Ontology in Knowledge Management and Decision Support (OKMDS): Making Better Decisions

Exploration by the Federal Knowledge Management Working Group, Ontolog, and NASA

Jeanne Holm, Andrew Schain, and Peter Yim

November 8, 2007

Agenda

- Opening by the Session Co-chair - Jeanne Holm and Peter Yim
- Self-introduction of participants (15~20 minutes) - All - skip if we have more than 25 participants
- Information and Data Management Evolution at NASA (30~45 min.) - Andrew Schain and Jeanne Holm
- Q & A and Open discussion by all participants (~30 minutes) - All
- Summary by the Session Co-Chair - Jeanne Holm and Peter Yim (~5 minutes)
- http://ontolog.cim3.net/cgi-bin/wiki.pl?ConferenceCall_2007_11_08

Leadership Team

- Thanks to everyone who is helping to lead and plan this series
  - Andrew Schain (NASA/HQ)
  - Denise Bedford (World Bank)
  - Jeanne Holm (NASA/JPL)
  - Ken Baclawski (NEU)
  - Kurt Conrad (Ontolog, Sagebrush)
  - Leo Obrst (Ontolog, MITRE)
  - Nancy Faget (GPO)
  - Peter Yim (Ontolog, CIM3)
  - Steve Ray (NIST)
  - Susan Turnbull (GSA)

Overview

- This "Ontology in Knowledge Management and Decision Support (OKMDS)" mini-series is a collaboration between NASA, Ontolog, and the Federal Knowledge Management Working Group and is co-organized by a team of individuals from various related communities passionate about creating the opportunity for an inter-community, collaborative exploration of the intersection between Ontology, Knowledge Management and Decision Support, that could eventually lead us toward "Better Decision Making"

Mini-Series Format

- The mini-series will span a period of about six months (Nov-2007 to May-2008), comprising talks, panel discussions and online discourse; with the virtual events being offered in both 'real world' (augmented conference calls) and 'virtual world' (Second Life) settings
- Open up dialogue and discovery at the promising intersection of Ontology and Knowledge Development and the role of both in decision support
- okmds-convene mailing list
  - Cross-posted with the KMgov mailing list
  - Join by sending email to: okmds-convene-join@ontolog.cim3.net

Some Opening Questions

- What is decision support?
- What is knowledge management?
- What are potential roles of ontologies in KM and DS?
- What topics should be covered to address these issues?
- Input regarding the mission, objectives, topics and priorities is always appropriate

Basis for the Exploration

- NASA’s mission of "Space Exploration" applied in its most expansive form, serves as the inspiration for this series
  - Need to effectively administer "knowledge space" to yield meaningful connections that are scalable and sustainable is a strategic challenge of all institutions, whether that knowledge resides primarily within, outside, or across an institution's span of control
  - Knowledge space must be integrated with institutional processes for policy making and development so that their effect on decisions is fundamental rather than incidental

Architecture in This Space

- Explore how Enterprise Architecture (using Ontology and KM) is the thoughtful making of space...a space with the tensile integrity needed by disparate institutions to create conditions for emergence of scientific and engineering knowledge needed for future space... where all humanity can thrive
  - As the famed architect, Louis Kahn noted, "Architecture is the thoughtful making of space”
- Explore how Ontology and KM "make space" to accommodate differences at multiple levels and contexts
  - Here, both individuals and institutions can more easily distill knowledge from complexity and make policies and decisions using knowledge based processes

Ontology Focus

- How can we combine at least three scaffolding approaches for the integrated and agile "build-out" of knowledge needed: community (structured bottom-up), folksonomy (unstructured bottom-up), and ontology (structured top-down)?

Questions for Exploration

- How can we explore the intersection of Ontology and Knowledge Management and Decision Support to define promising collaborations among them?
- How do we help people working with our organizations to discover useful knowledge?
- How can we structure information for decision support (both known and serendipitous inquiry)? Conversely, how can we structure decision making processes to take maximum advantage of knowledge?
- What are the ontologies to prioritize for scientific exchange?
- How does the use of semantic technologies draw these fields closer and support better knowledge discovery and better decision and policy making?

