

# **Mobile Geospatial Data Acquisition**

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## **Techniques, Application, Research**

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**Prof. Dr-Ing. Wolfgang Reinhardt**  
**Arbeitsgemeinschaft GIS**  
**Universität der Bundeswehr München**  
**<http://agis.bauv.unibw-muenchen.de>**

Brno – December 2004

# UniBw München

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About 3000 Students (mostly living on campus, mostly soldiers, staff is civil, Trimester system!)

10 Faculties / Departments – 13 programs

The Faculties:

- Civil Engineering, Geodesy and Geoinformatics (Univ)
- Electro and Information Technology
- Computer Science
- Aeronautics and Aerospace Technologies
- Education Sciences
- Social Sciences
- Economics
- Business Management (FH)
- Electrical Engineering
- Mechanical Engineering

# AGIS – GI lab

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**GI-Lab at UniBw M,  
civil engineering faculty  
founded: 1997 (Caspary/Reinhardt)**

tasks:

- Education, professional training
- Research
- Research transfer

15 scientists, mostly financed from 3. Party funds





— assoziiert —

**.GIS**  
Dr. Gerhard Joos

PhD. Rixing He,

'04



hardt

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# Current research projects

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## **Interoperability / standards**

- **GI-Interoperability based on XML/GML**
- **GI Normung / Standardisation (Quality procedures)**
- **Concepts for meta data**

## **Projects with utilities**

- **Quality management**
  - **Q-assurance**
  - **Process optimisation**

## **Object oriented classification / RS**

## **Data Visualization (SVG)**

## **GI education**

- **GI teaching modules (BMBF)**
- **GIS- Introduction / Virtuelle Hochschule Bayern (vhb)**

## **Mobile GI Services**

- **GI-based positioning of locomotives**
- **VISPA, Paramount (LBS for hiker / wanderer)**
- **Advanced Geo-Services (BMBF / DFG – Geotechnologien)**

# Overview

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- **History**
- **LBS – location based services**
- **Example: Project Paramount**
- **Mobile data acquisition**
  - **Project „Advanced GeoServices“**
  - **Concept of mobile client**
  - **User scenario**
  - **Research topics**

# History: GIS & GPS integration (80's-90's)

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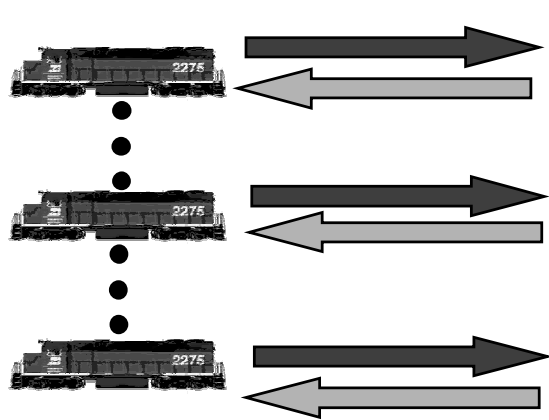
- **Use of (current) position in GIS applications**
- **Navigation applications**
  - ⇒ eg.: car navigation, „map matching“
- **Extension: Use of different sensors**
- **Many applications**
- **Example of our work: ALOIS**

# Example ALOIS (1997 – 2000)

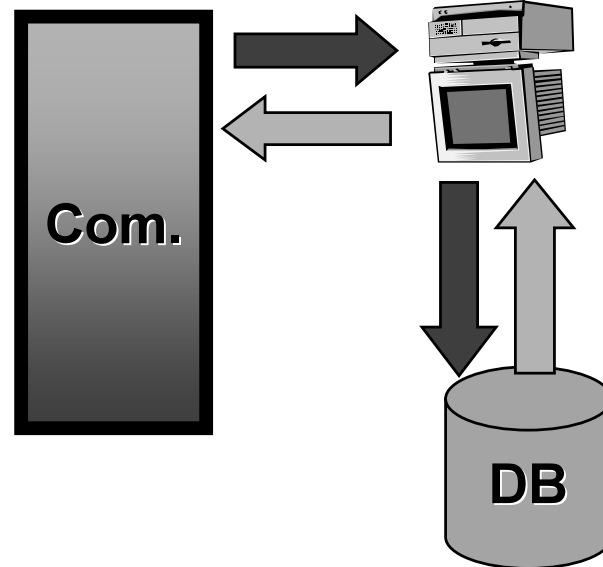
Main Task: Position of Loc's in a factory railway network

Factory area around 4 \* 8 km<sup>2</sup>, railway network: around 600 km, no GPS signal!

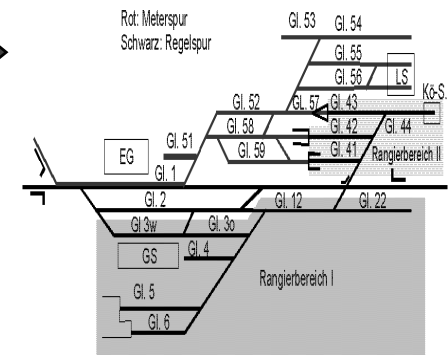
## Position (Locom.)



## Central computer



## Applications



e.g. logistics

Main research focus:

Position from various sensors: INS, Gyro compass, odometer (low price equipment)

Advanced map matching adopted to railway networks and different sensors

-> PhD Thesis (in german)



# Overview

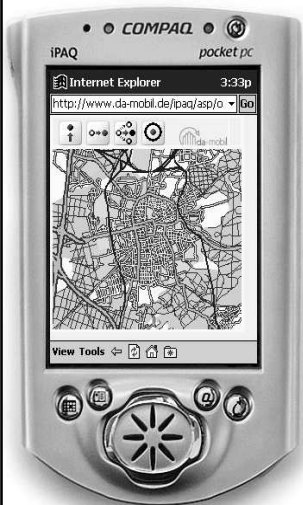
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- **History**
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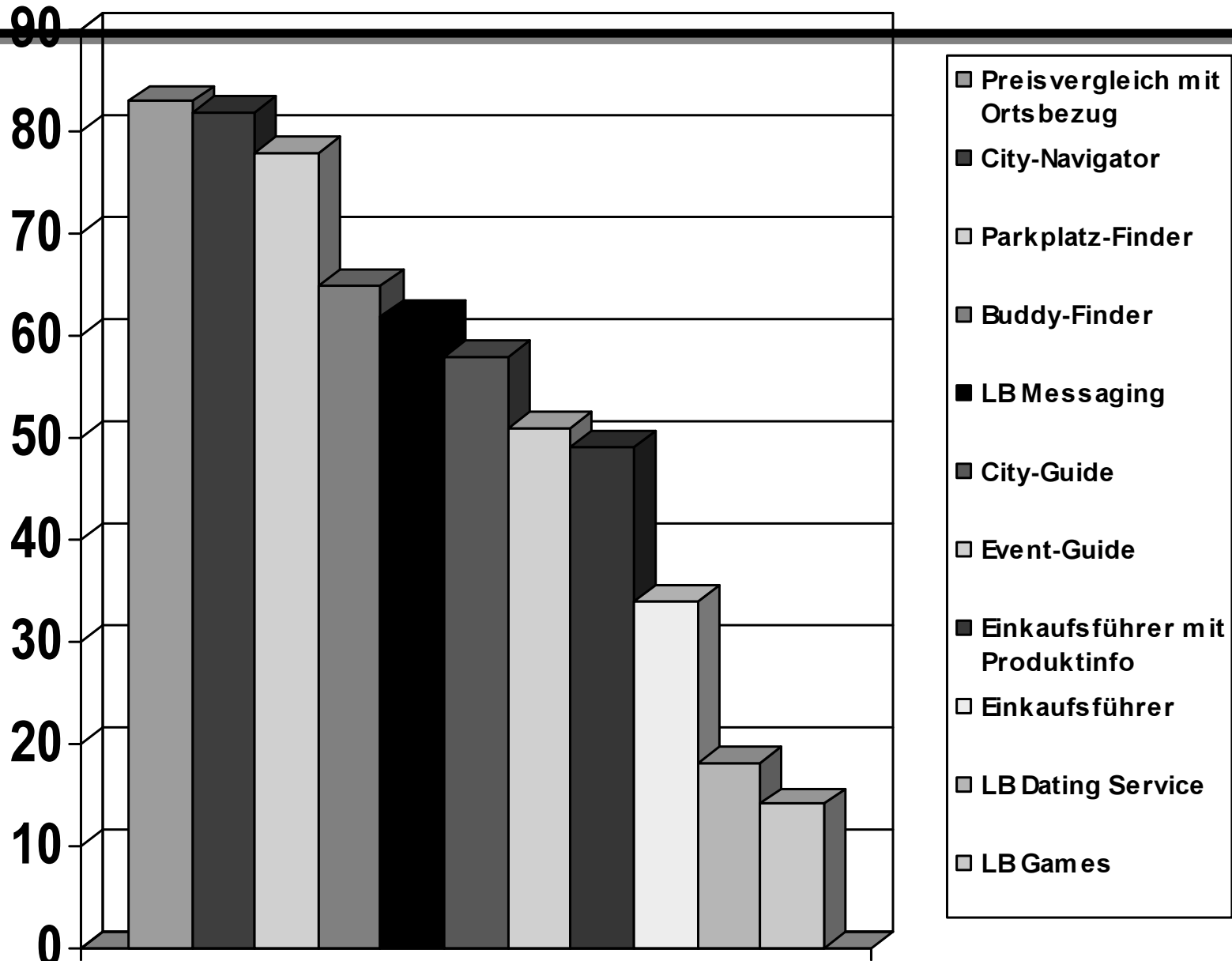
# Location based services - LBS



