Intelligent Agents Meet the Semantic Web

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ORNL, April 5, 2005

http://ebiquity.umbc.edu/v2.1/event/html/id/91/

Joint work with Anupam Joshi, Yun Peng, Scott Cost & many students.

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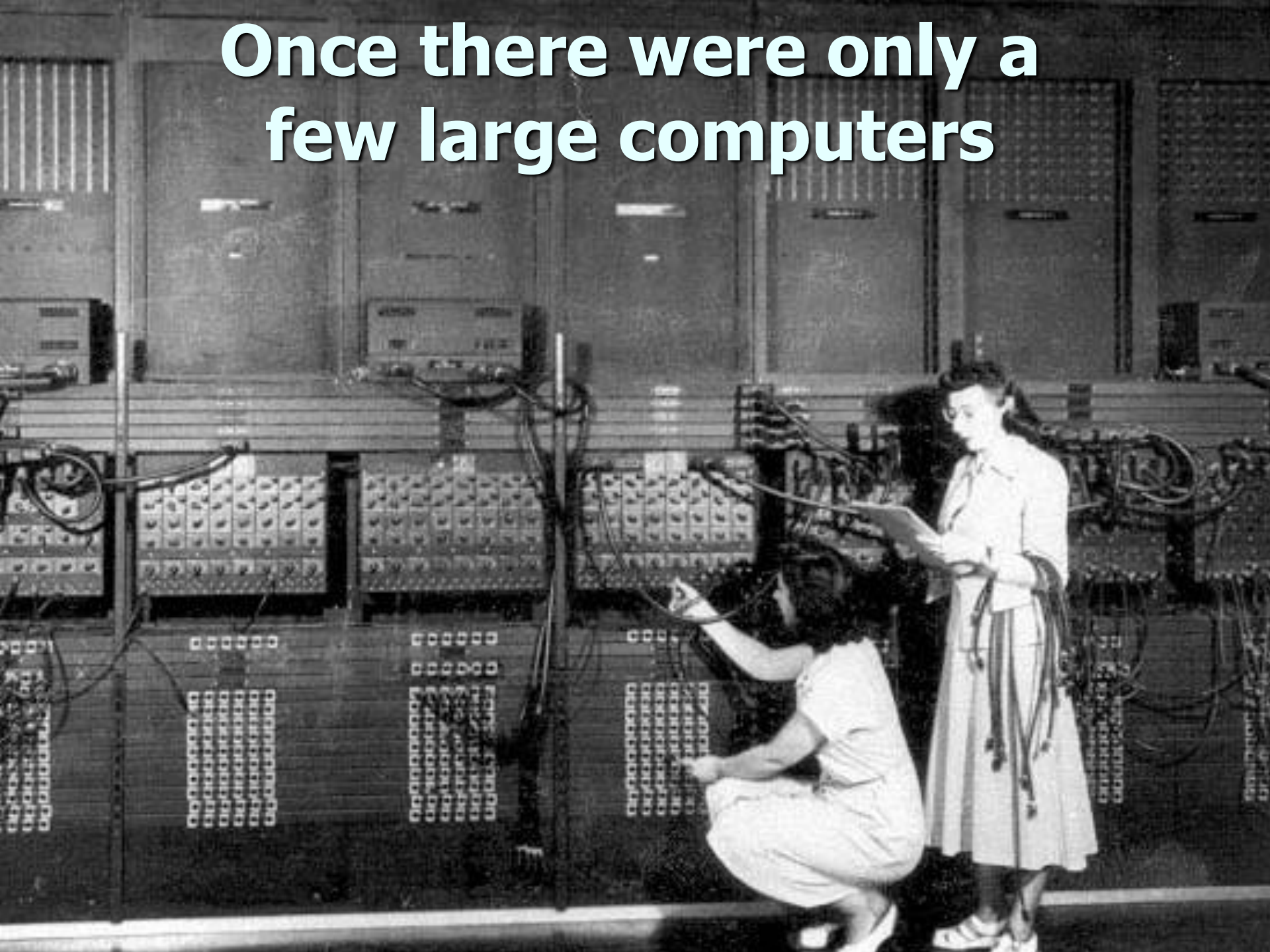
This talk

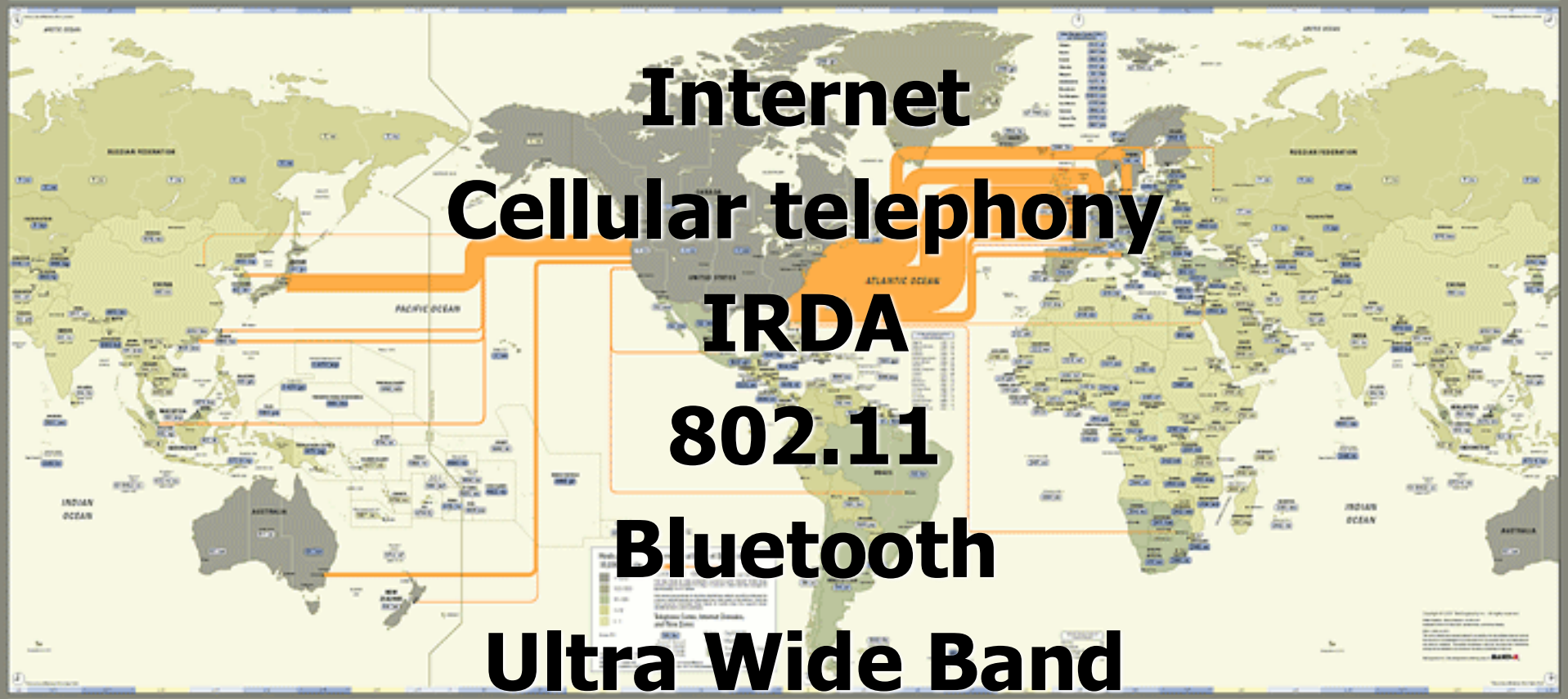
- Motivation
- Semantic web concepts and technologies
- Using the semantic web for
  (1) Pervasive computing
  (3) Information retrieval
- Conclusions

Once there were only a few large computers



Then there were many

And they all became physically inter-connected 24x7



Internet

Cellular telephony

IRDA

802.11

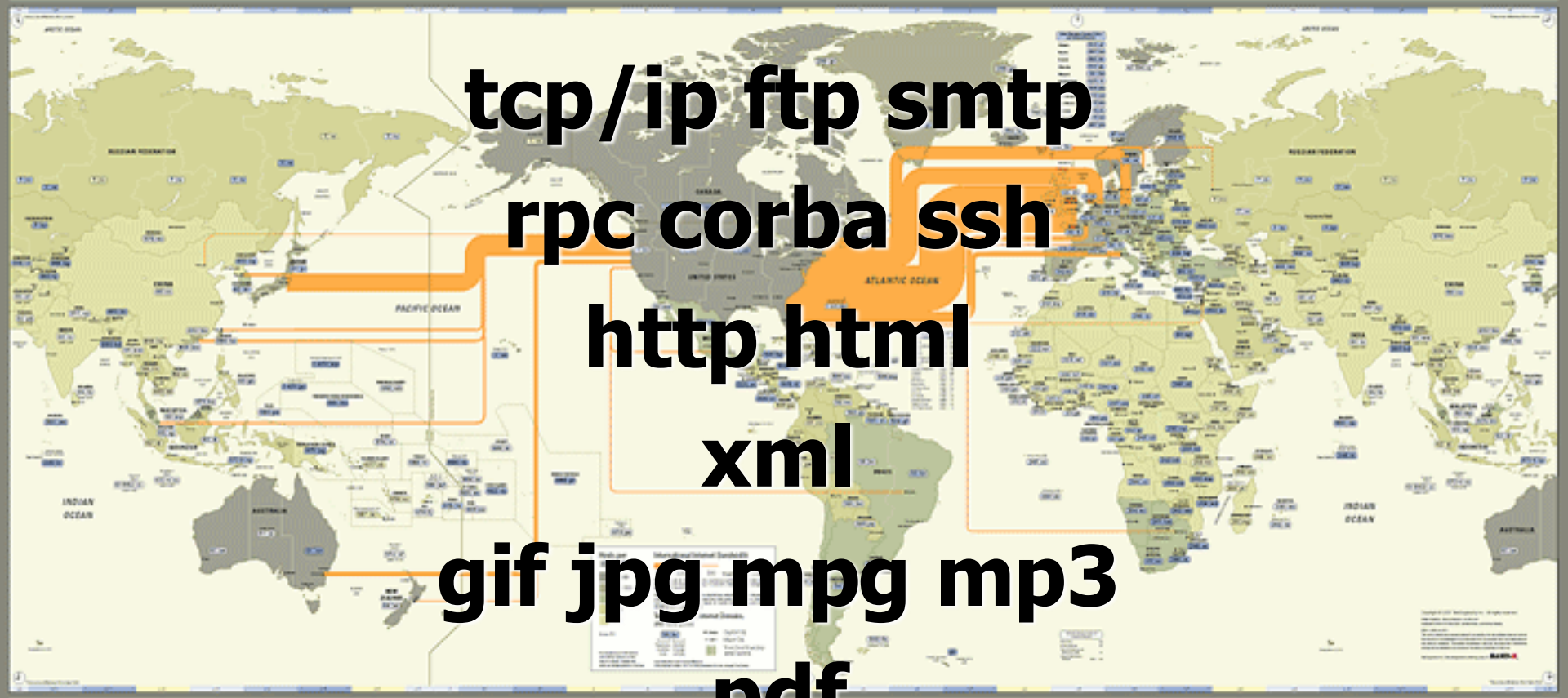
Bluetooth

Ultra Wide Band

RFID

and more to come

Software standards supported access and interoperability



The Result: today we have access to virtually all the world's knowledge

Google

MAPQUEST

Ask Jeeves

INTERNET ARCHIVE

CiteSeer

Autonomous Citation Indexing

INTERNET ARCHIVE

WayBackMachine

WIKIPEDIA

ebay

YAHOO!

amazon.com

But is mostly in the form of Natural Language Text, Images and Audio

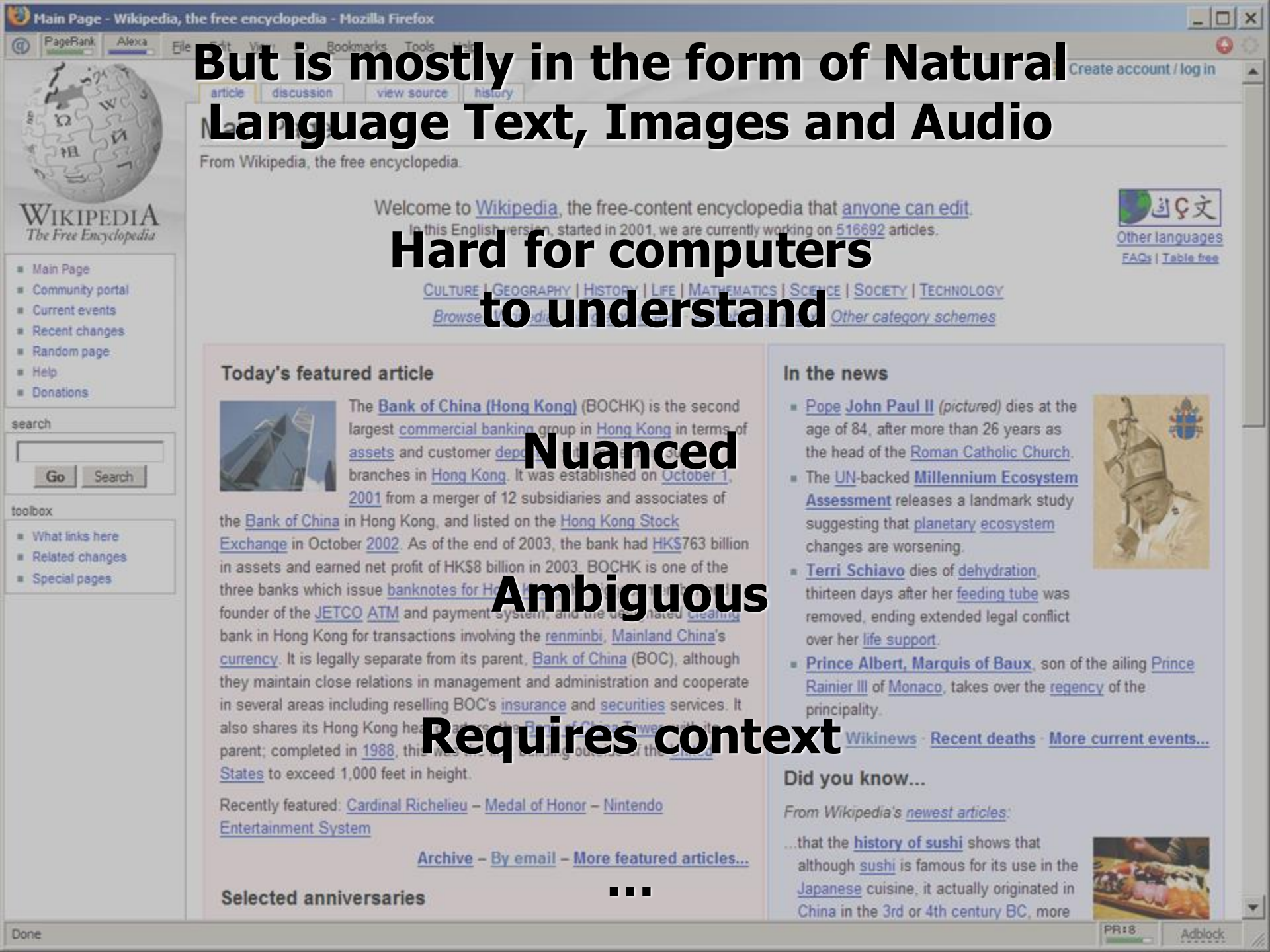
Hard for computers to understand

Nuanced

Ambiguous

Requires context

...

