# Sensor Network Pilots for DRM 2.0: Sensor Standards Harmonization Working Group Meeting at NIST

Brand L. Niemann (US EPA), Co-Chair,
Semantic Interoperability Community of Practice (SICoP)
Best Practices Committee (BPC), Federal CIO Council
September 12, 2006

# Background

- Invited to participate in the August 2-3, 2006, Summer Workshop on Net-Ready Sensors: The Way Forward:
  - See http://www.sensornet.gov/net_ready_workshop/
- Asked: Shall we do a DRM 2.0 Pilot for Net-Ready Sensor Data?
  - See http://www.sensornet.gov/net_ready_workshop/Brand-Niemann-SICoP08022006.pdf
- Suggested: Ontological Engineering Approach and 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.
  - Invited to participate in today's Sensor Standards Harmonization Working Group Meeting at NIST:
    - See http://www.sensornet.gov/net_ready_workshop/Brand_Niemann_Comments.pdf

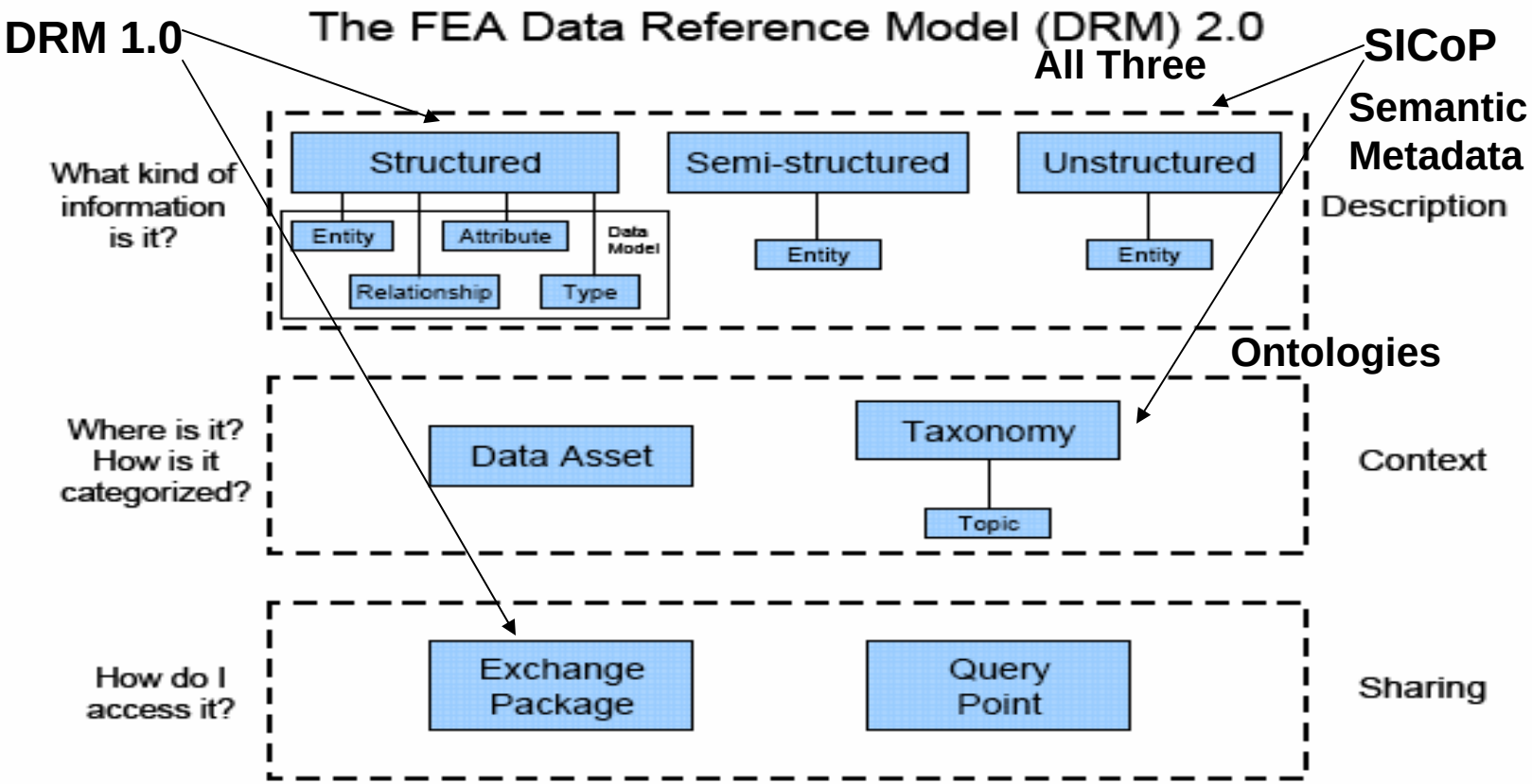
# Background

- Workshop Organizers asked me to show how a Wiki could facilitate group editing of the Workshop Notes:
  - See http://colab.cim3.net/cgi-bin/wiki.pl?NetReadySensorsWorkshop_2006_08_0203
  - Also see The Amazing Wikis in Government Computer News at http://www.gcn.com/print/25_25/41673-1.html
- Invited Donald F. (Rick) McMullen, Pervasive Technology Labs at Indiana University, to participate in our monthly Collaborative Expedition Workshops and present on CIMA and Semantic Interoperability for Networked Instruments and Sensors (Note: CIMA is Common Instrument Middleware Architecture):
  - See http://colab.cim3.net/cgi-bin/wiki.pl?ExpeditionWorkshop/OpenCollaboration_NetworkingSemanticInteroperability_2006_08_15#nid385A

# Outline

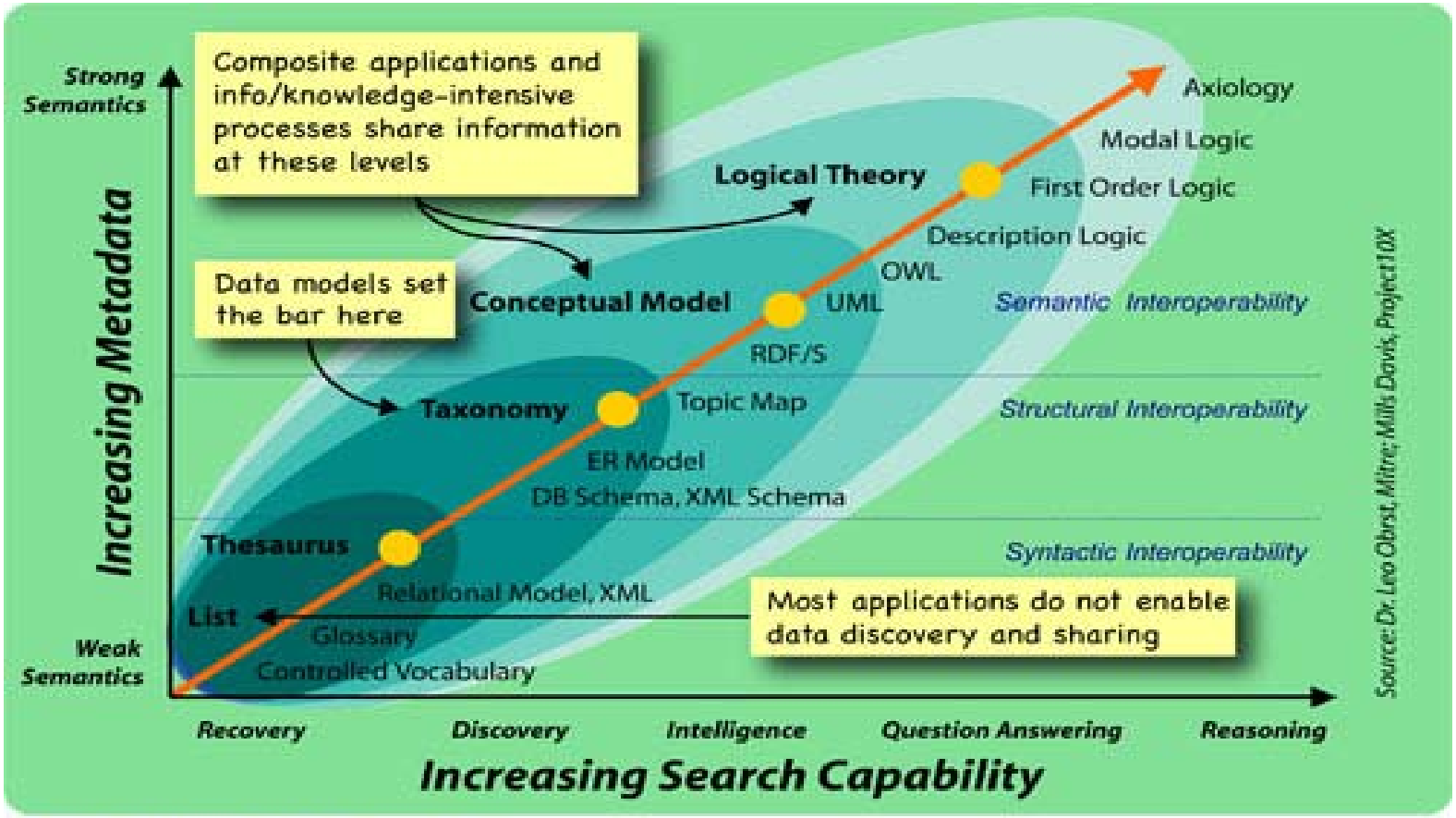
- 1. DRM 2.0 and SICoP's Knowledge Reference Model 1.0 and Metamodel
- 2. Ontological Engineering
- 3. Composite Applications and Semantic Wiki
- 4. Initial Pilot Results
- 5. Some Next Steps

