Cyberinfrastructure for Emissions Data & Tools

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Project Overview

Objectives: advance the implementation of the Networked Environmental Information Systems for Global Emissions Inventories (**NEISGEI**), an EPA initiative to develop a web-based global air emissions inventory network to provide

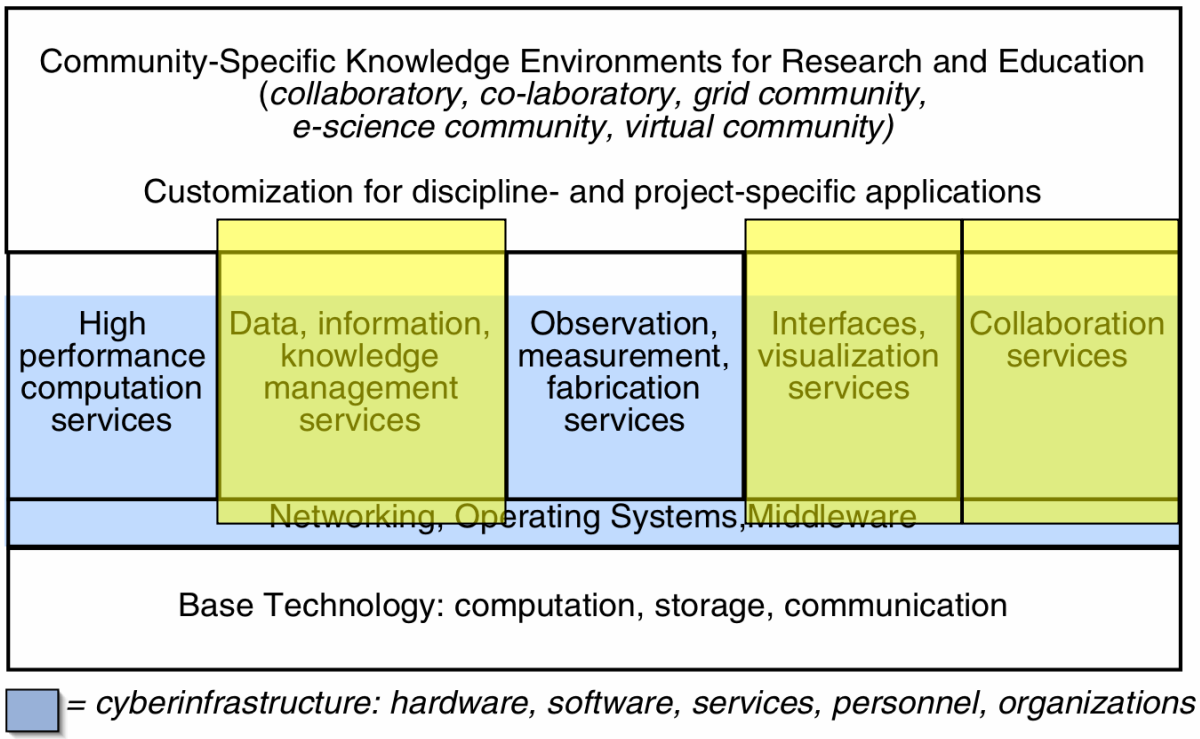
- access to distributed emission inventory data
- tools for data processing and analysis
- means for sharing data & tools
- an environment for collaboration

Approach: Develop, test, and implement components of an air quality cyberinfrastructure using the latest advances in information technology to make multi-scale air emissions data and tools easier to find, use and integrate.

Cyberinfrastructure

Cyberinfrastructure - information sciences and technologies used to build new types of scientific and engineering knowledge environments with the goal of pursuing research and management more effectively and efficiently.

"*Contemporary projects require effective federation of both distributed resources (data and facilities) and distributed, multidisciplinary expertise and cyberinfrastructure is a key to making this possible*." - NSF Blue Ribbon Report on Cyberinfrastructure, 2003



(Atkins, 2004)

