AUSTRIAN INSTITUTE OF TECHNOLOGY

SUDPLAN

# Sensor Web Enablement based Model Web Implementation for Climate Change Applications

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# What is SUDPLAN ?

- **S**ustainable **U**rban **D**evelopment **Plan**ner for Climate Change Adaptation
- A web-based planning, prediction and training tool
- Support decisions in long term urban planning
- Help to assure population's health, comfort, safety and life quality
- Sustainability of investments in utilities and infrastructures
- Within a changing climate
- Available for every city in Europe
- Rain, Air quality, Hydrology
- **http://sudplan.eu**

# SUDPLAN from the ICT viewpoint

- Common Services
  - Running somewhere in Sweden
  - Providing data about climate change scenarios
  - Providing different models

- Local Services
  - Running „here“
  - Providing local data as input to the Common Services
  - Providing local models specialized for local needs

- Scenario Management System
  - GUI
  - Management of data and model services
  - Visualisation
  - A lot of other things

# Long and growing list of services providing data and models

- Need a standard for integration
  - Minimize number of interfaces
  - Use existing knowledge and libraries
  - Allow integration with existing systems

- The good thing about standards
  - There is a lot of them to select from
  - Most standards are „flexible“ – They are not specified down to the last bit.

- The bad thing about standards
  - There is a lot of them to select from – how to ensure compatibility?
  - Most standards are „flexible“ – how to make them interoperable?

- Work around this problems
  - Use a standard with Self-Description features!

# All data have a geo reference

- Use of OGC standards
  - Freely available
  - Standard for data encoding
  - Standard for data transport
  - Standard for geographic references
  - Standards for services
  - Standards for model descriptions
  - And a lot more

  - Widely accepted and used standards, especially in the GIS community

http://www.opengeospatial.org/standards

# Services providing data

- Need to use them without prior knowledge about the data
- Need self describing data
- Observation and Measurement (O&M) describes the encoding of the observation data
  - Syntactical description
- Sensor Model Language (SensorML) describes the process producing the data
  - Semantic description

# Nearly all data changes over time

- So everything has to be modelled as a time series
  - Time series of scalars – e. g. temperature
  - Time series of compound features – e. g. wind: speed and direction
  - Time Series of grids – e. g. changing precipitation over Europe

- OGC SOS is designed to access sensor output
  - A sensor produces a series of results
  - As a sensor access service, SOS already provides the mechanisms to get descriptions of the data and the process of data production

# Services providing models

- Like data services we need to use them without prior knowledge
- Need to get a lot of information from the model service
  - Model description
  - Formal specification of parameters, input and output
    - OGC WPS can provide the above functionality
  - Scheduling
  - Monitoring
  - Cancelling
  - Client notification
    - OGC SPS provides this additional functionality

# Summary of Standards

- SOS for data transport
- SPS to encapsulate models
- O&M and SensorML to describe data and models
- UncertML to encode statistic information
- Other standards
  - WMS to provide overview maps
  - WFS to transport specific GML encoded information
  - WCS is not used in the moment

# Usage of the standards: O&M and SOS

- O&M gives a framework / set of rules of how to describe and encode the data
  - Well defined for timeseries of floats
  - Not so well defined for more complicated data types
  - Support for discrete coverages through “O&M part 2”
  - Nothing appropriate concerning continuous coverages

- SOS: use of “Self-Describing”
  - DescribeFeatureOfInterest returns a type description of the new type “SamplingGrid” (xml schema)
  - SamplingGrid extends sampledFeature – so the new type fits into the type schema
  - SamplingGrid contains a RectifiedGrid describing where the sampling takes place.

# Usage of the standards: UncertML

- Some models produce statistical data about the result

| | Mean rainfall | Maximum rainfall | Frequency of rainfall |
|---|---|---|---|
| Winter (Dec-Feb) | +3.1% | +9.3% | -1.5% |
| Spring (Mar-May) | +6.9% | +17.8% | +2.2% |
| Summer (Jun-Aug) | -1.2% | +17.5% | +2.3% |
| Autumn (Sep-Nov) | -1.5% | +6.1% | +1.6% |

- This is modelled in UncertML as this is a description of the model result from one particular model run

- This could also be modelled as a time series using O&M as the description has a time reference – the time period for which this values are calculated.