Questions *(continued)*

- How could "simulation-scripting" exercises in virtual worlds accelerate the development and sustained use of ontologies in the real world?
- How might these "simulation-scaffold" ontologies, in turn, improve the pace and complexity of learning associated with large-scale "modeling event" scenarios and mission-rehearsals that are anticipated in virtual world settings?
- How can we leverage ontologies to help improve knowledge management, and in so doing, allow organizations to make better decisions?

NASA's Story

- The challenge
- What already exists to help
- What we are trying to integrate
- Where we are headed

NASA's Journey Begins With a Challenge

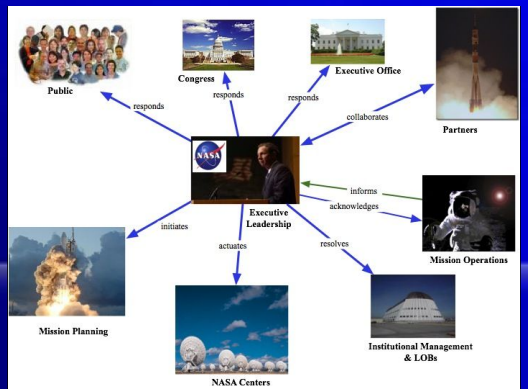
- Reliance on data and the information derived from it touches everything that NASA does
- NASA needs a strategy to help be more consistent about use of, reliance on, and trust in data, and which would enable information sharing and reuse
- Goal: describe a practical strategy for organizing information and data assets for discovery and reuse (by machines and humans)
- Recommend a strategy for Enterprise Architects to join with a larger community of practitioners and combine efforts to greater effect

OKMDS NASA Problem

- Critical information related to daily operation is becoming more difficult to find
- It is difficult to find relevant information that is known to be available
- It's virtually impossible to discover critical information that is relevant, but unknown
- When we cannot find resources, we often recreate them
  - When we have trouble integrating information, we often copy it
  - These habits make NASA's data volume and data integrity problems worse

Executive Decision Support

- Executive decisions can have an enormous impact on the future of NASA's employees and on the future of the nation's science, engineering, and research capabilities
  - Decisions can impact how public, congress, or executive branch views NASA and whether support for missions will continue
- The effect these decisions have on organizations, projects, budgets, and IT must be understood despite complexities and dependencies of processes and components
- Staff that provides analysis supporting executive decisions is hampered by not having access to similar cases from the past, or easy ability to determine linkages between actions and impacts at organizational, process, budget or infrastructure levels



