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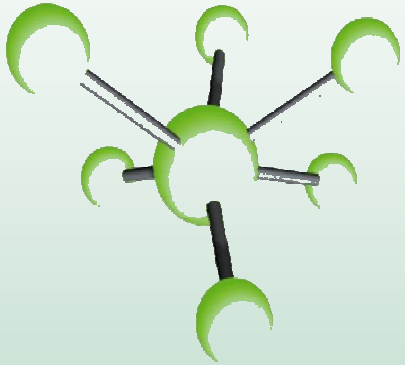
S@NY
Sensors Anywhere
FP6-033564



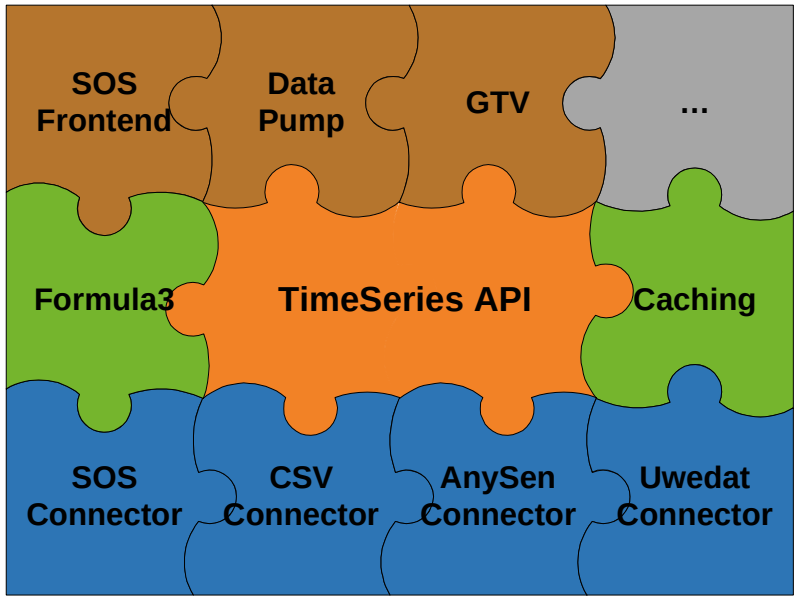
FOSS4G 2009 - Sydney

The Time Series Toolbox

Thomas Bleier, Arndt Bonitz, Bojan Božić,
Thomas Ponweiser

The Time Series Toolbox

- A set of API‘s and software components
- For building services and applications
- That work with time series data (record, process, store, publish, etc.)



Design Goals

- Modular architecture
  use components as you like, not „all-or-nothing“
- Standards-based
  e.g. OGC Sensor Observation Service
- Flexible design
  From single float values to complex data structures
- Extensible
  Well-defined interfaces allow easy extension

Environment / Requirements

- Main language: Java 1.6
- One component written in Python (→ Jython)
- Can be used in all types of applications:
  - Webservices (J2EE, etc)
  - Command-line applications
  - Desktop GUI applications

