

**Earth System Research Laboratory
Global Systems Division
Technology Outreach Branch**



Global Systems Division's Web Services
Jebb Stewart

NOAA/ESRL/GSD

**Affiliated with Colorado State University
Cooperative Institute for Research in the Atmosphere (CIRA)
December 15th, 2010**

Agenda

NextGen Background
Architecture - OGC Web Services
Capability Evaluation 2010
Impacts

NextGen Weather Data Cube

Fundamental Concepts

- **An integrated and nationally consistent common weather picture for observation, analysis, and forecast data available to all system users**
- **“Network Enabled” - available, secured, real-time, useful information**
- **“Virtual” repository with no single physical database or computer**
- **Conceptually unified source distributed among multiple physical locations and suppliers, of which NOAA is the primary data supplier**
- **Direct integration of weather information into operational decision making processes**

NextGen IT Team

GSD

Lynn Sherretz

Sher Schranz

Chris MacDermaid

Michael Leon

Jebb Stewart

– NextGen Program Manager

– Assistant NextGen Program Manager

– NextGen IT Technical Coordinator

– FAA NextGen IT Technical Lead

– NWS NextGen IT Technical Lead

Steve Ennis

Paul Hamer

Shannon Johnston

Adam Mabrouk

James Schroeter

MarySue Schultz

Jim Frimel

Patrick Hildreth

Bob Lipschutz

Glen Pankow

Jeff Smith

Mike Turpin

GSD is involved in both FAA NNEW and NWS NextGen Programs.

Architecture Background

OGC (Open Geospatial Consortium)

- International industry consortium
- Standards developed in a consensus process
- Geoprocessing applications interoperable

SOA (Service Oriented Architecture)

- Lots of disparate weather tracking / forecast systems
- Need to make services interoperable
- Consolidates systems/data from NOAA/FAA/DoD
- Efficient data delivery

Data Delivery Services

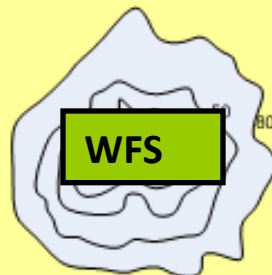
OGC-capable/compliant

- Web Feature Service (WFS)
- Web Coverage Service (WCS)
- Web Mapping Service (WMS)
- Sensor Observation Service (SOS)
- Registry/Repository (RegRep)

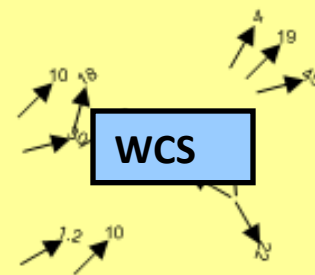
Common Weather Data Types and Service Mapping



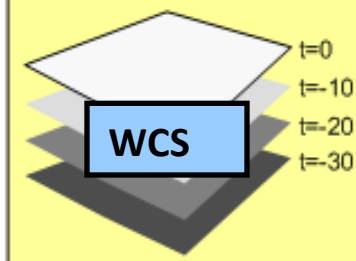
Images



Contour Data



Sparse Grids



Multi-Dimensional
Grids

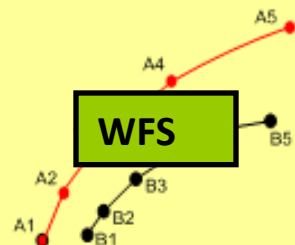
METAR KPHL 060054Z 10008KT 10SM
FEW055 BKN130 BKN250 14/08 A3020
RMK AO2 SLP225 T01440078

METAR KPHL 060054Z 10008KT 10SM
FEW055 BKN130 BKN250 14/08 A3021
RMK AO2 SLP225 T01440078

METAR KPHL 060254Z 05006KT 10SM
-RA FEW055 BKN080 OVC110 14/08
A3021 RMK AO2 RAB39 SLP230 P0000
60000 T01390078 51010

WFS

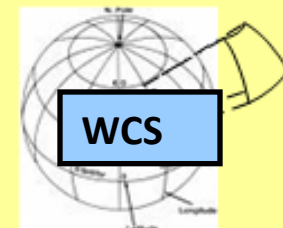
Alphanumeric Text



Trajectories



Polar Radar Beam Data



Planetary Swaths

WFS Reference Implementation

MIT/Lincoln Labs

- Non-gridded data (METAR, MDCR,TAF)
- Java, PL/SQL
- Data stored in XML in Oracle
- Requests made with SOAP client API
 - GetCapabilities
 - DescribeFeatureType
 - GetFeature
 - WFS-T – XML format WXXM (Weather Information Exchange Model)

WXXM, the Weather Data Model, is a UML-based structural definition for the exchange of information by users of and contributors to the 4-D Wx Data Cube. It was designed by Eurocontrol, in partnership with NNEW.