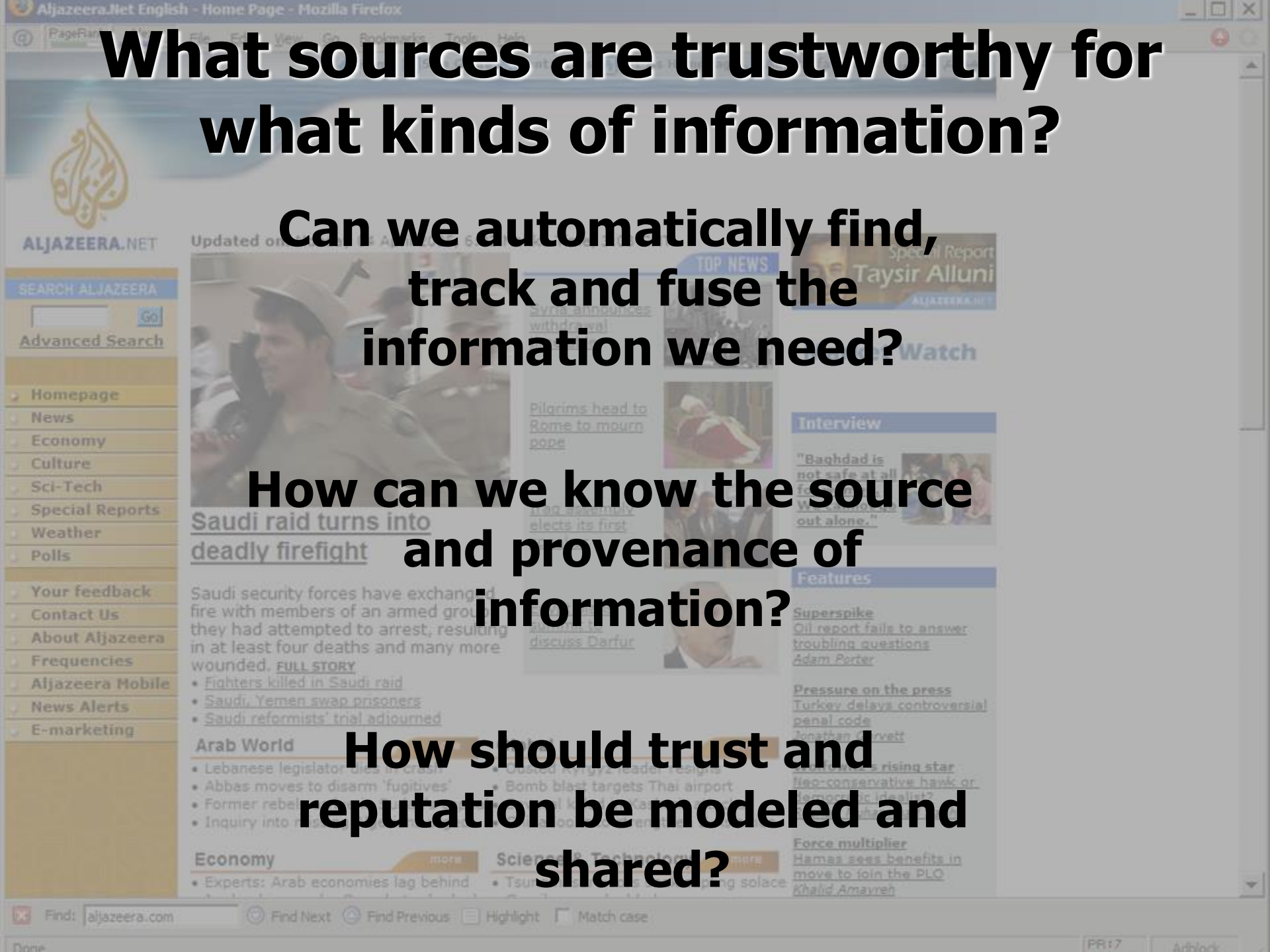


What sources are trustworthy for what kinds of information?

Can we automatically find, track and fuse the information we need?

How can we know the source and provenance of information?

How should trust and reputation be modeled and shared?



Computers helped make the problem and they can help solve it

We need agents and services to find, correlate and fuse information on the web.

They must be able to understand the content they discover publish their own conclusions, and communicate with one another.

They must advertise their own information services in a well understood form.

"XML is Lisp's bastard nephew, with uglier syntax and no semantics. Yet XML is poised to enable the creation of a Web of data that dwarfs anything since the Library at Alexandria."

-- Philip Wadler, *Et tu XML? The fall of the relational empire*, VLDB, Rome, September 2001.

"The web has made people smarter. We need to understand how to use it to make machines smarter, too."

-- Michael I. Jordan, paraphrased from a talk at AAAI, July 2002 by Michael Jordan (UC Berkeley)

"The Semantic Web will globalize KR, just as the WWW globalize hypertext"

-- Tim Berners-Lee

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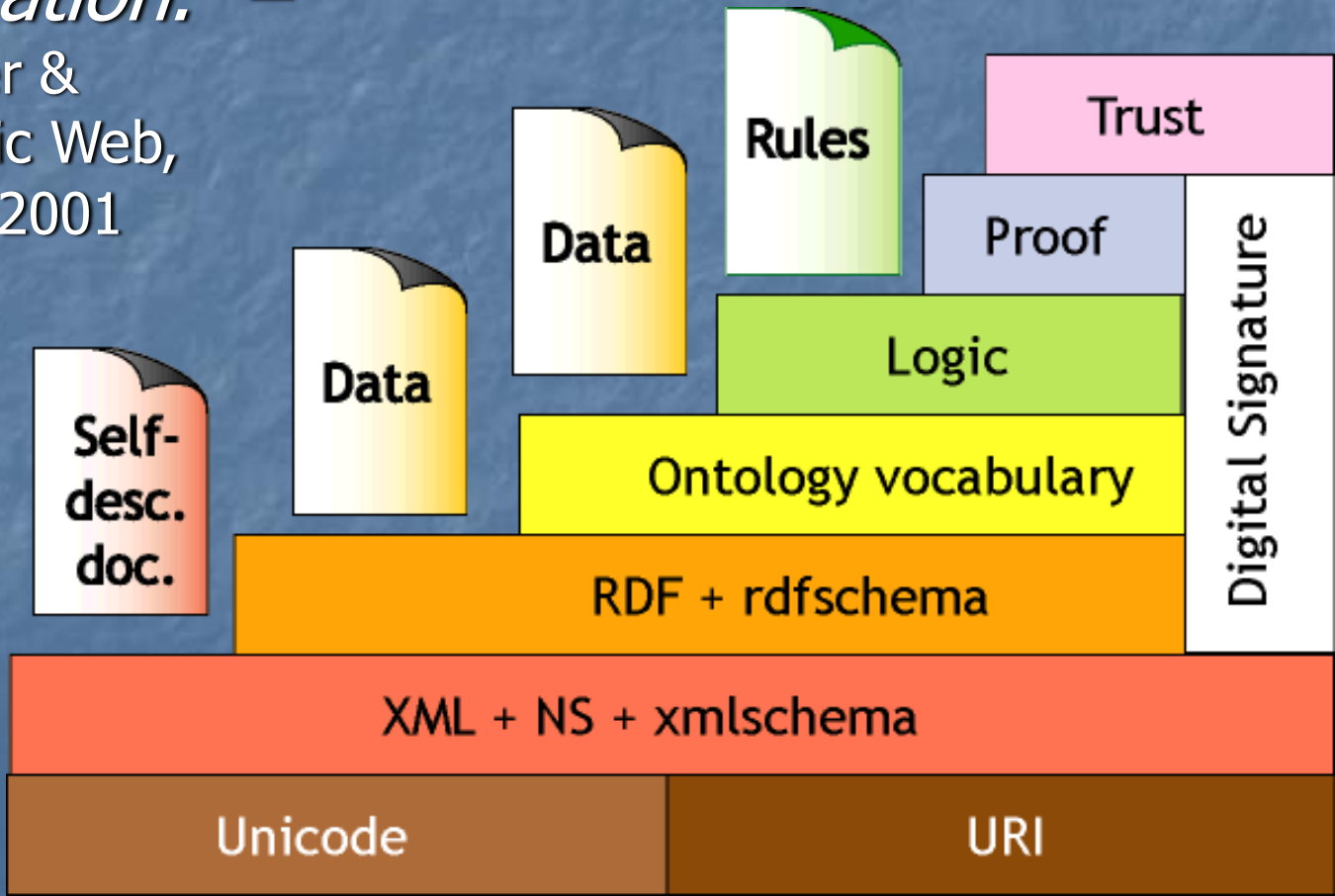
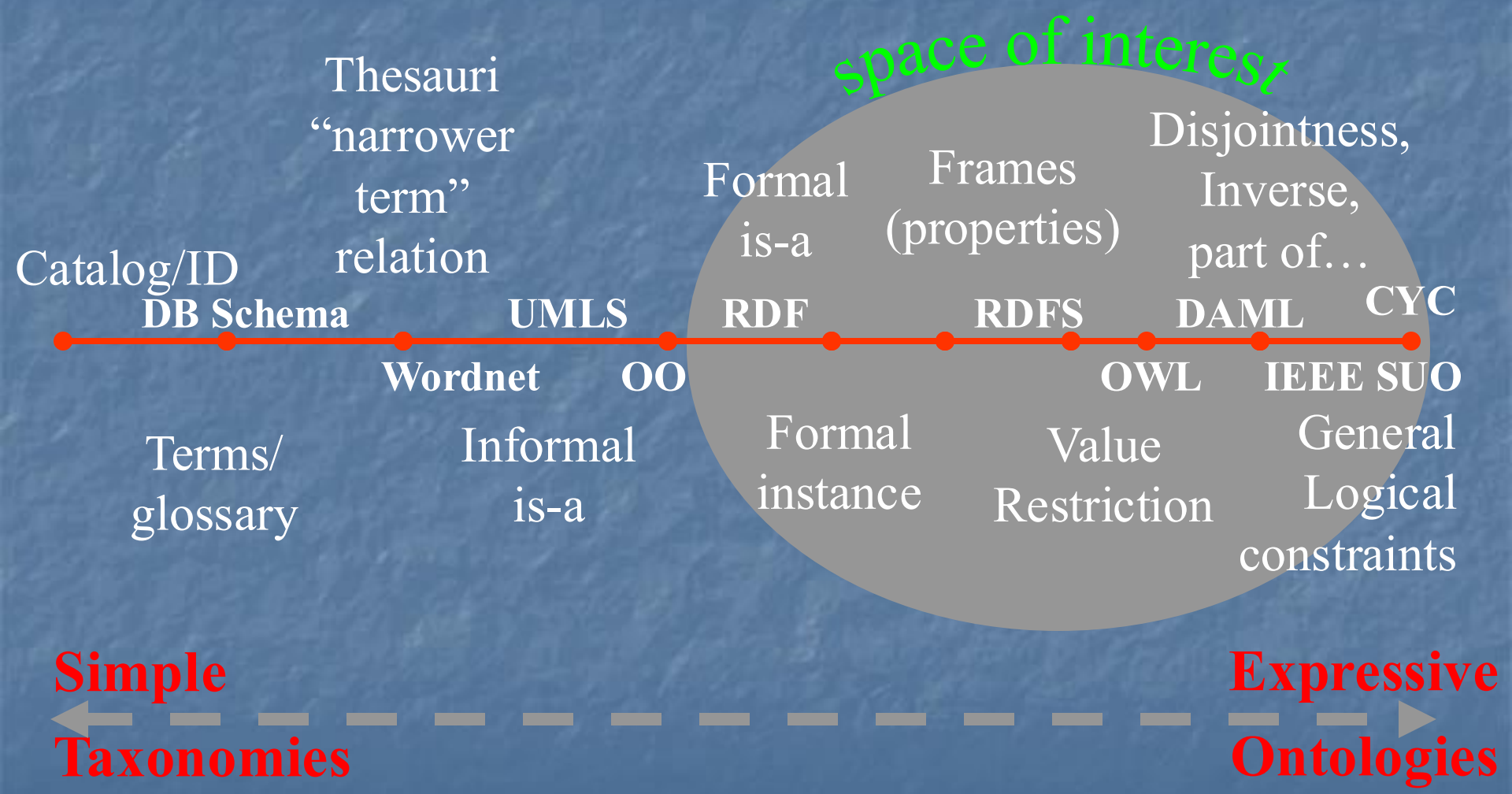
W3C's Semantic Web Vision

"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." –

Berners-Lee, Hendler & Lassila, The Semantic Web, Scientific American, 2001



What kind of Ontologies?
from controlled vocabularies to Cyc



After Deborah L. McGuinness (Stanford)

Today and tomorrow

- Simple ontologies like FOAF & DC in use today
  - We've crawled more than 1M FOAF RDF files
- We hope to be able to make effective use ontologies like Cyc in the coming decade
  - There are skeptics …
  - It's a great research topic …
- The SW community has a roadmap and some experimental languages …
- Industry is starting to use the Semantic Web (Adobe, Oracle, Cisco, Sun …)
- We need more experimentation and exploration

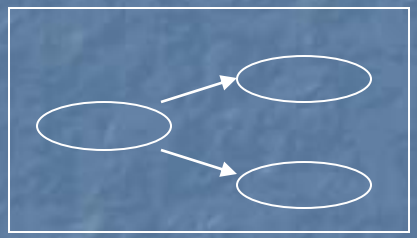
RDF is the first SW language

XML Encoding

```
<rdf:RDF ……..>
    <….>
    <….>
</rdf:RDF>
```

Good for Machine Processing

Graph



Good For Human Viewing

RDF Data Model

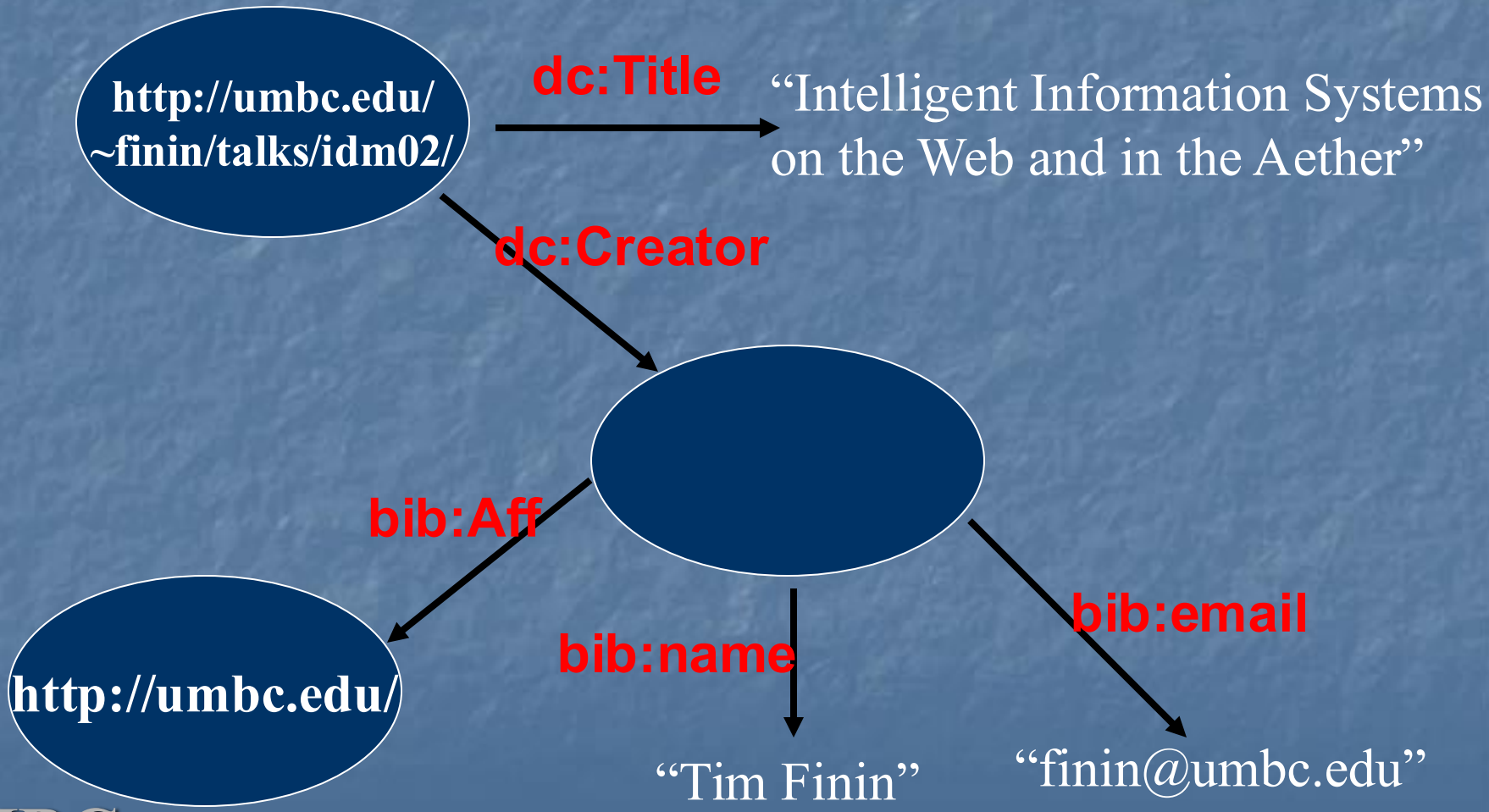
Triples

```
stmt(docInst, rdf_type, Document)
stmt(personInst, rdf_type, Person)
stmt(inroomInst, rdf_type, InRoom)
stmt(personInst, holding, docInst)
stmt(inroomInst, person, personInst)
```