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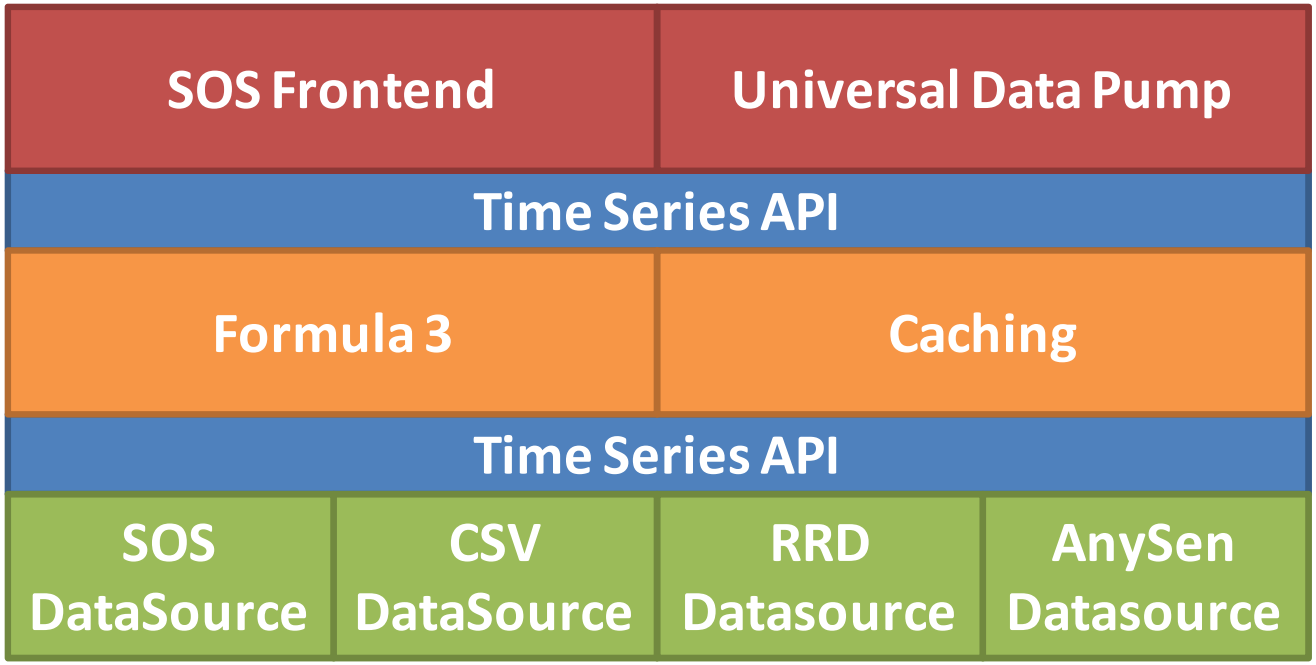
Layered Architecture

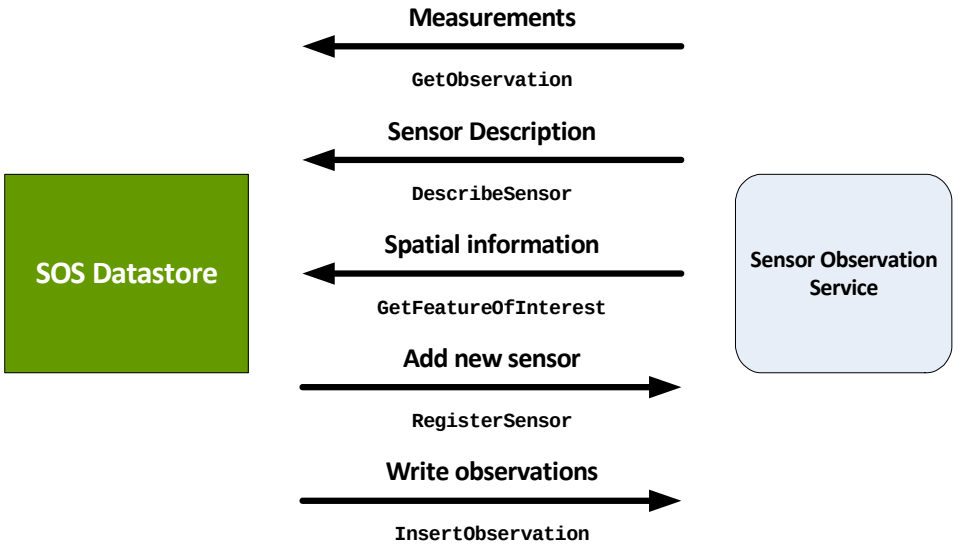
- Data connector components
- Core processing components
- Frontend components