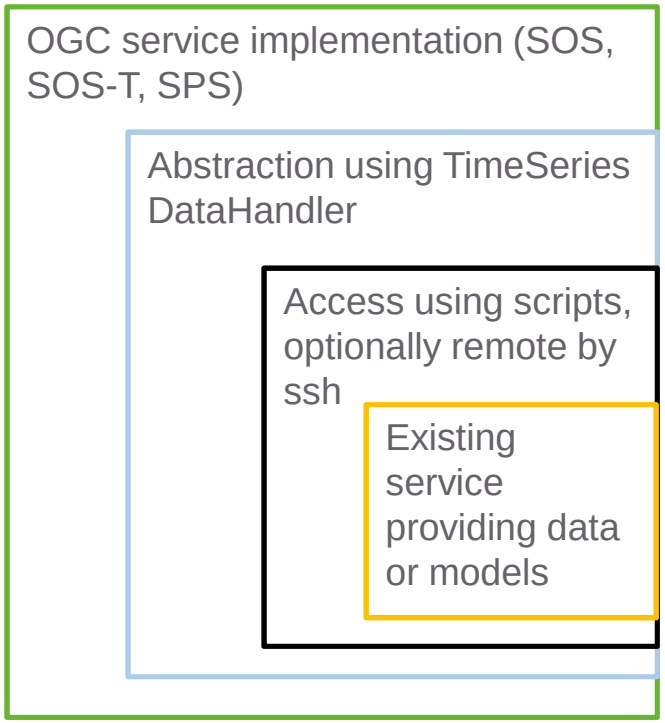
http://www.uncertml.org/

# Usage of the standards: SensorML

- SensorML is designed to describe Sensors.
  - This includes also a description of how a physical value (e.g. voltage from the sensor element) becomes an observation (e.g. Temperature in ℃)
- A model is also some type of sensor.
- SensorML is used to describe the model and its parameters
  - Needed to generate a GUI
  - Needed to produce a human readable description for the user

# SUDPLANS generic OGC service implementation

- Flexible OGC service implementation using TimeSeries DataHandler in the background
- Provides SOS, SOS-T and SPS
- DataHandler hiding scripts
- Fast implementation by using scripts providing descriptions and access to the target system
- For security reasons this access might be remote and ssh encrypted
- If needed for performance reasons the scripts might be replaced by a dedicated DataHandler later



# SUDPLANS SOS implementation

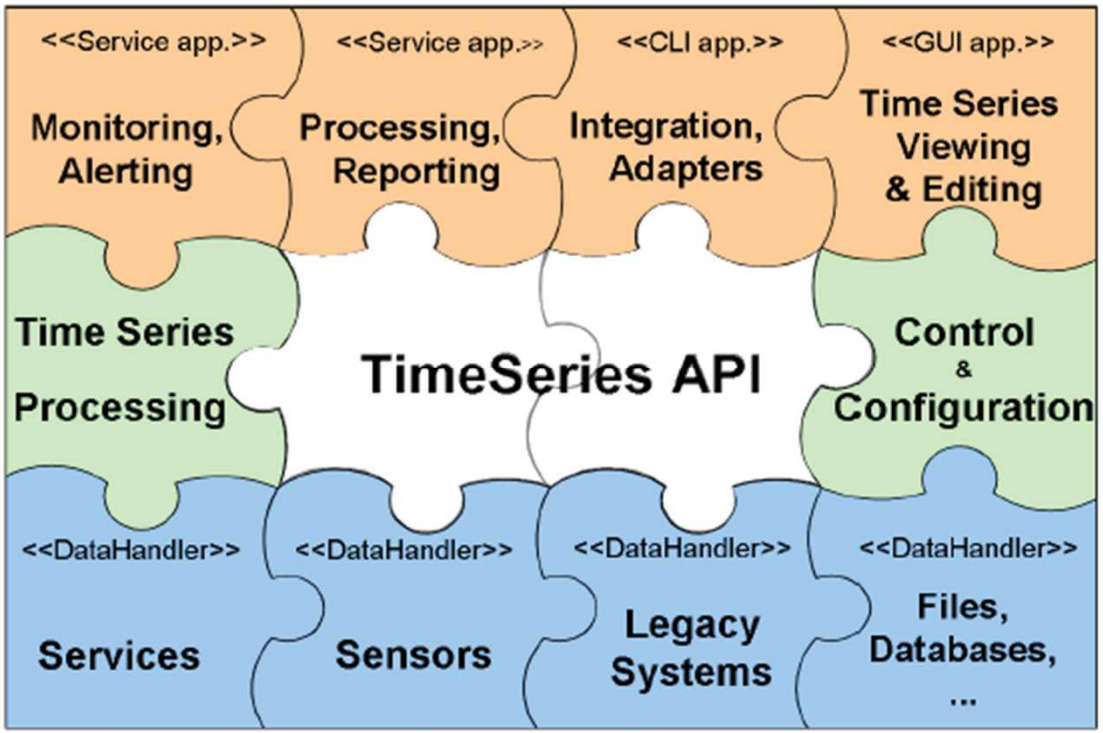
- Used to provide access to data stores
- SOS and SOS-T server
- Client with TimeSeries ToolBox DataHandler API
- Encoding of
  - Scalar observations
  - 2D grid data by extensions to the OGC SamplingFeature schema for describing SamplingGrid for continuous coverages
- O&M descriptions of the result model
- SensorML descriptions of the process from which the data originates
- Planned extensions
  - Support for 3D grid data
  - Support for aggregated data
  - Support for NETcdf data encoding