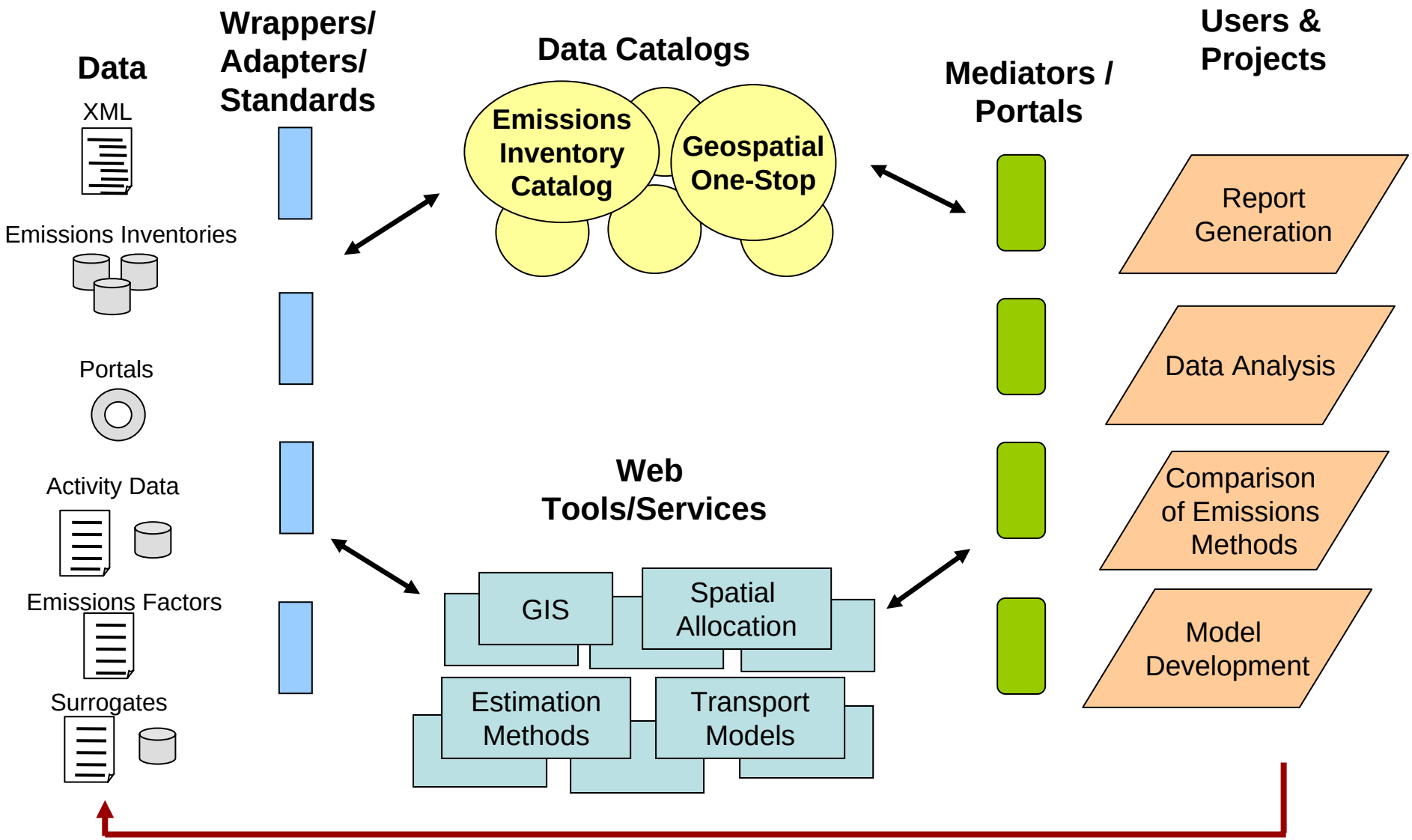
NEISGEI Networked Environmental Information Systems for Global Emissions Inventories

…is both a conceptual framework and implementation effort for the development of an integrated, distributed air emissions inventory

- **Tie together data at multi- spatial and temporal scales**
- **Provide shared, online tools for processing and analysis**
- **Provide for the seamless merging, processing and analysis of Internet accessible air quality-relevant data**
- **Make use of existing resources – partner/link with related projects**
- **Build a broad-based air emissions user community: scientists, regulators, policy analysts and the public**
- **Create the network and toolkit via specific, task-oriented projects**