Good For Reasoning

RDF is a simple language for building graph based representations

Simple RDF Example



XML encoding for RDF

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:dc="http://purl.org/dc/elements/1.1/"
    xmlns:bib="http://daml.umbc.edu/ontologies/bib/">
<description about="http://umbc.edu/~finin/talks/idm02/">
  <dc:title>Intelligent Information Systems on the Web and in the
Aether</dc:Title>
  <dc:creator>
    <description>
      <bib:Name>Tim Finin</bib:Name>
      <bib:Email>finin@umbc.edu</bib:Email>
      <bib:Aff resource="http://umbc.edu/" />
    </description>
  </dc:Creator>
</description>
</rdf:RDF>
```

A usecase: FOAF

- FOAF (Friend of a Friend) is a simple ontology to describe people and their social networks.
  - See the foaf project page: http://www.foaf-project.org/
- We recently crawled the web and discovered over 1,000,000 valid RDF FOAF files.
  - Most of these are from the http://liveJournal.com/ blogging system which encodes basic user info in foaf
  - See http://apple.cs.umbc.edu/semdis/wob/foaf/

```
<foaf:Person>
   <foaf:name>Tim Finin</foaf:name>
   <foaf:mbox_sha1sum>2410…37262c252e</foaf:mbox_sha1sum>
   <foaf:homepage rdf:resource="http://umbc.edu/~finin/" />
   <foaf:img rdf:resource="http://umbc.edu/~finin/images/passport.gif" />
</foaf:Person>
```

FOAF Vocabulary

Basics

- Agent
- Person
- name
- nick
- title
- homepage
- mbox
- mbox_sha1sum
- img
- depiction (depicts)
- surname
- family_name
- givenname
- firstName

Personal Info

- weblog
- knows
- interest
- currentProject
- pastProject
- plan
- based_near
- workplaceHomepage
- workInfoHomepage
- schoolHomepage
- topic_interest
- publications
- geekcode
- myersBriggs
- dnaChecksum

Documents & Images

- Document
- Image
- PersonalProfileDocument
- topic (page)
- primaryTopic
- tipjar
- sha1
- made (maker)
- thumbnail
- logo

Projects & Groups

- Project
- Organization
- Group
- member
- membershipClass
- fundedBy
- theme

Online Accts

- OnlineAccount
- OnlineChatAccount
- OnlineEcommerceAccount
- OnlineGamingAccount
- holdsAccount
- accountServiceHomepage
- accountName
- icqChatID
- msnChatID
- aimChatID
- jabberID
- yahooChatID

FOAF: why RDF? Extensibility!

- FOAF vocabulary provides 50+ basic terms for making simple claims about people
- FOAF files can use other RDF terms too: RSS, MusicBrainz, Dublin Core, Wordnet, Creative Commons, blood types, starsigns, …
- RDF guarantees freedom of independent extension
  - OWL provides fancier data-merging facilities
- **Result:** Freedom to say what you like, using any RDF markup you want, and have RDF crawlers merge your FOAF documents with other's and know when you're talking about the same entities.

After Dan Brickley, danbri@w3.org

No free lunch!

Consequence:

- We must plan for lies, mischief, mistakes, stale data, slander
- Dataset is out of control, distributed, dynamic
- Importance of knowing who-said-what
  - Anyone can describe anyone
  - We must record data provenance
  - Modeling and reasoning about trust is critical
- Legal, privacy and etiquette issues emerge
- Welcome to the real world

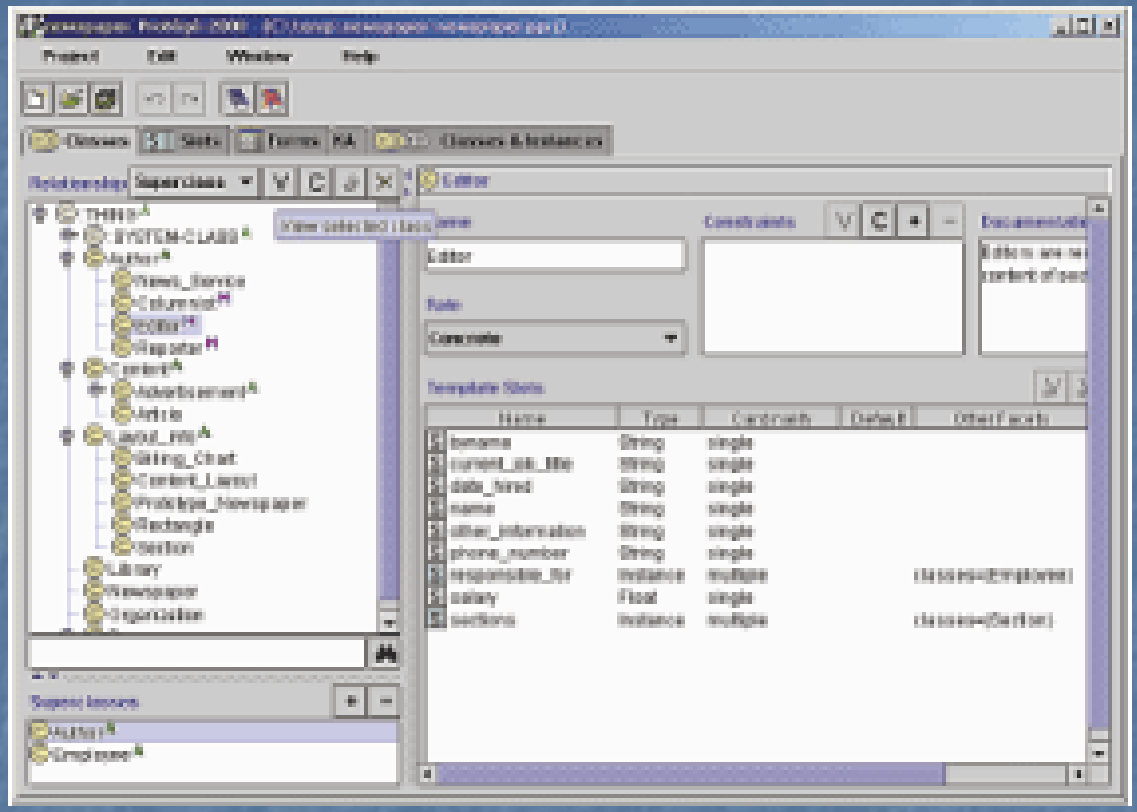
After Dan Brickley, danbri@w3.org

RDF is being used!

- **RDF has a solid specification**
- **RDF is being used in a number of web standards**
  - CC/PP (Composite Capabilities/Preference Profiles)
  - P3P (Platform for Privacy Preferences Project)
  - RSS (RDF Site Summary)
  - RDF Calendar (~ iCalendar in RDF)
- **And in other systems**
  - **Mozilla** & **Firefox** web browsers & Open directory
  - **Adobe** products via XMP (eXtensible Metadata Platform)
  - Web communities: LiveJournal, Ecademy, and Cocolog.
  - We've found over 2.2M RDF documents on the web
  - New **Oracle** and **Cisco** products

RDF Schema (RDFS)

- **RDF Schema adds taxonomies for classes & properties**
  - subClass and subProperty
- **and some metadata.**
  - domain and range constraints on properties
- **Several widely used KB tools can import and export in RDFS**



Stanford Protégé KB editor

- Java, open sourced
- extensible, lots of plug-ins
- provides reasoning & server capabilities

RDFS supports simple inferences

- An RDF ontology plus some RDF statements may imply additional RDF statements.
- This is not true of XML.
- Note that this is **part of the data model** and not of the accessing or processing code.

```
@prefix rdfs: <http://www.....>.
@prefix : <genesis.n3>.
 parent rdfs:domain person;
          rdfs:range person.
 mother rdfs:subProperty parent;
          rdfs:range person.
 eve mother cain.
```

