax based on RDF*
  - *Can define more complex, graph relationships*
  - *Using URIs as keys*
  - *On the Web*
- Includes standard vocabulary for describing properties and classes.:
  - *Datatypes (e.g., integer, date, string ..)*
  - *Relations (e.g. subclass of, property of ..)*
  - *Cardinality (e.g. exactly one ..)*
  - *Characteristics of properties (e.g. symmetry)*
  - *... and more*

Standards En Route

- Query
- Rules
- Transformations
- Deployment and application spaces
  - *Health Care and Life Sciences*
  - *thesauri, classification schemes, subject heading lists, taxonomies, 'folksonomies'*
  - *Content Labeling, Multimedia, Geospatial*
- Logic, proof, trust, etc. in the future?

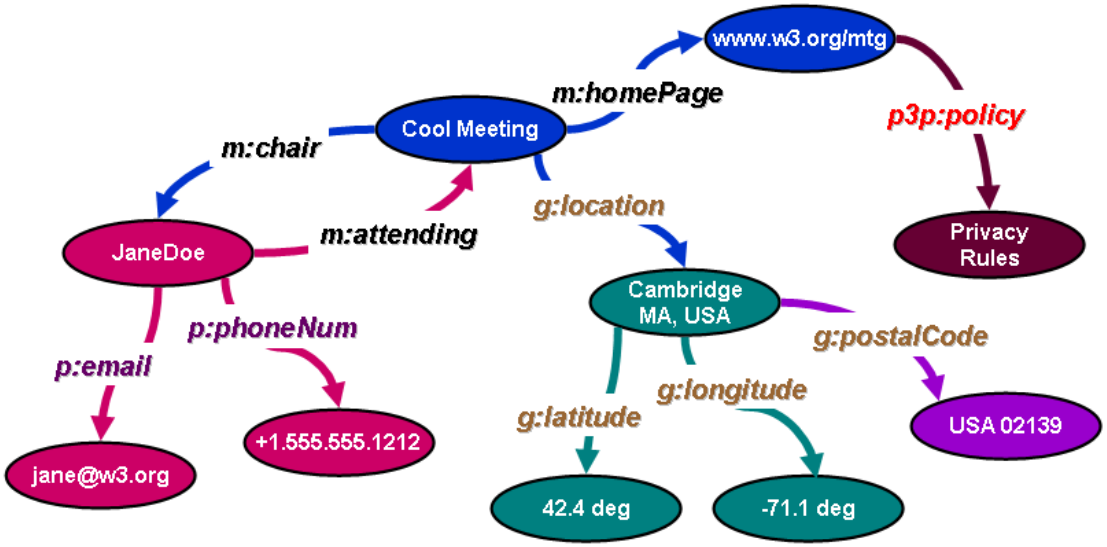
Most of the Current Web

- Minimal machine-processable information -- dumb links



Semantic Web: "Smarter" Resources and Links

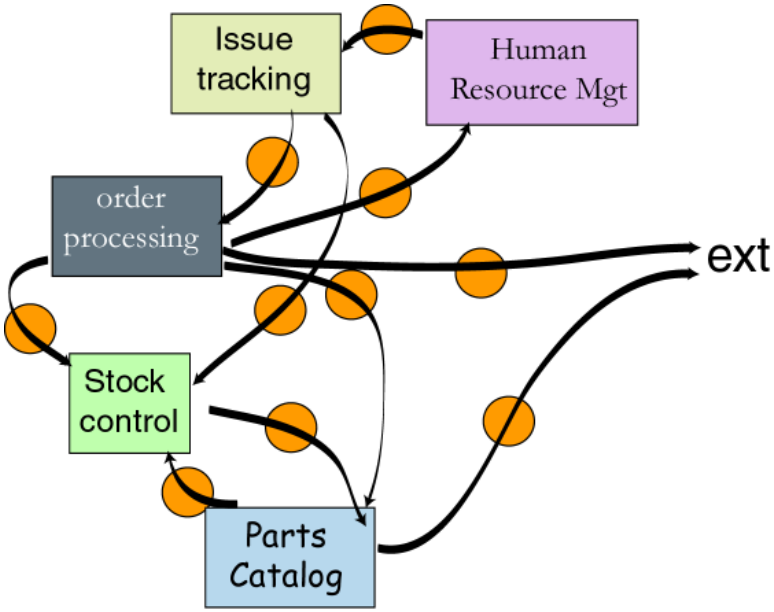
- More machine-processable information: data connected by relationships



