# LARGE-SCALE DATA ANALYTICS
## Applications and Technology

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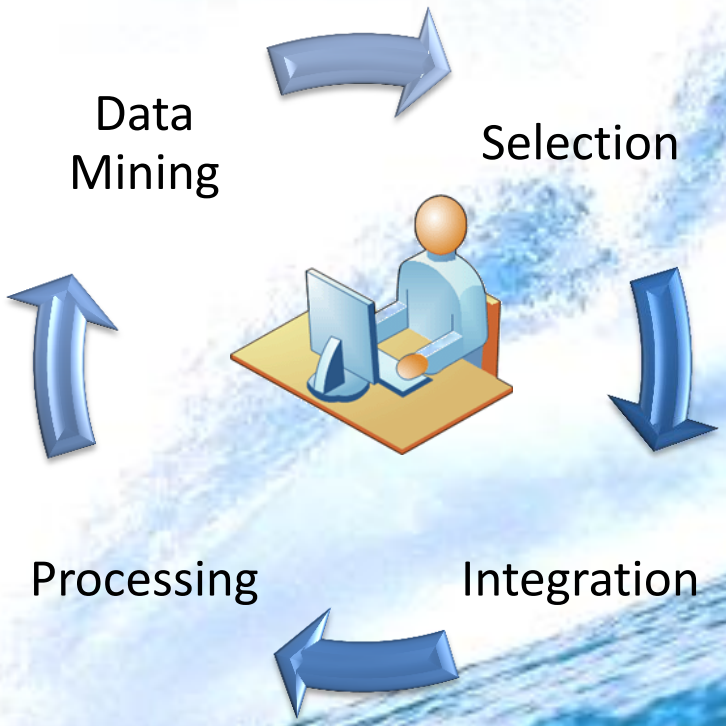
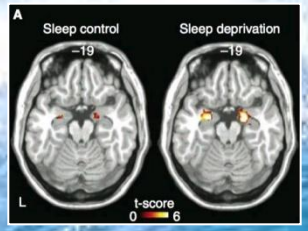
2nd SPLab Workshop , October 2012

# Today's Data Flood



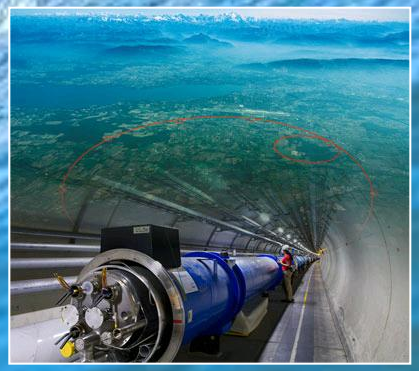




Medicine

Earth Observations


Business

Simulations



Scientific Experiments

# Big Data

- Every day, we create 2.5 quintillion ($10^{18)}$ bytes of data — so much that 90% of the data in the world today has been created in the last two years alone. This data is **big data.** The associated analytic processes are called **large-scale data analytics**.
- Big data usually includes data sets with sizes beyond the ability of commonly-used software tools to capture, manage, and process the data within a tolerable elapsed time.
- Big data sizes are a constantly moving target, as of 2012 ranging from a few dozen terabytes ($10^{12}$) to many petabytes ($10^{15}$) of data in a single data set.

# Towards High-Productive Analytics

- This term firstly appeared in the context of e-Science analytics.
- **E-Science Analytics** is a dynamic research field that includes rigorous and scientific methods of data preprocessing, integration, analysis, and visualization.
- A **high-productive analytics system** is one that delivers a high level of performance, guarantees a high level of accuracy of analytics models and other results extracted from analyzed data sets while scoring equally on other aspects, like usability, robustness, system management, and ease of programming.

# Response: Data-Intensive Research

- Offers powerful methods aiming at innovative new uses of computing, storage and network devices when

  capturing, managing, analyzing, and understanding data produced by modern science and business at rates that push the frontiers of current technologies.
- There is a number of research challenges.

New book: M. Atkinson, P. Brezany, et al. THE DATA BONANZA. Wiley, Autumn 2012.