# 1. 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**

# 1. SICoP's Knowledge Reference Model 1.0

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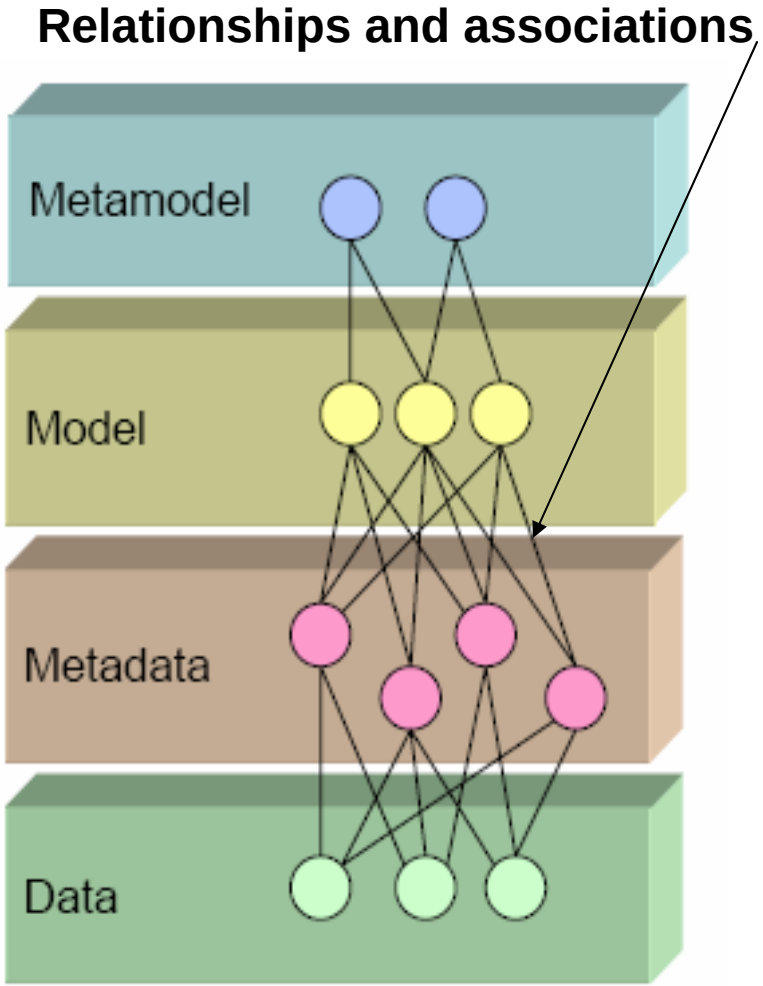
The point of this graph is that Increasing Metadata (from glossaries to ontologies) is highly correlated with Increasing Search Capability (from discovery to reasoning).

# 1. SICoP's DRM 2.0 Metamodel

- 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.

# 1. SICoP's DRM 2.0 and Beyond

- SICoP Does Projects for the CIO Council's Committees - One of Those Projects Was the DRM 1.0 and 2.0:
  - 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 6-7).
  - December 2005, DRM 2.0 – Description (3), Context (2), and Sharing (2) (see slide 5).
- So DRM 2.0 + Semantic Metadata = SICoP Knowledge Reference Model (KRM) 1.0.
- DRM 2.0 Implementation Evolves to the SICoP Semantic Wikis and Information Management (SWIM) WG.
  - **We developed the DRM 2.0 using a conventional Wiki so why not implement it (basic specification, SICoP metamodel, and semantic metdata) in a "Semantic Wiki"!**

# 2. Ontological Engineering

- Interoperability and Ontology:
  - Computer systems interoperate by passing messages.
  - Every message has a meaning (semantics) and a purpose (pragmatics).
  - The role of ontology is to make the semantics and pragmatics explicit in terms of the people, places, things, events, and properties involved.
  - Communications among people and computers are always based on task-oriented ontologies. Those ontologies are bottom-up, highly specialized, and usually de facto.
  - At every level, intentions, expressed in speech acts, are fundamental.

Source: John Sowa: Extending Semantic Interoperability To Legacy Systems and an Unpredictable Future, August 15, 2006, Collaborative Expedition Workshop, National Science Foundation, Arlington, VA.

# 2. Ontological Engineering

- Practical Solutions for Knowledge Discovery Challenges: Knowledge Representation and Complexity Control:
  - Level 1: Concept Extraction
  - Level 2: Relationships Between Words and/or Concepts
  - Level 3: Fully Expressive Representation Modes (e.g. RDF/OWL)
  - Level 4:
    - 4.a Context determination – usually applied to the entire information source that generated the set of specific entities; this helps to determine which ontologies / taxonomies to invoke for further understanding of the concepts and entities.
    - 4.b Geospatial referencing – a natural step following entity (place) extraction.
    - 4.c Analytics – e.g., associating and processing available “data” that correlates with extracted entities.
  - Level 5: Deep Semantic Analysis