```
parent a class.
person a property.
woman subClass person.
mother a property.
eve a person;
      a woman;
      parent cain.
cain a person.
```

From where will the markup come?

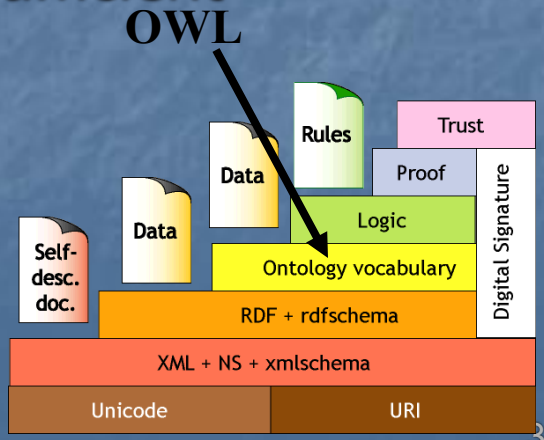
- A few authors will add it manually.
- More will use annotation tools.
  - SMORE: Semantic Markup, Ontology and RDF Editor
- Intelligent processors (e.g., NLP) can understand documents and add markup (hard)
  - Machine learning powered information extraction tools show promise
- Lots of web content comes from databases & we can generate SW markup along with the HTML
  - See http://ebiquity.umbc.edu/

From where will the markup come?

- In many tools, part of the metadata information is present, but thrown away at output
  - e.g., a business chart can be generated by a tool…
  - …it "knows" the structure, the classification, etc. of the chart
  - …but, usually, this information is lost
  - …storing it in metadata is easy!
- So *"semantic web aware"* tools can produce lots of metadata
  - E.g., Adobe's use of its XMP platform

W3C's Web Ontology Language (OWL)

- OWL released as W3C recommendation 2/10/04
  - See http://www.w3.org/2001/sw/WebOnt/ for OWL overview, guide, specification, test cases, etc.
- OWL provides a richer vocabulary to
  - describe ontologies and their properties and relations
  - Describe properties of properties (e.g., transitivity, inverse, cardinality constraints)
  - Create definitions (i.e., necessary and sufficient conditions)
  - Compliment
  - etc.



Semantic Web Rule Languages

- There are some things that your can not define in OWL, like the uncle relationship.
- Two extensions to owl provide rule languages to use with OWL
  - SWRL is a simple Datalog-like rule language whose conditions and conclusions are RDF triples
  - RuleML is a language that can encode most of first order language
- Several OWL reasons incorporate SWRL rules

OWL-S defines Services

- AN important use-case for OWL is to give semantically grounded descriptions for services
- These might be web services, grid services, or some other kind of service.
- OWL-S is an OWL ontology that can be used to describe services in terms of
  - Meta data (who, what, where, when, …)
  - Preconditions and effects
  - Inputs and outputs
  - Compositions and decompostions

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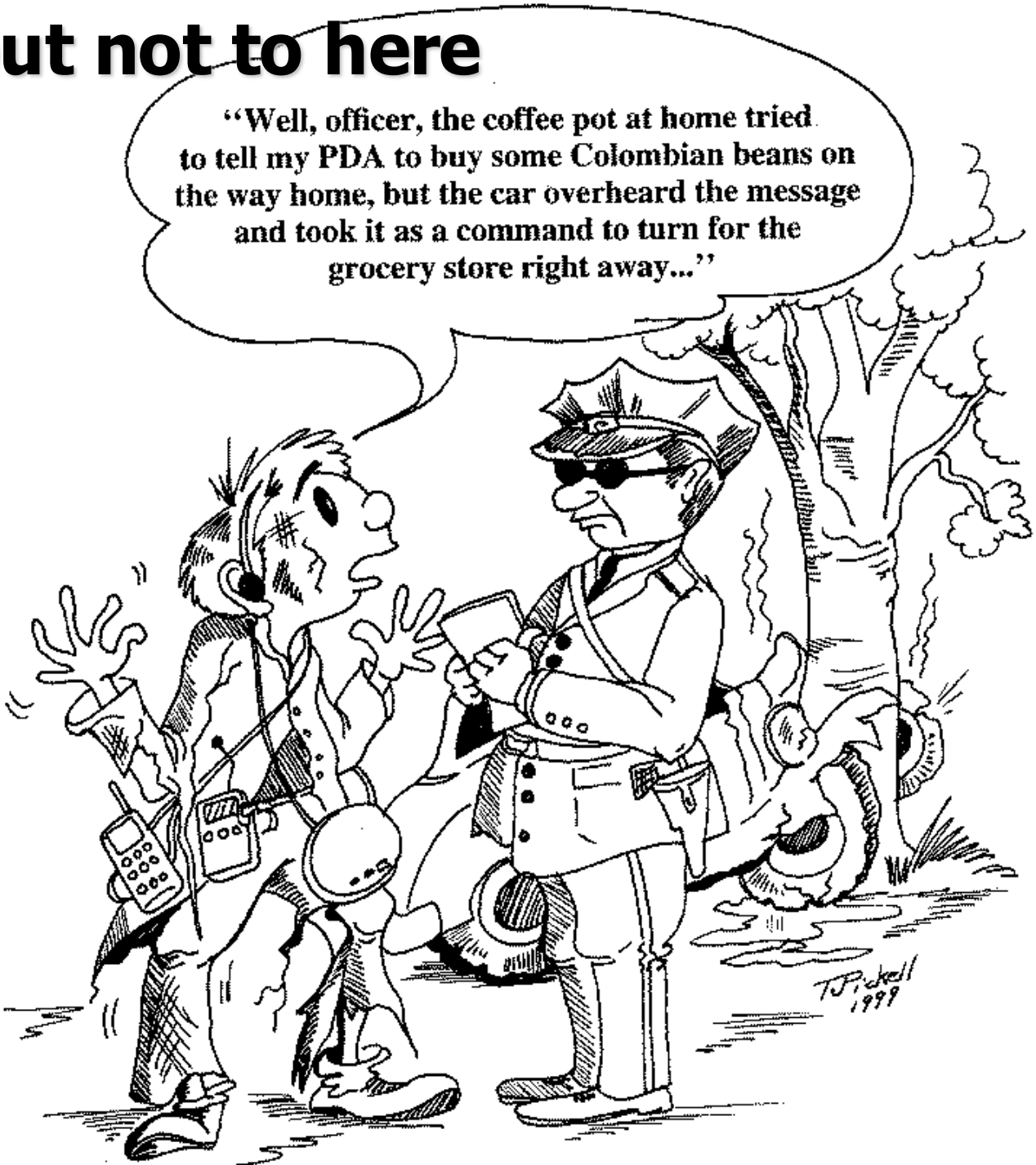
Motivation: moving from this

Motivation: to here

Motivation: but not to here



Pervasive Computing

"*The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it*" – Mark Weiser

Think: writing, central heating, electric lighting, water services, …

Not: taking your laptop to the beach, or immersing yourself into a virtual reality

This is a challenging environment

- While devices are getting smaller, cheaper and more powerful, they still have severe limitations.
  - Battery, memory, computation, connection, bandwidth
  - Each as limited sensors and perspective
- The environment is inherently dynamic with serendipitous connections and unknown entities
  - This makes security and trust important
- MANETS (mobile ad hoc networks) underlie pervasive infrastructures like Bluetooth
  - It's autonomous agents all the way down
- Privacy is a special concern
  - People and agents want to control how information about them is collected and used

Representing and Reasoning about Context

CoBrA: a broker centric agent architecture for supporting pervasive context-aware systems

- Using SW ontologies for context modeling and reasoning about devices, space, time, people, preferences, meetings, etc.
- Using logical inference to interpret context and to detect and resolve inconsistent knowledge
- Allowing users to define policies controlling how information about them is used and shared

TAGA: Travel Agent Game in Agentcities

Motivation
- Market dynamics
- Auction theory (TAC)
- Semantic web

Features
- Open Market Framewo
- Auction Services

nolog
- pril Agent F
- Semantic Web (RDF, OWL)
- Web (SOAP, WSDL, DAML-S)

Ontologies
- ://taga.umbc.edu/ontologies/
- travel.owl - travel concepts

Owl for modeling trust

Owl for publishing communicative acts

Owl for contract enforcement

Owl for negotiation

Owl for protocol description

Owl for representation and reasoning

Owl as a content language

