AIST

GEO Grid

Grid-based e-infrastructure for geosciences

Data Intensive Research Project(s) at ITRI/AIST

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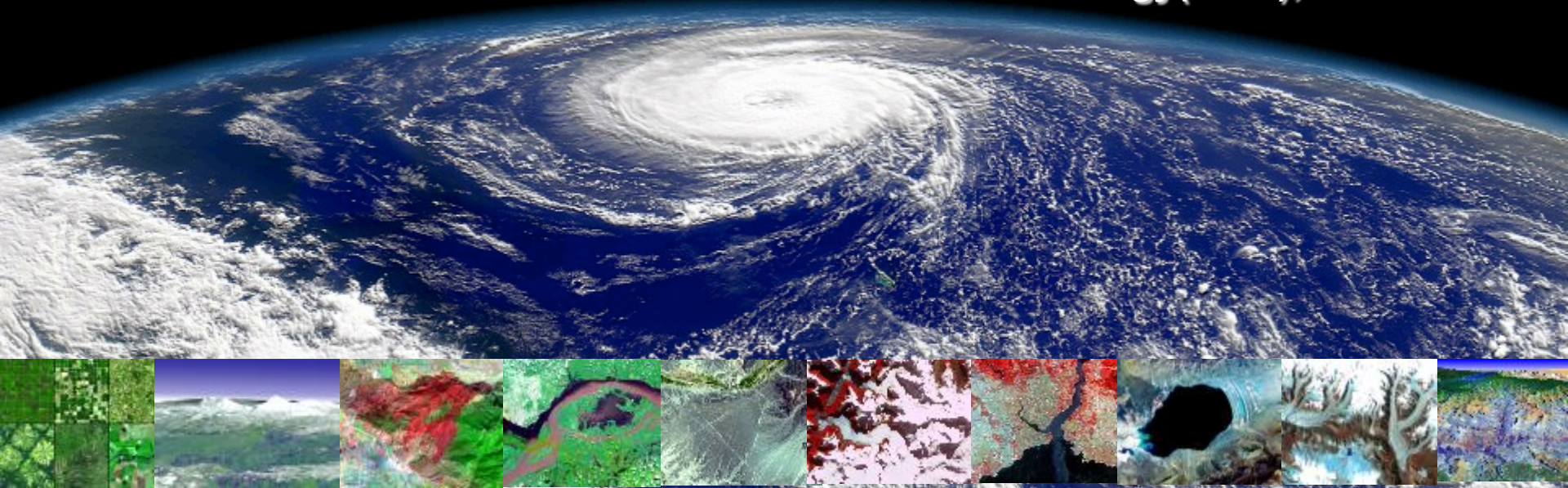


Background on AIST

- National Institute of **A**dvanced **I**ndustrial **S**cience and **T**echnology, Japan
  - Mission: Contribute to society through continuous advancement in technologies and support to Japanese industries
  - Supported by METI (Ministry of Economy, Trade and Industry)

- Established in 2001
  - Merging **15** different research institutes
    - Oldest is Geological Survey of Japan (est. 1882)
    - Set/maintain the kilogram calibration standard of Japan

- AIST ranked 7th in “Top 20 Japanese research institutions for all field”, Thomson Reuters, 2014

- Researchers (foreign nationals) 2,258 (96)
  - [Permanent] ..... [1,928]
  - [Fixed term] ..... [330]
- Administrative employees (foreign nationals) 675 (1)

Total number of employees: 2,933 (97)

- Executives (full time) 13
- Visiting researchers 159
- Postdoctoral researchers 200
- Technical staff 1,441

(As of April 1, 2015)

Number of researchers accepted through industry/academia/government partnerships

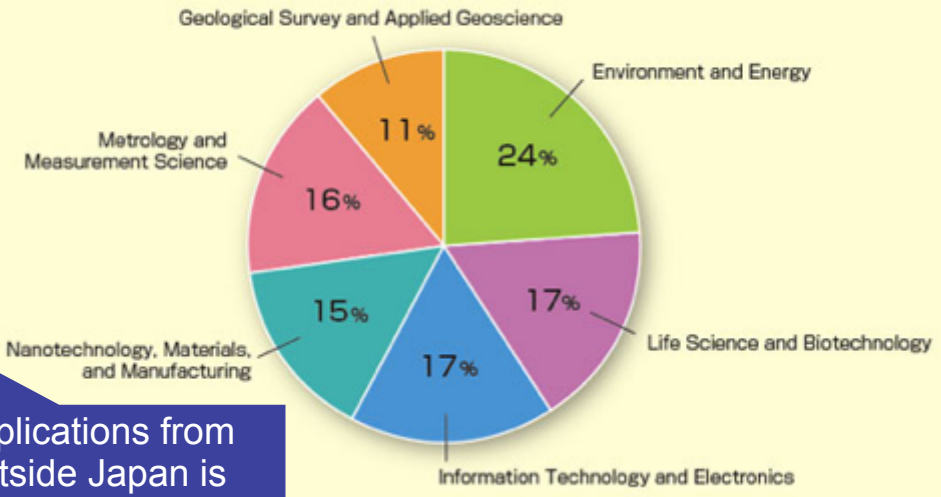
- Companies 1,774
- Universities 1,852
- Other organizations 972

(foreign nationals :426)

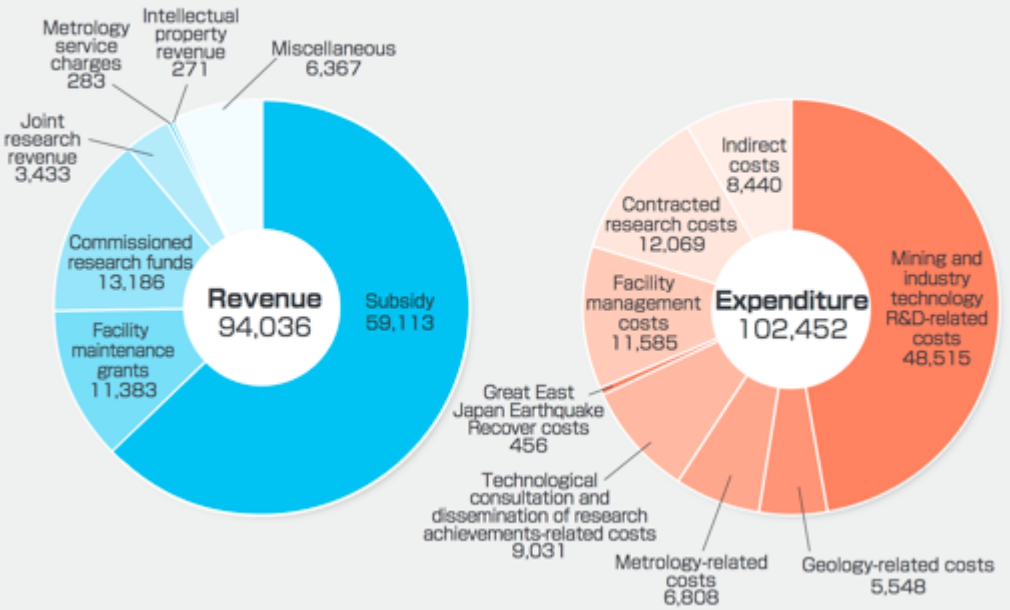
(Total number of researchers accepted in FY 2013)

Applications from outside Japan is highly recommended

Composition of researchers by research field (As of April 1, 2012)