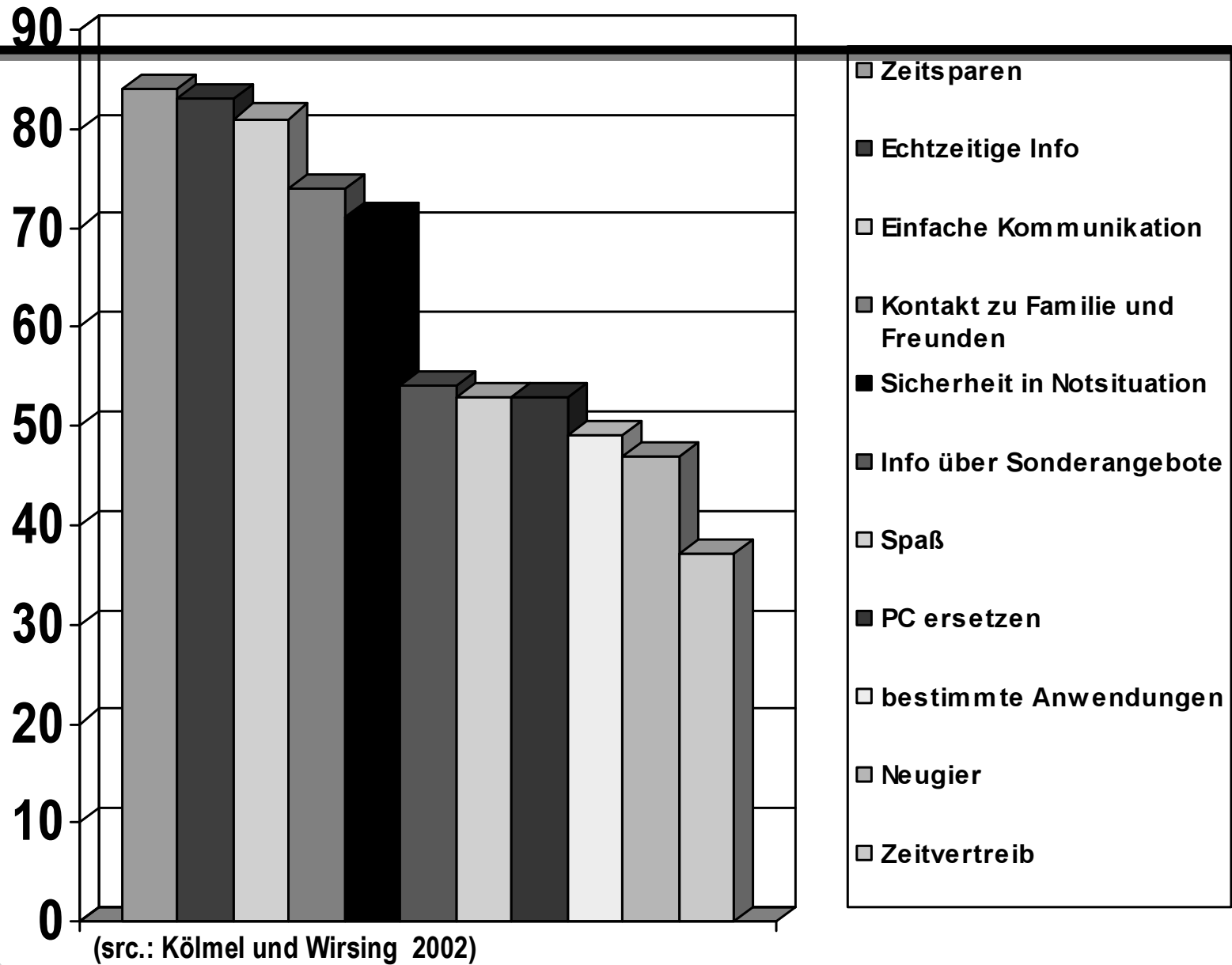
- **Services which consider the current position of the user to provide any content (Search for next location, tracking / safety, location aware advertisement ...)**
- **Hype in 2000/2001 -> Reality?**
- **Necessary:**
  - **Mobile Equipment**
  - **Service / Content (Data)**
  - **Communication**
  - **Location**



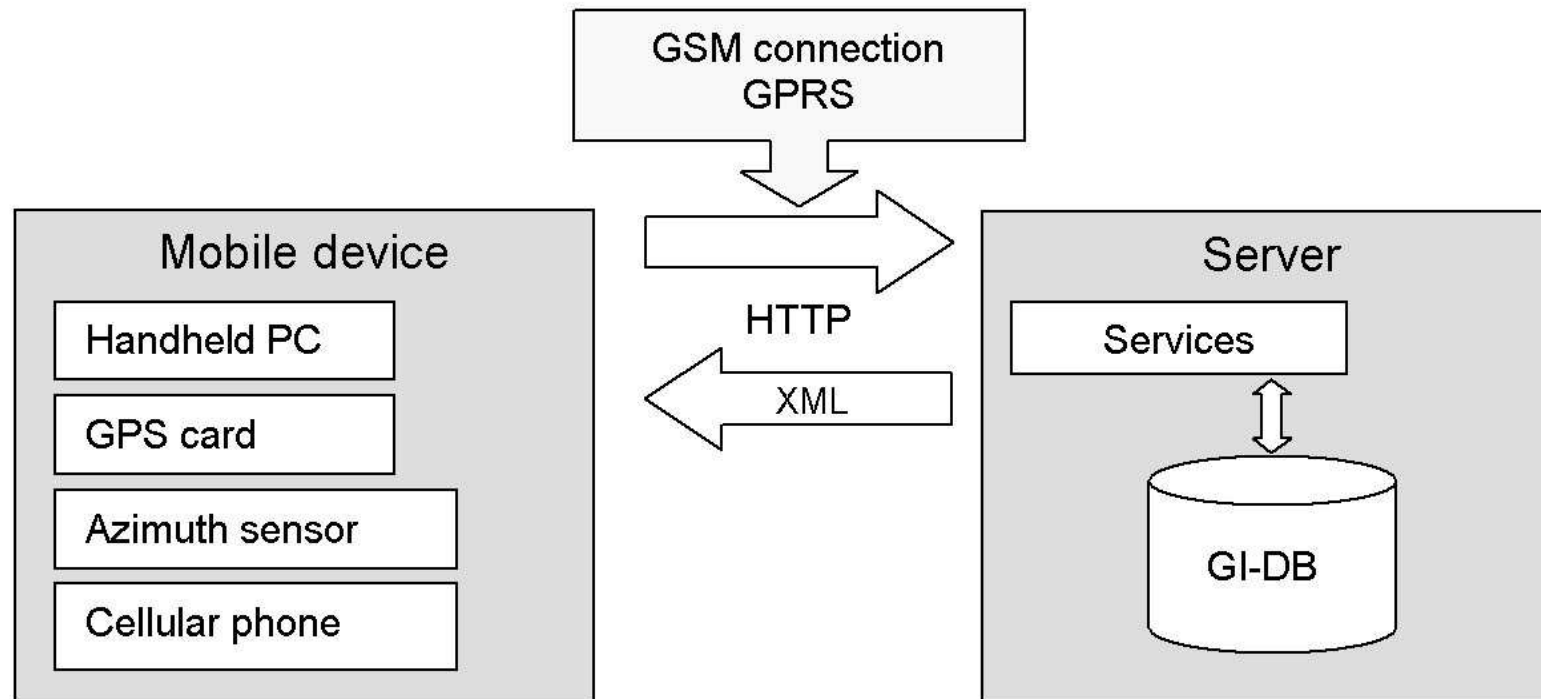
# Questionnaire: usage of LBS (how users want to use)



# Questionnaire: usage of LBS



# LBS – Architecture (example)



# Example: Project PARAMOUNT

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[www.paramount-tours.com](http://www.paramount-tours.com)

Consortium: (12/2001 – 09/2003, EU IST funded)

- IfEN GmbH, Poing ([www.ifen.com](http://www.ifen.com)) 
- AGIS UniBW München ([www.agis.unibw-muenchen.de](http://www.agis.unibw-muenchen.de)) 
- ICC, Institut Cartogràfic de Catalunya ([www.icc.es](http://www.icc.es))
- Bergwacht Bayern (S&R) ([www.bergwacht-bayern.de](http://www.bergwacht-bayern.de))
- Österreichischer Bergrettungsdienst (S&R)