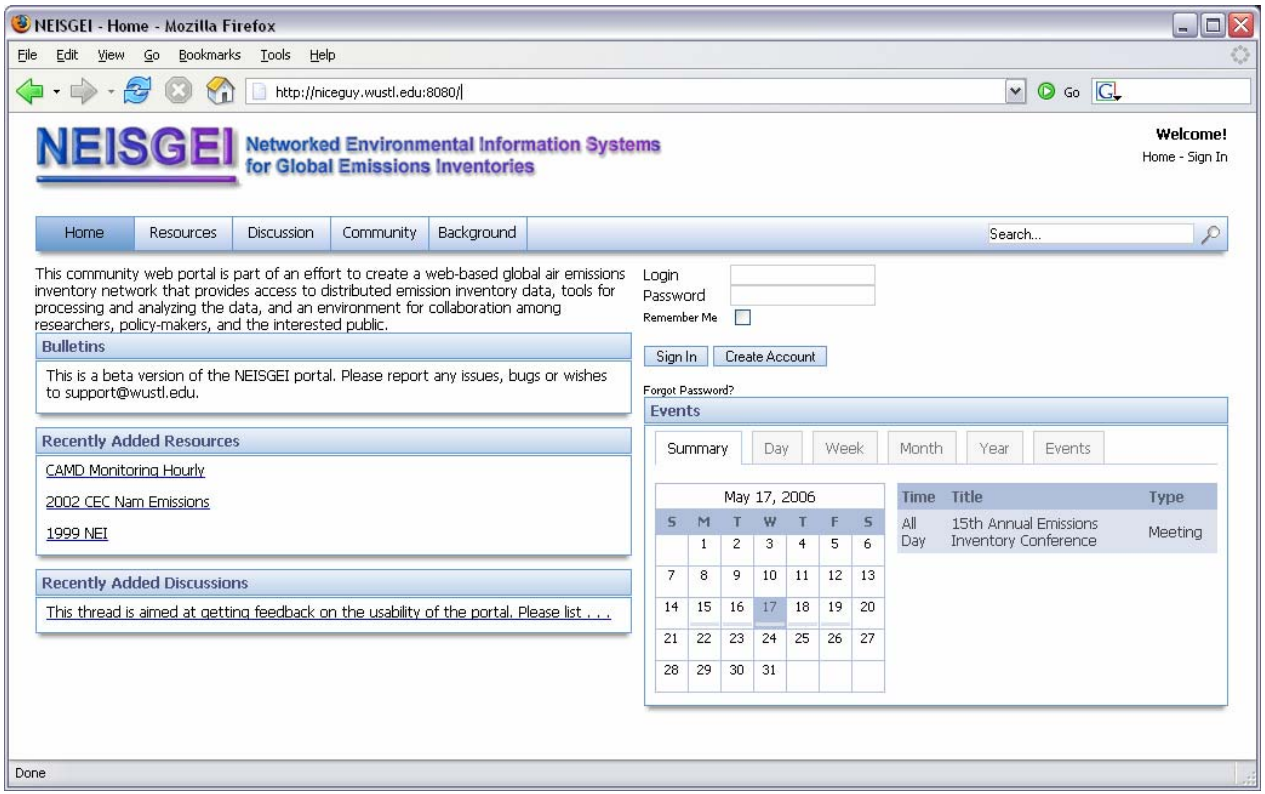
An air emissions “cyberinfrastructure”

Conceptual Diagram of an Emissions Cyberinfrastructure



NEISGEI Portal

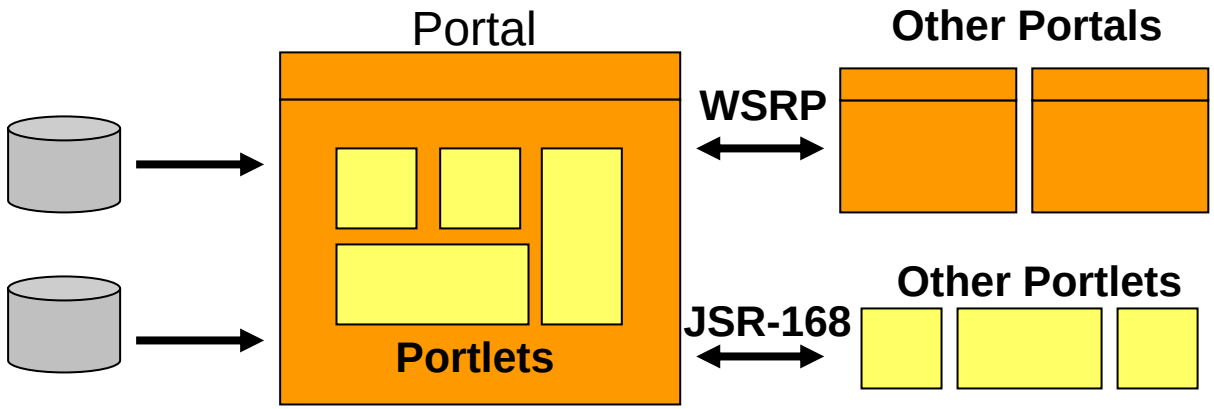
A community resource providing **access to**, **descriptions of**, and **dialogues about** an array of content and services for exploring and sharing **emissions data**, **tools** and **ideas**.



Built using **LifeRay**, and open-source portal package

Beta version accessible through **http://www.neisgei.org**

Portal / Portlet Standards



Java Portlet Specification (JSR-168), defines a standard application programming interface for J2EE (Java) based portal platforms. A portal developer can find collections of JSR-168 portlets on the web and simply embed them in their portal.

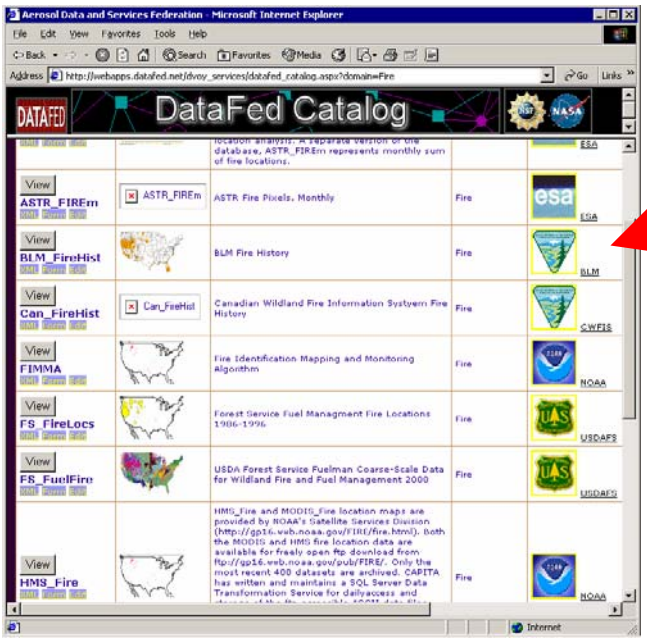
Web Services for Remote Portlets (WSRP) is an XML and web services specification that allows the remote sharing of portlets. WSRP allows portlets running on one portal to be displayed in another portal without requiring any additional programming by the portal developers.

