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Challenges and Opportunities for a new generation of data services for geoscience education and research

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Dr. Mohan Ramamurthy
Unidata Program Center
University Corporation for Atmospheric Research
Boulder, CO

The Ultimate Objective of a Data System/Service



- To provide requested data to users in a transparent, consistent, readily useable form;
 - Deliver the right data in the right format at the right time for ready use
- Users don't care as much about technology as they do about transparency and usability;



GEO Data Challenges

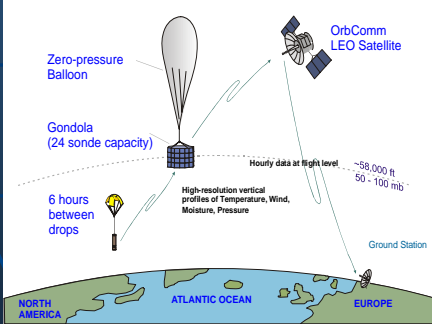
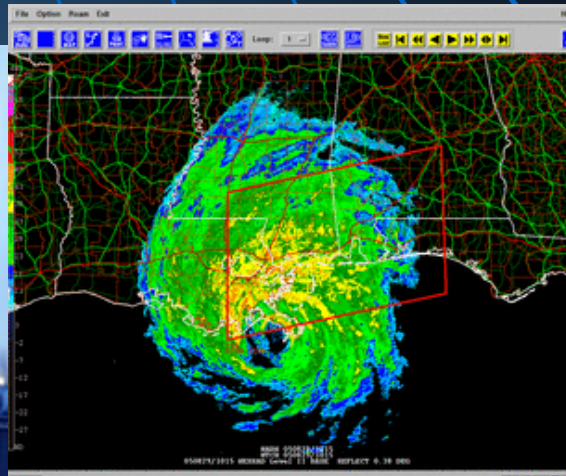
- Geosciences data are broad and diverse (atmospheric, hydrologic, oceanographic and earth sciences data)
- Different data types, formats, volumes, time and space scales, etc.
- Each domain has its own terminology and needs.
- Different cultures and values when it comes to using and sharing data

The challenges can be grouped into two broad categories: organizational and technical



Opportunity to Solve Real-world Problems

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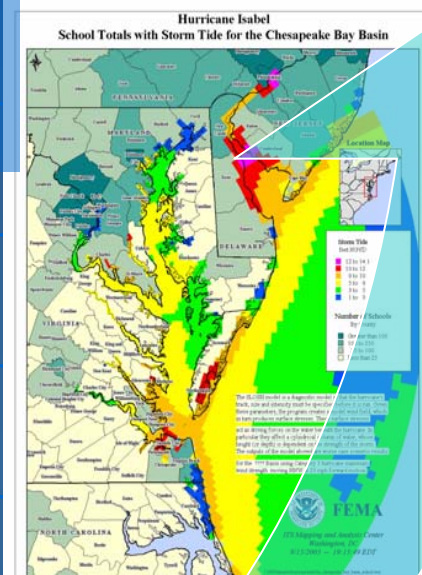


End-to-end Data Services

**GIS
Integration**

**ensemble
predictions**

Coastal Environments



**Decision
Support**

Need integrated services





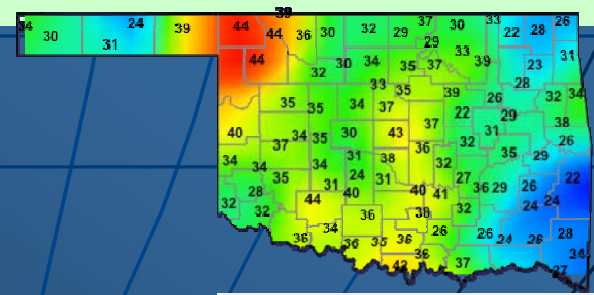
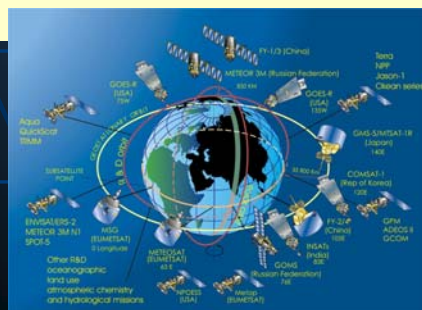
Opportunities and Challenges

GOES-R (2012)
*Hyperspectral
Environmental Suite
(~1600 channels)*

NPOESS (201?)
Both NPOESS and
GOES-R will have
data rates 30-60
times the current
rates