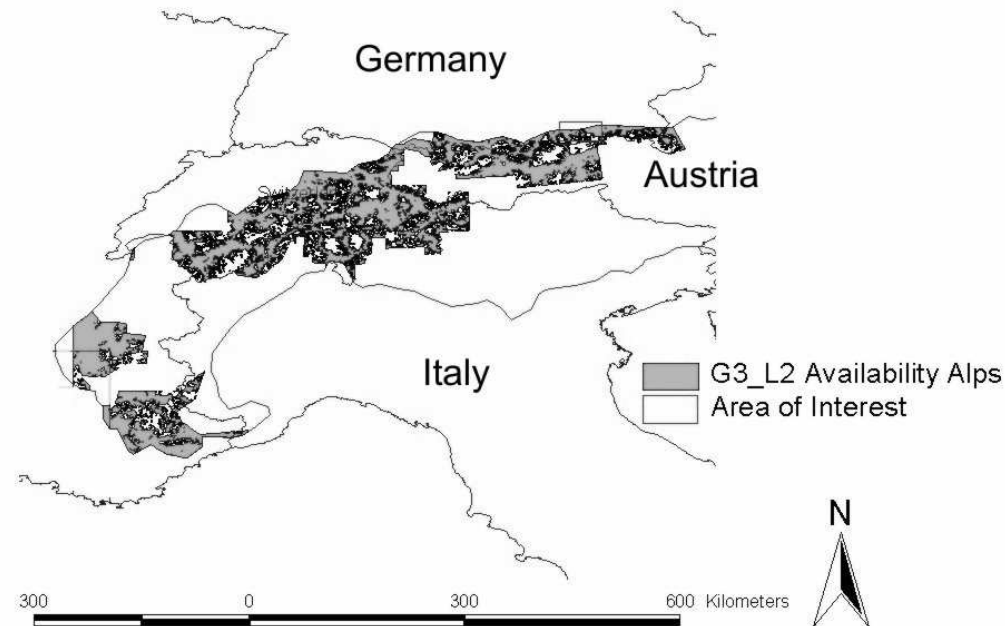
**Goal: Provide services for hiker and wanderer (to increase safety) – Show feasibility (2001!), Application: 2000!**



# Identify regions where service would be possible

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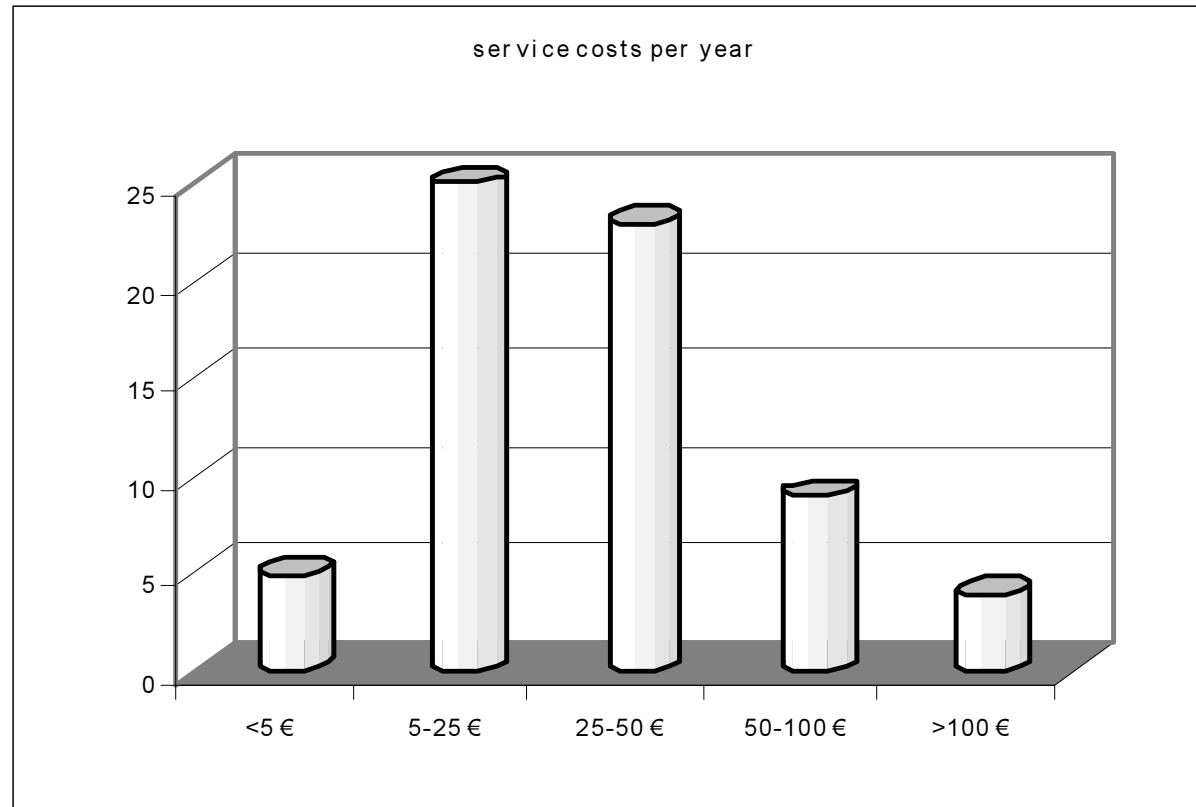
**Look for GSM, GPS and GI (vectors!) availability  
in Alps and Pyrenees (3G synthesis)**



# User involvement

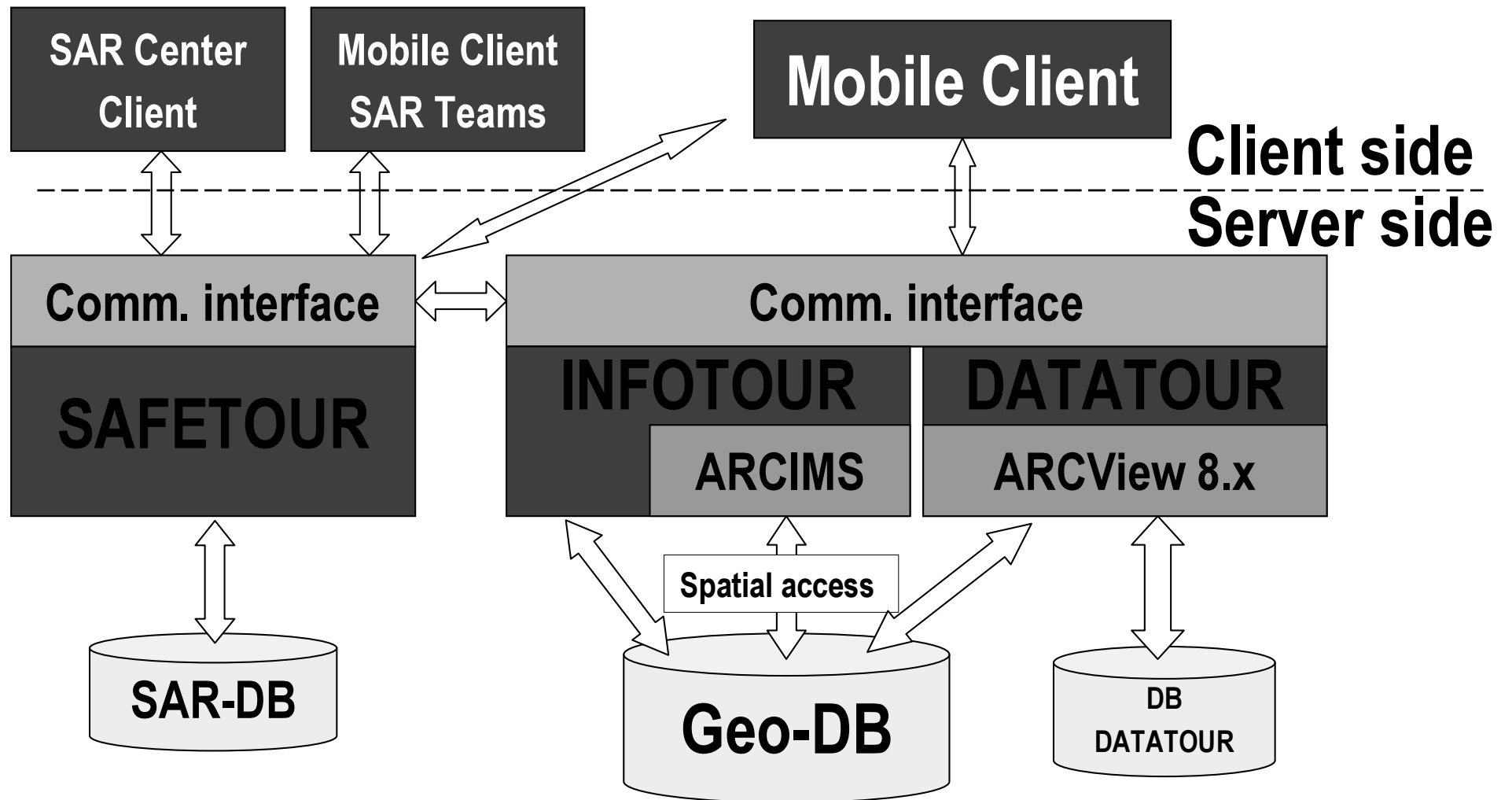
- Questionnaire in internet: ask for functionalities and acceptable fees

Result, e.g.: acceptable fee:

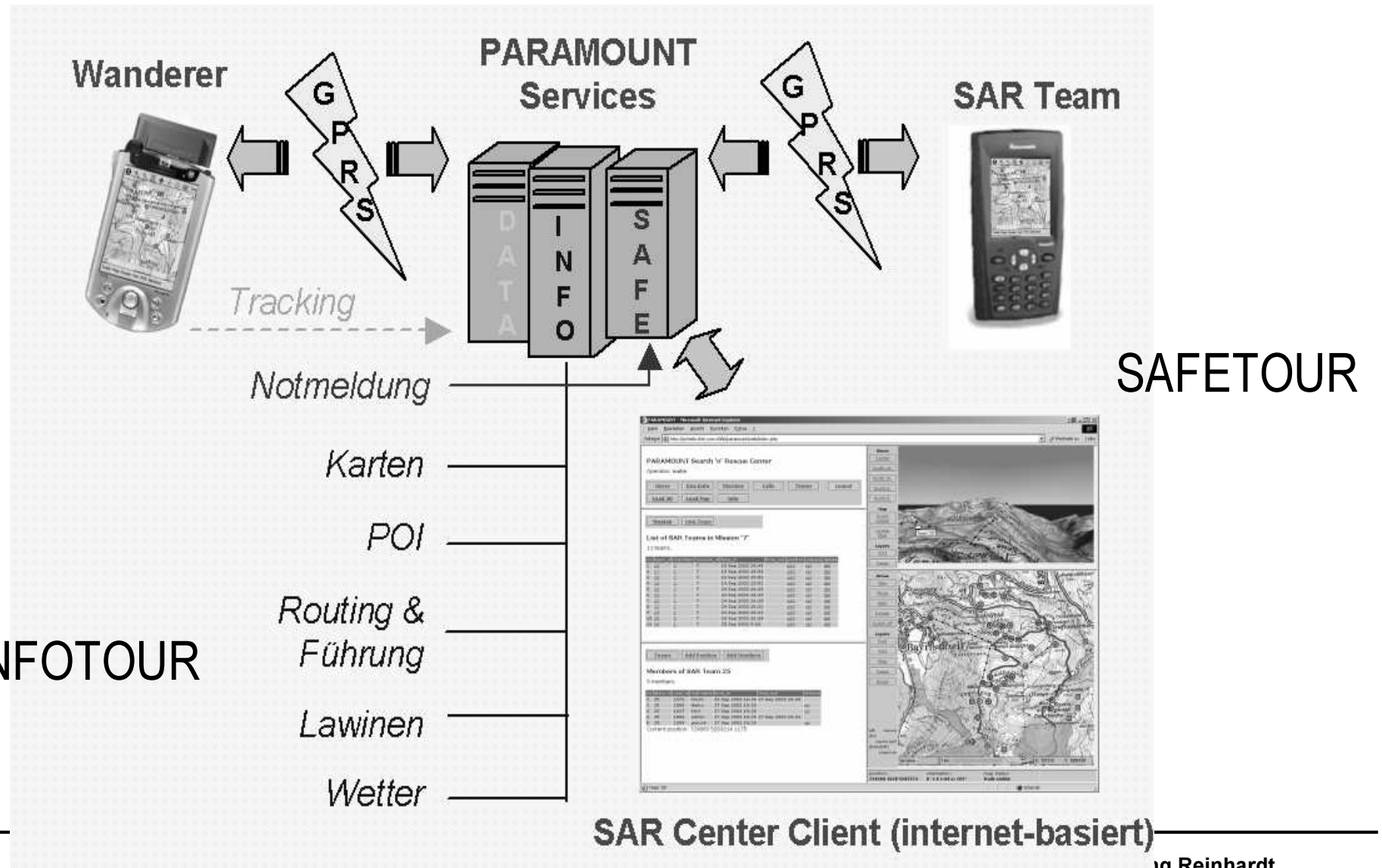




# Architecture of PARAMOUNT



# Example Paramount



# SAFETOUR: SAR Centre Client

PARAMOUNT - Microsoft Internet Explorer  
 Adresse: http://pcheiko.ifen.com:3080/paramount/web/index.php

PARAMOUNT Search 'n' Rescue Center  
 Operator: muhe

Buttons: Users, Geo Data, Missions, Calls, Teams, Logout, Load 3D, Load Map, Info

Buttons: Mission, New Team

List of SAR Teams in Mission '7'  
 11 teams.

no	team_id	members	mission_id	time_in	time_out	position	release	delete
1	16	2	7	19 Sep 2002 14:44		add	rel	del
2	17	1	7	19 Sep 2002 15:52		add	rel	del
3	18	1	7	19 Sep 2002 15:52		add	rel	del
4	19	1	7	19 Sep 2002 15:52		add	rel	del
5	20	2	7	24 Sep 2002 16:16		add	rel	del
6	21	1	7	24 Sep 2002 16:19		add	rel	del
7	22	1	7	24 Sep 2002 16:20		add	rel	del
8	23	1	7	24 Sep 2002 16:21		add	rel	del
9	24	1	7	24 Sep 2002 16:23		add	rel	del
10	25	5	7	24 Sep 2002 16:38		add	rel	del
11	26	1	7	25 Sep 2002 9:26		add	rel	del

Buttons: Teams, Add Position, Add Members

Members of SAR Team 25  
 5 members.

no	team_id	user_id	nickname	time_in	time_out	release
1	25	1072	hm10	24 Sep 2002 16:38	27 Sep 2002 10:20	
2	25	1000	Heiko	27 Sep 2002 10:20		rel
3	25	1037	hm3	27 Sep 2002 10:20		rel
4	25	1086	admin	27 Sep 2002 10:20	27 Sep 2002 10:21	
5	25	1089	gunsch	27 Sep 2002 10:20		rel

Current position: 729883 5283214 1175

Views: Center, South-W., North-W., North-E., North-E.

Map: Synch, ronize, Center, Map

Layers: POI, Users

Areas: New, Move, Split, Delete, Switch off

Layers: Trail, POI, Map, Users, Areas

Map controls: alt: move, ctrl: zoom out, ctrl+shift: zoom in

Map status: Trails visible

position: 728160 1620 5285573 orientation: 0 -1 0 2.88 a: 165° map status: Trails visible

Team '28'

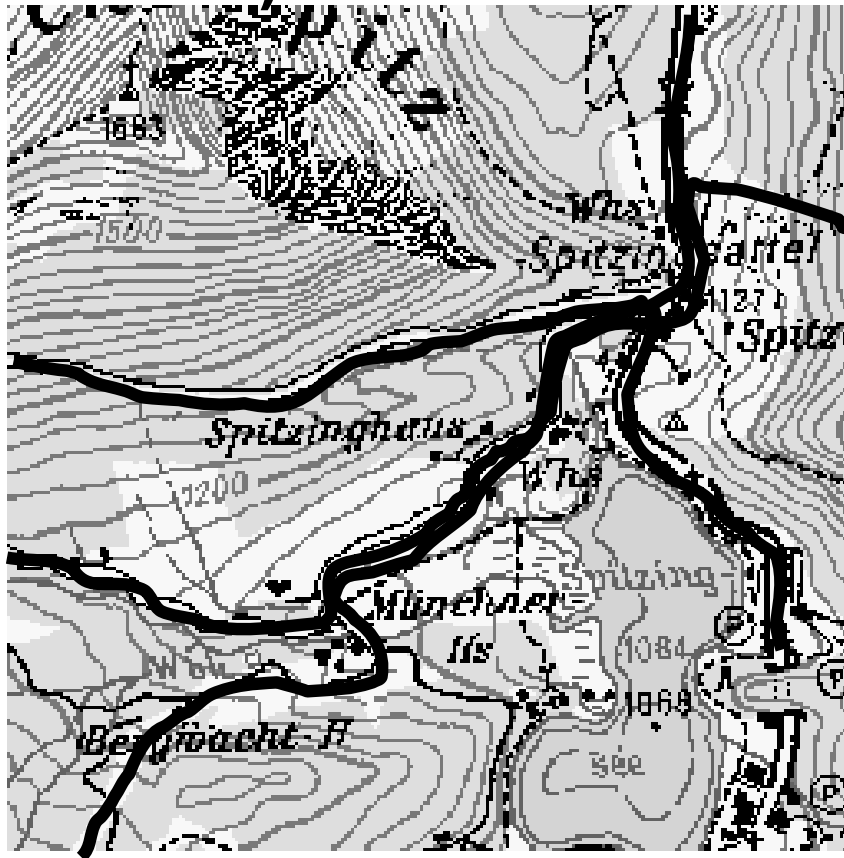
- Overview on Rescue actions
- Up-to-date Positions of Rescue teams



# DATATOUR: involvement of users

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**Users with GPS deliver hiking trails (vectors) and other infos (on POIs)**



**Algorithm development:**

- **Identify identical parts of trails**
- **Only trails who are delivered from different users are stored in the database („weights“ according to the number of deliverables)**
- **Research: Modelling of user trustiness / reliability**

# Testarea (Bavarian Alps)

- 2 areas in Bavaria with size: 30x30 km<sup>2</sup> (Spitzingsee region and Bayrischzell); one area in Pyrenees

- Data of one area:

- Vector data

- Points of Interest ~470

- Nodes ~2175

- Edges ~2800

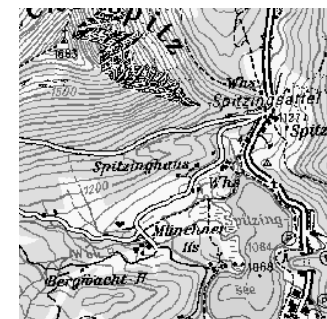
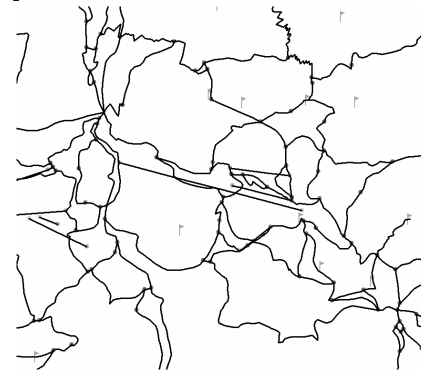
- Way points ~29800

- Additional information (POIs)

- Top. Maps (2 scales)

- Aerial photographs

- DGM 10m grid



# In action (costs)

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- **Costs for GPRS usage(T-D1)**