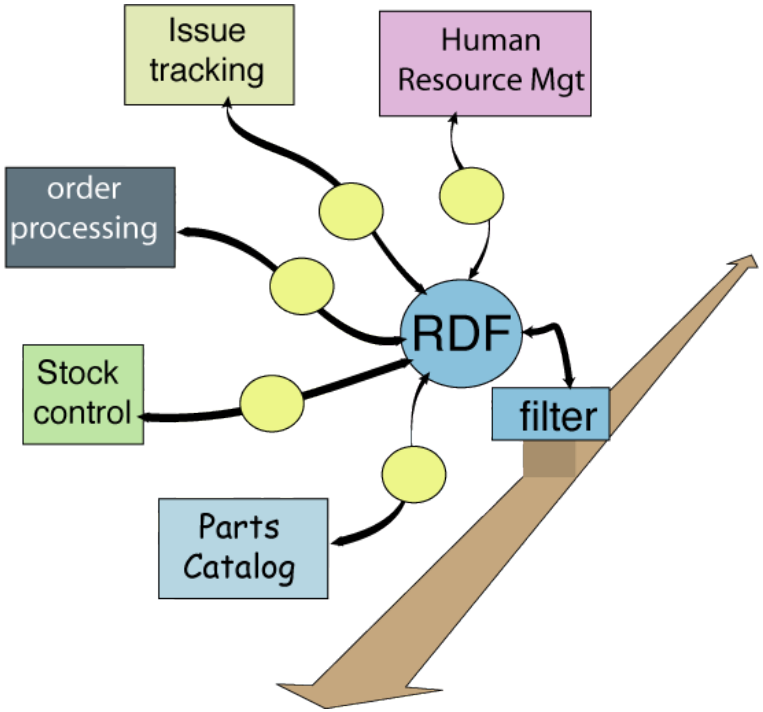
[ellipses = resources; color = one data source; x: = one ontology]

(see also more detailed example related to book searching and selling)

Enterprise Integration Today

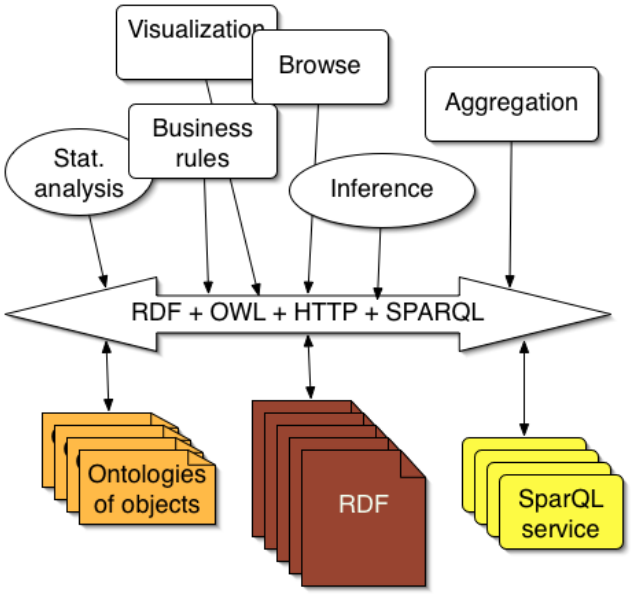


Enterprise Integration on the "RDF Bus"



Clients on the "RDF Bus"