IDM Requirements

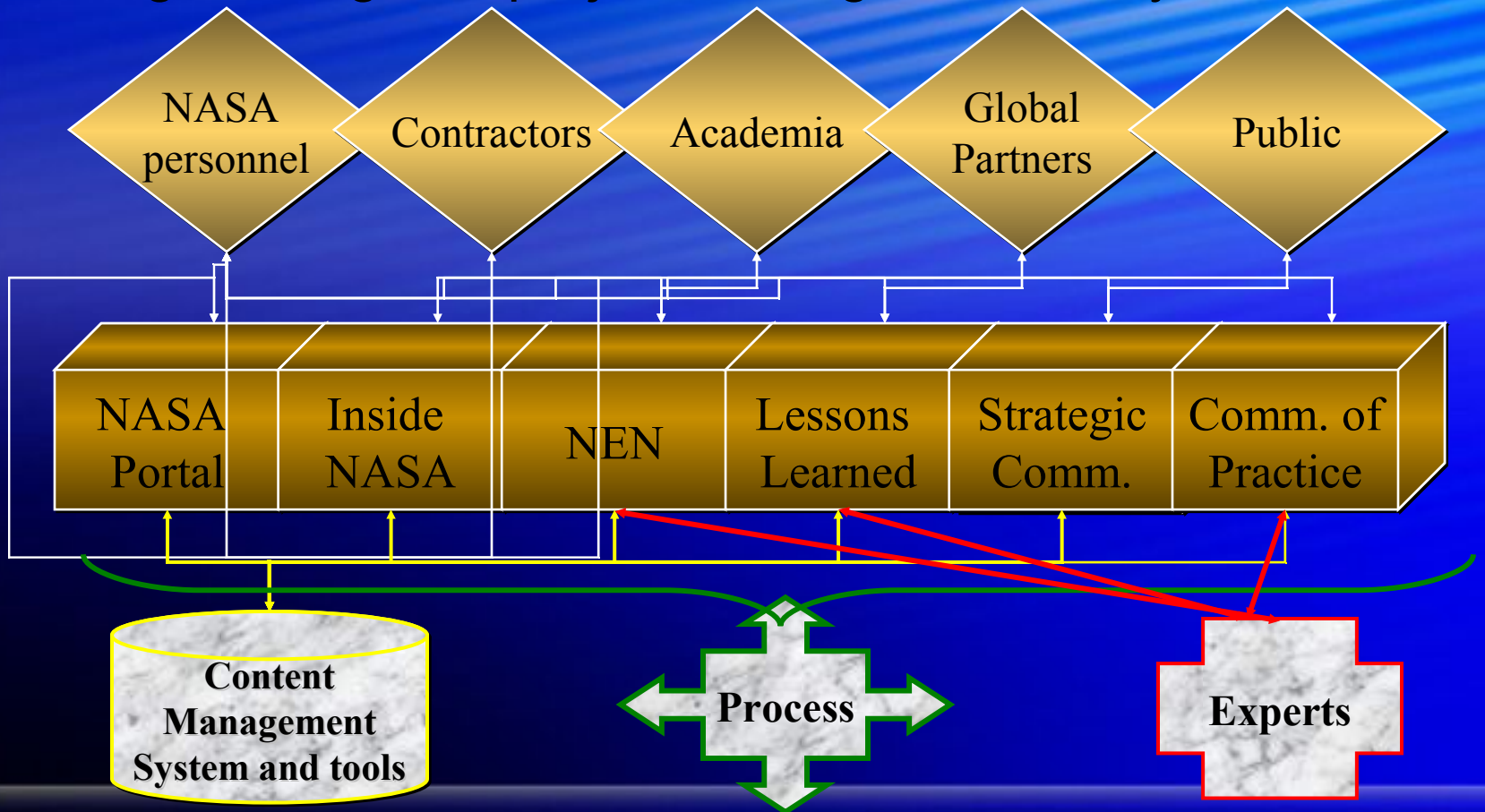
- From the problem statements and use cases we see *so far* a need for
  - Agility
  - Declarativeness
  - Formally verifiable, validatable
  - Expressive
  - Contextualizable
  - Annotatable
  - Meta-capabilities like currency, trust, provenance, and validity
  - Internationalization

Existing Support Components

- *Knowledge management projects*
- *Data services*
- *Enterprise architecture*
- Covered in future talks
  - Ontology activities at NASA and partners
  - NASA Taxonomy
  - Scientific and Technical Information program
  - Science and research organizers
  - Human behavioral studies in information sharing and knowledge discovery
  - Executive decision support studies
  - GIS and spatial knowledge research

Existing KM Framework

- Integrating knowledge management into our engineering and project management lifecycle