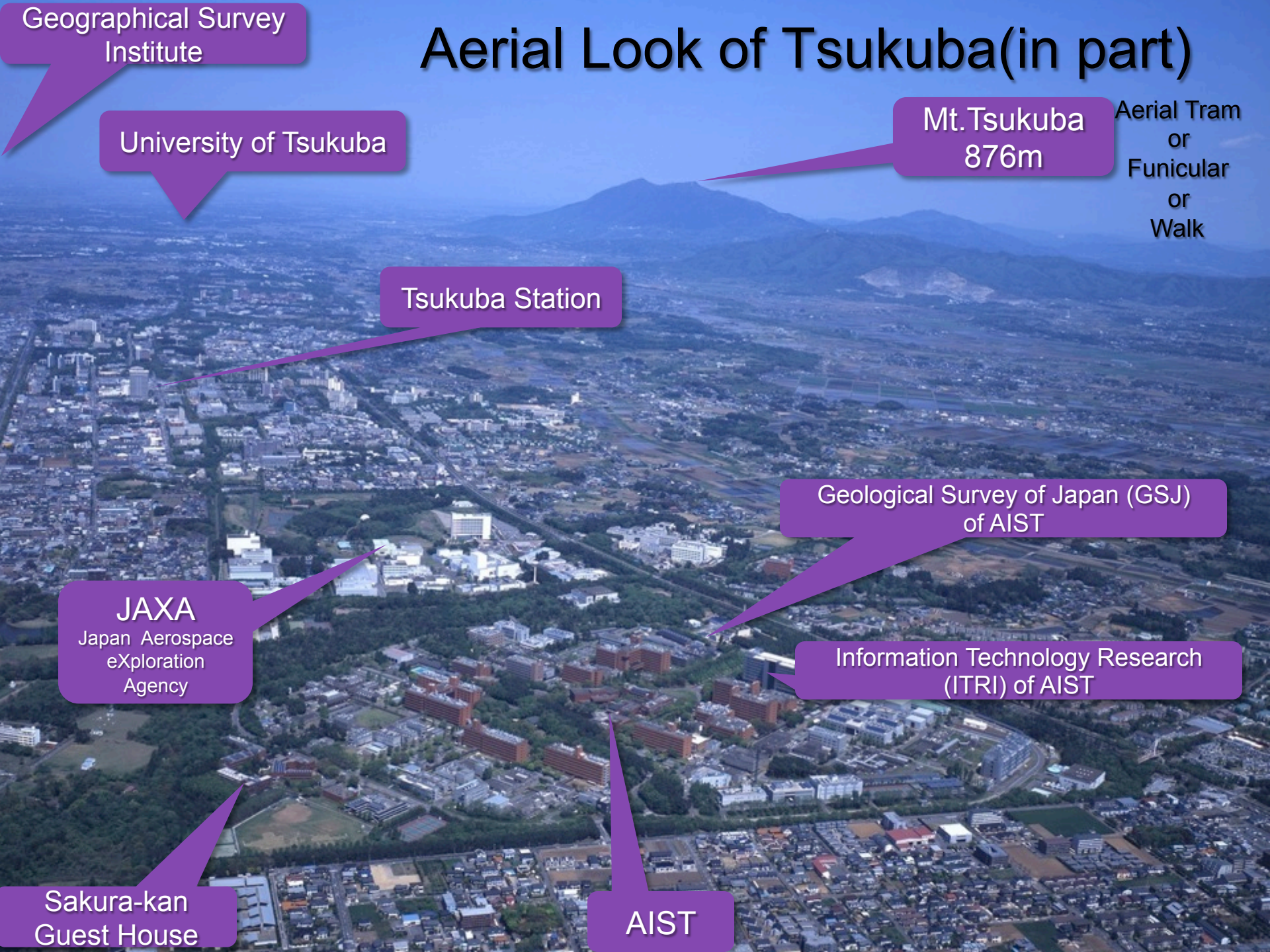


Financial Results for FY 2013 (unit : million yen)



Location of AIST

- Tsukuba (science) City
  - Government planned city
    - Est. in 1962
    - 1 university, 2 colleges
    - About 30 governmental research institutes including JAXA, KEK, NIMS
    - About 30~40 company labs
  - 60km Northeast from Central Tokyo
    - 45min with Tsukuba Express (TX)


Aerial Look of Tsukuba(in part)
Geographical Survey Institute
University of Tsukuba
Mt.Tsukuba 876m
Aerial Tram or Funicular or Walk
Tsukuba Station
Geological Survey of Japan (GSJ) of AIST
JAXA
Japan Aerospace eXploration Agency
Information Technology Research (ITRI) of AIST
Sakura-kan Guest House
AIST

Research at AIST

- 7 major research areas

Good for Cross-Domain Research

Cross-Domain/ Interdisciplinary R&Ds

GeoScience + IT

Bioscience + IT

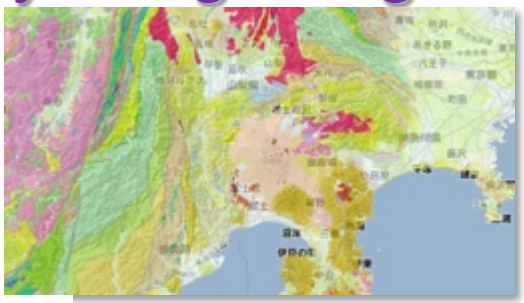
Mechanics + IT

Etc.

Data Integration Question

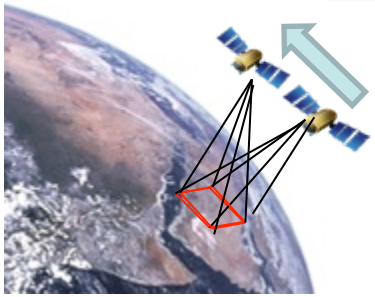
(same as last year)

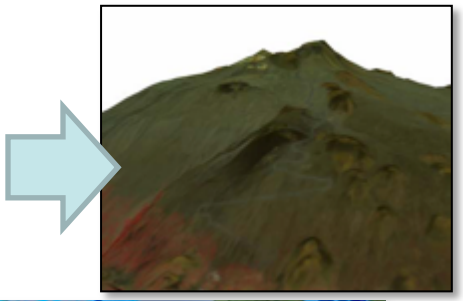
What knowledge can be obtained by integrating following data?



1. Geological Map

- Geological Survey of Japan is a part of AIST
  - sedimentary rocks,
  - volcano rocks,
  - grantic rocks etc.





