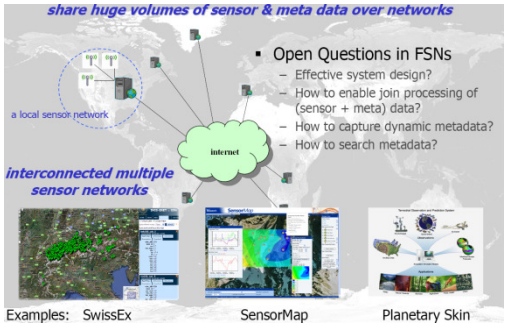
Research Platforms: SwissEx

Effective Metadata Management in Federated Sensor Networks

Hoyoung Jeung[1], Sofiane Sarni[1], Ioannis Paparrizos[1], Saket Sathe[1], Karl Aberer[1], Nicholas Dawes[2], Thanasis G. Papaioannou[1], Michael Lehning[2], Stephan Gruber[3], Mustafa Yuecel[4], Tonio Gsell[4], Jan Beutel[4]
1. Ecole Polytechnique Federale de Lausanne (EPFL), 2. Swiss Federal Institute for Snow and Avalanche Research (SLF), 3. University of Zurich, 4. Eidgenössische Technische Hochschule (ETH) Zurich

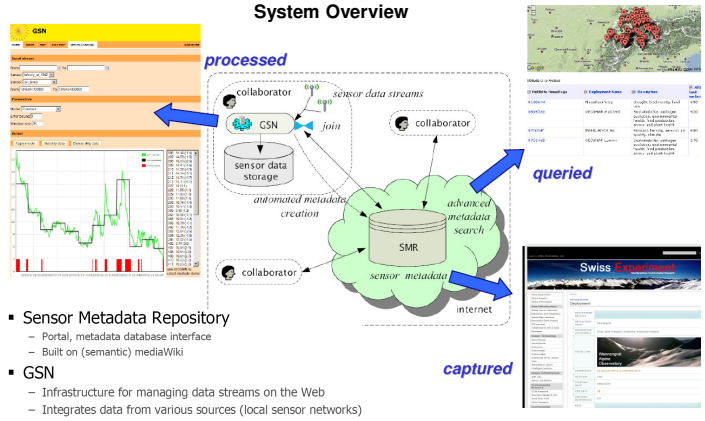
Contact:
Karl Aberer, EPFL-IC-IIF-LSIR, Bâtiment BC Station 14 Lausanne, +41 21 693 4679, karl.aberer@epfl.ch
http://www.swiss-experiment.ch/

Federated Sensor Networks



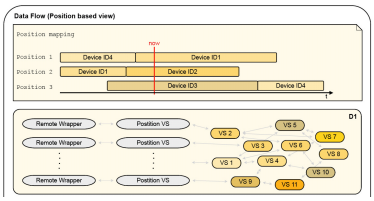
- Open Questions in FSNs
  - Effective system design?
  - How to enable join processing of (sensor + meta) data?
  - How to capture dynamic metadata?
  - How to search metadata?

System Overview



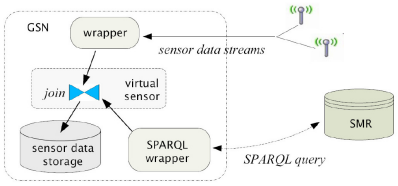
- Sensor Metadata Repository
  - Portal, metadata database interface
  - Built on (semantic) mediaWiki
- GSN
  - Infrastructure for managing data streams on the Web
  - Integrates data from various sources (local sensor networks)

Distributed Metadata Join



- An example in NCCR-MICS PermaSense

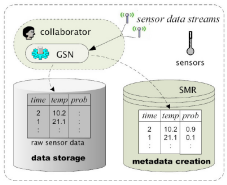
- Processing overview



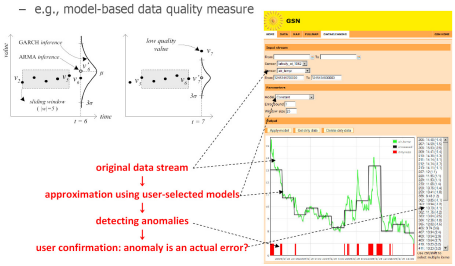
- Step 1 – Users compose metadata in SMR
- Step 2 – SPARQL wrapper configuration in GSN
- Step 3 – SPARQL query composition by GSN
- Step 4 – Caching SPARQL query results in GSN
- Step 5 – Join processing
  - SPARQL query results + real-time streams

Automated Metadata Generation

- Monitoring large numbers of sensor data streams
  - Manual approaches are infeasible
- Processing overview



- Step 1 - Users define/implement an operation in GSN
  - e.g., model-based data quality measure



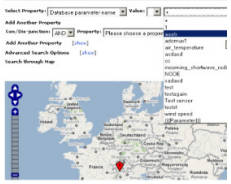
- Step 2 – Configurations in GSN
  - linking to the operation, what metadata to be created
- Step 3 – Dynamic metadata composition by GSN
  - Only when the user-defined operation is triggered
  - SensorML-based metadata template

```
<metadata>
    <deployement>EPFL_Deployement</deployment>
    <station>multidata</station>
    <sensor>temperature</sensor>
    <from>2010-05-17T14:00:41.826+02:00</from>
    <to>2010-05-17T14:00:41.826+02:00</to>
    <dirtiness>1.0</dirtiness>
</metadata>
```

- Step 4 – Metadata page creation in SMR
  - SMR creates a new page, containing the metadata received from GSN

Advanced Metadata Search

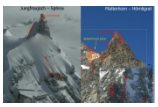
- The volume of metadata in FSN may become large
- Search results may contain too much relevant information
  - e.g., too many relevant metadata pages
  - which one is more relevant?
- Provides a rich set of search conditions
  - Multiple properties can be joined
  - Geographical search
  - Boolean operations (e.g., < >) can be combined
  - Dynamic presentation of existing data values



- Supports various types of visualization
  - e.g., bar, pie, graph, and map
  - aggregation of query results (e.g., sum, min, max and count)
  - search results export -> XML/CSV

GSN in Operation in Environmental Monitoring Projects

- 3 deployed field sites operational, 100'000'000 data points collected



NCCR-MICS PermaSense
Permafrost monitoring

CCES RECORD
River corridor restoration

- PermaSense - Global Sensor Network (GSN)
  - Dual GSN server architecture
  - Hierarchies and concatenation of virtual sensors enable on-line processing
  - Translates data from machine representation to SI values
  - Adds metadata