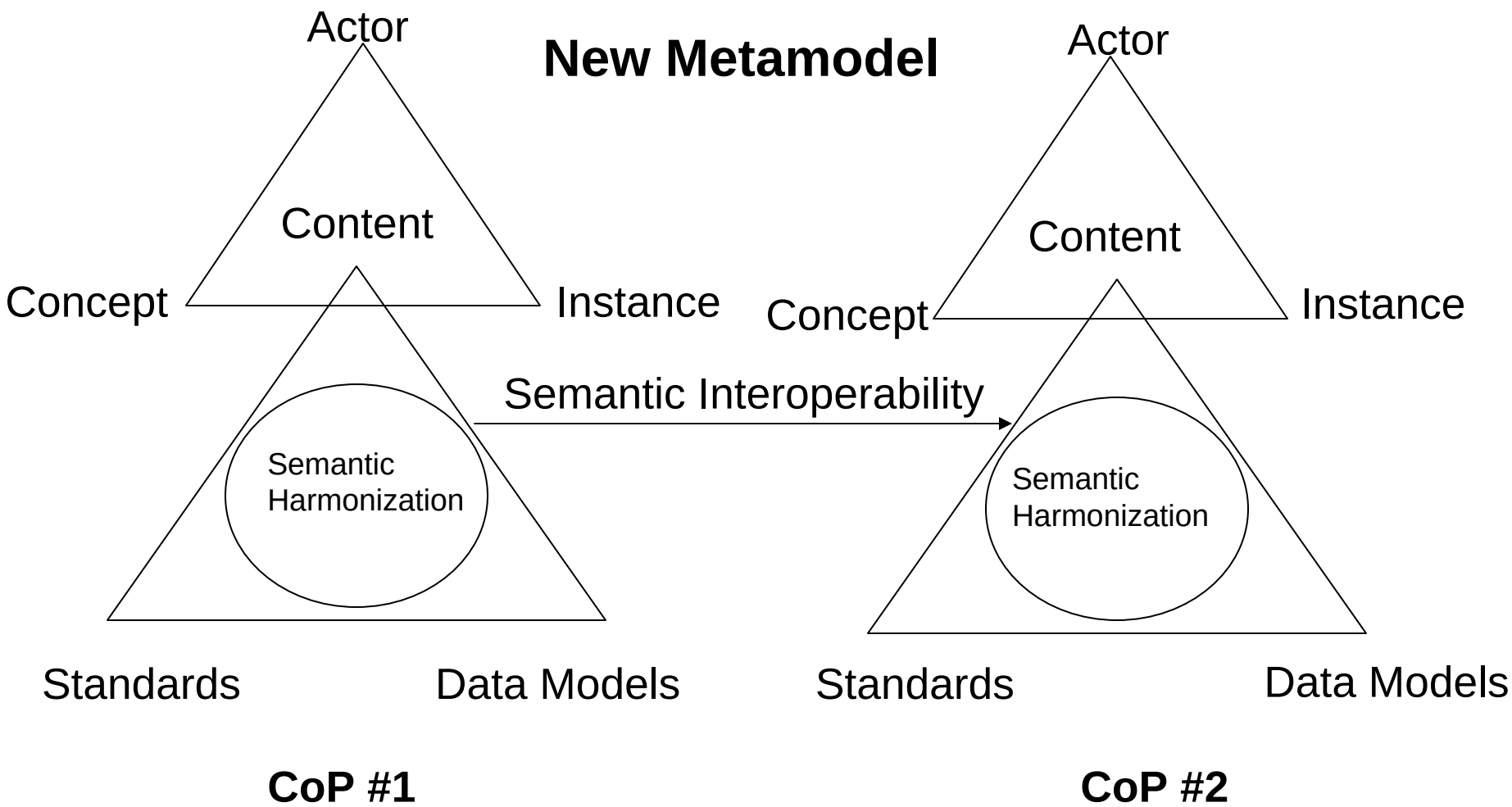
Source: Alianna Maren, 5th Semantic Interoperability for E-Government Conference Proposed Presentation, October 10-11th, MITRE, McLean, VA.

# 2. Ontological Engineering

- Ontologies are us: A unified model of social networks and semantics:
  - A tripartite model of ontologies:
    - Actors, concepts, and instances extending the traditional concept of ontologies (concepts and instances) with the social dimension.
    - Two case studies: (1) analysis of large scale folksonomy system and (2) extraction of community-based ontologies from Web pages.
    - Semantics emerge from the individual actions of a community at work.

Source: Peter Mika, Vrije Universiteit, Amsterdam, The Netherlands.