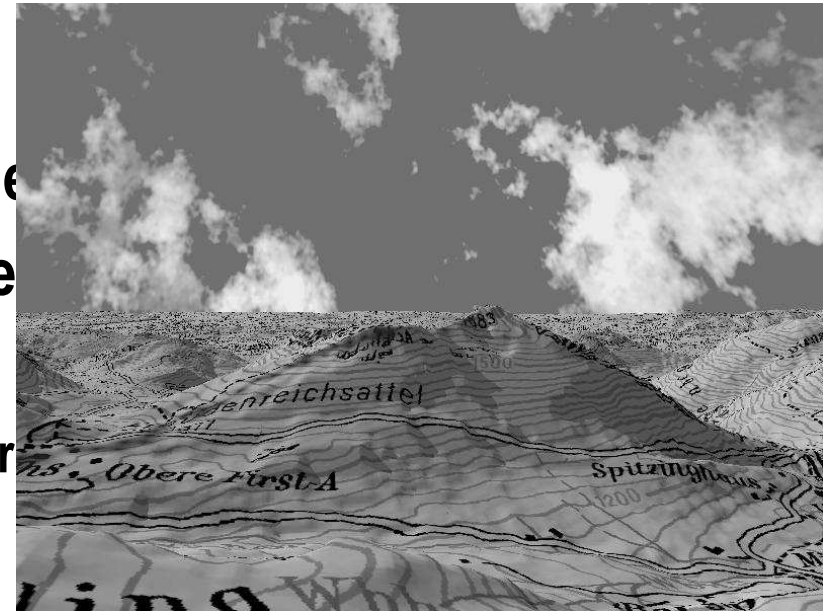
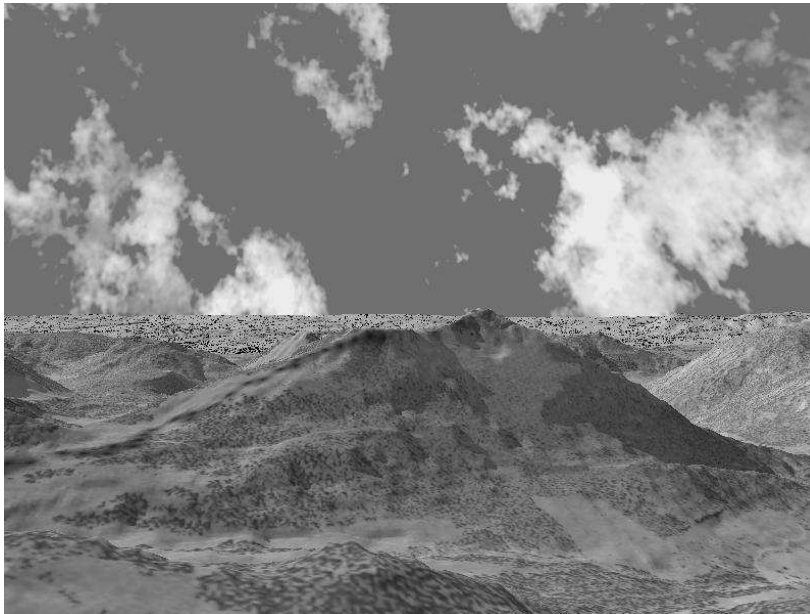
POI (~2kb)	~ 0,01 €
Map 1 640x640 m	~ 0,03 €
Map 2 1792x1792 m	~ 0,05 €
Rendered Image	~ 0,25 €
Average a day (2x9 Karten, 3x3D, routing etc. )	~ 1,5 €



# In action

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- „rendert“ Image



Luftbilder: © Bayer. Landesvermessungsamt

<http://www.bayern.de/vermessung>



# Mobile TourGuide Hardware

Pocket PC with GPS and GPRS-Modem or Mobile Phone





# Paramount - resumé

- Most user accept it (but some discussion: to much technique in mountains!
- On-line and off-line functionalities (sometimes poor GSM)
- SAR orgs find it very helpful: faster search!



**More information**

**Improved safety**



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# „Advanced GeoServices“

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**GEOTECHNOLOGIEN**

**Research Program „Geotechnologien“**

**Founded by BMBF (ministry of education and research) and  
DFG (german science society) (KZ 03F0381A)**

**Project duration: 10/2002 to 9/2005**

**Partner: Universität Karlsruhe - Institut für Photogrammetrie  
und Fernerkundung**



**Hochschule Vechta - Forschungszentrum für  
Geoinformatik und Fernerkundung**



**European Media Laboratory GmbH Heidelberg**



**UniBw München - AGIS**



# Main Tasks



In this presentation:

**complex Geodatabases**

**data from various**

**D data (Data base,**

**ity in Geo Sciences**

# Focus in this talk

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**Project part: „Mobile data acquisition,  
update and processing“  
AGIS & EML**

**Another name: Ubiquitous Computing**

# Main tasks of this part

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- **Access to different data from various sources in the field (-> processing)**
- **Generic approach, adoptable to various data models**
- **Architecture of a mobile client**
- **Use of standards (no proprietary solutions)**
- **Sensor integration**
- **Workflows for main tasks**
- **Quality management / assurance in the field!**

