Tutorial OGC
The SI Organization (Principal OGC Member)
Dec 18-19 2013

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Objectives

- Understand the OGC benefits and how it works
- Understand the main concepts of interoperability and the importance of standards
- Understand some of the OGC standards. What they are good for and the main operations
- Understand geospatial architectures

Wednesday

09:00-10:45 Value of Standards, OGC

10:45-11:00 Break

11:00-12:00 Interoperability Concepts, WFS

12:00-13:00 Lunch

13:00-14:15 GML, NIEM GML, WMS, SLD, KML

14:15-14:45 WCS

14:45-15:00 Break

15:00-16:00 SWE, GeoSMS

16:00-17:00 Metadata and Catalogs

Thursday

09:00-09:30 Recap

09:30-11:00 WPS

11:00-11:15 Break

11:15-12:30 Architecture

12:30-13:00 Lunch

13:00-14:45 Architecture

14:45-15:00 Break

15:00-15:30 Security, Context, GeoPackage

15:30-16:00 Compliance

16:00-17:00 Example Projects

Value of Standards

Why Standards?

"We want to have standards applied to all important interfaces . . . Being vendor-independent, vendor-neutral helps us protect our equity."

Dawn Meyerriecks, DISA, in an interview with the OpenGroup (2002)

Why Standards?

"People want the government to be transparent, so why shouldn't the technology be?"

Jim Willis, director of E-government at the Rhode Island Secretary of State office. (2002)

Why Standards?

"Standardization is one of the essential building blocks of the Information Society. There should be particular emphasis on the development and adoption of international standards ..."

The Declaration of Principles WSIS-03/GENEVA/DOC/0004 concluded in paragraph 44, from the first phase of the World Summit on the Information Society, Geneva, December 10 to 12 2003.

Why Standards?

"...integration is key. Using standard data structures and formats all data about any object of interest—any person, place or thing—can be easily shared with and accessed by anyone with the need to know..."

Letitia A. Long, Director, National Geospatial-Intelligence Agency, October 4, 2013, KMI Interview

Why Standards?

“ When you are delivering spatial web services on behalf of 20 government agencies to more than a 1000 organisations running their own spatial systems, you need standards."

Kylie Armstrong , Landgate

Why Standards?

"OGC's interface and encoding standards are an essential part of the National Spatial Data Infrastructure. They play a key role in providing technical interoperability among geospatial systems used at all levels of government..."

Ivan DeLoatch, Executive Director of the FGDC.

Why Open Standards?

They work better when they are open

Why Open Standards?

- Prevents a single, self-interested party from controlling a standard
- Lower systems and life cycle costs
- Encourage market competition: Choose based on functionality desired and avoid “lock in” to a proprietary solution
- Stimulates innovation beyond the standard by companies that seek to differentiate themselves.

Source: Open Standards, Open Source, and Open Innovation: Harnessing the Benefits of Openness, April 2006. Committee For Economic Development. www.ced.org

Why Open Standards?

"Governments like to say they can publish to OGC KML instead of Google KML ... everyone has confidence we won’t take advantage of the format or change it in a way that will harm anyone ..."

Michael Weiss-Malik, Google KML product manage

Economic Benefits of Standards

Benefits to German economy of 17 billion Euros in 2010! ... Standards promote worldwide trade, ... as well as improving security and communication. Standards have a greater effect on economic growth than patents or licenses.

*German DIN Study "Economic Benefits of Standardization"

Location Interoperability

Defined as the ability of diverse data sources, systems and organizations to work together (inter-operate).

Location Interoperability

- Ease information sharing
- Promote information reuse
- Reduce duplication of effort
- Flexibility to add new capabilities
- Vendor neutral
- Saves time, reduces cost, increases market choice, protects assets and lives

Location Interoperability Challenge

Ability to access, fuse and apply diverse content when and where needed is critical to situational awareness and disaster planning/ response in cross-boundary and cross-domain settings

The OGC Overview

Open Geospatial Consortium

- Funded in 1994
- Voluntary consensus (470+ members)
- Standards organization (40+ standards)
- Leads the development of standards for geospatial and location based services.

Open Geospatial Consortium (OGC)

Mission: To serve as a global forum for the collaboration of developers and users of spatial data products and services, and to advance the development of international standards for geospatial interoperability.

OGC in Policy Worldwide

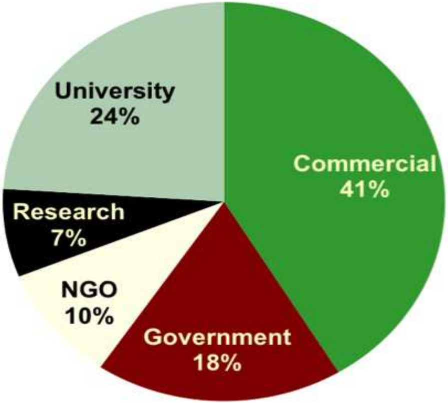
- National level policy and legislation
- European INSPIRE Directive
- Global Earth Observation System of Systems (GEOSS)
- European Space Agency
- Defense and Intelligence: NGA, NATO, ARMY ..
- Sub-national level: Delhi, Abu Dhabi, Western

What does the OGC as an entity provides?

- **An agreed upon consensus process**
    - to encourage effectiveness and efficiency
    - for defining, testing, documenting, and approving specifications
- **Staff knowledge, expertise and support** to work with the members to facilitate the consensus process
- A comprehensive **communications infrastructure**
- A **consensus-based forum** for conflict resolution

Members

http://www.opengeospatial.org/ogc/members/report/



Membership levels

- Strategic
- Principal
- Technical
- Associate

Associate Membership

- Voting Access to domain and standards working groups
- Receive 1 free registration to quarterly OGC Technical Committee meetings
- Access to the OGC Member Portal for all interested employees of the organization

Technical Membership

- Associate Member Benefits +
- Voting participation in the OGC Technical Committee
- Receive 2 free meeting registrations to each of the quarterly OGC Technical Committee meetings
- Discounts on OGC compliance certification for their products.

Principal Membership Features

- Broad access to OGC processes
- Voting participation in the OGC Technical Committee
- Voting participation in OGC Planning Committee
- Influence OGC market / domain direction
- Authority for OGC policies and procedures
- Approve OGC Board of Directors candidates
- Final approval for all OGC standards

Principal Membership Benefits

- 24 hours / year OGC staff support
- Receive 4 free registrations to quarterly OGC Technical Committee meetings
- Significant Compliance certification discounts
- Can assign one Associate and two individual memberships to Organization partners / sub-contractors
- Elevated visibility in OGC marketing and communications

Strategic Membership

- Principal Membership +
- Voting participation in the OGC Strategic Member Advisory Committee
- Receive 20 free meeting registrations to quarterly Technical Committee meetings
- Receive up to 40 hours of OGC staff support each year for internal training and advice
- May assign up to 4 individual and 2 Associate one-year memberships to Organization partners / sub-contractors

Industry Members

LOCKHEED MARTIN
ORACLE
Google
ESRI
EADS astrium
lat lon raumbezogene informationssysteme
PIXIA CORP
the SI
SAIC From Science to Solutions
BENTLEY
BAE SYSTEMS
INTERGRAPH
BOEING
DIGITALGLOBE
Leica Geosystems
Autodesk
Microsoft
ROLTA
Pitney Bowes Business Insight
galdos systems inc
agi
LIZARDTECH a celartem Company
Cadcorp
carmenta geospatial innovations
ITT
Trimble
COMPUSULT
PCI Geomatics
exactEarth
netcad
CPqD Telecom & IT Solutions
GeoEye
Snowflake software

And many, many more…

Strategic Members

- Lockheed Martin
- US Geological Survey
- US Dept of Homeland Security
- National Aeronautics & Space Administration
- US National Geospatial-Intelligence Agency

Principal

- Arizona State University
- BAE Systems – C3I Systems
- Bentley Systems
- Dept. of Science & Technology (India)
- EADS Astrium
- Esri
- Feng Chia University (Taiwan)

Principal

- GIS Center for Security (UAE)
- Google
- Intergraph Corporation
- lat/lon GmbH
- Oracle USA
- Pixia Corp
- The SI Organization
- United Nations
- US National Oceanic and Atmospheric Administration

Example Government Members US

- US DHS
- US DNI (PM/ISE)
- US EPA
- US FAA
- US NASA
- USGS / FGDC
- US NGA
- US NOAA
- Dept. of Land Conservation and Development (Oregon, USA)
- Oakridge National Lab

Example Government Members Europe

- Eurocontrol
- European Environment Agency
- European Space Agency
- EU Joint Research Centre
- UK MET
- METEO France
- BRGM (France)
- Ordnance Survey (UK)
- State Land Agencies (Germany)
- City of Vienna (Austria)

OGC Alliance Partners

GRSS

W3C

ISO International Organization for Standardization

web3D Consortium

GSDI Global Spatial Data Infrastructure

International Environmental Modelling & Software Society (iEMSs)

IETF

AGILE

World Meteorological Organization
Working together in weather, climate and water

OpenGridForum
Open Forum | Open Standards

OSGeo
Your Open Source Compass

OMG
Object Management Group

DGIWG
Digital Geographic Information Working Group

IEEE

isprs

mismo

OASIS

buildingSMART
International Alliance for Interoperability

oma
Open Mobile Alliance

ncoic

OSCRE

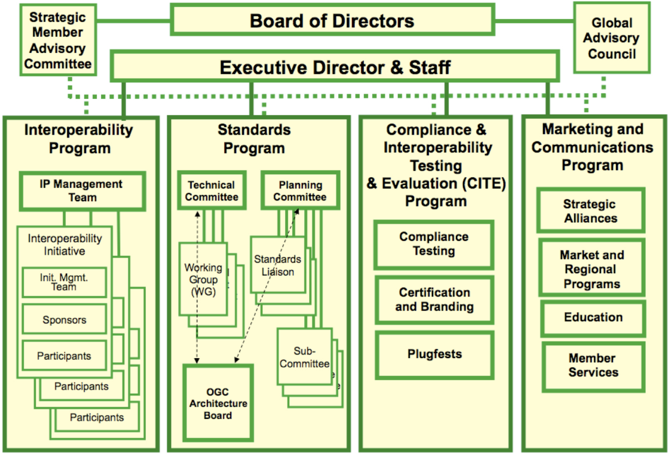
Implementations

There are: 751 Implementing Products and 194 Compliant Products

The table provides a summary of implementing and compliant products. Click on a Specification to view all associated registered products. You can also click the column headers to sort the table.

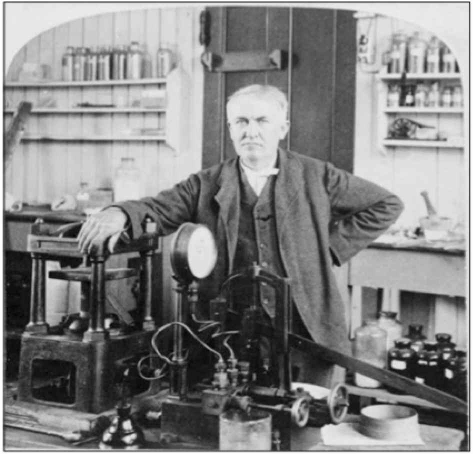
Total = Number of implementations. **Comp** = Number of compliant products.			
Total	Comp.	Specification / Version	Abrv / Version
462	77	Web Map Service (1.1.1)	WMS 1.1.1
293	54	Web Feature Service (1.0.0)	WFS 1.0.0
271	63	Web Map Service (WMS) Implementation Specification (1.3.0)	WMS 1.3.0
265	0	Web Map Service (1.0)	WMS 1.0
233	0	Web Map Service (1.1)	WMS 1.1
214	36	Web Feature Service (WFS) Implementation Specification (1.1.0)	WFS 1.1.0
181	34	Web Coverage Service (WCS) Implementation Specification (Corrigendum) (1.0.0)	WCS 1.0.0
161	0	Geography Markup Language (GML) Encoding Specification (3.1.1)	GML 3.1.1
146	0	Filter Encoding (1.0)	Filter 1.0
134	0	Geography Markup Language (2.1.2)	GML 2.1.2

OGC Structure



The OGC Interoperability Program (IP)

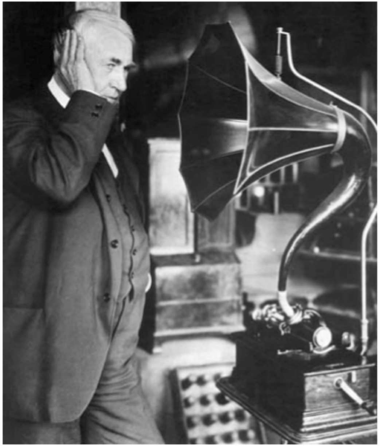
How do we know if an idea works?

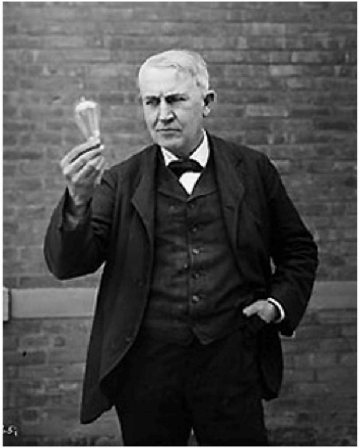


I have not failed, I’ve just found 10,000 ways that won’t work.

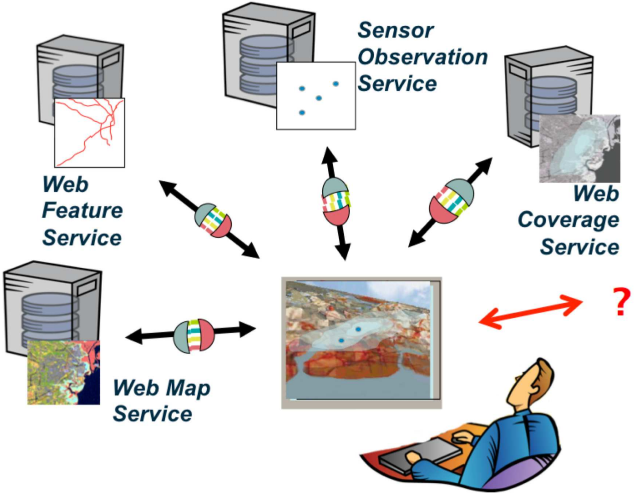
Thomas Edison

Innovation about what?





Innovation about what?



Interoperability Program (IP)

- A global, innovative, hands-on rapid prototyping and testing program designed to unite users and industry in accelerating interface development and validation, and the delivery of interoperability to the market.
- 70 initiatives since 1999
- **Deliverables:**
    - Technical Documents
    - Prototype Implementations
    - Demonstrations

Benefits of Involvement in IP Initiatives

For Participants

- Early insights and skill building
- Early visibility
- Early market deployment
- Direct influence
- Broaden market reach

Benefits of Involvement in IP Initiatives

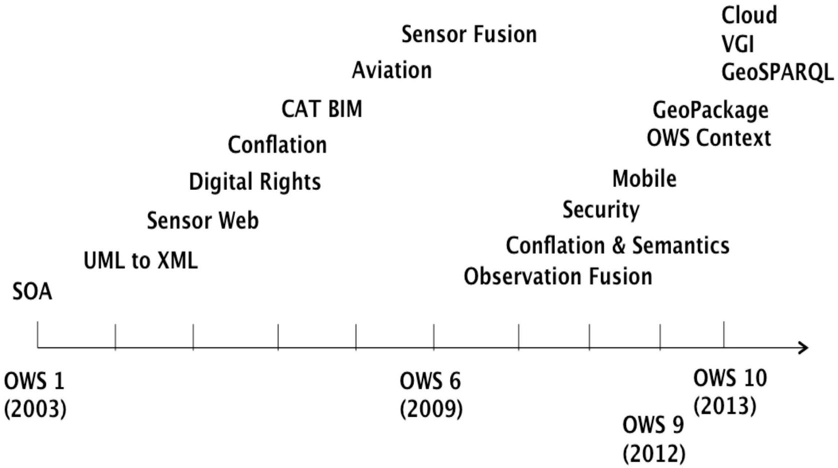
For Sponsors

- Ability to Determine Market Interest
- Accelerated process - workable interface specifications in 4-6 months
- Vendors test, validate and demonstrate interface integrity – Rapid time to market
- Leverage of other sponsor’ funding to solve common/similar problems
- Significant ROI 2-3.5 overall (and as high as 25 for individual sponsors)

IP Type of activities

- **Testbeds**: provide an environment for collaborative, fast-paced, multi-vendor rapid prototyping efforts to define, design, develop, and test candidate interface and encoding specifications.
- **Pilots**: apply and test OGC standards in real world applications using standards-based commercial off-the-shelf (SCOTS) products that implement OGC standards. Pilot Projects also help organizations identify gaps to be addressed by further standards development work.
- **Interoperability Experiments**
- **Concept Development Studies**
- **Plugest**

Testbed Activities



OWS-9 Testbed numbers

- 55 organizations
- More than 200 individuals
- 60 components (Servers, Clients ..)
- 28 reports
- $2.85 Million
- Duration: less than year

OWS-9 Testbed Sponsors

- US National Geospatial Intelligence Agency (NGA)
- US Geological Survey (USGS)
- US Army Geospatial Center (AGC)
- US Federal Aviation Administration (FAA)
- EUROCONTROL

OWS-9 Testbed Sponsors

- US National Aeronautics & Space Administration (NASA)
- UK Defence Science & Technology Laboratory (DSTL)
- Lockheed Martin Corporation
- GeoConnections/Natural Resources Canada
- GeoViqua/CREAF/European Commission (EC)

OWS-9 Testbed Participants

52north
lat/lon raumbezogene informationssysteme
COMPUSULT
COMSOFT
Secure Dimensions
con terra
bolt innovative research
terradue 2.0
LUCIAD high performance visualization
CREAF MiraMon
EUSC European Union Satellite Centre
INTERGRAPH
University of Reading
TerraPixel®
MEEO Meteorological Environmental Earth Observation
rasdaman raster data management
IDS INGEGNERIA DEI SISTEMI
LISAsoft Linking IT
CNR-IIA
The Carbon Project
TRIA GNO SYS
ENVITIA World Class Spatial Information Technologies
galdos systems inc
OpenGeo
Speed 2
iGSI
EOX
ifgi
GIS.FCU
Snowflake software
ATMOSPHERE
NATIONAL WEATHER SERVICE
HARRIS
GEORGE MASON UNIVERSITY
interactive instruments
Universität der Bundeswehr München
Consiglio Nazionale delle Ricerche

The OGC Standards Development Program

It's all about coordinating people

“Interoperability seems to be about the integration of information. What it’s really about is the coordination of organizational behavior.”

David Schell, OGC Founder

Standards Development Program

- Consensus standards process similar to other Industry consortia (World Wide Web Consortium, OMA etc.).
- 33 “core” standards
- 15 extensions/profiles

What is a standard?

- A **document**, established by **consensus** and **approved** by the OGC Membership, that provides rules and guidelines, aimed at the optimum degree of interoperability in a given context.
- **Conveys:**
    - Community requirements
    - Member requirements
    - Market trends
    - Technology trends

Standards List

http://www.opengeospatial.org/standards/is

Observations and Measurements - XML Implementation	2.0	10-025r1	Simon Cox	2011-03-22

This standard specifies an XML implementation for the OGC and ISO Observations and Measurements (O&M) conceptual model (OGC Observations and Measurements v2.0 also published as ISO/DIS 19156), including a schema for Sampling Features. This encoding is an essential dependency for the OGC Sensor Observation Service (SOS) Interface Standard. More specifically, this standard defines XML schemas for observations, and for features involved in sampling when making observations. These provide document models for the exchange of information describing observation acts and their results, both within and between different scientific and technical communities.
See more...

