

Net-Ready Sensors: The Way Forward Workshop

Oak Ridge National Laboratory, DoD's Joint Executive Office for Chemical and Biological Defense, and the National Institute of Standards and Technology

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Semantic Interoperability Community of Practice (SICoP)
Best Practices Committee (BPC), CIO Council

August 2, 2006

Overview

- For developers and program managers from government and industry with an interest in the next generation of “net-ready sensors” for military and homeland security CBRN architectures and applications.
- Five topics: service discovery, data formats, transport and routing, service architectures, and application programming interfaces.
- Invited to speak about: XML formats, SICoP, Data Reference Model 2.0, Interoperable Service Architectures and Pilots.

My Background

- US EPA Office of the Chief Information Officer and Environmental Information, Enterprise Architecture Team:
 - EPA Data Architecture for DRM 2.0
- Federal Chief Information Officer Council, Data Reference Model 2.0:
 - Lead for Implementation Through Testing & Iteration
- Federal CIO Council's Two Committees:
 - Co-Chair, SOA Community of Practice
 - First SOA for E-Government Conference, May 23-24, 2006
 - Co-Chair, SICoP
 - Semantic Interoperability Community of Practice
 - World Wide Web Consortium's Semantic Web Standards and Semantic Agents
- And Long Ago in a Far Away Galaxy:
 - Meteorologist at Desert Test Center with a Top Secret Clearance to Work on CBRN and Taught Dispersion Meteorology Class to Dugway Proving Ground Staff.

EPA's Interest

- We do extensive environmental monitoring and clean-up:
 - Air and water quality, toxic chemicals (Superfund), bio-surveillance, etc.
 - See Ozone & Beach Alerts, Real-time Chesapeake Bay Water Quality, etc.
- We have developed Emergency Response Applications:
 - Computer-Aide Management of Emergency Operations (CAMEO) – LandView on CD-ROM and DVD.
 - Local Emergency Planning Committees (LEPC) and Risk Management Plans Database.
 - VoiceXML for Universal Access – Reverse 911 for Alerting.
- We supported the early SensorML work (Stefan Falke, AAAS Fellow at EPA).
 - See SensorML and SWE: Mike Botts, University of Alabama, Huntsville.
- We support the OMB Federal Enterprise Architecture Geospatial Line of Business:
 - Recently helped start a Geospatial Ontology CoP to support the GS LoB that relates to this workshop. E.g. see DHS Geospatial Data Model and June 20-22nd Workshop.

Outline

- 1. XML Formats (slide 6)
- 2. SICoP (slides 7-8)
- 3. Data Reference Model 2.0 (slides 9-16)
- 4. Interoperable Service Architectures and Pilots (slides 17-28)
- 5. Questions & Answers (slide 29)
- 6. Comments/Suggestions (slides 30-32)

1. XML Formats

- Yes, but RDF and OWL were invented for enterprise applications:
 - See July 7, 2005, The Semantic Web - An Interview with Tim Berners-Lee by Andrew Updegrave, Consortium Standards Bulletin, Volume 4, No. 6. See Section III. Critics (page 5) for responses to criticisms of the Semantic Web: "Now I use RDF and its all so simple – but if I hadn't have had three years of XML hell, I wouldn't ever have understood" and "A critical part, perhaps not obvious from the (SW) specs, is the way different communities of practice develop independently, bottom up, and then can connect link by link, like patches sewn together at the edges."
 - <http://www.consortiuminfo.org/bulletins/pdf/jun05/feature.pdf>
 - Also see DRM 2.0 Collaborative Workshops:
 - http://colab.cim3.net/cgi-bin/wiki.pl?ExpeditionWorkshop/DesigningTheDRM_DataAccessibility_2005_08_16

2. SICoP

- **Charter (March 2004):**
 - The Semantic Interoperability Community of Practice (SICoP) is established by a group of individuals for the purpose of achieving "semantic interoperability" and "semantic data integration" focused on the government sector. The SICoP seeks to enable Semantic Interoperability, specifically the "operationalizing" of these technologies and approaches, through online conversation, meetings, tutorials, conferences, pilot projects, and other activities aimed at developing and disseminating best practices. (Only Excerpt)
- **Co-Chairs (Non-government and Government):**
 - Mills Davis, Project10X.Com, and Brand Niemann, US EPA
- **Web Presence:**
 - Web Site, Conventional Wiki, and Test Semantic Wiki (see Section 5.)
- **Activities:**
 - White Papers (2), Conferences (4), Projects (6), and Pilot Projects (many) in Support of the Federal Enterprise Architecture, Agencies, Programs, and now European SemanticGov Project Consortium.