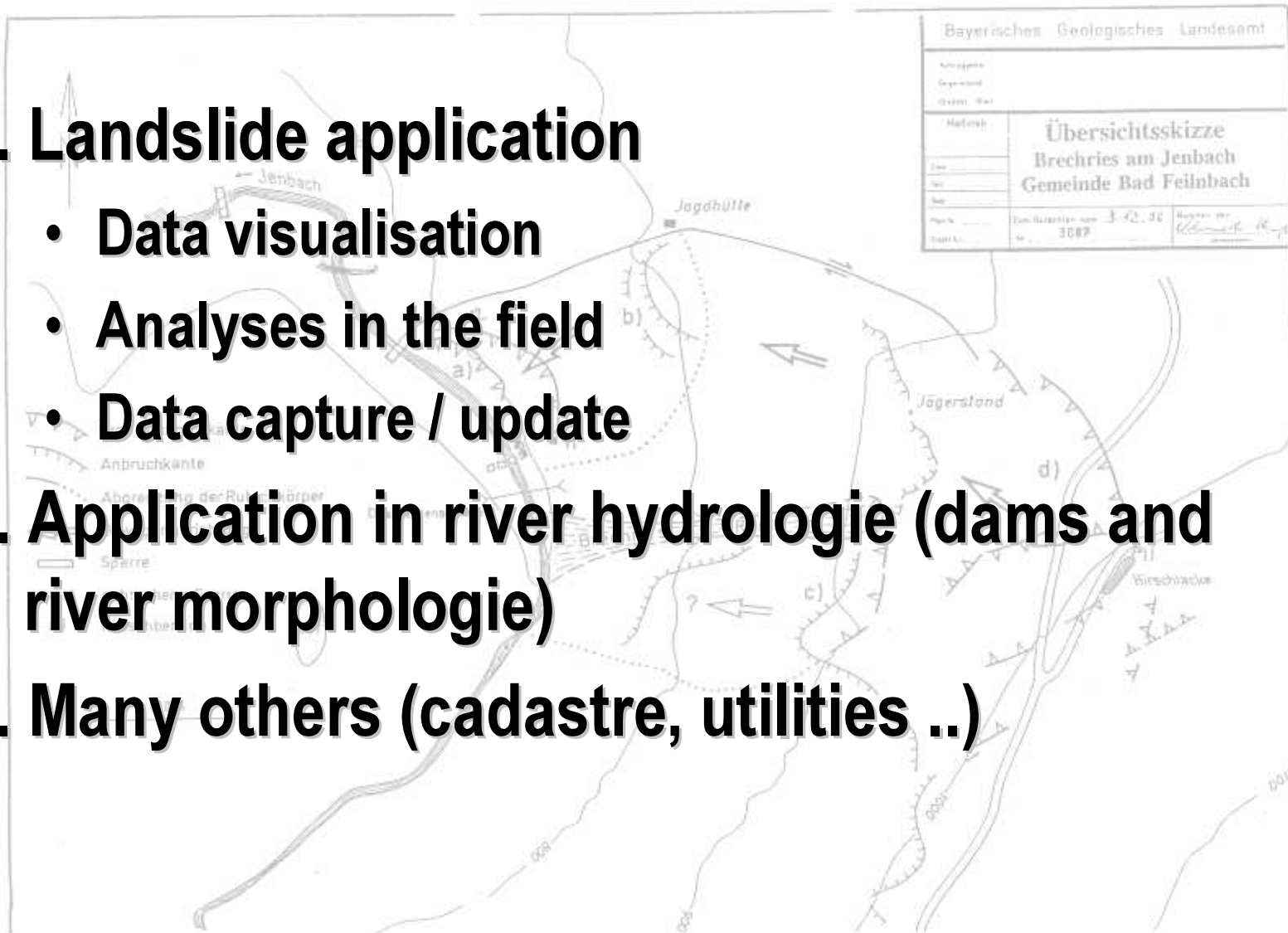
# Fields of application

## 1. Landslide application

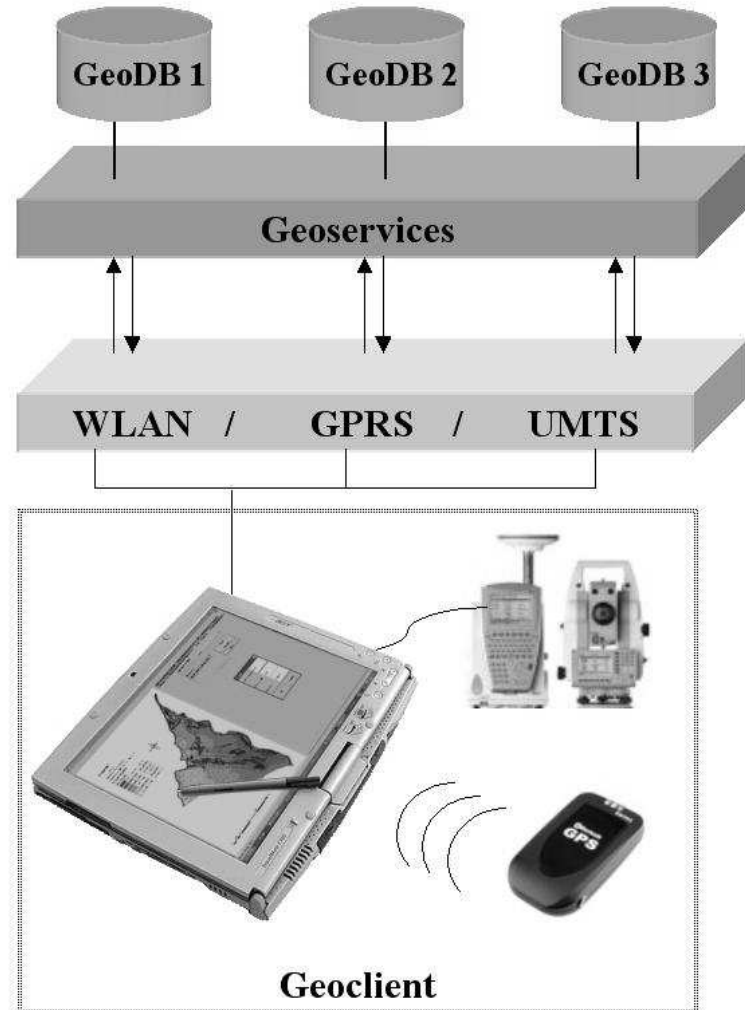
- Data visualisation
- Analyses in the field
- Data capture / update

## 2. Application in river hydrologie (dams and river morphologie)

## 3. Many others (cadastre, utilities ..)



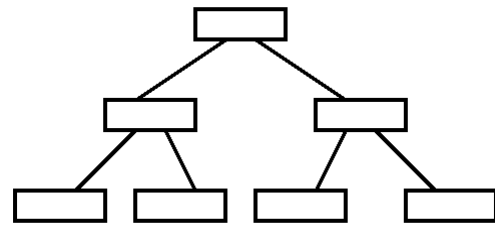
# Concepts for mobile acquisition



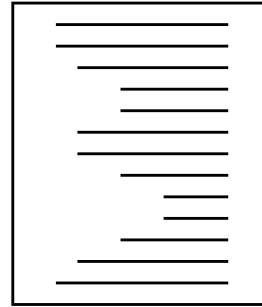
- Use of distributed datasets in the field in real-time
- Open, standards-based architecture, e.g. based on OGC Specifications like WFS, GML, XML,...
- Integration of different measuring instruments, e.g. GPS, total stations (surveying instrument)



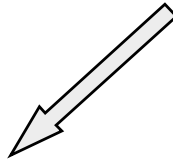
# Generic mobile acquisition process



Data model

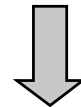
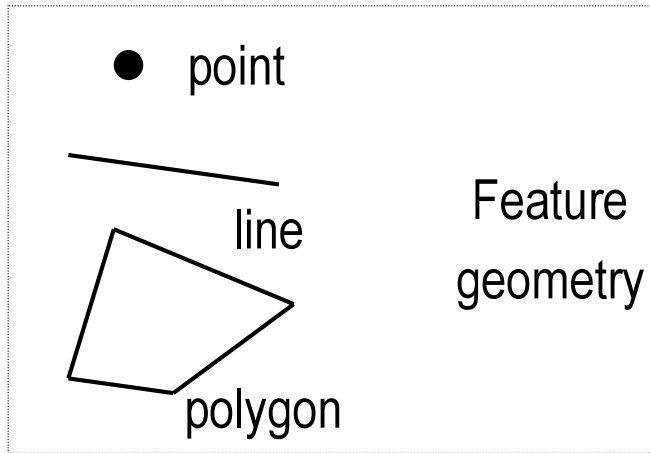


GML/XML Schema



Feature attributes

+



[Generate geo-feature]

# Landslide application scenario

## Testgebiet Balingen

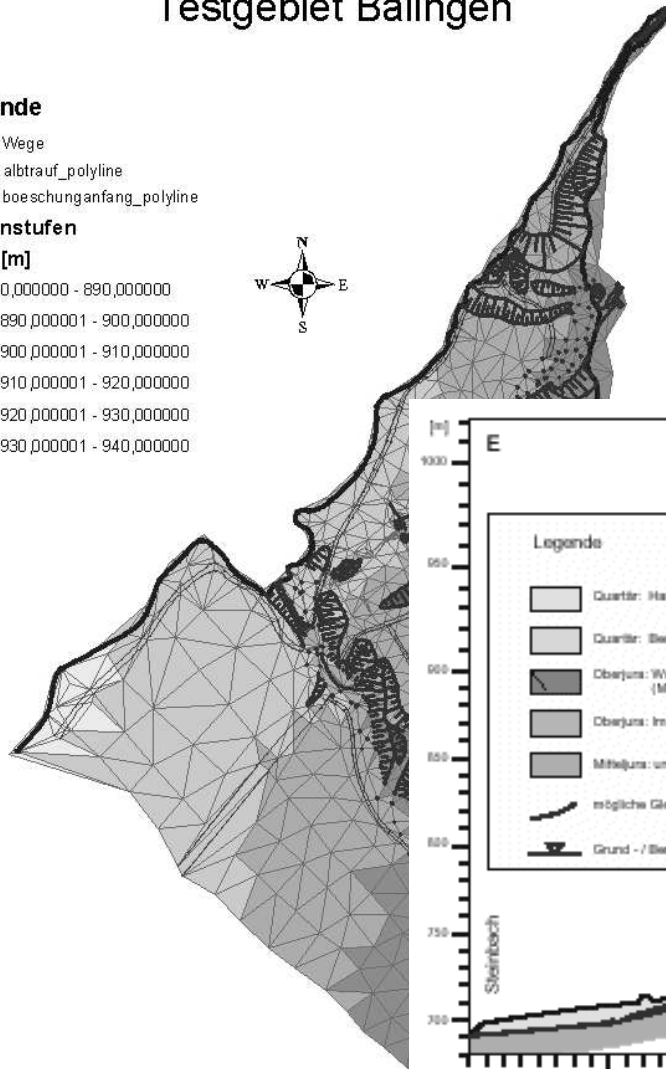
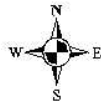
### Legende

- Wege
- albrauf\_polyline
- boeschunganfang\_polyline

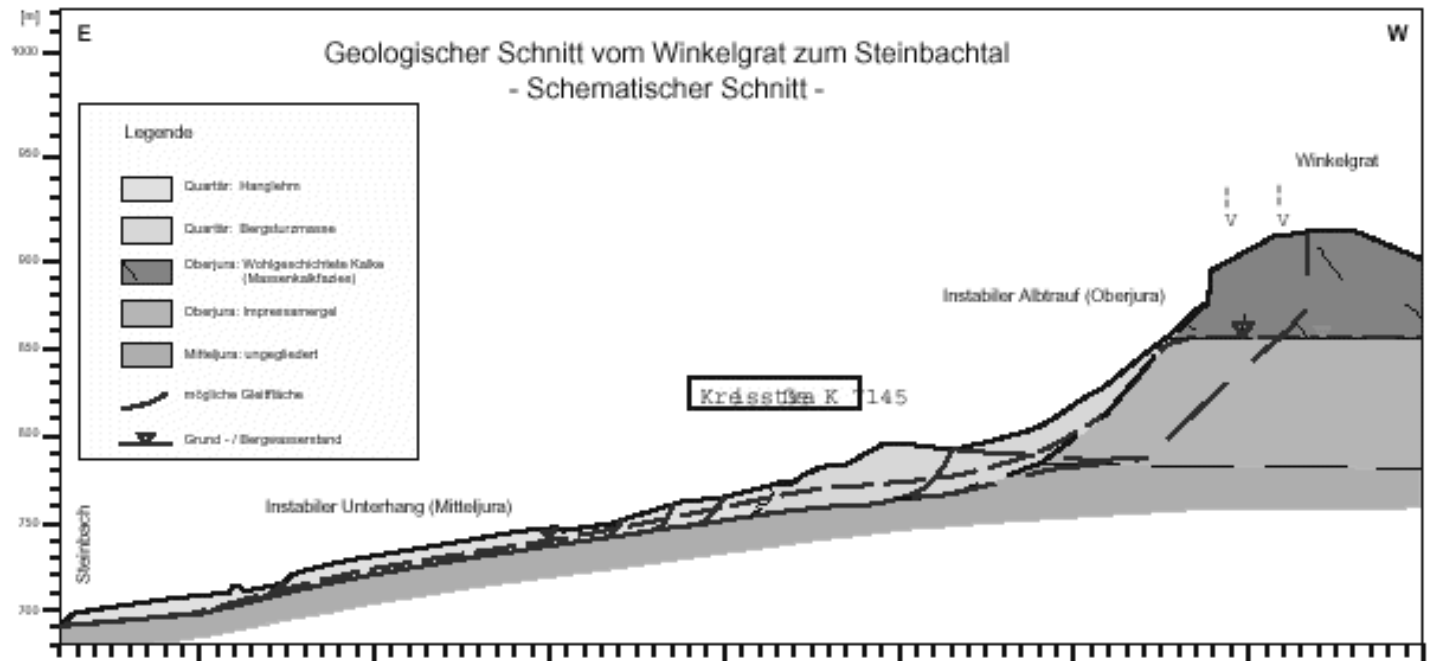
### Höhenstufen

#### Höhe [m]

- 0,000000 - 890,000000
- 890,000001 - 900,000000
- 900,000001 - 910,000000
- 910,000001 - 920,000000
- 920,000001 - 930,000000
- 930,000001 - 940,000000