Global, coupled models
at a grid spacing of
1-5 km, integrated
for multi-decades

- Heterogeneity and complexity of distributed observing, modeling, data, and communication systems
- Nature of data coverage: diversity and multiple spatial and temporal scales
- Use of legacy and contemporary technologies
- Lack of standards and interoperability
- User community not monolithic
- Political, technological, and cultural and regulatory barriers
- Integration with GIS and Decision Support Systems



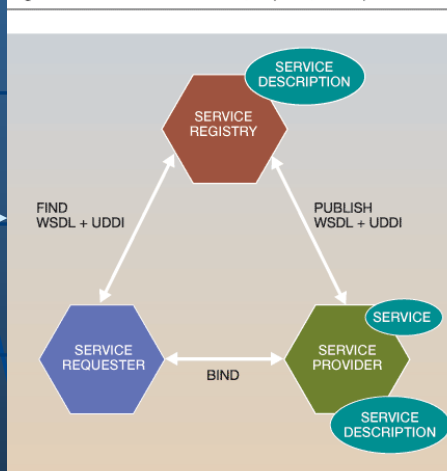


Data Services: An Evolution

- An evolution from proprietary data systems towards more open standards-based web services.
- Data services must address consumer needs; This is not a distant vision but a reality today in eCommerce.
 - KNOW YOUR USER!
- The transition to web services creates incredible opportunities but poses many challenges.



Figure 1 Web services actors, objects, and operations



Understanding Web Services

XML, WSDL, SOAP, and UDDI

Eric Newcomer

Independent Technology Guides
David Chappell, Series Editor



Web Services and E-Commerce

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Have one to sell?

Tremendous strides have been made in the commercial space by companies like Amazon, EBay, Yahoo & Google



Google Maps & Google Earth

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Personal Weather Stations Google Map

Display Type: Temperature / Wind Dew Point / Humidity Precipitation

Map Satellite Hybrid

Current Forecast

North Mission (Valencia & Market)

Temperature: 45.3 °F
 Dew Point: 35.4 °F
 Humidity: 68%
 Wind: Calm
 Pressure: 30.09in
 Precipitation: 0in/hr

[KCASANFR49](#)
 lat: 37.77
 lon: -122.42
 Elevation: 0 ft

Place	Station	Dew Point
Marin County DPW Corporation Yard	KCANICAS2	35.5° F
Deer Park	KCAFAIR7	36.4° F
Muir Beach	KCAMUIR1	37.8° F
Red Hill	KCASANAN1	30.6° F
Near Library	KCAMILLV4	26.7° F
San Rafael	KCASANRA2	29.6° F
St. Marys	KCAMORAG2	36.3° F
Daly City	KCADALYC1	35.8° F
Vallemar District	KCAPACIF1	32.8° F
Stern Grove	KCASANFR44	38.8° F
Above Bridgeway	KCASAUAS3	36.3° F
Pacific Highlands		
Larkey Park		
Peacock Gap		
Tiburon		
Twin Peaks		
Westwood Park		
The Panhandle		
Noe Valley		

Member of the
 Weather Underground
 Data Exchange
 26122
 members

Google Earth

File Edit View Add Tools Help

Local Search Directions

Places

- NOAA TOPHADOWATCH #836 Valid from 2:30 PM until 1:00 AM EDT for FLORIDA
- URGENT - IMMEDIATE BROADCAST REQUESTED
- WDSS # Example: Hurricane Wilm
- Reflectivity Colorbar
- Merge Reflectivity Composite 24851824-878912.tif
- Merge Reflectivity Composite 24851824-888132.tif
- Merge Reflectivity Composite 24851824-898142.tif

Layers

- National Geographic Magazine
- Google Earth Community
- Community Showcase
- Google Earth Community (thank)
- Dining
- Lodging
- Banks/ATMs
- Bars/Clubs
- Coffee Shops
- Shopping Malls
- Major Retail
- Movie/DVD Rentals
- Grocery Stores

