SmartMet Server
Providing MetOcean Data
Roope Tervo, Mika Heiskanen, Tarja Riihisaari, Mikko Visa and Mikko Rauhala
FMI Open Data

- Finnish Meteorological Institute opened its data in 2013.
- Basically everything FMI owns was opened.
- Data is provided in freely in machine readable format.
- FMI Open Data Portal follows INSPIRE requirements.
- The very same data portal works as Open Data and INSPIRE portal.
Data Sets

• Way beyond INSPIRE Data Specification scope
  • Instantaneous weather and marine observations
    • AWS, soundings, mast, air quality, sun radiation, marine, lightning…
  • Radiation observations by Radiation and Nuclear Safety Authority (STUK)
  • Road weather observations
  • Model data from 6 different weather and marine models
  • Weather radar images
  • Climatological data
    • Observation time series, analysis, climatological reference…
Data Models

- Observations and point forecasts as GML
  - The same data is published in two different formats.
- Gridded data is provided in appropriate binary format (GRIB, NetCDF…)
  - WFS members contains the metadata ‘envelope’ with a link to a actual data
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
Producing INSPIRE Data Products

Observations

Database

SmartMet Server

SmartMet Server WFS

In-memory database with latest data. Server provides logic for fetching data from local or master database.

XML response

INSPIRE compliant
Producing INSPIRE Data Products

File System → SmartMet Server → SmartMet Server WFS

1. Forecast model data is provided by the file system.
2. The SmartMet server receives the forecast data and prepares it for dissemination.
3. The SmartMet server WFS (Web Feature Service) converts the data into an INSPIRE compliant XML response, containing metadata and a link to the binary data.

10/4/2016
Open Meteorological Data with OGC and INSPIRE - Roope Tervo
Producing INSPIRE Data Products

File System
SmartMet Server
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.

Forecast model data

File System
SmartMet Server
SmartMet Server Download

10/4/2016
Open Meteorological Data with OGC and INSPIRE - Roope Tervo
SmartMet In a Nutshell

- Data and product server for MetOcean data
- High capacity & availability
- Data is extracted and products generated always on-demand
- INSPIRE Compliant
- Operative since 2008
  - FMI client services (since 2008)
  - Finnish Meteorological Institute (FMI) Open Data Portal (since 2013)
SmartMet In a Nutshell

• Several input sources
  • GRIB-, NetCDF-, etc. files via internal data format querydata
  • PostGIS database (vectors)
  • SQL database (point observations)

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

• Basis of FMI product generation
Open Source

• Going to be published as Open Source in Q4/2016
• MIT license
• https://github.com/fmidev
Architecture

- **Frontend**
  - Load balancer
  - Knowledge about backend services

- **Backend**
  - Different backends may contain different services

- **Plugin-based architecture**
  - *Engines* provides shared access to the data
  - *Plugins* provides APIs based on services provided by engines
WMS

- Version 1.3.0
- Supports png, svg, jpeg, tiff
- Supports all proj.4 projections
- Supports for time and other custom dimensions
- Data sources: grid data and PostGIS
  - Contours coverages and isolines on-fly from grid data (qengine)
  - Draws PostGIS geometries based on database queries
- Generates SVG which are rendered to requested raster format
  - Supports rich effects of SVG rendering model
  - Styling with CSS
  - Rendering done with librsvg
- Configuration with json
  - Configuration variables can be overridden in requests (i.e. thresholds)
WMS

• Support for meteorological specific visualizations
  • Wind barbs, wind arrows…
  • Support for thresholds
  • i.e. draw images only where temperature is between -2 and 2 degrees
  • Also possibility to mask content based on other parameter (i.e. draw precipitation areas only where wind gusts are over 8 m/s)

• Very efficient cache
  • Supports frontend product cache
  • Several LRU caches in backend
    • For contours, SVG products and ready rendered products

• Performance up to 2000 req/s
  • With FMI setup (see slide 26)
WFS

- Version 2.0.0 Basic Profile
- INSPIRE Compliant
- Support all proj.4 projections
- Capabilities: ImplementsQuery, ImplementsAdHocQuery, ImplementsMinStandardFilter,
  ImplementsMinSpatialFilter, ImplementsMinTemporalFilter
- Supports KVP- and XML-encodings
- Support for simple and complex features
- Data sources: grid data (qengine) and observation data (obsengine)
  - Point forecasts from grid data
  - Contours from grid data
  - Observations from obsengine
- Most of the data provided via stored queries to access good enough performance
Download (WCS-like)

• Provides grid data (from qengine) as binary data
• Supported output formats: GRIB1, GRIB2, NetCDF and Querydata,
• Supports all EPSG projections (depends on output format support)
• Supports slicing and trimming by
  • area (bbox)
  • elevation (pressure and/or model level)
  • time (start time, end time and origin time)
• Possibility to define grid resolution by
  • selecting every Nth grid point to x and y direction
  • grid size → data is interpolated to new grid points
FMI Setup

• 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
• Databases
  • Master Observation Database: Oracle
  • Location Database: PostGIS 9.4
Performance

• Production (with FMI setup)
  • > 30 000 000 req/day
  • Baseline 200 req/s
  • Peaks over 650 req/s
  • Average response times varies depending on the request:
    • WFS: 140 ms/req, WMS: 130 ms/req, Timeseries: 30 ms/req, Autocomplete: 4 ms/req
    • Overall average: 70 ms/req
  • Over 99.95% availability
Performance

• Load testing (production setup):
  • Peaks over 4300 req/s
  • Avg 173 ms, 95% of responses in 244 ms, median 54 ms
• Slow query queue easy to DoS due to possibility to large data requests and heavy operations
  • No effect to fast query queue
Roadmap for the future

WCS support
- Implement WCS interface for download plugin

GRIB and NetCDF support for input data
- Support for GRIB and NetCDF data as input data without converting data to internal data format
- Possibility to provide data from its original source via single API

Clustering support over Internet
-
http://roopetervo.com
https://github.com/fmidev
https://facebook.com/fmibeta
http://www.slideshare.net/tervo/
https://en.ilmatieteenlaitos.fi/open-data

FINNISH METEOROLOGICAL INSTITUTE

www.fmi.fi