2. 3D Elevation Model

- Created by our ASTER Satellite
  - Produce 3D-model by stereo-matching

3. Real Time Rain Sensors

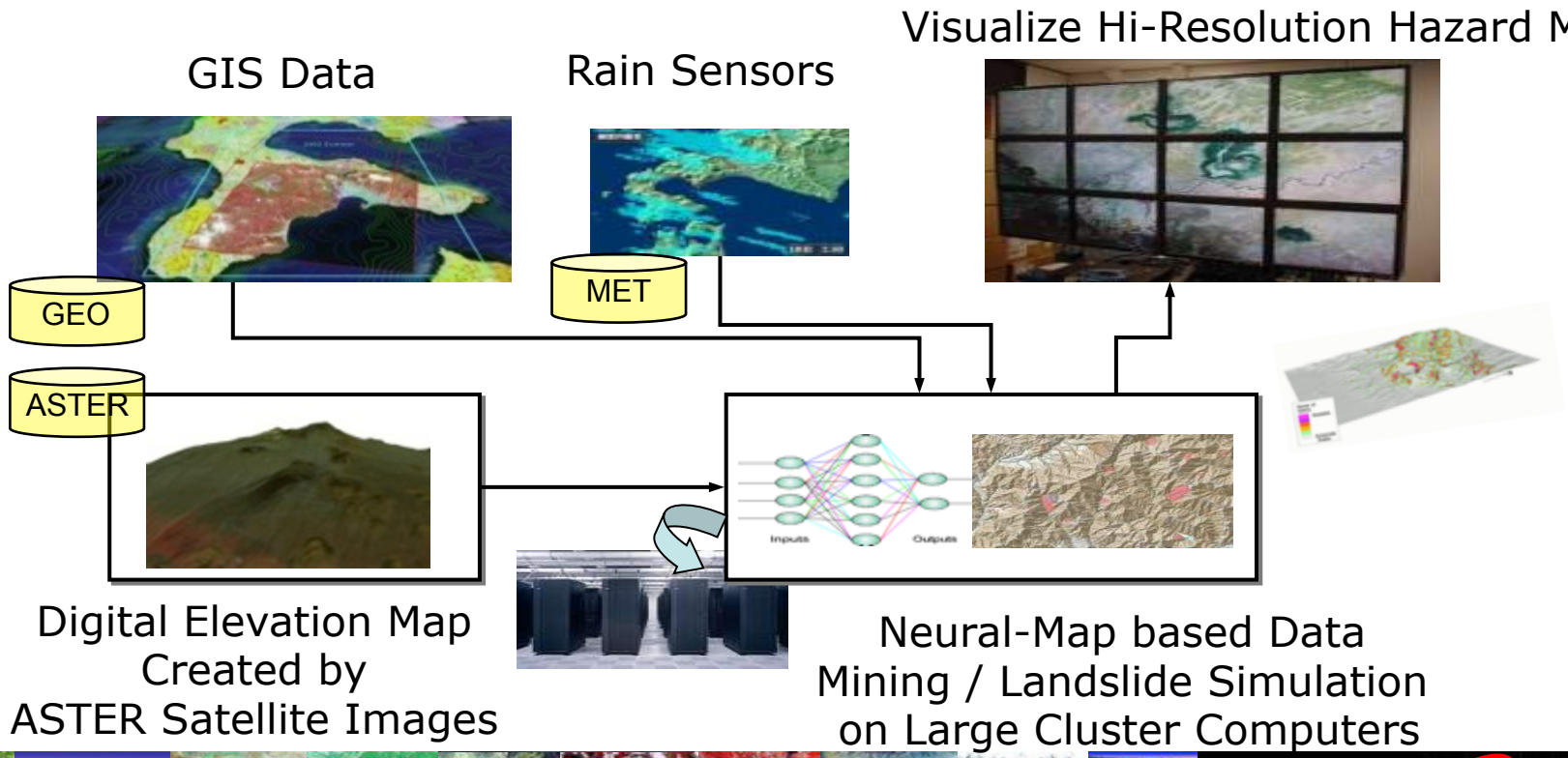
- Provided by JMA(japan meteorological agency)

Answer: Hazard Map for Landslide

(One typical application of GEO Grid)

Key R&D Technologies

1. **Distributed Database Integration (Linked Data/Heterogeneous DB etc.)**
2. **Data Mining & Simulation on the Cloud (Neural-Net, Machine Learning)**
3. **Multi-Screen Visualization (Tiled Wall Software)**



Geoscience + IT

GeoGrid: An Example of Data Intensive Research Projects at ITRI

What is GEO Grid?

http://www.geogrid.org

GEO = Geospatial

Grid = Grid (cloud) Computing

e-Science infrastructure on heterogeneous data archives

– Cross-Domain (joint) project from 2004

Geospatial Contents
Satellite Data
Geology Data
Various Maps

GEOGrid

Advanced IT
Distributed DB
HPC/Cloud

Geology/Environment Units in AIST.

IT/CS Units in AIST

– **Core archive contents: Our Satellite Sensor Data**
  - ASTER satellite images >= 200TB(2000,000 scenes, y2000->)
  - Now extending to manage (Petabyte-Scale) PALSAR, PRISM, Landsat8 etc.

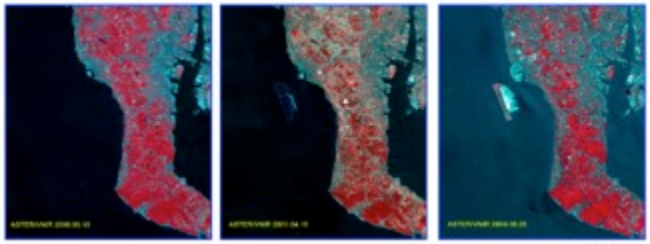
– **Core technologies: Grid Based => Parallel/Distributed R&D**
  - Distributed file system: Gfarm (started at AIST, Now at Tsukuba-U)
  - Database Integration: OGSA-DAI@Uk /Distributed SPARQL
  - Tsukuba-GAMA: Integrated Credential(Authentication) Management(some codes are included in MyProxy)

Major Technical Achievements of GEO Grid in 10 years

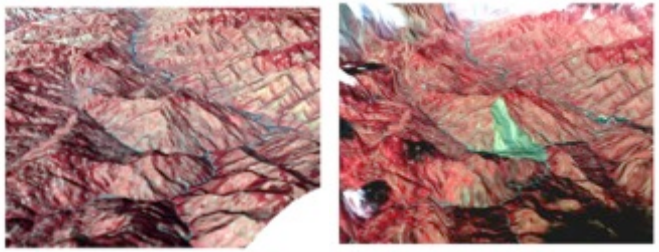
- **Petabyte-Class Large Scale Data Archive & Analysis**
  - Gfarm
- **Single sign-on system using Grid Security**
  - Tsukuba-GAMA
- **Heterogeneous Metadata Management based on OGC Standard**
  - AIST-CSW
- **Service-based Distributed Database Access**
  - OGSA-DAI(Web Services)

Data Archives

- ASTER sensor on NASA Terra satellite (2000~)
  - Resolution(Mid-range):15m(VNIR),30m(SWIR),90m(TIR)/px
  - 60km wide
    - 50~60GB daily Level 0 data transfer from NASA to JAPAN
  - 16 day observation cycle
    - Good for detecting long range change(= large computation)
  - 2 cameras with different angles
    - Can create DEM (Digital Elevation Model) by stereo matching



- Landsat-8 (by USGS)
  - Latest earth observation satellite launched 2013
    - 15m/Pan 30m/Color
    - 16 day observation cycle for the same area
  - Free and Open!



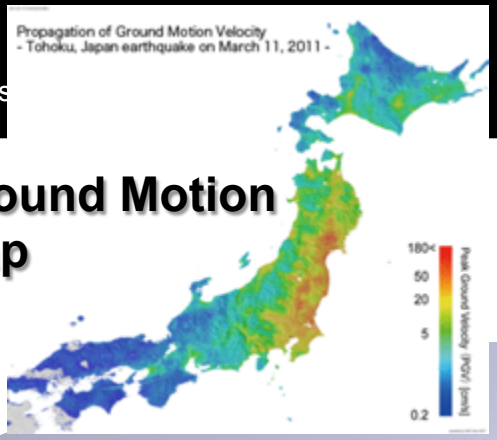
DEM of Pakistan Landslide 2005

- AIST set up the ground station for Landsat-8 (with Tokai-U)
  - Receives the daily data directly from the satellite
  - Can publish the data to the Internet in semi real-time
    - 2 hrs in AIST by our high performance computing (1 day in USGS)