# SUDPLANS SPS implementation

- Used to wrap models
- SPS Client with TimeSeries ToolBox DataHandler API
- Large amount of input and output data can be transferred using the SOS-T server (distinction between model parameters and input data)
- Provides
  - Model offering descriptions
  - Process (e.g. model) description in SensorML
  - Parameter-Description for automatic GUI generation
  - Asynchronous model execution
  - Management of model runs (cancel / update)
  - Progress and status information
- Limitations of current implementation
  - Not all optional methods are implemented
  - Including notification functionality as defined by SPS standard

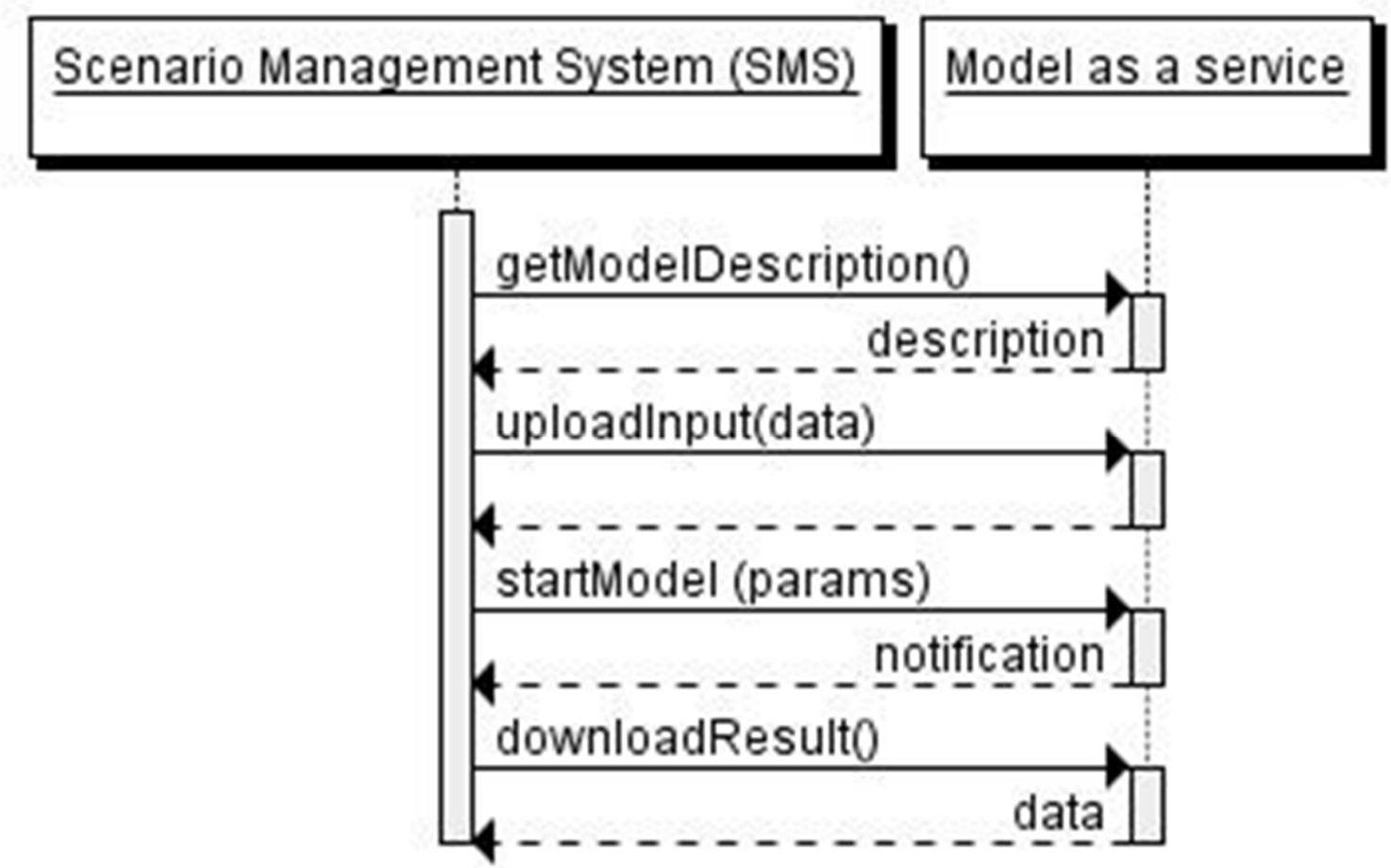
# TimeSeries-Toolbox

- The implementation of SOS and SPS related software is based on the *TS-Toolbox API* from AIT. The *TS-Toolbox API* provides the means to conveniently deal with arbitrary Time Series .