WFS Development

- GSD is exploring open source implementations without licensing costs or restrictions
 - GeoServer (<http://www.geoserver.org>)
 - Deegree (<http://www.deegree.org>)
- Data stored in PostGIS, other storage formats are possible
- Both implement versions 1.0 and 1.1 of WFS Specification
- WFS Specification requires at least GML, doesn't prevent serving other formats.

WFS TAF Response

```
<avwx:TAF
  xmlns:wfs="http://www.opengis.net/wfs/2.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:wx="http://www.eurocontrol.int/wx/1.1" xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:om="http://www.opengis.net/om/1.0/gml32" xmlns:xlin="http://www.w3.org/1999/xlink"
  xmlns:avwx="http://www.eurocontrol.int/avwx/1.1">
  <avwx:rawText>TAF
  KDEN 150439Z 1505/1524 18009KT P6SM SCT060 BKN200
    FM150600 21008KT P6SM SCT140
    FM151600 07008KT P6SM FEW080 SCT140
    FM160200 15009KT P6SM BKN080</avwx:rawText>

  <avwx:aerodromeWxForecast>
    <wx:Forecast gml:id="KDEN_02">
      <om:samplingTime>
        <gml:TimePeriod gml:id="KDEN_03">
          <gml:beginPosition>2010-09-15T05:00:00Z</gml:beginPosition>
          <gml:endPosition>2010-09-16T00:00:00Z</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>
      <om:procedure xlink:href="urn:fdc:faa.gov:System:Forecast:Weather:01234" xmlns:xlink="xlink"/>
      <om:observedProperty xlink:href="http://www.eurocontrol.int/ont/avwx/1.1/wx.owl#AerodromeWx" xmlns:xlink="xlink"/>
      <om:featureOfInterest xlink:href="#KDEN_04" xmlns:xlink="xlink"/>
      <om:result>
        <wx:WxFeatureCollection gml:id="KDEN_06">
          <wx:featureMember>
            <avwx:AerodromeWx gml:id="KDEN_07">
              <avwx:windDirection uom="deg">180</avwx:windDirection>
              <avwx:horizontalVisibility>
                <avwx:HorizontalVisibility gml:id="KDEN_8">
                  <avwx:prevailingVisibility uom="SM">6</avwx:prevailingVisibility>
                </avwx:HorizontalVisibility>
              </avwx:horizontalVisibility>
              <avwx:windSpeed uom="kt">9</avwx:windSpeed>
```

GeoServer MDCR GML Response

```
- <wfs:FeatureCollection numberOfFeatures="0" timeStamp="2010-12-14T11:42:51.882-07:00"
  xsi:schemaLocation="https://troi/projects/nnws http://geoc-test.fsl.noaa.gov:8080/geoserver/wfs?service=WFS&version=1.1.0&
  request=DescribeFeatureType&typeName=wx%3Amdcr_data http://www.opengis.net/wfs http://geoc-test.fsl.noaa.gov:8080
  /geoserver/schemas/wfs/1.1.0/wfs.xsd">
  - <gml:featureMembers>
    - <wx:mdcr_data gml:id="mdcr_data.fid--2f5e907b_12ce626a5fc_-4335">
      - <gml:location>
        - <gml:Point srsDimension="2" srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
          <gml:pos>-69.8 18.77</gml:pos>
        </gml:Point>
      </gml:location>
      <wx:mdcrid>0</wx:mdcrid>
      <wx:reporttype>MDCR</wx:reporttype>
      <wx:aircraftid>IUAX02</wx:aircraftid>
      <wx:longitude>-69.8</wx:longitude>
      <wx:latitude>18.77</wx:latitude>
      <wx:altitude>3109.0</wx:altitude>
      <wx:timeposition>2010-07-27T07:46:00Z</wx:timeposition>
      <wx:issuetime>null </wx:issuetime>
      <wx:year>2010</wx:year>
      <wx:month>7</wx:month>
      <wx:day>27</wx:day>
      <wx:hour>7</wx:hour>
      <wx:minute>46</wx:minute>
      <wx:second>0</wx:second>
      <wx:windspeed>4.6</wx:windspeed>
      <wx:winddirection>105.0</wx:winddirection>
      <wx:airtemperature>281.4</wx:airtemperature>
      <wx:turbulence>null </wx:turbulence>
    - <wx:location>
      - <gml:Point srsDimension="2" srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
        <gml:pos>-69.8 18.77</gml:pos>
      </gml:Point>
    </wx:location>
```