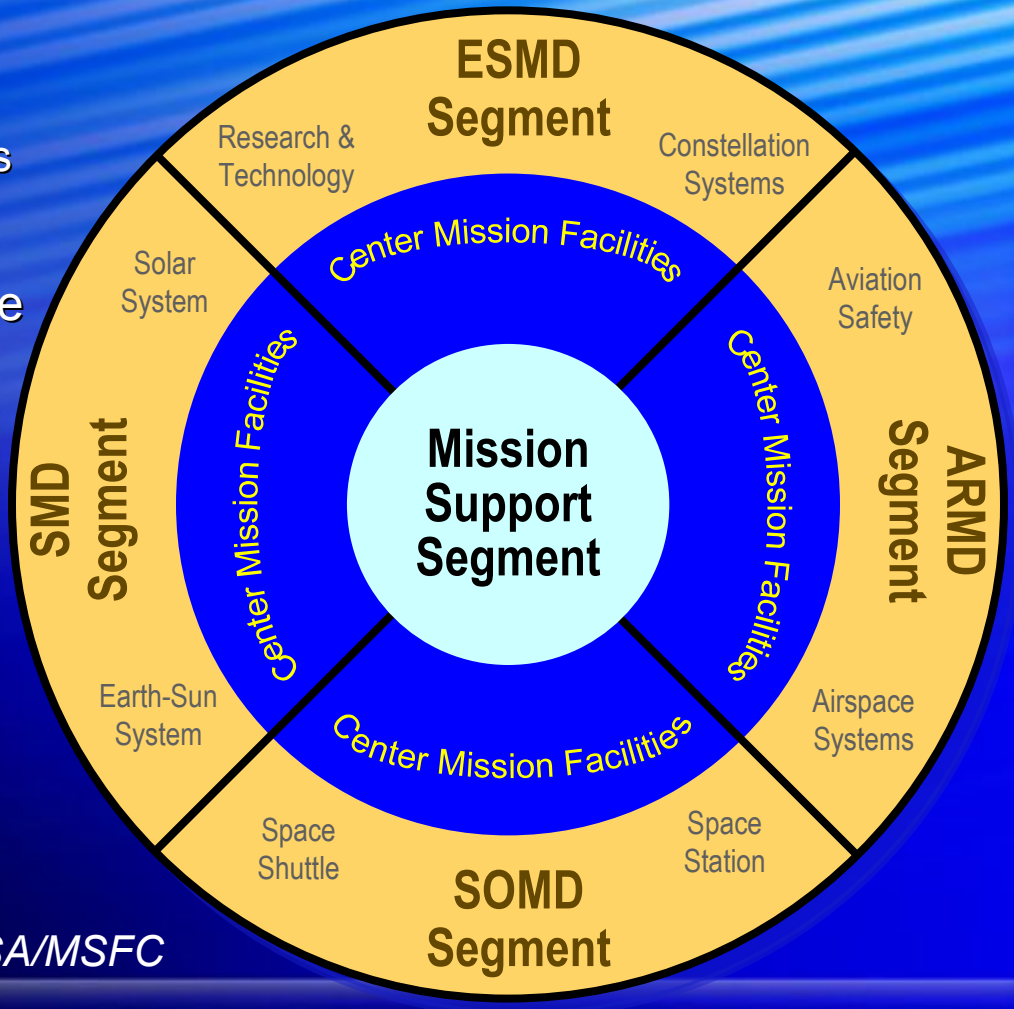


Laying the KM Groundwork

	2003	2004	2005	2006	2007
Customers	• Public • Educators	• NASA personnel	• Engineers • Project teams	• Disciplines • Communities	• Engineers and partners
Stakeholders	• CIO • Public Affairs • Education	• CIO • Strategic Communications	• Engineers • Mission directorates	• Employees • Senior management	• Scientists • Peer-to-peer collaboration
System	• NASA Portal • KM for Space (U.N.)	• InsideNASA • Research Web	• NASA Eng. Network • Emergency ops	• Communities of practice	• InsideNASA v.2 • Collab 2.0
KM Infrastructure (99.95%)	• O/S • Applications and storage • Hosting (VeriCenter)		• Caching (Akamai) and streaming • Service desk • Customization support		
Tools	• Digital Asset Management (eTouch), Vignette, Verity, Urchin	• +SunOne, WebEx, eRoom	• +NASA Xerox (NX), Jabber (instant messaging)	• +Semantic web, W3C standards, expertise locator	• +Social networking, Web 2.0, next-gen collaboration

Existing Enterprise Architecture

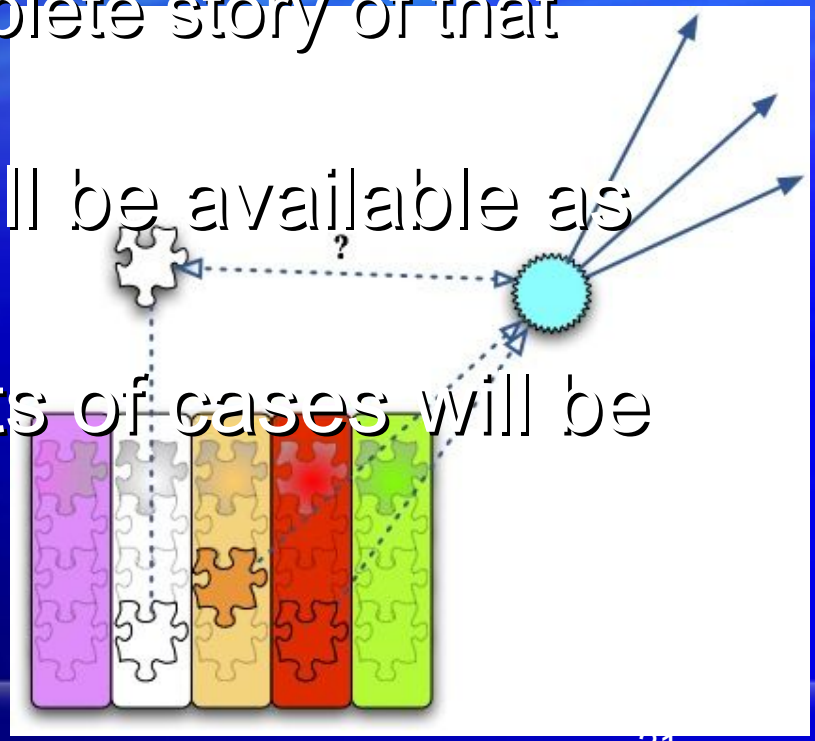
- NASA has 5 segment architectures
  - One for each Mission Directorate--our lines of business
  - One for Agency cross-cutting capabilities (e.g., IT and CFO)
- Each business has its own unique common operational elements
  - Ground processing
  - Payload processing
- Each business has Federal Enterprise Architecture (FEA) unique Elements
  - International Space Station
  - Shuttle
  - CLV
  - CEV