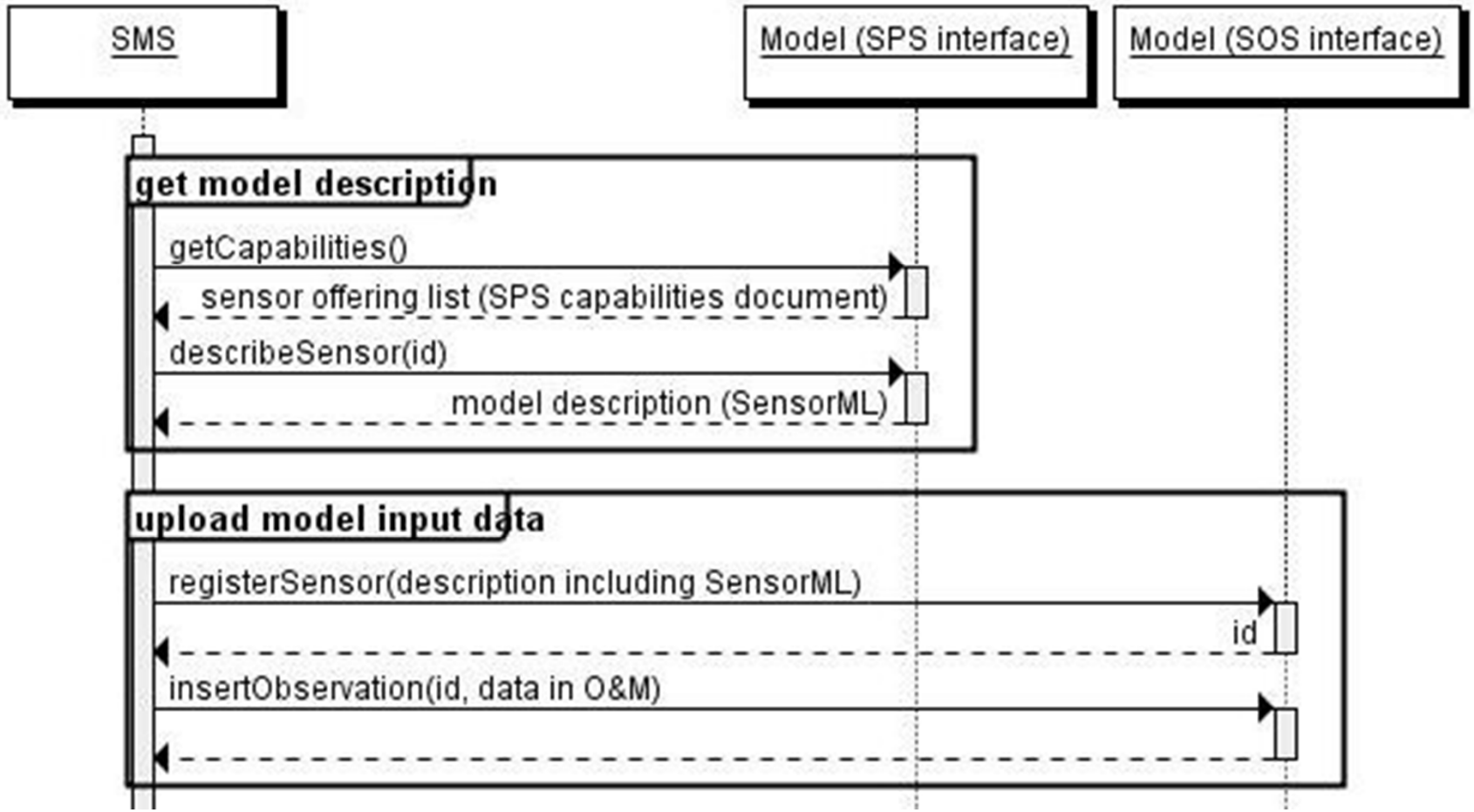



http://ts-toolbox.ait.ac.at

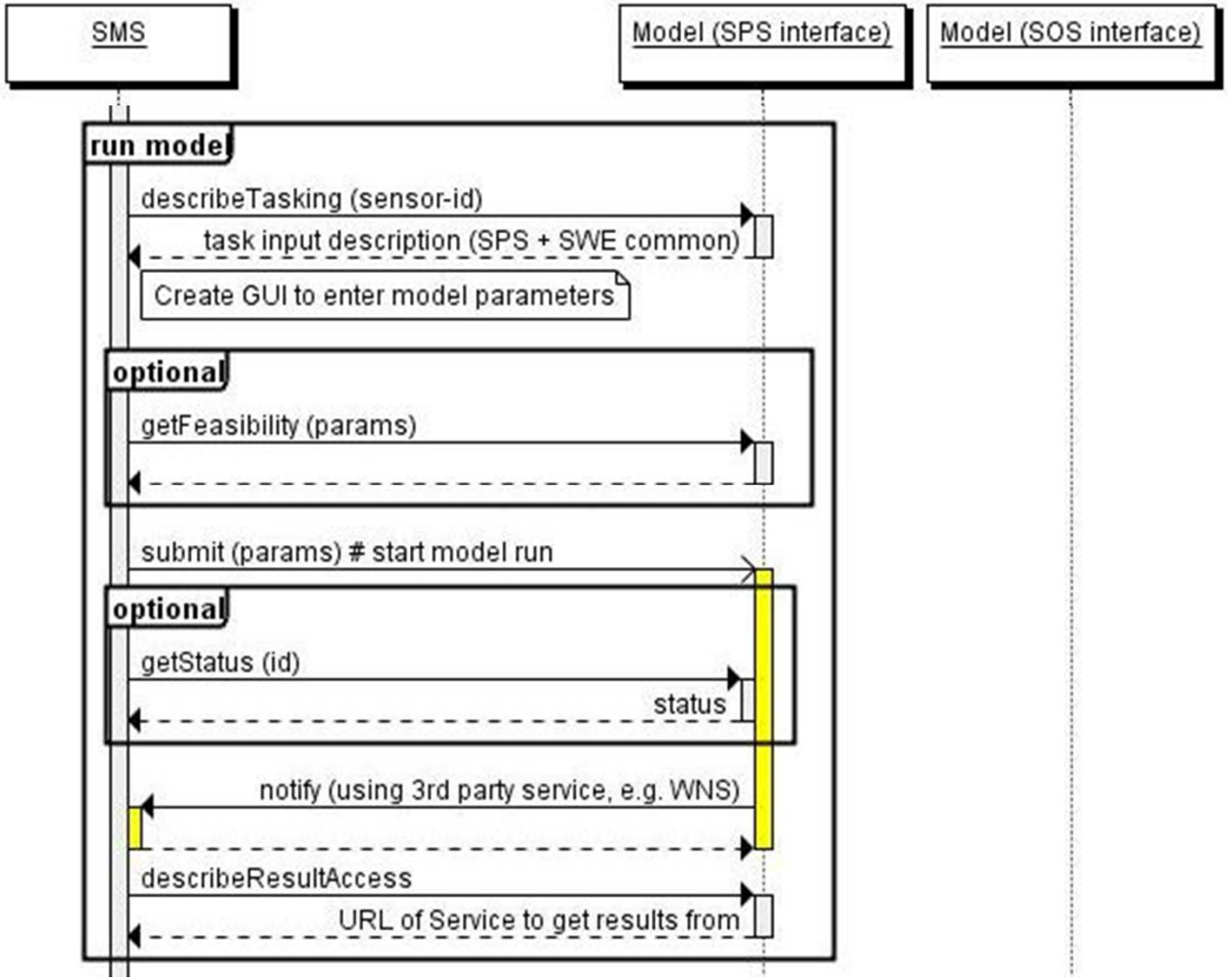
# Model-as-a-Service invocation



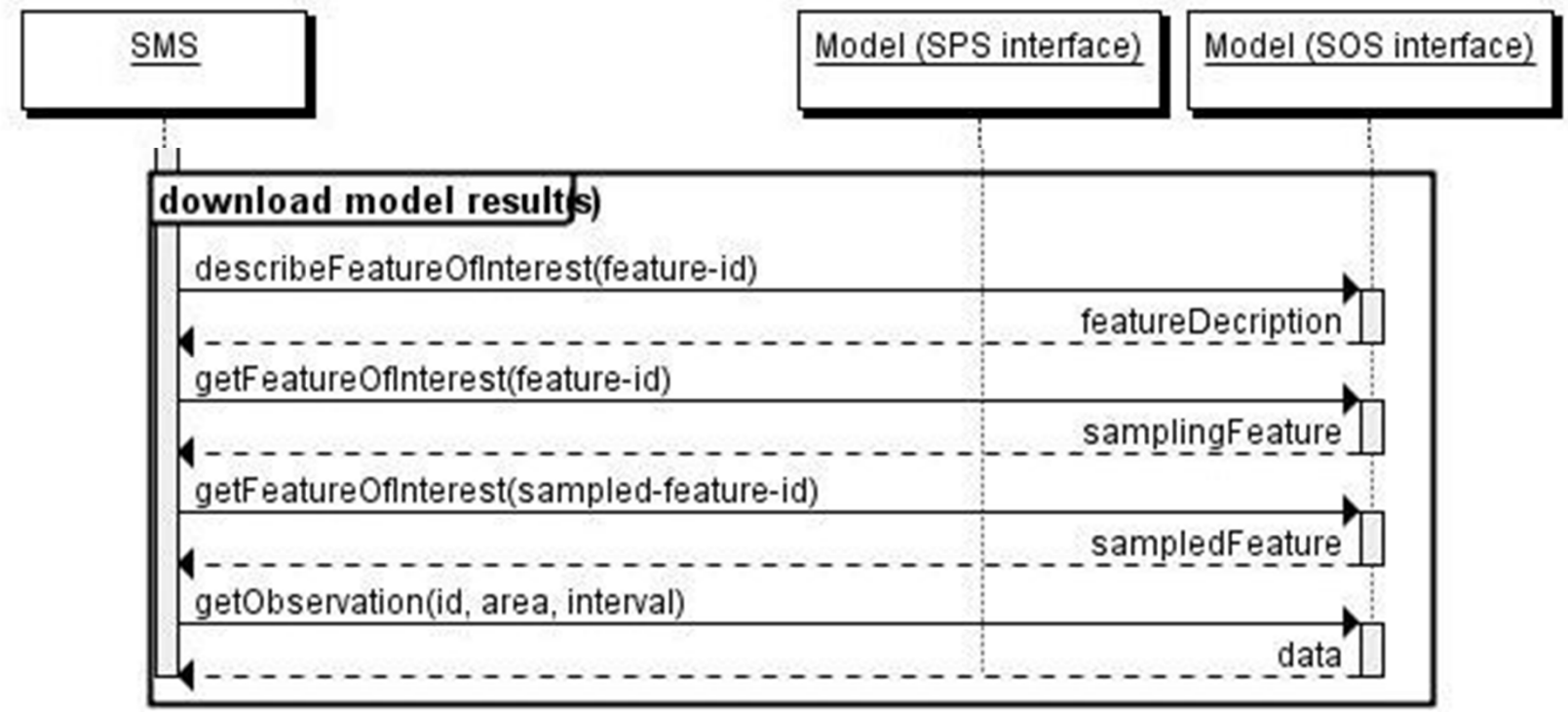