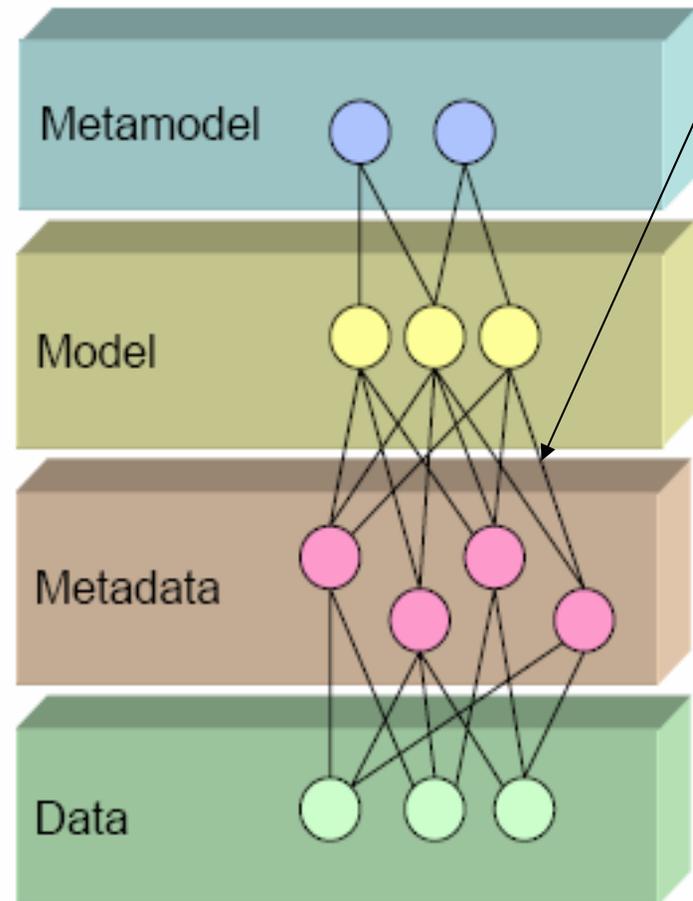
2. SICoP

- One of Those Projects Was the DRM:
 - December 2004, DRM 1.0 – Just structured data (Description) and exchange packages (Sharing).
 - February 2005, SICoP White Paper 1 (“Data Architecture of the Future”) – All three types of data (Description) and ontologies (Context).
 - October 2005, SICoP DRM 2.0 Implementation Guide – Metamodel and Semantic Metadata (see slides 8 - 9).
 - December 2005, DRM 2.0 – Description (3), Context (2), and Sharing (2) (see slide 10).
- So DRM 2.0 + Semantic Metadata = SICoP Knowledge Reference Model (KRM).
- DRM 2.0 Implementation Evolves to the SICoP Semantic Wikis and Information Management (SWIM) WG

3. Data Reference Model 2.0

Relationships and associations

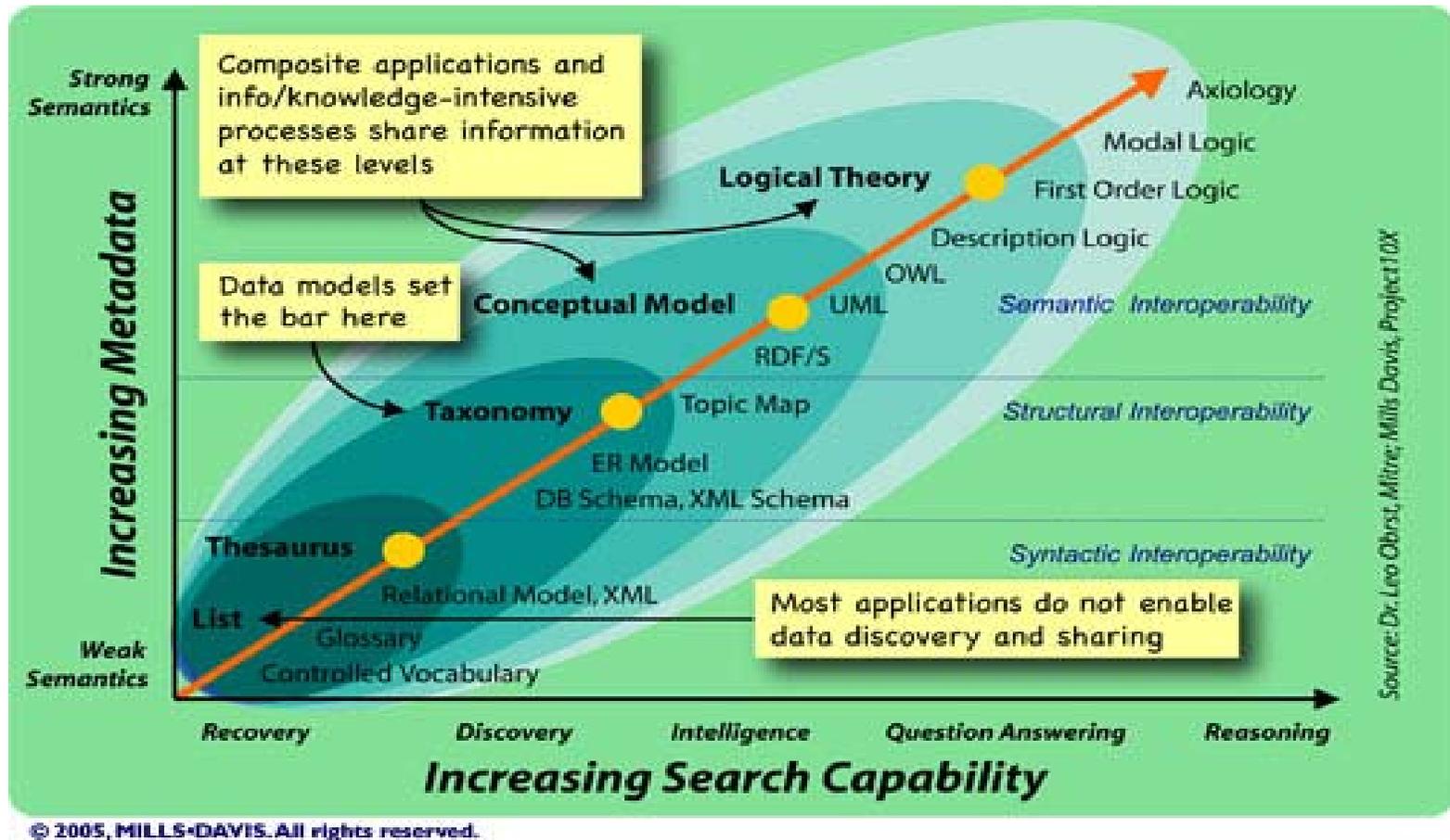
- Metamodel: Precise definitions of constructs and rules needed for abstraction, generalization, and semantic models.
- Model: Relationships between the data and its metadata.
- Metadata: Data about the data.
- Data: Facts or figures from which conclusions can be inferred.