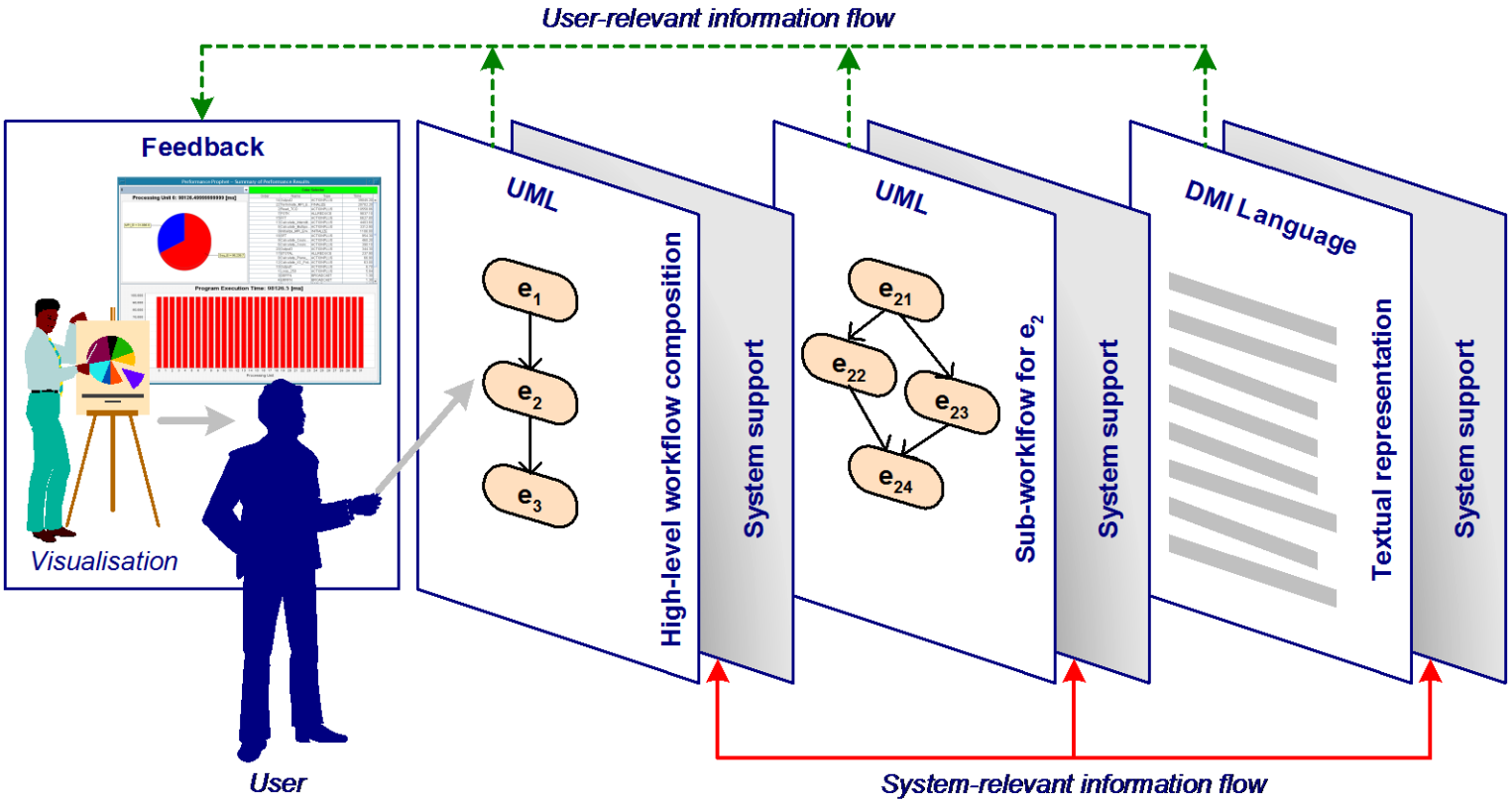
# Grid- and Cloud-Based Data Analytics

- **GridMiner** (www.gridminer.org)
  - is based on the Globus 4 Toolkit, OGSA-DAI.
  - includes: BPEL-based workflow engine, distributed and parallel data integration and mining and OLAP services, data provenance subsystem, etc.
- **CloudMiner** (www.cloudminer.org)
  - includes the GridMiner's functionality.
  - additionally addresses data stream processing framework called StreamMiner.

# ADMIRE Project

- The aim has been to create advanced, distributed data integration and analysis platform working on data streaming principles. Key outputs:
  - Language DISPEL (Data-Intensive Systems Process Engineering Language)
  - Process Designer (workflow construction/optimization)
  - ADMIRE Platform processing/executing DISPEL
- Suite of validating applications
  - customer relationship management
  - environmental risk management
  - analysing gene expression imaging data
  - seismology & astronomy