To the end-user, it appears that the portlets are running locally within their portal, when they may actually reside in remotely-running portals.

The hope is that these standards (along with others) allow content exchange among emissions-related portals.

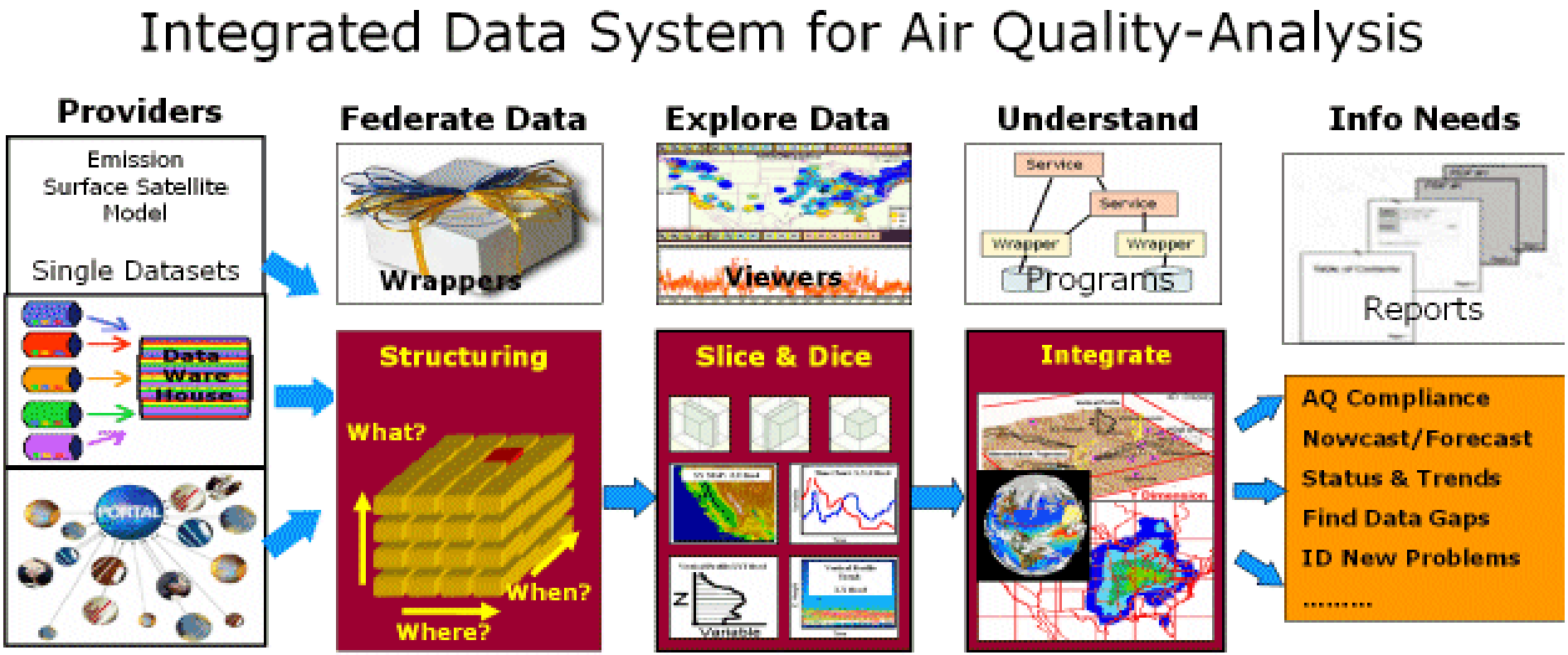
Federated data system - DataFed

The air quality community is supported by a **non-intrusive, incremental data integration** infrastructure based on Internet standards (web services) and a set of web-tools evolving through the federated data system, **DataFed.** (Husar et al., 2004)