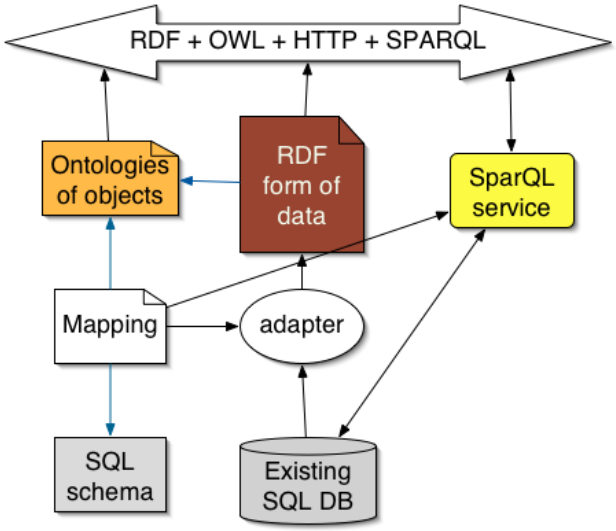
New data applications can be built on top of RDF bus, for example:



See Semantic Web interface concepts for other types of data sources (Tim Berners-Lee)

Adapting SQL/RDBMS Databases

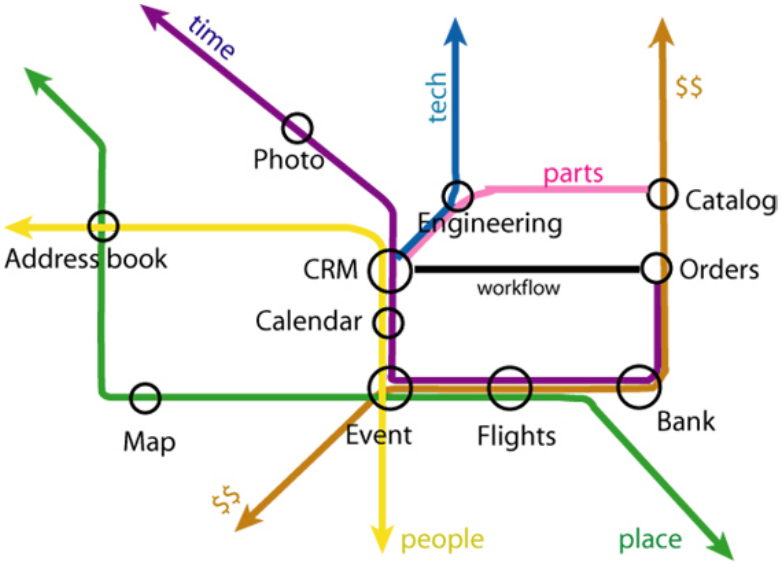
Keep your existing systems running, and add RDF interfaces:



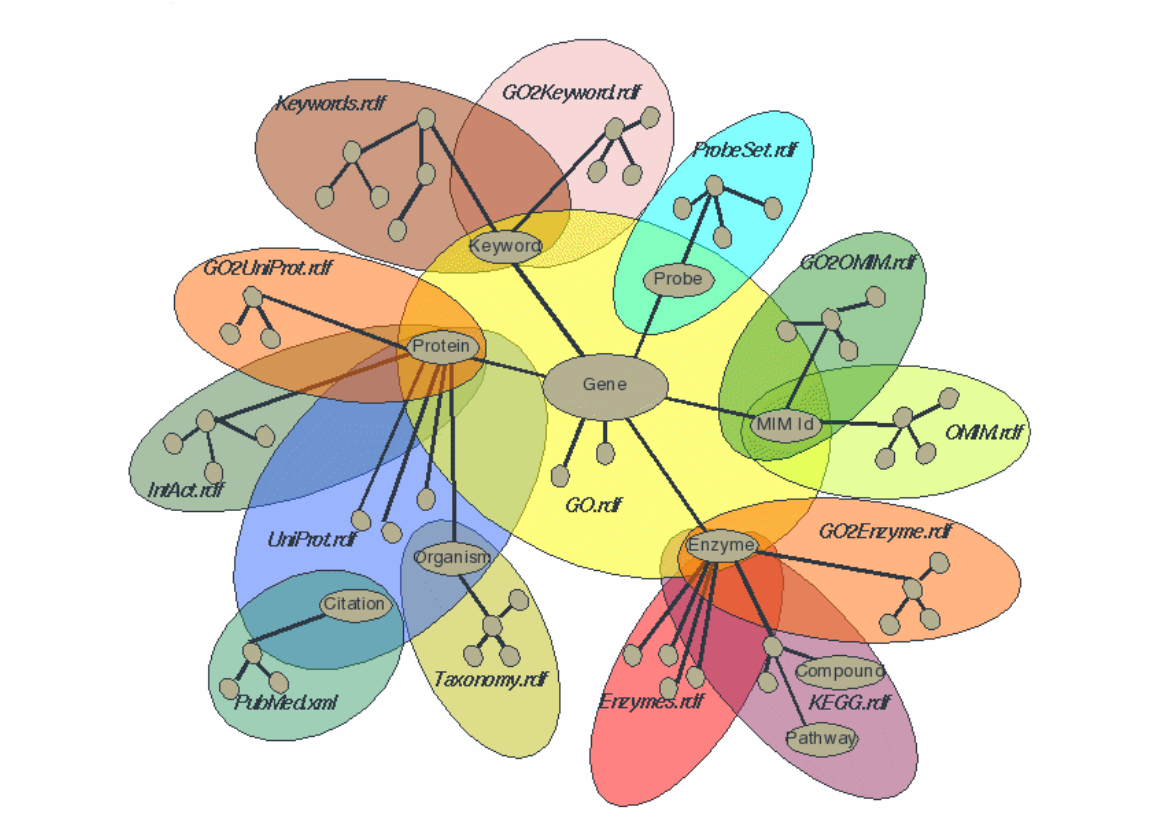
Examples of DBMS interfaces: 1.life sciences, 2.conference information

See Semantic Web interface concepts for other types of data sources (Tim Berners-Lee)

Applications Linked via Semantic Web



Life Science Onotologies Linked via Semantic Web



Challenges Ahead

Classic "chicken and egg problem" en route to "network effect"

- Providing information in Semantic-Web-friendly ways
  - *Exposing existing data stores as RDF*
  - *Automated and human-assisted tools to create RDF stores, ontologies, mappings*
- Making data accessible to people and programs
  - *Usable interfaces to masses of semantic data*
    - Search, filtering, aggregation, processing, graphics
  - *Access via multiple modes, multiple devices*
- Addressing broader operational and social needs
  - *Universality, quality, provenance, versioning, safety, privacy, access control, authorization, trust*

Getting Familiar with the Semantic Web

- See more detailed tutorial*
- Research groups (e.g., MIT/DIG, UMD, UBristol, DARPA/DAML, etc.)
- Commercial initiatives (HP, IBM, Oracle, Nokia, etc.)
- Conferences (e.g., ISWC, SemTech, etc.)
- Follow W3C's work to drive incubation and standardization
- Large datasets are accumulating. E.g.:
  - *IngentaConnect bibliographic metadata storage: over 200 million triplets, RDF version of Wikipedia: more than 47 million triplets, Tracking the US Congress: data stored in RDF (around 25 million triplets), RDFS/OWL Representation of Wordnet: also downloadable as 150MB of RDF/XML, "Département/canton/commune" structure of France published by the French Statistical Institute*
- Other portal examples:
  - *Sun's White Paper Collections and System Handbook collections; Nokia's S60 support portal; Harper's Online magazine linking items via an internal ontology; Oracle's virtual press room; Opera's community site,…*
- Development tools

Timing Strawman

- 2006+. Strategic planning. Model your data.
- 2007. Test by adding value to your organization's data web:
  - *Build SemWeb wrappers around a few databases*
  - *Integrate disparate datasets to solve a few unsolved problems*
  - *Offer filtered SemWeb data to partners, customers*
- 2008. Customers, partners demand SemWeb data. More tools available.
- 2009+. Build new, replace legacy applications.