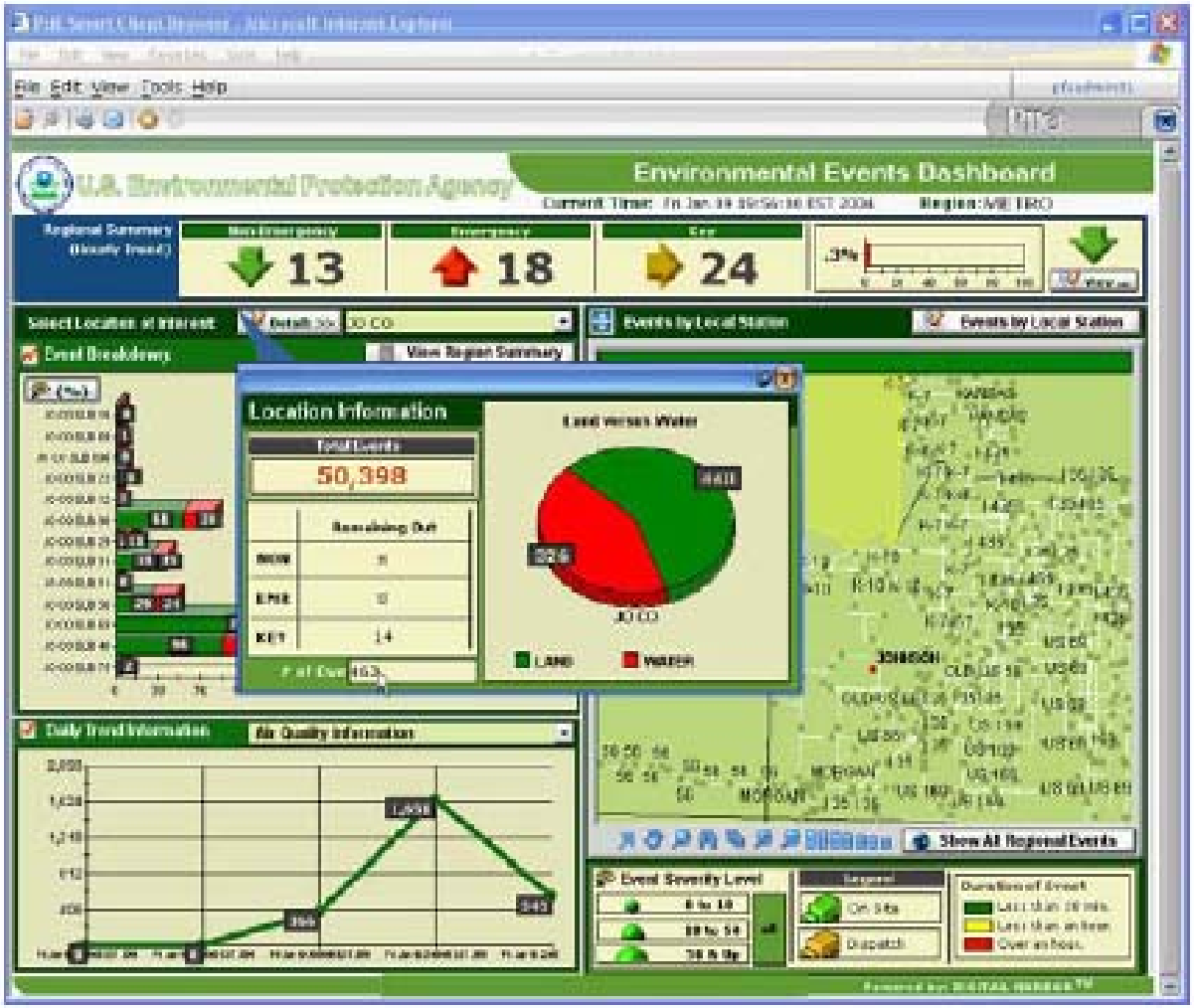
# 2. Ontological Engineering



# 3. Composite Applications and Semantic Wikis

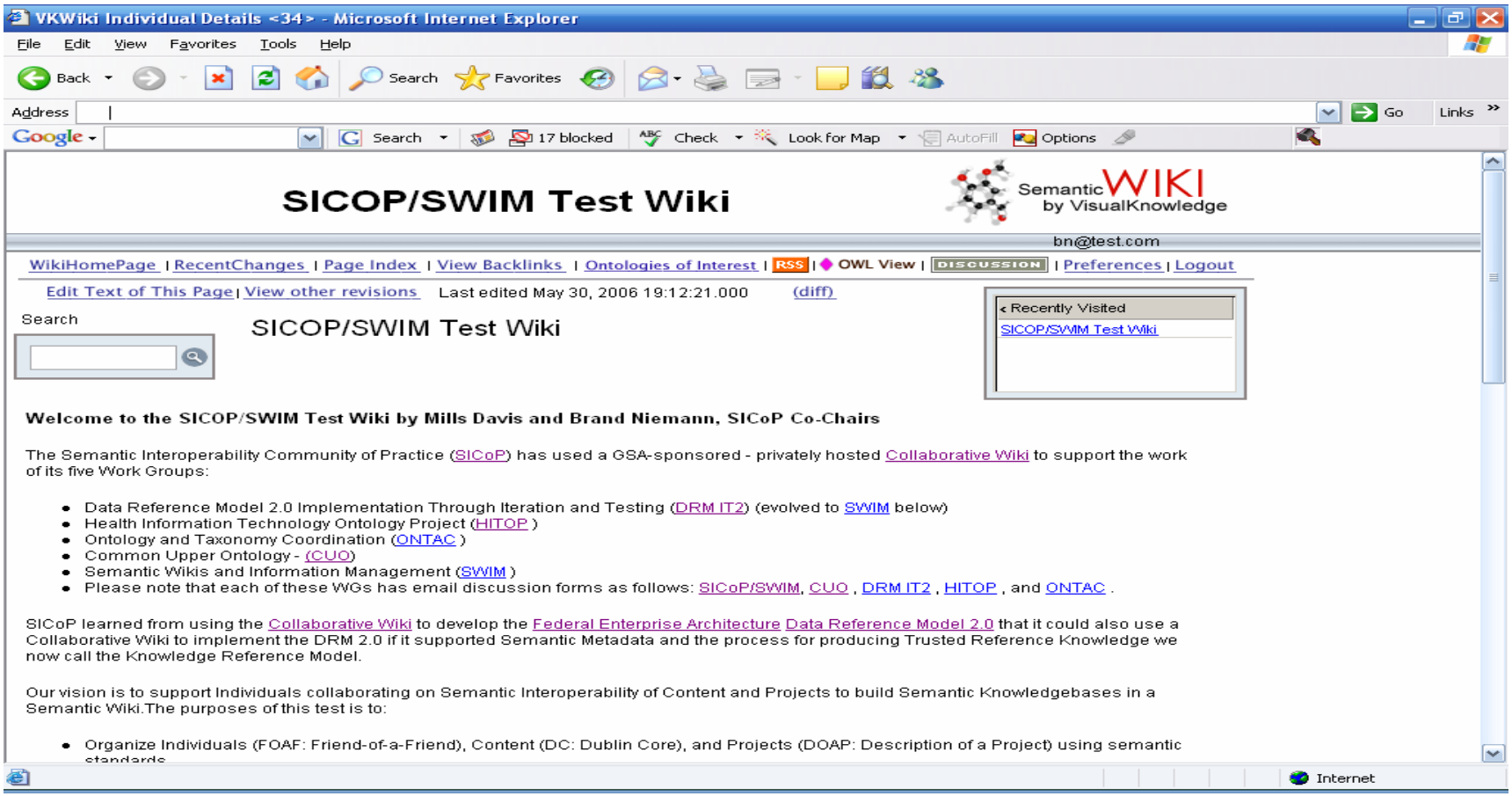
- Composite Applications Use a Business Ontology to Make Diverse and Distributed Data and Information Sources Interoperate and Deliver a High-End User Interface:
  - See SICoP Pilots with Digital Harbor.
- Semantic Wikis Implement the SICoP DRM 2.0 and KRM 1.0 by Allowing Communities of Practice to Collaborate on Managing (using and reusing) Ontologies and Building Ontology-Driven Applications.
  - See SICoP Pilots with Visual Knowledge and other Semantic Wiki Developers.

# 3. Composite Applications



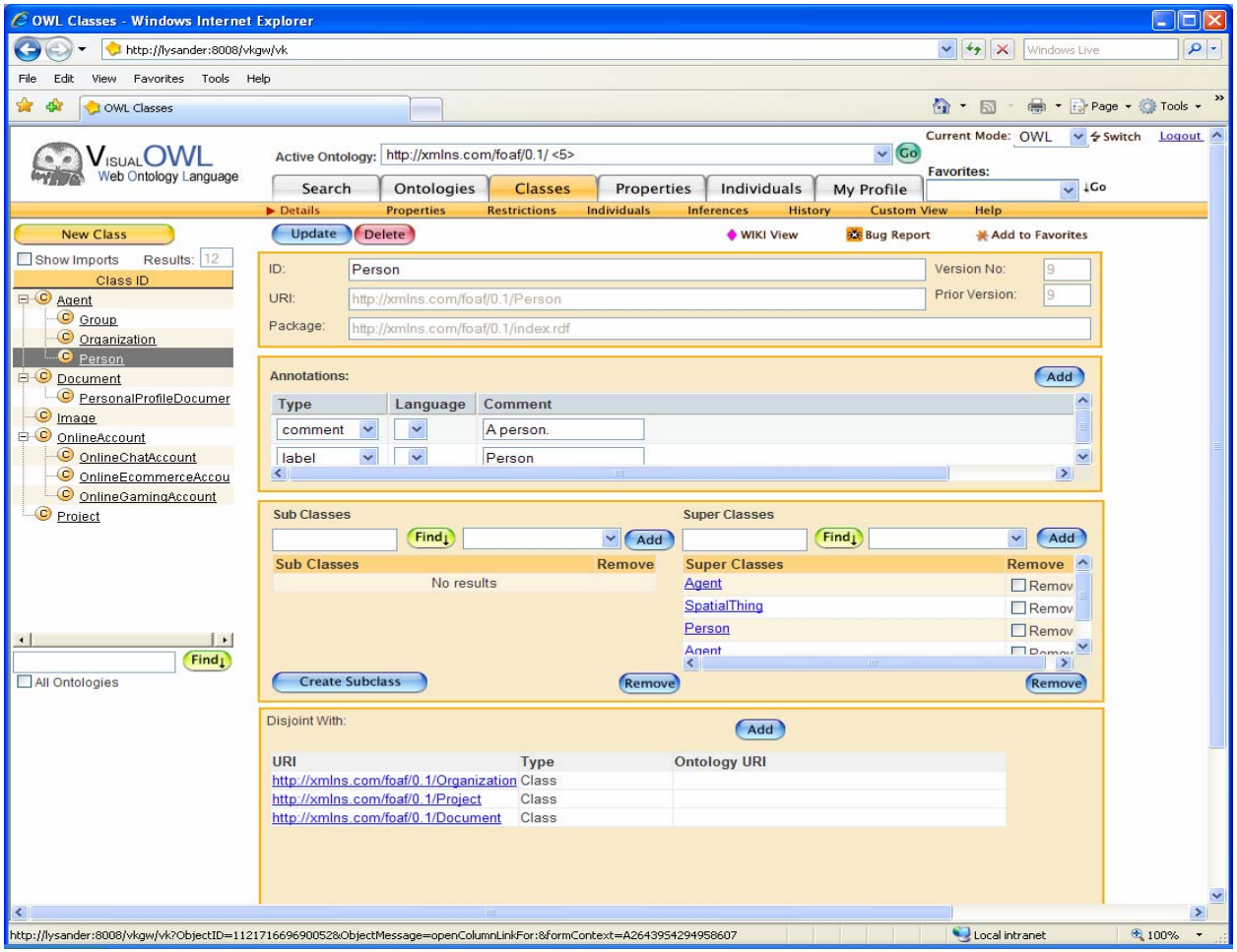

Executable Integration of the FEA Reference Models in Composite Applications Fact Sheet at http://web-services.gov/SICoPPilotFactSheet_Final.pdf

# 3. Semantic Wikis




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

# 3. Semantic Wikis

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# 4. Initial Pilot Results

- 4.1 “Ontology” of The Workshop (see slide 22).
  - 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.