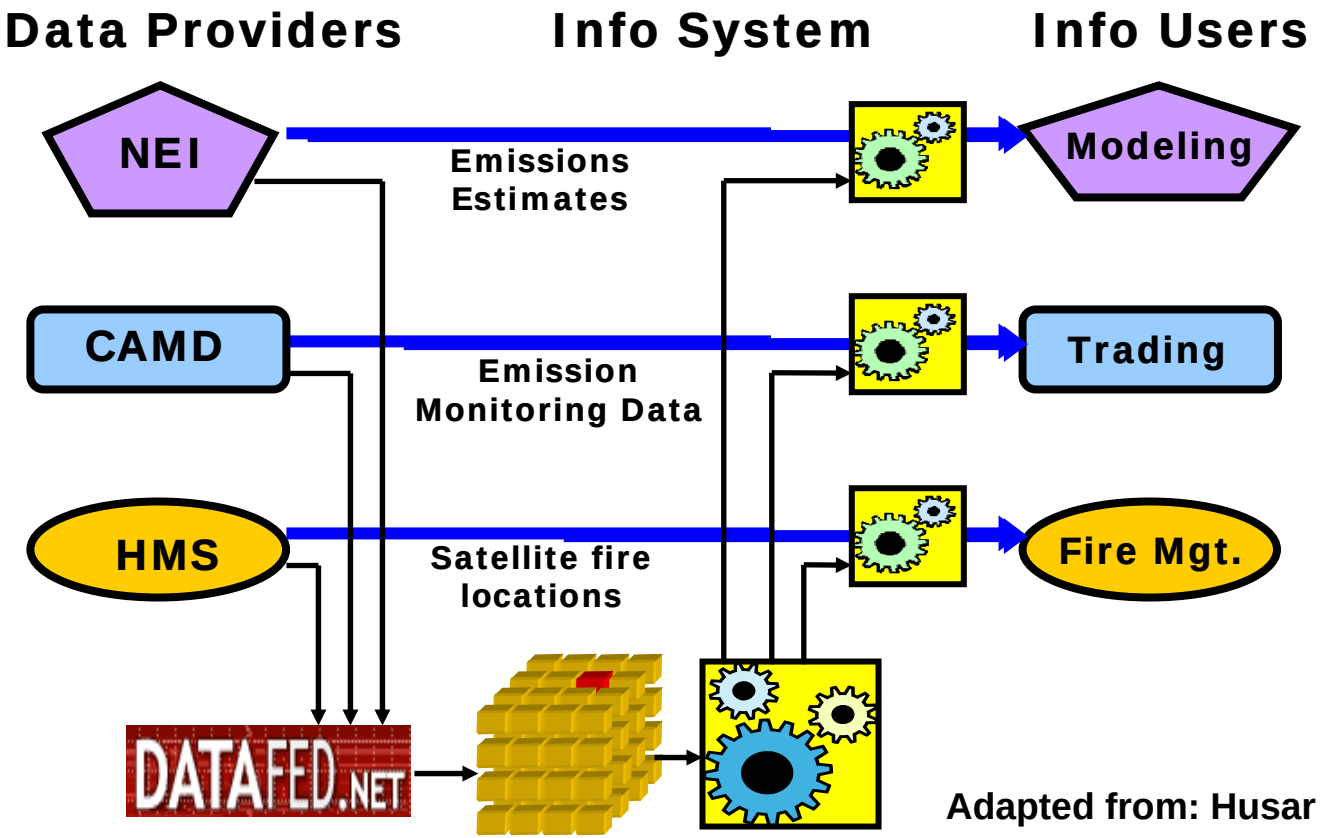
http://datafed.net

DataFed Information Flow



Source: Husar et al., 2004

AQ Information Systems: Current and augmented with DataFed



Adapted from: Husar et al., 2004

- Current info systems are **project/program oriented** and provide end-to-end solutions
- Part of the data resources can be **shared for re-use** through DataFed
- Through DataFed, the **data are homogenized** into multi-dimensional cubes
- **Data processing** and rendering can then be performed through standard web services
- Each project/program can be **augmented by federated data and services**