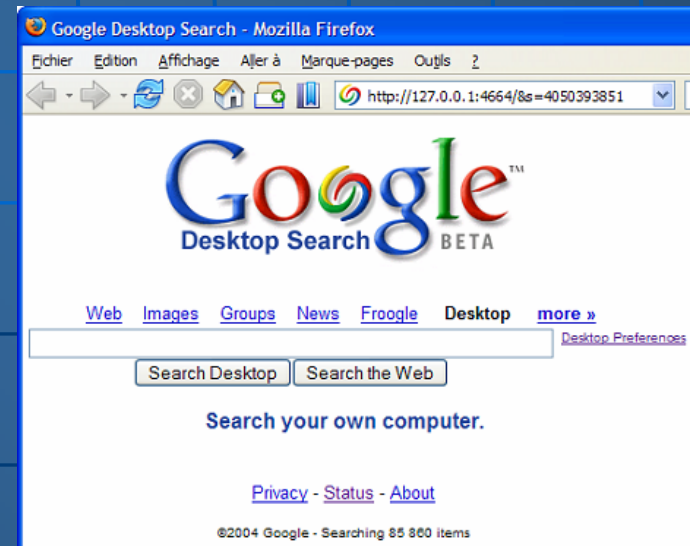
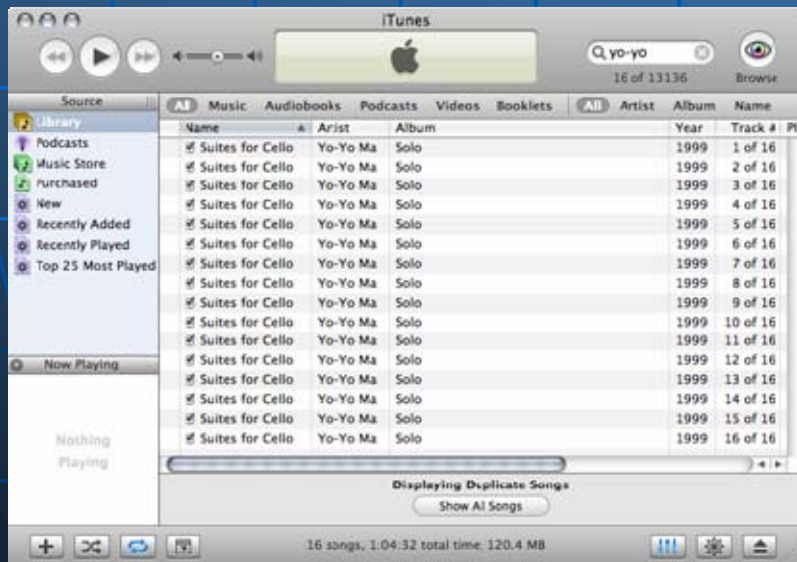
How is this magic performed?

Answer: AJAX! (A collection of web technologies)



Seamless access to and sharing of data anywhere

- From device, desktop, local and institutional libraries to archives anywhere on the Internet



We can learn a lot from these examples



Integration, Integration, Integration

- Provides the greatest opportunity as well as the biggest challenge (Number one on my top 10 list)
 - Linking of heterogeneous, stove-piped, legacy systems and components (in a system of systems approach) in a dynamic, flexible and modular manner.
 - Data structure (format, models, types)
 - API level challenges – interoperability
 - Standards – there are too many
 - Semantics - Knowledge representation (sparse)



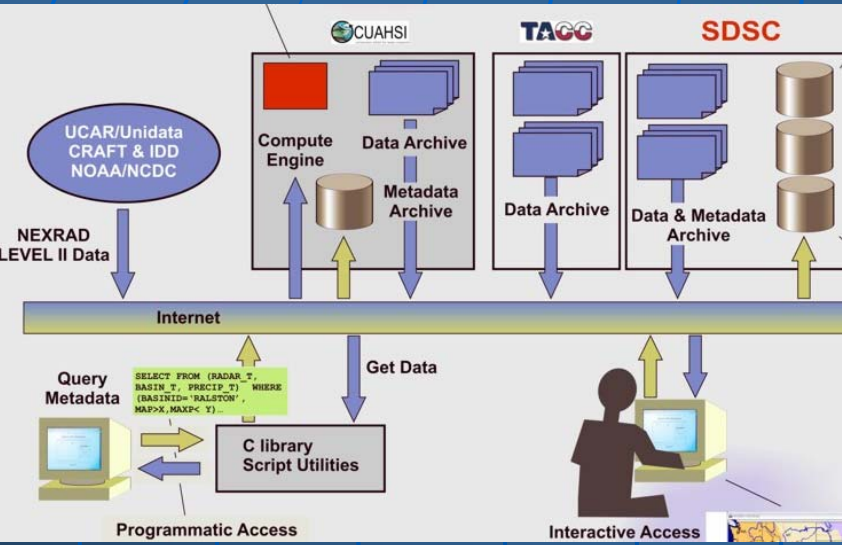
Metadata Challenges

- ❖ Need for rich metadata for data discovery (browse, search, query), and integration,
- ❖ Critical to implementation of a data systems in a service oriented architecture
- ❖ Crucial for improved semantics (inference, vocabulary mapping, ontology service, mining, etc.)