Source: Professor Andreas Tolk, August 16, 2005

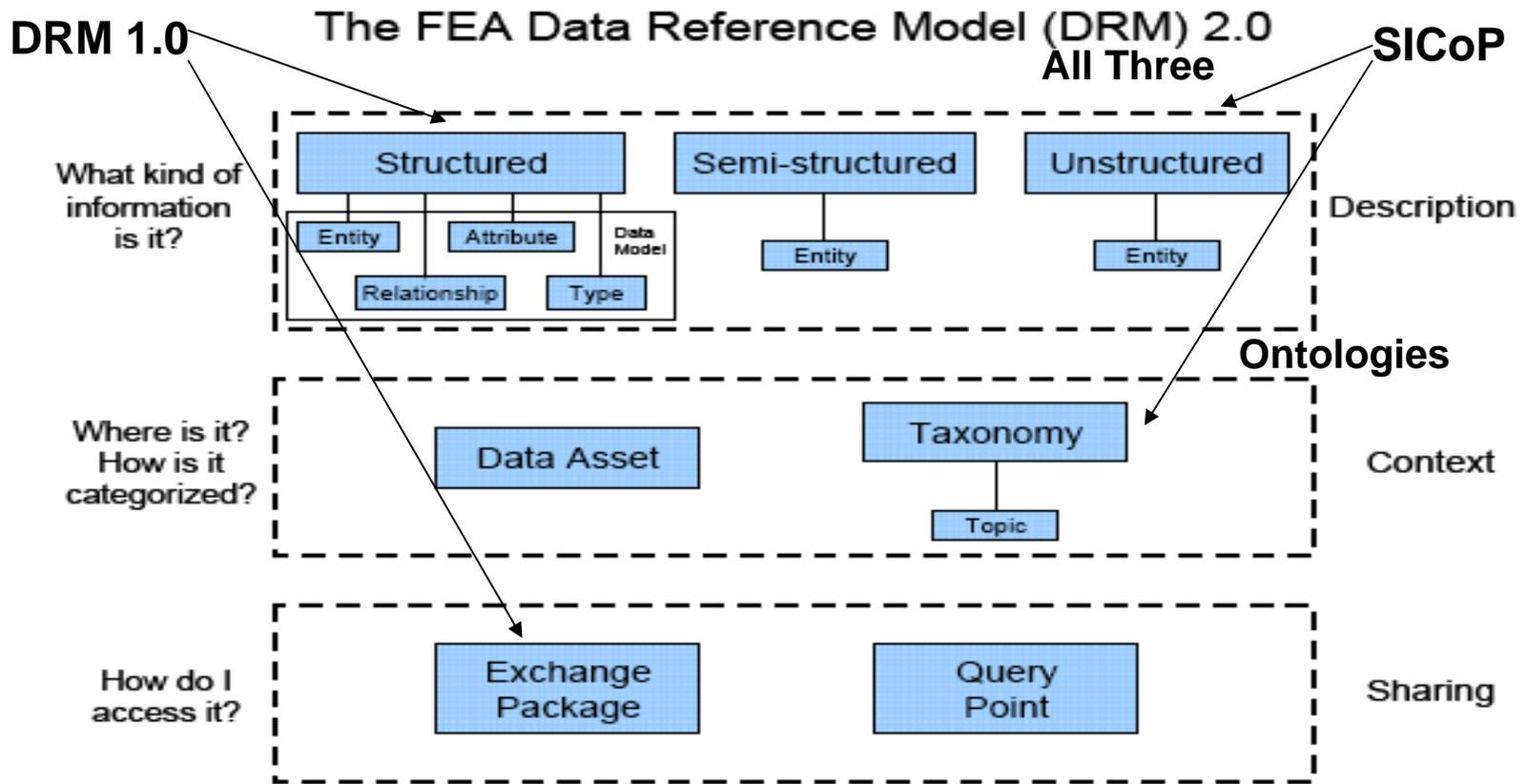
The purpose of this schematic is to show that we need to describe information model relationships and associations in a way that can be accessed and searched. ⁹