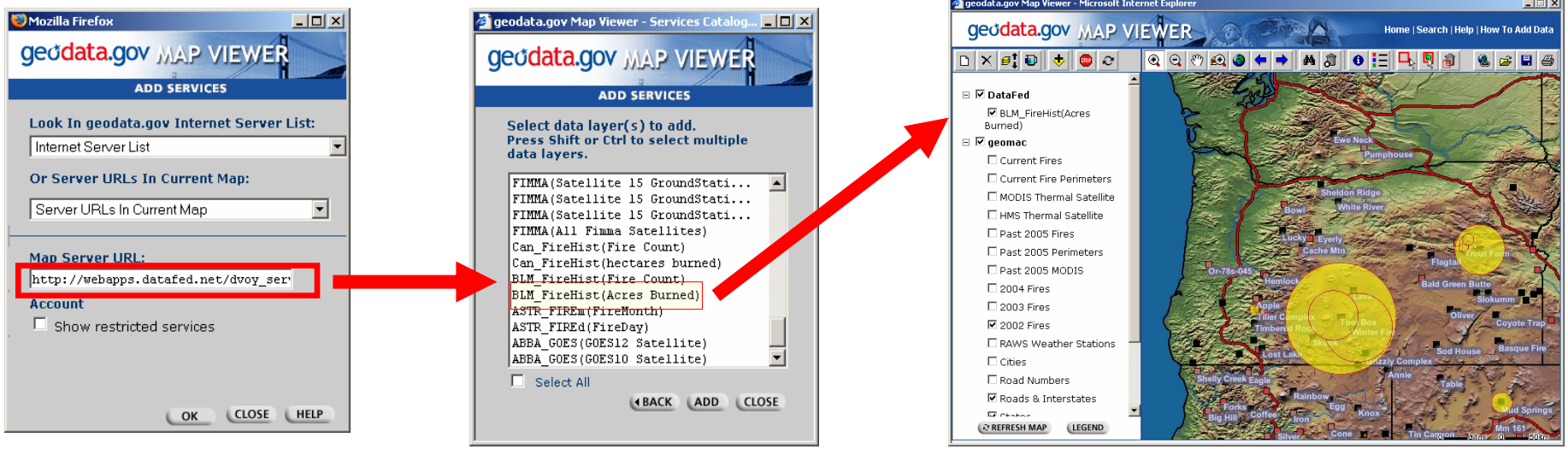
Geospatial Web Standards

Standards for finding, accessing, portraying, and processing geospatial data are defined by the **Open Geospatial Consortium (OGC)**.

- ***Web Map Server (WMS)*** for exchanging map images, but the
- ***Web Feature Service (WFS)*** retrieves discrete feature data
- ***Web Coverage Service (WCS)*** allows access to multidimensional data that represent coverages, such as grids.
- ***Sensor Observation Service (SOS)*** multidimensional access to measurement data

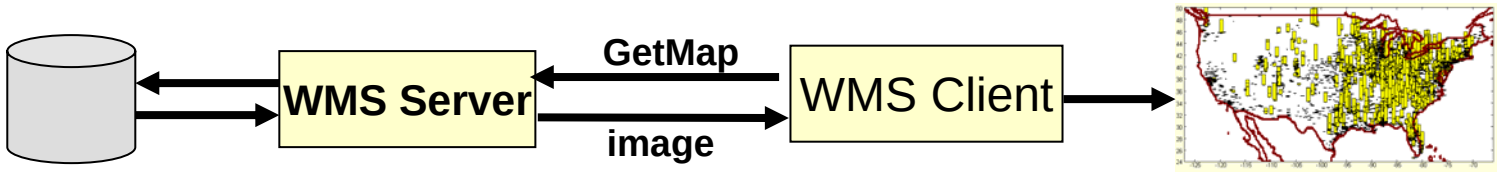
While these standards are based on the geospatial domain, many are designed to be extended to support non-geographic data "dimensions," such as time and the many other dimension tables found in emissions inventories.

Geospatial One-Stop



DataFed-OGC Description: http://www.datafed.net/DataLinks/OGC/OGC.htm

Web Map Service (WMS)



GetMap Request

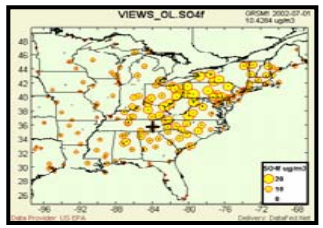
http://webapps.datafed.net/ogc_EPA.wsfl
?SERVICE=wms
&REQUEST=GetMap
&VERSION=1.1.1
&SRS=EPSG:4326
&STYLES=
&LAYERS=NEI_EGU.SO2
&BBOX=-127.00,24.00,-66.00,50.00
&TIME=1999-01-01T00:00:00
&FORMAT=image/png
&EXCEPTIONS=application/vnd.ogc.se_inimage
&TRANSPARENT=TRUE
&BGCOLOR=0xFFFFFF
&WIDTH=700
&HEIGHT=350

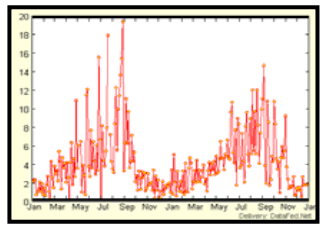
Web Coverage Service (WCS)

GetCoverage Request

http://webapps.datafed.net/ogc_EPA.wsfl
?SERVICE=wcs
&REQUEST=GetCoverage
&VERSION=1.0.0
&CRS=EPSG:4326
&COVERAGE=EPA_CAMD_HOUR.SO2_MASS
&FORMAT=NetCDF-table
&BBOX=-82.4606,42.9258,-82.4606,42.9258,0,0
&TIME=2002-04-01T15:00:00Z/2002-04-30T15:00:00Z
&WIDTH=700
&HEIGHT=350
&DEPTH=99

Multidimensional Air Quality Data Storage and Delivery through OGC Protocols





param_abbr	value
BI	13
ERC	17
KBDI	223
PPT	0
RH	46
SC	2
tmp	51
Wind	6

WMS

Data View Services

WMS

WFS

WCS

SOS

SensorML

SOS

Facilities

Monit./Estim.

Poll-Meth

Facility Info.