OGC City Geography Markup Language (CityGML) Encoding Standard	2.0	12-019	Gerhard Gröger, Thomas H. Kolbe, Claus Nagel, Karl-Heinz Häfele	2012-04-04

CityGML is an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is an application schema for the Geography Markup Language version 3.1.1 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211. The aim of the development of CityGML is to reach a common definition of the basic entities, attributes, and relations of a 3D city model. This is especially important with respect to the cost-effective sustainable maintenance of 3D city models, allowing the reuse of the same data in different application fields.
See more...

OGC GeoSPARQL - A Geographic Query Language for RDF Data	1.0	11-052r4	Matthew Perry and John Herring	2012-06-12

This standard defines a set of SPARQL extension functions [W3C SPARQL], a set of RIF rules [W3C RIF Core], and a core RDF/OWL vocabulary for geographic information based on the General Feature Model, Simple Features [ISO 19125-1], Feature Geometry and SQL MM.
See more...

OGC KML	2.2.0	07-147r2	Tim Wilson	2008-04-14

KML is an XML language focused on geographic visualization, including annotation of maps and images. Geographic visualization includes not only

Type of Specifications

Implementation Specifications - Standards

Basis for working software; detail the interface structure between software components

Abstract Specifications

Conceptual foundation / reference model for specification development

Best Practices

Describe use of specifications

Engineering Reports

Results from the OGC Interoperability Program

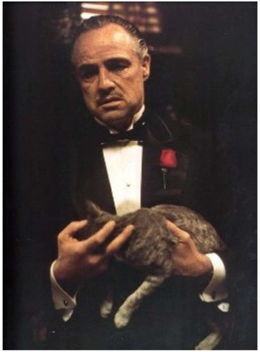
Discussion Papers

Forum for public review of concepts

What it takes

- Requires collaboration on a global basis
- Requires concensus by many organizations
- Requires give and take
- Requires certified, repeatable process

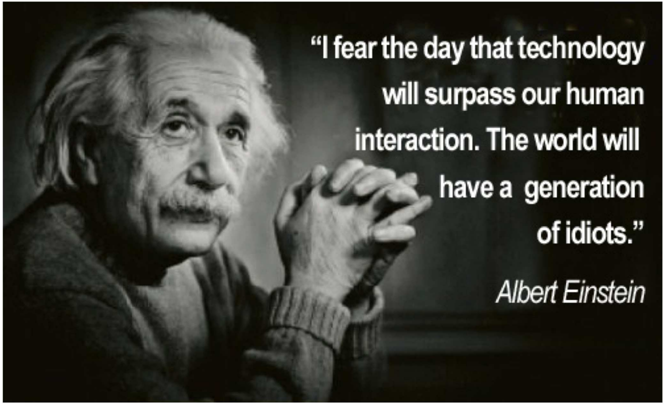
The Core of Consensus Philosophy



"Never get angry. Never make a threat. Reason with people."

Don Vito Corleone
(The Godfather)

Is Social


"I fear the day that technology
will surpass our human
interaction. The world will
have a generation
of idiots."
Albert Einstein

Consensus decision-making

Is a group decision making process that seeks the consent of all participants. Consensus may be defined professionally as an acceptable resolution, one that can be supported, even if not the "favourite" of each individual.

- This is what the OGC standards process is all about!
- Guided by the TC Policies and Procedures
- Also documented in the TAO: A Guide for New Members, the OGC New Member Orientation, and numerous other documents.
- Also guided by the OGC Principals of Conduct

Technical Committee

- Where the formal standards development consensus discussion and approval process occurs.
- Comprised of a number of Domain Working Groups (DWGs or WGs for short) and Standards Working Groups (SWGs).
- Work guided by the Technical Committee Policies and Procedures

Domain Working Groups (DWGs)

Where Members discuss technical requirements, use cases, and issues related to the development and revision of OGC standards. The results of OGC interoperability projects are presented and discussed. Many Member presentations on the use of OGC standards. Any Member or invited guest can attend any DWG session.

3D Information Management DWG

Interoperation across the AEC / CAD / Geospatial domains

- 3D City Models
- 3D Visualization and Portrayal Services
- Location Services
- Indoor Location / Navigation
- CityGML Discussions

Aviation DWG

Develop and test standards-based service-oriented architecture to support the provision of valuable aeronautical information directly to flight decks and Electronic Flight Bags (EFB)

Business Value DWG

Engage senior managers, commercial, sales and marketing professionals from the OGC membership in activities to identify, organize and promote the business value of OGC standards.

Coverages

Promote and oversee development of OGC Implementation Specifications for exploitation of, and accessing, coverage data, including images and other grid coverages. Secondary purposes include promoting use of these specifications, and refining the OGC Abstract Specification as may be needed to better support these specifications.

Workflow

A forum for describing, discussing, and solving any issues related to geospatial workflows. By geospatial workflow we mean any workflows that contain any or all processes that relate to geospatial processes and/or data. The primary focus of this DWG is to help individuals and organizations to identify smarter, easier, and more economical ways to build, migrate, manage, and maintain workflows.

Business Intelligence and Decision Support

Discuss requirements for interfaces necessary for interoperable service chaining (common expression and execution) in the areas of data mining, Integrated Client to access all OWS services and simulation. The DS DWG is currently reworking its mission to better reflect current OGC and IT best practices with regard to decision support.

Defence and Intelligence DWG

Real time access, integration, and fusion of static and real time assets for counter-terrorism, in support of the Warfighter, and other command and control operations

Earth System Science (ESS) DWG

Coordination point for multiple DWGs working geosciences, environmental, and other activities related to the use of OGC standards

Very recent: GeoSciML Discussions

Energy and Utilities DWG

Focus on the global energy and utilities community, which is defined as individuals and organizations engaged in the geospatial aspects of the planning, delivery, operations, reliability and ongoing management of electric, gas, oil and water services throughout the world.

Geosemantics

The mission of the Geosemantics DWG to establish an interoperable and actionable semantic framework for representing the geospatial knowledge domains of information communities as well as mediating between them.

Land Development and Infrastructure DWG

Assess the feasibility of moving the LandXML Schema into LandGML. Engage the existing LandXML user community to identify current satisfaction with the schema and to understand desired enhancements. Develop a demonstration project to test the proposed strategy. Goal: Open Civil and Survey Data Exchange

Law Enforcement and Public Safety (LEAPS) Domain Working Group

Forum for uniting communities of users including government agencies, industry, research organizations, non-governmental organizations and others. Promotes dialog, collaboration and innovation concerning interoperability and standards harmonization within the LEAPS community.

Location Services and Mass Market Domain Working Group

- Navigation
- GeoPackage
- KML
- Mobile – GeoSMS
- Moving Features

Met/Oceans DWG

Enables collaboration and communication between groups with meteorological and oceanographic interests. Maintains a list of topics of interest to the meteorological and oceanographic communities for discussion, defining feedback to the OGC SWGs, and performing interoperability experiments.

http://external.opengeospatial.org/twiki_public/MetOceanDWG

Sensor Web Enablement (SWE) DWG

Enable discovery and tasking of sensor assets, and the access and application of sensor observations for enhanced situational awareness - Sensor Model Language (SensorML) - Observations & Measurements (O&M) - Sensor Planning Service (SPS) - Sensor Observation Service (SOS) - Catalogue Service - Sensor Alert Service (SAS)

And - IEEE 1451 smart sensor standard - OASIS (alert) standards

Standards Working Groups (SWGs)

- Groups that work on a new (candidate) OGC standard or revision to an existing OGC standard
- Members only may participate
- Guided by the OGC Policies and Procedures
- OGC Intellectual Property policies in full effect
- Usually last from 6 months to 18 months

What is the OGC Planning Committee?

- The Planning Committee provides guidance and the management structure for the Technical Committee and the Interoperability Program.
- Members participate in OGC business planning and market focus activities
- Manages the consortium’s technology release process
- Approves special negotiated memberships and committee participation.
- Must be a Principal or Strategic Member or a TC representative to the PC to participate in PC activities.

What is the OGC Architecture Board (OAB)?

- Work with the TC and the PC to insure architecture consistency of the Baseline and provide guidance to the OGC membership to insure strong life cycle management of the OGC standards baseline
- Reviews all OGC standards and revisions to standards prior to public comment.
- General technology discussions and guidance
- Evaluate candidate standards for fast track process
- Issue resolution
- Nominated and Elected by the OGC Membership

Domain Working Groups by Market

- Aviation
- Business Intelligence and Decision Support
- Defence and Intelligence
- Earth System Science (ESS)
- Energy and Utilities
- Hydrology
- LandInfra
- Law Enforcement and Public Safety (LEAPS)
- Location Services and Mass Market Domain
- Met/Oceans

Domain Working Groups by Technology

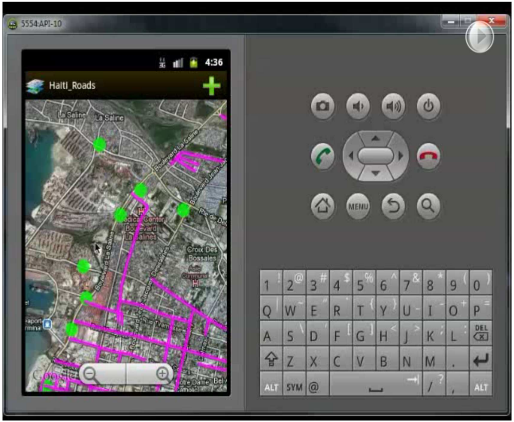
- 3D
- Geosemantics
- Security
- Sensor Web Enablement (SWE)
- Workflow

Introduction to Distributed Computing and Web Services

Publishing Geospatial Data

First Map of the World
Catal Huyuk (South East Turkey) 6200 BC

Publishing Geospatial Data



Viewing and creating data from mobile devices

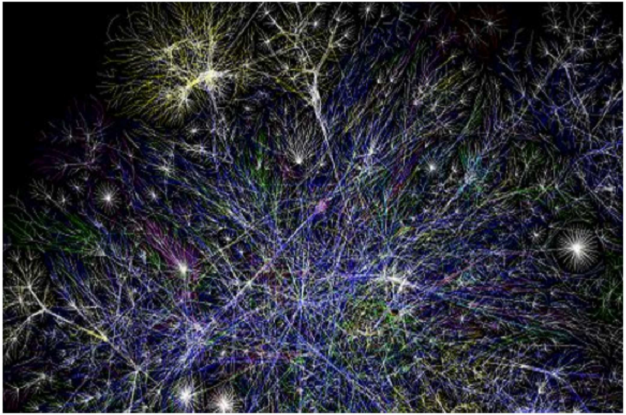
Geo Package

What changed?

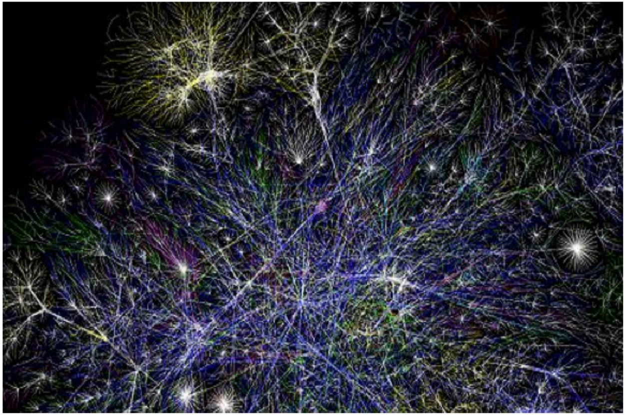
What changed?

Technology

What is this?



Internet



World Wide Web

- Enabled by Internet
- All **Information** from Computers connected around the world.

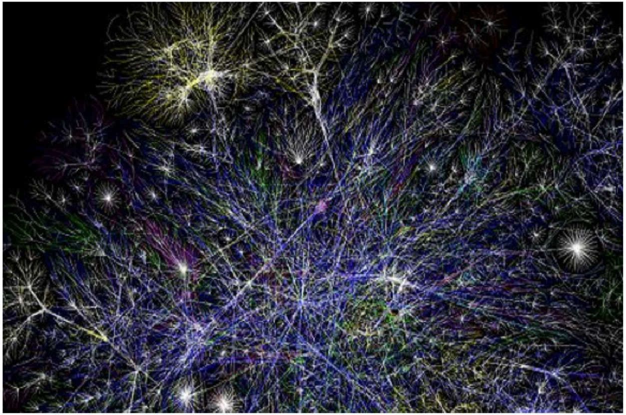
How do we connect to the Web?

- URL
- HTTP GET
- Protocols
- Encodings
- ...

Uniform Resource Locator (URL)

- http://my.umbc.edu/
- ftp://ftp.funet.fi/pub/standards/RFC/rfc959.txt
- mailto:bermud@me.com

Every node can be a URL



Protocols

Protocols

- TCP/IP
- HTTP (GET, POST)

HTTP GET is a URL

```
http://localhost:8080/geoserver/topp/ows?
service=WFS&
version=1.0.0&
request=GetCapabilities
```

HTTP has Parameters and Values

```
http://localhost:8080/geoserver/topp/ows?

service=WFS&
version=1.0.0&
request=GetCapabilities
```

HTTP POST

```
<?xml version="1.0"?>
   <wfs:GetCapabilities
      service="WFS"
      version="1.0.0"
     ...
```

Encodings

<XML />

Service

Distinct part of the functionality that is provided by an entity through interfaces. (ISO 19119:2005)

Interface

Named set of operations that characterize the behaviour of an entity.

Operations

- Specification of a transformation or query that an object may be called to execute. It has a name and a list of parameters.
- For example GetFeature of WFS
- Is defined by a set of protocols (e.g. HTTP GET)

Service

http://en.wikipedia.org/wiki/File:Roomba_original.jpg

Interfaces


Room Selection Interface
Electric Interface
http://en.wikipedia.org/wiki/File:Roomba_orignal.jpg

In an OGC Web Service

- Service = WFS 2.0
- Interface = Basic or Transaction
- Operations for Basic = DescribeFeature and GetFeature
- Protocol = GetFeature uses HTTP Get

Let's Try - Setup

To view HTTP requests, we can use Firefox:

- Open: Tools / Web Developer / Web Console
- Select Net

Let's Try - Test

- Open any page
- Open a wrong URL
- Inspect the console
- Click on example petition: "Get http:// ...."

What Should I get back if I ask a server for a "Toluca"

- A Map of Toluca
- A video
- A picture
- The history
- List of Hotels
- ???

There is a need to design specialized operations

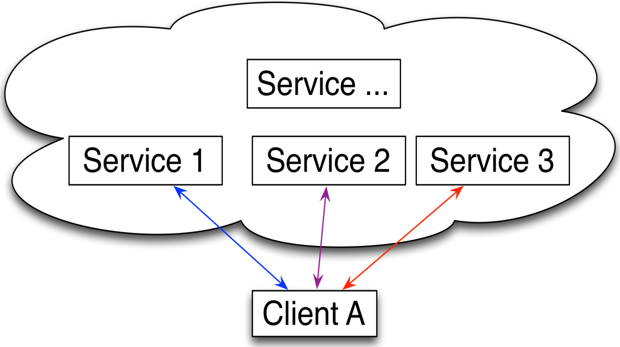
For example, for restaurants services:

- Find me all restaurants 5 km from here
- Find me the restaurant with the best guacamole
- Add my review to restaurant X: " Meat very good, service terrible"
- Reserve the restaurant X for two for today at 8 PM and bring 25 red flowers to the table

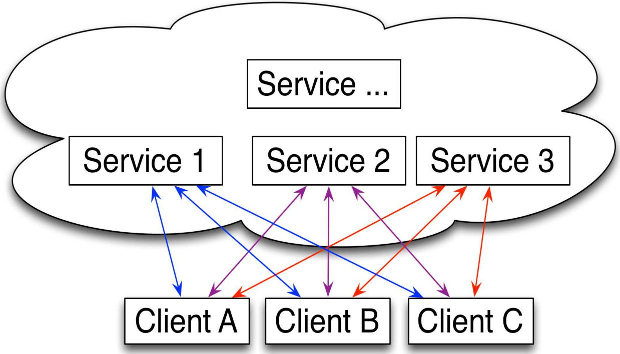
How to get a map?

- getMap
- getImage
- get2dmap
- getlocation
- ...

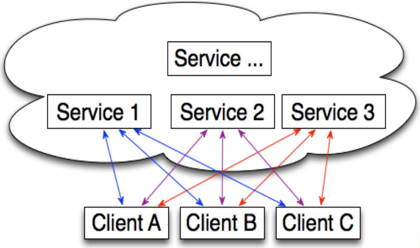
Heterogeneous Services



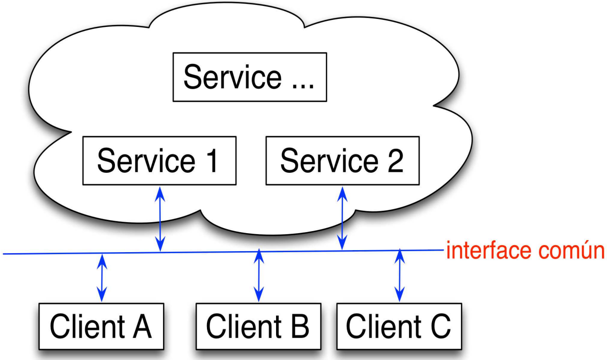
Heterogeneous Services



Lack of agreement looks bad



Agreement of Interfaces- Great!



OWS Common

OGC Web Services Common Standard

Specifies many of the aspects that are common to OGC Web Service (OWS) interface Implementation Standards.

OWS Common Aspects

- GetCapabilities operation (request, parameters, response)
- Exception reports
- Operations parameters
    - Bounding box
    - Coordinate reference systems
    - Format parameters
    - Data descriptions
    - Multilingual text encoding
- Operation request (HTTP GET and HTTP POST)
- Guidance for OWS Implementation Specifications

Example in GetCapabilities

GetCapabilities Request

```
<WFS_Capabilities version="2.0.0"
   xmlns="http://www.opengis.net/wfs/2.0"
   xmlns:wfs="http://www.opengis.net/wfs/2.0"
   xmlns:ows="http://www.opengis.net/ows/
   1.1" ...">
   <ows:ServiceIdentification>
    <ows:Title>WFS 2.0.0 CITE Setup</ows:Title>
    <ows:Abstract></ows:Abstract>
    ...
    <ows:ServiceTypeVersion>2.0.0</ows:ServiceTypeVersion>
   </ows:ServiceIdentification>
  <ows:ServiceProvider>
```

xml elements prefixed with *ows* are defined in ows common

Example in GetCapabilities (cont.)

```
<ows:OperationsMetadata>
    <ows:Operation name="GetCapabilities">
      <ows:DCP>
        <ows:HTTP>
          <ows:Get
            xlink:href="http://cite.lat-lon.de/
               deegree-webservices-3.3.6/
               services/wfs200?"/>
          <ows:Post
            xlink:href="http://cite.lat-lon.de/
               deegree-webservices-3.3.6/
               services/wfs200"/>
        </ows:HTTP>
```

Example in GetCapabilities (cont.)

```
<ows:WGS84BoundingBox>
  <ows:LowerCorner>
      4.486395 51.604992
   </ows:LowerCorner>
  <ows:UpperCorner>
      5.928631 51.680515
  </ows:UpperCorner>
</ows:WGS84BoundingBox>
```

Example in an Error Message

Request example:

```
http://cite.lat-lon.de/deegree-webservices-3.3.6/services/wfs200?
   service=WFS&
   version=2.0.0&
   request=BadRequest
```

Link

Example in an Error Message (Cont.)

