NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Earth Science Data Systems Working Groups

Technology Infusion Working Group

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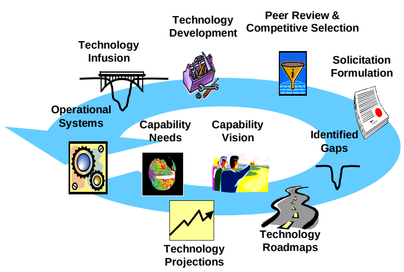
Mission

- Enable NASA Earth Science Enterprise to reach its research, application, and education goals more quickly and cost effectively through widespread adoption of key emerging information technologies

Scope

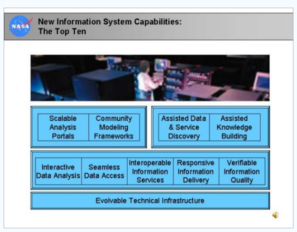
- Information technologies that...
  - Provide capabilities critical to ESE mission & vision
  - Have been substantially developed (TRL 6-9) but not widely deployed
  - Cannot be obtained simply through reuse of mature subsystems or software
  - May be slow to adopt due to unique characteristics of Earth science data (e.g., large volumes, 4-dimensions)

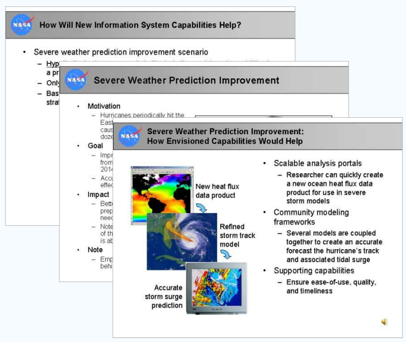


Earth Science Capability Vision

Capability Vision

- Describes 10 capabilities comprising an Earth science information system capability vision
- Identifies technologies critical to achieving the vision
- Positions capabilities and technologies within a real-world scenario
- Used to develop a shared understanding of the vision within the community





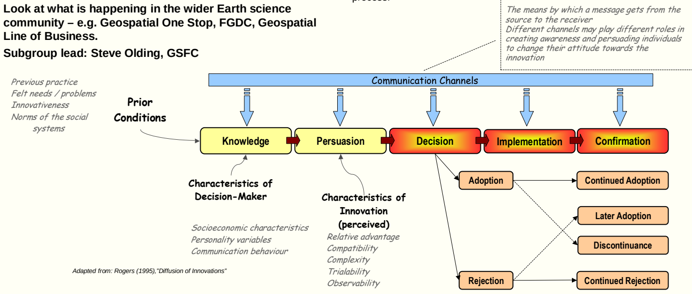
The Capability Vision uses a hypothetical science scenario to illustrate the envisioned capabilities in a practical context

Process and Strategies Subgroup

- **Complete and publish infusion readiness assessment**
- **Define a process for monitoring new and emerging technologies**
  - **•How do we identify the disruptive innovations?**
  - **•How do we assess technology maturity?**
- **Develop TIWG Earth science technology radar – a graphical representation of new and emerging technologies, their relevance and importance to the Earth science community.**
- **Look at what is happening in the wider Earth science community – e.g. Geospatial One Stop, FGDC, Geospatial Line of Business.**
- **Subgroup lead: Steve Olding, GSFC**

Understanding The Innovation Decision Process…

The innovation-decision process is the process by which the prospective user of the innovation forms the decision to adopt or reject the new technology. The Earth science community is a complex structure of different individuals, groups, and organizations which make independent assessments of the relative merits of a new technologies and make independent decisions on whether to adopt a new technology. The model below describes some of the key steps and characteristics involved in the innovation-decision process.

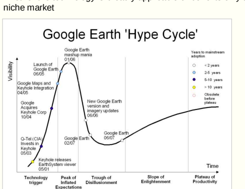


Adapted from: Rogers (1995),"Diffusion of Innovations"

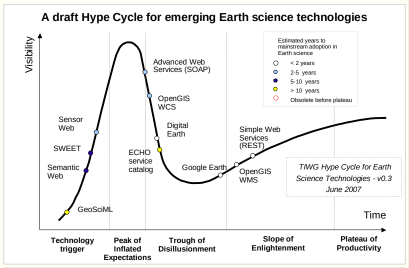
Identifying New and Emerging Technologies

Hype Cycle (Gartner)