Dim Tables

Sites

Site_ID
Map_No
Universal_Site_ID
Network_Code
Site_Code
Site_Index
Site_Collocation_ID
AIRS_Site_ID
Site_Name
LDM_Code
Longitude
Latitude
Elevation
Address
State_Province_Code
Zip_Code
City

Times

Obs_Time
Uni_Time

Fact Table

Air_Obs

Air_Obs_ID
Site_ID
Parameter_ID
Obs_Date
Obs_Time
Method_ID
Calc_Method_Flag
Obs_Value Data Value
Obs_Uncertainty

Dim Tables

Parameters

Parameter_ID
Parameter_Code
Parameter_Species_Code
Parameter_Property_Cod
Parameter_Type_Code
Unit_ID
Unit_Code
Size_ID
Size_Code
Parameter_Desc
Param_Info_Source
Chem_CAS_Num

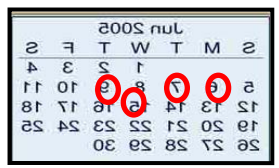
Methods

Method_ID
Method_Desc
Instrument_ID
Sampling_Freq_Code
Sampling_Duration_Co
Sampling Height (m)
Obs_Type_Code

Relational Data Model

Pollutant/Method

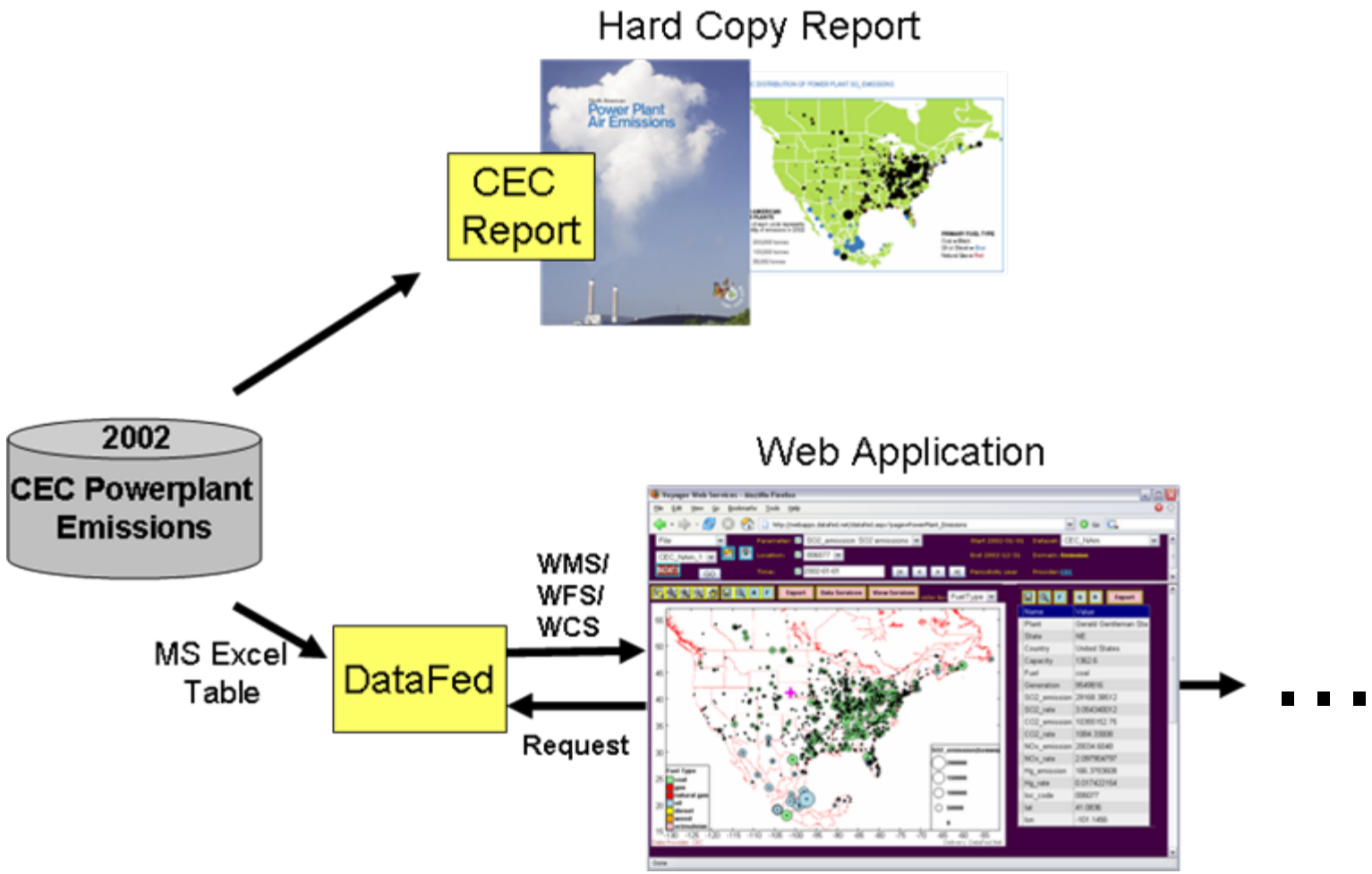
- nitrogen dioxide
- sulfur dioxide
- carbon monoxide.



