GEO Grid: Federating Geospatial Data and Integrating Services

Satoshi Sekiguchi, Yoshio Tanaka, Isao Kojima
Grid Technology Research Center
National Institute of Advanced Industrial Science and Technology (AIST), Japan
What is the AIST?

- One of the largest Nat’l Labs in Japan
  - 3,500 employee+3,000 staff
- Research topics include
  - Environment
  - Material
  - Bio/Life science
  - Standards (JIS/ISO)
  - Geology
  - Semiconductor device
  - IT/Computer Science
  - etc.
- NIST+USGS+DOE labs+NIH

AIST Tsukuba Main Campus
7 other campuses across Japan

Tsukuba
Narita
Tokyo

40km
50km
50km
What is the GEO Grid?

The GEO (Global Earth Observation) Grid is aiming at providing an *E-Science Infrastructure* for worldwide Earth Sciences communities to accelerate GEO sciences based on the concept that relevant data and computation are *virtually integrated* with a certain *access control* and ease-of-use interface that are enabled by a set of Grid and Web service technologies.

**AIST: OGF Gold sponsor (a founding member)**

**AIST: OGC Associate member (since 2007)**

- **Satellite Data**
  - Geology Data
  - Geo* Contents
  - GIS data
  - In-situ data

- **Grid Technologies**

- **Resources**

- **Applications**
  - Geosciences
  - Environment
  - Conservation
  - Disaster mitigation
ASTER : Main content of AIST GEO Grid

- ASTER was developed by METI with AIST scientific & engineering supports
- Global land coverage of Digital Elevation Model of 15m spatial resolution
- Excellent geo-location accuracy
  - Easy to mosaic (or make a seamless image/DEM)
  - Easy to overlay to GIS data
- Powerful spectral analysis
  - VNIR 3 bands (+backward 1 band)/SWIR 6 bands/TIR 5 bands
- 2000~
ASTER Global land coverage

ASTER archive 1.4 million images = 140 TB
Digital Elevation Model of 15m spatial resolution
Landslides volume estimation using ASTER DEM

Synthetic bird eyes view with ASTER image and DEM

Volume: 0.06 km$^3$, area: 0.5 km$^2$

at DEM difference > 50 m

14NOV2000 11OCT2005
ASTER excellent geo-location accuracy

Easy to overlay GIS data (ex. Road map) without adjustment manually

Boulder, CO
Development-caused change at Suvarnabhumi Airport (near Bangkok, Thailand)

Data achieved since 2000
More effective use of ASTER Data

- Incorporate with geospatial information to overlay
  - Integrated data search service across multiple satellite imagery data sets
  - Interoperable with GIS based on OGC services and others
    - WMS, WFS, WCS, CSW
    - ISO 19115, GML, GeoSciML
  - Compliance with owners’ access control policy of data/service
  - Grid Security Infrastructure – AuthN, AuthZ, Accounting

- Integrating with processing (computing) services
  - Heavy and/or light simulations: WPS, Grid RPC, etc
  - Resource management – infra provider
  - Complex workflow support in portals incl. data access, simulation execution, visualization, etc.
ASTER – FORMOSAT-2 Integrated Data Search
Get satellite imagery of a particular location from federated databases

Input Key:
- Period
- Lat/Lon
- Cloud

Result
- No
- Yes

ASTER
FORMOSAT-2

Google Earth

Input Key
- Period
- Lat/Lon
- Cloud

ImageOne
Overlay GIS
GEO Grid use case scenario
Volcano monitoring

Melapi

←3D+Temp

Energy Cone Simulation
Simulation of Pyroclastic flows on volcanos

form numerical simulations of lava and/or pyroclastic flows on volcanos for prediction and mitigation of the hazard.

Position
- UTM(x) 438815.547
- UTM(y) 9166345.806

Hc_height 10 [m] (>0; e.g. 10)
H/L min 0.2 (> 0; e.g. 0.2)
H/L max 0.4 (< 1; e.g. 0.4)
H/L interval 0.02 (e.g. 0.02)

Simulate

show confirm window
prediction and mitigation of the hazard.

Position: 438815.547, 9166345.806
Hc height: 10 m
H/L: 0.2 ~ 0.4 0.02 interval
A Workflow example

“Disaster prevention and mitigation (Volcano)”

Monitoring of crustal deformation by PALSAR

In-situ observations by CCOP members

Hazard Map for Evacuation planning

GEO

ASTER

High resolution DEM provided from ASTER

Simulation of lava and/or pyroclastic flow on GEO Grid
A Workflow example

“Disaster prevention and mitigation (Landslide)”

Geology map (GSJ)

Rain fall (AMEDAS/Fieldserver)

Early warning system based on Susceptibility map

High resolution DEM provided from ASTER

Large scale Computer simulation using actual landslide DB
But, it was not so simple ...