3. Data Reference Model 2.0



The point of this graph is that Increasing Metadata (from glossaries to ontologies) is highly correlated with Increasing Search Capability (from discovery to reasoning).

3. Data Reference Model 2.0



Source: Expanding E-Government, Improved Service Delivery for the American People Using Information Technology, December 2005, pp. 2-3. http://www.whitehouse.gov/omb/budintegration/expanding_egov_2005.pdf

3. Data Reference Model 2.0

- Summary:
 - Slide 8: We need to describe information model relationships and associations in a way that can be accessed and searched.
 - Slide 9: Increasing Metadata (from glossaries to ontologies) is highly correlated with Increasing Search Capability (from discovery to reasoning).
 - Slide 10: Three things about data (Description, Context, and Sharing) are needed for information sharing.

3. Data Reference Model 2.0

- The FEA framework and its five supporting reference models (Performance, Business, Service, Technical and Data) are now used by departments and agencies in developing their budgets and setting strategic goals. With the recent release of the Data Reference Model (DRM), the FEA will be the “common language” for diverse agencies to use while communicating with each other and with state and local governments seeking to collaborate on common solutions and sharing information for improved services.

Source: Expanding E-Government, Improved Service Delivery for the American People Using Information Technology, December 2005, pages 2-3.
http://www.whitehouse.gov/omb/budintegration/expanding_egov_2005.pdf

3. Data Reference Model 2.0

- The preceding chart (slide 10) illustrates the potential uses of the newly released DRM Version 2.0:
 - The FEA mechanism for identifying what data the Federal government has and how it can be shared in response to a business/mission requirement.
 - The frame of reference to facilitate Communities of Interest (which will be aligned with the Lines of Business) toward common ground and common language to facilitate improved information sharing.
 - Guidance for implementing repeatable processes for sharing data Government-wide.

Source: Expanding E-Government, Improved Service Delivery for the American People Using Information Technology, December 2005, pages 2-3.

http://www.whitehouse.gov/omb/budintegration/expanding_egov_2005.pdf

3. Data Reference Model 2.0

- Reference Model:
 - A reference model is an abstract framework for understanding significant relationships among the entities of some environment that enables the development of specific architectures using consistent standards or specifications supporting that environment.
 - A reference model consists of a minimal set of unifying concepts, axioms and relationships within a particular problem domain, and is independent of specific standards, technologies, implementations, or other concrete details. (It does seek to provide a common semantics that can be used unambiguously across and between different domains. December 15, 2005).
 - Source: OASIS Reference Model for Service Oriented Architecture, Committee Draft 1.0, 7 February 2006:
 - <http://www.oasis-open.org/committees/download.php/16587/wd-soa-rm-cd1ED.pdf>