Information Society Technologies

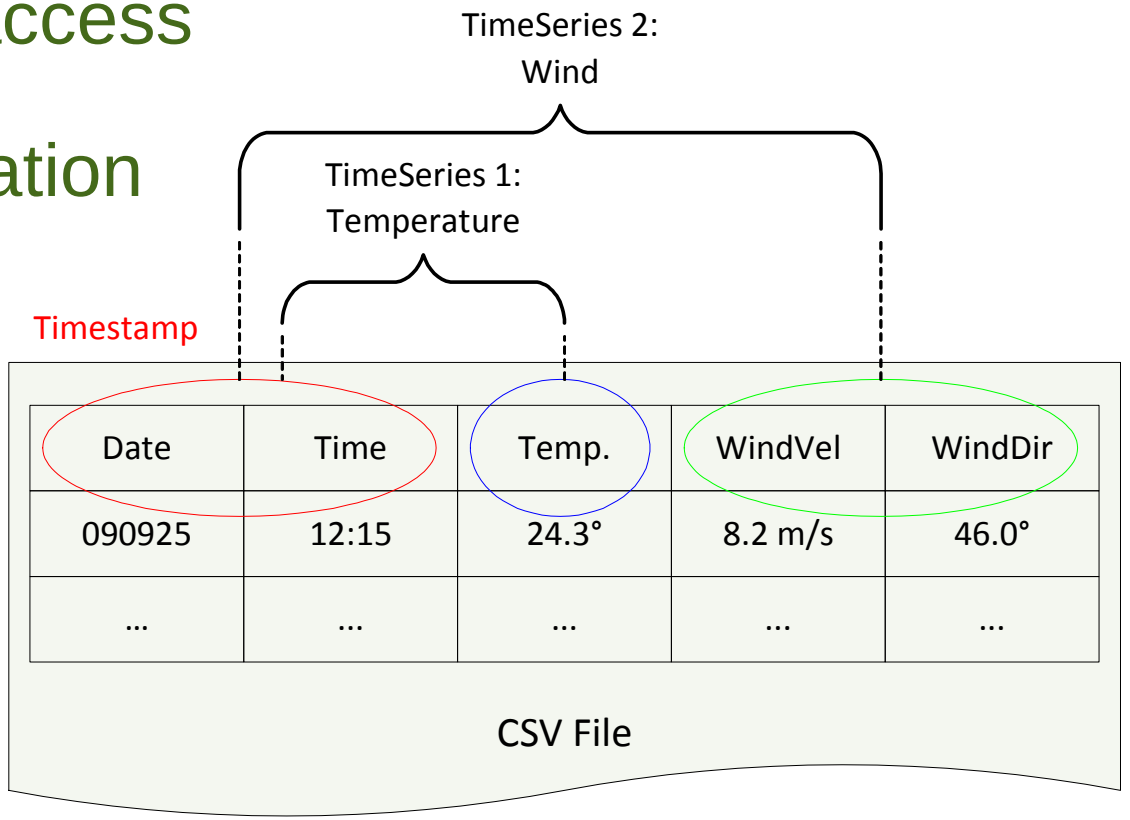
Data connector: SOS DataStore

- Accessing Sensor Observation Services
- Read: Observations, SensorML, Features
- Write: Observations, RegisterSensor
- Flexible parser
  (e.g. SOS 1.0 / 0.31)



Data connector: CSV DataStore

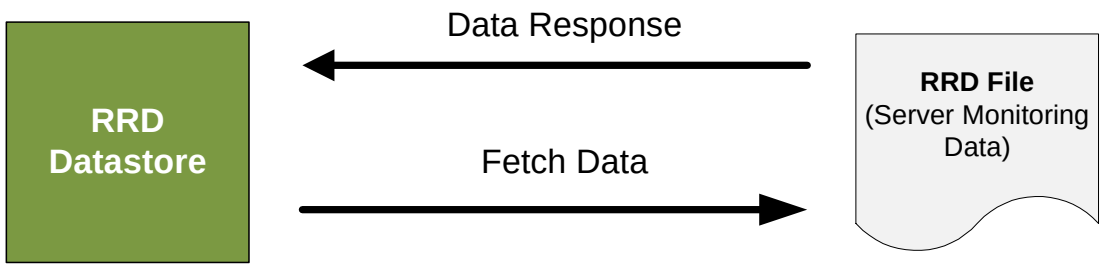
- Access Comma Separated Value Files
- Read and write access
- Flexible configuration
  - Separators
  - Formats
  - Values



Data connector: RRD DataSource

- Round Robin Database (http://oss.oetiker.ch/rrdtool/)
- Currently read-only access to data
- Integration of existing RRD files

  (e.g. from system monitoring applications)