- "Technology Trigger"
  - The first phase of a Hype Cycle is the "technology trigger" or breakthrough, product launch or other event that generates significant press and interest.
- "Peak of Inflated Expectations"
  - In the next phase, a frenzy of publicity typically generates over-enthusiasm and unrealistic expectations. There may be some successful applications of a technology, but there are typically more failures.
- "Trough of Disillusionment"
  - Technologies enter the "trough of disillusionment" because they fail to meet expectations and quickly become unfashionable. Consequently, the press usually abandons the topic and the technology.
- "Slope of Enlightenment"
  - Although the press may have stopped covering the technology, some businesses continue through the "slope of enlightenment" and experiment to understand the benefits and practical application of the technology.
- "Plateau of Productivity"
  - A technology reaches the "plateau of productivity" as the benefits of it become widely demonstrated and accepted. The technology becomes increasingly stable and evolves in second and third generations. The final height of the plateau varies according to whether the technology is broadly applicable or benefits only a niche market



A draft Hype Cycle for emerging Earth science technologies



Prediction Markets (e.g. Yahoo Tech Buzz Game)

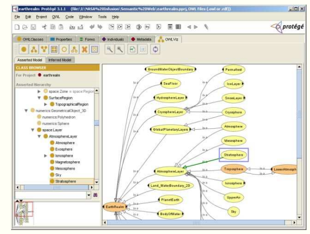
What is the Tech Buzz Game?
The Tech Buzz Game is a fantasy prediction market for technology. Your goal as a player is to predict how popular various technologies will be in the future. Popularity or buzz is measured by Yahoo! Search frequency over time. Predictions are made by buying virtual stock in technologies you think are about to boom, and selling when substance doesn't match the hype.

Expert Knowledge + Tracking Tech Trends (e.g. O'Reilly Radar)

"Our methodology is simple: we draw from the wisdom of the alpha geeks in our midst, paying attention to what's interesting to them, amplifying these weak signals, and seeing where they fit into the innovation ecology. Add to that the original research conducted by our Research team, and you start to get a good picture of what the technology world is thinking about. What books are people just now starting to buy, and which are falling off in interest? Which tech-related Google AdWords are rising or falling in price? What can we learn from predictive markets tracking tech trends? What do help-wanted ads tell us about technology adoption?"

Semantic Web Subgroup

- **Develop awareness and understanding of Semantic Web technologies and capabilities within the working group.**
- **Develop a plan for wider dissemination of technologies, capabilities, and opportunities to the wider Earth science community.**
- **Contribute to the maturation of Earth science ontologies.**
- **Identify components of semantic web and map to NASA TRLs.**
- **Develop an initial roadmap for Semantic Web infusion in the Earth science domain.**
- **Support the Federation Semantic Web Cluster in developing demonstrations.**
- **Subgroup lead: Peter Fox, NCAR**



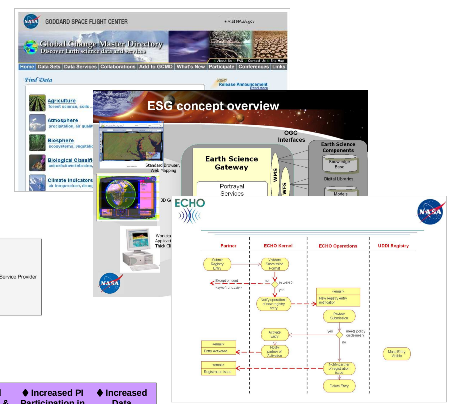
Semantic Web Roadmap

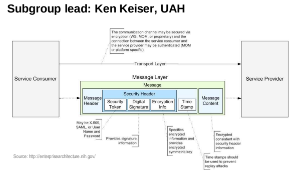
		Current	Near Term (0-2 yrs)	Mid Term (2-5 yrs)	Long Term (5+ yrs)
Results	Outcome	♦ Improved Information Sharing	♦ Increased Collaboration & Interdisciplinary Science	♦ Acceleration of Knowledge Production	♦ Revolutionizing how science is done
Results	Output	♦ Geospatial semantic services established	♦ 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
Capability	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
Technology	Languages/ Reasoning	♦ RDF, OWL, OWL-S	♦ Geospatial reasoning, OWL-Time	♦ Numerical reasoning	♦ Scientific reasoning

- Ontology (n.d.). The Free On-line Dictionary of Computing. http://dictionary.reference.com/browse/ontology
  - –An explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them.
- Semantic Web
  - –An extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation, www.semanticweb.org
- Semantic Grid
  - –Semantic services to use the resources of many computers connected by a network to solve large scale computational problems
- Provenance
  - –origin or source from which something comes, intention for use, who/what generated for, manner of manufacture, history of subsequent owners, sense of place and time of manufacture, production or discovery, documented in detail sufficient to allow reproducibility.
- Technology Infusion Roadmap
  - –Timeline for widespread adoption of key technologies including tailoring to Earth science needs