# Invocation details 1



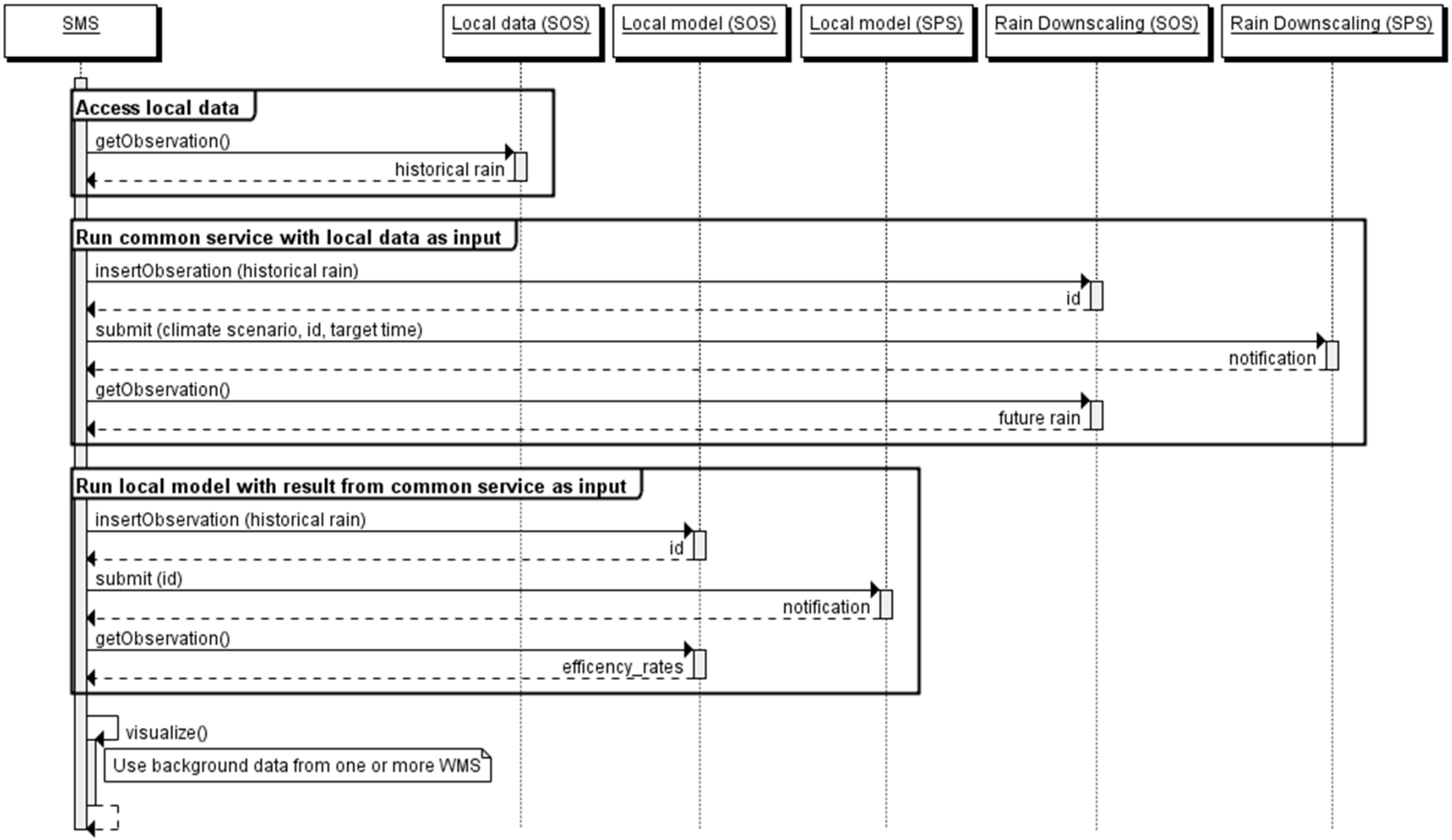
# Invocation details 2



# Invocation details 3



# Invocation details Linz: Two models



# Sustainable Urban Development Planner for Climate Change Adaptation

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## Partners

1. Swedish Meteorological and Hydrological Institute
2. Austrian Institute of Technology
3. cismet GmbH
4. Czech Environmental Information Agency
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6. Deutsches Forschungszentrum für Künstliche Intelligenz
7. Stockholm Uppsala Air Quality Management Association
8. City of Wuppertal
9. Technische Universität Graz