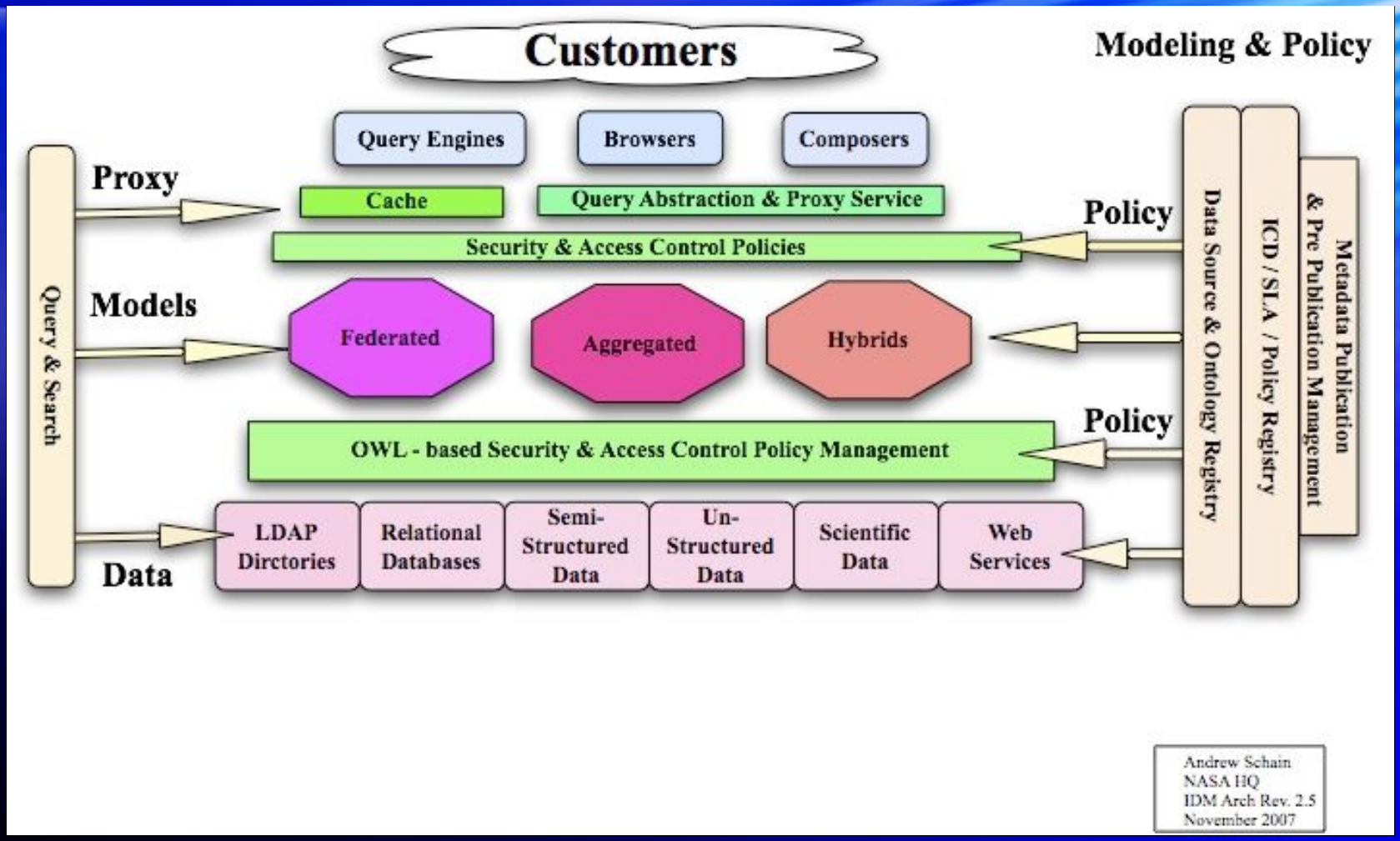
From Ken Griffey, NASA/MSFC

Future State

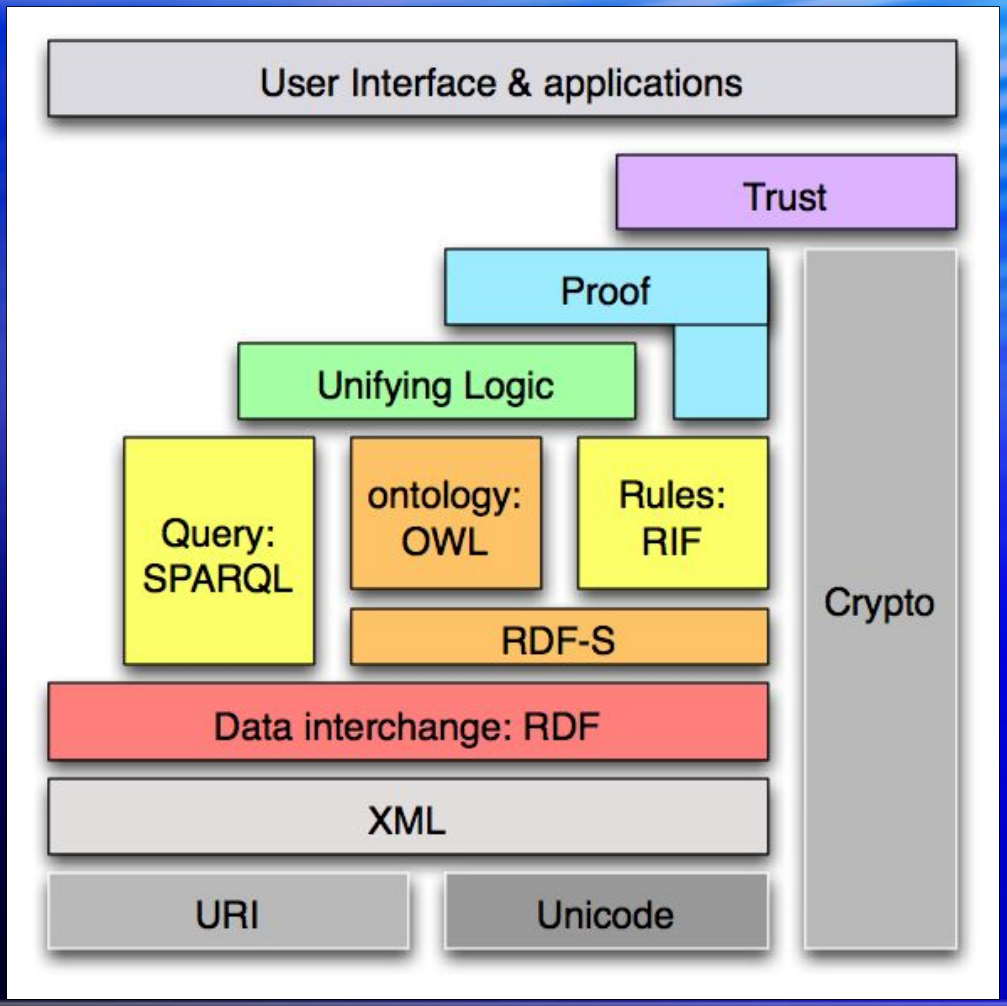
- Previous decisions are “packaged”
  - Actions taken to support them, the impacts and the ultimate results will be linked together to give a complete story of that decision
- Each decision story will be available as case histories
- Relations and elements of cases will be available