WCS Reference Implementation

NCAR/RAL

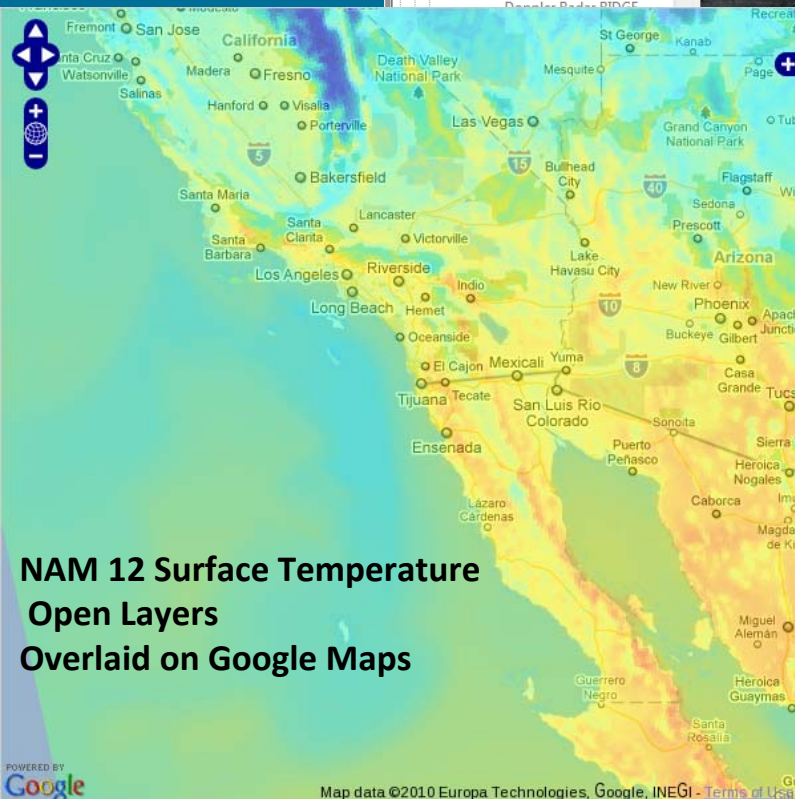
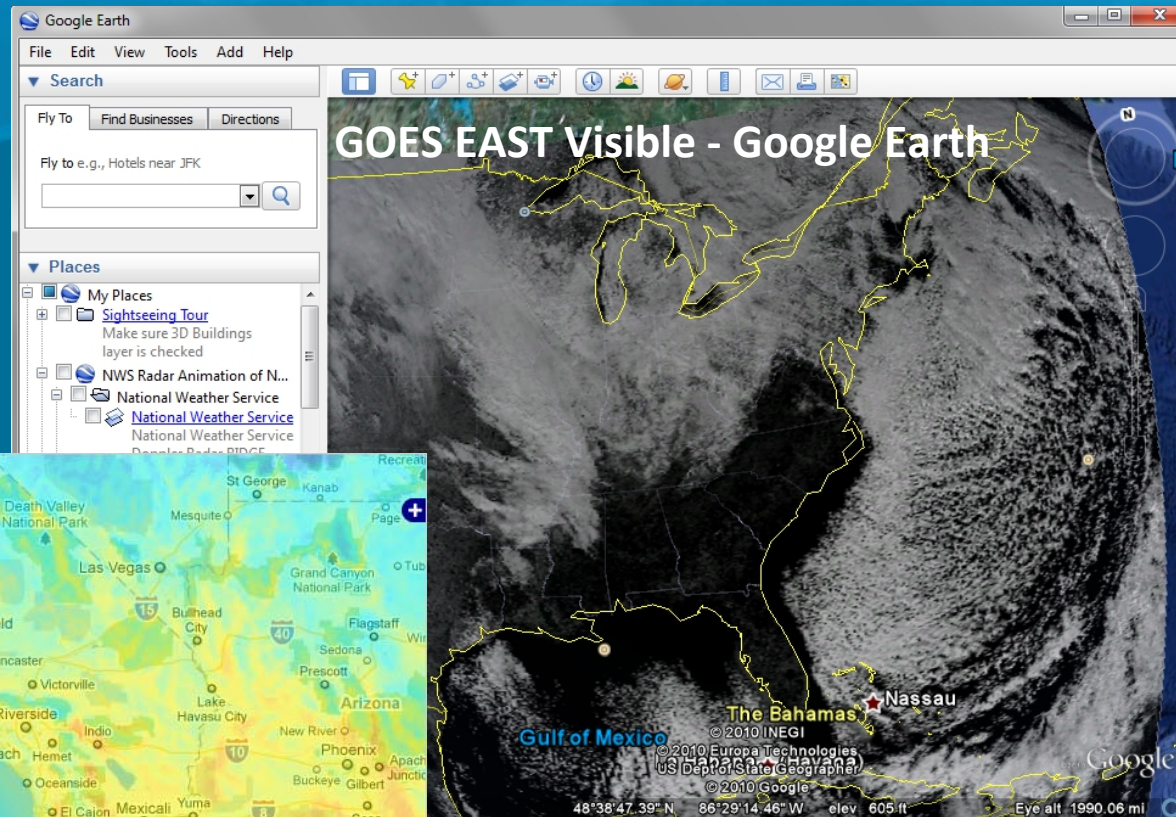
- Gridded datasets (satellite, reflectivity, models)
- Java using ServiceMix (FUSE), NetCDF
- Developed by NCAR/RAL
- Format is NetCDF
- Like IDV, Java NetCDF tools for manipulation and display
- Data in backing flat file store as-is
- Coordinate Reference System (CRS) handled transparently
- Requests made with SOAP client API
 - GetCapabilities
 - DescribeCoverage
 - GetCoverage