Data connector: AnySen DataSource

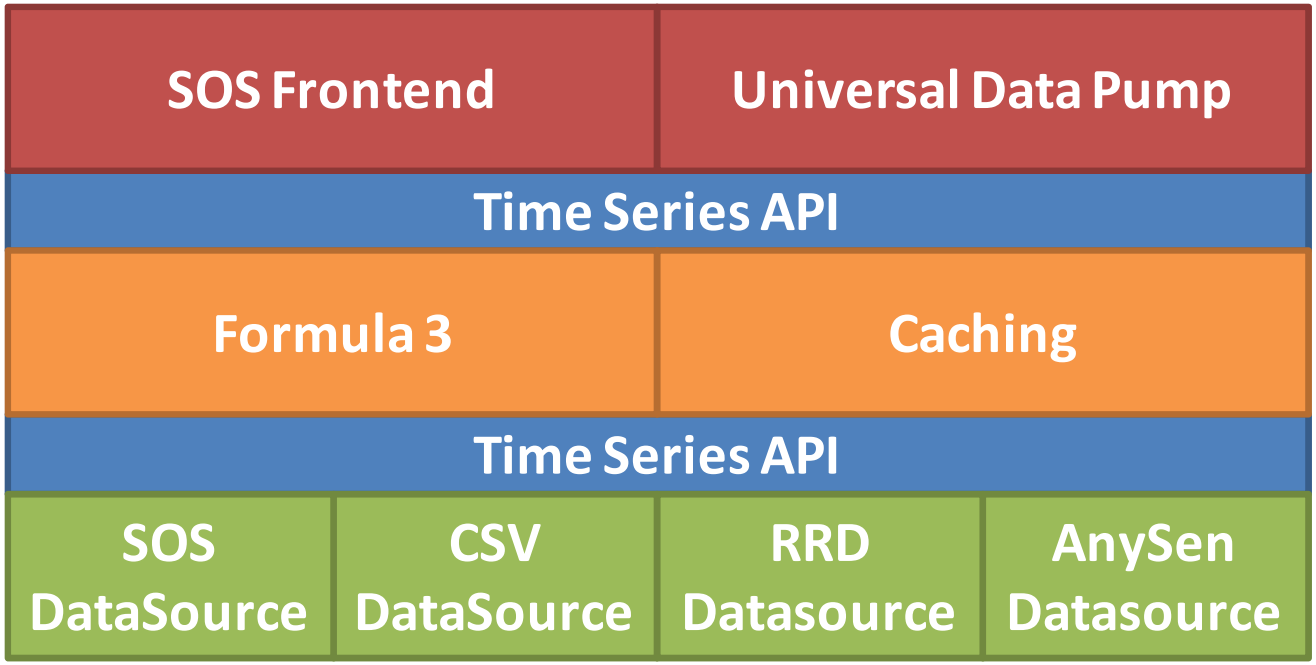
- Data aquisition directly from a sensor
- Designed for serial streaming sensors
- Flexible configuration of parser
- Plug & measure – get config from repository

Data Connector API

```
public interface DataStore {

    // connection
    public void connect(String connectString);
    public void connect(Map<String, String> properties);
    public void disconnect();

    // configuration
    public Object getDataStoreProperty(String key);
    public void setDataStoreProperty(String key, Object value);

    // time series
    public List<String> getTimeSeriesIds();
    public List<String> findTimeSeriesIds(Map<String,
        Object> timeSeriesProperties);

    ...
}
```

Layered Architecture

- Data connector components
- **Core processing components**
- Frontend components

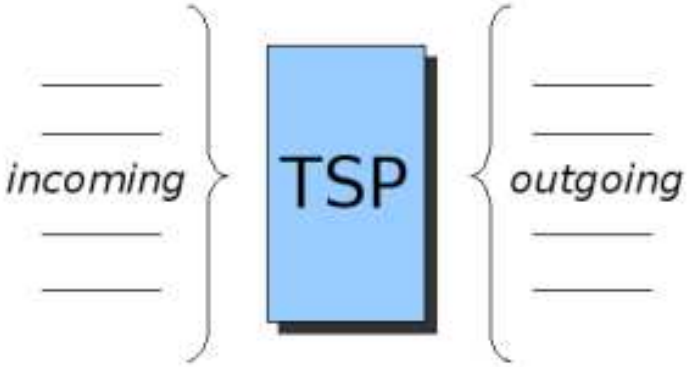


Formula 3

- „Time Series Processor“
- Read time series data
  from connectors via TSAPI
- Process data:

```
< [n] * 2 >
< [n-2 .. n].sum >
< ( t-3 hours .. t ].mean > every 30 mins
```