# Development of Workflow Specifications – Concept of a Process Designer

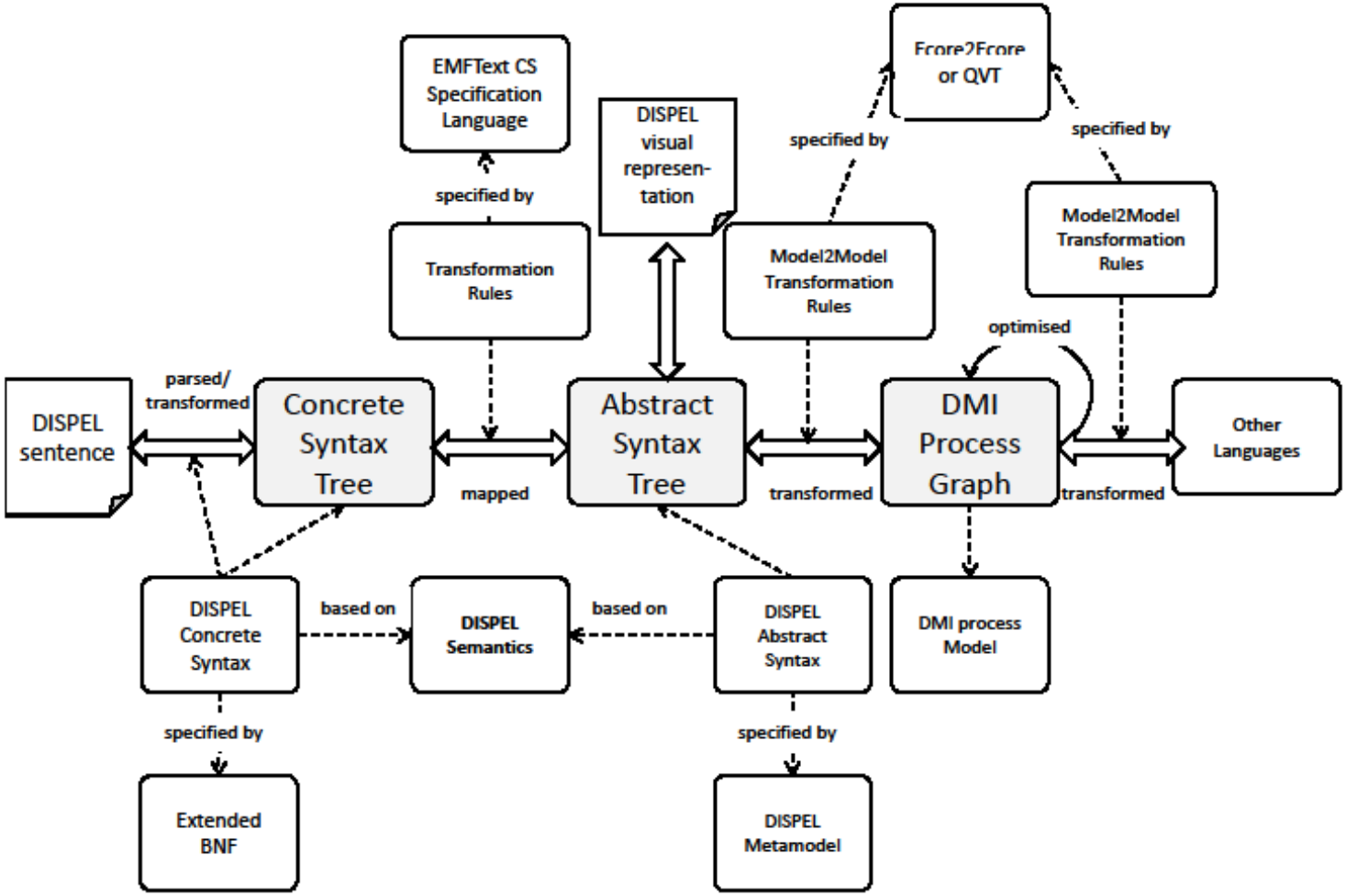


# DISPEL Example

```
use uk.org.ogsadai.SQLQuery;
use uk.org.ogsadai.TupleToWebRowSetCharArrays;
use eu.admire.Results;
use eu.admire.MultiClassify;

SQLQuery query = new SQLQuery;
String expression = "select * from stats limit 2000";
|- expression -| => query.expression;
|- "DbViennaTestResource" -| => query.resource;

TupleToWebRowSetCharArrays toWRS = new TupleToWebRowSetCharArrays;
query.data => toWRS.data;

Results result = new Results;
|- "results" -| => result.name;
toWRS.result => result.input;

submit toWRS;
```

Remark: The ADMIRE Platform and DISPLEL examples can be downloaded.