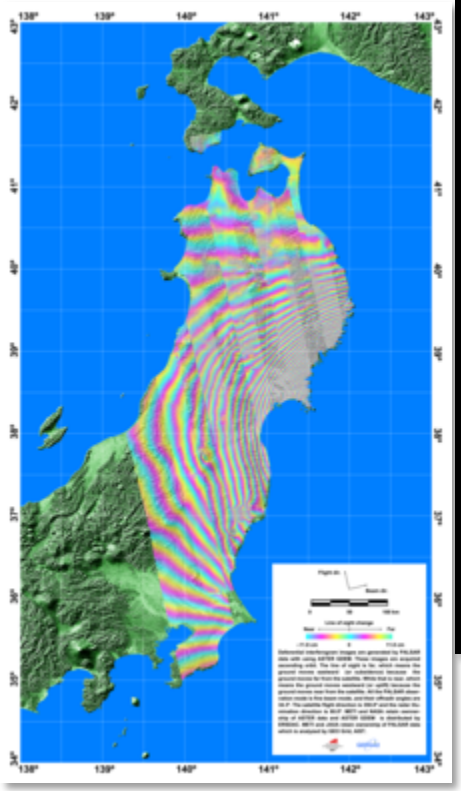
3.11 science data examples produced by the GEO Grid

Grid-bas

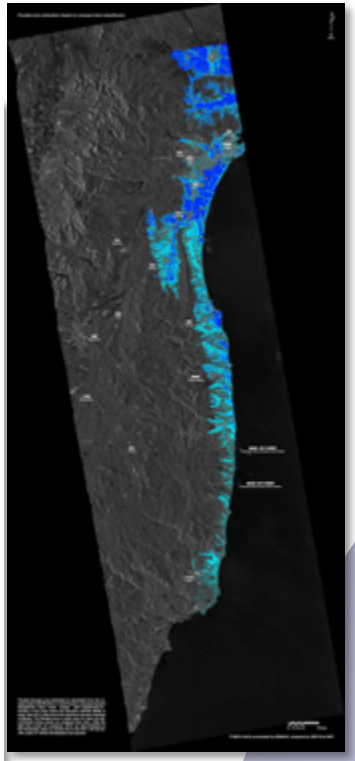
Ground Motion Map



Ground move with radar(SAR) satellite



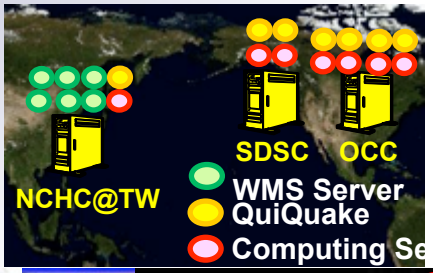
Flood simulation



ASTER images with 3D DEM

GEO Grid archive/cluster is also damaged by 3.11 earthquake

We evacuated our environment using cloud technology and continued to process data in collaboration with OCC/ SDSC/NCHC etc.



AIST

Public Service http://landsat8.geogrid.org

Latest/Historical Data can be Downloaded and Viewed

User Contributions Like "I found interesting things!" by Facebook

Constellation

- ASTER = 16 days cycle
- Landsat-8 = 16 days cycle
- ASTER+Landsat-8 = 8 days cycle (same orbits)

Target: Daily change detection

– Example: Skybox (which is acquired by Google) has a plan to launch 20 satellites

We are investigating to do the same thing with existing (and new) satellites

Analysis

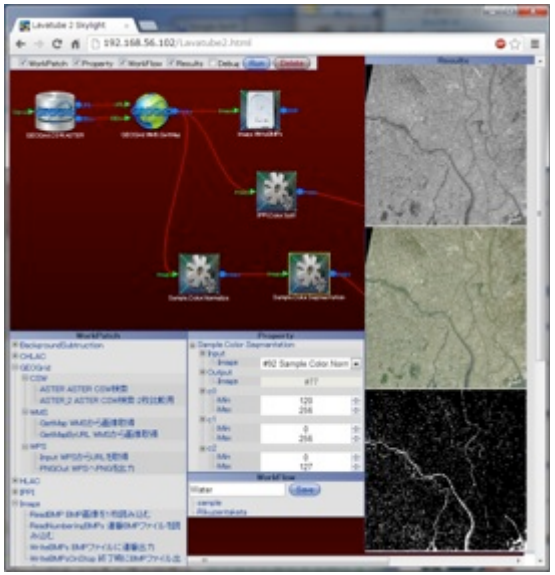
Workflow engine: Lavatube

Machine Learning System: Hivemall

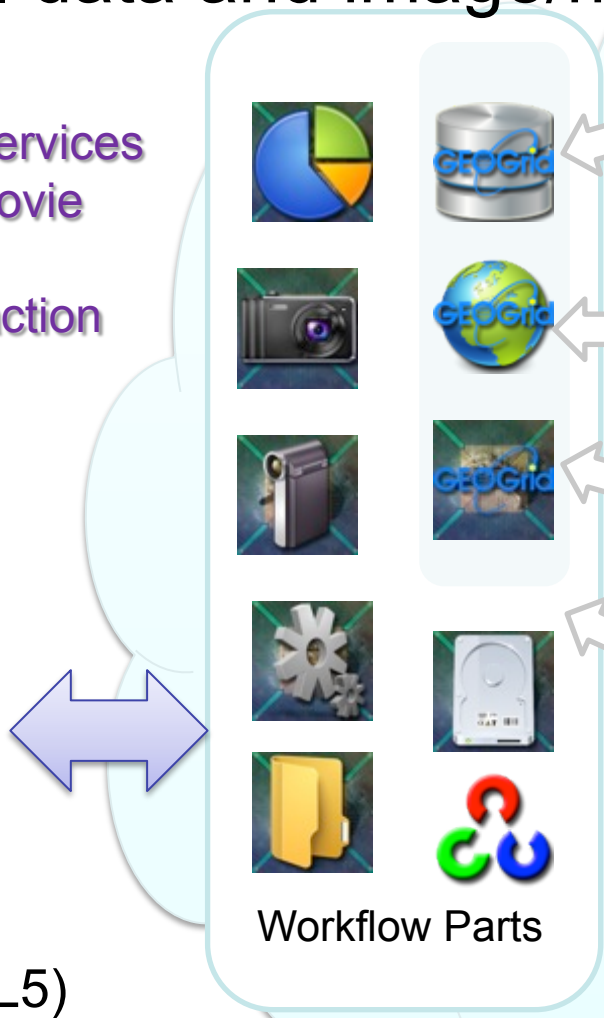
Our yet another Workflow Engine: Lavatube

for spacio-temporal data and image/movie processing

1. Support rest-based OGC (OpenGeospatial Consortium) services
2. Support various image/movie processing modules
3. Provide High-Level interaction



Browser Interface(HTML5)
or Windows engine



OGC Services
- Metadata Search
- Database Access
- Processing

- Hivemall: Scalable Machine Learning Library for Apache Hive
- A collection of machine learning algorithms as Hive UDFs/UDTFs
  - Classification & Regression
  - Recommendation
  - k-Nearest Neighbor Search
- An open-source project on Github
  - Licensed under LGPL
  - github.com/myui/hivemall (bit.ly/hivemall)

Application

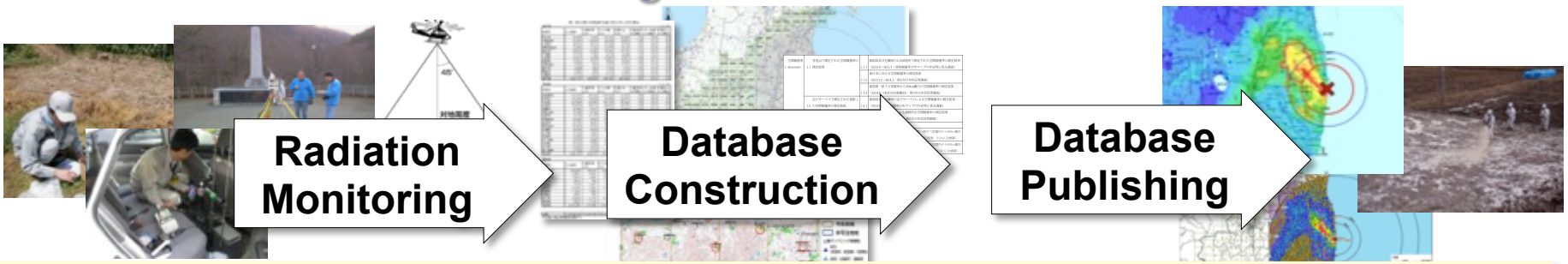
Radiation Monitoring Database for Fukushima