Error Response:

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport
   xmlns:ows="http://www.opengis.net/ows/1.1"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://www.opengis.net/ows/1.1
      http://schemas.opengis.net/ows/1.1.0/owsExceptionReport.xsd"
      version="2.0.0">
  <ows:Exception
   exceptionCode="InvalidParameterValue"
   locator="request">
    <ows:ExceptionText>
      No service for request type 'BadRequest' is configured / active.
    </ows:ExceptionText>
  </ows:Exception>
</ows:ExceptionReport>
```

References

Link at OGC

http://www.opengeospatial.org/standards/common

Geographic Modeling Language (GML)

GML

The Geography Markup Language GML is an XML grammar for exchanging geographic data on the Internet. GML serves as a modeling language for communities dealing with geospatial features, GML also serves as an open interchange format for transactions of geographic features between system.

GML is also an ISO standard [#ISO-19136:2007].

The latest version of GML is 3.2.1.

GML

- Defines an abstract feature model
- Provides XML Schemas
- Provides primitives:
    - Geometry
    - Feature Types
    - Coordinate Reference Systems

Feature

Feature has Properties

height = 3.2 m

Geospatial Feature

location

Generalization

Class = Feature Type = Tree

Properties of Tree:

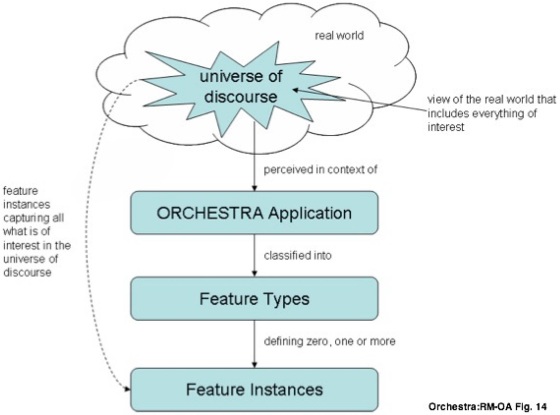
- Height
- Location

All my Trees will have a height and location.

Feature Instance

My favorite tree in Cartagena is the one in front of the hotel Colombia.
Height = 5 mt
Location: Latitude, Longitude
10.407793,-75.551262

Features Modeling



Orchestra:RM-OA Fig. 14

Feature Instance of Type Bridge in GML

```
<Bridge>
  <span>100</span>
  <height>200</height>
  <gml:centerLineOf>
    <gml:LineString>
       <gml:pos>100 200</gml:pos>
       <gml:pos>200 200</gml:pos>
    </gml:LineString>
  </gml:centerLineOf>
</Bridge>
```

GML provides an abstract feature model

```
<complexType name="AbstractFeatureType" abstract="true">
   …
    <complexContent>
          <extension base="gml:AbstractGMLType">
              <sequence>
                  <element ref="gml:boundedBy" minOccurs="0"/>
                  <element ref="gml:location" minOccurs="0"/>
        <!-- additional properties must be specified
            in an application schema -->
              </sequence>
          </extension>
      </complexContent>
```

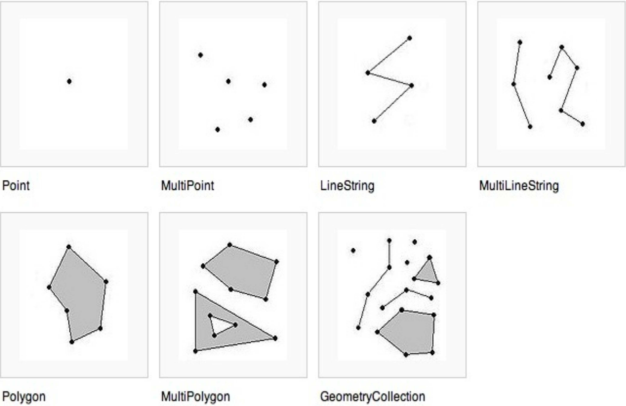
Feature Model for the Bridge Example

```
<xs:schema targetNamespace="http://www.ibbb.org"
      xmlns=""
      xmlns:gml="http://www.opengis.net/gml"
      xmlns:xs="http://www.w3.org/2001/XMLSchema"
      elementFormDefault="qualified"
      attributeFormDefault="unqualified">
   ….
</schema>
```

Feature Model for the Bridge Example

```
<xs:complexType name="BridgeType">
     <xs:complexContent>
          <xs:extension base="gml:AbstractFeatureType">
              <xs:sequence>
              <xs:element name="span"  type="xs:integer"/>
              <xs:element name="height" type="xs:integer"/>
                 <xs:element ref="gml:centerLineOf"/>
               </xs:sequence>
            </xs:extension>
     </xs:complexContent>
 </xs:complexType>
```

GML Geometries



GML Points

```
<gml:Point>
   <gml:pos>0 100</gml:pos>
</gml:Point>

<gml:Point>
   <gml:coordinates>0,100 </gml:coordinates>
</gml:Point>

<gml:Point>
   <gml:coord>0,100 </gml:coord>
</gml:Point>
```

GML Lines

```
<gml:LineString gml:id="p21"
       srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
     <gml:posList dimension="2">
          45.67 88.56 55.56 89.44
      </gml:posList>
 </gml:LineString >
```

How can radio station be modeled?

- Point - when looking at a country map
- Polygon - location of the building
- Multipolygon - Area of Transmition

GML Flavors

GML 2

points, polygons and lineStrings

GML 3

GML 2 + Curves, surfaces, and coverages

GML 3 Simple Feature profiles

GML 3 that looks like GML 2

Communities develop their own Application Schemas

CityGML

Common information model for the representation of 3D urban objects. It defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantic and appearance properties. Included are generalization hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. Major cities in Germany and other locations are being modeled in CityGML. For example, Stuttgart and Berlin city models.

http://www.citygml.org

Communities develop their own Application Schemas

GeoSciML

Accommodates the goal of representing geoscience information associated with geologic maps and observations, as well as being extensible in the long-term to other geoscience data.

An approved standard in that community

http://www.opengis.net/GeoSciML/

Communities develop their own Application Schemas

AIXM

The Aeronautical Information Exchange Model (AIXM) Specification supports the data-centric environment. It supports aeronautical information collection, dissemination and transformation throughout the data chain.

http://www.aixm.aero

Other Application Schemas

- ALKIS/ATKIS - German National Cadastre
- AgroXML - Used in Farm Management Information Systems
- CAAML - Canadian Avalanche Association Markup Language
- CleanSeaNet - Near real time oil spill monitoring
- CSML – Climate Science Modelling
- CWWL - Cyclone Warning Markup Language
- DAFIF – Defense aviation
- GML in JPEG2000
- Tiger/GML - US Census

http://www.ogcnetwork.net/gmlprofiles

Web Feature Service (WFS)

Web Feature Service (WFS)

- Service (Protocol)
- Do the following with Geographic Features:
    - publish
    - access
    - manipulate

WFS Operations

- *getCapabilities* - summary of the service
- *DescribeFeatureType* - structure of the feature types
- *GetFeature* - get the feature instance
- *Transaction* - create, update and delete geographic features
- *Lock Feature* - Protects feature record when updating it.

Web Feature Service (WFS) Demo

GeoServer Demo

- GeoServer is the reference implementation for WFS 1.1.0.
- Open and free software
- Java-based
- Available at: http://geoserver.org

GeoServer Demo

To run the demo a local installation will be used

- http://localhost:8080/geoserver/web/
- click on Demos
- Explore Operations

Example GetCapabilities Request

Request example:

```
http://localhost:8080/geoserver/topp/ows?
service=WFS&
version=1.0.0&
request=GetCapabilities
```

Link to GetCapabilities

Example DescribeFeature Request

Request example:

```
http://localhost:8080/geoserver/topp/ows?
 service=WFS&
 version=1.1.0&
 request=DescribeFeatureType&
 typeName=topp:tasmania_water_bodies
```

Link to DescribeFeature

Example GetFeature Request

Request example:

```
http://localhost:8080/geoserver/topp/ows?
service=WFS&version=1.1.0&request=getFeature&
TypeName=topp:tasmania_water_bodies
```

Link to getFeature request

Query based on values of properties

Lakes with area > 1067000000 cm.

```
http://localhost:8080/geoserver/topp/ows?
  service=WFS&version=1.1.0&request=getFeature&
  TypeName=topp:tasmania_water_bodies&
  FILTER=
     <Filter xmlns="http://www.opengis.net/ogc">
       <PropertyIsGreaterThan>
         <PropertyName>AREA</PropertyName>
         <Literal>1067000000</Literal>
       </PropertyIsGreaterThan>
     </Filter>
```

Link to GetFeature with filter

Client - Server Demo

- Open uDIG
- **Connect with geoserver:**

  http://localhost:8080/geoserver/topp/ows

References

OGC Standards

http://www.opengeospatial.org/standards

GML Application Profiles

http://www.ogcnetwork.net/gmlprofiles

GeoServer

http://docs.geoserver.org/stable/en/user/data/vector/index.html

uDIG

http://udig.refractions.net

WEB Map Service (WMS)

This tutorial provides a practical introduction to OGC Web Map Service (WMS) Interface standard.

Goals

- Understand what WMS can be used for
- Understand WMS requests and best practices

Web Map Service (WMS)

The latest version of WMS is 1.3.0 [#ogc-06-042].

A WMS Server:

- Provides information about what maps a service can produce
- Produces a Map
- Answers queries about content of a Map

WMS Usage

- Produce a Map
- Answer queries about content of the map

WMS Operations

- GetCapabilities
- GetMap
- GetFeatureInfo

WMS Exmpales

The examples are based on a local installation of GeoServer http://geoserver.org/

WMS GetCapabilities

Request example:

```
http://localhost:8080/geoserver/topp/wms?
service=WMS&
version=1.3.0&
request=GetCapabilities
```

Link

WMS GetCapabilities Response

Provides information about:

- How to invoke GetMap
- Types of exceptions
- List of layers

WMS GetMap

Request example:

```
http://localhost:8080/geoserver/wms?
bbox=-130,24,-66,50&
styles=population&
Format=image/png&
request=GetMap&
layers=topp:states&
width=550&height=250&
srs=EPSG:4326
```

`Link
<http://localhost:8080/geoserver/wms?bbox=-130,24,-66,50&styles=population&Form
>`_

WMS GetFeatureInfo

Request example:

```
http://localhost:8080/geoserver/wms?
bbox=-130,24,-66,50&
styles=population&
format=jpeg&
info_format=text/plain&
request=GetFeatureInfo&
layers=topp:states&
query_layers=topp:states&
width=550&height=250&x=170&y=160
```

Link

WMS GetLeyendGraphic

Optional request, provided by WMSs that support SLD

Request example:

```
http://localhost:8080/geoserver/topp/ows?
service=WMS&
request=GetLegendGraphic&
format=image%2Fpng&width=20&height=20&layer=states
```

Link

KML

This tutorial provides an introduction to KML

KML is used for

- Annotate the Earth
- Specify icons and labels to identify locations on the surface of the planet
- Create different camera positions to define unique views for KML features
- Define image overlays to attach to the ground or screen
- Define styles to specify KML feature appearance

KML is used for

- Write HTML descriptions of KML features, including hyperlinks and embedded images
- Organize KML features into hierarchies
- Locate and update retrieved KML documents from local or remote network locations
- Define the location and orientation of textured 3D objects

KML Example

```
<kml xmlns="http://www.opengis.net/kml/2.2">
    <Document>
       <name>Document.kml</name> <open>1</open>
       <Style id="exampleStyleDocument">
           <LabelStyle>
           <color>ff0000cc</color>
           </LabelStyle>
         </Style>
```

KML Example

```
<Placemark>
    <name>Document Feature 1</name>
    <styleUrl>#exampleStyleDocument</styleUrl>
    <Point>
       <coordinates>-122.371,37.816,0</coordinates>
    </Point>
</Placemark>
```

KML Example

```
        <Placemark>
            <name>Document Feature 2</name>
            <styleUrl>#exampleStyleDocument</styleUrl>
            <Point>
               <coordinates>-122.370,37.817,0</coordinates>
            </Point>
        </Placemark>
   </Document>
</kml>
```

Web Coverage Service (WCS)

Coverage

Definition:

space/time-varying phenomena that relate a spatio-temporal domain to a (possibly multidimensional) range of properties

Domain:

grids; polygons, points, etc.

Range components:

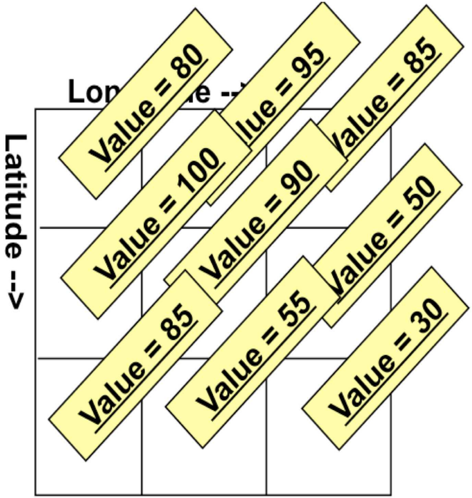
vector- or scalar-valued

Coverage

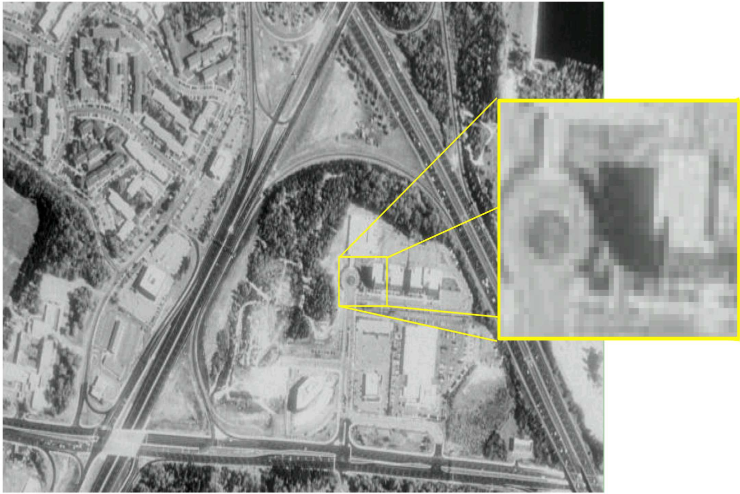
Examples:

- Raster image
- Polygon overlay
- Digital elevation matrix

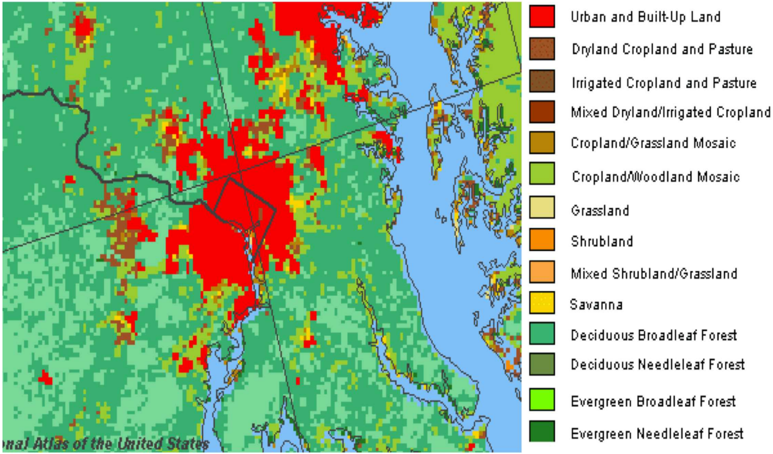
Coverage


Value = 80
Value = 95
Value = 85
Value = 100
Value = 90
Value = 50
Value = 85
Value = 55
Value = 30
Latitude -->

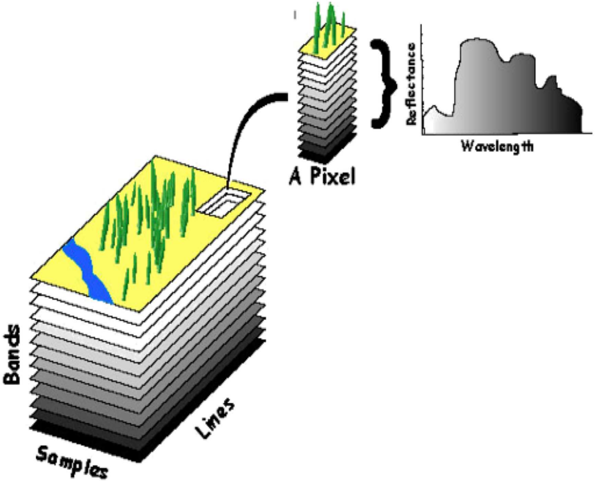
Visible Brightness



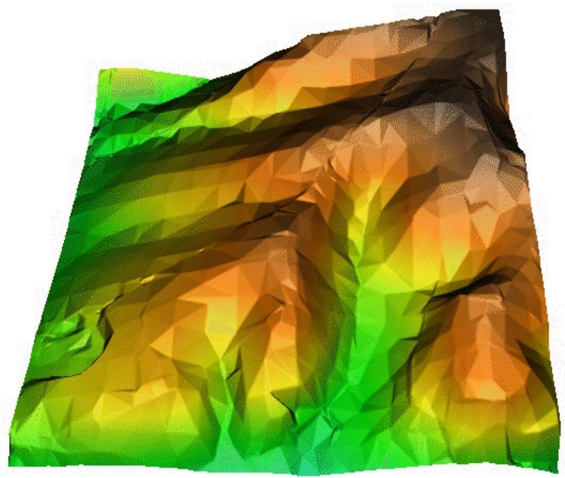
Land use / Land Cover



Multi Spectral Imagery



Triangulated Irregular Network (TIN)



WCS Operations

- **GetCapabilities**: delivers an XML-encoded description of service properties and the data holdings offered by the server inquired;
- **DescribeCoverage**: delivers XML-encoded descriptions of coverages (such as their location in space and time);
- **GetCoverage**: delivers a coverage (or part thereof), either as original data or processed, in some suitable data format.

WCS Protocol Extensions

WCS requests and responses can make use of one of the following protocols:

- GET/KVP: using the HTTP GET protocol for sending key-value-pair (KVP) encoded requests and receiving XML metadata and binary coverage data
- POST/XML: using the HTTP POST protocol for transferring XML data and binary coverage data
- SOAP/XML: using the SOAP protocol for transferring XML data and binary coverage data

WCS format extensions

WCS format encodings allow to deliver coverages in various data format:

- GML
- GeoTIFF
- HDF-EOS
- NITF

Examplar Implementations for Imagery

ESA Heterogeneous Missions Accessibility (HMA)

WCS Application Profile for Earth Observation

Spot Image

WCS for the International Charter on Space and Major Disasters.

Geoeye Geofuse

Imagery holdings with less than 20% cloud cover

Intermap NEXTMap

1-meter vertically accurate digital elevation models and geometric images

Latest Version

Title

OGC® WCS 2.0 Interface Standard- Core: Corrigendum

Version

2.0.1

Document Number

09-110r4

URL

http://www.opengeospatial.org/standards/wcs

Exercise

Server:

EOxServer ESA

URL for Demo Details

http://ows.eox.at

Exercise

1. Explore get Capabilities
2. Invoke the GetCoverage
3. Invoke DescribeCoverage

WCS Get Capabilities

Request example:

```
http://ows.eox.at/cite-wcs?
service=wcs&
version=2.0.0&
request=getcapabilities
```

Link

WCS Describe Coverage

Request example:

```
http://ows.eox.at/cite/ows?
service=wcs&
version=2.0.0&
request=describecoverage&
coverageid=MER_FRS_1PNUPA20090701_124435_
   000005122080_00224_38354_6861_RGB
```

Link

WCS GetCoverage

Request example:

```
http://ows.eox.at/cite-wcs?service=wcs&
version=2.0.0&
request=getcoverage&
CoverageID=MER_FRS_1PNUPA20090701_
  124435_000005122080_00224_38354_6861_RGB
```

Link

Overview Sensor Web Enablement (SWE)

SWE definition

Set of OGC standards that work together to better:

- discover
- access
- control
- use sensor data.

SWE scope

Let's call all these **Sensor Systems** or *Systems*

- Detectors
- Sensors
- Sensor Networks
- Platforms

SWE motivation

- Systems are disconnected
- Systems are heterogeneous
- Systems produce massive amount of data

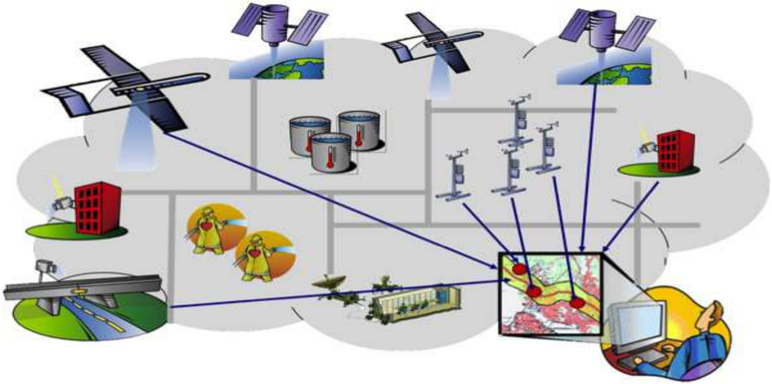
Systems are disconnected

Systems are heterogeneous

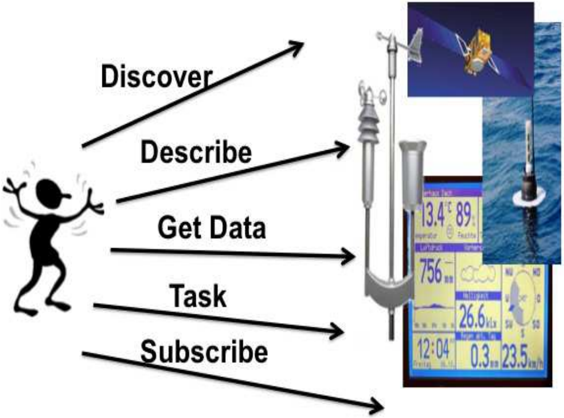
Systems produce lots of data

640 terabytes of operational data on just one Atlantic crossing

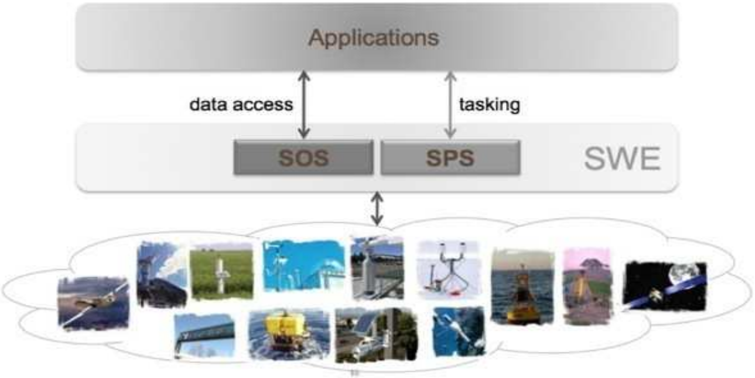
User connected to sensor systems



SWE requirements



SWE solution



SWE encoding standards

- Observations and Measurements (O&M)
- SensorML
- SWECommon
- PUCK

SWE interface standards

- Sensor Observation Service
- Sensor Planning Service
- PUCK

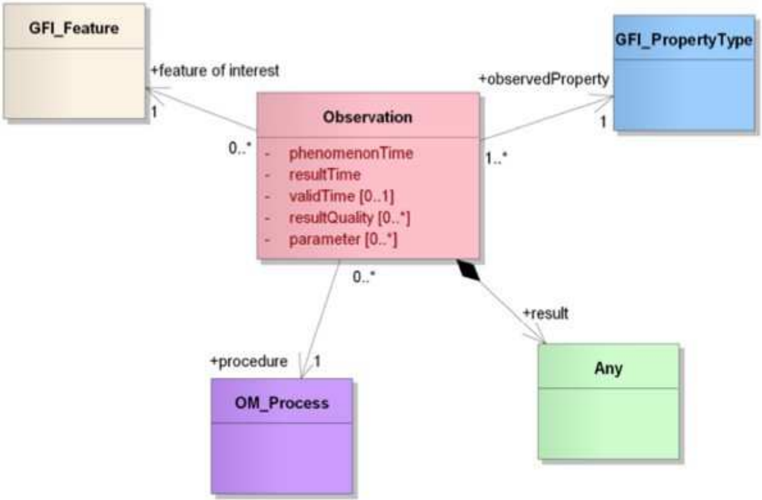
Observations and Measurements (O&M)

This tutorial provides an introduction to the OGC Encoding Standard Observations and Meaurementes

O&M

- An observation is an *event* that
- estimates an *observed property*
- of a *feature of interest*,
- using a *procedure*, and
- generating a *result*

O&M UML


GFI_Feature
+feature of interest
1
0..*
Observation
- phenomenonTime
- resultTime
- validTime [0..1]
- resultQuality [0..*]
- parameter [0..*]
+observedProperty
1
1..*
GFI_PropertyType
0..*
+result
+procedure
1
OM_Process
Any

O&M XML Example

Lets walk through an example from Geonovum

O&M XML Header

```
<?xml version="1.0" encoding="windows-1250"?>
     <om:Measurement gml:id="obsTest"
        xmlns:om="http://www.opengis.net/om/1.0"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xmlns:xlink="http://www.w3.org/1999/xlink"
        xmlns:gml="http://www.opengis.net/gml"
          xsi:schemaLocation="http://www.opengis.net/om/1.0
          ../extensions/observationSpecialization_override.xsd">
```

O&M XML Time

```
<om:samplingTime>
  <gml:TimeInstant>
    <gml:timePosition>2008-10-14T00:09:53+02:00</gml:timePosition>
  </gml:TimeInstant>
</om:samplingTime>
```

O&M XML Procedure

```
<om:procedure
   xlink:href=
         "urn:ogc:object:feature:OSIRIS-HWS:
            a1ef1094-c201-4f9f-8f2e-0ff97bf65f03"/>
```

O&M XML Observed Property

```
<om:observedProperty
   xlink:href="urn:x-ogc:def:property:OGC::RelativeHumidity"/>
```

O&M XML Feature of Interest

```xml
    <om:featureOfInterest>
          <sa:SamplingPoint
       gml:id=
          "urn:ogc:object:feature:OSIRIS-HWS:
             a1ef1094-c201-4f9f-8f2e-0ff97bf65f03"
       xsi:type="ns:SamplingPointType"
          xmlns:ns="http://www.opengis.net/sampling/1.0"
       xmlns:gml="http://www.opengis.net/gml">
     <gml:name>roof of the ifgi</gml:name>
     <sa:sampledFeature
       xlink:href="urn:ogc:object:feature:
          OSIRIS-HWS:hygrometera1ef1094-c201-4f9f-8f2e-0ff97bf65f03"/>
     <sa:position>
       <gml:Point srsName="urn:ogc:def:crs:EPSG:4326">
         <gml:pos>52.07349 9.42125</gml:pos>
       </gml:Point>
     </sa:position>
   </sa:SamplingPoint>
 </om:featureOfInterest>
```

O&M XML Observed Property

```
   <om:result uom="%"
      xlink:href="urn:x-ogc:def:uom:OGC:percent" >41
   </om:result>
</om:Measurement>
```

SWECommon

SWECommon provides

- primitive data types (boolean, categories, text, quantities ..)
- aggregate data types (records, arrays, matrices)
- specialized data types (curves, time dependent)
- Structure to encode quality information
- Structure to provide semantic annotations

SWECommon relation with other encoding standards

- In SensorML inputs and outputs are express via SWECommon
- In O&M the result can be expressed with SWECommon

SWECommon XML Example

Namespace declaration:

```
<?xml version="1.0" encoding="UTF-8"?>
<swe:DataStream id="EXAMPLE_01"
   xmlns:swe="http://www.opengis.net/swe/2.0"
   xmlns:gml="http://www.opengis.net/gml/3.2"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:xlink="http://www.w3.org/1999/xlink"
   xsi:schemaLocation=
         "http://www.opengis.net/swe/2.0 http://schemas.opengis.net/sweCommon/2.0/swe.xsd">
```

SWECommon XML Example

Element Count:

```
<swe:elementCount>
   <swe:Count>
      <swe:value>10</swe:value>
   </swe:Count>
</swe:elementCount>
```

SWECommon XML Example

Data Record and definition of first field (Time):

```
<swe:elementType name="weather_data">
   <swe:DataRecord>
      <!-- -->
      <swe:field name="time">
         <swe:Time definition=
               "http://www.opengis.net/def/property/OGC/0/SamplingTime">
            <swe:label>Sampling Time</swe:label>
            <swe:uom xlink:href=
               "http://www.opengis.net/def/uom/ISO-8601/0/Gregorian"/>
         </swe:Time>
      </swe:field>
```

SWECommon XML Example

Definition of second field (Temperature):

```
<swe:field name="temperature">
   <swe:Quantity definition=
         "http://mmisw.org/ont/cf/parameter/air_temperature">
      <swe:label>Air Temperature</swe:label>
      <swe:uom xlink:href="Cel"/>
      <swe:constraint>
         <swe:AllowedValues>
            <swe:value>1</swe:value>
            <swe:value>2</swe:value>
                      <swe:value>3</swe:value>
            <swe:interval>-50 +50</swe:interval>
            <swe:significantFigures>2</swe:significantFigures>
         </swe:AllowedValues>
```

```
      </swe:constraint>
   </swe:Quantity>
</swe:field>
```

SWECommon XML Example

Definition of third field (Pressure):

```
<swe:field name="pressure">
   <swe:Quantity definition=
         "http://mmisw.org/ont/cf/parameter/air_pressure">
      <swe:label>Atmospheric Pressure</swe:label>
      <swe:quality>
         <swe:Quantity definition=
               "http://sweet.jpl.nasa.gov/2.0/sciUncertainty.owl#Accuracy">
            <swe:uom code="%"/>
            <swe:value>10</swe:value>
         </swe:Quantity>
      </swe:quality>
      <swe:uom code="mbar"/>
   </swe:Quantity>
</swe:field>
```

SWECommon XML Example

Definition of fourth and fifth fields (Wind Vector):

```
      <swe:field name="windSpeed">
         <swe:Quantity definition=
                  "http://mmisw.org/ont/cf/parameter/wind_speed">
            <swe:uom code="km/h"/>
         </swe:Quantity>
      </swe:field>
      <!-- -->
      <swe:field name="windDirection">
         <swe:Quantity definition=
               "http://mmisw.org/ont/cf/parameter/wind_to_direction">
            <swe:uom code="deg"/>
         </swe:Quantity>
      </swe:field>
      <!-- -->
   </swe:DataRecord>
</swe:elementType>
```

SWECommon XML Example

Definition of the encoding and the data:

```
   <swe:encoding>
      <swe:TextEncoding tokenSeparator=","
            blockSeparator="&#32;"
            decimalSeparator="."/>
   </swe:encoding>
   <swe:values>
      2009-01-01T10:00:25Z,25.3,1098,5,56
      2009-01-01T10:00:35Z,25.4,1098,15,59
      2009-01-01T10:00:45Z,25.4,1098,12,42
      ...
   </swe:values>
</swe:DataStream>
```

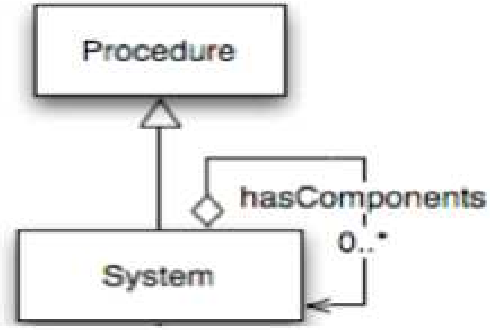
Sensor Model Language
(SensorML)

SensorML For Sensor Systems

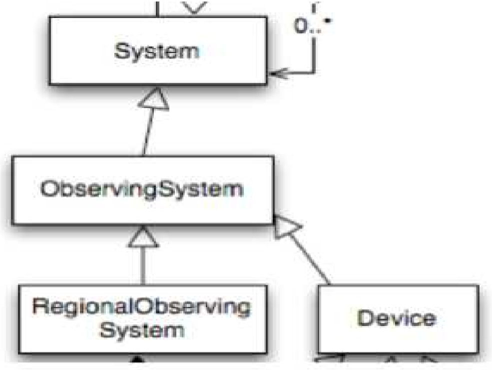
Model to describe Sensor Systems:

- Detector
- Sensor
- Platform
- Observatories

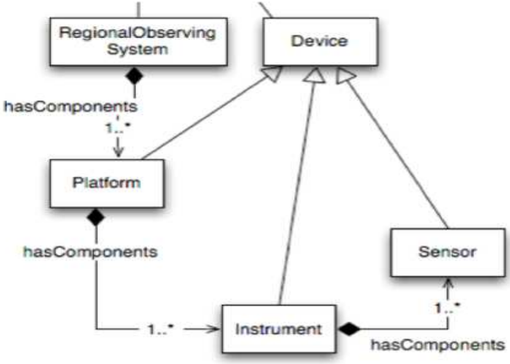
SensorML can define systems



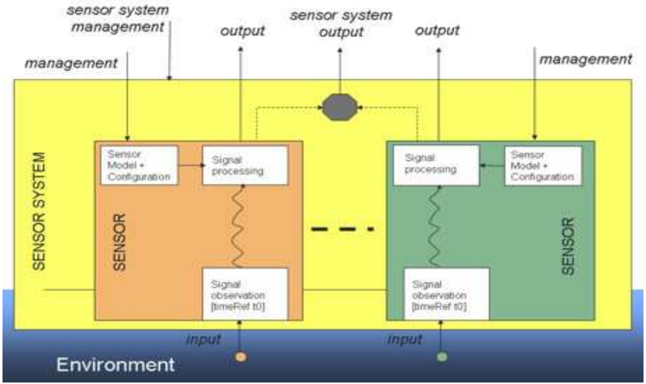
Some types of environmental systems



Instrument composition



SensorML Instrument System



Sensor Web Enablement Architecture, OGC-06-021r4

SensorML can describe a process

Model to describe processes

- inputs
- output
- service chaining

SensorML Processes

Non-Physical Processes

Processes where physical location or physical interface of the process is not important (e.g. a fast-Fourier process)

Physical Processes

Processes where physical location or physical interface of the process is important (e.g. a sensor system)

Atomic Processes

Processes that are considered Indivisible either by design or necessity

<<ProcessType>>
ProcessModel

+ name : string
+ description[0..1] : string
+ metadataGroup
+ input [0..*] : anyData
+ output [1..*] : anyData
+ parameter [0..*] : anyData
+ method : ProcessMethod

<<ProcessType>>
Component

+ name : string
+ description[0..1] : string
+ metadataGroup
+ input [0..*] : anyData
+ output [1..*] : anyData
+ parameter [0..*] : anyData
+ spatialReferenceFrame[0..1] : EngineeringCRS
+ temporalReferenceFrame [0..1] : TemporalCRS
+ boundedBy [0..1] : Envelope
+ position [0..1] : Position
+ interface [0..1] : InterfaceDefinition
+ method : ProcessMethod

Composite Processes

Processes that are composed of other processes connected in some logical manner

<<ProcessType>>
ProcessChain

+ name : string
+ description[0..1] : string
+ metadataGroup
+ input [0..*] : anyData
+ output [1..*] : anyData
+ parameter [0..*] : anyData
+ component [1..*] : Process
+ connection [0..*] : Link

<<ProcessType>>
System

+ name : string
+ description[0..1] : string
+ metadataGroup
+ input [0..*] : anyData
+ output [1..*] : anyData
+ parameter [0..*] : anyData
+ spatialReferenceFrame[0..1] : EngineeringCRS
+ temporalReferenceFrame [0..1] : TemporalCRS
+ boundedBy [0..1] : Envelope
+ position [0..1] : Position
+ interface [0..1] : InterfaceDefinition
+ component [1..*] : Process
+ connection [0..*] : Link

SensorML XML Example

Lets walk through a SensorML example from Geonovum

SensorML XML Keywords

```
<keywords>
  <KeywordList>
    <keyword>weather station</keyword>
    <keyword>precipitation</keyword>
    <keyword>wind speed</keyword>
    <keyword>temperature</keyword>
  </KeywordList>
</keywords>
```

SensorML XML Identification

```xml
<identification>
  <IdentifierList>
    <identifier name="uniqueID">
      <Term definition="urn:ogc:def:identifier:OGC:uniqueID">
        <value>urn:ogc:object:feature:Sensor:IFGI:weatherStation123</value>
      </Term>
    </identifier>
    <identifier name="longName">
      <Term definition="urn:ogc:def:identifier:OGC:1.0:longName">
        <value>OSIRIS weather station 123 on top of the IfGI building</value>
      </Term>
    </identifier>
    <identifier name="shortName">
      <Term definition="urn:ogc:def:identifier:OGC:1.0:shortName">
        <value>OSIRIS Weather Station 123</value>
      </Term>
    </identifier>
  </IdentifierList>
</identification>
```

SensorML XML Classification

```xml
<classification>
  <ClassifierList>
    <classifier name="intendedApplication">
      <Term definition="urn:ogc:def:classifier:OGC:1.0:application">
        <value>weather</value>
      </Term>
    </classifier>
  </ClassifierList>
</classification>
```

SensorML XML Valid Time

```
<validTime>
  <gml:TimePeriod>
    <gml:beginPosition>2009-01-15</gml:beginPosition>
    <gml:endPosition>2009-01-20</gml:endPosition>
  </gml:TimePeriod>
</validTime>
```

SensorML XML Capabilities

```
<capabilities>
  <swe:DataRecord definition="urn:ogc:def:property:capabilities">
    <swe:field name="status">
      <swe:Text definition="urn:ogc:def:property:OGC:1.0:status">
        <gml:description>The operating status of the system.</gml:description>
        <!-- station is active -->
        <swe:value>active</swe:value>
      </swe:Text>
    </swe:field>
    <!-- Area that is observed by the station. In this case is insitu
     It matches the location of the station.  -->
    <swe:field name="observedBBOX">
      <swe:Envelope definition="urn:ogc:def:property:OGC:1.0:observedBBOX">
        <swe:lowerCorner>
```

```
<swe:Vector>
  <swe:coordinate name="easting">
    <swe:Quantity axisID="x">
```

```xml
          <swe:uom code="m"/>
          <swe:value>2592308.332</swe:value>
        </swe:Quantity>
      </swe:coordinate>
      <swe:coordinate name="northing">
        <swe:Quantity axisID="y">
          <swe:uom code="m"/>
          <swe:value>5659592.542</swe:value>
        </swe:Quantity>
      </swe:coordinate>
    </swe:Vector>
  </swe:lowerCorner>
  <swe:upperCorner>
    <swe:Vector>
      <swe:coordinate name="easting">
        <swe:Quantity axisID="x">
          <swe:uom code="m"/>
```

```xml
              <swe:value>2592308.332</swe:value>
            </swe:Quantity>
          </swe:coordinate>
          <swe:coordinate name="northing">
            <swe:Quantity axisID="y">
              <swe:uom code="m"/>
              <swe:value>5659592.542</swe:value>
            </swe:Quantity>
          </swe:coordinate>
        </swe:Vector>
      </swe:upperCorner>
    </swe:Envelope>
  </swe:field>
 </swe:DataRecord>
</capabilities>
```

SensorML XML Contact

```
<contact>
  <ResponsibleParty gml:id="WWU_IfGI_weather_station_contact">
    <organizationName>Westfälische Wilhelms-Universität Münster - Sensor Web and Simulation Lab</organizationName>
    <contactInfo>
      <address>
        <electronicMailAddress>swsl-ifgi@listserv.uni-muenster.de</electronicMailAddress>
      </address>
    </contactInfo>
  </ResponsibleParty>
</contact>
```

SensorML Position

```xml
<position name="systemPosition">
  <swe:Position referenceFrame="urn:ogc:def:crs:EPSG:6.14:31466">
    <swe:location>
      <swe:Vector gml:id="SYSTEM_LOCATION">
        <swe:coordinate name="easting">
          <swe:Quantity axisID="x">
            <swe:uom code="m"/>
            <swe:value>2592308.332</swe:value>
          </swe:Quantity>
        </swe:coordinate>
        <swe:coordinate name="northing">
          <swe:Quantity axisID="y">
            <swe:uom code="m"/>
            <swe:value>5659592.542</swe:value>
```