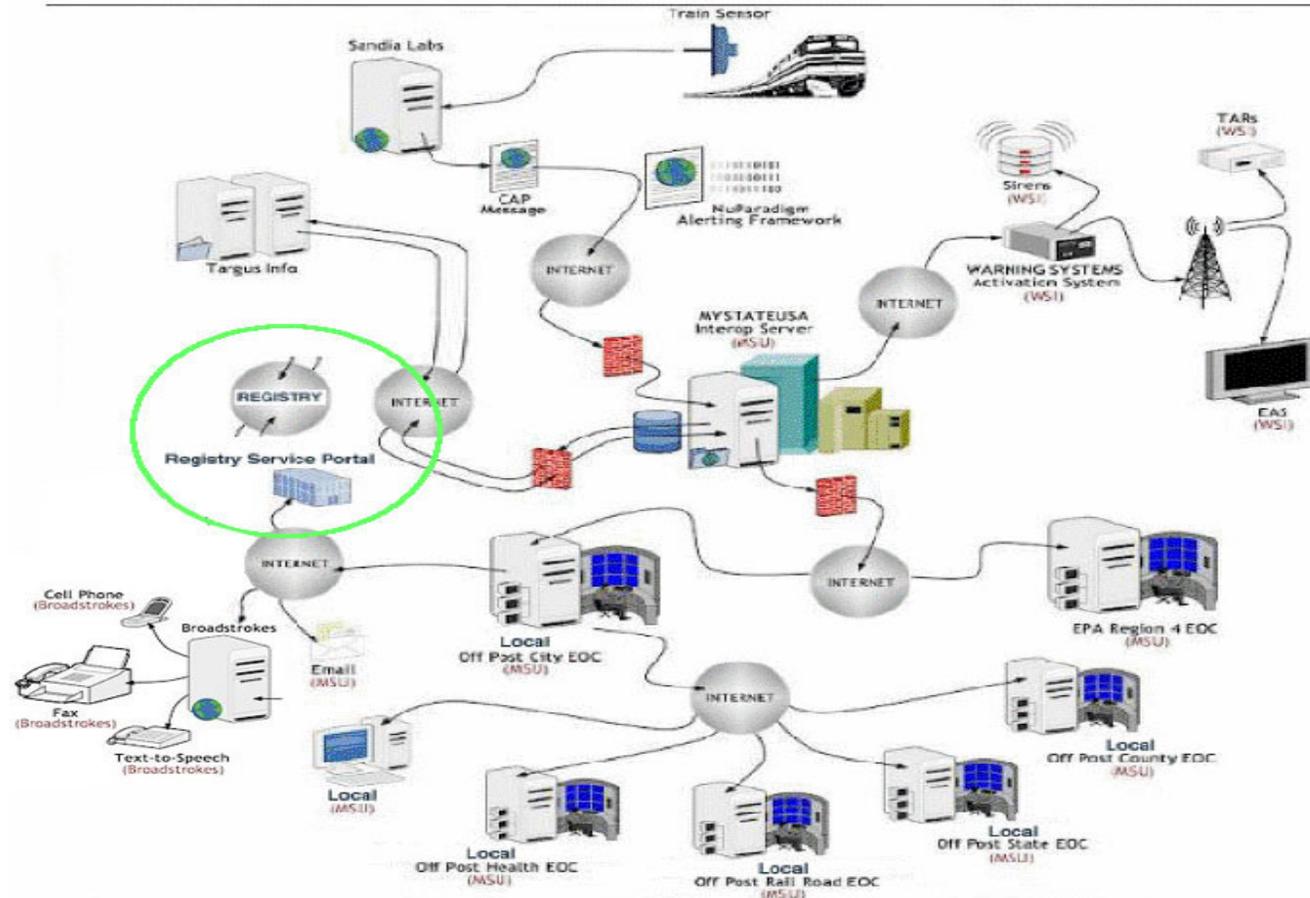
3. Data Reference Model 2.0

- Conceptual Data Model – a model to guide data architecture and not a model to guide database development.
- But an ontology provides both a – CDM and an executable application based on DRM 2.0!
- So Data Architecture can be implemented in ontology-driven information systems.

4. Interoperable Service Architectures and Pilots

- Semantic Interoperability Architecture (SIA):
 - See GSA Newsletter on Disaster Management, March 31, 2006 at
http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/Disaster%20Management%20Mar%202006_R2641S_0Z5RDZ-i34K-pR.pdf
 - See SCoP Pilots on page 18 for "Public-Private Collaboration for Semantic Interoperability in Emergency Management Information Sharing," (slide 17) and page 32 for "Disaster Response Pilot Demonstrates Web Services and Semantic Naming Technology" (slide 18).
- These pilots use W3C and OASIS standards to create and use an "Event Ontology" and "Semantic Web Services" across a network.
 - Workshop attendees David Ellis, Gary Ham, and Elysa Jones participate in this.

4. Interoperable Service Architectures and Pilots



Source: SOA for E-Government Interoperability at Work: Improving Rapid First Response - The Right Service at the Right Fingertips at the Right Time, SOA for E-Government Conference, May 23-24, 2006. See http://colab.cim3.net/cgi-bin/wiki.pl?SOAforEGovernment_2006_05_2324#nid325D

4. Interoperable Service Architectures and Pilots

- The semantics portion of the approach is based on an evolving global standard known as the Universal Data Element Framework (UDEF). The UDEF is a method for categorizing data element concepts (as defined by ISO/IEC 11179) that exist across multiple applications. It assigns each data element concept an alphanumeric tag plus a semantically rich name – that in most cases can stand-alone without requiring a separate definition.
 - For example, “Purchase Order Number” found in an invoice from industry to the government is a commonly encountered data element concept. This concept has a UDEF tag d.t.2_13.35.8 and associated UDEF name
Purchase.Order.DOCUMENT_Government.Assigned.IDENTIFIER.
- See Videos of Live Demos:
 - <http://www.opengroup.org/udedefinfo/demo0511/demos.htm>
 - <http://www.opengroup.org/projects/udedef/doc.tpl?CALLER=index.tpl&gdi d=9189>

4. Interoperable Service Architectures and Pilots

- Convergence of Semantic Naming and Identification Technologies?
 - RFID is about unique identification of physical objects (tags)
 - RDF leverages URIs as universal, unique identifiers, to describe all kinds of resources (identifiers)
 - IPV6 is about unique identification of devices attached to the Internet (addresses)
 - UDEF is about unique semantic naming of anything to make it easier to find and use (names mapped to addresses)
 - ISO/IEC 11179 is about defining and registering data element concepts (metadata registry)
 - Persistent Uniform Resource Locators (PURLs), Digital Object Identifiers (DOIs), Handles, and Archival Resource Keys (ARKs) are about persistent and searchable identifier schemes (identifiers).

