SmartMet Server
Providing INSPIRE Compliant MetOcean Data

Roope Tervo, Mikko Rauhala, Mikko Visa, Mika Heiskanen
Finnish Meteorological Institute
FMI Open Data

- Finnish Meteorological Institute opened its data in 2013.
- Basically everything that FMI has property rights was opened.
- Both (near) real-time and historical and climatological data.
- Data is provided in freely in machine readable format.

https://en.ilmatieteenlaitos.fi/open-data
FMI Open Data Portal follows INSPIRE requirements.

The very same data portal works as Open Data and INSPIRE portal.
View Service (WMS)

• Based on GeoServer
• Only the most common layers published
• Provides a quick view to the data
Catalog Service (CSW)

- Based on GeoNetwork
- Provides high level metadata
Download Service (WFS 2.0)

- Web Feature Service (WFS) 2.0 Simple Profile
- Based on stored queries
  - Predefined data sets with possibility for additional parameters (i.e. time and area)
- Based on SmartMet Server
In a Nutshell

- Data and product server for MetOcean data
- High capacity & availability
  - FMI installation handles over 30 000 000 requests each day
- Data is extracted and products generated on-demand
- INSPIRE Compliant
- Operative since 2008
  - FMI client services (since 2008)
  - Finnish Meteorological Institute (FMI) Open Data Portal (since 2013)
  - Going to be used at Copernicus C3S Climate Data Store (ECMWF)
- Open source
In a Nutshell

• Several input sources
  • GRIB-, NetCDF-, etc. files (multi-dimensional grid data)
  • PostGIS database (vectors)
  • Point database (point observations)

• Several output interfaces and formats
  • WMS, WFS 2.0
  • JSON, XML, ASCII, HTML, SERIAL
  • GRIB1, GRIB2, NetCDF
Usage

- Basis of most FMI product generation
Open Source

• Published in 2016 in GitHub
  • https://github.com/fmidev/smartmet-server
  • https://hub.docker.com/u/fmidev/
• MIT Licence
• Documentation in GitHub

• FMI host the development
  • Small contributions with pull requests
  • In larger contributions, implementation plan is recommended (in GitHub wiki)
  • CLA (Contributor Licence Agreement) is required
Architecture

- **Frontend**
  - Load balancer
  - Knowledge about backend services
- **Backend**
  - Different backends may contain different services
- **Plugin-based architecture**
  - *Engines* provide shared access to the data
  - *Plugins* provide services (APIs) built upon engines
Most Important Components

• Frontend
  • Provides HTTP 1.1 server
  • Monitors status of backend services and provides load balancing
  • Provides LRU product cache
• Data Engines (providing C++ API)
  • Querydata engine provides access to the grid data
  • Observation engine provide access to the point data in database
  • Geonames and gis engines provide geolocation information
Most Important Components

• Plugins (providing HTTP API)
  • **WMS**: Generates SVG images from grid data on-demand, which are rendered to requested raster format
  • **WFS**: Point data output for grid data and observations
  • **Timeseries**: Custom point data interface with support for aggregate values over time and area
  • **Download / WCS**: Grid data output
Post-Processing Capabilities

• Corrects the data based on accurate DEM (up to 30 meter resolution) and land/water information
• Calculates derivative parameters
• Support for aggregate values over time and area
Producing INSPIRE Data Products

Observations

05/09/17

SmartMet Server Providing INSPIRE Compliant MetOcean Data

Database

SmartMet Server obsengine

SmartMet Server WFS

In-memory database

latest data. Server provides

logic for fetching the data from

local or master database.

On-the-fly formatting
(based on template)

INSPIRE compliant
XML response
Producing INSPIRE Data Products

Point Forecasts

SmartMet Server Providing INSPIRE Compliant MetOcean Data

File System

SmartMet Server qengine

SmartMet Server WFS

Memory mapped data.

Server provides logic for interpolation of data for requested area and time.

On-the-fly formatting (based on template)

INSPIRE compliant XML response
Producing INSPIRE Data Products

Grid Forecasts 1/2

File System

SmartMet Server qengine

SmartMet Server WFS

Forecast model data

Server provides relevant metadata to fetch the data content

On-the-fly formatting (based on templates)

INSPIRE compliant XML response containing meta data and link to binary data
Producing INSPIRE Data Products
Grid Forecasts 2/2

File System

SmartMet Server qengine

SmartMet Server Download

Memory mapped data. Server provides logic for interpolation of data for requested area and time.

Format the data to requested format and projection.

Binary data

05/09/17
FMI Setup
In 2017

- **2 frontends**
  - RAM: 256G
  - CPU: 24x 2.10GHz
  - OS: RHEL7
- **7 backends**
  - RAM: 12G
  - CPU: 24x2.50GHz
  - OS: RHEL7
- **Load Balancer**
  - F5 BIG IP 11
Performance
Production (FMI Setup)

Typical load

- 30 – 80 M req/day
- Baseline 200 req/s
- Peaks over 650 req/s

Average response times

<table>
<thead>
<tr>
<th>Service</th>
<th>Average Response Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFS</td>
<td>140 ms/req</td>
</tr>
<tr>
<td>WMS</td>
<td>130 ms/req</td>
</tr>
<tr>
<td>Timeseries</td>
<td>30 ms/req</td>
</tr>
<tr>
<td>Autocomplete</td>
<td>4 ms/req</td>
</tr>
</tbody>
</table>
Performance
Load Tests (with 5 servers)

• Scenario based on operative use at FMI
• Peaks over 4300 req/s
• Avg 173 ms, 95% of responses in 244 ms, median 54 ms
• Possibly heavy data requests require QoS management
  • Independent queues for slow and fast queries
Roadmap

Native GRIB and NetCDF support for input data

Support for GRIB and NetCDF data as input data without converting data to internal data format

Clustering support over Internet

Possibility to provide data from its original source via single API (*bring users to data*)
https://github.com/fmidev
https://hub.docker.com/u/fmidev/
https://en.ilmatieteenlaitos.fi/open-data

http://roopetervo.com
http://www.slideshare.net/tervo

www.fmi.fi