This is a difficult problem, because you need to know your audience and their use cases



Integrating Datasets with Databases

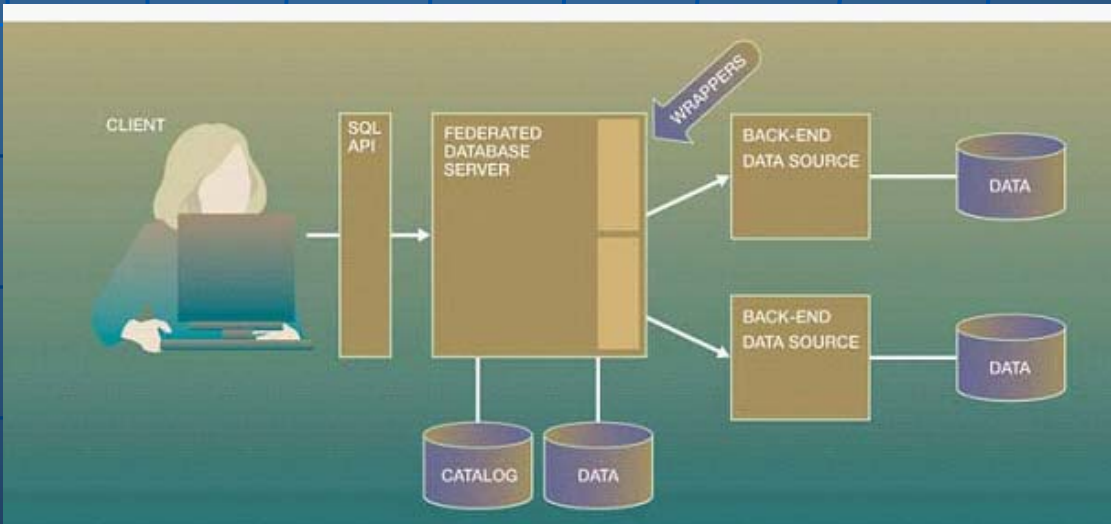


Need Data Federation & Transactional Systems to link heterogeneous systems

We have much to learn from eCommerce community

Security is a major challenge in federated data services

Smart brokering services are needed