FIPA pl e services, including directory facilitators enhanced to use OWL-S for service discovery

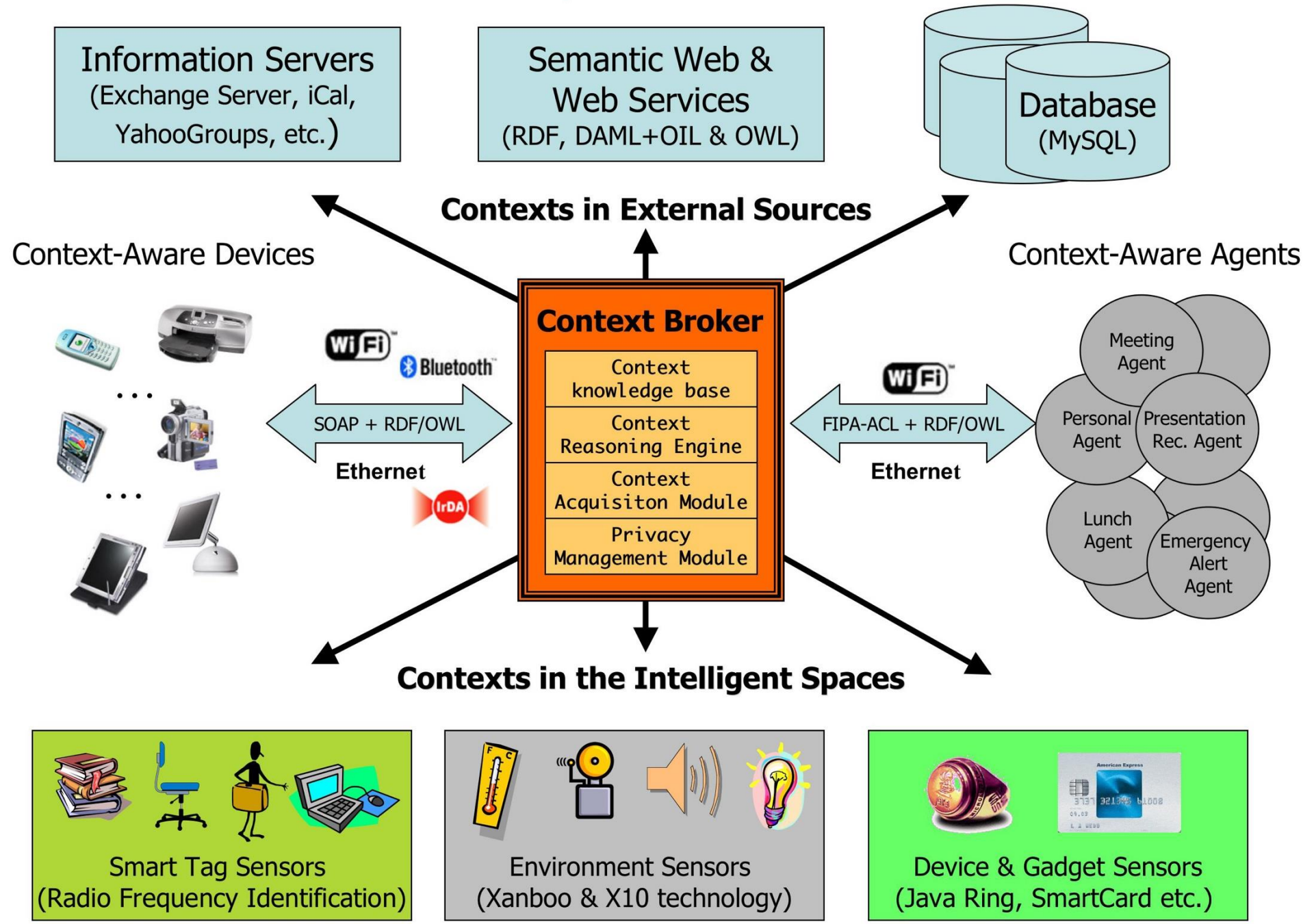
Owl for authorization policies

Owl for service descriptions

http://taga ed

UMBC
an Honors University in Maryland

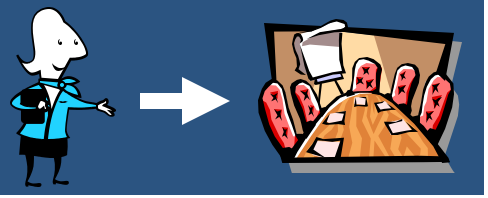
A Bird's Eye View of CoBrA



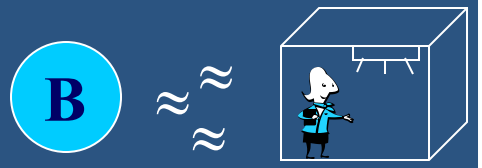
A Typical CoBrA Use Case

Alice in Wonderland*

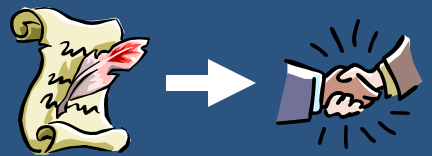
Alice enters a conference room



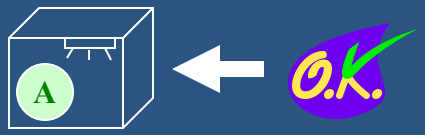
The broker detects Alice's presence



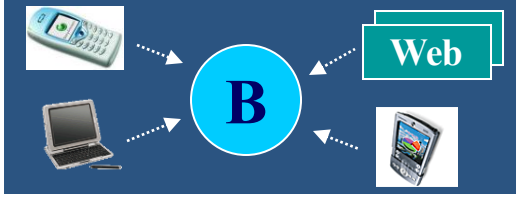
The broker negotiates privacy policy with Alice



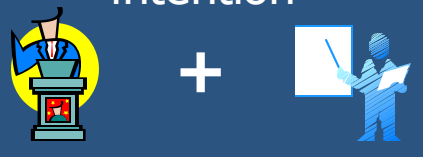
Policy says, "can share with any agents in the room"



The broker builds the context model



The broker knows Alice's role and intention

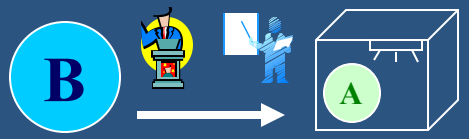


* Our intelligent meeting room

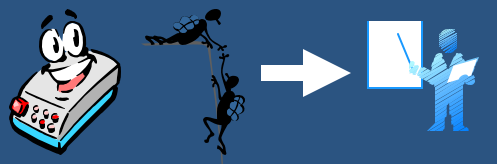
A Typical CoBrA Use Case

Alice in Wonderland

The broker informs the subscribed agents

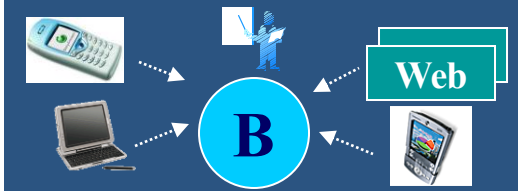


The projector agent wants to help Alice

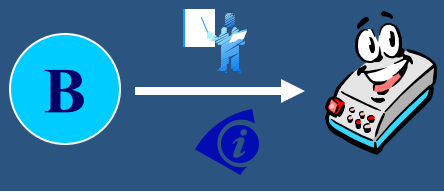


The projector agent asks slide show info.

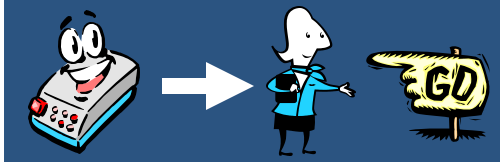
The broker acquires the slide show info.



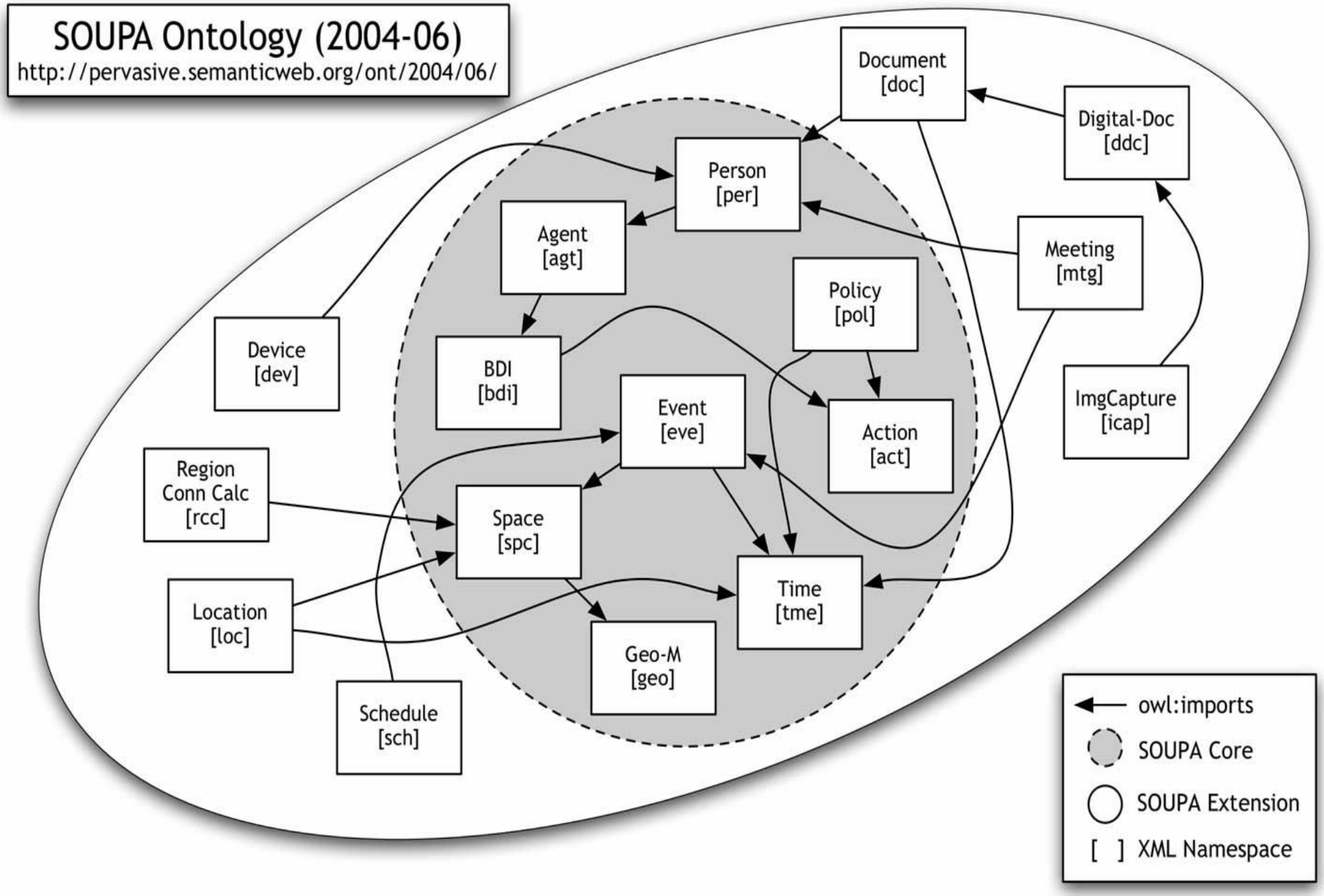
The broker informs the projector agent



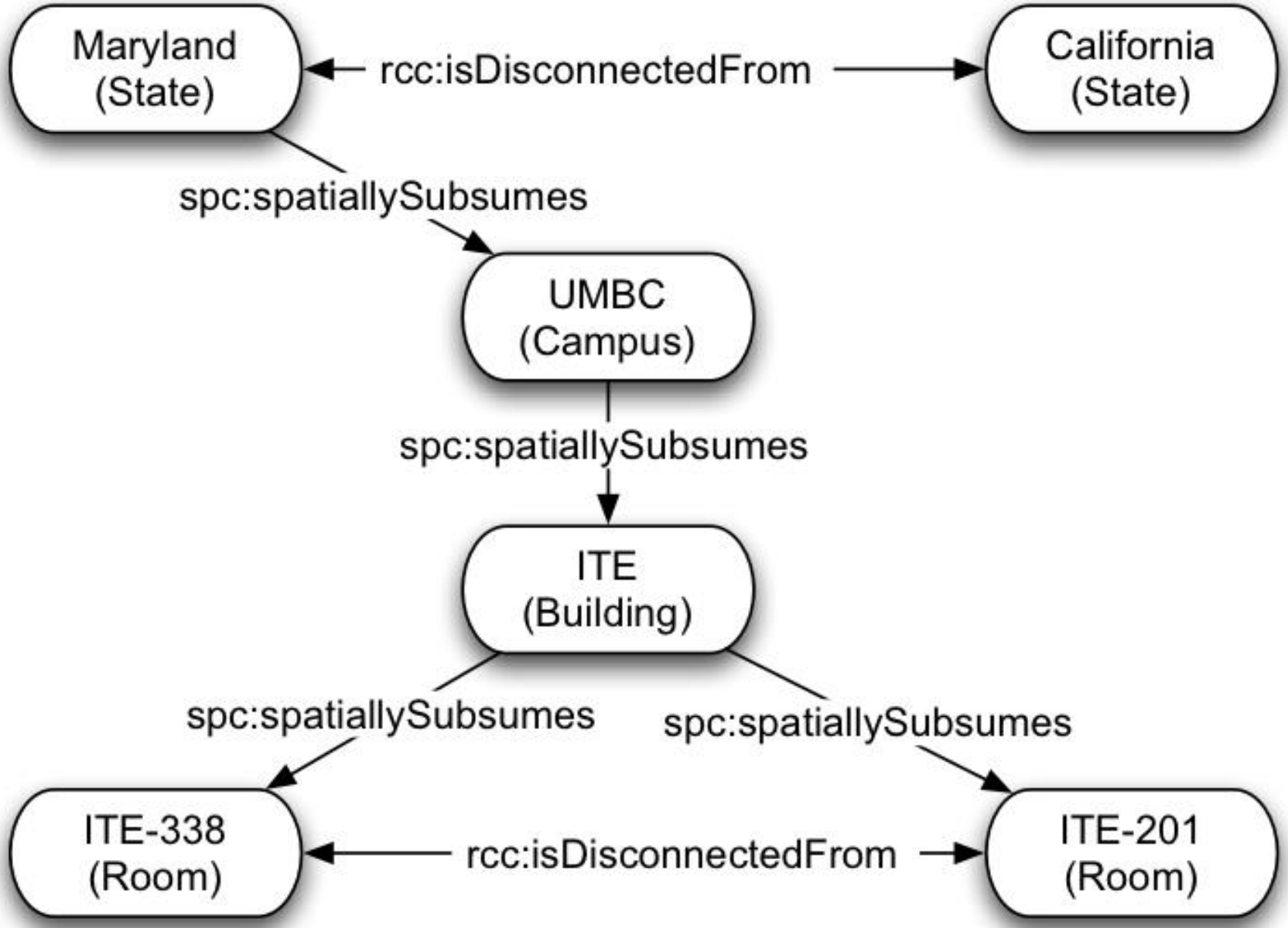
The projector agent sets up the slides



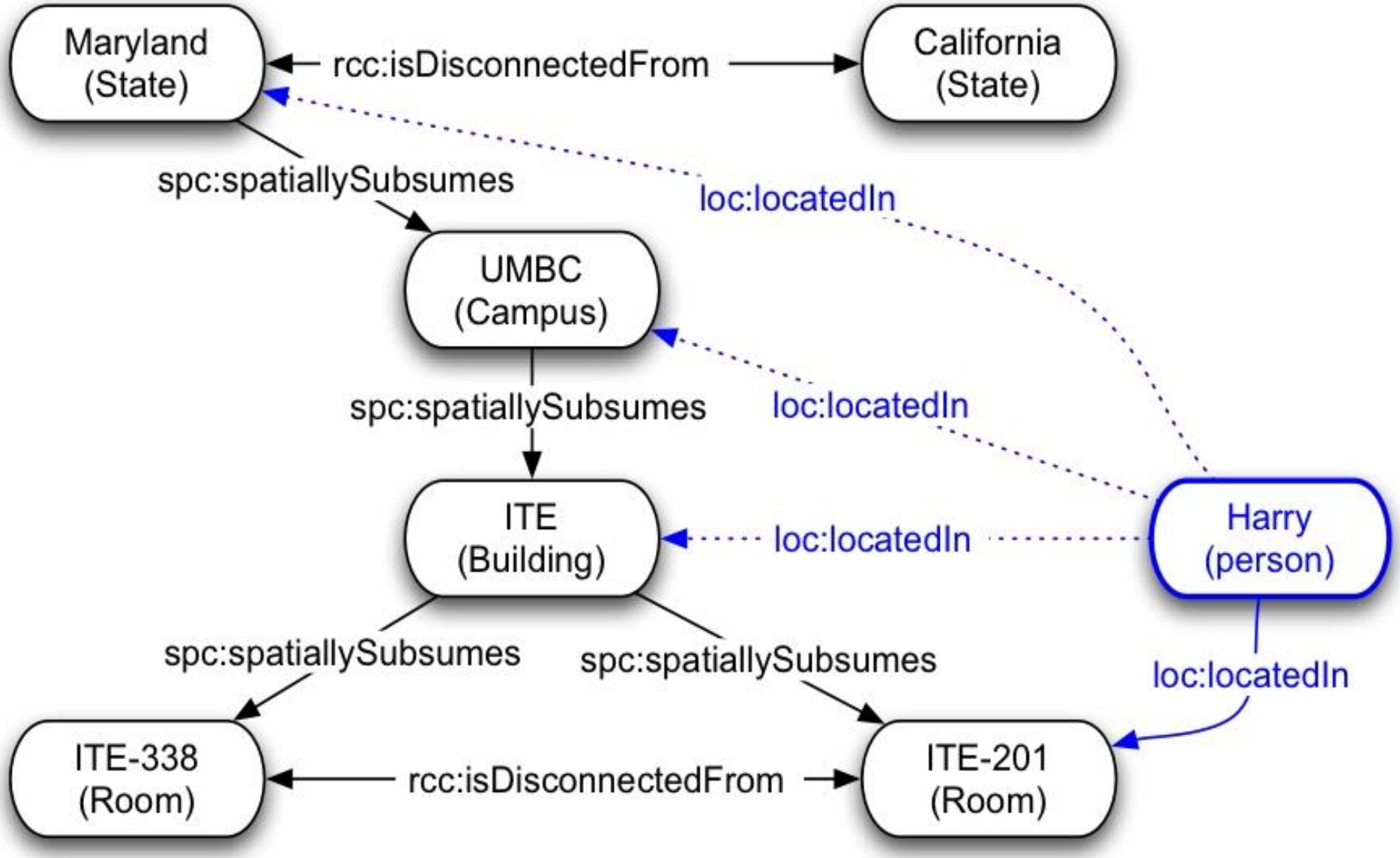
SOUPA Ontology provides common vocabulary



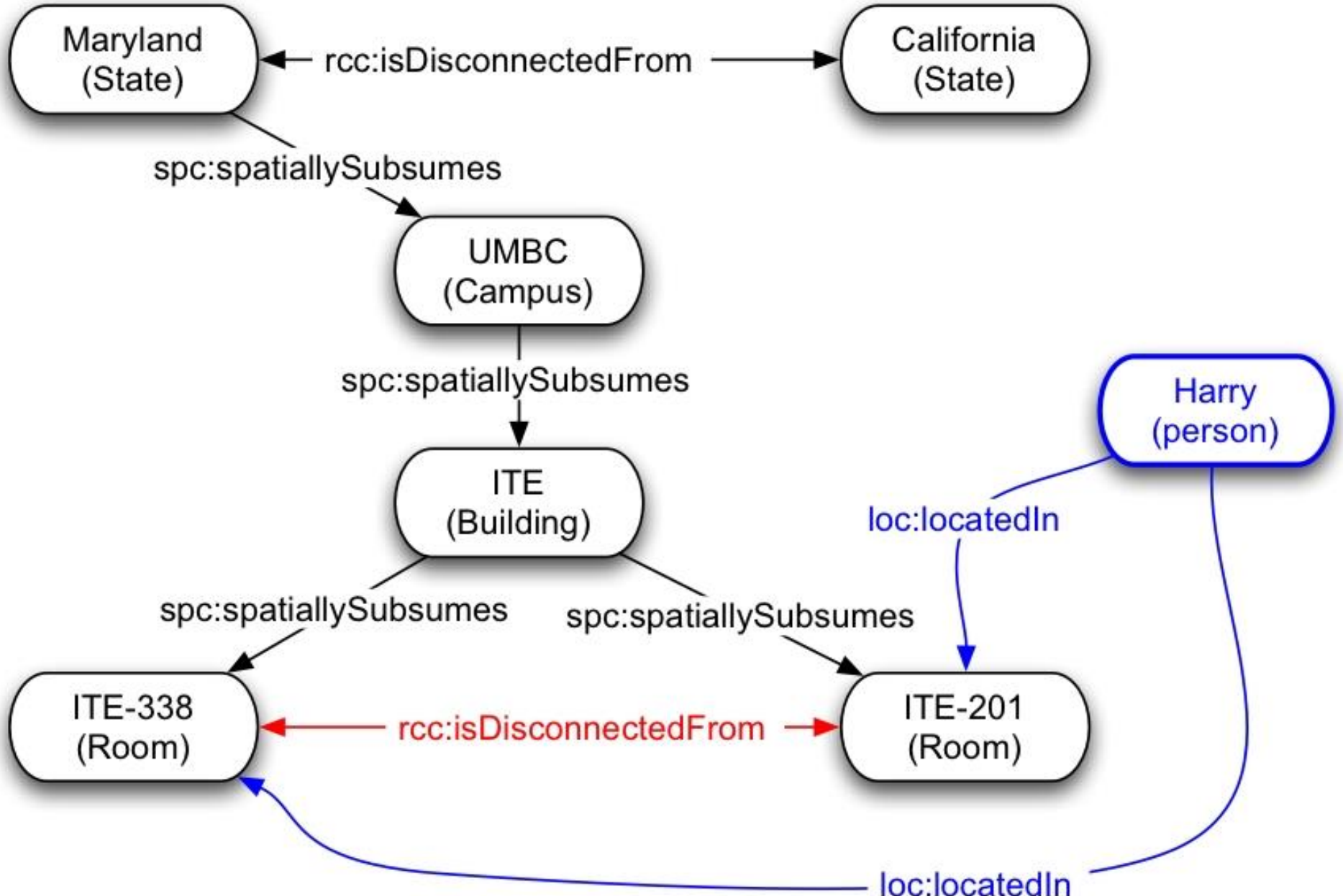
A Simple Spatial Model of UMBC



Where's Harry?



Detecting Inconsistencies



What about Privacy?

- The information sharing behavior of the context broker is governed by a set of policies
- Expressed in a declarative Policy language
- The set includes policies for the organization(s), space, devices and people involved.

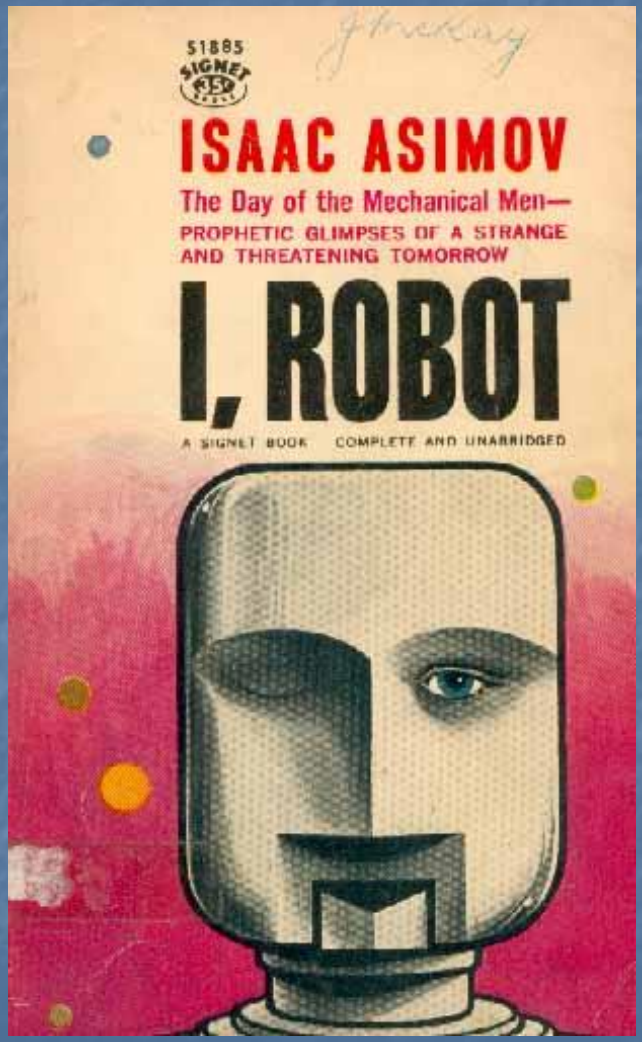
1st Autonomous Agent Policy

1 A robot may not injure a human being, or, through inaction, allow a human being to come to harm.

2 A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

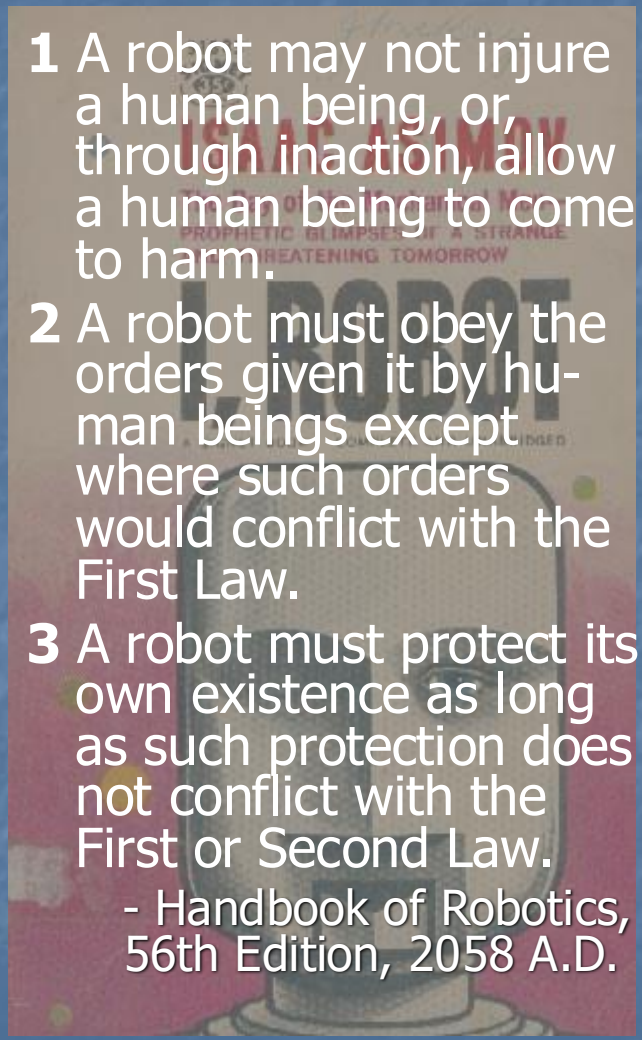
3 A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

- Handbook of Robotics, 56th Edition, 2058 A.D.



It's policies all the way down

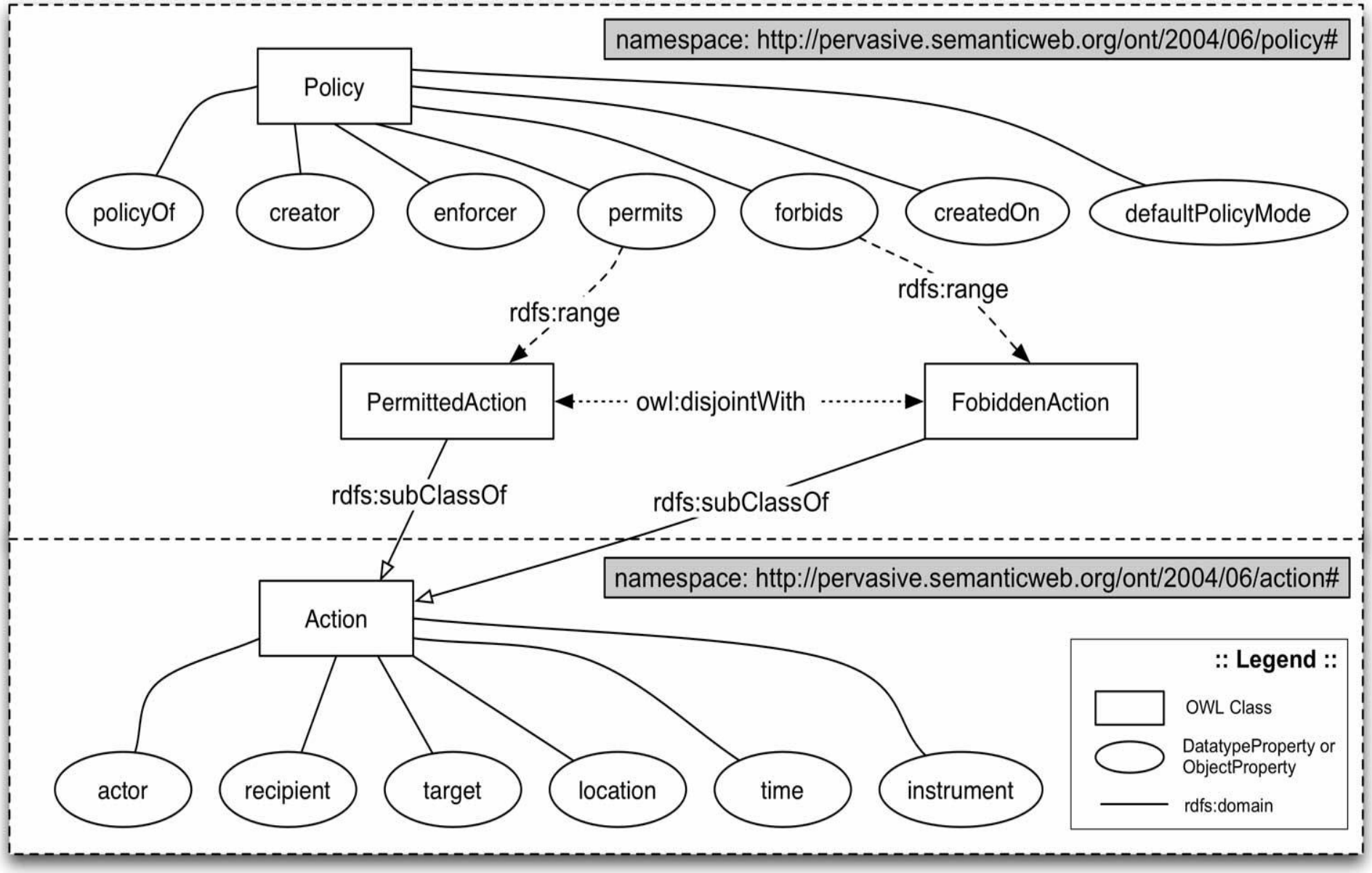
- In Asimov's world, the robots didn't always strictly follow their policies
  - Unlike traditional "hard coded" rules like DB access control & OS file permissions
- Autonomous agents need policies as "norms of behavior" followed by good citizens including policies for what happens if they don't follow policies
- So, it's natural to worry about …
  - How agents governed by multiple policies can resolve conflicts among them
  - How to deal with failure to follow policies – sanctions, reputation, etc.
  - Whether policy engineering will be any easier than software engineering



Privacy Protection in CoBrA

- Users define policies to permit or prohibit the sharing of their information
  - Policies are provided by personal agents or published on web pages
  - and use the SOUPA ontologies as well as other SW assertions (e.g., FOAF, schedules)
- The context broker follows user defined policies when sharing information, unless contravened by higher policies

The SOUPA Policy Ontology



Policy Reasoning Use Case

- The speaker doesn't want others to know the specific room that he's in, but is willing for others to know he's on campus
- He defines the following privacy policy
  - Share my location with a granularity >= "State"
- The broker
  - isLocated(US) => Yes!
  - isLocated(Maryland) => Yes!
  - isLocated(UMBC) => Uncertain..
  - isLocated(ITE-RM210) => Uncertain..

What we learned

- FIPA and OWL were good for integrating disparate components
- Even when some of these were running on cell phones!
- OWL made it easy to mix content from different ontologies unambiguously
- The use of OWL made it easy to take advantage of information published in XML on the web
  - e.g., foaf information, privacy policy

What we learned

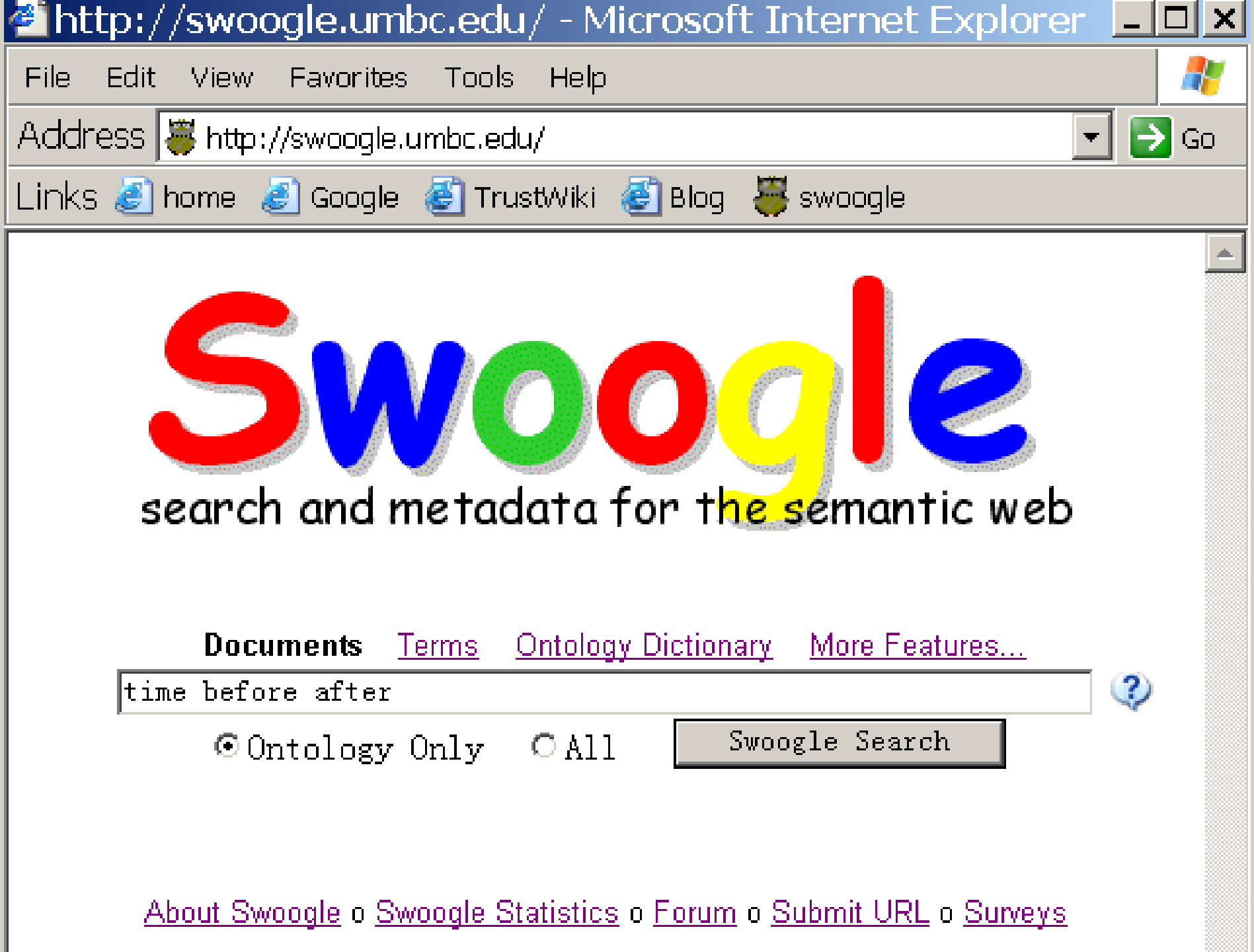
- Declarative policies can be used to model security, trust and privacy constraints
- Reasonably expressive policy languages can be encoded on OWL
- This enables policies to depend on attributes and context information available on the semantic web