- Output time series data via TSAPI



Formula 3

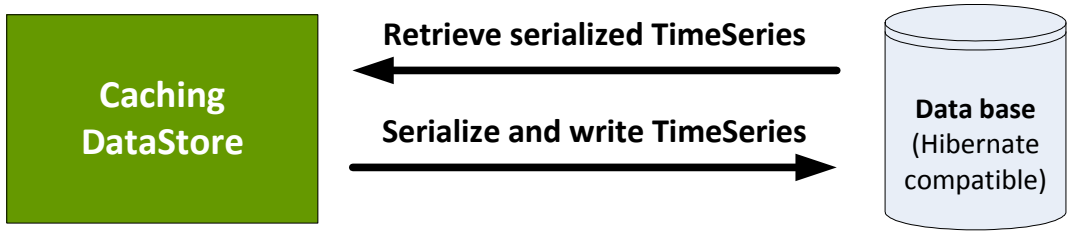
- Functionality
  - Calculation (arithmetic)
  - Parameters for formulas
  - Time patterns, slot/range selection
  - Conditions
  - Predefined functions, user defined functions
- Example use cases
  - Aggregation, Mean values, etc.
  - Filtering, Classification

Formula 3 - implementation

- Design goal: usable as a „standalone“ library on major platforms (Java, DotNET, „native“)
- → Implemented in Python
- TS Toolbox contains Formula 3 running on Jython

Caching

- Store time series data in local database
- Temporary storage
- Use cases: caching, prefetching, local storage, etc.
- Currently implements configurable prefetching