```xml
          </swe:Quantity>
        </swe:coordinate>
        <swe:coordinate name="altitude">
          <swe:Quantity axisID="z">
            <swe:uom code="m"/>
            <swe:value>297.0</swe:value>
          </swe:Quantity>
        </swe:coordinate>
      </swe:Vector>
    </swe:location>
  </swe:Position>
</position>
```

SensorML Inputs

```
<inputs>
  <InputList>
    <input name="precipitation">
      <swe:ObservableProperty definition="urn:ogc:def:property:OGC:1.0:precipitation"/>
    </input>
    <input name="wind">
      <swe:ObservableProperty definition="urn:ogc:def:property:OGC:1.0:wind"/>
    </input>
    <input name="atmosphericTemperature">
      <swe:ObservableProperty definition="urn:ogc:def:property:OGC:1.0:temperature"/>
    </input>
  </InputList>
</inputs>
```

SensorML Outputs

```
<outputs>
  <OutputList>
    <output name="precipitation">
      <swe:Quantity definition="urn:ogc:def:property:OGC:1.0:precipitation">
        <swe:uom code="mm"/>
      </swe:Quantity>
    </output>
    <output name="windDirection">
      <swe:Quantity definition="urn:ogc:def:property:OGC:1.0:windDirection">
        <swe:uom code="deg"/>
      </swe:Quantity>
    </output>
    <output name="windSpeed">
      <swe:Quantity definition="urn:ogc:def:property:OGC:1.0:windSpeed">
```

```
        <swe:uom code="m/s"/>
      </swe:Quantity>
    </output>
```

```
    <output name="temperature">
      <swe:Quantity definition="urn:ogc:def:property:OGC:1.0:temperature">
        <swe:uom code="Cel"/>
      </swe:Quantity>
    </output>
  </OutputList>
</outputs>
```

SensorML Components

```xml
<components>
  <ComponentList>
    <component name="rainGauge" xlink:href="http://mySensorMLregistry.com?object=98765"/>
    <component name="anemoneter" xlink:href="http://mySensorMLregistry.com?object=33333"/>
    <component name="thermometer">
      <Component>
        ...
      </Component>
    </component>
  </ComponentList>
</components>
```

SensorML Component

```
<!-- similar to System, Contact and Position Information are inherited -->
<Component>
  <keywords>
    ...
  </keywords>
  <identification>
    <IdentifierList>
      <identifier name="uniqueID">
        <Term definition="urn:ogc:def:identifier:OGC:uniqueID">
          <value>urn:ogc:object:feature:Sensor:IFGI:thermometer123</value>
        </Term>
      </identifier>
      <identifier name="longName">
        <Term definition="urn:ogc:def:identifier:OGC:1.0:longName">
```

```
          <value>OSIRIS Thermometer at weather station 123</value>
        </Term>
      </identifier>
      <identifier name="shortName">
        <Term definition="urn:ogc:def:identifier:OGC:1.0:shortName">
```

```
          <value>OSIRIS Thermometer 123</value>
        </Term>
      </identifier>
    </IdentifierList>
  </identification>
  <classification>
    <ClassifierList>
      <classifier name="sensorType">
        <Term definition="urn:ogc:def:classifier:OGC:1.0:sensorType">
          <value>thermometer</value>
        </Term>
      </classifier>
    </ClassifierList>
  </classification>
  <capabilities>
    <swe:DataRecord definition="urn:ogc:def:property:capabilities">
      <swe:field name="status">
```

```
        <swe:Text definition="urn:ogc:def:property:OGC:1.0:status">
          <gml:description>The operating status of the system.</gml:description>
          <swe:value>active</swe:value>
        </swe:Text>
      </swe:field>
```

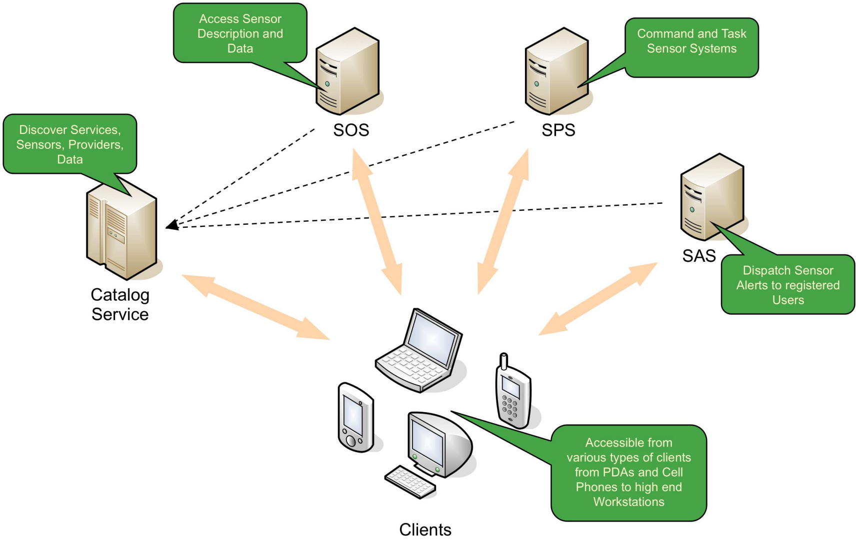
```
    </swe:DataRecord>
  </capabilities>
  <inputs>
    <InputList>
      <input name="atmosphericTemperature">
        <swe:ObservableProperty definition="urn:ogc:def:property:OGC:1.0:temperature"/>
      </input>
    </InputList>
  </inputs>
  <outputs>
    <OutputList>
      <output name="temperature">
        <swe:Quantity definition="urn:ogc:def:property:OGC:1.0:temperature">
          <gml:groupName codeSpace="ObservationOffering"> Weather </gml:groupName>
          <swe:uom code="Cel"/>
        </swe:Quantity>
      </output>
    </OutputList>
  </outputs>
</Component>
```

SWE Services

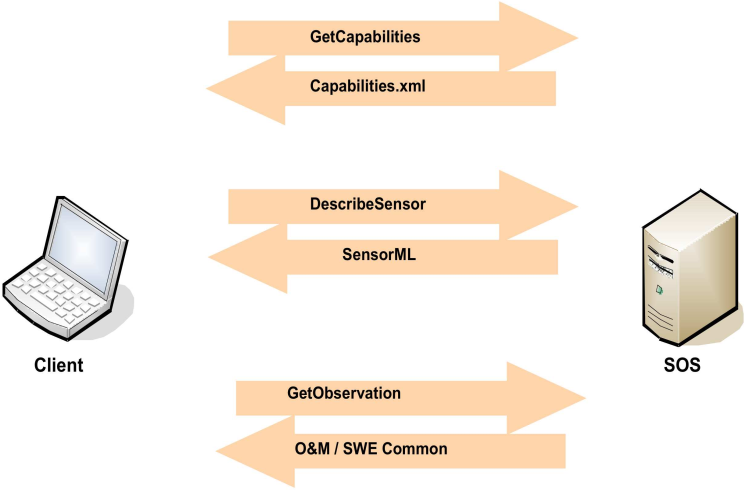
SWE Services

- **Sensor Observation Service** – Access observations and descriptions for sensor systems
- **Sensor Alert Service** – Subscribe to alerts based upon sensor observations
- **Sensor Planning Service** – Request collection feasibility and task sensor system for desired observations
- **Web Notification Service** – Manage message dialogue between client services for long duration (asynchronous) processes
- **Sensor Registries** – Discover sensors and sensor observations

SWE Services


Access Sensor Description and Data
SOS
Command and Task Sensor Systems
SPS
Discover Services, Sensors, Providers, Data
SAS
Catalog Service
Dispatch Sensor Alerts to registered Users
Accessible from various types of clients from PDAs and Cell Phones to high end Workstations
Clients

SOS Operations



SOS GetCapabilities

Request example:

```
http://sensorweb.demo.52north.org/52nSOSv3.2.1/sos?
request=GetCapabilities&
version=1.0.0&
service=SOS
```

Link

SOS DescribeSensor

Request example:

```
http://sensorweb.demo.52north.org/52nSOSv3.2.1/sos?
request=DescribeSensor&
version=1.0.0&
service=SOS&
procedure=urn:ogc:object:feature:Sensor:IFGI:ifgi-sensor-1&
outputFormat=text/xml;subtype="sensorML/1.0.1
```

SOS GetObservation

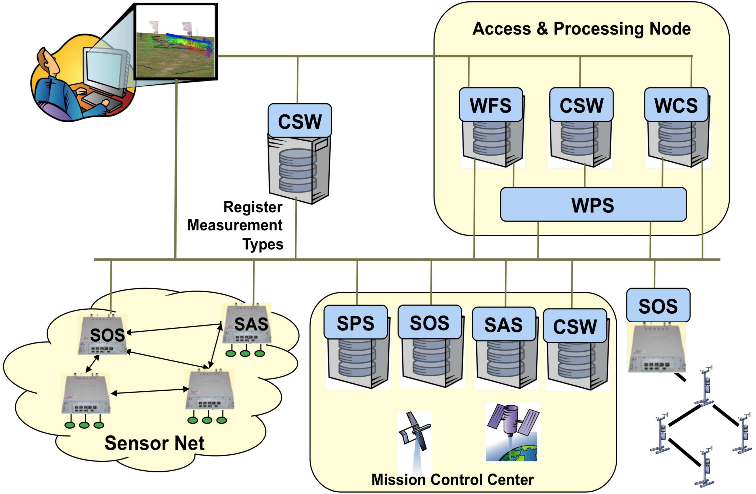
Request example:

```
http://sensorweb.demo.52north.org/52nSOSv3.2.1/sos?
request=GetObservation&
version=1.0.0&
service=SOS&
offering=GAUGE_HEIGHT&
procedure=urn:ogc:object:feature:Sensor:IFGI:ifgi-sensor-1&
observedProperty=urn:ogc:def:phenomenon:OGC:1.0.30:waterlevel&
resPonSeFormat=text/xml;subtype="om/1.0.0
```

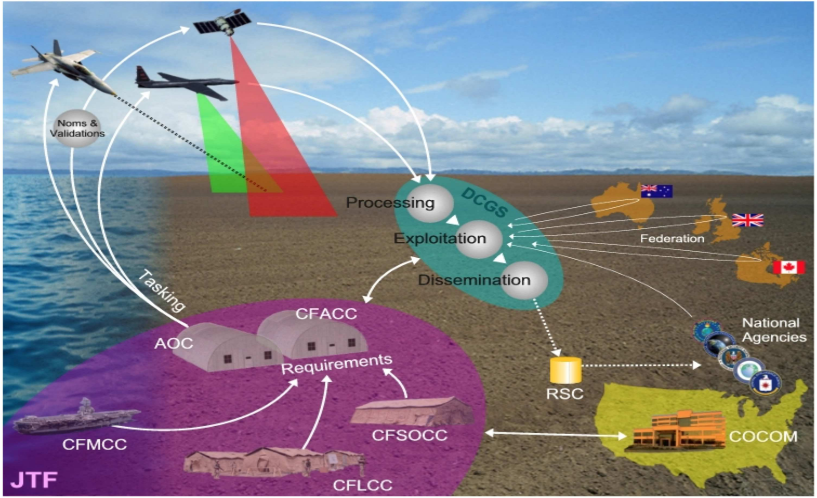
SWE By National Data Buoy Center

SOS NDBC Link

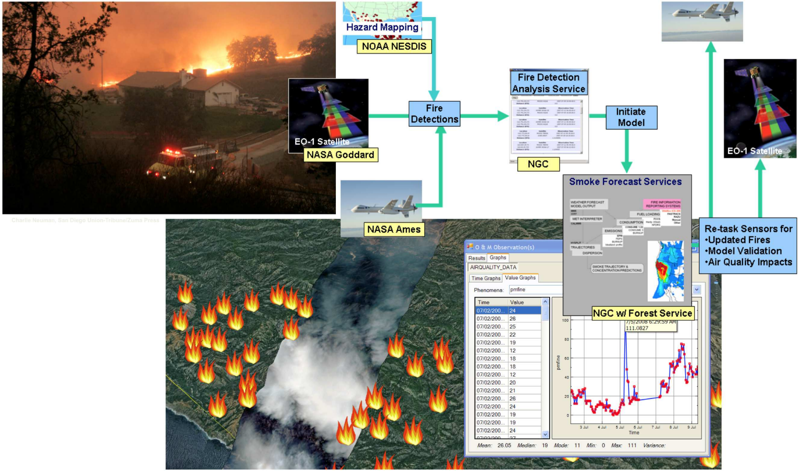
SWE and Geo-processing Workflow



SWE in Defense



SWE in Air Quality



Open GeoSMS

Overview

Open GeoSMS is an open-coordinate short message service (SMS) standard to allow transmission of map information and communications among different platforms of digital maps. The goal is to share location information across operating systems and applications.

Real Time Alerts

Characteristics

- Multilingual
- Multi-device
- Harmonized with many existing applications
- Incorporates relevant ISO standards

Compatible with other standards

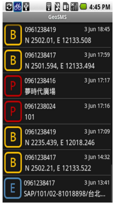
Open GeoSMS encoding for location is compatible with other OGC standards, such as those for sensor webs and earth imaging.

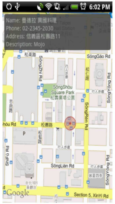
It is also compatible with standards such as the OASIS Common Alerting Protocol (CAP) standard and the IETF RFC Presence Information Data Format Location Object (PIDF-LO).

Organizations using Open GeoSMS

Free App: Open GeoSMSer

- Free download from Android Marketplace
- Get GPS data and send Open GeoSMS to your contact
- Receive Open GeoSMS, bring up map and POI info
- Developed with Open GeoSMS SDK from ITRI





Metadata and Catalogs

- Metadata
- Search
- Catalog
- FGDC
- ISO
- Profiles
- CSW Operations
- OpenSearch

Resource

- A thing
- Anything which is worth uniquely identifying (over the Web)
- Can be data

Metadata

- Data about a resource
- Data about data

Metadata

This is the <u>metadata</u> for this.

What is Missing ?

Nutrition Facts

Serving Size 172 g

Amount Per Serving

Calories 200	Calories from Fat 8
	% Daily Value*
Total Fat 1g	1%
Saturated Fat 0g	1%
Trans Fat	
Cholesterol 0mg	0%
Sodium 7mg	0%
Total Carbohydrate 36g	12%
Dietary Fiber 11g	45%
Sugars 6g	
Protein 13g	

Vitamin A	1% •	Vitamin C	1%
Calcium	4% •	Iron	24%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NutritionData.com

What is Missing ?

Metadata - Who

- Who collected the data?
- Who processed the data?
- Who wrote the metadata?
- Who to contact for questions?
- Who to contact to order?
- Who owns the data?

Metadata - What

- What are the data about?
- What project were they collected under?
- What are the constraints on their use?
- What is the quality?
- What are appropriate uses?
- What parameters were measured?
- What format are the data in?

Metadata - Why

- Why were the data collected?

Where

- Where were the data collected?
- Where were the data processed?
- Where are the data located?

When

- When were the data collected?
- When were the data processed?

How

- How were the data collected?
- How were the data processed?
- How do I access the data?
- How do I order the data?
- How much do the data cost?
- How was the quality assessed?

Metadata requires update

1980	2005
British Honduras	Belize
West Germany	Germany

Metadata Value

- Organizations: captures the knowhow of an organization
- Developers: help share reliable information
- Users: helps discover data

Search

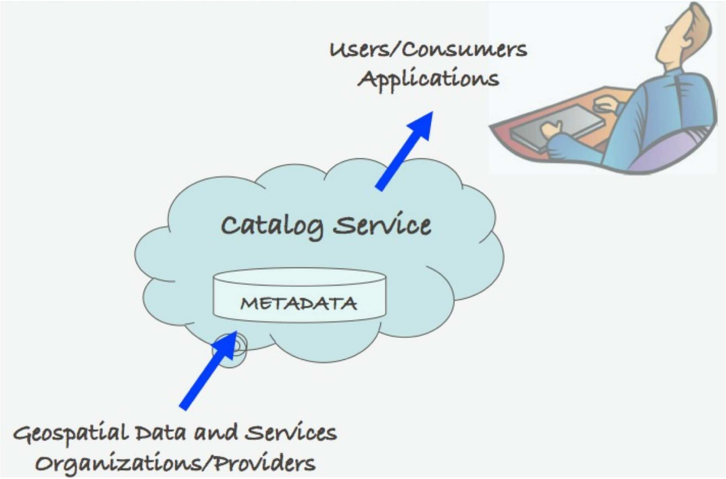
Discovery & evaluation of resources through (summary) metadata

Catalog

- Organized, detailed, descriptive list of items
- arranged systematically (so they can be found)

Catalog

Catalog Service



Registry

System for maintaining a register or authoritative list of names / values / types / relationships (so they can be referenced)

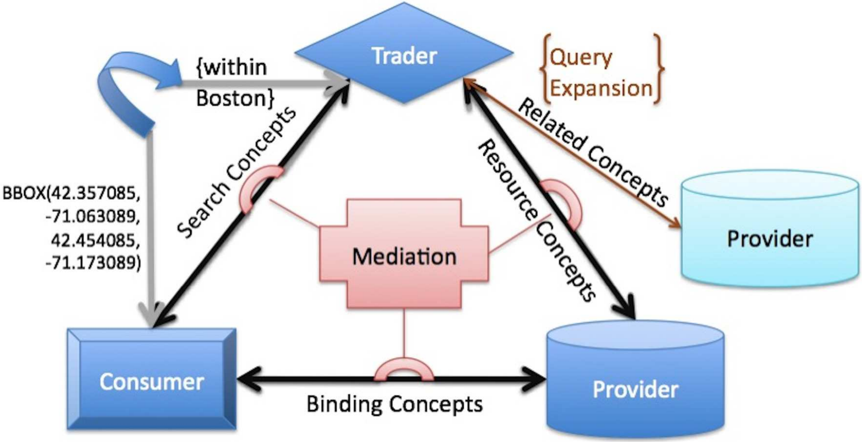
Repository or Archive

Place for storage of resources (so they can be retrieved)

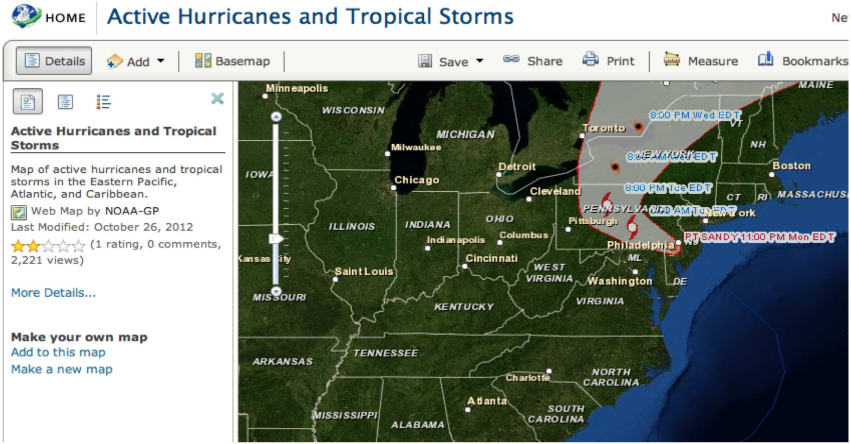
Trader

- Intermediary in a service oriented architecture
- Connects providers with consumers)

Discovery using SOA



Example: Geospatial Platform



Metadata for Hurricane Map

Active Hurricanes and Tropical Storms

Map of active hurricanes and tropical storms in the Eastern Pacific, Atlantic, and Caribbean.

Web Map by NOAA-GP

Last Modified: October 26, 2012

(1 rating, 2,222 views)

Sign In to rate this item.

Open

Description

This map contains the following layers:

Watches, Warnings and Advisories

A warning is issued when a hazardous weather or hydrologic event is occurring, imminent or likely. A warning means weather conditions pose a threat to life or property.
People in the path of the storm need to take protective action.

A watch is used when the risk of a hazardous weather or hydrologic event has increased significantly, but its occurrence, location or timing is still uncertain

Comments (0)

Metadata for Hurricane Map

Access and Use Constraints

The services in this map are not operational and therefore may not be available 24x7.

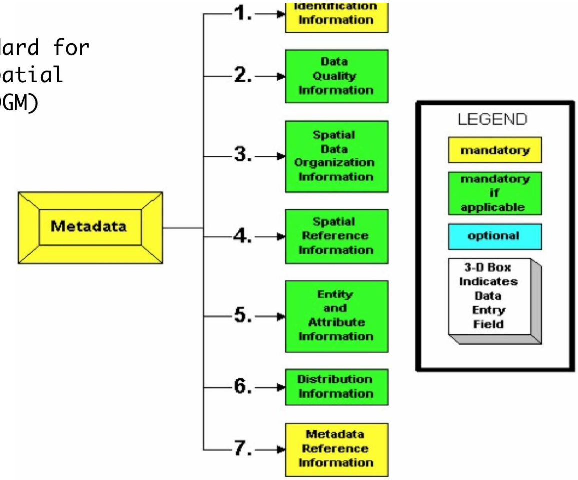
Map Contents

Atlantic and Caribbean:
http://gis.srh.noaa.gov/ArcGIS/rest/services/AtStormViewer/MapServer
Eastern Pacific:
http://gis.srh.noaa.gov/ArcGIS/rest/services/EpStormViewer/MapServer
Imagery with Labels:
http://services.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer
Imagery with Labels:
http://services.arcgisonline.com/ArcGIS/rest/services/Reference/World_Boundaries_and_Places/

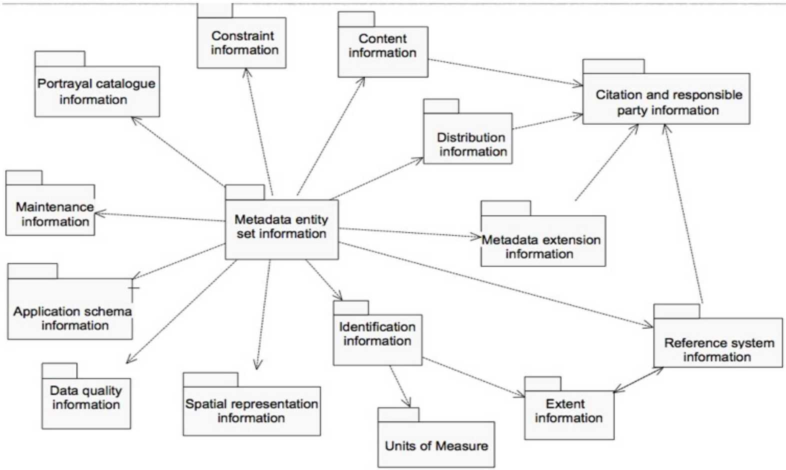
Tags	hurricane forecast, tropical storms
Credits	National Weather Service, National Hurricane Center
Size	184 KB
Extent	Left: -95.05 Right: -50.8
	Top: 44.73 Bottom: 16.44

FGDC

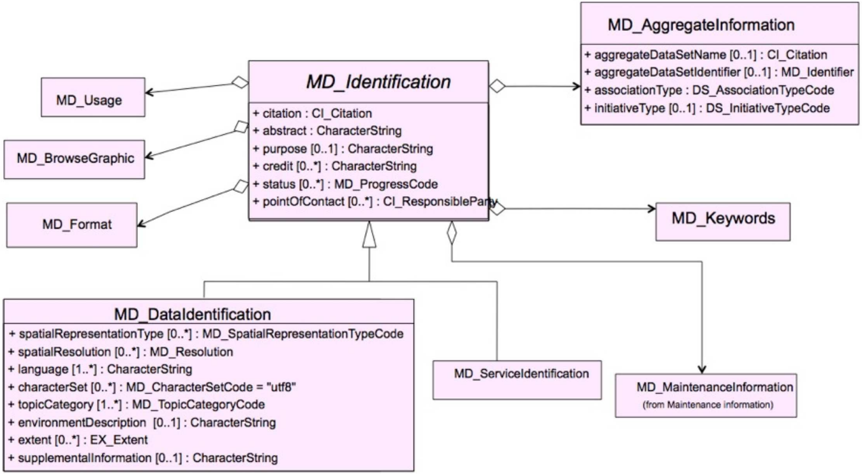
Content Standard for Digital Geospatial Metadata (CSDGM)



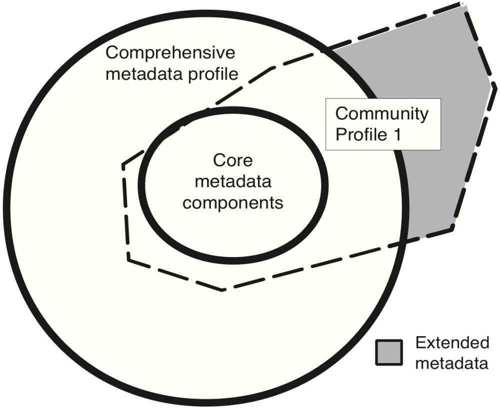
ISO 19115 Geographic Information



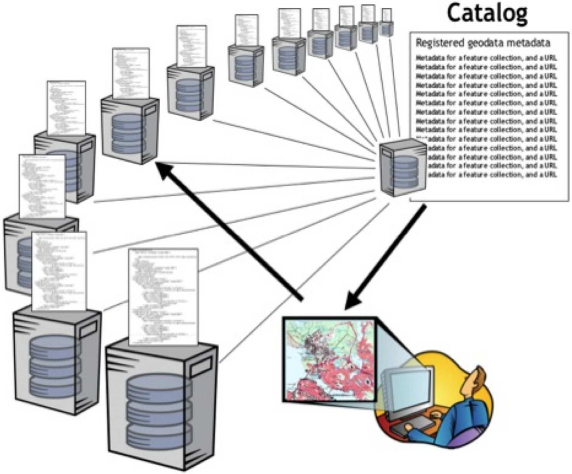
ISO 19115 Geographic Information



Profiles


Comprehensive metadata profile
Community Profile 1
Core metadata components
Extended metadata

Catalog Service



Catalog Services

- CSW
- ISO 19119 Metadata Profile
- Z39.50 Profile
- OASIS ebRIM Profile
- OpenSearch

CSW Record


```xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<Record
   xmlns="http://www.opengis.net/cat/csw/2.0.2"
   xmlns:dc="http://purl.org/dc/elements/1.1/"
   xmlns:dct="http://purl.org/dc/terms/"
   xmlns:ows="http://www.opengis.net/ows"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2
                       ../../../csw/2.0.2/record.xsd">
```

CSW Record

```
...
<Record ...
  <dc:identifier>00180e67-b7cf-40a3-861d-b3a09337b195</dc:identifier>
  <dc:title>Image2000 Product 1 (at1) Multispectral</dc:title>
  <dct:modified>2004-10-04 00:00:00</dct:modified>
  <dct:abstract>IMAGE2000 product 1 individual orthorectified
        scenes. IMAGE2000 was  produced from ETM+ Landsat 7
        satellite data and provides a consistent European
        coverage of individual orthorectified scenes in national
        map projection systems.</dct:abstract>
  <dc:type>dataset</dc:type>
```

CSW Record


```
 ...
 <Record ...
   <dc:subject>imagery</dc:subject>
   <dc:subject>baseMaps</dc:subject>
   <dc:subject>earthCover</dc:subject>
   <dc:format>BIL</dc:format>
   <dc:creator>Vanda Lima</dc:creator>
   <dc:language>en</dc:language>
   <ows:WGS84BoundingBox>
      <ows:LowerCorner>14.05 46.46</ows:LowerCorner>
      <ows:UpperCorner>17.24 48.42</ows:UpperCorner>
   </ows:WGS84BoundingBox>
</Record>
```

Queryable Terms

OGC Term	XML Element
Title	dc:title
Subject	dc:subject
Abstract	dc:description
Modified	dc:modified
Type	dc:type

Queryable Terms

OGC Term	XML Element
Format	dc:format
Identifier	dc:identifier
Source	dc:source
Association	dc:relation
BoundingBox	ows:BoundingBox

OGC Queryable Terms

AnyText

Full text search

CRS

Coordinate Reference System

BoundingBox

For identifying a geographic area of interest

Example Services

GI CAT

PYCSW

ESRI GeoPortal

CSW Operations

- GetCapabilities
- DescribeRecord
- GetRecordById
- GetRecords
- Harvest

CSW GetCapabilities

```
http://ec2-174-129-9-172.compute-1.amazonaws.com/
gi-cat-RI/services/cswiso?
service=CSW&
version=2.0.2&
request=GetCapabilities
```

Link

CSW DescribeRecord

```
http://ec2-174-129-9-172.compute-1.amazonaws.com/
gi-cat-RI/services/cswiso?
service=CSW&
version=2.0.2&
request=DescribeRecord
```

Link

CSW GetRecords

```
http://ec2-174-129-9-172.compute-1.amazonaws.com/
gi-cat-RI/services/cswiso?
service=CSW&
version=2.0.2&
request=GetRecords&
typeNames=csw:Record&
resultType=results&
elementSetName=full&
outputSchema=http://www.opengis.net/cat/csw/2.0.2&
NAMESPACE=xmlns(csw=http://www.opengis.net/cat/csw/2.0.2)
```

Link

Advanced Queries

Performed:

- CQLTEXT
- FILTER

Asynchronous CSW Harvest Request

```xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<Harvest
  service="CSW"
  version="2.0.2"
  xmlns="http://www.opengis.net/cat/csw/2.0.2"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2
                        ../../../csw/2.0.2/CSW-publication.xsd">
  <Source>http://www.yourserver.com/metadata.xml</Source>
  <ResourceType>http://www.fgdc.gov/metadata/csdgm</ResourceType>
  <ResourceFormat>application/xml</ResourceFormat>
  <HarvestInterval>P14D</HarvestInterval>
  <ResponseHandler>
      ftp://ftp.myserver.com/HarvestResponses</ResponseHandler>
</Harvest>
```

Asynchronous CSW Harvest Response

```xml
<?xml version="1.0" encoding="UTF-8"?>
<csw:HarvestResponse
      xmlns:csw="http://www.opengis.net/cat/csw/2.0.2">
  <csw:Acknowledgement timeStamp="2011-12-05T15:13:59">
    <csw:EchoedRequest>
        <csw:Harvest ...
        </csw:Harvest>
    </csw:EchoedRequest>
    <csw:RequestId>
      e7684bec-1fa9-4053-814f-7ae970d7a4a1
    </csw:RequestId>
  </csw:Acknowledgement>
</csw:HarvestResponse>
```

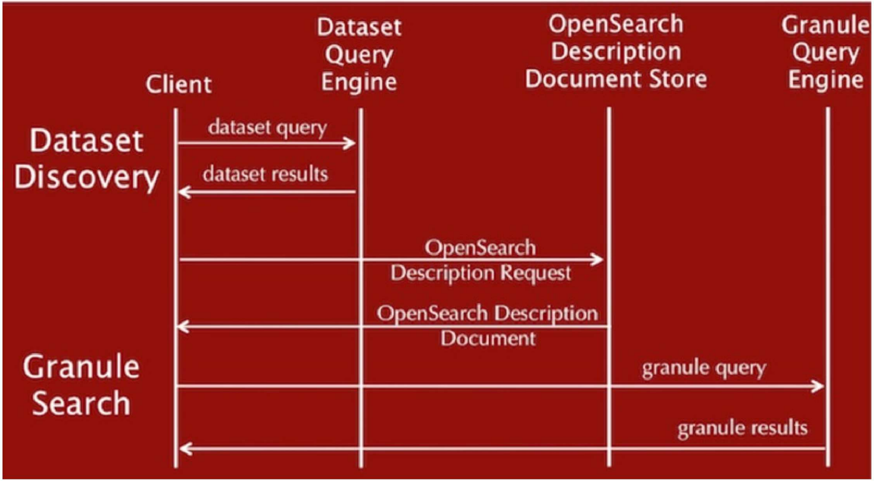
Synchronous CSW Harvest Request

```
<?xml version="1.0" encoding="UTF-8"?>
<csw:Harvest
         xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
         xmlns:gmd="http://www.isotc211.org/2005/gmd"
         service="CSW" version="2.0.2">
   <csw:Source>
      http://[ URL to the target CSW server ]?
      request=GetCapabilities&amp;service=CSW
      &amp;version=2.0.2
   </csw:Source>
   <csw:ResourceType>
      http://www.isotc211.org/schemas/2005/gmd/
   </csw:ResourceType>
</csw:Harvest>
```

Synchronous CCSW Harvest Response

```xml
<?xml version="1.0" encoding="UTF-8"?>
<csw:HarvestResponse
   xmlns:csw="http://www.opengis.net/cat/csw/2.0.2">
    <csw:TransactionResponse>
        <csw:TransactionSummary>
            <csw:totalInserted>22</csw:totalInserted>
            <csw:totalUpdated>0</csw:totalUpdated>
            <csw:totalDeleted>0</csw:totalDeleted>
        </csw:TransactionSummary>
    </csw:TransactionResponse>
</csw:HarvestResponse>
```

OpenSearch


Client
Dataset Query Engine
OpenSearch Description Document Store
Granule Query Engine
Dataset Discovery
dataset query
dataset results
OpenSearch Description Request
OpenSearch Description Document
Granule Search
granule query
granule results

OpenSearch

```xml
<?xml version="1.0" encoding="UTF-8"?>
<OpenSearchDescription
     xmlns="http://a9.com/-/spec/opensearch/1.1/">
  <ShortName>Mirador Dataset Search</ShortName>
  <Description>Use Mirador Dataset Search to obtain a
  list of Earth Science Data Sets</Description>
  <Tags>Mirador Dataset Search</Tags>
  <Contact>mirador-disc@listserv.gsfc.nasa.gov</Contact>
  ...
```

OpenSearch

```
<Url type="application/atom+xml"
        template="http://mirador.gsfc.nasa.gov/cgi-bin/
           mirador/collectionlist.pl?
        keyword={searchTerms}&
        page=1&
        count={count}&
        osLocation={geo:box}&
        startTime={time:start}&
        endTime={time:end}&
        format=atom"/>
```

OpenSearchGeo

```
http://example.com/?
q=pizza&
bbox=-111.032,42.943,-119.856,43.039&
format=rss
```

OpenSearchGeo

```
http://example.com/?
q=pizza&
lat=43.25&lon=-123.45
&radius=10000&
format=rss
```

OpenSearchGeo

```
http://example.com/?
q=pizza&
l=boston&
format=rss
```

Credits

- NOAA NCDDC Metadata training materials

Web Processing Service (WPS)

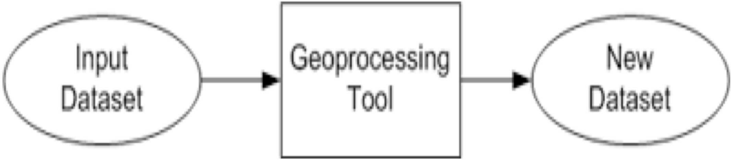
This tutorial provides an introduction to the OGC Web processing Service (WPS) Interface Standard.

Geoprocessing

A GIS operation used to manipulate GIS data.

Examples?

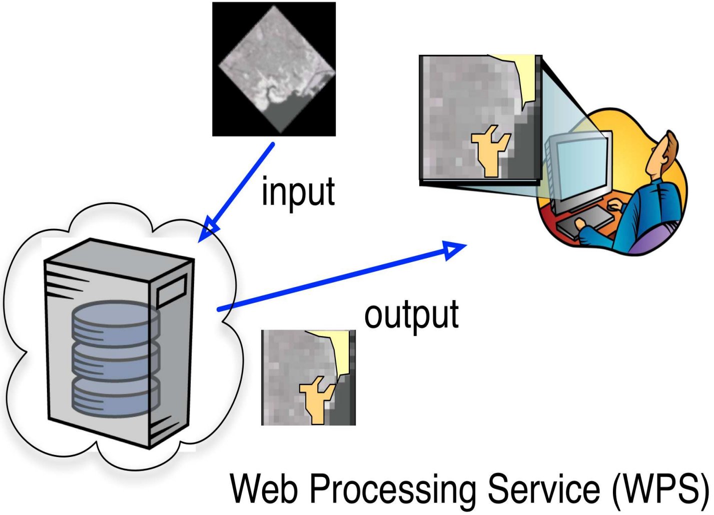
Data Processing



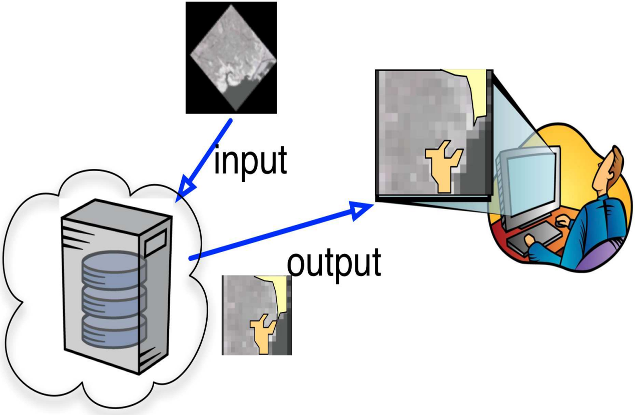
Types of Operations

- Feature Overlay
- Feature Selection
- Topology processing
- Raster processing
- Data Conversion
- Feature Analysis

Web Processing Service

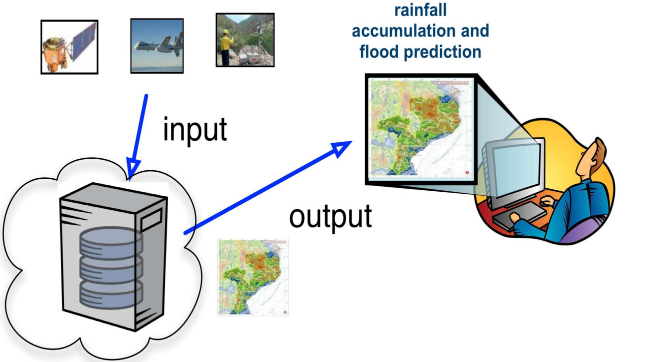


Classification



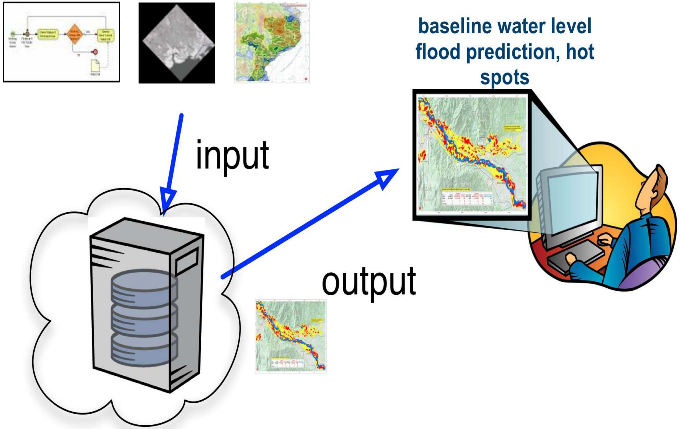
Web Processing Service (WPS) - Classification

Model Run



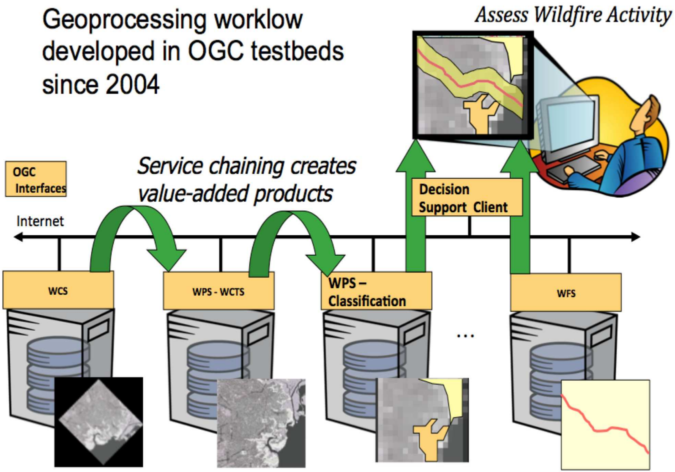
Web Processing Service (WPS) - Model Running

Workflows

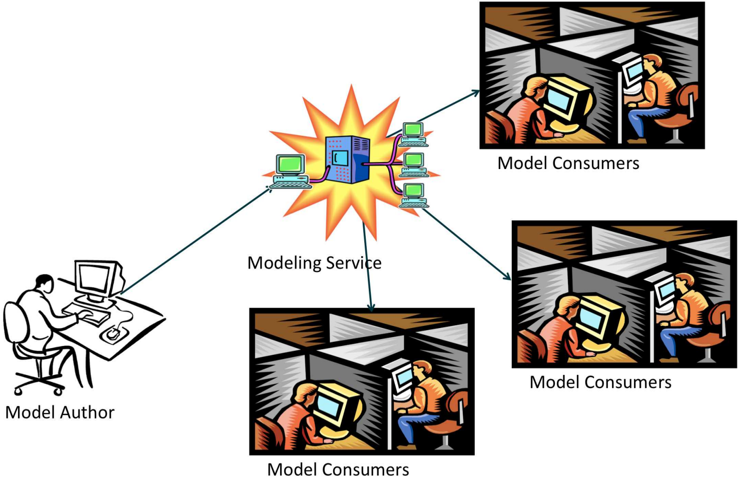


Web Processing Service (WPS) - Workflows

Service Chaining



Reusability



Operations

GetCapabilities

returns information about the service

DescribeProcess

returns details of a specific process including its inputs and outputs

Execute

returns, for a specific process, the output(s) of a process

WPS GetCapabilities

Request example:

```
http://geoprocessing.demo.52north.org:8080/wps/WebProcessingService?
Request=GetCapabilities&
Service=WPS&
Version=1.0.0
```

Link

WPS DescribeProcess

Request example:

```
http://geoprocessing.demo.52north.org:8080/wps/WebProcessingService?
Request=DescribeProcess&
Service=WPS&
version=1.0.0&
identifier=org.n52.wps.extension.GetFuelPriceProcess
```

Link

WPS Execute

Request example:

```
http://geoprocessing.demo.52north.org:8080/wps/WebProcessingService?
Request=Execute&
Service=WPS&
version=1.0.0&
identifier=org.n52.wps.extension.GetFuelPriceProcess&
dataInputs=fuelType=diesel
```

Link

Note how the dataInputs are provided. If more than one, separate by ";"

Parameters DescribeProcess

- service
- request
- describeProcess
- identifier

Input

- URL
- GML
- Image
- Data

Output

- URL
- GML
- Image
- Another service

Open Layers Demo

http://openlayers.org/dev/examples/wps.html

- inspect process types
- run a buffer operation

52North Demo

http://geoprocessing.demo.52north.org:8080/wps/test.html

- run the default buffer operation
- what can I input to the process?

52North Demo

Use another feature collection as input.

For example this getFeature request

More information link

Geospatial Architectures

Computing Architecture

RM-ODP: Different views of the organization of a computing system: Enterprise, Information, computing, engineering, Technology.

Computing Architecture

WIKIPEDIA: A system architecture or systems architecture is the conceptual design that defines the structure and/or behavior of a system. An architecture description is a formal description of a system, organized in a way that supports reasoning about the structural properties of the system. It defines the system components or building blocks and provides a plan from which products can be procured, and systems developed, that will work together to implement the overall system.

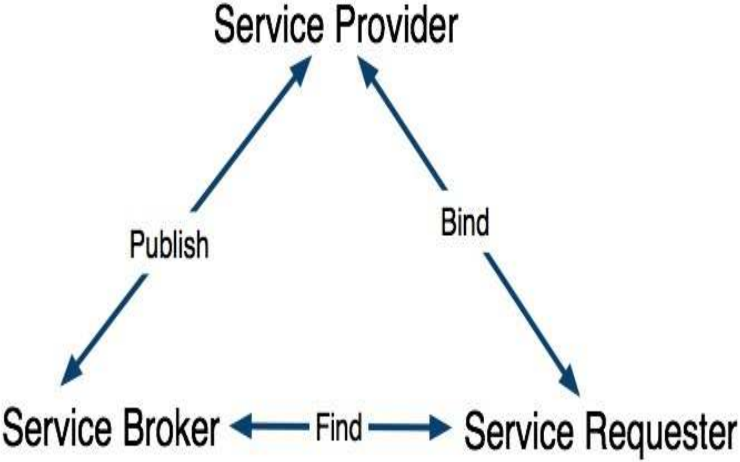
Principles of an Architecture

- Comprehensive framework for developers
- Covers access and process
- Allow variety of sources
- Allow generic computer interfaces
- Within an open information technology environment

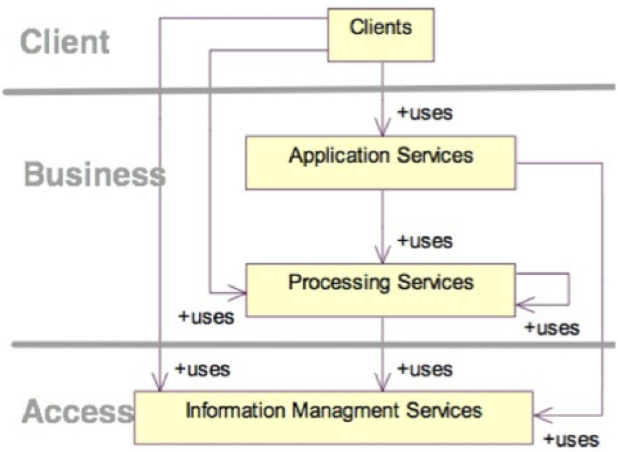
Service Oriented Architecture

(Wikipedia) SOA: computer systems architectural style for creating and using business processes, packaged as services, throughout their lifecycle.

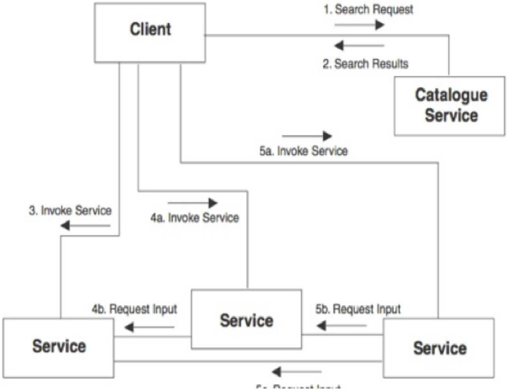
Service Oriented Architectures



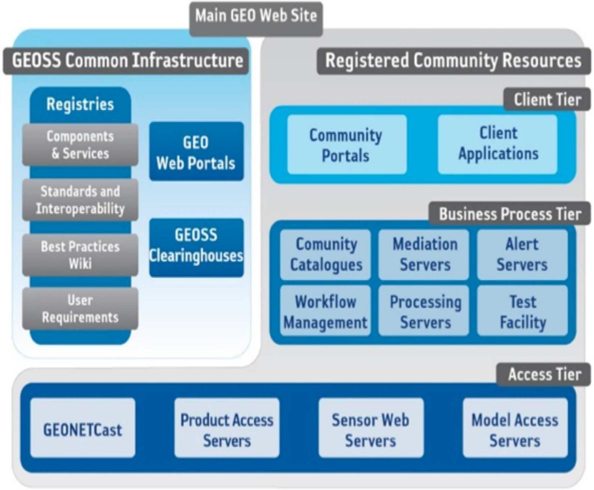
Service Tiers



Chaining


Client
1. Search Request
2. Search Results
Catalogue Service
5a. Invoke Service
3. Invoke Service
4a. Invoke Service
4b. Request Input
Service
5b. Request Input
Service
Service

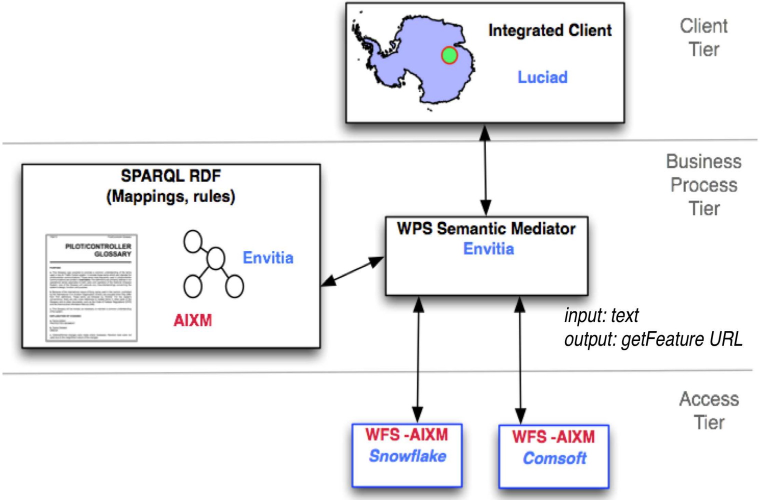
Multitier Architectures



Mediate between heterogeneous sources

- Pilots want to search data using terms from a well know glossary
- Data is in WFS (AIXM)

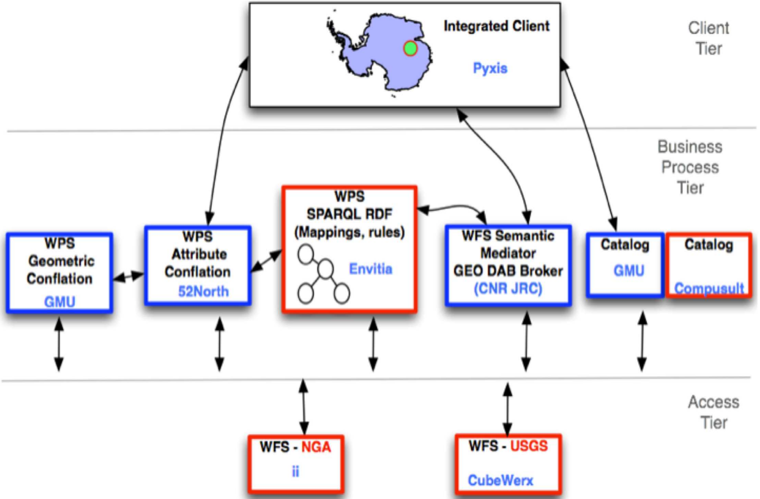
3 Tier Architectures



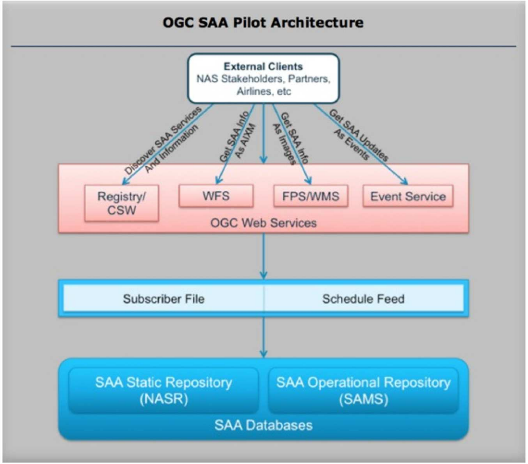
Conflate between heterogeneous models

- Two data sources
- Different models
- One has well know styles associated to its features
- Want to complemented missing data

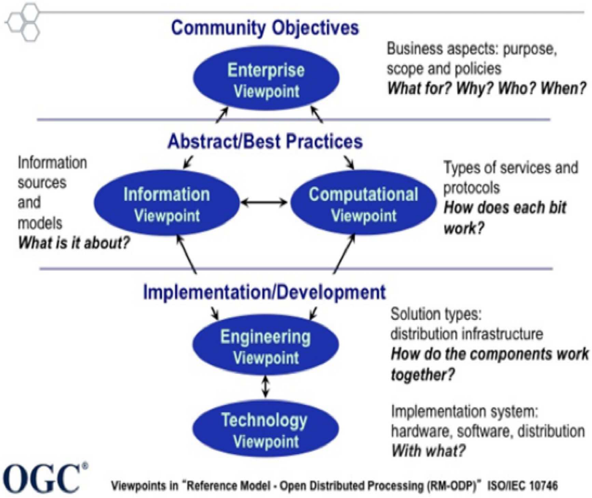
3 Tier Architecture for Conflation



Aviation SAA Pilot



Designing - RM ODP



Enterprise Viewpoint

- stake holders viewpoint
- why the effort in being undertaken
- scope
- objectives
- **defined by: Use Cases**

Enterprise Viewpoint Example

Problem:

Pilots have difficulties querying aviation data Data uses different terminology to what they are used to.

Solution:

Develop a system that allows querying of Aviation data through user terminology from a Pilots’ Glossary

Example use case:

User search for data using Pilot Glossary

Information Viewpoint

- **Conceptual models for**
    - Data
    - Metadata
- **Defines Encoding, For example:**
    - WaterML
    - GML
    - SensorML

Information Viewpoint Example

AIXM in GML

for Aviation Data

Air Transportation Ontology in OWL

for Pilot Glossary terms

AIXM ontology in OWL

to represent Feature Types in AIXM

Computational Viewpoint

Interfaces among service consumers and providers. For example:

- WFS
- WMS
- SOS
- WCS
- CSW
- WPS
- etc..

Computational Viewpoint Example

WFS (AIXM)

to provide aviation data

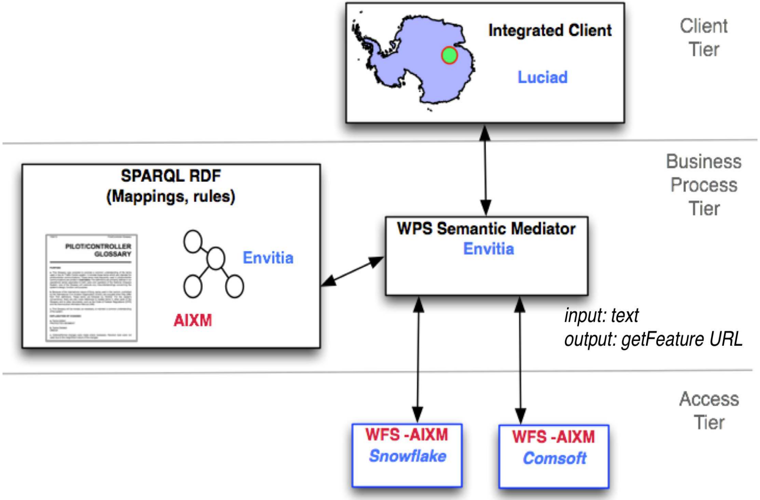
GeoSPARQL

to provide ontologies (including mappings)

Engineering Viewpoint

- Describes Architecture. Which components are needed?
- Explains how services related to each other.
- Services are linked via the interfaces listed in the computational viewpoint.

Engineering Viewpoint Example



Other References

- OGC 08-062r7 - OGC Reference Model (2.1).
- OGC 02-112 - Topic 12 - The OpenGIS Service Architecture
- OGC 07-097 - Reference Model for the ORCHESTRA Architecture
- OGC 10-028r1 - GIGAS Methodology for comparative analysis of information and data management systems
- OGC 11-013r6 - OGC Engineering Report: Water Information Services Concept Development Study
- OGC 11-055 - OGC SAA Pilot Study Engineering Report

Architecture Exercise

Problem

- Agency A and Agency B want to develop an information system to access robbery incidents in a city. They both need access to the information.
- Sources: UAV, citizen data from mobile phones, reports from police officers, 911 center
- **Providers:**
    - 911 command center
    - Wireless Carriers
    - UAV service provider
    - Central Police command center
- **Design an Information System using RM-ODP**

Enterprise Viewpoint

You are hired by Agencies A and B. You need to understand the objectives of the system. Come up with 5 use cases.

Think in terms of the client functionality. - What will th user interface looks like. - If they are buttons what do they do? - What is the default view? Use case example: CLient get base map.

Information Viewpoint

- Conceptual models
- Data types
- Data formats
- For example: RobberyML, which is a GML application profile for robbery events ..

Computational Viewpoint

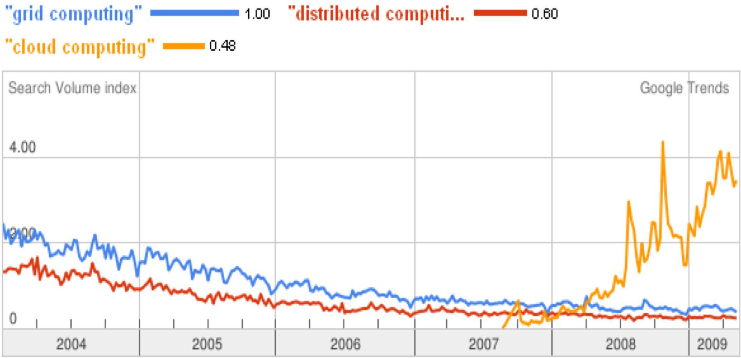
Which Services are required. Usually: - SOS for sensor data - SPS for planning sensors - WFS for vector data - WMS for images - WCS for coverages - WPS for processes - CSW for cataloging services

Engineering Viewpoint

- Is the architecture
- If 3-tier. Put client on the top. Sources on the bottom. Then for every use case create a component that responds to the client requests. If client needs an image from vector data, then a component in the architecture will be a WMS that is also a WFS client. This components can be the source data or in the middle tier.
- Put square boxes presenting the services
- Lines you can put the encoding that is being send by the server

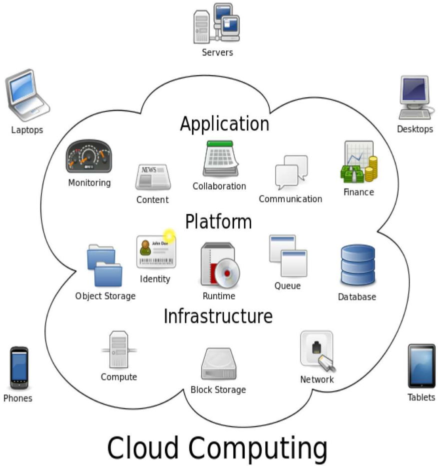
Cloud Computing

Trend

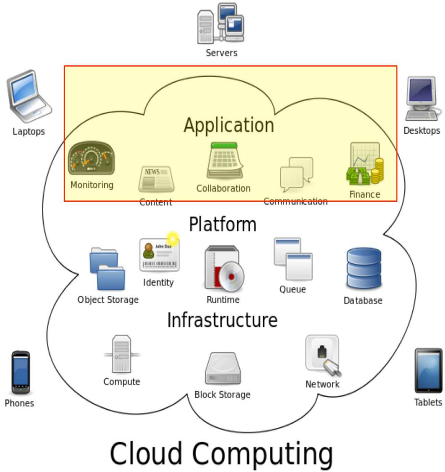


"grid computing" 1.00
"distributed computi... 0.60
"cloud computing" 0.48
Search Volume index
Google Trends
4.00
2.00
0
2004
2005
2006
2007
2008
2009

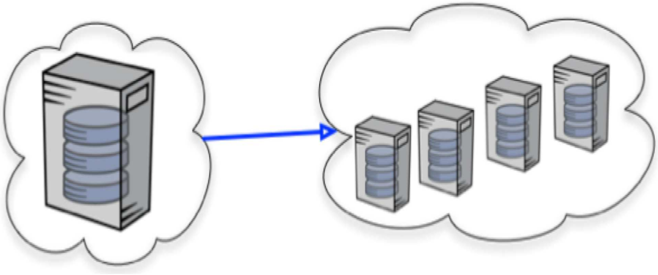
Cloud Computing



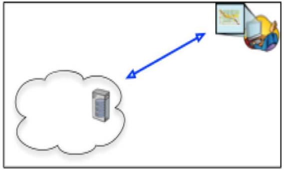
Software as a Service

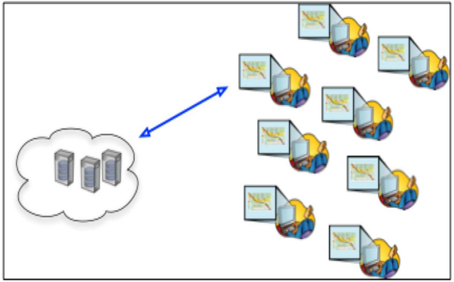


Scalability

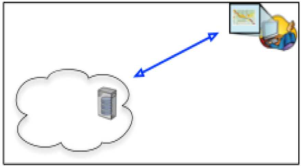


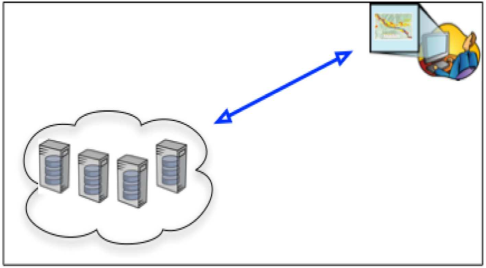
Multiple Requests



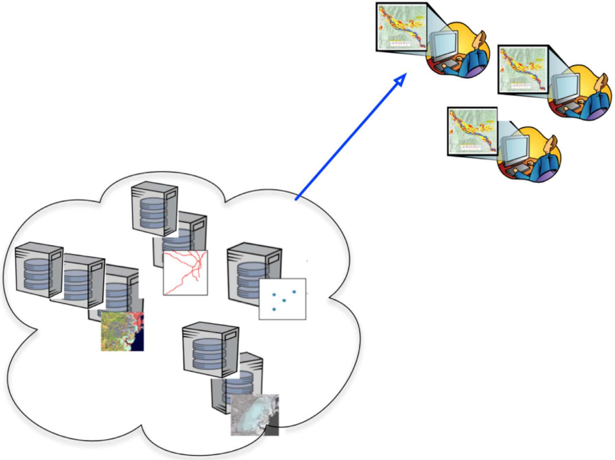


Process Intensive





OGC Services in the Cloud



Comparison Platform as Services

A COMPARISON OF PLATFORM AS A SERVICE (PAAS) CLOUDS WITH A DETAILED REFERENCE TO SECURITY AND GEOPROCESSING SERVICES

Byron Ludwig* and Serena Coetzee

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Commission IV, WG IV/5

KEY WORDS: platform as a service, PaaS, geoprocessing, cloud computing, distributed computing, service level agreement, SLA, security

ABSTRACT:

Cloud computing is an emerging computing paradigm aimed at running services over the internet to provide scalability and flexibility. The advantages in using the cloud for start-up and small businesses that lack infrastructure have been shown to far outweigh the disadvantages. Cloud platform services, also known as Platform as a Service (PaaS), provide a computing platform or solution stack on which software can be developed for later deployment in a cloud. However, there are a number of security challenges because users of the cloud have to rely on third party companies to provide confidentiality, integrity and availability. Geoprocessing is the manipulation of geographic information, ranging from simple feature overlays and geocoding to raster processing and advanced climate modelling. The Open Geospatial Consortium's (OGC) Web Processing Service (WPS) defines a standardized interface that facilitates the publishing of geospatial processes. Parallelization and distribution of geoprocessing services

Monitoring Based Grid Computing

A SOA based debris flow monitoring system

Author(s): Lan-Kun Chung
Geographic Inf. Syst. Res. Center, Feng Chia Univ., Taichung, Taiwan

ABSTRACT

Taiwan is located at the collision boundary of the Philippine sea plate and the Eurasian plate. The mountain terrain is precipitous and the region, on the whole, is characterized by fragile rocks and frequent seismic activity. In addition, the concentrated torrential rainfall brought by typhoons cause extensive disasters, debris flow, the most serious disaster caused by torrential rainfall, lead to very heavy casualties in recent years. There are 17 fixed debris flow monitoring stations and 2 mobile stations deployed in Taiwan. However, the whole architecture was designed in late 2000 and implemented by traditional and proprietary methodologies. Hence, several interoperability issues have been unveiled in the recent years when the needs of interoperability increased. In this study, we propose a whole new and open standards based debris flow monitoring architecture following the service oriented architecture (SOA) paradigm. Relevant open geospatial consortium (OGC) standards (for example Web processing service, WPS specification and sensor web enablement, SWE technologies) and advancements from grid computing where lead into the proposed architecture. The use of open standards and distributed computing technologies in the proposed architecture enables heterogeneous resources (data, processing and computing power) interoperability. This study also implements an OGC WPS grid processing profile that was developed in the OGC Web services, Phase 6 (OWS-6) initiative of the OGC interoperability program.

Geoprocessing in Hybrid Clouds

Geoprocessing in Hybrid Clouds

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Abstract. Meeting specific Quality of Service parameters in distributed architectures is one of the key requirements to build an operational infrastructure. This applies especially to SDIs, which offer geoprocessing functionality. This paper describes Hybrid Clouds as a means to meet these requirements in a efficient way by scaling the processing base load on internal (Private Cloud) and peak loads to external (Public Cloud) Cloud Computing infrastructure. The paper describes an architecture for Hybrid Clouds and a scenario performing image processing at a data center by the means of a Hybrid Cloud.

WMS in Google App Engine

GIS in the cloud: implementing a web map service on Google App Engine

Author: J. D. Blower University of Reading, United Kingdom

Many producers of geographic information are now disseminating their data using open web service protocols, notably those published by the Open Geospatial Consortium. There are many challenges inherent in running robust and reliable services at reasonable cost. Cloud computing provides a new kind of scalable infrastructure that could address many of these challenges. In this study we implement a Web Map Service for raster imagery within the Google App Engine environment. We discuss the challenges of developing GIS applications within this framework and the performance characteristics of the implementation. Results show that the application scales well to multiple simultaneous users and performance will be adequate for many applications, although concerns remain over issues such as latency spikes. We discuss the feasibility of implementing services within the free usage quotas of Google App Engine and the possibility of extending the approaches in this paper to other GIS applications.

OGC and Security

Approach

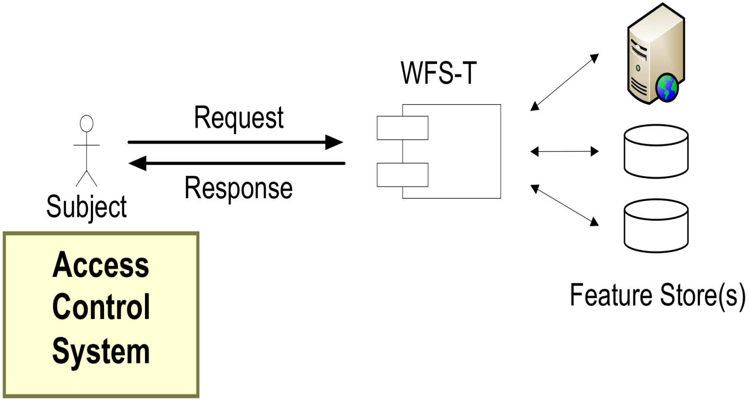
The OGC does not develop authentication, authorization and security standards.

The OGC defines best practices and extensions to existing standards from other standards organizations.

Extensions

- XACML (OASIS): access control policy language in XML and a processing model to interpret the policies
- GeoXACML (OGC): geographic access control rules for distributed geographic content.

OWS-8 AIXM Architecture

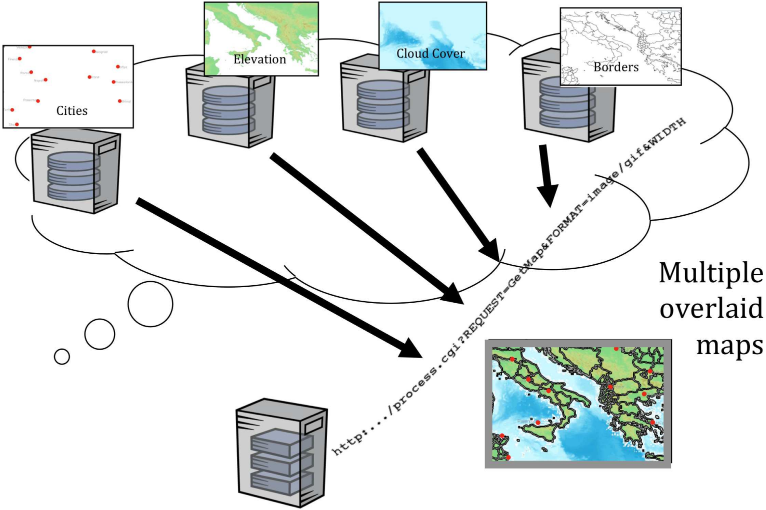


OWS-8 AIXM Architecture

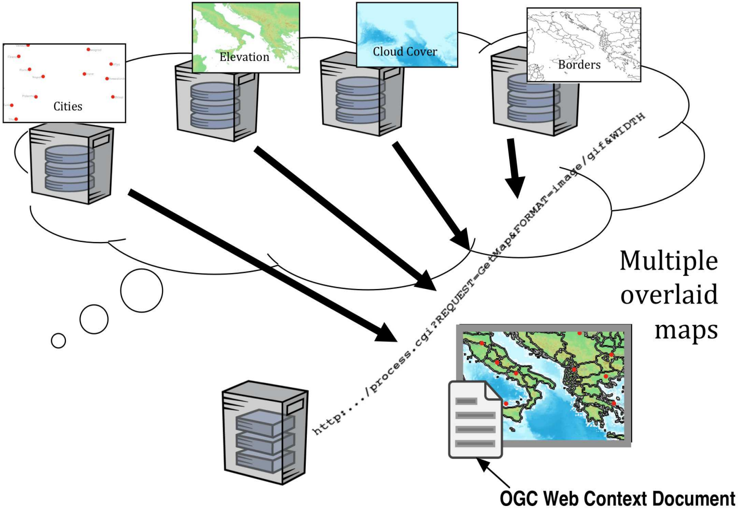
- XACML based Access Control Systems support the enforcement of complex, fine grained rights
- GeoXACML extension of XACML supports geometry and spatial functions
- Examples:
    - deny if user interacts with a service on IP 123.123.123.123
    - permit if Alice has activated role xyz and interacts with services of type WFS 2.0
    - permit if GetFeature requests refer to features of type Runway within a certain area
    - permit if the request is a valid (de-)commissioning for features of type RadarSystem

OGC Web Context

A Map from different sources



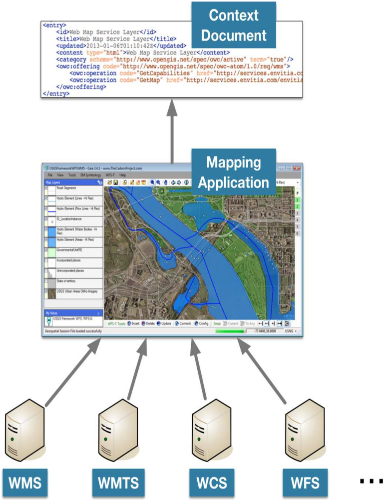
How do we share the map?



For example sharing via Email

OGC Web Context Document

Sources


Context Document
<entry>
<id>Web Map Service Layer</id>
<title>Web Map Service Layer</title>
<updated>2013-01-06T01:10:42Z</updated>
<content type="html">Web Map Service Layer</content>
<category scheme="http://www.opengis.net/spec/owc/active" term="true"/>
<owc:offering code="http://www.opengis.net/spec/owc-atom/1.0/req/wms">
<owc:operation code="GetCapabilities" href="http://services.envitia.co
<owc:operation code="GetMap" href="http://services.envitia.com/envitia
</owc:offering>
</entry>
Mapping Application
WMS
WMTS
WCS
WFS
...

Anatomy of a context document

- A context document extends the Atom XML format (or in the future JSON).
- It contains Atom <entries> which have OGC <offering>s.
- Offerings are data sources: Services (e.g. WMS, WFS, WMTS and WCS) or file-based data sets (e.g like GML, KML and PDF).
- File-based data sets may be specified by reference with a URL, or included inline.
- OGC service offerings contain a GetCapabilites request and a request to get data, such as GetMap, GetTiles, GetFeature, etc.
- Offerings do not have to be spatial, so clients implementing Context should handle non-spatial offerings in a way other than mapping them.

Example WMS