See http://colab.cim3.net/cgi-bin/wiki.pl?OpenGroupSICoP_2006_04_27

4. Interoperable Service Architectures and Pilots

- There are many sources of uncertainty, such as measurements, unmodeled variables, and subjectivity.
- The Semantic Web is based on formal logic for which one can only assert facts that are unambiguously certain.
- The Bayesian Web is a proposal to add reasoning about certainty to the Semantic Web.
- The basis for the Bayesian Web is the concept of a Bayesian network.

Source of slides 20-24: Professor Ken Baclawski at http://colab.cim3.net/cgi-bin/wiki.pl?OpenGroupSICoP_2006_04_27#nid33XG and Co-author of *Ontologies for Bioinformatics*, 2005, MIT Press.

4. Interoperable Service Architectures and Pilots

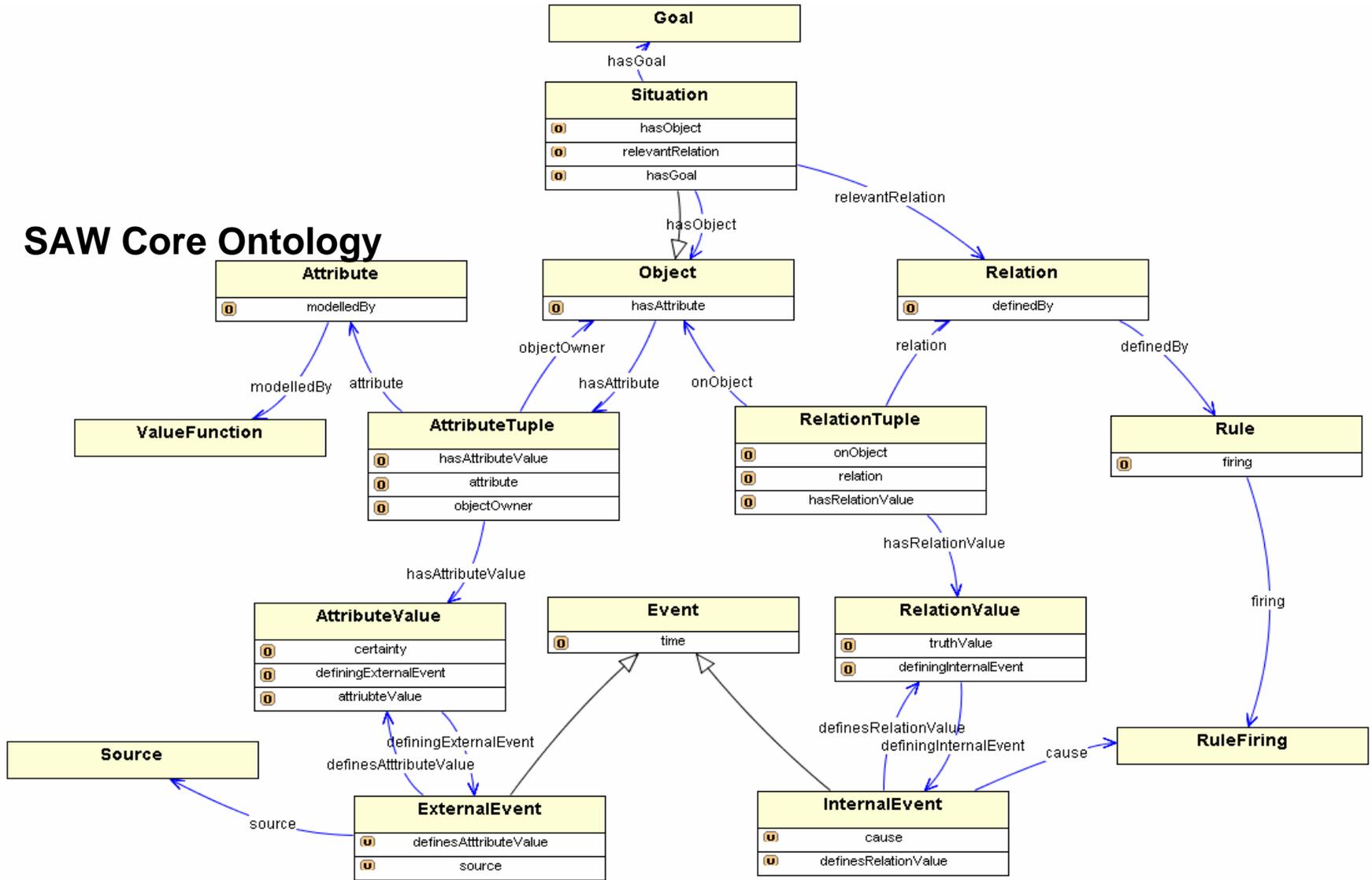
- Situation awareness (SAW) is “knowing what is going on around oneself.”
 - More precisely, SAW is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future (Endsley & Garland).
- SAW occurs at level 2 of the Joint Defense Laboratories (JDL) model.