# 4.1 “Ontology” of The Workshop

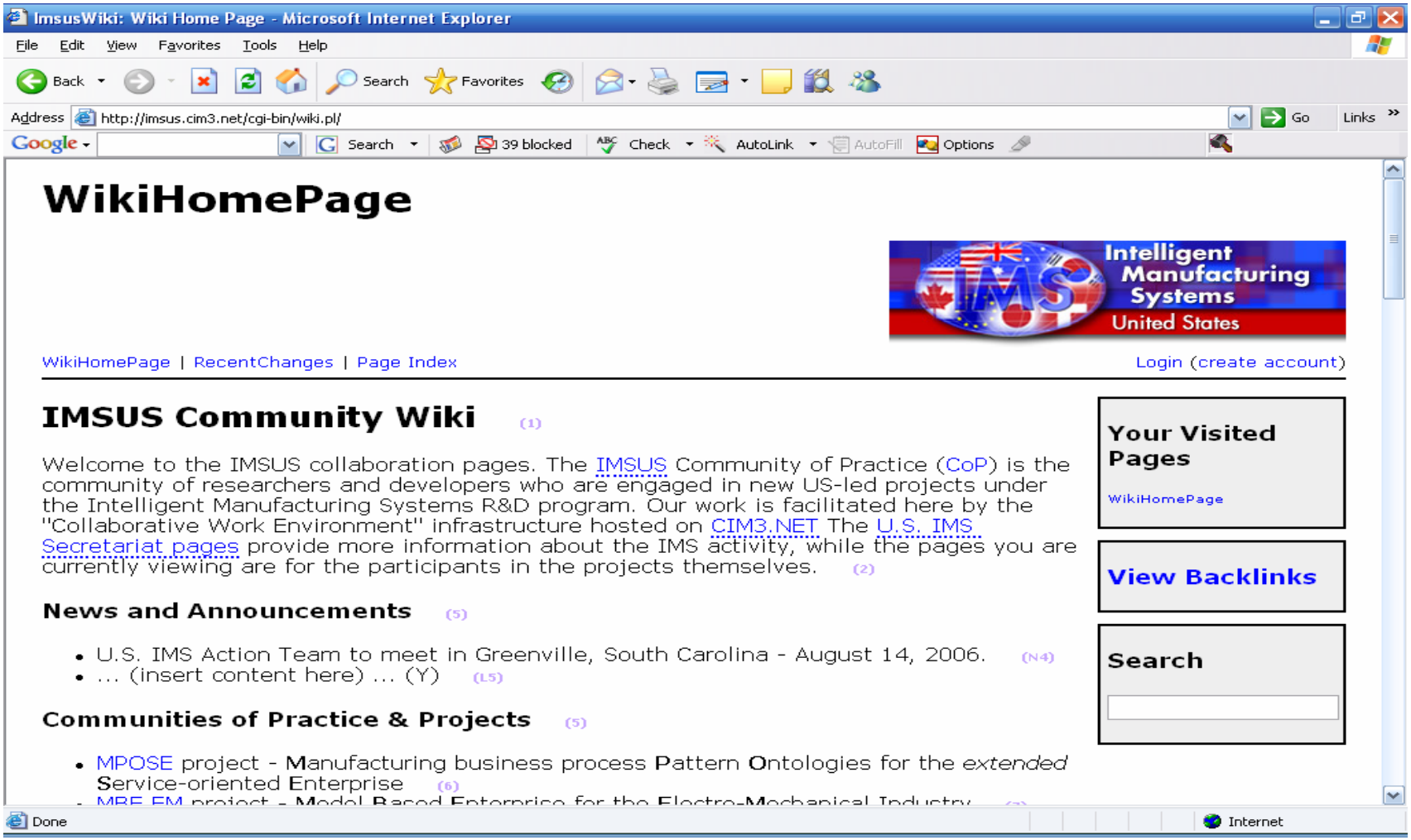
| Concept | Definition | “Local” Instance | “Global” Instance |
|---|---|---|---|
| Network | Internet | Net-centric | IPV6 |
| Ready | Plug-and-Play | Like USB | NCOIC*, OGC, etc. |
| Sensors | CBRN | Vendor examples | DoD/NIST/ ORNL |

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

# 4. Initial Pilot Results

- 4.2 Conventional Wiki:
  - NIST uses them for the Intelligent Manufacturing Community of Practice (see next slide):
    - See http://imsus.cim3.net/cgi-bin/wiki.pl/
  - Workshop Organizers asked me to show how a Wiki could facilitate group editing of the Workshop Notes (see slide 19):
    - See http://colab.cim3.net/cgi-bin/wiki.pl?NetReadySensorsWorkshop_2006_08_0203

# 4.1 Conventional Wiki

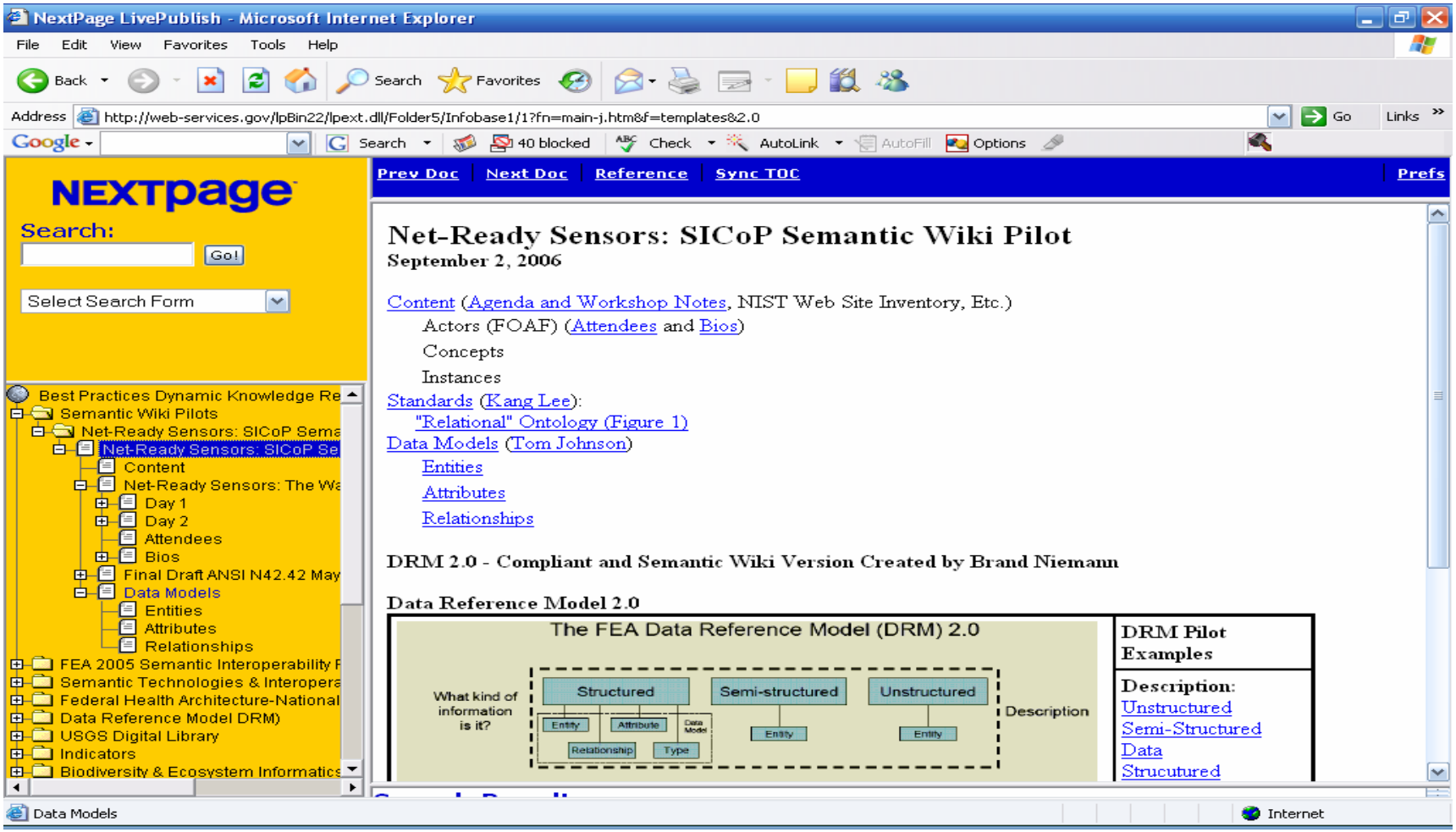


# 4.1 Conventional Wiki

# 4. Initial Pilot Results

- 4.3 Metamodel for Ontologizing (recall slide 12):
  - Content (DRM 2.0 Unstructured):
    - August 2-3rd Workshop:
      - Actor: Bryan Gorman
      - Concept: Workshop Themes
      - Instance(s):
        - » CBRN Data Model
        - » ANSI N42.42 Standard
        - » Common Alerting Protocol (CAP)
      - Intent: Workshop Scope