WMS Reference Implementation

NcWMS

- Georeferenced Images
- Java using Tomcat, NetCDF
- Developed by Reading e-Science Centre at the University of Reading, UK.
- Output Formats: JPEG, GIF, PNG, KMZ.
- CRS handled transparently
- Requests made with SOAP client API or Key Value Pairs
 - GetCapabilities
 - GetMap
 - GetFeatureInfo (Optional Implementation from Specification)

WMS Examples



SOS Reference Implementation

Deegree

- Observation and Sensor data (METAR, TAF, Sensor Information)
- Java, Implements 1.0 Specification
- Uses Observations & Measurements (O&M) data model and Sensor Model Language (SensorML). Generic model that uses attributes to describe data.
- Requests made with SOAP client API or Key Value Pairs
 - GetCapabilities
 - DescribeSensor
 - GetObservation
 - GetFeatureOfInterest (Optional)

SOS Examples – 1 of 2

```
<?xml version="1.0" encoding="UTF-8"?>
<om:ObservationCollection xmlns:gml="http://www.opengis.net/gml"
  xmlns:om="http://www.opengis.net/om/1.0" xmlns:swe="http://www.opengis.net/swe/1.0.1"
  xsi:schemaLocation="http://www.opengis.net/om/1.0 http://schemas.opengis.net/om/1.0.0/om.xsd"
  xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <om:member>
    <om:Observation>
      <gml:name>urn:MyOrg:observation:1234abcde</gml:name>
      <om:samplingTime>
        <gml:TimePeriod>
          <gml:beginPosition> 2005-08-05T12:21:13Z </gml:beginPosition>
          <gml:endPosition> 2005-08-05T12:23:59Z </gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>
      <om:procedure xlink:href="urn:ogc:object:Sensor:MyOrg:12349"/>
      <om:observedProperty xlink:href="urn:ogc:def:property:MyOrg:AggregateChemicalPresence"/>
      <om:featureOfInterest xlink:href="urn:ogc:def:feature:OGC-SWE:3:transient"/>
      <om:result>
        <swe:DataArray gml:id="ChemicalRecords">
          <swe:elementCount>
            <swe:Count>
              <swe:value>5</swe:value>
            </swe:Count>
          </swe:elementCount>
          <swe:elementType name="Components">
            <swe:SimpleDataRecord gml:id="DataDefinition">
              <swe:field name="time">
                <swe:Time definition="urn:ogc:property:time:iso8601"/>
              </swe:field>
              <swe:field name="longitude">
                <swe:Quantity definition="urn:ogc:property:location:EPSG:4326:longitude">
                  <swe:uom code="deg"/>
                </swe:Quantity>
              </swe:field>
              <swe:field name="latitude">
                <swe:Quantity definition="urn:ogc:property:location:EPSG:4326:latitude">
                  <swe:uom code="deg"/>
                </swe:Quantity>
              </swe:field>
              <swe:field name="DPM">
                <swe:Quantity definition="urn:ogc:def:property:OGC:ChemicalPresenceInAirDPM">
                  <swe:uom code="ppm"/>
                </swe:Quantity>
              </swe:field>
              <swe:field name="MS">
                <swe:Quantity definition="urn:ogc:def:property:OGC:ChemicalPresenceInAirMS">
```