- Policies are applicable at almost every level of the stack, from systems and networking to multiagent applications.

This talk

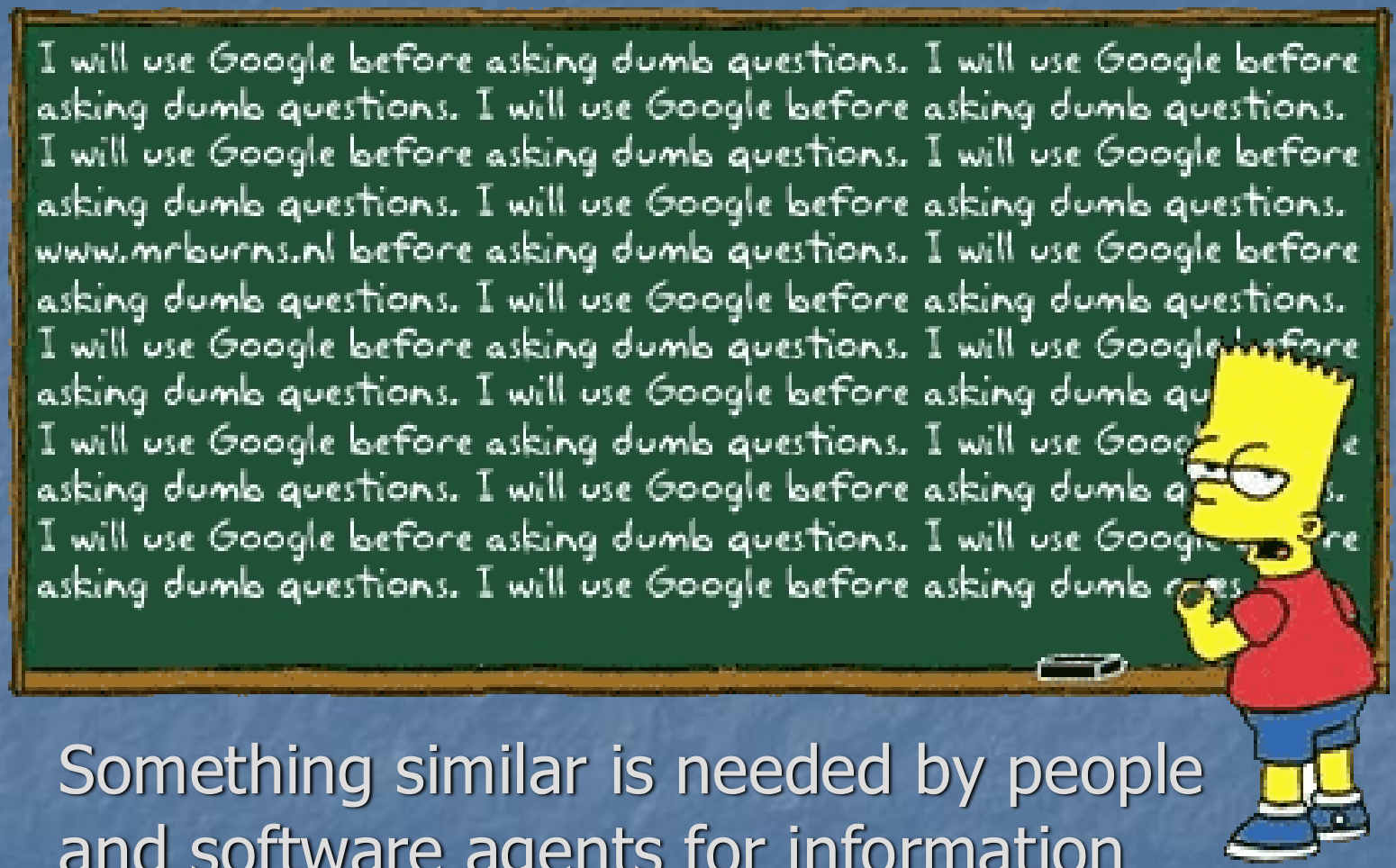
- Motivation
- Semantic web concepts and technologies
- **Using the semantic web for**

  (1) Pervasive computing

  (3) Information retrieval

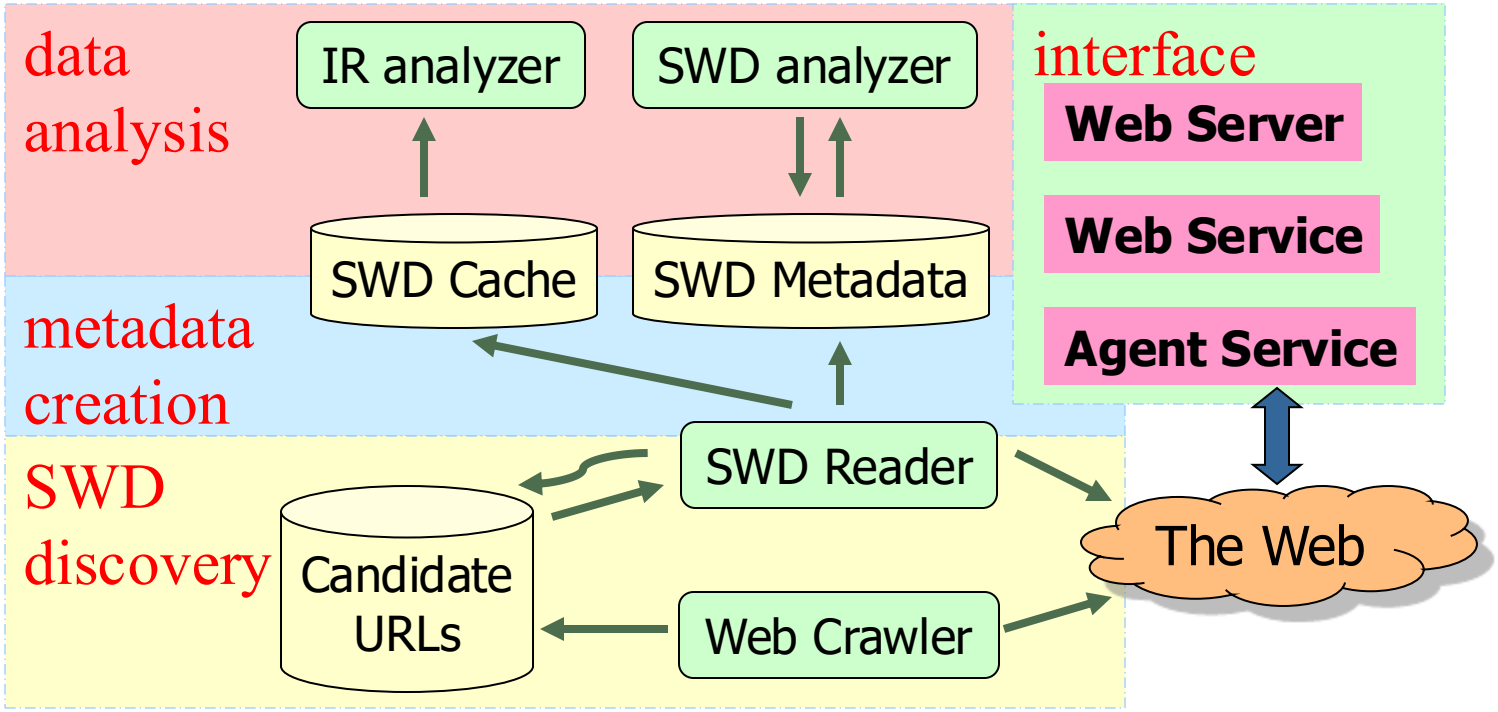

http://swoogle.umbc.edu/ - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://swoogle.umbc.edu/
Go
Links home Google TrustWiki Blog swoogle
Swoogle
search and metadata for the semantic web
Documents Terms Ontology Dictionary More Features...
time before after
Ontology Only All
Swoogle Search
About Swoogle o Swoogle Statistics o Forum o Submit URL o Surveys

Google has made us smarter



Something similar is needed by people and software agents for information on the semantic web.

Swoogle Architecture

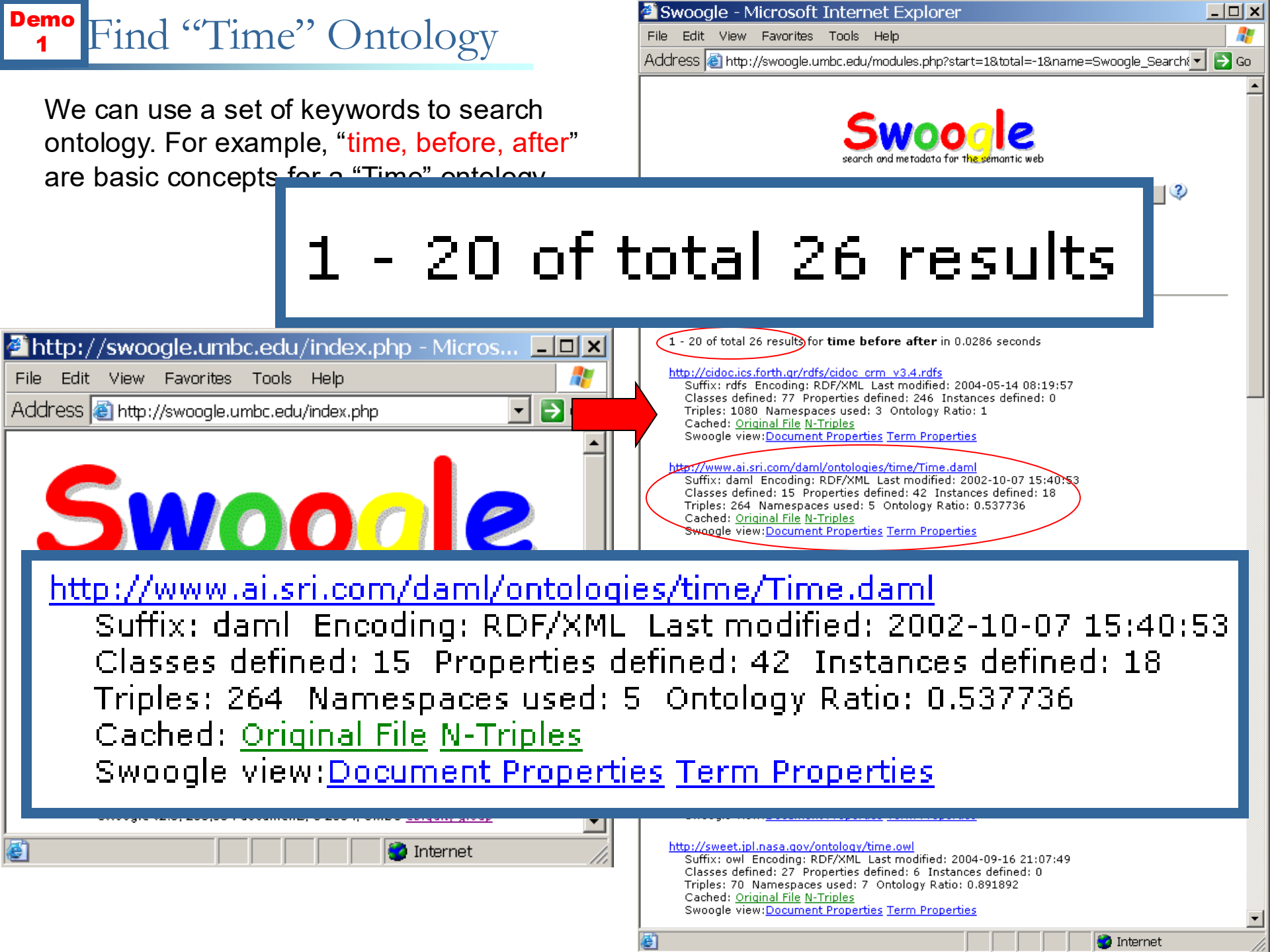


340K SWDs, 48M triples, 97K classes, 55K properties, 7M individuals (April 2005)

Demo 1

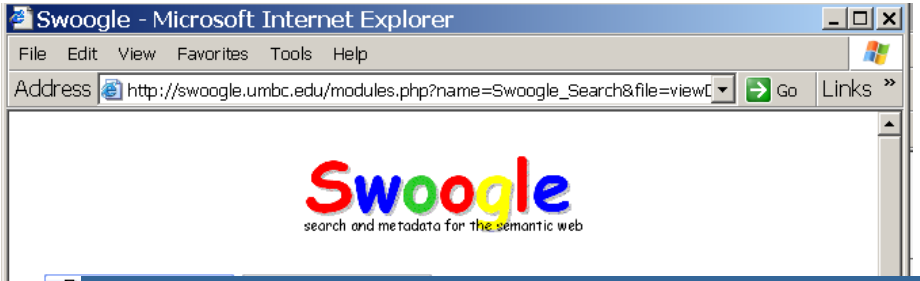
Find "Time" Ontology

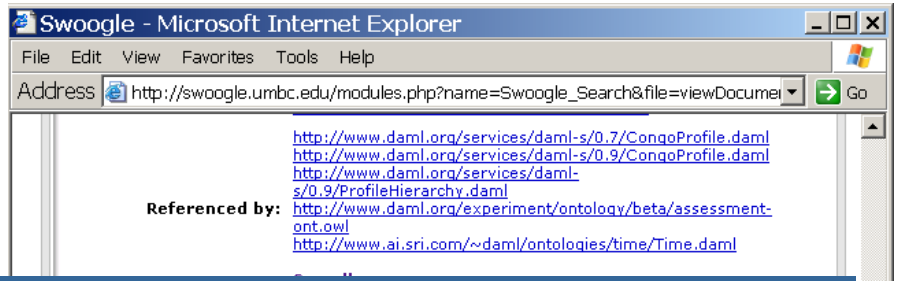
We can use a set of keywords to search ontology. For example, "time, before, after" are basic concepts for a "Time" ontology



Demo 2(a)

Digest "Time" Ontology (document view)





http://www.ai.sri.com/daml/ontologies/time/Time.daml

Other properties

Dates:	Age: 757 days; Modified: 2002-10-07 15:40:53; Crawled: 2004-09-24 20:16:17;
Size in bytes:	unknown
cache:	Original File N-Triples
Swoogle URI ID:	7547

Instances Defined:	18	?		
weight:	819	?	**Swoogle Rank Score:** 0.15783	?
Type:	Ontology/Instance mixture (53%)	?		

Demo 2(b)

Digest "Time" Ontology (term view)

Swoogle - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://swoogle.umbc.edu/modules.php?name=Swoogle_Search&file=viewD Go Links

Swoogle
search and metadata for the semantic web

Document View | Terms View

http://www.ai.sri.com/daml/ontologies/time/Time.daml

Apply: Hyperdaml Dumpont RDF validator ObjectViewer

Defined Classes

Local name	URI
TemporalDescription	http://www.ai.sri.com/daml/ontologies/time/Time.daml#TemporalDescription
TemporalEntity	http://www.ai.sri.com/daml/ontologies/time/Time.daml#TemporalEntity
ProperInterval	http://www.ai.sri.com/daml/ontologies/time/Time.daml#ProperInterval
Instant	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Instant
Second	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Second
Minute	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Minute
Hour	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Hour
Event	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Event
Month	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Month
Year	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Year
ProperIntervalSet	...ies/time/Time.daml#ProperIntervalSet
Day	...ies/time/Time.daml#Day
Week	...ies/time/Time.daml#Week
TimeZone	http://www.ai.sri.com/daml/ontologies/time/Time.daml#TimeZone
Interval	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Interval

TimeZone

Defined Properties

Local name	URI	Type
daySlotOf	...com/daml/ontologies/time/Time.daml	UniqueProperty
beginOf	...com/daml/ontologies/time/Time.daml	ObjectProperty
before	...ologies/time/Time.daml	TransitiveProperty
intAfter	...ologies/time/Time.daml	ObjectProperty

before

intAfter

Swoogle - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://swoogle.umbc.edu/modules.php?name=Swoogle_Search&file=viewDocume Go

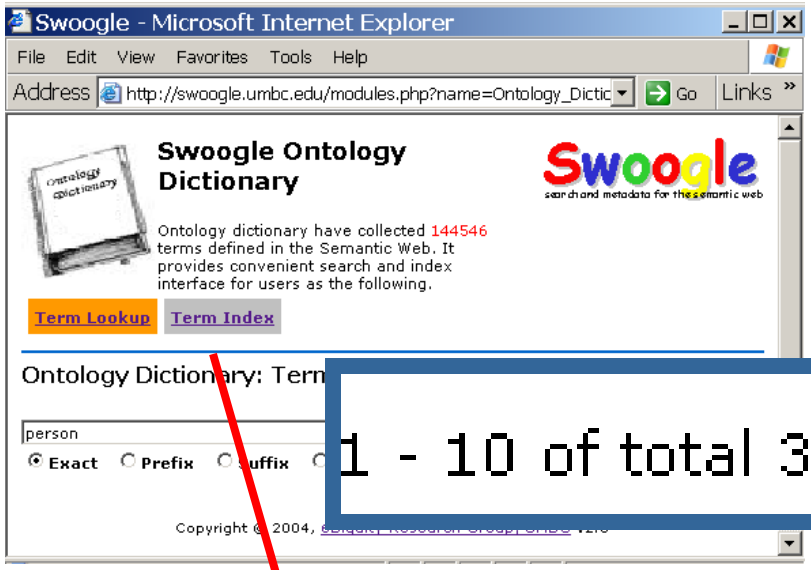
Populated Classes

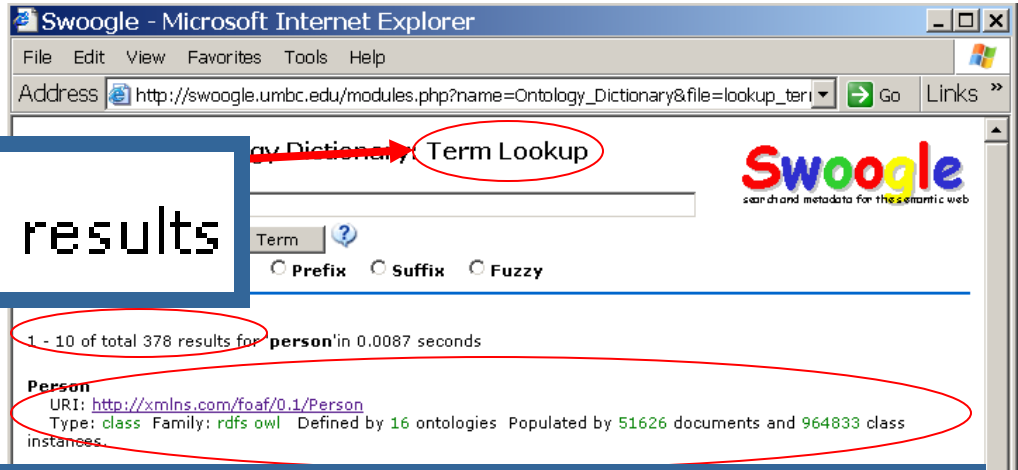
Local name	URI	Count
UniqueProperty	http://www.daml.org/2001/03/daml+oil#UniqueProperty	22
ObjectProperty	http://www.daml.org/2001/03/daml+oil#ObjectProperty	22
DatatypeProperty	http://www.daml.org/2001/03/daml+oil#DatatypeProperty	19
Class	http://www.daml.org/2001/03/daml+oil#Class	15
Restriction	http://www.daml.org/2001/03/daml+oil#Restriction	8
decimal	http://www.w3.org/2000/10/XMLSchema#decimal	7
TimeZone	http://www.ai.sri.com/daml/ontologies/time/Time.daml#TimeZone	5
Instant	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Instant	2
Event	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Event	2
TransitiveProperty	http://www.daml.org/2001/03/daml+oil#TransitiveProperty	1
Ontology	http://www.daml.org/2001/03/daml+oil#Ontology	1
Interval	http://www.ai.sri.com/daml/ontologies/time/Time.daml#Interval	1