Layered Architecture

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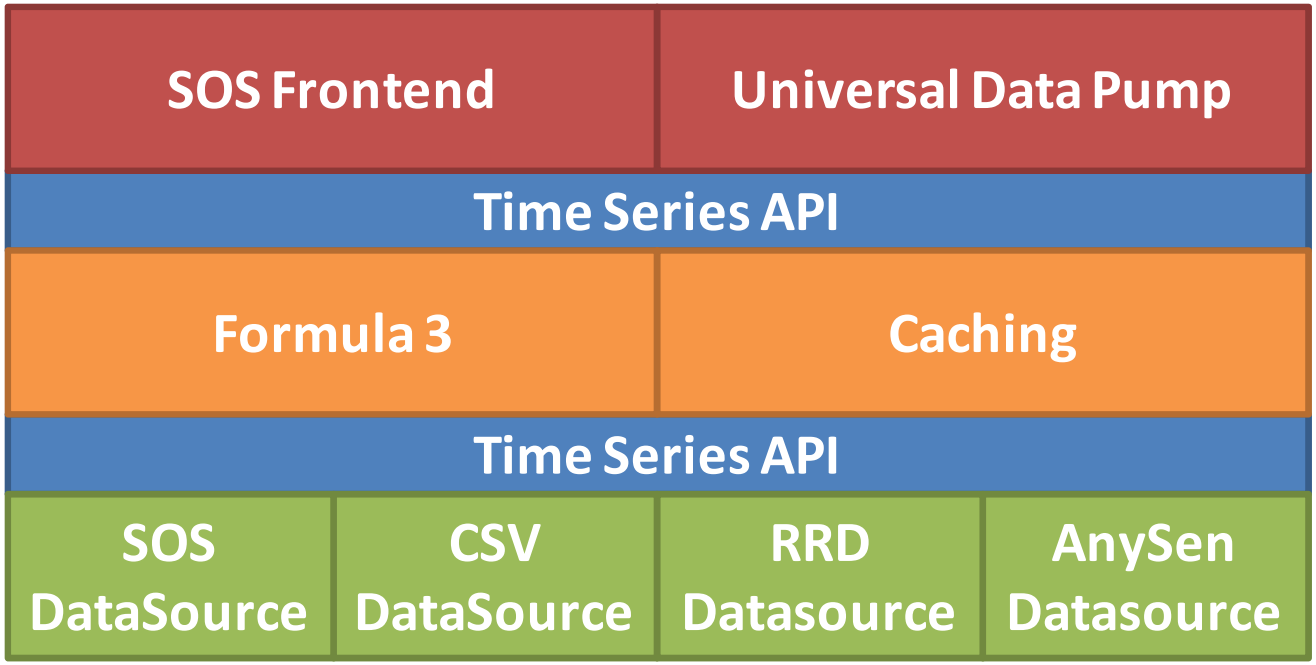
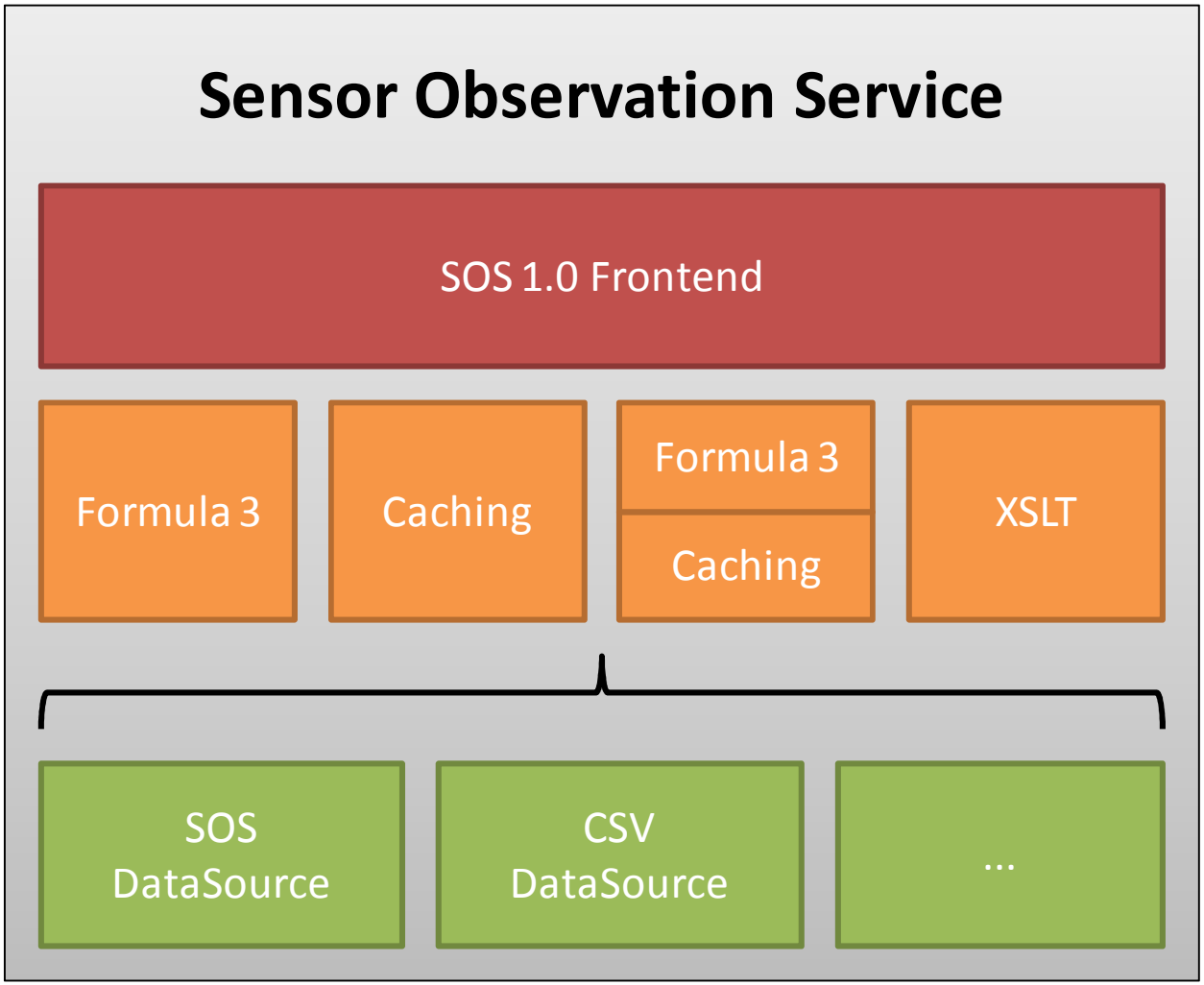