SOS Examples – 2 of 2

```
</swe:elementType>
<swe:encoding>
  <swe:TextBlock tokenSeparator="," decimalSeparator="." blockSeparator="@@"/>
</swe:encoding>
<swe:values> 2005-08-05T12:21:13Z,-77.8912,38.512,20,0@@@
2005-08-05T12:22:08Z,-77.8912,38.512,30,0@@@ 2005-08-05T12:22:54Z,-77.8912,38.512,0,0@@@
2005-08-05T12:23:03Z,-77.8912,38.512,10,10@@@ 2005-08-05T12:23:59Z,-77.8912,38.512,10,0
</swe:values>
</swe:DataArray>
</om:result>
</om:Observation>
</om:member>
<om:member>
<om:Observation>
  <gml:name>urn:MyOrg:observation:1234abcd</gml:name>
  <om:samplingTime>
    <gml:TimePeriod>
      <gml:beginPosition> 2005-08-05T12:23:03Z </gml:beginPosition>
      <gml:endPosition> 2005-08-05T12:23:59Z </gml:endPosition>
    </gml:TimePeriod>
  </om:samplingTime>
  <om:procedure xlink:href="urn:ogc:object:Sensor:MyOrg:12350"/>
  <om:observedProperty xlink:href="urn:ogc:def:property:MyOrg:AggregateChemicalPresence"/>
  <om:featureOfInterest xlink:href="urn:ogc:def:feature:OGC-SWE:3:transient"/>
  <om:result>
    <swe:DataArray gml:id="ChemValues2">
      <swe:elementCount>
        <swe:Count>
          <swe:value>2</swe:value>
        </swe:Count>
      </swe:elementCount>
      <swe:elementType name="Components" xlink:href="#DataDefinition"/>
      <swe:encoding>
        <swe:TextBlock tokenSeparator="," decimalSeparator="." blockSeparator="@@"/>
      </swe:encoding>
      <swe:values> 2005-08-05T12:23:03Z,-77.8912,38.512,10,10@@@
2005-08-05T12:23:59Z,-77.8912,38.512,10,0 </swe:values>
    </swe:DataArray>
  </om:result>
</om:Observation>
</om:member>
</om:ObservationCollection>
```

Testing Portal

- Provides functional tests and performance monitoring of the WFS and WCS at ESRL.
- Functional tests can be run individually or as a entire suite.
- Provides detailed information on test(s) success or failure
- Provides capability to submit ad hoc requests
- Provides continuous, automated performance monitoring of the OGC Web Services

Testing Portal Example



Reg/Rep Implementation

- Data catalog of metadata
 - endpoint
 - dataset
- Searchable
- Commercial product (but uses PostgreSQL)
- RI's interface with RegRep
- Administration UI
- Federated capability

NextGen 4-D Weather Data Cube Capability Evaluation

Capability Evaluation (CE) at the William J. Hughes Technical Center (WJHTC) September, 2010

- **Participants:**

- Meteorological Development Laboratory (MDL)
- Global Science Division (GSD)
- Aviation Weather Center (AWC)
- National Severe Storms Laboratory (NSSL)
- National Center for Atmospheric Research (NCAR)
- Massachusetts Institute of Technology / Lincoln Laboratory (MIT/LL)
- WJHTC – Radar and Mosaic Processor (RAMP)
- WJHTC – Regional Automated Weather Observing System Data Acquisition Service Provider (RASP)