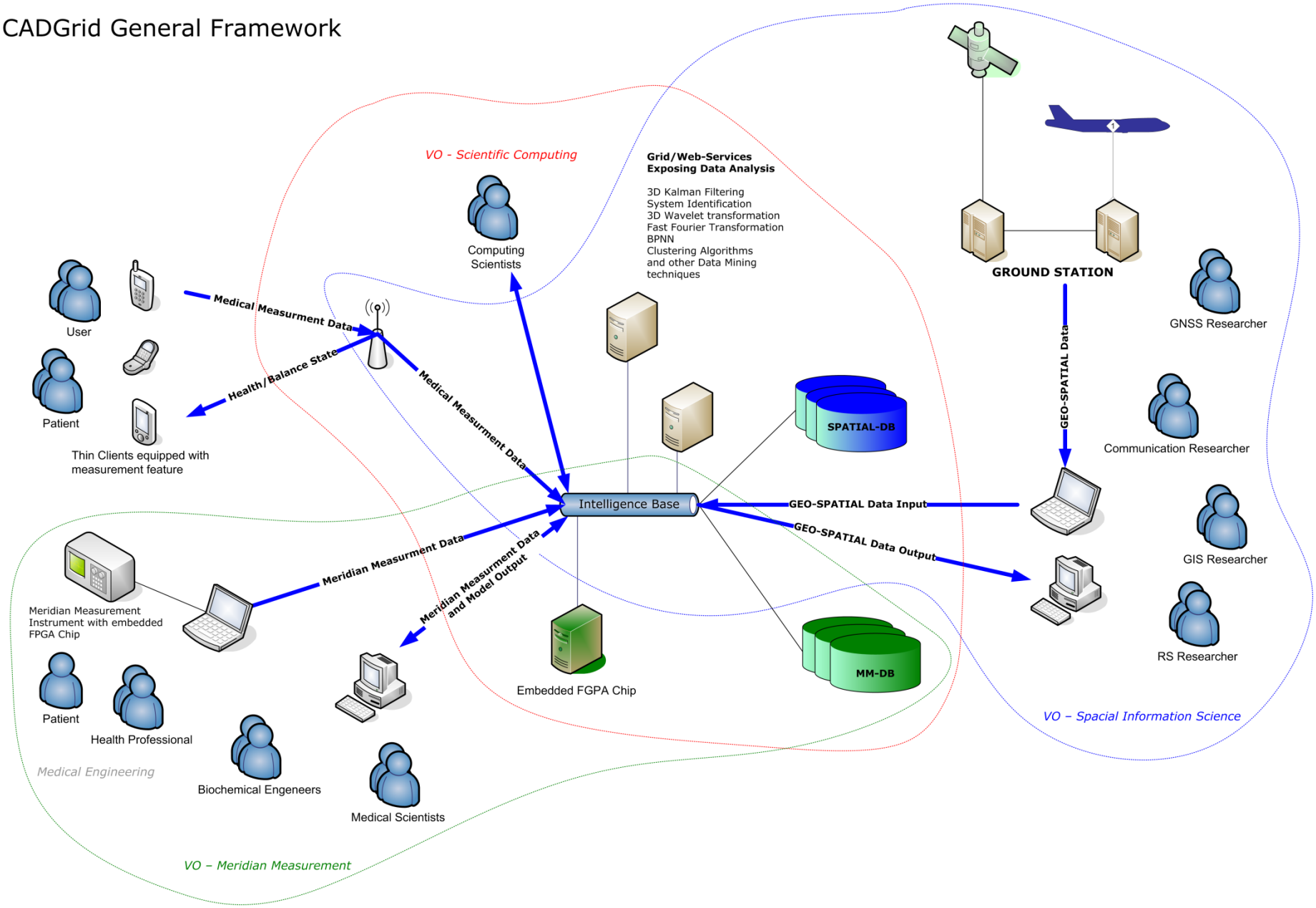
# Process Designer‘s Modelling



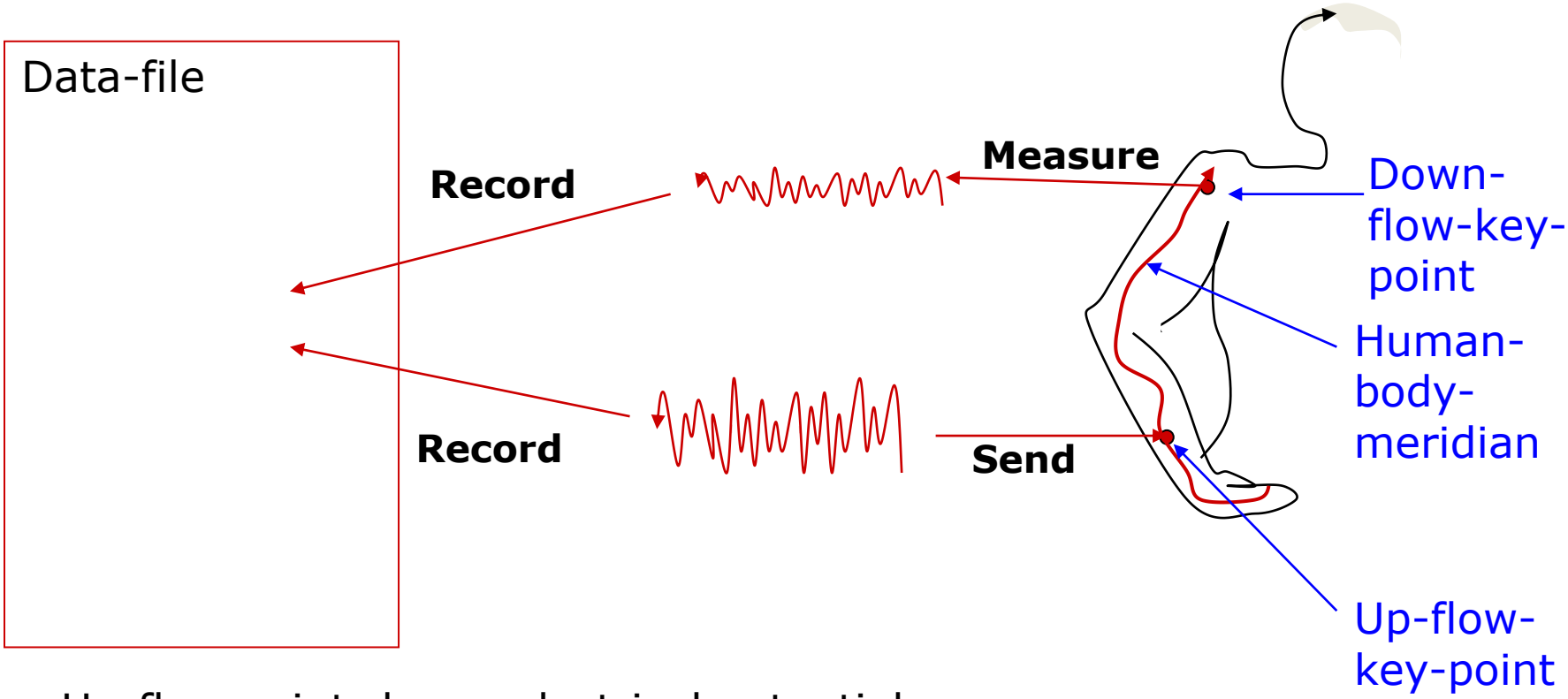
# GridMiner

- Full-fledged large-scale knowledge discovery system. It included
  - Mediator/wrapper data integration
  - Parallel and distributed OLAP, neural network and decision tree services
  - Interactive workflow management
  - Provenance subsystem, etc.
- Applications
  - Non-invasive blood glucose measurement
  - Management of TBI patients