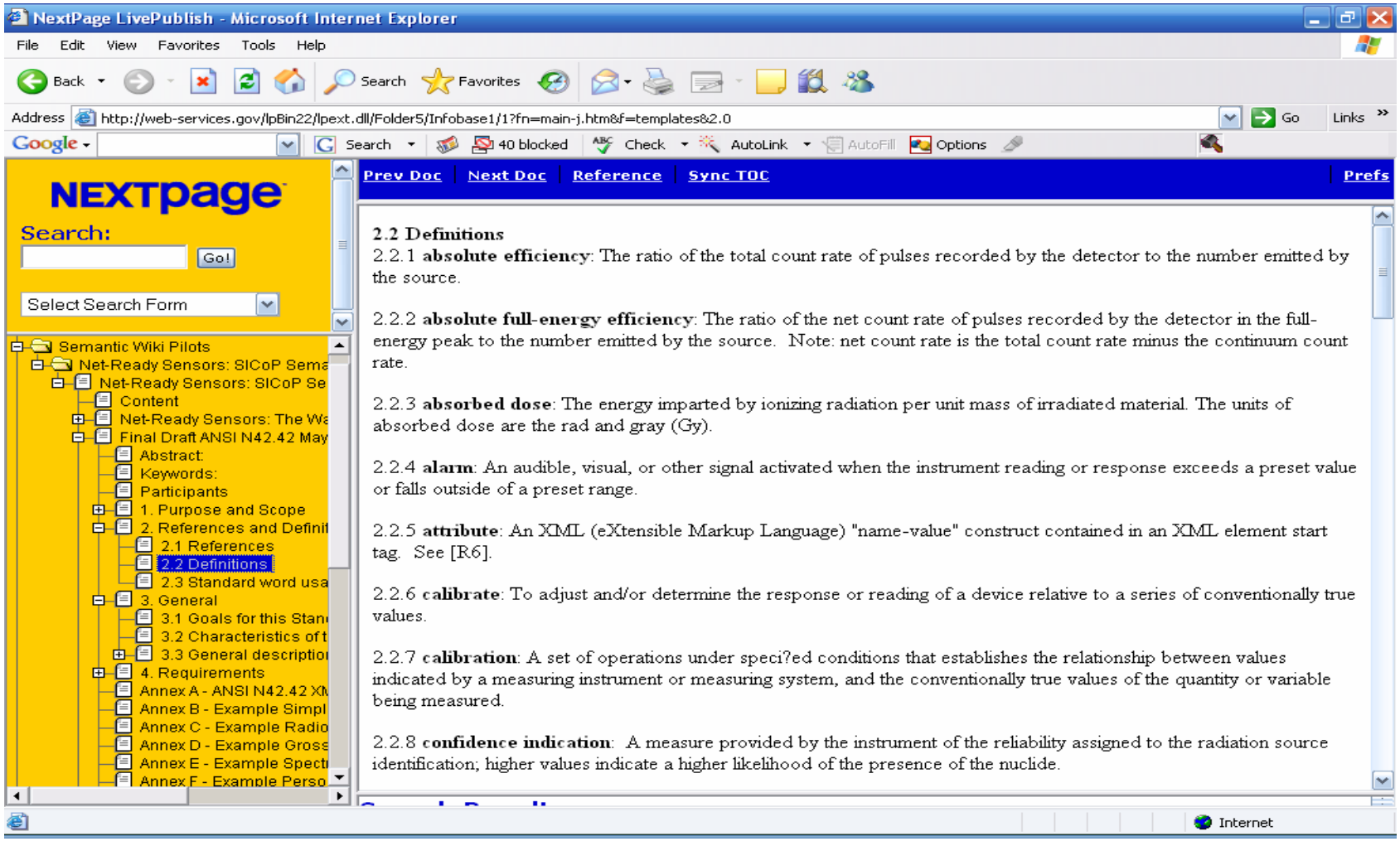
# 4. Initial Pilot Results



# 4. Initial Pilot Results

- 4.3 Metamodel for Ontologizing (recall slide 12):
  - Standards (DRM 2.0 Semi-structured):
    - ANSI N42.42 Standard (Final Draft, May 2, 2006):
      - Keywords: Data format, radiation detectors, DHS standards, Homeland security
      - References and Definitions (Standard word usage)
      - General (Characteristics of the data format and General description of the ANSI N42.42 data format)
      - Requirements (Data types and enumerations, ANSI N42.42 schema elements and attributes, and Possible data elements by class of instrument)
      - Seven Annexes (ANSI N42.42 XML Schema, 5 file examples, and extension of the N42.42 standard example)