Project Overview

Radiation Monitoring Data is important to:

- Understand what happened at the accident in the past
- Help the decision making for the future

National Project to continuously Monitor/Construct/Publish Radiation Monitoring Database of Fukushima Area



Project Structure as of 2013

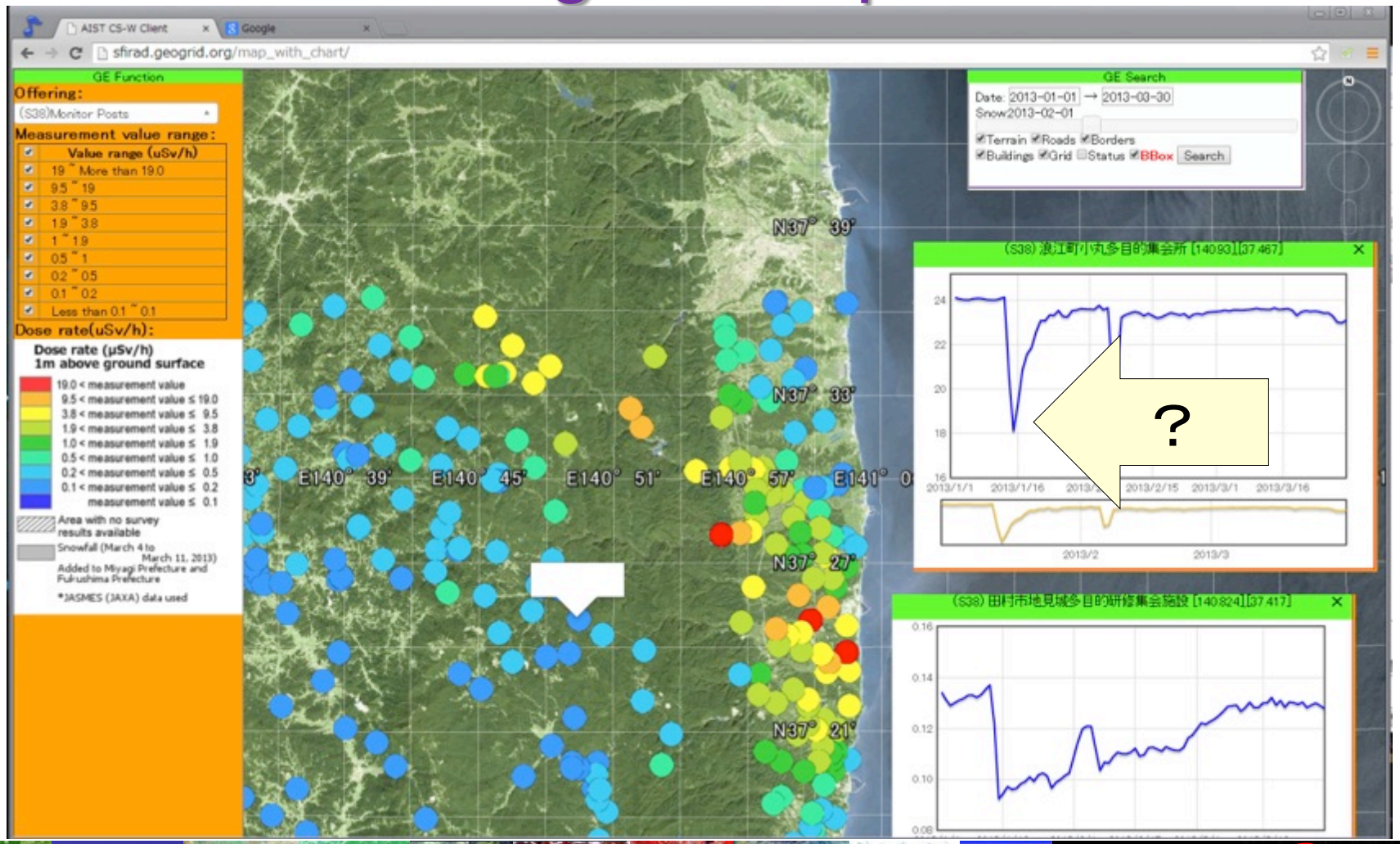
Nuclear Regulation Authority (NRA), JAPAN

Project Management: Japan Atomic Energy Agency (JAEA)

JAEA	AIST (National Institute of Advanced Industrial Science and Technology (AIST))	Hokkaido University	Japan Map Center (Company)
2 Teams	2 Teams	2 Teams	1 Team

Partners ・・・・・ GIS. FCU Okayama-U, The Institute of Statistical Mathematics,,

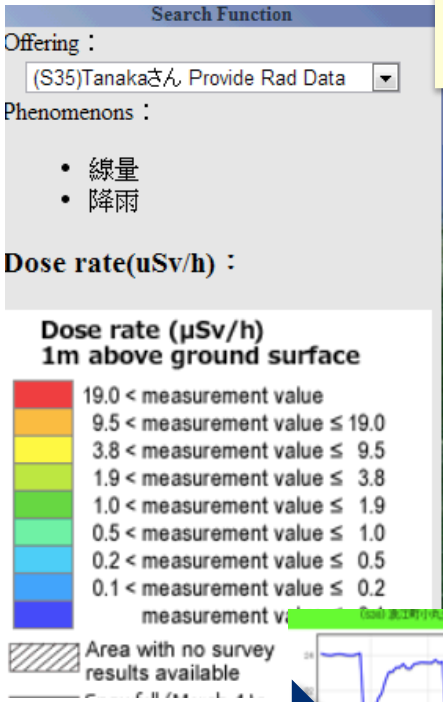
Example Data Integration Application using OGC specs

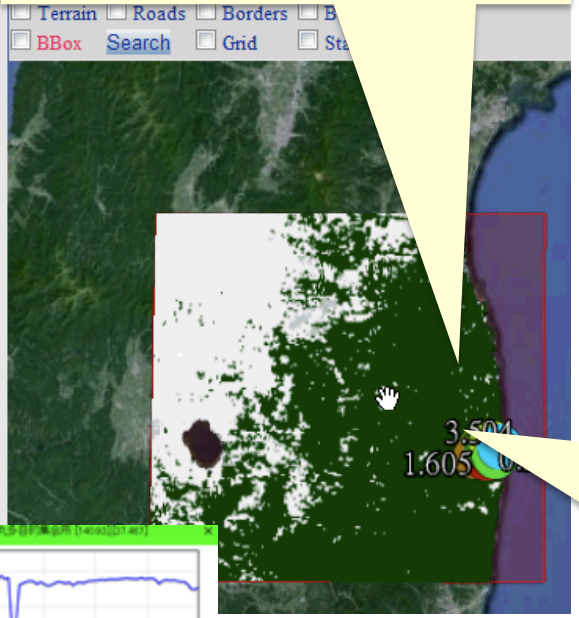


Combine SOS (Sensor Observation Service) with other WMS (Web Map Service) data source (Weather)