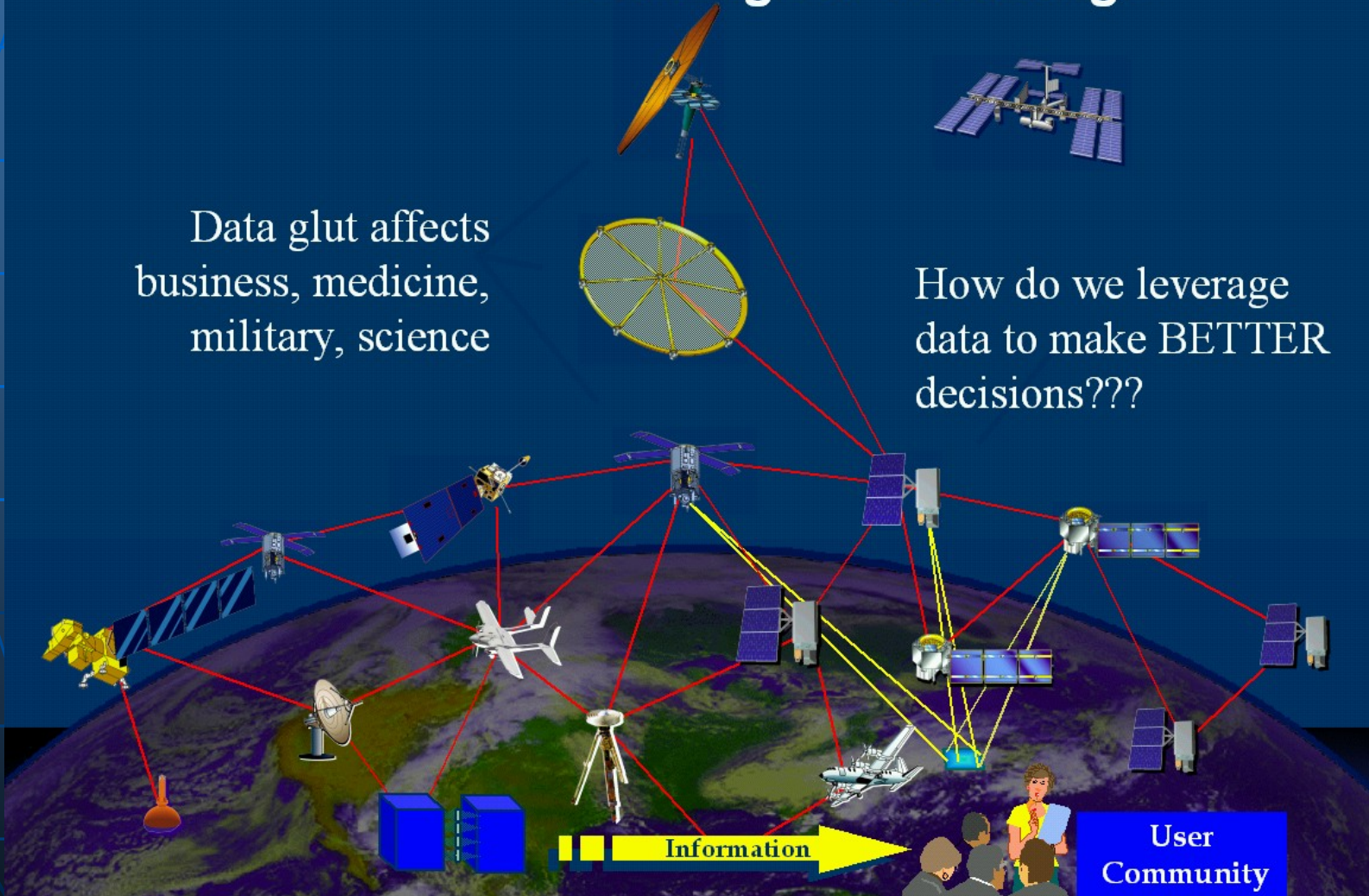


Data Glut

“...drowning in data but starving for knowledge”

Data glut affects business, medicine, military, science

How do we leverage data to make BETTER decisions???



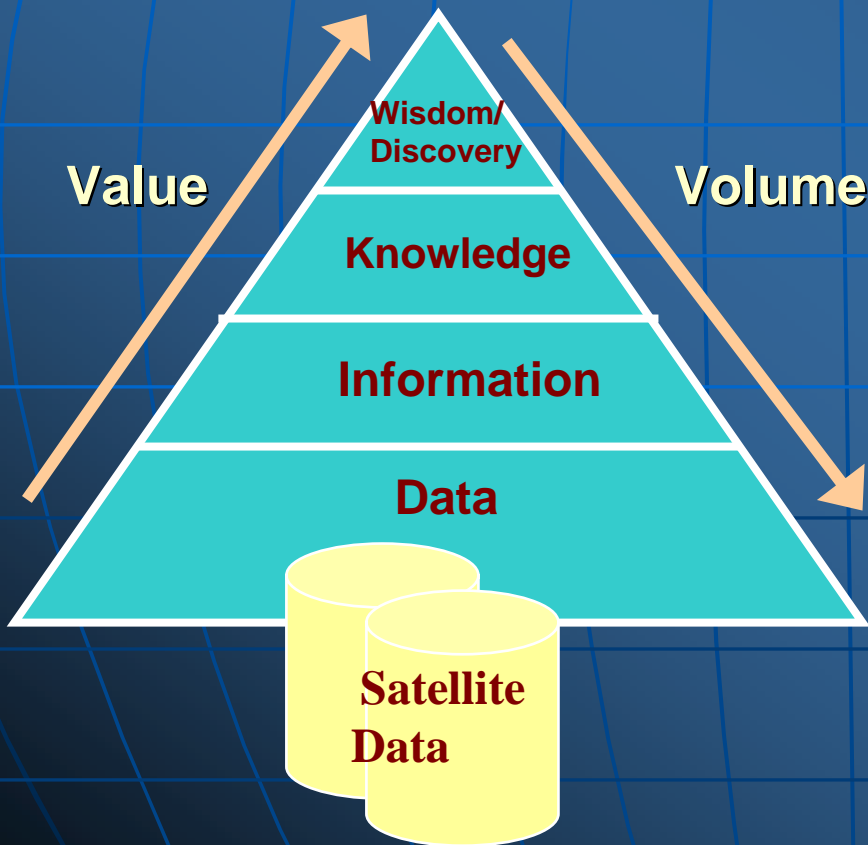
Source: Sara Graves, 2002



Data Mining,

Knowledge Discovery & Management

End Users (Decision Makers,
Students, Scientists)



