OGC-based Database/Sensor Federation Framework for Fukushima Radiation Monitoring Data

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About Us

AIST = National Institute of Advanced Industrial Science and Technology, JAPAN

• Mainly funded by METI (Ministry of Economy, Trade and Industry)
  ≈2200 Researchers + Supporting Staffs

– **Industrial Research**
  • Bridge between basic research and product development

– **Cross-Domain R&D** (Ex. Information technology with Geoscience)

6 Major Research Area

- **Environment and Energy**
  Aiming to realize a sustainable society

- **Information Technology and Electronics**
  Toward a society where intellectual activities are accelerated with the safe use of information technology

- **ITRI**

- **Life Science and Biotechnology**
  Contributing to healthy and active lives

- **Nanotechnology, Materials and Manufacturing**
  Developing new manufacturing technologies that lead to the use of outstanding materials

- **Metrology and Measurement Science**
  Establishing common scales for industrial measurement and dissemination of advanced evaluation technology for administration measures

- **Geological Survey and Applied Geoscience**
  Understanding and living with the Earth
Fukushima Radiation Monitoring Database Project

“東京電力福島第一原子力発電所事故による環境モニタリング等データベースの構築事業”
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

Project Management

- Nuclear Regulation Authority (NRA), JAPAN
- Japan Atomic Energy Agency (JAEA)

Partners

- JAEA: 2 Teams
- Hokkaido University: 2 Teams
- Japan Map Center (Company): 1 Team
- Okayama-U, The Institute of Statistical Mathematics,
AIST’s Role in the Project


Real-Time Monitoring Posts/Sensors
- 4000 radiation monitoring points in Fukushima-area
- Produce raw data in every 10 minutes for 3 years
- Approx. 22 million Records (as of 2013)

Periodical Monitoring Result Database (Car, Helicopter, Soils etc.)
- 239 CSV Files (data collected by "県" or "全国")
- Approx. 17 million Records
- 31 CSV table types (for possible one schema)
- Japanese characters for the attribute name

Sensor/Database that JAEA produced => “Legacy” style data like CSVs.

1. Convert/Wrap “Legacy” sensors and data (CSVs and raw data) and provide them as standard Web Services
2. Construct a data federation framework based on 1.

Framework
- Easy to access/interoperate
- Easy to re-use
- Easy to combine with other geospatial data

Various Radiation Sensors
- Need to handle various sensors

OGC (Open Geospatial Consortium) Web Services
OGC Sensor Web (SWE)
Framework Implementation

- **Access Data:** **SOS and W*S**
  - Sensor Observation Service
  - Web Map/Feature/Coverage Service
    - Interface to radiation measurements
    - Federate with other OWS servers

- **Process Data:** **WPS**
  - Web Processing Service
    - Spacial&Temporal Analytics
    - Produce various format
      - KMZ, AVI etc.

- **Publish Data:** **WMS**
  - Web Map Service
    - WMS Time of maps
      - KMZ
      - Rich Client with Google Earth/Map
Application Implementation using our Framework (OGC OWS+LinkedOpenData/GeoSPARQL)

- In collaboration with radiation experts
  - To demonstrate the usefulness of our framework
    create useful knowledge with good productivity
Access Service Implementation

- Single OGC SOS (Sensor Observation Service) Service for
  - Real-time Monitoring Post Database
    - Over 25 million records for 4000 sensing points in every 10 minutes
    - Data is obtained from the dedicated system which handles all sensors
  - Periodical Monitoring Results Database
    - > 40 types of monitoring (Car Survey, Airborne Survey etc.)
    - Over 17 million records

- Rich Client with Google Earth/Map (Prototype)
  - GUI for SOS search & display with BBOX, Date Range, Dose Rate, etc.
  - Simple analytics functions (ex. Writing Graph)
Example Data Integration Application using OGC specs
Combine our SOS with other WMS data source(Weather)

Human exposure to natural background radiation, 0.27uSv/h

January 1, 2013
The dose rate was relatively high

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

Snow effect

Simple overlay can be useful
Database Federation Application 2

- Radiation data with Landcover (Land Use) data
  - Landcover Data (Satellite image analysis of JAXA ALOS)

  Radiation Data
  OGC Sensor Web Service

  Landcover Data
  OGC Web Service

  OGC Web Processing Service

  Analytics

- Environmental Dose Reduction Rate
  - Urban & Water => Fast
  - Ever-Green => Slow

  This data can be used for estimation of the future reduction
Implementation Issues

Issue in SOS: Too many sensing points
Moving Sensors(Car/Helicopter)=millions of sensors=FOIs

• **Current Status**: Many existing software cannot handle too many FOIs efficiently.
  – FOI(Feature Of Interest): Core info in OGC SOS spec
  – getCapabilities will crash if we had a millions of FOIs and sensors

• **Our Approach**:
  – Create abstracted/aggregated FOIs.
    • Good for area information
    • Not good for mobile objects(trajectory)

Issue in Schema: Standard Schema for Radiation Data

• **Current Status**: CSVs => No International Standard
  – Total Number of CSV is over 200 + Real-time monitoring (raw) data.
  – Number of CSV/Raw data types is 31 for possible one single schema.
  – How to integrate these Legacy data(CSV’s) to possible one SOS schema?

• **Our Approach**:
  – Standardization: Discussion started with JAEA people and IAEA
  – Tools: Create data integration tool
Tool: AIST CSV Importer

Contribution mainly by FCU.GIS  ->  worked well for SOS data

Simple Schema Integration/Mapping/Conversion Tool based on the previous data imports.

1. Read CSV and analyze the structure
2. Give “possible” mapping to the SOS(SensorML) schema
3. User can edit/improve the mapping
4. Mapping is stored into knowledge DB and re-used for further analysis

Result of CSV analysis to map SOS

Knowledge pool based on previous analyses

Analysis

Mapping

Mapping Results

User Interface to check/improve Mapping
OGC spec for Linked Open Data

OWS (OGC Web Service) based Data/Sensor Service
  - Works well for the geospatial data and applications

• **Requirement:**
  Need to federate with other “Open Data”
  - Governmental Statistics/Linked Open Data (LOD)/RDF

• **Issue:**
  - LOD with Geospatial Data (Sensors & Databases)

• **Our Approach**
  - Construct GeoSPARQL endpoints for the radiation data
  - Database Integration using GeoSPARQL / SPARQL

Data Integration using GeoSPARQL

GeoSPARQL is also
OGC specification based
On W3C SPARQL
Collective Dose = Dose Rate \times X Population Statistics

- Statistics provided by Ministry of Public Management
  - Can be provided with RDF/LOD
- **Rich Client with same style GUI:** Can search with Area(BBOX&Area), Date, Value, Age, Sex, etc.
  - Converted to GeoSPARQL queries
Summary

Under JAEA’s project management, AIST constructed an OGC based framework for Fukushima radiation monitoring data.

The results include:

1. **A prototype SOS service** for millions of JAEA data and sensors.
2. **Data/Sensor Federation Framework** based on OGC service specifications
   - OGC OWS and GeoSPARQL/LOD
3. **SOS import tool** for handling large numbers of CSV file types.
4. Several **Application Showcases** to demonstrate the power of the standard (OGC) protocols/frameworks.

We will continue this R&D project for 2014 with JAEA and our international partners.