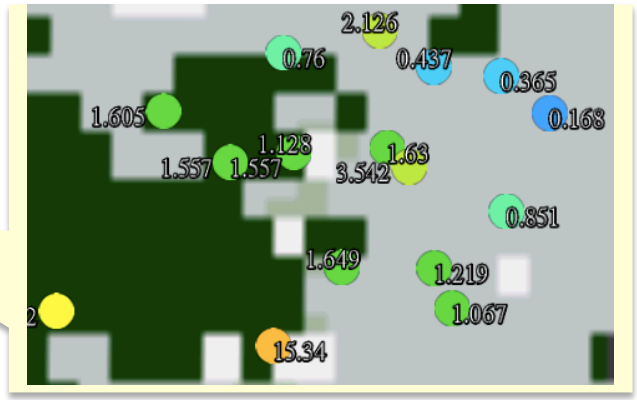
Human exposure to natural background radiation, 0.27uSv/h

Jan 1, 2013
The dose rate was relatively high

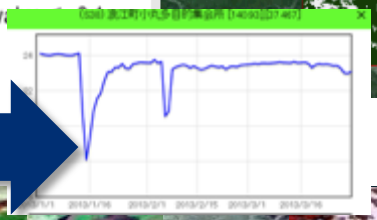




Jan 16, 2013
The dose rate was relatively low when there was heavy snow



Snow effect



Simple overlay can be useful

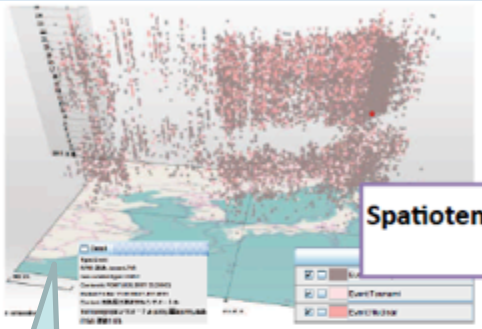
Directions

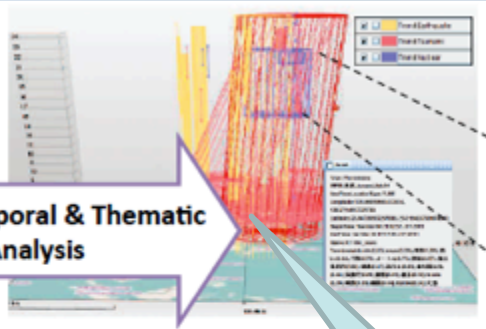
Social, Mobile & Crowdsourcing

Data Integration Issue: Administrative & Non-Administrative Data

- Administrative Data (Current GEO Grid Data)
  - Governmental & official data
  - Limited amount with controlled quality
- Non-Administrative Data
  - NPO, Social media, crowdsourcing (Twitter, etc.)
  - Large amount, variable quality

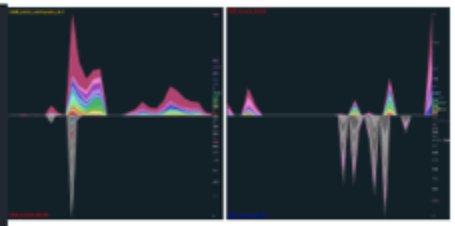
Application Examples





Spatiotemporal & Thematic Analysis

- mTrend (ACMGIS2011 Demonstration)



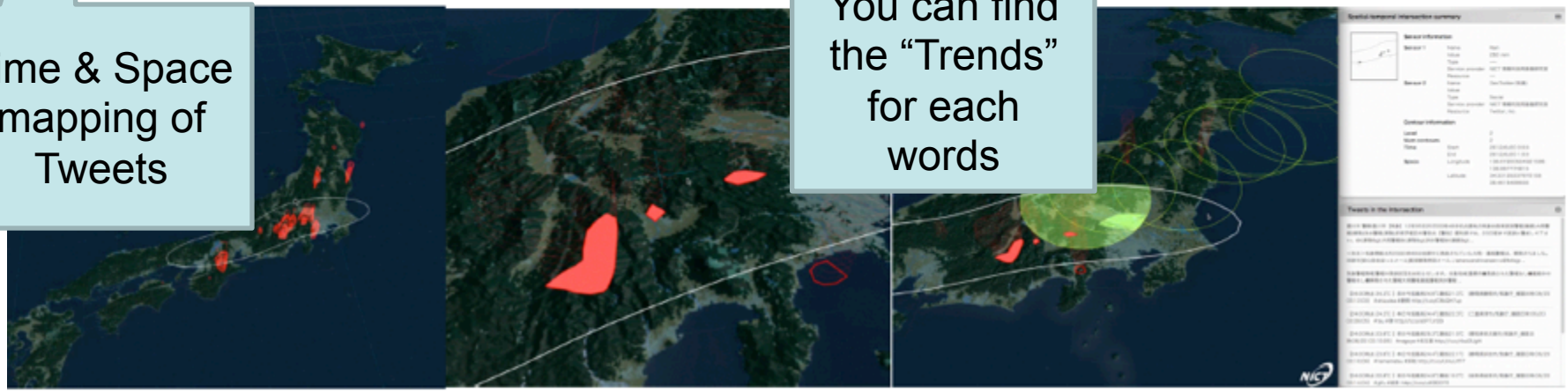
Comparing thematic patterns in correlated tweets by keyword streams

Mapping, clustering, and regression: (2011/03/02-2011/03/24)
1) earthquake-related tweets
2) tsunami-related tweets
3) nuclear-related tweets

地理情報システムの[illegible]カンファレンス
ACM GIS 2011で優秀テ[illegible]を受賞

Time & Space mapping of Tweets

You can find the “Trends” for each words



- Cyber-Physical Data Cloud: An Infrastructure for Interconnecting Heterogeneous Sensor Data (WTP2012 Demonstration)

Situation creation on the basis of intersection area of outbreaks between tweets and natural phenomena

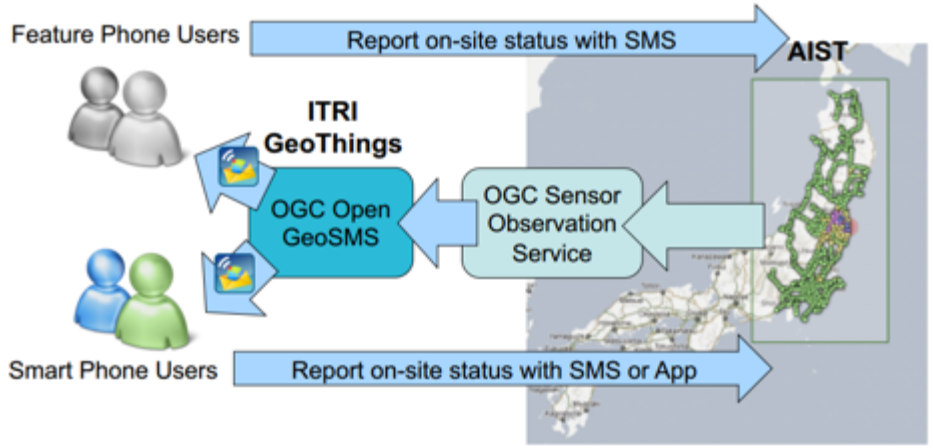
Crowdsourcing and Notifications Joint Research with Taiwan ITRI

工業技術研究院
Industrial Technology Research Institute

ITRI & AIST Joint Research Project
Data Integration and Messaging Fram
Crowdsourced and Administrative Sen

莊國煜
Kuo-Yu slayer Chuang
slayer@itri.org.tw

Crowdsourced Radiation Sensors



Linked Open Data

Federated SPARQL with "Best-Effort" Query Processing

Linked Open Data (LOD)