4. Interoperable Service Architectures and Pilots

- The SAW Assistant (SAWA) is an OWL based tool for obtaining situation awareness from observed events and lower level data fusion processes.
- SAWA is based on a series of ontologies:
 - The SAW Core Ontology
 - Ontology for uncertainty
 - Domain specific ontologies and rules

4. Interoperable Service Architectures and Pilots

SAW Core Ontology



4. Interoperable Service Architectures and Pilots

Situation Monitor - Scenario: Repairable Asset Inspection Scenario

File Scenario Relevant-Relations Situation-Objects Window Help

Next >

Event ID	Date	Time	Source
E2	12:00:00.00	2005-04-06	CommandCenter

Inference Depth: 1.2 | Rule Firing: 992 | Assertion Rate: 1.3 | More Info

Relevant Relation - Graphical Inspector

```

    graph LR
      F16-brake-rotor -- criticalAt --> BaseAlpha
      F16-wheel -- marginalAt --> BaseAlpha
      F16-wheel -- marginalAt --> BaseBeta
      BaseGamma -- marginalAt --> F16-wheel
    
```

Situation Objects - Graphical Inspector

Base	Part	Count
BaseAlpha	F16	3
BaseAlpha	F16-engine	20
BaseAlpha	F16-landing-gear	3
BaseAlpha	F16-wheel	0
BaseAlpha	F16-brake-pad	4
BaseAlpha	F16-brake-rotor	0
BaseBeta	F16	0
BaseBeta	F111	6
BaseBeta	F18	3
BaseDelta	F16	2
BaseDelta	F111	0
BaseDelta	F18	4
BaseGamma	F16	3
BaseGamma	F111	3
BaseGamma	F18	2

Relevant Situation Objects

Object (x)	Relation (...)	Object (y)	Certainty	Time
F16-brake-rotor	criticalAt	BaseAlpha	0.8600	2005-00-06 12:00:...
F16-wheel	marginalAt	BaseBeta	0.8008	2005-00-06 12:00:...
F16-wheel	marginalAt	BaseAlpha	0.8008	2005-00-06 12:00:...
F16-wheel	marginalAt	BaseGamma	0.8008	2005-00-06 12:00:...

Situation Objects - Graphical Inspector

n	Event	Base	Part	Certainty	Time	GoodParts	FixableP...
1	E2	BaseAlpha	BaseAlpha	1.0		0	0
2	E2	BaseAlpha	F16	0.86	2005-04-06T12:0...	2	1
3	E2	BaseAlpha	F18	0.86	2005-04-06T12:0...	2	0
4	E2	BaseAlpha	F111	0.86	2005-04-06T12:0...	2	0
5	E2	BaseAlpha	F16-wheel	0.86	2005-04-06T12:0...	0	0
6	E2	BaseAlpha	F16-landin...	0.86	2005-04-06T12:0...	3	0
7	E2	BaseAlpha	F16-engine	0.86	2005-04-06T12:0...	10	10
8	E2	BaseAlpha	F16-brake-...	0.86	2005-04-06T12:0...	4	0
9	E2	BaseAlpha	F16-brake-...	0.86	2005-04-06T12:0...	0	0
10	E2	BaseAlpha	F18-wheel	0.86	2005-04-06T12:0...	1	10
11	E2	BaseAlpha	F18-landin...	0.86	2005-04-06T12:0...	4	1
12	E2	BaseAlpha	F18-engine	0.86	2005-04-06T12:0...	2	1
13	E2	BaseAlpha	F18-brake-...	0.86	2005-04-06T12:0...	12	10

4. Interoperable Service Architectures and Pilots

The screenshot shows a Microsoft Internet Explorer browser window. The address bar contains the URL for the SICOP/SWIM Test Wiki. The page title is "SICOP/SWIM Test Wiki". The page content includes a search box, navigation links, and a welcome message from Mills Davis and Brand Niemann. The page also lists several work groups and their associated projects.

SICOP/SWIM Test Wiki

Semantic WIKI by VisualKnowledge

bn@test.com

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Search SICOP/SWIM Test Wiki

Welcome to the SICOP/SWIM Test Wiki by Mills Davis and Brand Niemann, SICoP Co-Chairs

The Semantic Interoperability Community of Practice (SICoP) has used a GSA-sponsored - privately hosted [Collaborative Wiki](#) to support the work of its five Work Groups:

- Data Reference Model 2.0 Implementation Through Iteration and Testing ([DRM IT2](#)) (evolved to [SWIM](#) below)
- Health Information Technology Ontology Project ([HITOP](#))
- Ontology and Taxonomy Coordination ([ONTAC](#))
- Common Upper Ontology - ([CUO](#))
- Semantic Wikis and Information Management ([SWIM](#))
- Please note that each of these WGs has email discussion forms as follows: [SICoP/SWIM](#), [CUO](#), [DRM IT2](#), [HITOP](#), and [ONTAC](#).