integer	http://www.w3.org/2000/10/XMLSchema#integer	1

Populated Properties

Local name	URI	Count
type	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	106
range	http://www.w3.org/2000/01/rdf-schema#range	35
domain	http://www.w3.org/2000/01/rdf-schema#domain	33
comment	http://www.w3.org/2000/01/rdf-schema#comment	28
subClassOf	http://www.w3.org/2000/01/rdf-schema#subClassOf	19
onProperty	http://www.daml.org/2001/03/daml+oil#onProperty	8
value	http://www.w3.org/1999/02/22-rdf-syntax-ns#value	8
inverseOf	http://www.daml.org/2001/03/daml+oil#inverseOf	7
hasValue	http://www.daml.org/2001/03/daml+oil#hasValue	7
label	http://www.w3.org/2000/01/rdf-schema#label	3
atTime	http://www.ai.sri.com/daml/ontologies/time/Time.daml#atTime	2
toClass	http://www.daml.org/2001/03/daml+oil#toClass	1
imports	http://www.daml.org/2001/03/daml+oil#imports	1
disjointWith	http://www.daml.org/2001/03/daml+oil#disjointWith	1
endOf	http://www.ai.sri.com/daml/ontologies/time/Time.daml#endOf	1
dayOf	http://www.ai.sri.com/daml/ontologies/time/Time.daml#dayOf	1
beginOf	http://www.ai.sri.com/daml/ontologies/time/Time.daml#beginOf	1
versionInfo	http://www.daml.org/2001/03/daml+oil#versionInfo	1
subPropertyOf	http://www.w3.org/2000/01/rdf-schema#subPropertyOf	1

Demo 3 Find Term "Person"





1 - 10 of total 378 results

Person
URI: http://xmlns.com/foaf/0.1/Person
Type: class Family: rdfs owl Defined by 16 ontologies Populated by 51626 documents and 964833 class instances.

person
URI: http://xmlns.com/foaf/0.1/person
Type: class Family: Defined by 0 ontologies Populated by 163 documents and 3236 class instances.

Not capitalized! URIref is case sensitive!

Demo 4

Digest Term "Person"

Term Definition: http://xmlns.com/foaf/0.1/Person

- Related Terms (same namespace)
- Related Terms (same local name)

Class Properties (Fused) | **Instance Properties (from ontology)** | **Instance Properties (from instances)**

Fused Definition of http://xmlns.com/foaf/0.1/Person

It is defined as **class** by 15 SWDs with 8 predicates

#	Predicate-Value	Related Ontology
1	http://www.w3.org/2003/06/sw-vocab-status/ns#term_status	
	↳testing	6 source
2	owl:disjointWith	
	↳foaf:Organization	6 source
	↳foaf:Document	5 source
	↳foaf:Project	5 source

Instance Properties (from ontologies) of http://xmlns.com/foaf/0.1/Person

By analyzing ontologies, this class is rdfs:domain of 167 different properties

167 different properties

#	Prope		Related Ontology
1	http://		6 source
			2 source
2	http://		6 source
		rdfs:Resource	2 source
3	http://xmlns.com/foaf/0.1/knows	foaf:Person	8 source

Instance Properties (from instances) of http://xmlns.com/foaf/0.1/Person

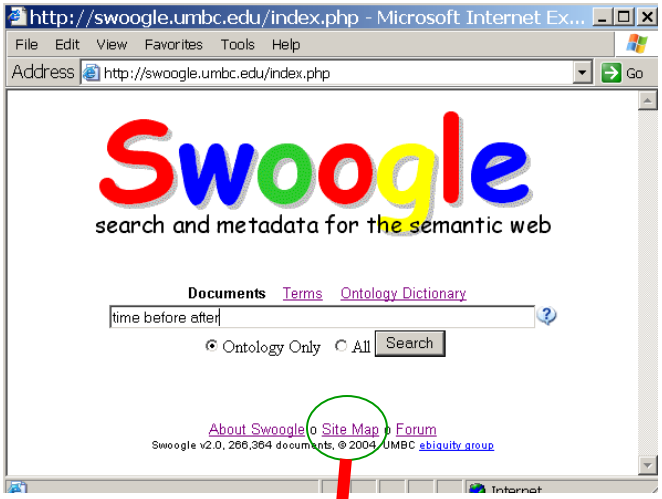
By analyzing the instances, this class is domain of 562 different properties

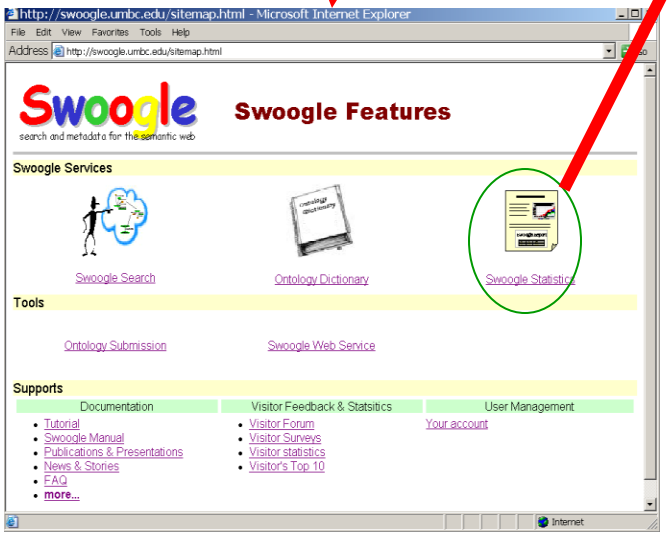
562 different properties

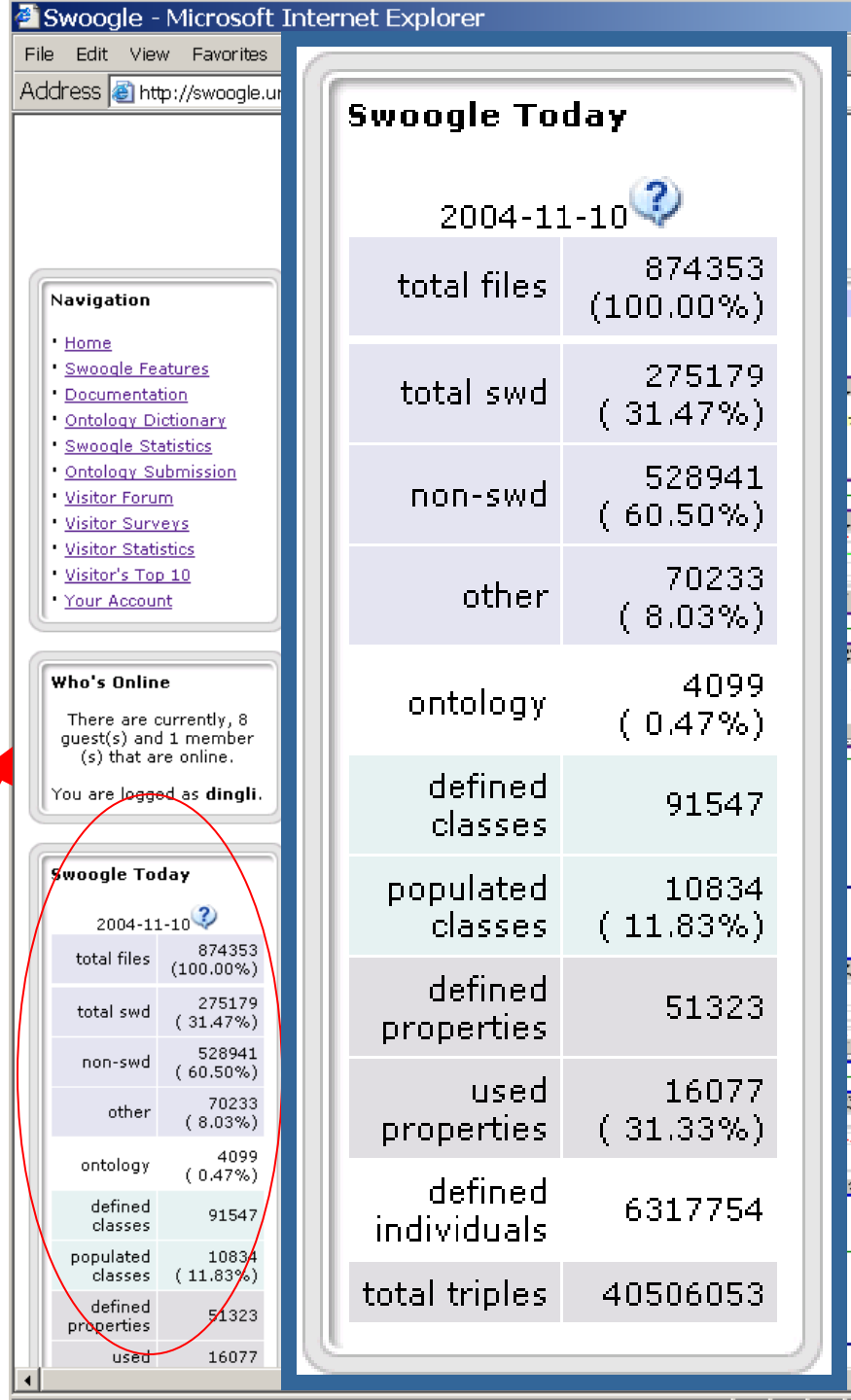
#	property			
1	foaf:mbox_sha			1daf964b378ed9caf1
2	foaf:nick			
3	foaf:weblog			ipop/
4	foaf:name	33090 sources	4	????
5	rdfs:seeAlso	31905 sources	329	http://dac.lolipop.jp/bookmarks/foaf.rdf
6	foaf:knows	29957 sources	3187	179dce4:fe896e1b77:-7fe3

Demo 5(a)

Swoogle Today







Demo 5(b)

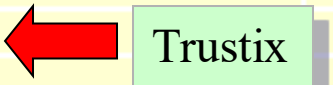
Swoogle Statistics

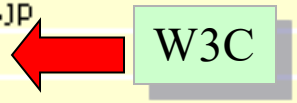
SWD per Website (Top 500 website)

(generated at: Thu, 6 Jan 2005 12:49:49 -0500)

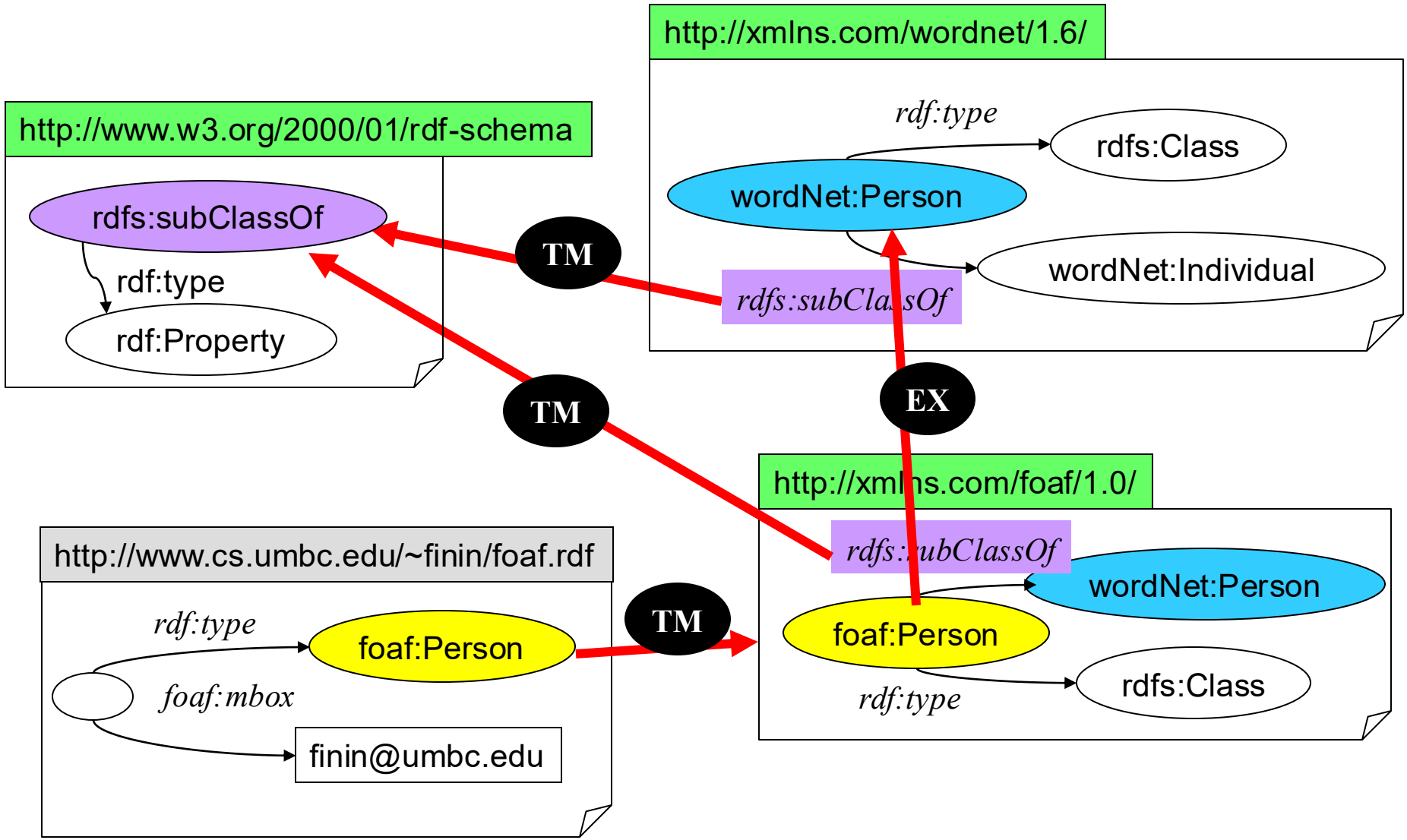
There are 130882 websites that hosting 336456 SWDs

rank	host name	swd count	swd percentage	google estimation	nswd count	nswd/swd
1	blog.livedoor.jp	15599	4.64 %	73000	2589	0.1660
2	www.ecademy.com	10052	2.99 %	0	82	0.0082
3	www.uklug.co.uk	8717	2.59 %	0	1	0.0001
4	www.livejournal.com	8338	2.48 %	0	2295	0.2752
5	xml.tabulets.com	7826	2.33 %	0	2167	0.2769
6	www.deadjournal.com	7224	2.15 %	0	6761	0.9359
7	testers.cpan.org	5678	1.69 %	0	21	0.0037
8	blog.goo.ne.jp	5374	1.60 %	25600	350	0.0651
9	www.amagle.com	5090	1.51 %	10500	5799	1.1393
10	yaplog.jp	4420	1.31 %	10900	4015	0.9084
11	blogs.dion.ne.jp	3723	1.11 %	14300	2735	0.7346
12	www.w3.org	3071	0.91 %	11700	3735	1.2162
13	ameblo.jp	2983	0.89 %	0	90	0.0302
14	mirrors.webthing.com	2895	0.86 %	2650	2023	0.6988
15	www.mypress.jp	2891	0.86 %	12400	1018	0.3521
16	blog.drecom.jp	2552	0.76 %	6770	850	0.3331
17	www.kwark.org	2543	0.76 %	43	468	0.1840
18	iw.stanford.edu	2501	0.74 %	1730	18	0.0072