Try to create a huge linked knowledge cloud

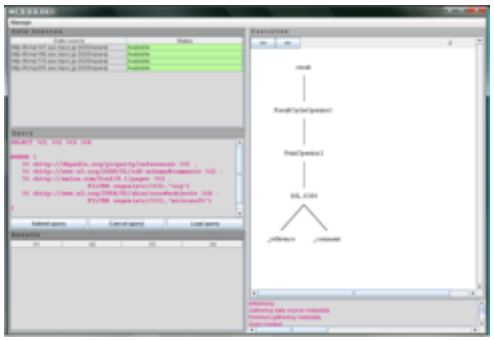
- The data is written with RDF (Resource Description Framework)
  - The Standard for the Semantic web community
- Highly distributed and rapidly increasing
  - More than 300 sites, billion~trillion triples
- Cross-Domain
  - GEO, BIO, Government, Media, etc
  - Many governmental data is going to be published as LOD
- Issues
  - Distributed SPARQL processing may be slow, but a centralized data service lacks freshness
  - Heterogeneity with SPARQL Endpoints, plain RDF Texts

Our Approach
Hybrid Adaptive Query Processing

Based on the **freshness, coverage** and the **response time**

Adaptive Query optimization

Pre-defined Query Processing Schedule



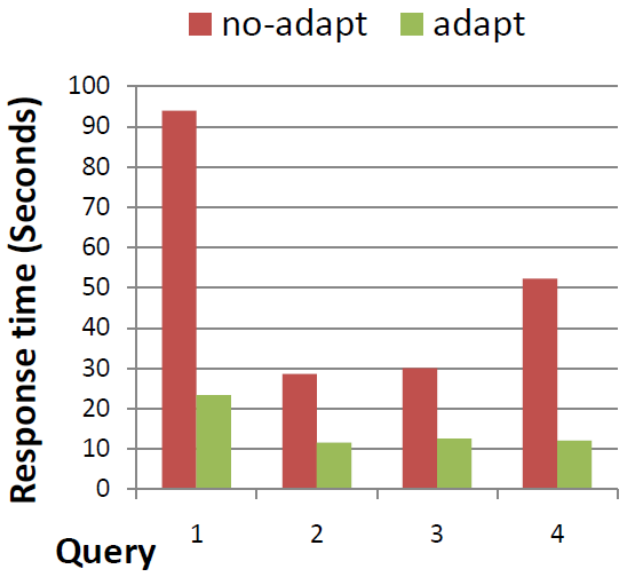
Network delays, Too many results Site troubles, etc...

Modified Processing Adaptively

```
dbo: <http://dbpedia.org/ontology/>
dbp: <http://dbpedia.org/property/>
owl: <http://www.w3.org/2002/07/owl#>
rdf:  <http://www.w3.org/2000/01/rdf-schema#>
skos: <http://www.w3.org/2004/02/skos/core#>
foaf: <http://xmlns.com/foaf/0.1/>

Query 1 (Result size = 150):
select * where {
 ?x dbp:reference ?ref .      777,679
 ?x rdf:comment ?comment .    10,000
 ?x skos:subject ?subj .      9971
 ?x foaf:page ?page .         10,000
 ?x rdf:type ?type .          800,000
 FILTER ( regex(str(?subj),"building") )
}
Query 2 (Result size = 8):
select * where {
 ?x dbp:reference ?ref .      777,679
 ?x rdf:comment ?comment .    10,000
 ?x skos:subject ?subj .      9971
 ?x foaf:page ?page .         10,000
 ?x rdf:type dbo:book         3105
}
Query 3 (Result size = 8):
select * where {
 ?x dbp:reference ?ref .      777,679
 ?x rdf:comment ?comment .    10,000
 ?x skos:subject ?subj .      9971
 ?x foaf:page ?page .         10,000
 ?x rdf:type dbo:book         3105
 ?x dbo:releaseDate ?date     (DBP) 126,737
}
```

```
Query 4 (Result size = 13):
select * {
 ?book rdf:type dbo:Book .    3105
 ?book foaf:page ?p .         10,000
 ?book owl:sameAs ?link       (DBP) 10,121,699
}
```

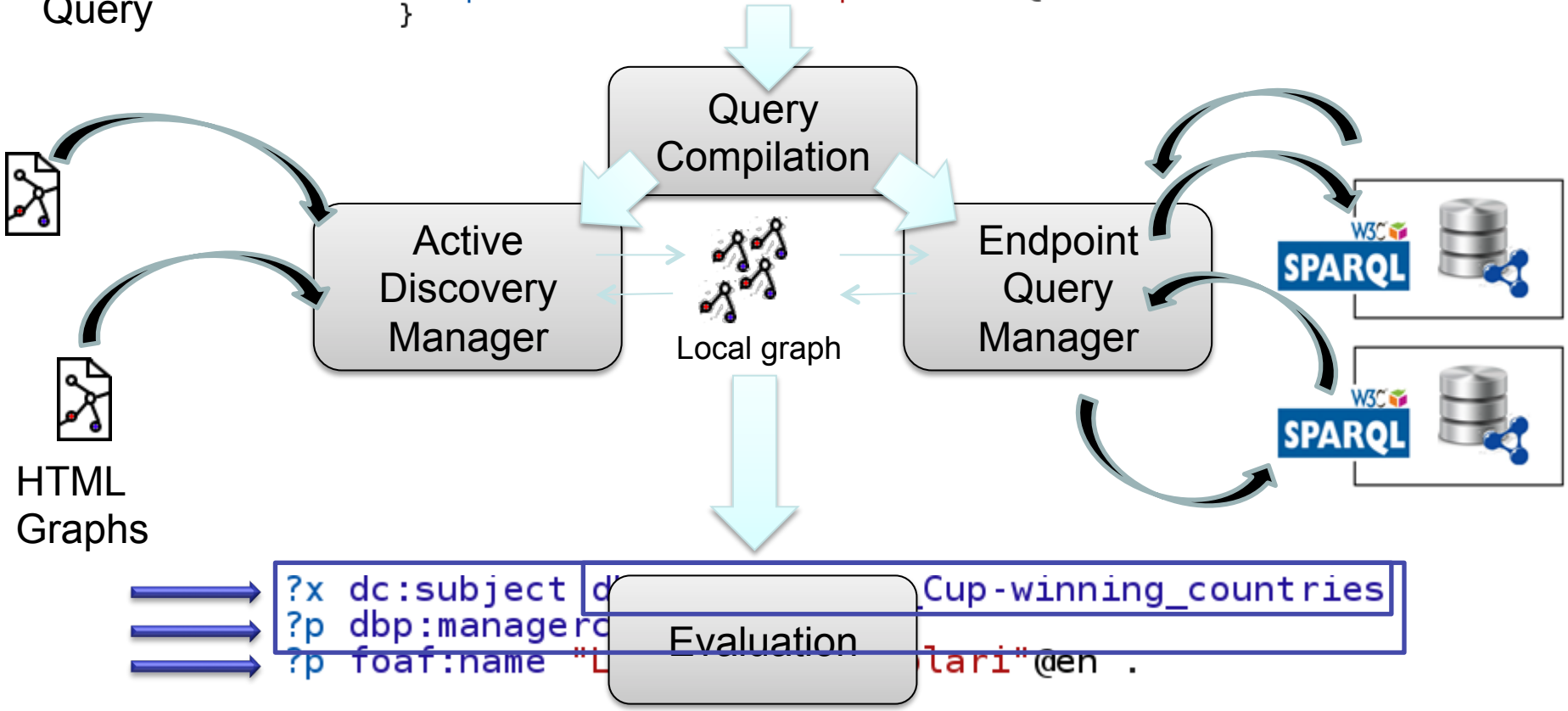


Achieve good performance around 10 distributed SPARQL endpoints (still small for 300 ;-<)