Key Interfaces

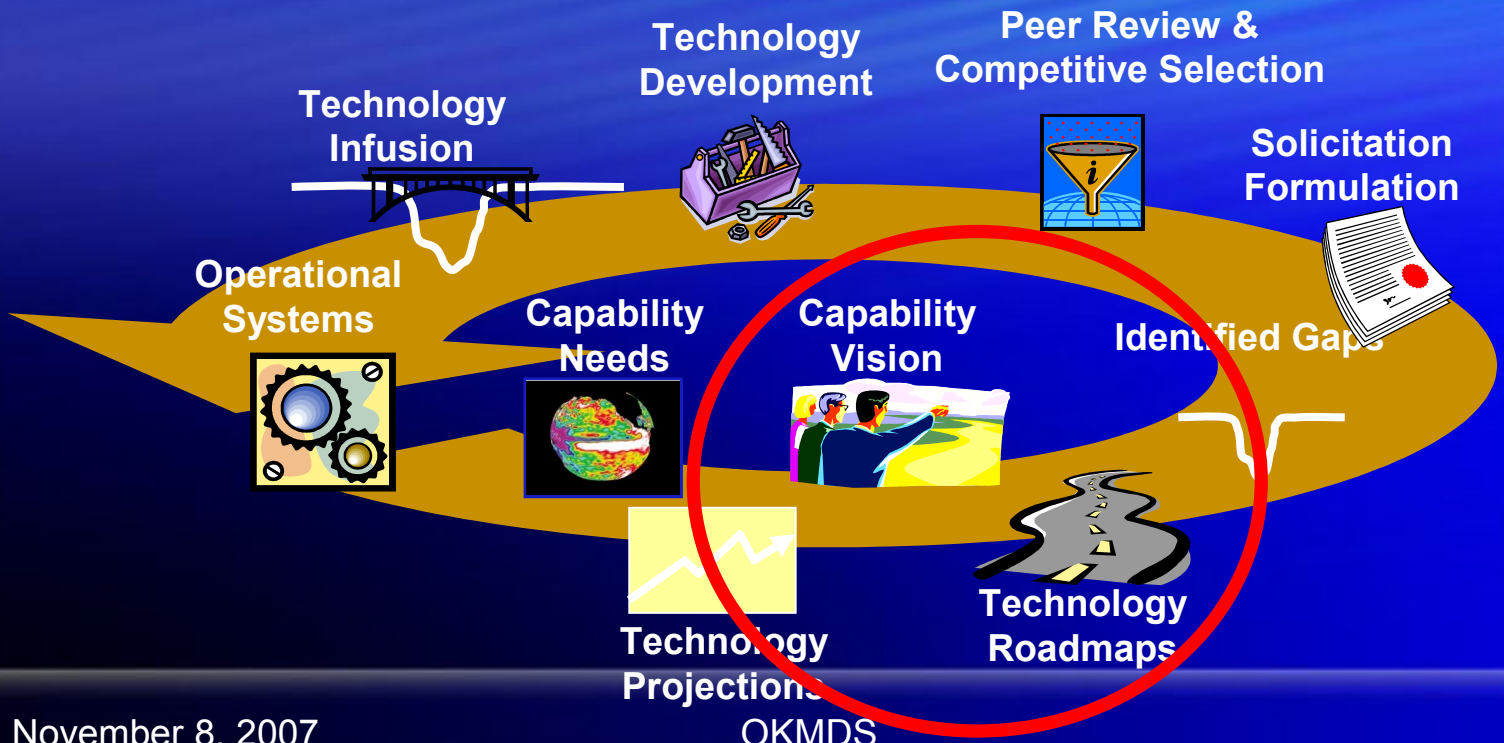


Key Interfaces and Standards



Background: Technology Infusion

- Established a capability vision for Earth science information systems
- Identified Interoperable Information Services as a key capability in the vision
- Identified semantic web as one of the primary supporting technologies
- Currently defining a roadmap for semantic web technology infusion