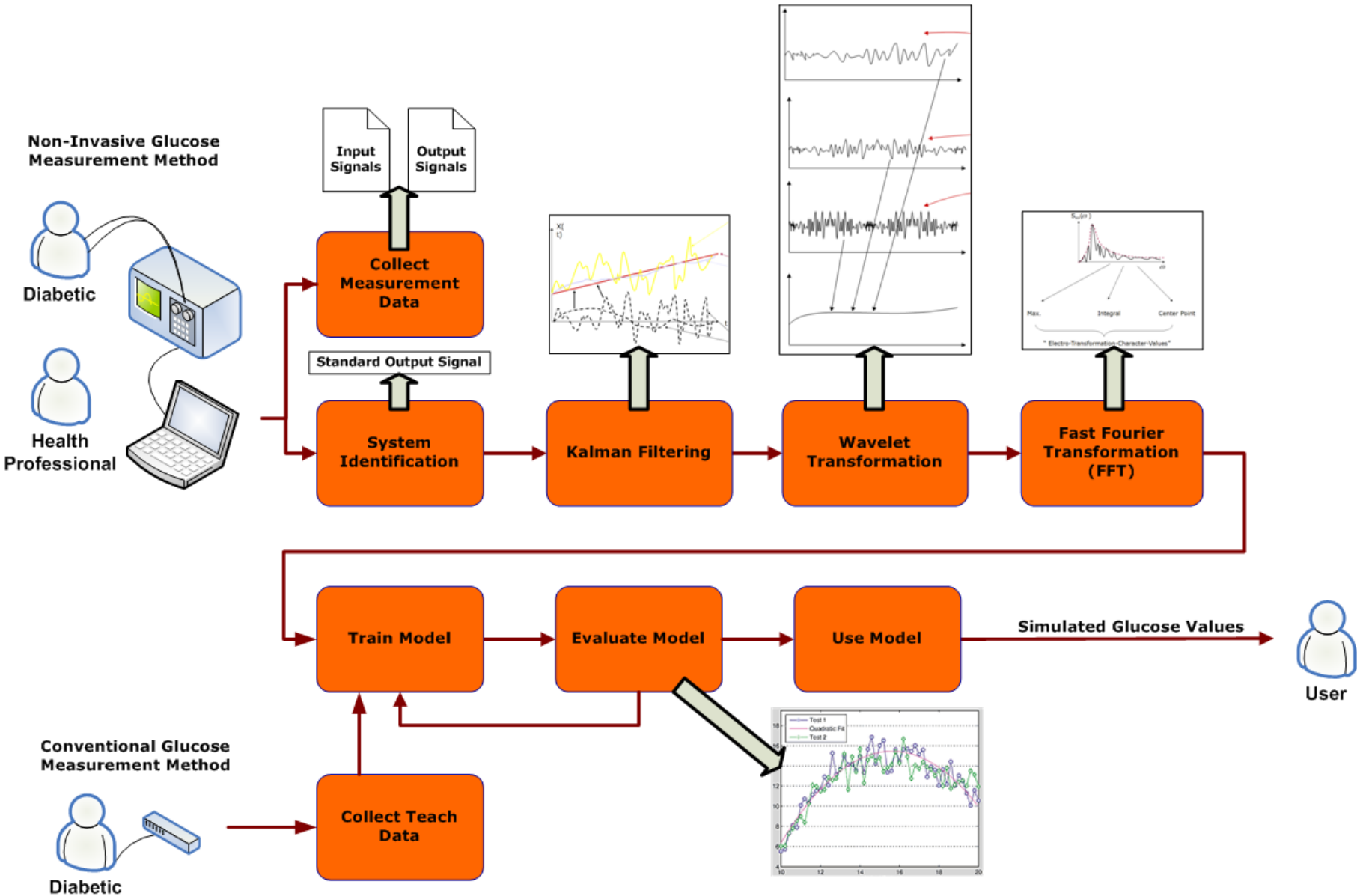
# CADGrid General Framework



# Active Measurement



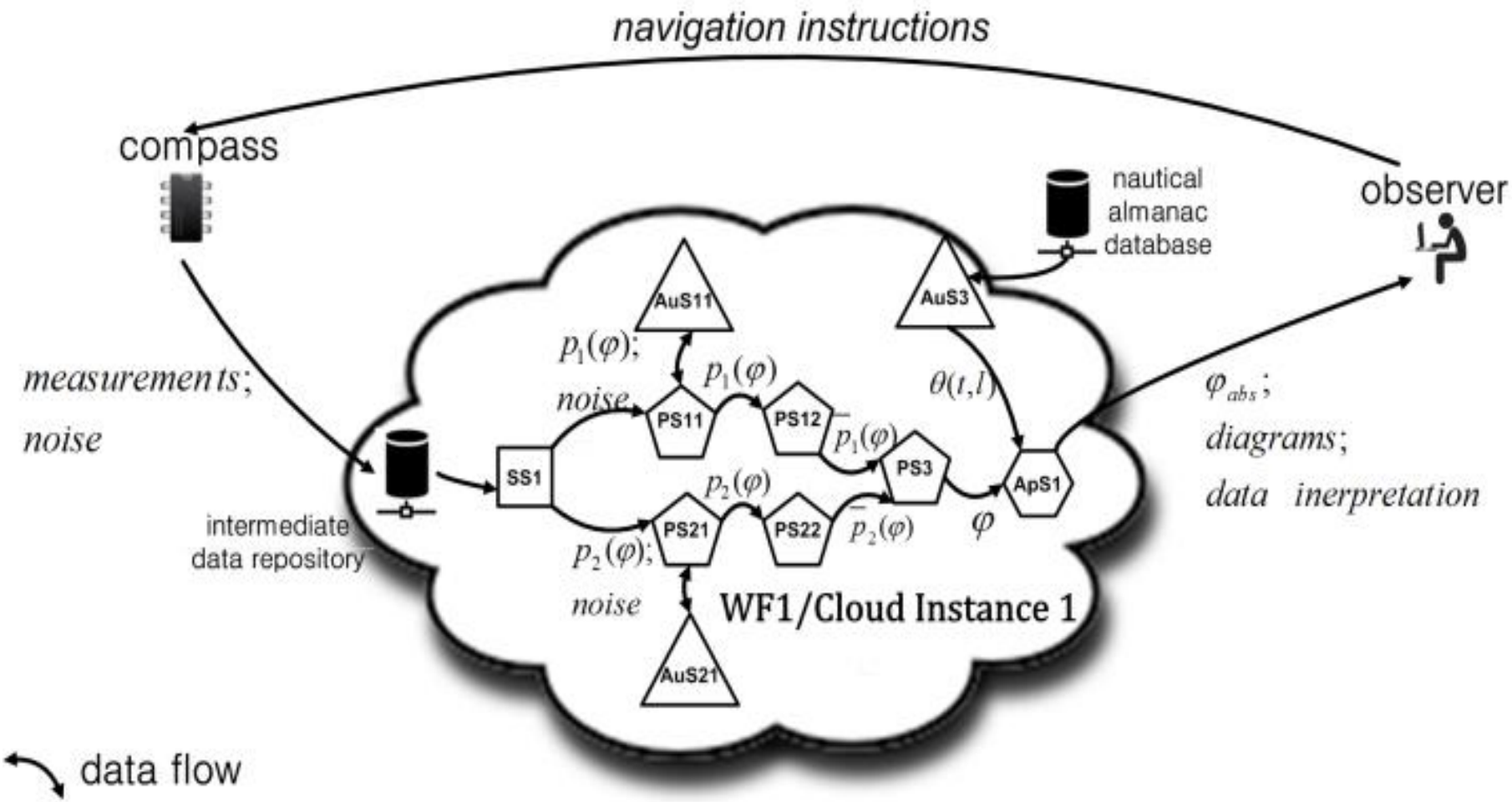

Up-flow point: lower electrical potential
Down-flow point: higher electrical potential
Fingers and toes: zero potential


Non-Invasive Glucose Measurement Method
Diabetic
Health Professional
Input Signals
Output Signals
Collect Measurement Data
Standard Output Signal
System Identification
Kalman Filtering
Wavelet Transformation
Fast Fourier Transformation (FFT)
Train Model
Evaluate Model
Use Model
Simulated Glucose Values
User
Conventional Glucose Measurement Method
Diabetic
Collect Teach Data