NextGen 4-D Weather Data Cube Capability Evaluation Continued

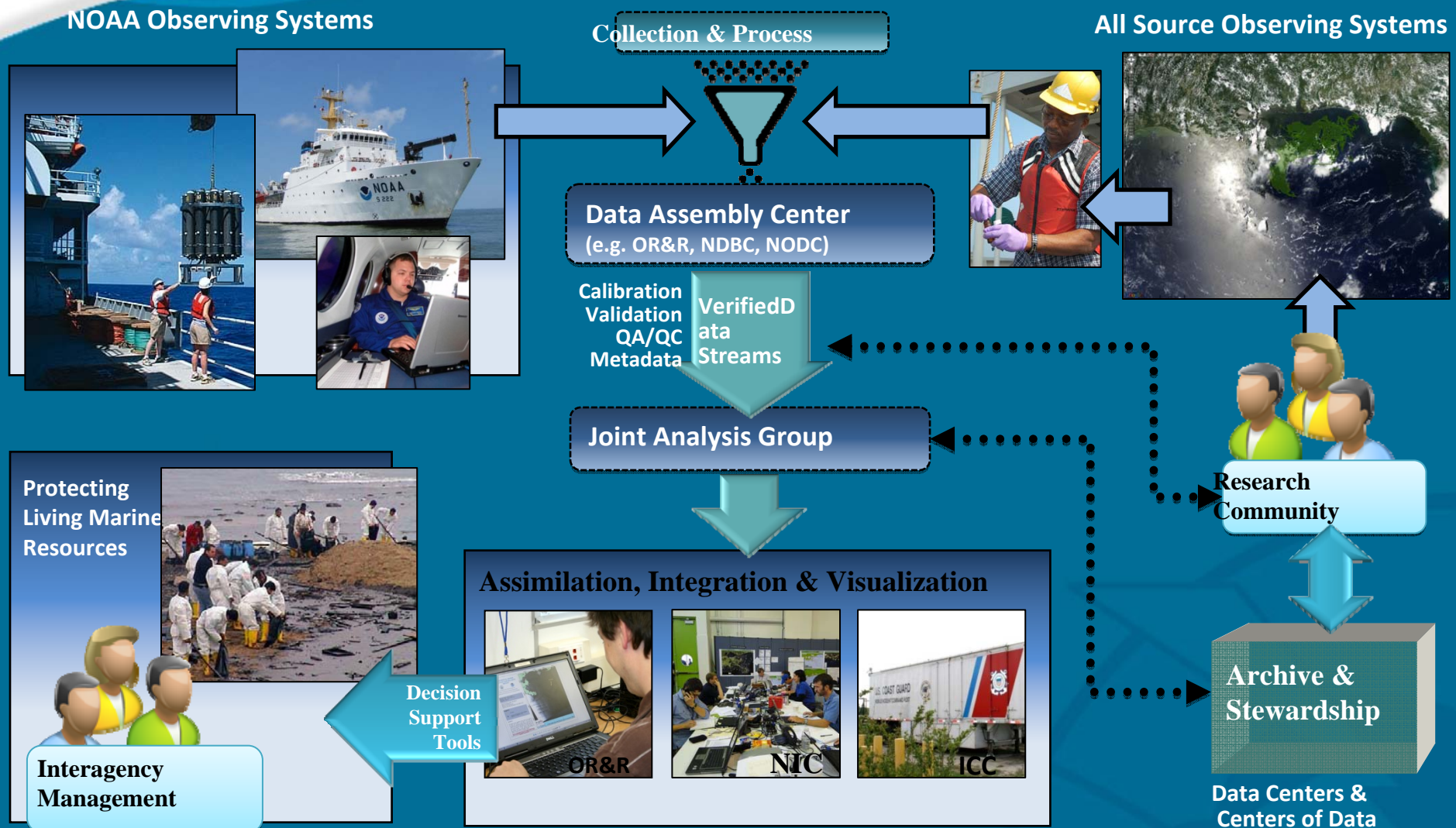
GSD ran the following services running during the FY 2010
Capability Evaluation

- MIT/LL WFSRI
- NCAR/RAL WCSRI
- Reg/Rep
- Testing Portal

Impacts

- By using standardized data models and specifications, any client that understands these services can use data.
- Improves collaboration and interoperability.
- Tools/Utilities Easily combine data from different services
- Specifications support sub-setting and data filtering allowing consumers to grab only the data they need.
- Specifications support ability to re-project data into different CRS
- Services will provide Publish/Subscribe mechanisms allowing consumer to maintain most recent data

Integrating Data Access to Address an Ecological Disaster



Deepwater Horizon



<http://www.noaa.gov/sciencemissions/bpoilspill.html>

GeoPlatform.gov is a one-stop shop for detailed near-real-time information and data about the response to the Deepwater Horizon/BP oil spill.

NOAA's response has been immediate and sustained, strategic and scientific.

From day one, NOAA has been tracking every aspect of this spill: where the oil is going on the surface and under the sea, and what the consequences are to coastal communities, wildlife and the marine environment. We are bringing all scientific methods to this task:

- * Satellites in space
- * Planes in the air
- * Boats on the water
- * Gliders below the surface
- * Scientists on the ground



Questions?

Email: Jebb.Q.Stewart@noaa.gov