SICoP learned from using the [Collaborative Wiki](#) to develop the [Federal Enterprise Architecture Data Reference Model 2.0](#) that it could also use a Collaborative Wiki to implement the DRM 2.0 if it supported Semantic Metadata and the process for producing Trusted Reference Knowledge we now call the Knowledge Reference Model.

Our vision is to support Individuals collaborating on Semantic Interoperability of Content and Projects to build Semantic Knowledgebases in a Semantic Wiki. The purposes of this test is to:

- Organize Individuals (FOAF: Friend-of-a-Friend), Content (DC: Dublin Core), and Projects (DOAP: Description of a Project) using semantic standards.

See Open Collaboration: Networking Geospatial Information Technology for Interoperability and Spatial Ontology, June 20-22nd, Collaborative Expedition Workshop at http://colab.cim3.net/cgi-bin/wiki.pl?ExpeditionWorkshop/OpenCollaboration_NetworkingGeospatialInformationTechnology_2006_06_20

4. Interoperable Service Architectures and Pilots

Visual OWL Web Ontology Language interface showing the 'Ontologies' tab. The interface includes a sidebar with a list of ontologies, a main area with tabs for Search, Ontologies, Classes, Properties, Individuals, and My Profile. The 'Ontologies' tab is active, displaying a form for editing an ontology with fields for Name, Package URL, and Version No. Below the form are sections for Annotations and Imports, and a summary table of ontology statistics.

Type	Language	Comment
No results		

Imports:	< Ontology
Total number of Classes:	0 (Defined: 0 , Imported: 0)
Total number of Datatype Properties:	0 (Defined: 0 , Imported: 0)
Total number of Object Properties:	0 (Defined: 0 , Imported: 0)
Total number of Annotation Properties:	0 (Defined: 0 , Imported: 0)
Total number of Individuals:	0 (Defined: 0 , Imported: 0)

See Open Collaboration: Networking Geospatial Information Technology for Interoperability and Spatial Ontology, June 20-22nd, Collaborative Expedition Workshop at http://colab.cim3.net/cgi-bin/wiki.pl?ExpeditionWorkshop/OpenCollaboration_NetworkingGeospatialInformationTechnology_2006_06_20

4. Interoperable Service Architectures and Pilots

- Collaborative Expedition Workshop #53, Tuesday, August 15, 2006 at NSF, Open Collaboration: Networking Semantic Interoperability Across Distributed Organizations and Their Ontologies:
 - John Yanosy: As part of our work we are creating higher semantic layers building on the excellent work of EDXL and CAP, so that the power of OWL ontologies can be used to create many common operating pictures of the state of emergency disaster response coordination activities.
 - See http://colab.cim3.net/cgi-bin/wiki.pl?ExpeditionWorkshop/OpenCollaboration_NetworkingSemanticInteroperability_2006_08_15
- 5th International Semantic Web Conference, November 5-9, 2006, Semantic Sensor Network Workshop:
 - See <http://www.ict.csiro.au/ssn06/>

5. Questions & Answers

- Your turn now or during the social hour.
- Shall we do a DRM 2.0 Pilot for Net-Ready Sensor Data?
- Contact Information:
 - Brand Niemann, U.S. EPA
 - 202-564-9491, niemann.brand@epa.gov
 - <http://colab.cim3.net/cgi-bin/wiki.pl?BrandNiemann>
 - <http://web-services.gov/>
 - <http://colab.cim3.net/cgi-bin/wiki.pl?SICoP>

6. Comments/Suggestions

- “Ontology” of This Workshop (see slide 32).
 - Concept, definition, and instance and a wise balance between working locally and working globally.
- The focus was on technology and standards but need a business architecture as well.
 - Relationship to IPV6 – biggest Federal Government IT Transition Mandate for FY 2007-2008.
 - Relationship to Agency and Interagency Emergency/Disaster Response Architectures and Programs.
 - Relationship to the Federal Enterprise Architecture (if want significant funding and collaboration from multiple agencies) (see next slide).
 - Note that Technology and Standards is at the bottom of the architecture stack – important, but much more is needed to sell it.

Federal Enterprise Architecture

- Address Reference Models in IT Investment Proposals (Exhibit A-300):
 - Performance – goals and metrics
 - Business – business case
 - Services – components (existing, new, reusable)
 - Data – data model
 - Technology – technology and standards
- This is where SICoP can help you:
 - We will participate in the NIST-led Sensor Standards Harmonization Working Group (September 12th).
 - Could do a Composite Application Pilot using a business ontology for a Sensor Network and a Semantic Wiki Pilot for Collaboration and Harmonization of Multiple Data Models for Sensor Networks.

“Ontology” of This Workshop

Concept	Definition	“Local” Instance	“Global” Instance
Network	Internet	Net-centric	IPV6
Ready	Plug-and-Play	Like USB	NCOIC*, OGC, etc.
Sensors	CBRN	Vendor examples	DoD/NIST/ORNL

* Network Centric Operations Industry Consortia (MOU at August 15th Workshop)