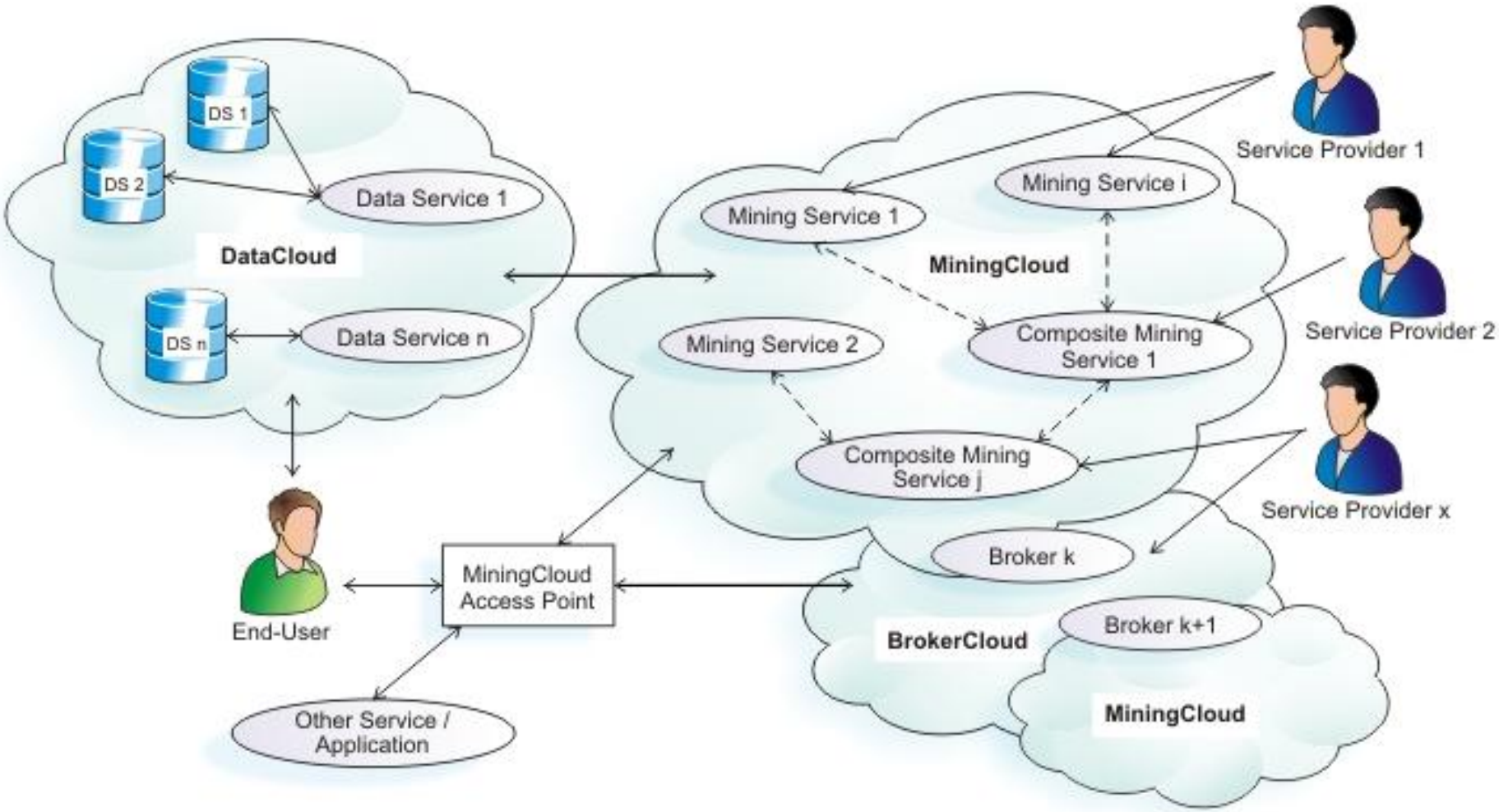
# CloudMiner

- GridMiner services
- Focus na stream management
  - elastic OLAP
  - stream mining
- New applications
  - Navigation systems
  - intelligent ambient assisted living

# Bionic Global Navigation System Based on Polarized Light



# CloudMiner


DS 1
DS 2
DS n
Data Service 1
Data Service n
DataCloud
Mining Service 1
Mining Service i
MiningCloud
Mining Service 2
Composite Mining Service 1
Composite Mining Service j
Service Provider 1
Service Provider 2
Service Provider x
End-User
MiningCloud Access Point
Other Service / Application
Broker k
Broker k+1
BrokerCloud
MiningCloud