Data services must provide solutions for data reduction and mining

Services are needed to turn Data to Knowledge



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Bridging Communities with a Range of Computing Capabilities



Grid computing shows promise and creates many exciting opportunities;

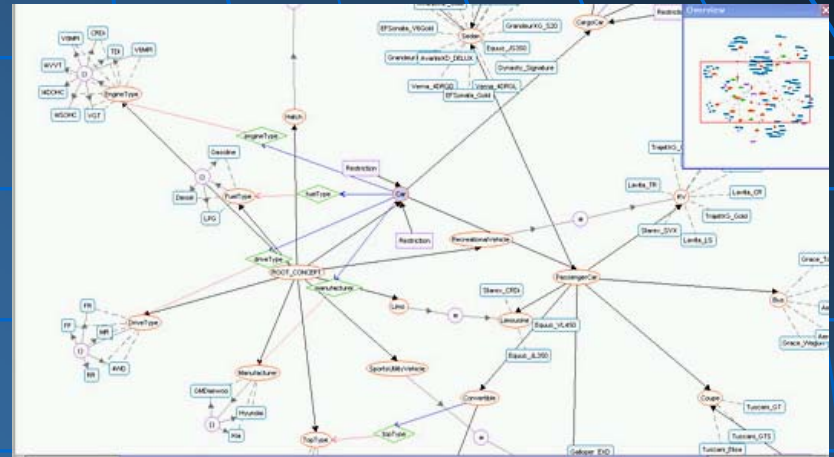
Before we realize its potential, many technological, cultural and systemic challenges remain





Education Integration

- Combining Data Objects with Learning Objects key to enhancing educational value of data
- Need to integrate the two types of objects more comprehensively and with metadata & ontology services and concept maps



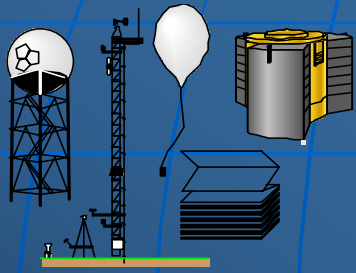
We still have very far to go to realize the vision of a Semantic Web.

Progress has been VERY SLOW!

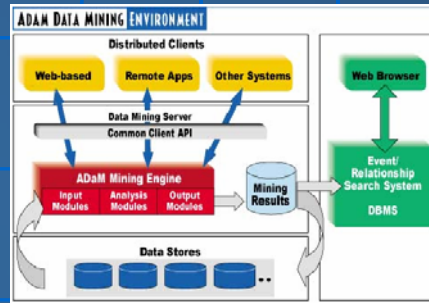
Barrier to entry is high.

RDF/OWL provides an approach.

Dynamically Adaptive Data Services: Next Frontier



Streaming
Observations



Data Mining

Storms Forming



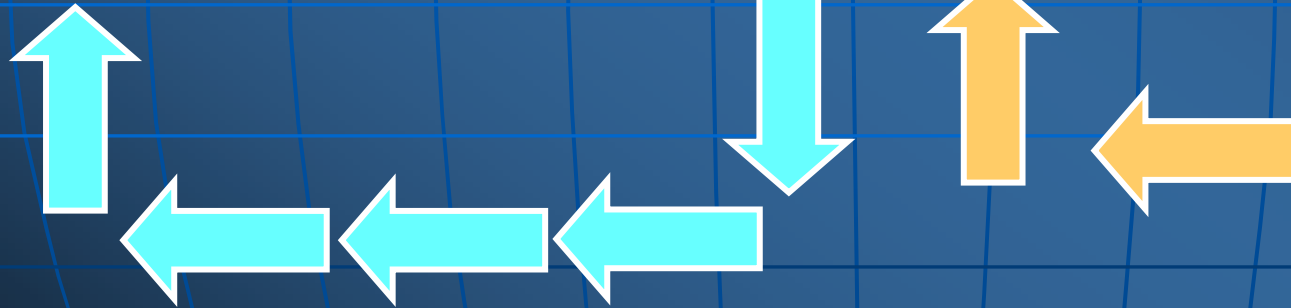
Forecast Model



TeraGrid and the Alliance



On-Demand
Grid Computing



Monitoring and notification services
play a crucial role