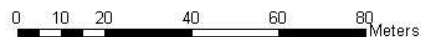


Test areas near Balingen  
and Rosenheim, Germany



source: LGRB BW

source: LGRB BW news 2002



Wolfgang Reinhardt

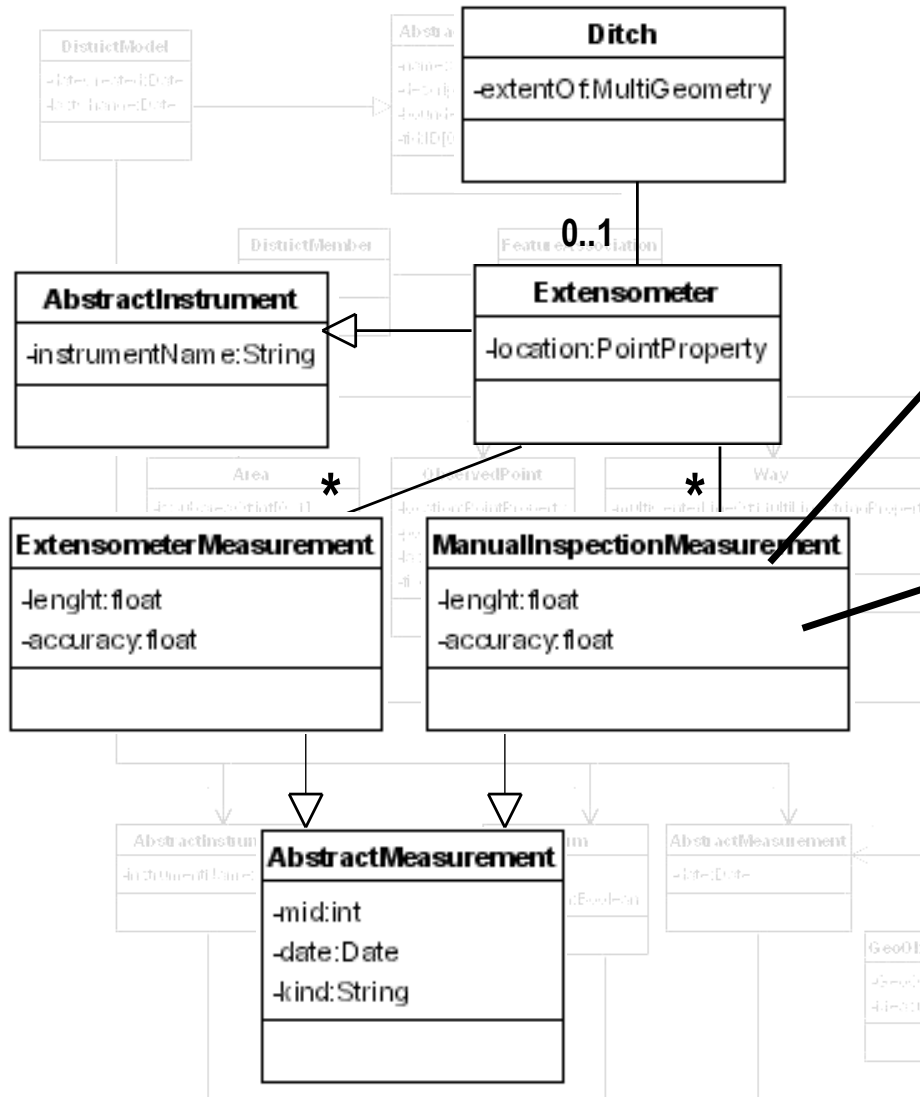
# Landslide application scenario

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## Test area Balingen

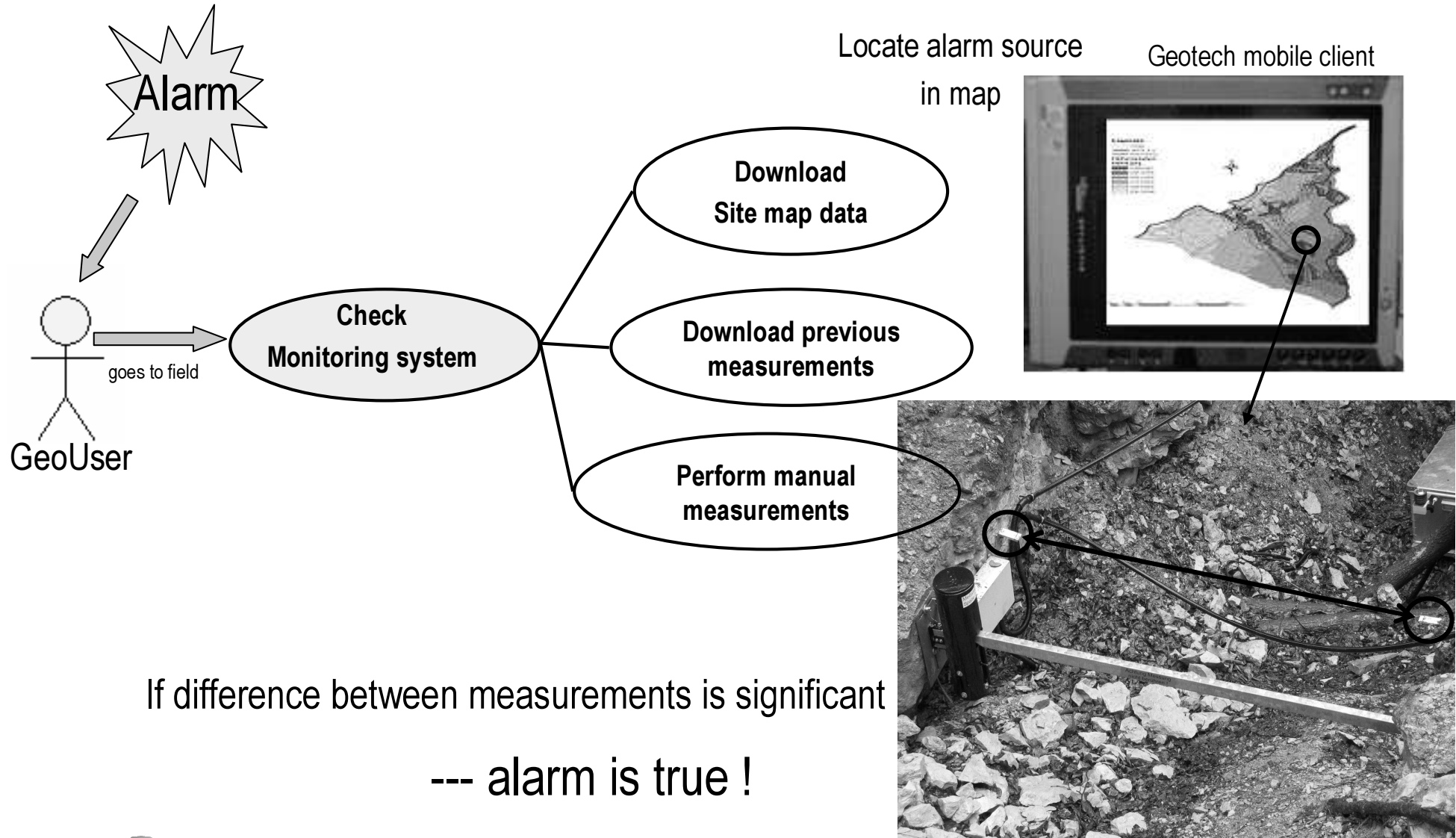


# Data model example



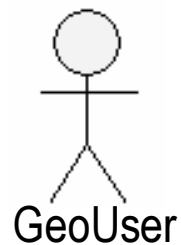
Geological objects,  
measuring instruments  
and measurements

# Use case: Landslide alarm

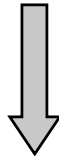


# Use case: Landslide alarm

What has changed in the area?



e.g. gaps, ditches, slope edges, ..