Killer apps (or even failures) could radically change the timeline.

Summary

- **Evolution toward one Web ...**
  - ***of Data and Services, on Everything, for Everyone***
- **Strong business case for**
  - *Understanding emerging standards*
  - *Implementing standards as they appear likely*
  - *Participating in standards orgs supports both of these*
- **A good resource ...**

http://www.w3.org/

Discussion

Extra Slides

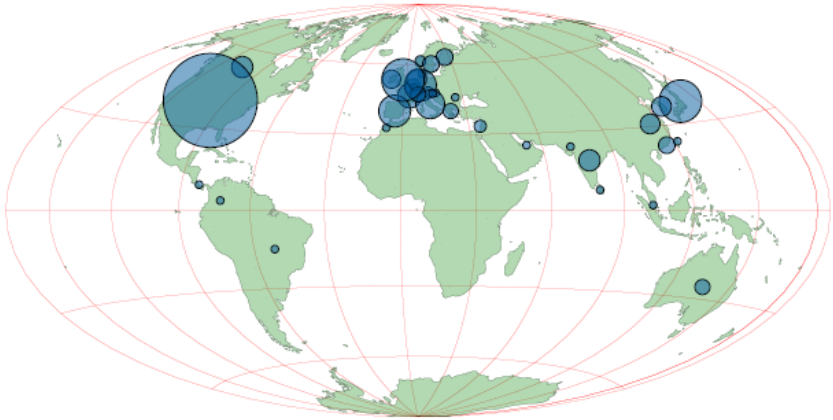
World Wide Web Consortium

W3C's Mission: Leading the Web to its Full Potential

Founded by Web inventor Tim Berners-Lee in 1994, W3C is:

- **Unique International Standards Organization**
  - *Providing the **Vision** to Lead*
  - ***Engineering** the **Open Standards** that Make the Web Work*
- 19 **Hosts/Offices**: **MIT** | **ERCIM** | **Keio** | | Australia | Benelux/Bénélux | 中国 | Suomi | Deutschland und Österreich | Ελλ•δα | 香港 | Magyarország | •••• | ••••• | Italia | 한국 | •••••• | España | Sverige | United Kingdom and Ireland | (*map)*
- 435 **Members** *(history map, largest)*
- 800 **Technologists** developing standards in 60 **Groups**
- 65 Member-neutral **Technical Staff**
- Accountable to the **Global Public**

(Membership / Benefits / "At a Glance" brochure)



Who are W3C's Members?

"Third-class companies make products; second-class companies develop technology; first-class companies set standards."

- **W3C's Members includes ...**
  - *most of the world's leading IT companies*
  - *other large and small companies*
  - *academic and research institutions*
  - *government agencies*
  - *non-profit organizations*
- **... which are ...**
  - *developing Web-based products*
  - *using Web technologies*
  - *conducting research on the Web*
  - *developing specifications built upon W3C's work*

* popular saying in Chinese business and government, from *"China's Post-WTO Technology Policy: Standards, Software and the Changing Nature of Techno-Nationalism*", by Richard P. Suttmeier and Yao Xiangkui.
Full-fee Members (Jul 2006)

Why Do People Participate in W3C?

- **Leadership**
  - *Introduce ideas through submissions, workshops, Incubator Groups*
  - *Influence standards through Working Group participation, review, implementation*
- **Early insight into market trends**
  - *Access world's foremost Web technologists from Member & Team*
  - *Plan for emerging technologies & markets through Member-confidential access*
- **Promoting image as innovator**
  - *Participate in international media activities, press releases, testimonials (e.g., MWI)*
  - *Display your logo on W3C site (250K visits/day) and W3C logo on your site*

(Membership / Benefits / How to join W3C / "At a Glance" brochure)