Hybrid & Adaptive Query Processing

User's SPARQL Query

```
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX dbp: <http://dbpedia.org/resource/property>
SELECT * WHERE {
    ?x dc:subject dbp:FIFA_World_Cup-winning_countries .
    ?p dbp:managerclubs ?x .
    ?p foaf:name "Luiz Felipe Scolari"@en .
}
```



Query Result

You can get rough answer in 10 seconds,,
or
More accurate answer with a long time

BioScience + IT

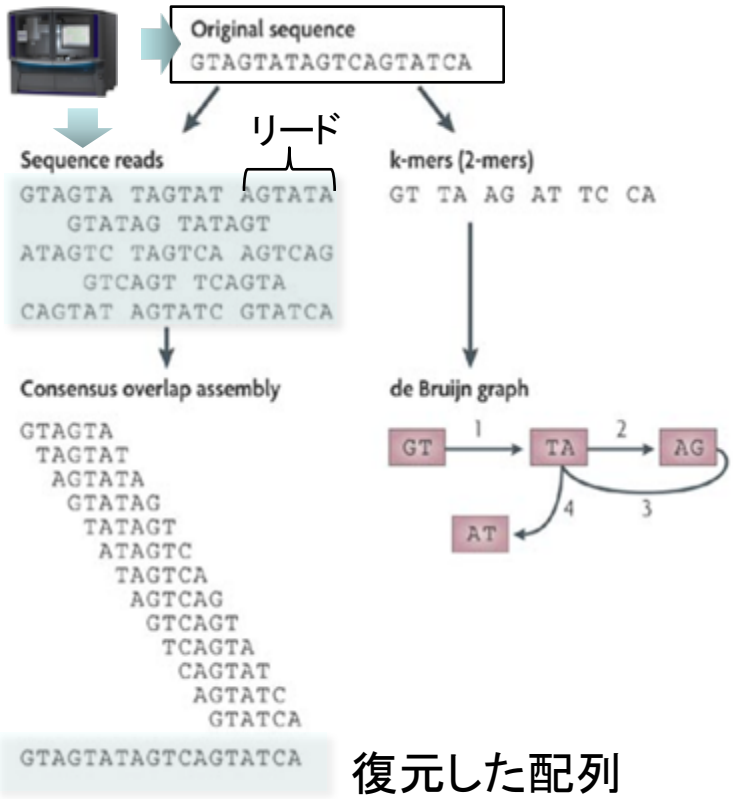
BIO-CAD/LEAD

Hydra: Molecular Visualization

High Performance Genomics Assembly

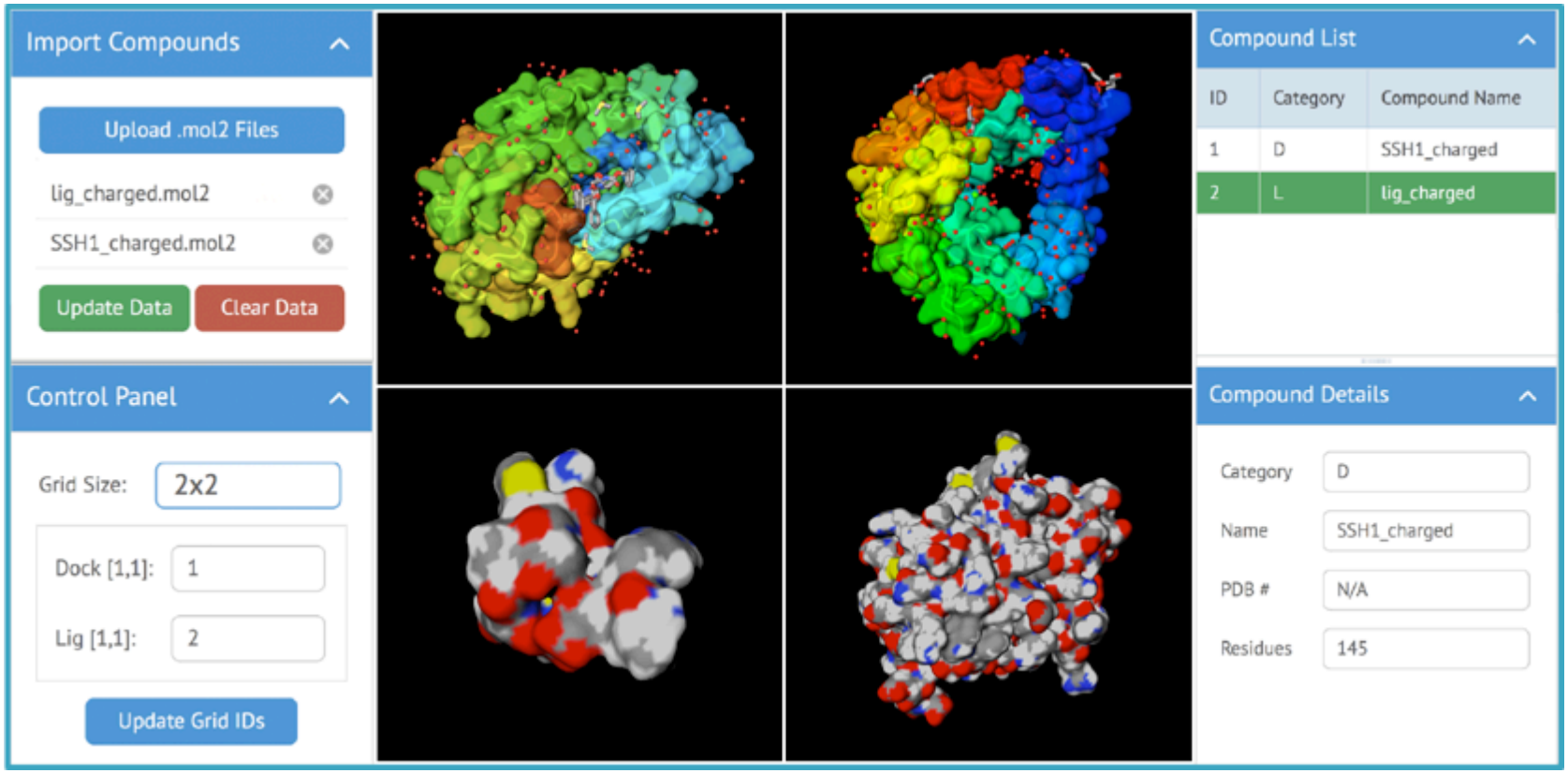
- **Next Generation Sequencers**

  Huge set of short reads are obtained
  - **1 read: ATGC（base）100(50basex2)**
  - **Total : 100million reads just for 1 run**



- **Hybrid Assembly Workflow**
  - MPI parallelized (SAET, ASiD)
  - Improve the algorithms (Velvet)
  - To achieve scalability and performance enhancements

Hydra Molecular Visualization



- Create a more device agnostic tool

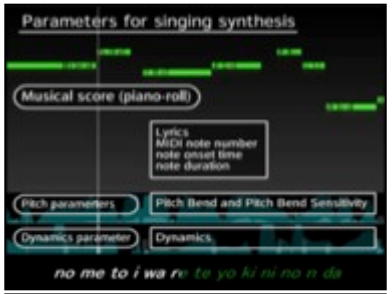
  Visualization of multiple protein-ligand interactions

Mechanics + IT

Media-related R&D

Media-Related R&D

- IT behind the robot
  - Computer Singing Systems
    - **VocaListener**
    - **VocaWatcher**



- Active Music-Listening

Web Service

  - **Songrium**

Summary

- AIST has many interdisciplinary data-oriented R&D projects
  - Geospatial
  - Linked Data
  - Bioinformatics
  - Multimedia (Music/Songs)
- Looking forward to the OSDC students contribution

- AIST YouTube: https://www.youtube.com/user/aistchannel

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