- More sophisticated security architecture
- Data access and integration
GEO Grid Players & Tools

Player

End Users
Portal & VO mgr
Data Provider
Resource Provider

Tools

Web browser
Project Goal
Scientific data
Application, IT resource

Product

GEO Grid Client
Customized Web portal VO Management System
GEO Grid Data Service
GEO Grid Hosting Service

GEO Grid Tool Kit
GEO Grid Portal Dev. Kit
VO tools
GEO Grid Service Dev. Kit
Application

Disaster mitigation
Environment monitoring
Natural resource exploration

Workflow, Portal, PSE

Service Integration

Data Access + Computing

Job Submission
Brokering
Storage Services

Registry
Accounting
Data Transfer

Info. Services
Resource Mgmt.
Structured Data Access

Open Grid Service

Data and computing as services

Registry
Accounting
Data Transfer

Info. Services
Resource Mgmt.
Structured Data Access

Service

Security, Messaging, Communication

Connectivity

Resource

Computing, Data & Storage

Structured Data

Relational/XML/RDF/WebDB
Security issues
FOUR categories of Data Access Attribute

- **OPEN**
  - Cat. 2: Open to Many (Black list)
  - Cat. 1: Open to All (Public)

- **CLOSE**
  - Cat. 3: Close to Many (White list)
  - Cat. 4: Close to All (Private)
You might need to have like this

Virtual Organization (VO) enabled by GRID

- Cat 3 Project/Community
- Cat 2 Domain Common

Private

local

In-Situ
PEN
Cluster
ASTER

Internet

Cat. 1 Public
Security Architecture Design Policy

- Introduces concept of VO (Virtual Organization)
- Data and computation are provided as “services” via standard protocols and APIs.
- A VO is created dynamically by integrating available services and resources according to the interests and requirements of the VO.
- User-level Authentication and VO-level Authorization
  - User’s right is managed (assigned) by an administrator of his belonging VO.
  - Access control to a service is configured by the service provider according to the publication policy. There are some options of the access control:
    - VO-level, Group/Role-based, User-level, etc.
  - Scalable architecture for the number of users.
Overview and usage model of the GEO Grid system
Security Architecture

GEO Grid Portal

Account DB

GAMA

CA

MyProxy

credential repository

GEO Grid Portal

X.509 long-lived certificates

X.509 proxy certificates

VOMS server

Project Admin

User A
w/o certificate

login "username /Password"

User B
w/ certificate

Anonymous User

account creation

login by certificate

anonymous login

1. simple query

2. Fetch Meta Data into

GEO Grid Meta Data Catalogue

3. Data Access with appropriate method

blacklist
whitelist
grid-mapfile
config file
LCAS
LCMAPS
Filesystem ACL

Virtual DB

aster

File

ASTER

(WFS)

ASTER

(JPEG)

ASTER

(WMS)

PDP #1

PDP #2

PDP #n

Service Provider

VOMS

serverserver

W/ VOMS attributes

Project

Admin

blacklist
whitelist
grid-mapfile
config file
LCAS
LCMAPS
Filesystem ACL

Meta Data

Filesystem ACL

PDP #1

PDP #2

PDP #n

AuthZ

aster

(WFS)

ASTER

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Data Integration
GEO Grid data integration - at a glance

Support of OGC standards with Grid-based federated Databases
Data Integration Requirements(1)

★ Support of Geo-Spatial Standards

**OGC standards**
- CSW for catalog service
- WMS, WFS, WCS for geospatial data services
- WPS for data processing
- OGC spatial query

**Data Format standards**
- Data
  - GML and other XML data format
- Metadata(schema)
  - ISO19115, Dublin Core, ebXML etc.
Data Integration Requirements (2)

★ Support of Distributed Database Federation

- Support of multi-level distributed database federation
  - Local = Different Resources under one Service
  - Enterprise
  - Global = Distributed Services over the world

- Support of Heterogeneous Resources
  - Relational databases
  - XML databases
  - Web databases
Data Integration Requirements (3)

★ Support of the Grid Technology

-support of the VO concept
  - VO based database authorization/security management

-support of grid standards & middlewares
  - OGF Standards & Middleware
    - WS-RF/Globus, MDS,GSI(VOMS),
  - OASYS/W3C
    - BPEL, Service Registry(ebXML/UDDI)
Approach

- Multi-level-distributed data integration
  → Service-based Database Integration Middleware

- Support of VO concept
  → OGSA-DAI with VOMS

- Support of Grid Standard & Middleware
  → Grid based Database Middleware
A sample of ASTER DEM image on Tiled Display