SOS Frontend

- Sensor Observation Service Frontend to TSAPI
- Serve data from multiple data connectors
- On-the-fly processing using Formula 3
- Local caching/prefetching of data
- Based on 52°North SOS
- SensorML generation/transformation with XSLT

SOS Frontend: application schema



SOS Frontend: use cases

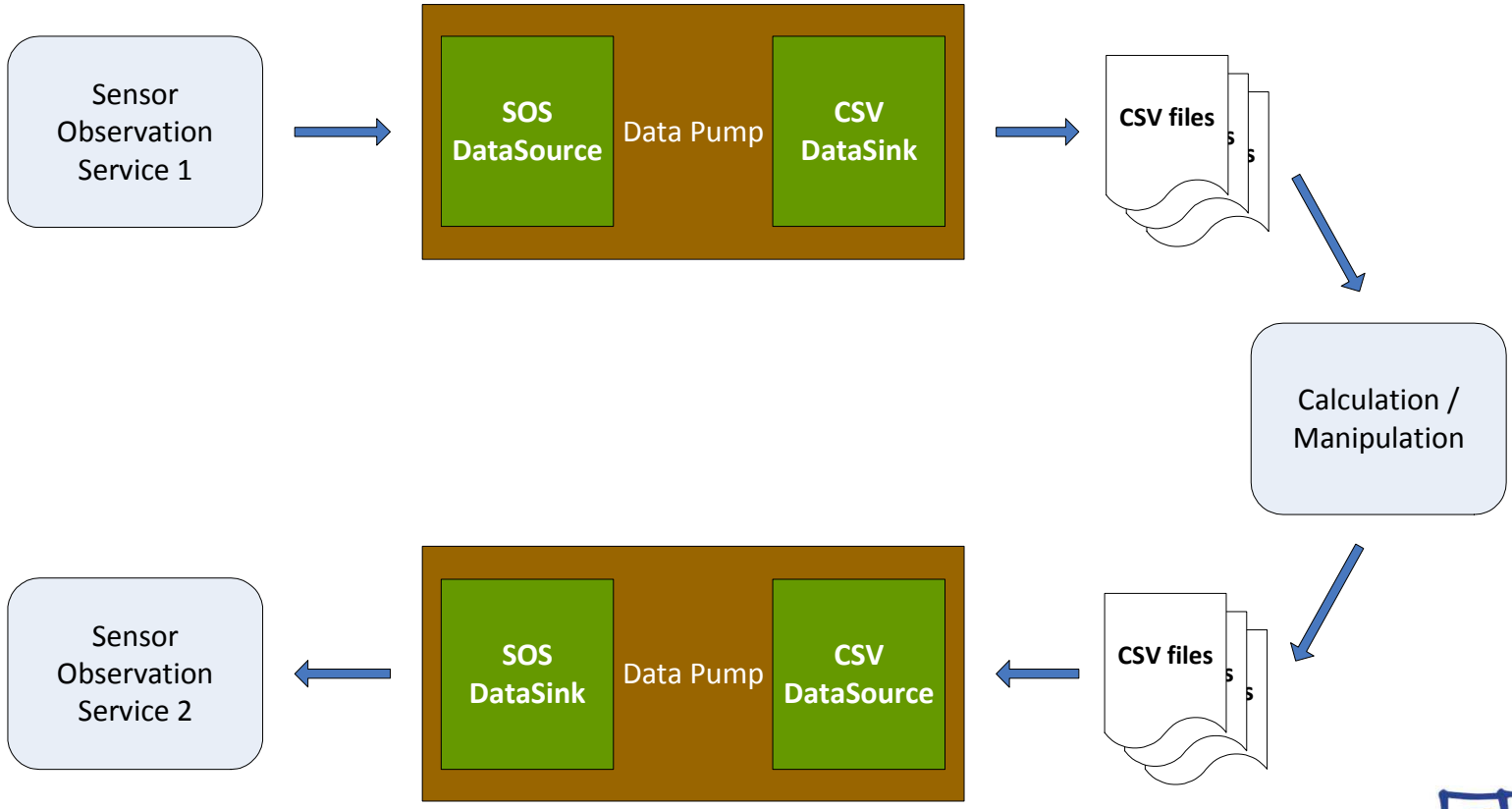
- SOS Interface to DataSource (CSV, Legacy, etc.)
- SOS with on-the-fly processing
- Cascading SOS: custom views, transformations, caching, etc.
- Data preparation for reporting
- …

Universal Data Pump

- Read data from a DataSource
- Write to one or more DataSink(s)
- Configurable (config file and commandline)
- → Batch Processing
- CSV → SOS, SOS → CSV, Legacy → SOS, AnySen → CSV, AnySen → SOS, etc.