19	tinysofa.iszerviz.hu	2471	0.73 %	12200	1089	0.4407
20	testers.astray.com	2291	0.68 %	0	1	0.0004





Ranking with Rational Surfing Model: An Example



Swoogle's Triple Store lets you shop

Swoogle - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

Google finin NEWS umbc Research Teaching Service Shop personal C-SPAN fun Main Page - Wikipedi... Reference my del.icio.us

Swoogle
search and metadata for the semantic web

4 Documents
317 Triples your account leave TripleShop

Your Cart

finin, you have **4** documents, **317** triples in your cart.

Save this cart >>

Check Out Update Cart

Item	Remove
http://www.mindswap.org/2003/owl/swint/terrorism Suffix: --- Encoding: RX Last modified: 2004-02-03 19:21:20 Classes defined: 19 Properties defined: 27 Instances defined: 0 Triples: 233 Namespaces used: 8 Ontology Ratio: 0.676471 Cached: Original File N-Triples Swoogle view:Document Properties Term Properties	
http://swint.mindswap.org/2003/submit-rdf/63.rdf Suffix: rdf Encoding: RX Last modified: 2004-05-17 16:03:51 Classes defined: 3 Properties defined: 10 Instances defined: 8 Triples: 38 Namespaces used: 8 Ontology Ratio: 0.619048 Cached: Original File N-Triples Swoogle view:Document Properties Term Properties	
http://swint.mindswap.org/2003/submit-rdf/52.rdf Suffix: rdf Encoding: RX Last modified: 2004-05-17 16:03:51 Classes defined: 3 Properties defined: 7 Instances defined: 4 Triples: 21 Namespaces used: 7 Ontology Ratio: 0.714286 Cached: Original File N-Triples Swoogle view:Document Properties Term Properties	
http://swint.mindswap.org/2003/submit-rdf/54.rdf Suffix: rdf Encoding: RX Last modified: 2004-05-17 16:03:51 Classes defined: 2 Properties defined: 8 Instances defined: 7 Triples: 25 Namespaces used: 7 Ontology Ratio: 0.588235 Cached: Original File N-Triples Swoogle view:Document Properties Term Properties	
Item	Remove

And check out your triples into any of several reasoners

Done PR:0 Adblock

Summary

2004

Swoogle (Mar, 2004)

- Automated SWD discovery
- SWD metadata creation and search
- Ontology rank (rational surfer model)
- Swoogle watch
- Web Interface

Swoogle2 (Sep, 2004)

- Ontology dictionary
- Swoogle statistics
- Web service interface (WSDL)
- Bag of URIref IR search
- Triple shopping cart

2005

Swoogle3 (May 2005)

- Better discovery & revisit strategies
- Better navigation models
- Index instance data
- More metadata (ontology mapping and OWL-S services)
- Better web service interfaces

This talk

- Motivation
- Semantic web concepts and technologies
- Using the semantic web for
  (1) Pervasive computing
  (3) Information retrieval
- **Conclusions**

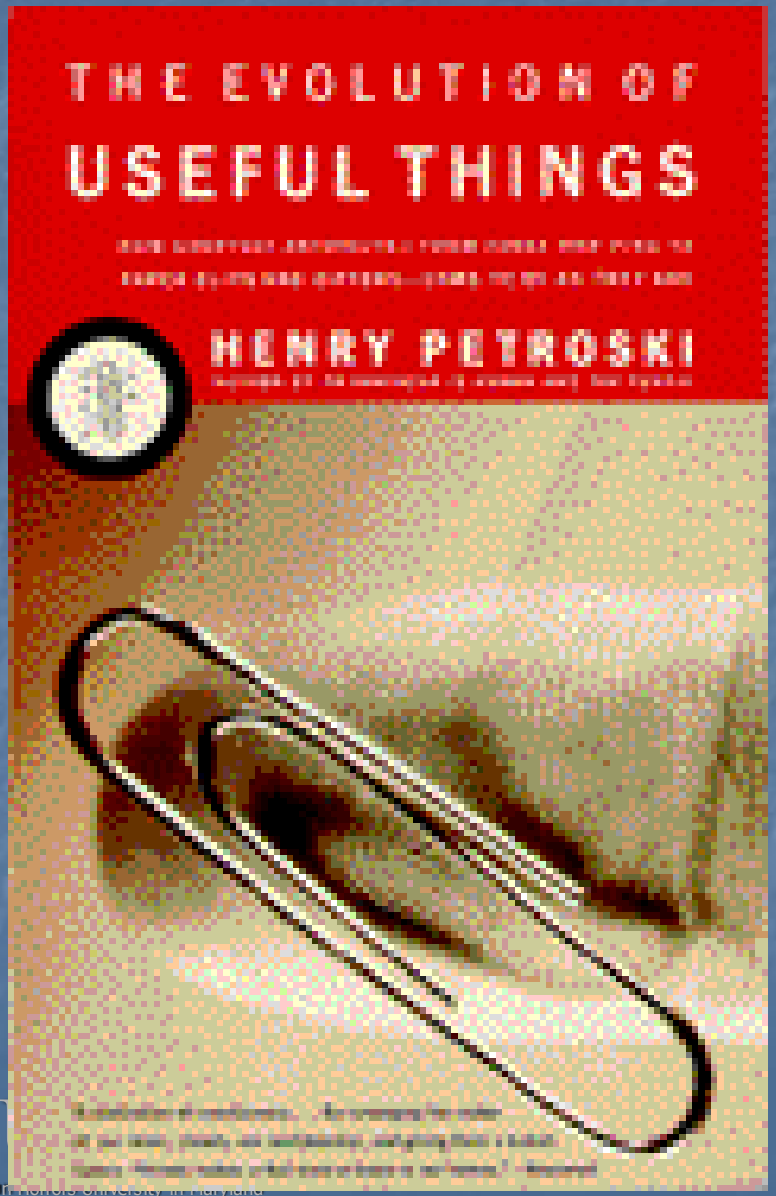
Conclusions & final thoughts

- The web will contain the world's knowledge in forms accessible to people and computers
- We need better ways to discover, index, search and reason over SW knowledge
- Special attention must be applied to security, privacy and trust
- We must develop, deploy and build on open, non-proprietary standards for knowledge sharing.
- The W3C standards RDF and OWL are a foundation for the first generation

How do we get there from here?

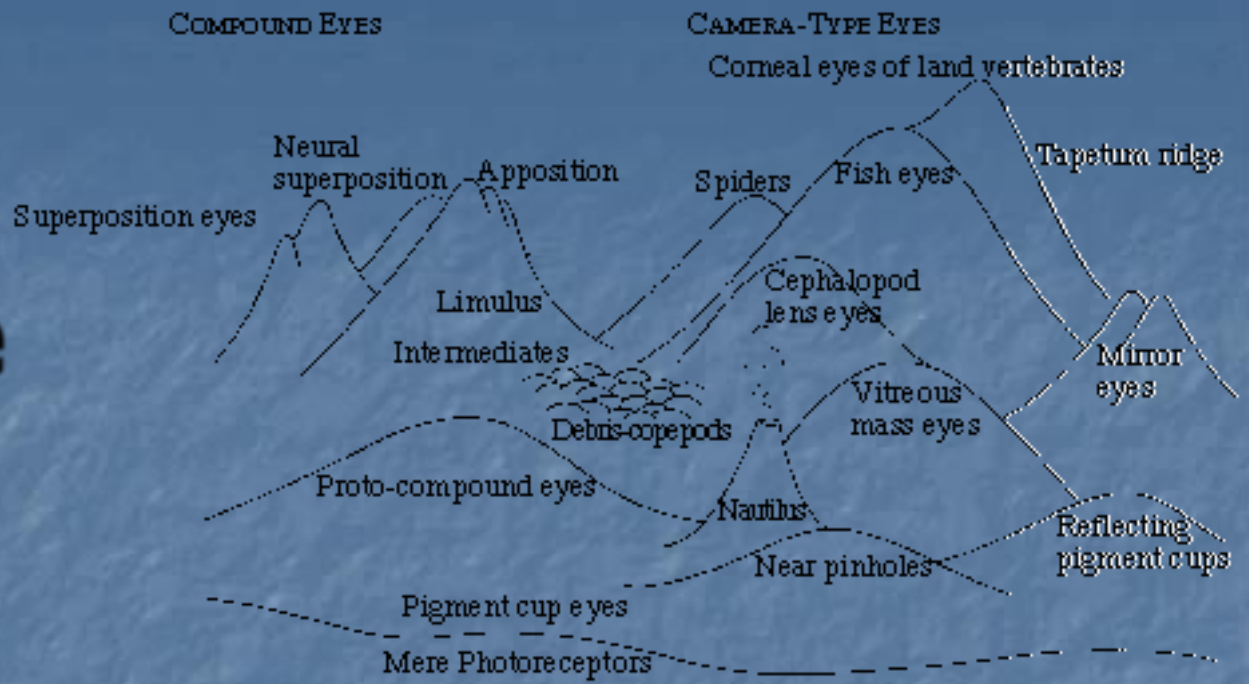
- This semantic web emphasizes ontologies – their development, use, mediation, evolution, etc.
- It will take some time to really deliver on the agent paradigm, either on the Internet or in a pervasive computing environment.
- The development of complex systems is basically an evolutionary process.
- Random search carried out by tens of thousands of researchers, developers and graduate students.

T.T.T: things take time



- Prior to the 1890's, papers were held together with straight pens.
- The development of "spring steel" allowed the invention of the paper clip in 1899.
- It took about 25 years (!) for the evolution of the modern "gem paperclip", considered to be optimal for general use.

Climbing Mount Improbable



"The sheer height of the peak doesn't matter, so long as you don't try to scale it in a single bound. Locate the mildly sloping path and, if you have unlimited time, the ascent is only as formidable as the next step."

-- Richard Dawkins, *Climbing Mount Improbable*, Penguin Books, 1996.

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Tuesday, July 20, 2004, 10:22:24 EDT

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Page generated in 0.000 seconds.

Annotated in OWL