SmartMet Server
Providing MetOcean Data

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FMI Open Data

Finnish Meteorological Institute opened its data in 2013.

Basically everything that FMI has property rights was opened.

Data is provided in freely in machine readable format.

https://en.ilmatieteenlaitos.fi/open-data
## Some Example Data Sets

<table>
<thead>
<tr>
<th>Data set</th>
<th>Description</th>
<th>Time Interval</th>
<th>Estimated publish date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Observations</td>
<td>Temperature, Wind, Humidity, Ground Temperature…</td>
<td>10 min</td>
<td>Open, older data to be added</td>
</tr>
<tr>
<td>Weather forecast model HIRLAM RCR</td>
<td>Point forecasts and grid data</td>
<td>Latest model run (4 times a day) 0…54 h</td>
<td>Open</td>
</tr>
<tr>
<td>Aviation Observations</td>
<td>METAR</td>
<td>30 min</td>
<td>open</td>
</tr>
<tr>
<td>Weather Radars</td>
<td>Precipitation Rate, Precipitation Amount…</td>
<td>5 min</td>
<td>Open, older data to be added</td>
</tr>
<tr>
<td>Lightning</td>
<td>Thunder Strikes in Finland</td>
<td>5 min</td>
<td>Open</td>
</tr>
</tbody>
</table>
FMI Open Data Portal follows INSPIRE requirements.

The very same data portal works as Open Data and INSPIRE portal.
FMI Open Source Software

Finnish Meteorological Institute opened its data

2013

FMI starts to open its software

2016

https://en.ilmatieteenlaitos.fi/open-data
SmartMet Server

- Basis of FMI product generation

FMI Open Data Portal & FMI INSPIRE Data Services
Backend for clients’ web services
Integration to clients’ systems
Backend for mobile applications
Backend for FMI public pages
Backend for FMI Client Services
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

FMI Open Data Portal & FMI INSPIRE Data Services

Backend for clients’ web services

Integration to clients’ systems

Backend for mobile applications

Backend for FMI public pages

Backend for FMI Client Services
Open Source

- Published in 2016 in GitHub
  - [https://github.com/fmidev/smartmet-server](https://github.com/fmidev/smartmet-server)
- MIT Licence
- Documentation in GitHub

- FMI will host the development
  - Small contributions with pull requests
  - In larger contributions, implementation plan is recommended (in GitHub wiki)
  - CLA (Contributor Licence Agreement) will be 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
FMI Setup

In 2016

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

Typical load

- > 30 000 000 req/day
- Baseline 200 req/s
- Peaks over 650 req/s

Average response times

<table>
<thead>
<tr>
<th>Service</th>
<th>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>

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Performance
Load Tests (Production Setup)

- 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*)

WCS support

Implement WCS interface for download plugin
Hands-on?

Source code and documentation: https://github.com/fmidev/smartmet-server

Unofficial Docker image: https://hub.docker.com/r/meteofi/smartmetserver/