Monitoring / Estimates

Dynamic Emissions Browsing with Web Applications

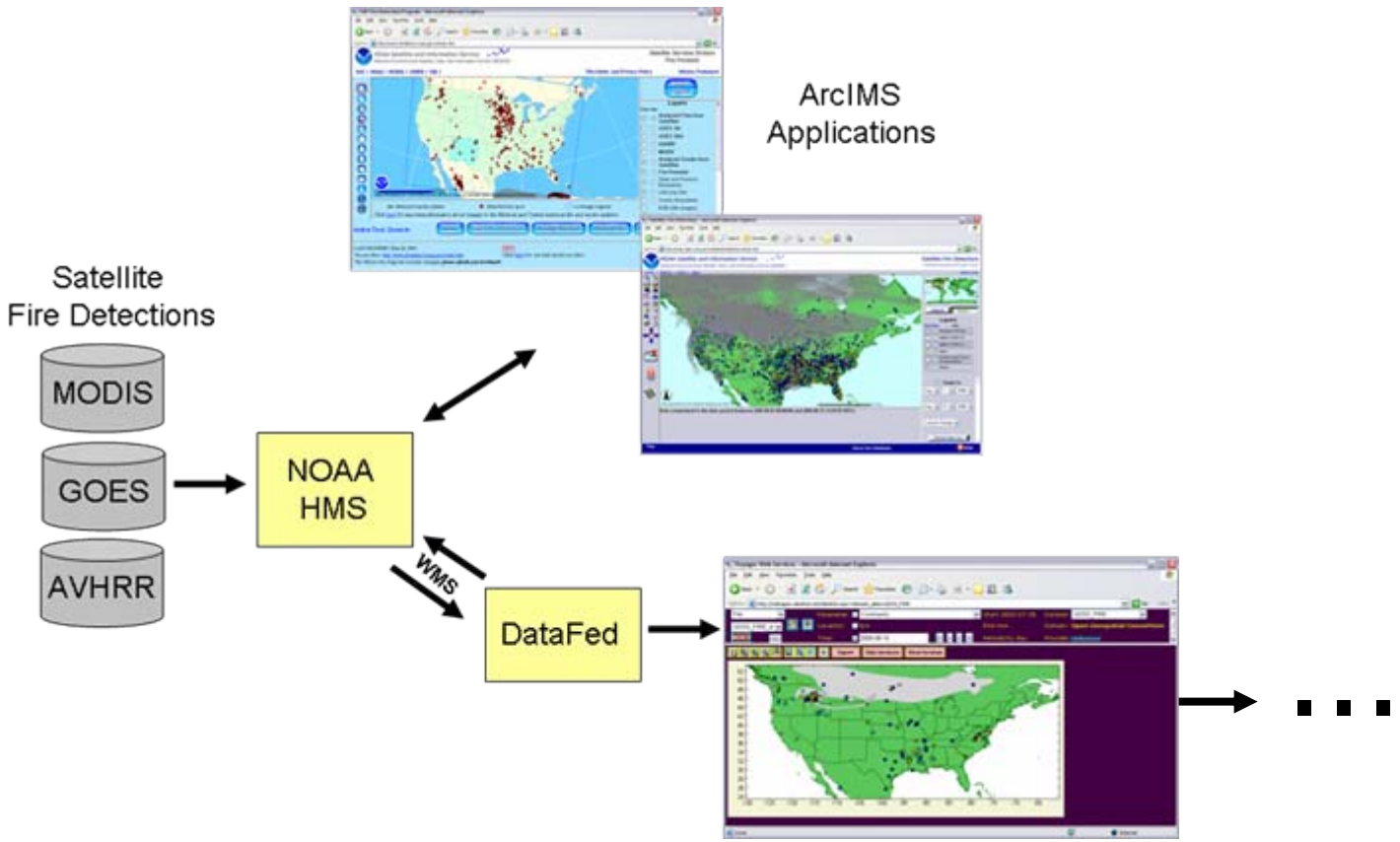
A web application supplements a hard copy report by providing dynamic map and table creation allowing a user to focus on a spatial region or a particular plant.



http://webapps.datafed.net/datafed.aspx?page=PowerPlant_Emissions

Fire Locations and Smoke “Value Chain”

OGC Web Mapping Service (WMS) access to NOAA HMS fire location and smoke plume data make them directly accessible through the DataFed framework and available to NEISGEI applications.



Visualizing Emissions Data

Visualizing emissions data with GoogleEarth and World Wind:

1) involves very little programming
2) provides integrated access to GIS and satellite imagery
3) makes available more advanced visualization tools, such as World Wind's temporal animation facility