```
<entry>
   <owc:offering
   code="http://www.opengis.net/spec/owc-atom/1.0/req/wms">
   <owc:operation code="GetCapabilities" method="GET"
      type="application/xml"
      href="http://aserver/wms?
      SERVICE=WMS&amp;VERSION=1.3.0&amp;
         REQUEST=GetCapabilities"/>
   <owc:operation code="GetMap" method="GET" type="image/png"
      href="http://http://aserver/wms?
         SERVICE=WMS&amp;VERSION=1.1.1&amp;
         REQUEST=GetMap ...

         "/>
   </owc:offering>
</entry>
```

Example WMS

```
<owc:operation code="GetMap" method="GET" type="image/png"
   href="http://http://aserver/wms?
      SERVICE=WMS&amp;
      VERSION=1.1.1&amp;
      REQUEST=GetMap&amp;
      SRS=EPSG:4326&amp;
      BBOX=-2,45,8,55&amp;
      WIDTH=500&amp;
      HEIGHT=500&amp;
      LAYERS=385d7d71-650a-:MER_RR__2P000262.tif&amp;
      FORMAT=image/png&amp;
      BGCOLOR=0xffffff&amp;
      TRANSPARENT=TRUE&amp;
      EXCEPTIONS=application/vnd.ogc.se_xml"/>
```

Example WFS

```
<entry>
  <owc:offering code="http://www.opengis.net/spec/owc-atom/1.0/req/wfs">
    <owc:operation method="GET”
      code=" href="http://aService/wfs?
      SERVICE=WFS&amp;VERSION=1.0.0&amp;
      REQUEST=GetCapabilities"
      type="text/xml" />
    <owc:operation method="GET"
      code="GetFeature" href="http://aService/wfs?
      SERVICE=WFS&amp;VERSION=1.1.0&amp;
      REQUEST=GetFeature&amp;
      NAMESPACES=
         xmlns(tds,http:%2F%2Fmetadata.dod.mil%2Fmdr%2Fns%2FGSIP%2F3.0%2Ftds%2F3.0)&amp;
      OUTPUTFORMAT=text/xml;%20subtype=gml/3.2.1&amp;
      BBOX=-90,-180,90,180&amp;
      TYPENAME=gml:AbstractFeature" />
  </owc:offering>
</entry>
```

Status

- Publicly available version 1.0 soon
- https://portal.opengeospatial.org/files/?artifact_id=56598

GeoPackage

Motivation

- Shapefiles, as a format, are dinosaurs
- web services don’t work without internet access
- internet sucks power from a mobile device

Overview

A GeoPackage is a platform-independent SQLite database file. It may contain:

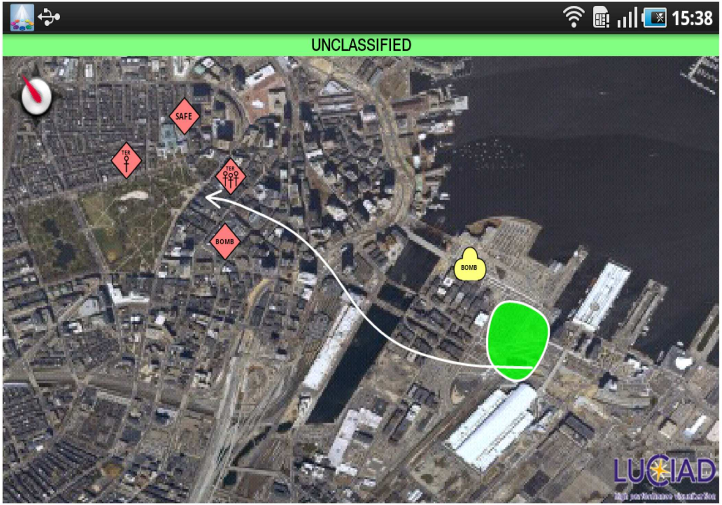
- Data in any geographic or projected CRS using any Datum
- Vector Feature User Data Tables
  - GP BLOB Geometry Binary Format containing WKB Geometries
  - Linear 2D Geometries with optional elevation and measure values
- Tile Matrix Pyramid User Data Tables
  - PNG and JPEG Tiles
  - Zoom times two (adjacent zoom level pixel sizes)

First Open Source Implementation

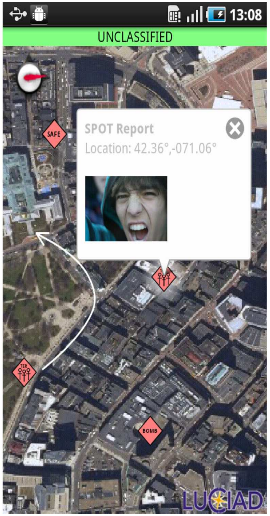
Luciad libgpkg

https://bitbucket.org/luciad/libgpkg A SQLite 3 extension that provides a minimal implementation Distributed under the Apache Software License version 2.0

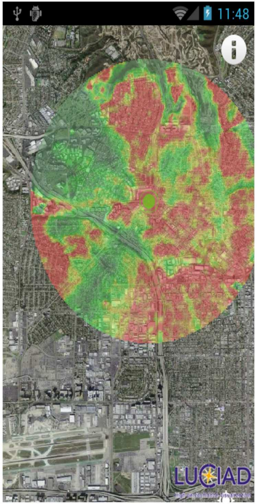
Create and edit annotations in the field



Spot reporting



Access elevation data



Specification at GitHub

http://opengis.github.io/geopackage/

OGC® GeoPackage Encoding Standard (OGC 12-128r9)

By: GeoPackage Standards Working Group (SWG), Editor: Paul Daisey – Version 0.9.7, 2013

Table of Contents

GeoPackage Table for Features

gpkg_spatial_ref_sys

defines spatial reference systems

gpkg_contents

identifies user data tables

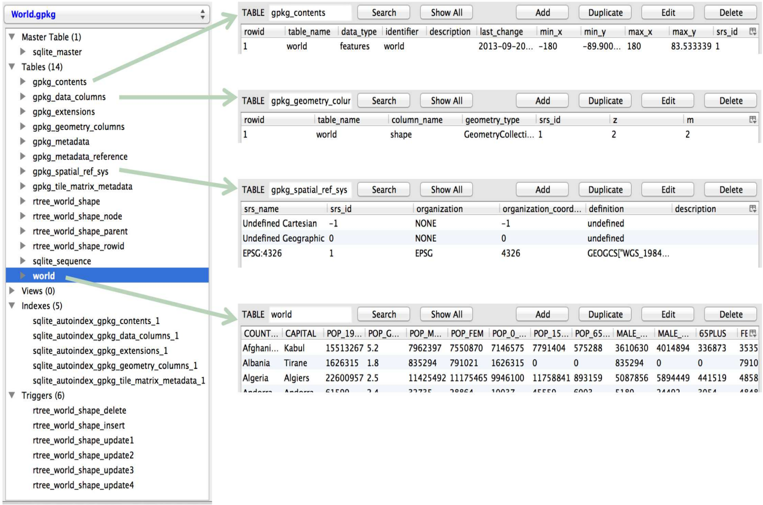
gpkg_geometry_columns

identifies feature geometries

user_data_feature_tables

contain feature data

Example SQL Tables



GeoPackage Table for Tiles

gpkg_spatial_ref_sys

defines spatial reference systems

gpkg_contents

identifies user data tables

gpkg_tile_matrix_set

tile pyramid envelope

gpkg_tile_matrix

describes tile zoom levels

user_data_tiles_tables

contain tile pyramids

GeoPackage Status

- currently in final voting status by OGC for public adoption.
- vote closes in early January 2014
- http://opengis.github.io/geopackage/

OGC Compliance

Presented the:

- Compliance Orientation Slides (video)
- Client Demo

Exemplar Project

Presented the OWS-9 Demo

Contact Information

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lbermudez@opengeospatial.org