Web Services Subgroup

- **Develop practical demonstration(s) of web services and web services chaining capabilities. Document lessons learned from the web services demonstrations.**
- **Promote the participation of the Earth science community in the ECHO web services registry.**
- **Review the ECHO services registration process from an end user perspective.**
- **Develop white paper on SOA security.**
- **Review and update the Web Services Roadmap.**
- **Subgroup lead: Ken Keiser, UAH**



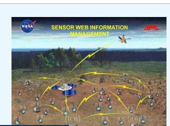


		Current	Near Term	Mid Term	Long Term
Results	Outcome	♦ Improved Information Sharing; ♦ Accelerated Research & System Cost Savings	♦ Increased Collaboration & Interdisciplinary Science	♦ Increased PI Participation in Information Production	♦ Increased Data Utilization
Results	Output	♦ Geospatial services established	♦ Open geospatial services proliferate	♦ Production quality geospatial services	♦ Intelligent Services
Capability	Assisted Discovery & Mediation	♦ Parameter-based product searches and access	♦ Full geospatial logical searches and access	♦ Semantic geospatial search & access	♦ Automatic service mediation
Capability	Interoperable Information Infrastructure	♦ Local processing + data exchange	♦ Basic data tailoring services (data as service)	♦ Interoperable geospatial services (analysis as service)	♦ Metadata-driven data fusion (semantic service chaining)
Technology	Data	♦ Open data access established (OpenDAP, OGC)	♦ Common geospatial schema adopted (GML, ESML)	♦ Geospatial service catalog established (WSDL, UDDI)	♦ Open geospatial ontology converges (OWL)
Technology	Messaging	♦ Open service protocols established (HTTP, REST)	♦ Common service protocol, description adopted (SOAP, WSDL)	♦ Unified security & identity management (WS-Security, SAML)	♦ Standard workflow language infused (BPEL)

- Web Service Standards
  - BPEL Business Process Execution Language (Service orchestration)
  - DAML DARPA Agent Markup Language (Semantic web)
  - HTTP Hypertext Transfer Protocol (Transport)
  - OWL Web Ontology Language (Metadata)
  - RDF Resource Description Framework (Metadata)
  - SAML Security Assertion Markup Language (Security)
  - SOAP Simple Object Access Protocol (Messaging)
  - UDDI Universal Description, Discovery & Integration (Service discovery)
  - WSDL Web Services Description Language (Service description)
  - XML Extensible Markup Language (Data structure)
  - WS-* Supporting standards

Sensor Web Subgroup

- **What is a sensor web? Identifying the key features.**
- **Identifying benefits and challenges.**
- **Exploring a vision for sensor webs.**
- **Subgroup lead: Karen Moe, GSFC/ESTO**



Some Sensor Web Definitions

- A coherent set of distributed "nodes", interconnected by a communications fabric, that collectively behave as a single, dynamically adaptive, observing system. (Talabac, GSFC)
- An interconnected "web of sensors" that coordinates observations by spacecraft, airborne instruments and ground-based data-collecting stations. Instead of operating independently, these sensors collect data as a collaborative group, sharing information about an event as it unfolds over time. (NASA press release)
- A networked set of sensors in which information is shared between sensors, and sensors automatically modify their behavior on the basis of the collected data. (Sherwood, JPL)

A Sensor Web Vision

- A Vision for NASA Sensor Webs for Earth Science - On-demand sensing of a broad array of environmental and ecological phenomena across a wide range of spatial and temporal scales, from a heterogeneous suite of sensors both in-situ and in orbit.
- Sensor webs will be dynamically organized to collect data, extract information from it, accept input from other sensor / forecast / tasking systems, interact with the environment based on what they detect or are tasked to perform, and communicate observations and results in real time.
- *Definition: A coordinated observation infrastructure composed of a distributed collection of resources that can collectively behave as a single, autonomous, task-able, dynamically adaptive and reconfigurable observing system that provides raw and processed data, along with associated meta-data, via a set of standards-based service-oriented interfaces.* (AIST)

Working Group Co-chairs: Rob Raskin NASA/JPL and Karen Moe NASA/ESTO
http://www.sciencedatasystems.org/infusion/
http://www.esdswg.org/techinfusion/

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