SUPPORT PATIENTS THROUGH E-SERVICE SOLUTIONS

www.spes-project.eu

# Dementia Appl. Use Cases

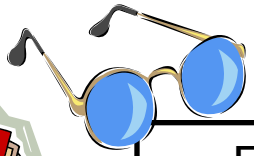
Brain Stimulation

Persons with dementia

Orientation Support

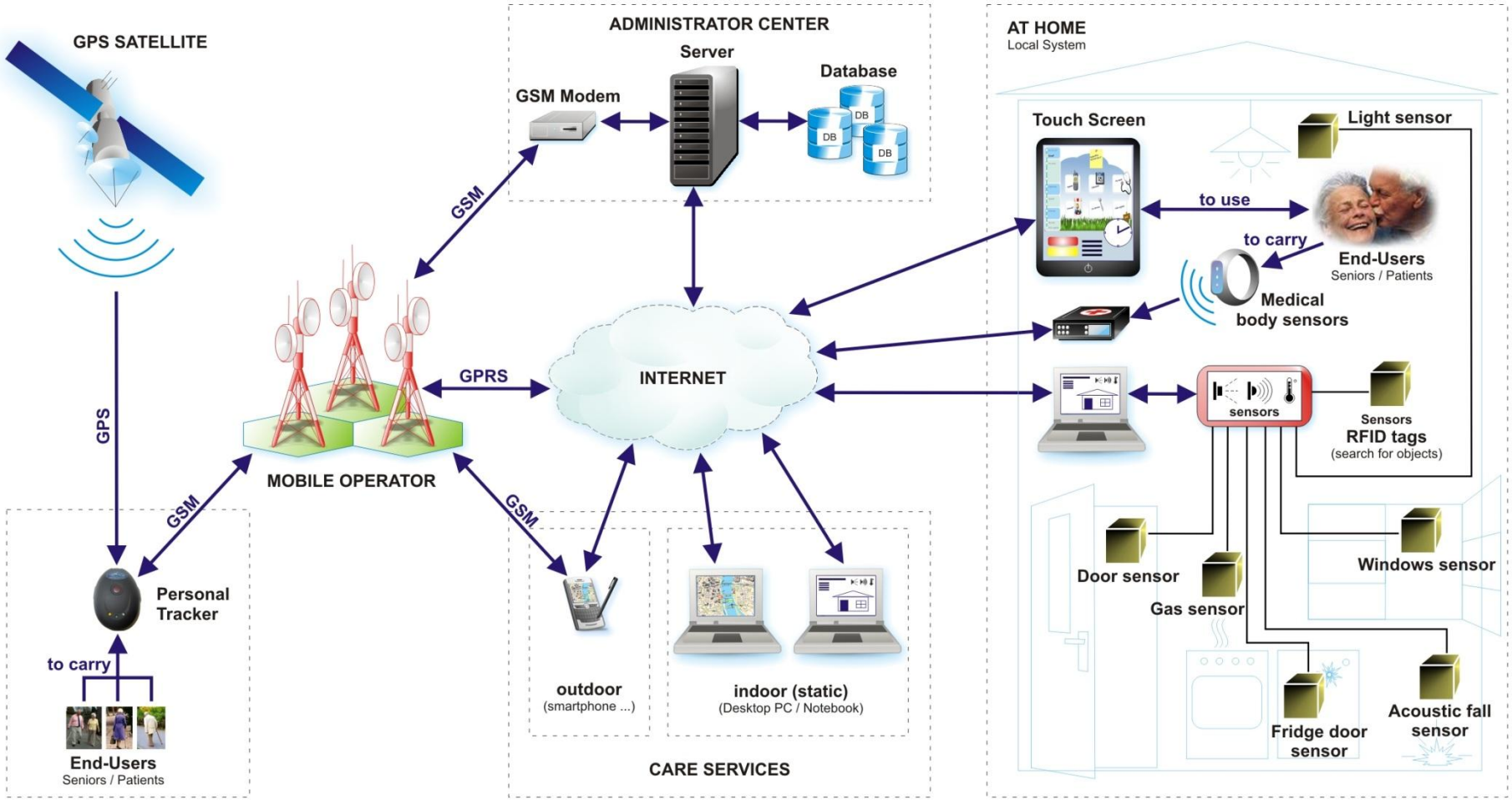

Talking Key

Preventing dangerous Situations

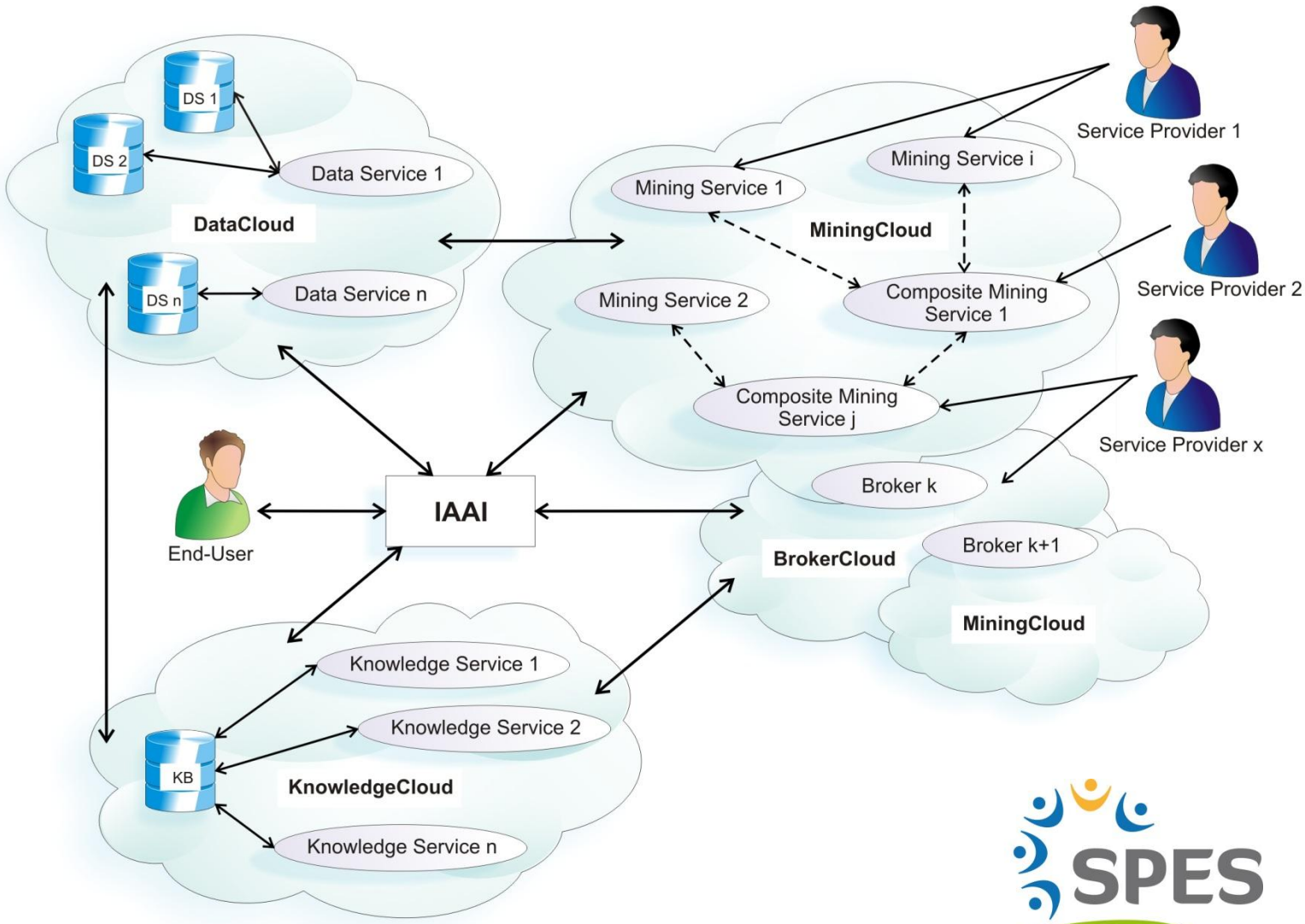


Finding Things again

# Future Work: Next Generation of Ambient Asssited Living



# Cloud-Based Ambient Asssited Living




SPES

# Data Space

- Primary data
  - Internal data: out- & indoor monitoring
  - External data: social networks, information associated with the map area, etc.
- Derived data
  - Knowledge patterns extracted
  - Rules (representing static knowledge)
- Background data
  - Different advices and observations
  - Pointers to knowledge sources, like literature, videos, etc.

# Data Minig Tasks – Analytical Functions

- Observation/monitoring illness progression
  - Can data about the motion in an environment help discover/identify/predict patients‘ worsening/impairment?
  - Estimating influence of the day time, weather, etc.
- Impact of data analysis results
  - Care modification/improvement Support for medical research (e.g. neuroscience)
  - Objective criteria for estimation of „Improvement of Quality of Life“.

# Conclusions

- Growing importance of data-intensive research.
- Cloud features match the requirements
- CloudMiner/StreamMiner
- Future research plans: Intelligent Ambient Assisted Living
- Sky Computing (Metaclouds)?

Thank you for your attention!