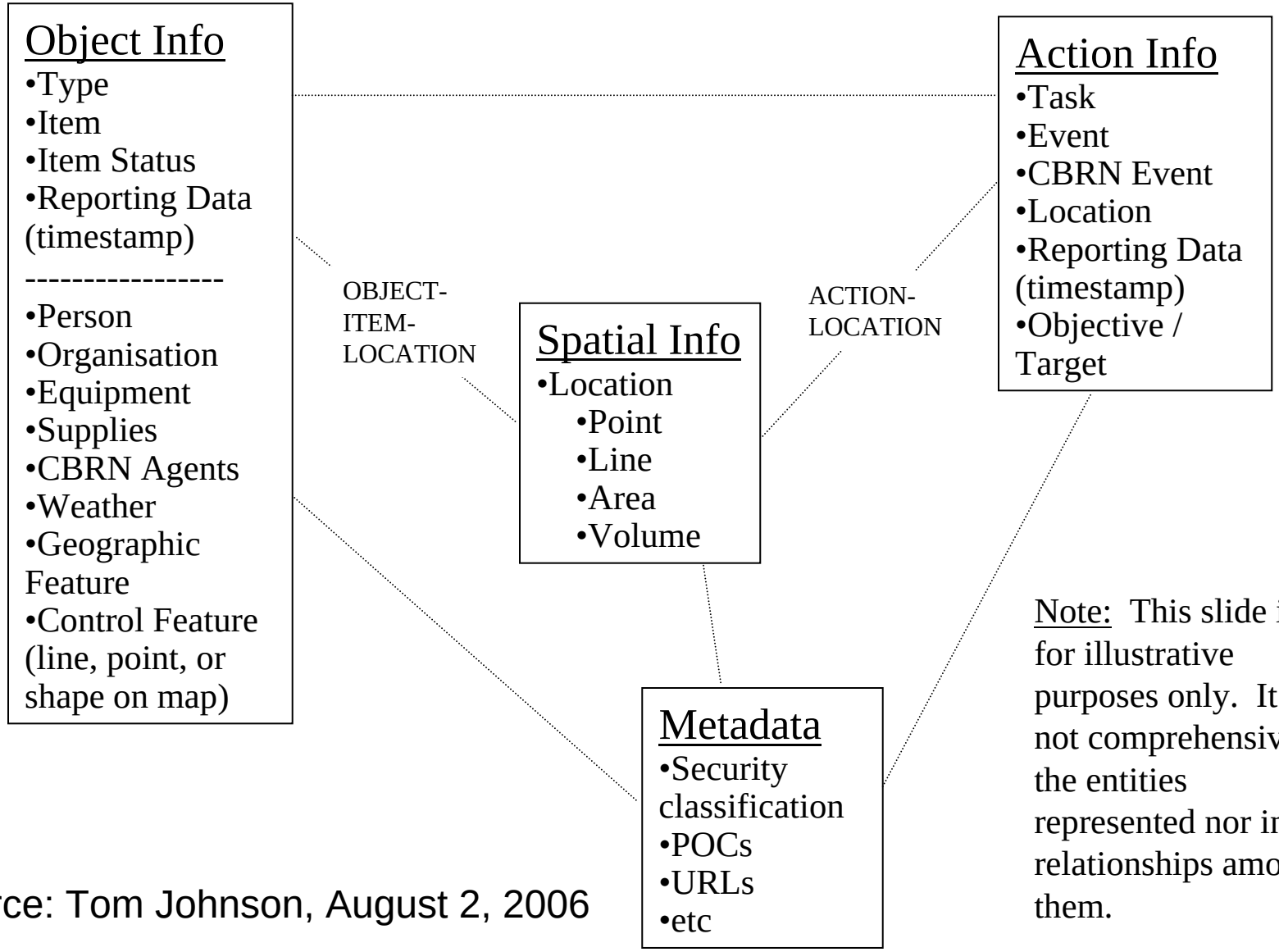
# 4. Initial Pilot Results



# 4. Initial Pilot Results

- 4.3 Metamodel for Ontologizing (recall slide 12):
  - Data Models (DRM 2.0 Structured):
    - CBRN Data Model Version 1.4 (Tom Johnson):
      - High-Level Overview (see next slide).
      - Entities: 446, Attributes: 3611, and Relationships (parent-child): 1317.
      - Irwin Representation (too detailed to see), Data Dictionary (Excel) and XML Schema: Can import into TopQuadrant's TopBraid Composer, Visual Knowledge's Visual Owl, etc.
      - Use in SOA and plans for Version 1.5.
      - Caveat: Represents a conceptual model of CBRN Battlespace relationships and common semantics and syntax. The model does not represent a canned software solution for system interoperability.
    - Comment: This is where an ontology can provide both a conceptual data model and an executable artifact in an application!

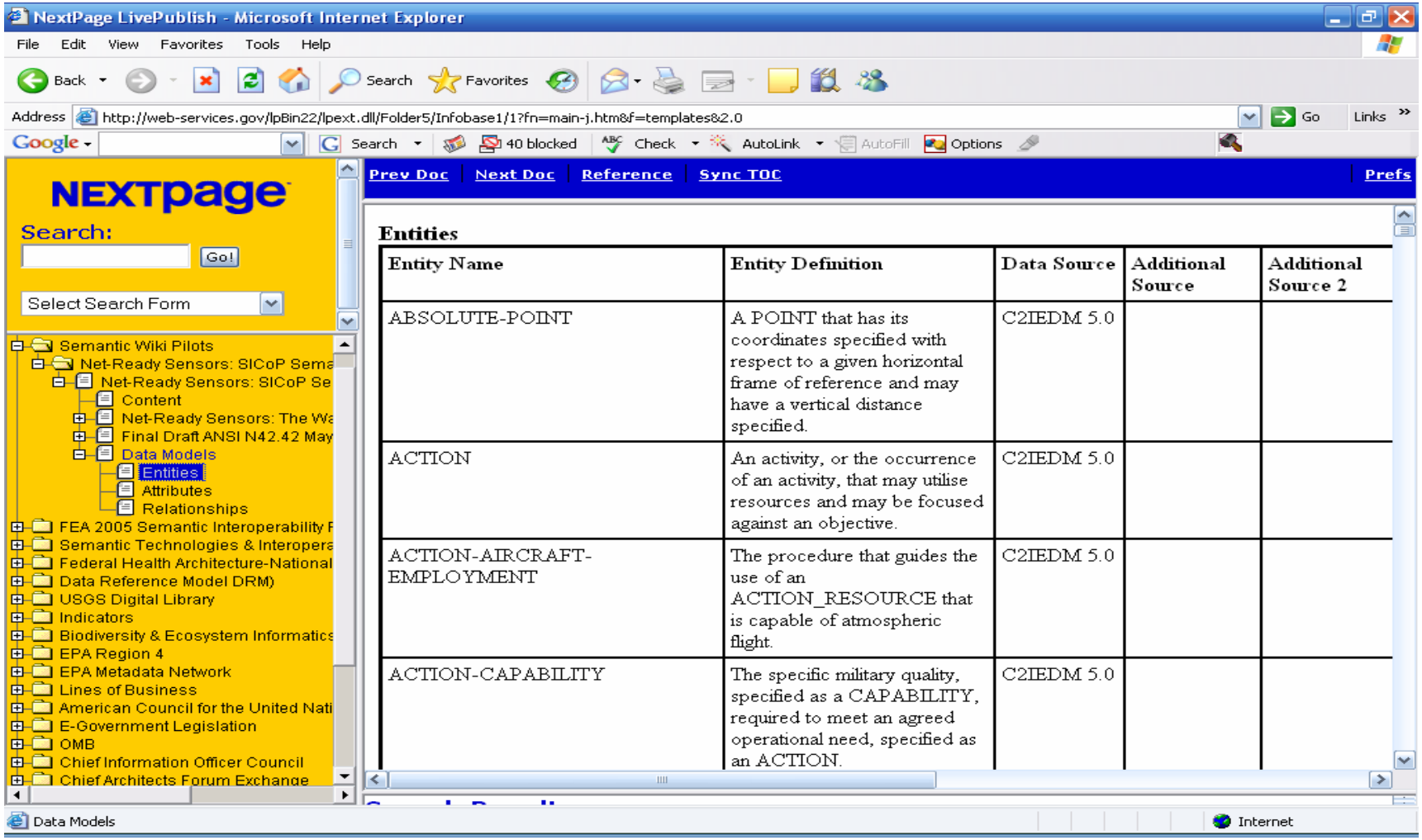
# CBRN Data Model High-level Overview




Note: This slide is for illustrative purposes only. It is not comprehensive in the entities represented nor in the relationships among them.