Data Pump – Example Scenario

- Export data from SOS into a CSV file
- e.g. for legacy modeling application



Example config file - structure

```
<?xml version="1.0" encoding="UTF-8"?>
<DatapumpConfiguration xmlns="http://enviro.ait.ac.at/datapump/configuration">

  <General>
    <ErrorHandling>
      ...
    </ErrorHandling>
  </General>

  <DataSource>
    <Connection>
      ...
    </Connection>

    <Filter>
      ...
    </Filter>
  </DataSource>

  <DataSink>
    <Connection>
       ...
    </Connection>
  </DataSink>

</DatapumpConfiguration>
```

Example config file - datasource

```
<?xml version="1.0" encoding="UTF-8"?>
<DatapumpConfiguration xmlns="http://enviro.ait.ac.at/datapump/configuration">
  ...
  <DataSource>
    <Connection>
      <Parameter key="ds:protocol" value="SOS"/>
      <Parameter key="ds:connect_string“
                 value="http://enviro5.arcs.ac.at/SOSuwedat10/sos"/>
    </Connection>

    <Filter>
      <Parameter key="ts:offering" value="all"/>
      <Parameter key="ts:observed_property" value="urn:ogc:def:phenomenon:arcs:wiv"/>
      <Parameter key="ts:feature_of_interest" value="urn:ogc:object:feature:arcs:s404"/>

      <!-- Query time interval -->
      <Parameter key="time:start" value="2007-05-01T00:00:00+0200"/>
      <Parameter key="time:end"   value="2007-05-24T01:59:59+0200"/>
    </Filter>
  </DataSource>
  ...
</DatapumpConfiguration>
```

Example config file - datasink

```
<?xml version="1.0" encoding="UTF-8"?>
<DatapumpConfiguration xmlns="http://enviro.ait.ac.at/datapump/configuration">
  ...
  <DataSource>
     ...
  </DataSource>
  <DataSink>
    <Connection>
      <Parameter key="ds:protocol" value="CSV"/>

      <!-- Filename "-" stands for standard output -->
      <Parameter key="ds:connect_string" value="-"/>

      <!-- Column labels -->
      <Parameter key="csv:labels" value="Time|Value|Unit"/>

      <!-- Which properties to put in which column -->
      <Parameter key="csv:fields" value="time|slot:value:value|ts:ts:unit"/>

      <!-- Dateformat for time stamps -->
      <Parameter key="csv:format:dateformat" value="yyyy-MM-dd HH:mm"/>
    </Connection>
  </DataSink>
</DatapumpConfiguration>
```

Datapump running

- Running the following command:

```
$ java -jar datapump.jar config.xml
```

- Generates a file with the following content:

```
Time;Value;Unit
2007-05-01 00:00;1.2346;m/s
2007-05-01 00:30;0.73287;m/s
2007-05-01 01:00;1.0861;m/s
2007-05-01 01:30;0.98261;m/s
2007-05-01 02:00;0.95999;m/s
2007-05-01 02:30;1.1562;m/s
2007-05-01 03:00;1.0709;m/s
2007-05-01 03:30;0.64072;m/s
...
```

Time Series Toolbox Availability

- Developed by AIT within the SANY project
- Available under dual license :
  open source (GPL) and commercial license
- Next version currently being released at:
  http://sourceforge.net/projects/timeseriestool/
- For more info contact:
  thomas.bleier@ait.ac.at

Future developments

- API cleanup / refactoring
- More dataconnectors
- More applications

- <insert your requirements here>

SANY – Sensors Anywhere

SANY is an

Integrated Project

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Information Society Technologies

SANY Consortium

Project acronym	SANY
Project reference	IST-2006-033564
Project type	Integrated Project
Start date	01/09/2006
Duration	36 months
Budget	11,2 M€
EC contribution	7,0 M€

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Thank you!

Questions?

Information Society Technologies