Semantic Web Roadmap

		Current	Near Term 0-2 years	Mid Term 2-5 years	Long Term 5+ years
Results	Outcome	♦ Improved Information Sharing	♦ Increased collaboration and interdisciplinary science	♦ Acceleration of knowledge production	♦ Revolutionizing how science is done
	Output	♦ Geospatial semantic services established	♦ Geospatial semantic services proliferate	♦ Scientific semantic assisted services	♦ Autonomous inference of science results
Capability	Assisted Discovery & Mediation	♦ Some common vocabulary based product search and access	♦ Semantic geospatial search & inference, access	♦ Semantic agent-based searches	♦ Semantic agent-based integration
	Interoperable Information Infrastructure	♦ Local processing + data exchange	♦ Basic data tailoring services (data as service), verification/ validation	♦ Interoperable geospatial services (analysis as service), results explanation service	♦ Metadata-driven data fusion (semantic service chaining), trust
Technology	Vocabulary	♦SWEET core 1.0 based on GCMD/CF	♦ SWEET core 2.0 based on best practices decided from community	♦ SWEET 3.0 with semantic callable interfaces via standard programming languages	♦ Reasoners able to utilize SWEET 4.0
	Language/ Reasoning	♦ RDF, OWL, OWL-S	♦ Geospatial reasoning, OWL-Time	♦ Numerical reasoning	♦ Scientific reasoning

Creating Information and Data Management

- To create the Information and Data Management (IDM) services, processes, and support, three critical items are needed
  - IDM services
    - Model registry
    - Controlled vocabularies
    - Data source catalog for sources and query for other decisions
    - Agreement and MOU repository
    - Data reference model
  - Information access processes
    - More generally, access control inclusive of e-Authentication
    - Work with Security, Export Control, and other key stakeholders
  - Knowledge management
    - Architecture for capturing, organizing, storing, and sharing knowledge
    - Mission support, internal collaboration, and public engagement
    - Integrated search (build a common search utility that obviates the need for local instances)--strategy and business case

Near-Term Ideas

- Integrated knowledge management, search, and information access architecture, built on enterprise architecture
- Build a prototype repository service in collaboration with our community of practice
- Assist developers in building a proof-of-concept repository for ontologies and SLAPs and begin initial testing and requirements refinement
- Construct go-to standards for new applications and models
- Gain access to and participate in key W3C standards groups (e.g. WS-policy)

Long-Term Path

- Create repository of ontologies, data reference models, and SLAPs
- Refine the application architecture, identifying the initial set of candidate services to be deployed, and recommending the tools and standards, including those for ontology engineering and querying, development frameworks, inference engines, and data stores
- Develop and deploy new applications using a Service-Oriented Architecture (SOA) approach; this will allow applications to access information from other applications in an ad hoc manner without having to retool and recode
- Advertise applications and their interfaces using standards such as WSDL so they can be discovered automatically
- Cohesive knowledge development between NASA, its partners, and customers via standards, SLAs, and machine-readable format

Where Are We Headed?

- Develop and deploy new classes of applications that merge data, services and physical resources into a semantically aware, adaptive environment
- Deploy software agents that can autonomously scan published knowledge and metadata and automatically connect them, or harvest them for information, anticipating users' needs: give the users the data they need when the need it, in a form relevant to their current task
- Develop agents that can learn, anticipate needs, discover relevant data, and enter into transactions all on behalf of their human users
- Systems model experts' patterns and behaviors to gather knowledge implicitly
- Seamless knowledge exchange with robotic explorers
- Knowledge systems collaborate with experts for new research concepts

Tentative Coming Attractions

- We are looking for interesting speakers from other agencies and organizations in addition to the following NASA partners
  - Semantic Solutions to Finding Experts--POPS (Andrew Schain, NASA, and Kendall Clark, Clark-Parsia)
  - Ontologies for Earth Science (Rob Raskin, NASA/JPL)
  - NASA Taxonomy for Knowledge Discovery (Jayne Dutra, NASA/JPL)
  - Organizing Science Knowledge (Rich Keller, NASA/Ames)
  - Making NASA Scientific and Technical Information Accessible and Useable (Greta Lowe, NASA/LaRC)
  - New Technologies for Collaboration (Tom Soderstrom, NASA/JPL)
  - Spaces for Knowledge Discovery (Marcela Oliva, Los Angeles City Colleges)
  - Information Sharing for Lunar Missions (Dan Berrios, NASA/Ames)
  - Human Aspects of Organizing Information (Charlotte Linde, NASA/Ames)

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