Source: Tom Johnson, August 2, 2006

# 4. Initial Pilot Results

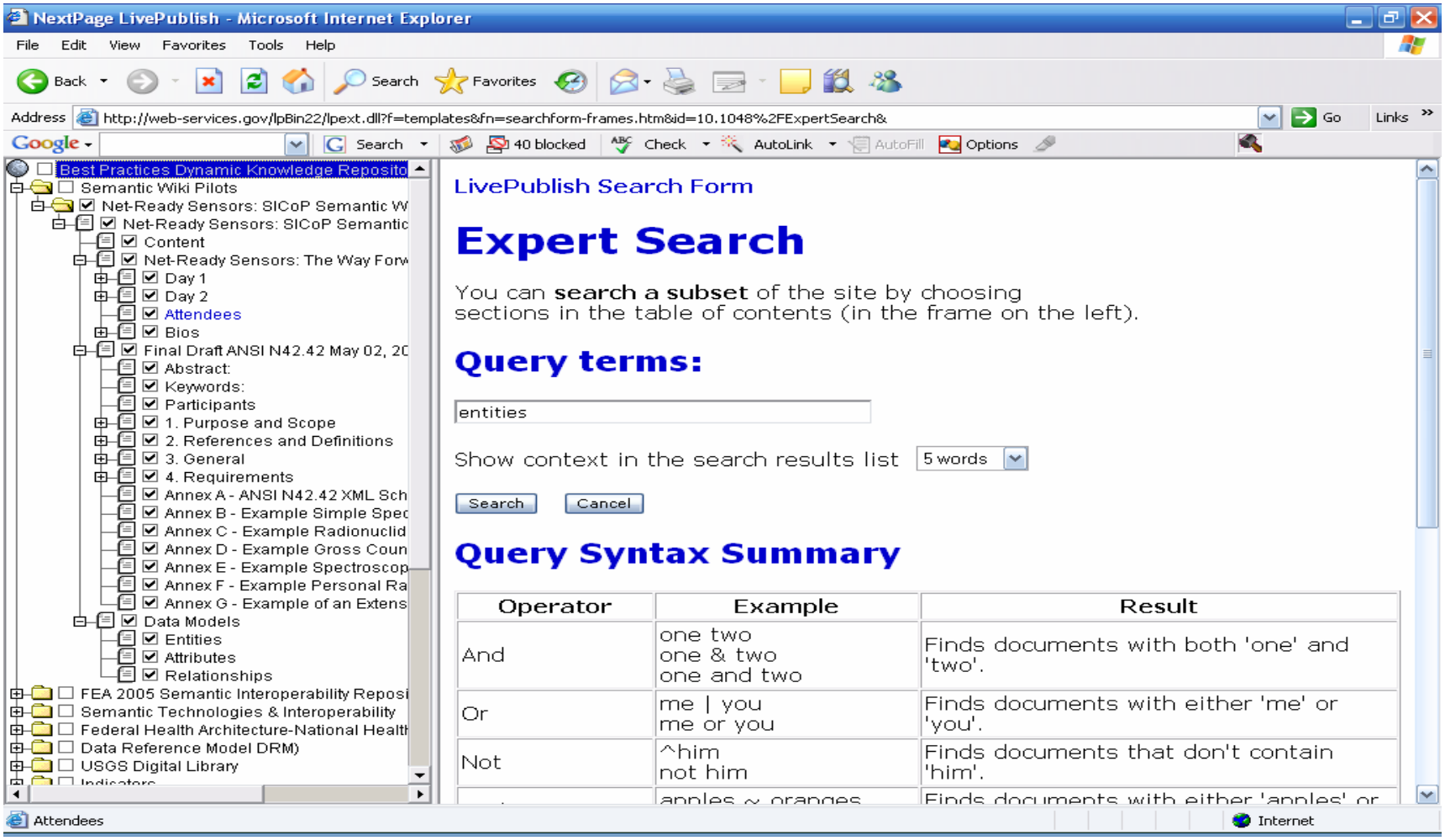



**Entities**

| Entity Name | Entity Definition | Data Source | Additional Source | Additional Source 2 |
|---|---|---|---|---|
| ABSOLUTE-POINT | A POINT that has its coordinates specified with respect to a given horizontal frame of reference and may have a vertical distance specified. | C2IEDM 5.0 | | |
| ACTION | An activity, or the occurrence of an activity, that may utilise resources and may be focused against an objective. | C2IEDM 5.0 | | |
| ACTION-AIRCRAFT-EMPLOYMENT | The procedure that guides the use of an ACTION_RESOURCE that is capable of atmospheric flight. | C2IEDM 5.0 | | |
| ACTION-CAPABILITY | The specific military quality, specified as a CAPABILITY, required to meet an agreed operational need, specified as an ACTION. | C2IEDM 5.0 | | |

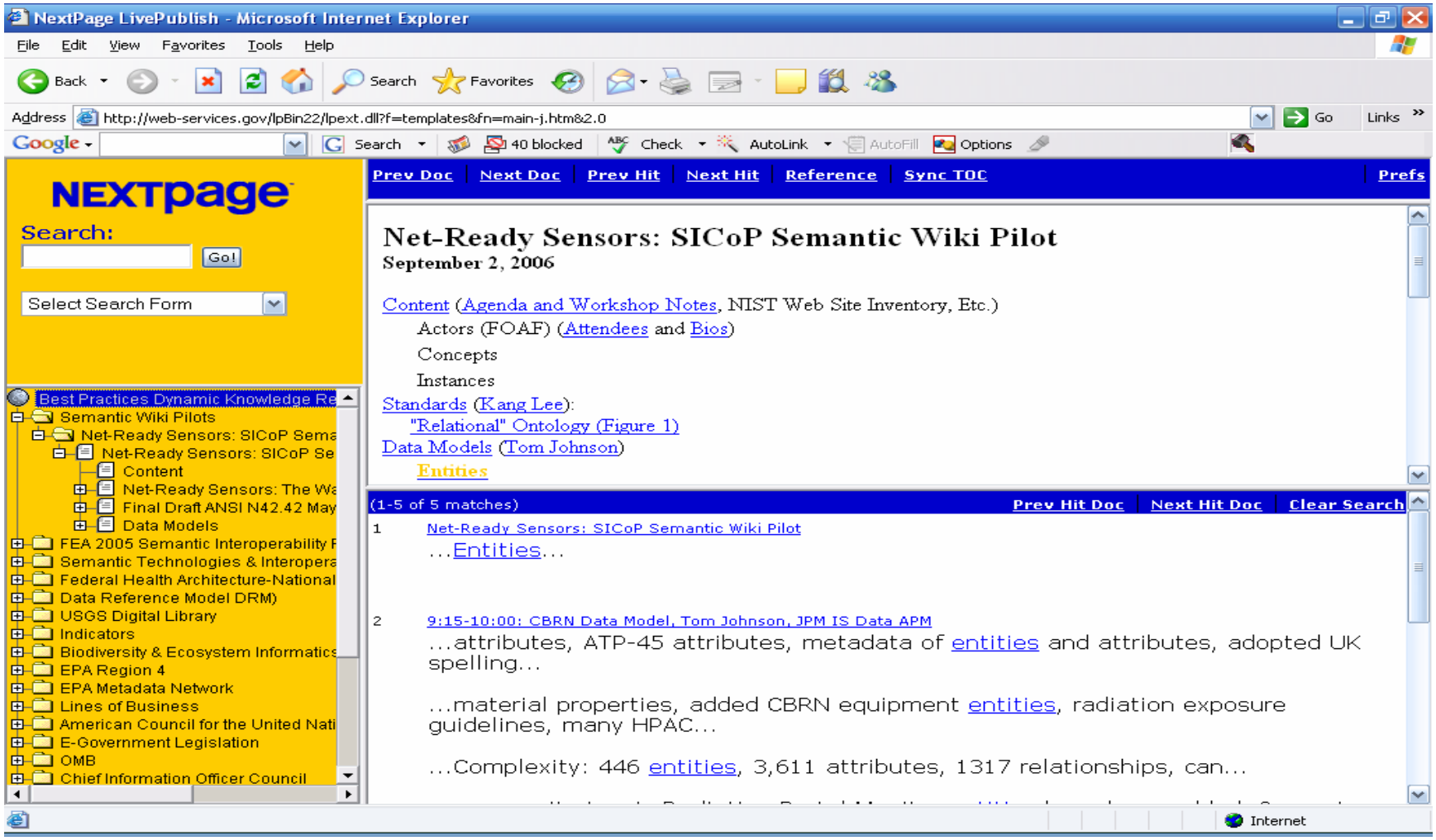
# 4. Initial Pilot Results

## 4.4 Search: Form



# 4. Initial Pilot Results

## 4.4 Search: Results



# 5. Some Next Steps

- Sensor Standard Harmonization, Kang Lee, August 29, 2006:
  - Solution of Sensor Standard Harmonization-Slide 41:
    - The sensor standard harmonization is to extract the common terminologies, properties used by many of the sensor standards, and create a common sensor data model which could be a new standard to be developed or an existing sensor standard to be revised.
    - A common set of sensor terminology and sensor classification
    - Common Properties or Characteristics of Sensors
    - Extract common properties of sensors from the existed sensor standards
    - Add additional information or specified information to sensor common data model
    - Map and translate common sensor model to each of existed sensor standard

# 5. Some Next Steps

- We have proposed and piloted a new metamodel for organizing a Community of Practices information based on the Federal Data Reference Model 2.0 and Ontological Engineering principles.
- The Sensor Standard Harmonization CoP needs a collaborative tool to accomplish the objectives in the previous slide.
- SICoP is offering its VK Test Semantic Wiki in the next slide to accomplish this purpose.

# 5. Some Next Steps

**http://vkwiki.visualknowledge.com/**