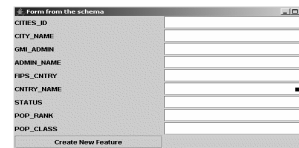
quality assurance !

e.g. Ditch class

Selects Feature Class

Performs geometry measurements

Enters attribute values



E_Farm from the schema	
CITY_ID	
CITY_NAME	
GRM_ADMIN	
ADMIN_NAME	
FIPS_CITY	
CNTY_NAME	
STATUS	
POP_RANK	
POP_CLASS	

Create New Feature

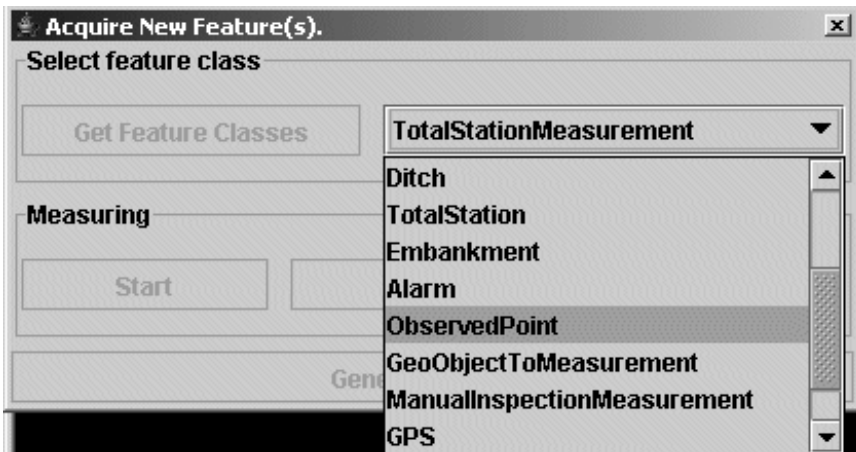
Ditch attributes

Geotech mobile client



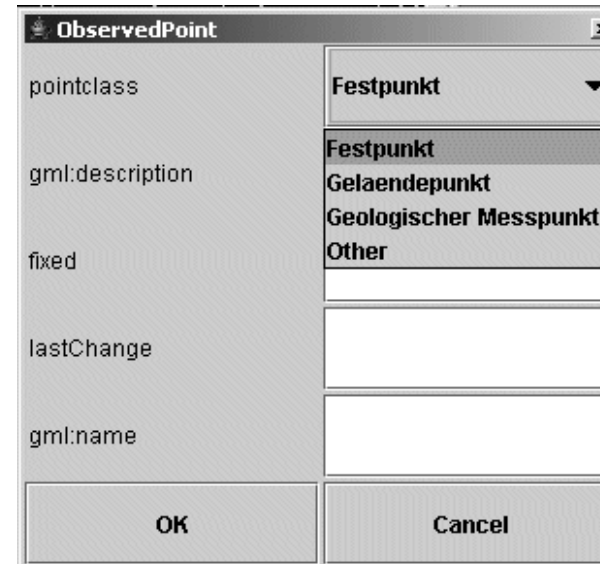
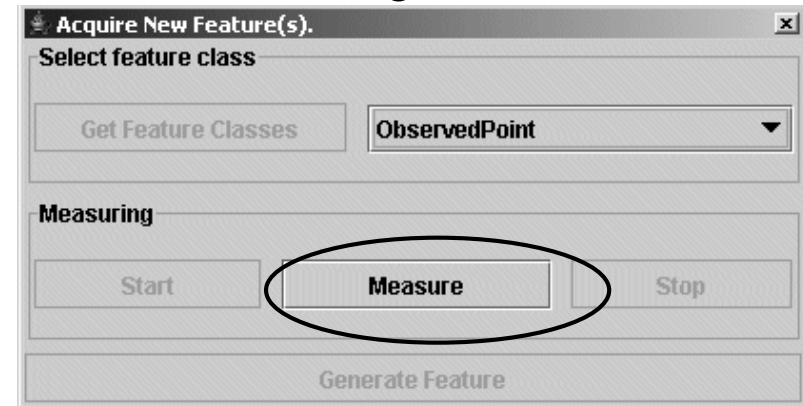
# Online geospatial data acquisition

## Feature class selection



GeoUser selects ObservedPoint class !

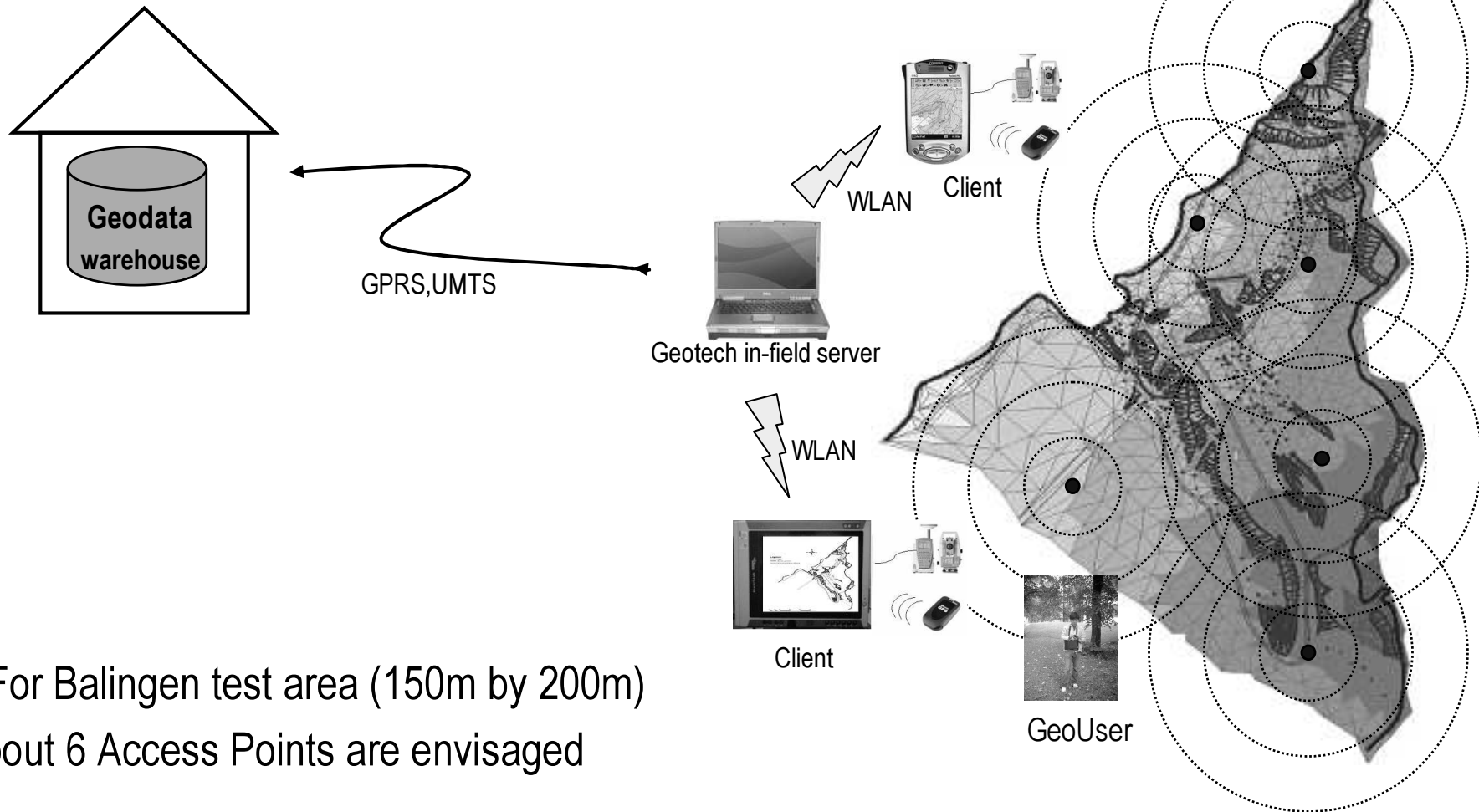
## Generating feature



Attributes form

# Online geospatial data acquisition

## System configuration



- For Balingen test area (150m by 200m) about 6 Access Points are envisaged



# Summary Geotech project

- Application scenario has been defined
- Data acquisition concept implemented (Prototype)
  - „Open System“ implemented (basic services)
  - Wireless access to GeoServices, usage of data from distributed data bases
  - Measurements by GPS
  - Dynamic form generation for attributes input
  - Feature generation
  - More tests necessary -> workflows, Improvements
- Data transactions / update concept (e.g. inserts, deletes) -> WFS-T
- Quality control/checks in the field
- Integration of sensors based on standards
- Advanced Services (.. 3D, 4D ...)

# Research questions raised

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- Deficits in „Modelling chain“ (Appl. ... UML, ... , GML)
- Modelling of observation & measurements
- Integrate sensors / sensor networks, Integrate sensor data (different kind, quality ...)
  - (in progress – 1 PhD candidate – Admire Kandawasvika)
- Quality management / assurance:
  - Define rules in user language in the conceptual model, translate it to a „system readable form“
  - Involvement of workflow tools
  - (in progress – 2 PhD candidates – Fei Wang, Stephan Mäs)
- Others

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# Examples of recently started work

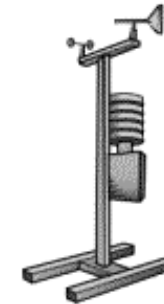
## 1. Example: Sensor networks

# Sensor Integration – Sensor web

## OGC Sensor Web

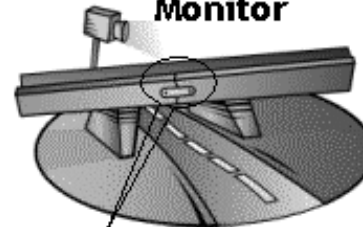
- All sensors connected to the Web
- All sensors report position & observations
- Sensor modeling and encoding: SensorML
- Observation encoding: O&M (GML-based)
- Access observations through Sensor Collection Services
- Plan collections through Sensor Planning Services
- Access sensor-related metadata through Web Registry Services
- Messaging through Web Notification Services

Industrial Process Monitor



Environmental Monitor

Traffic Monitor



Strain Gauge

Health Monitor



Stored Sensor Data



Webcam



Airborne Imaging Device



Satellite-borne Imaging Device

OGC

© 2002, 2003, Open GIS Consortium, Inc.

...making the World to Communicate Geographically

5

# Sensor networks - examples

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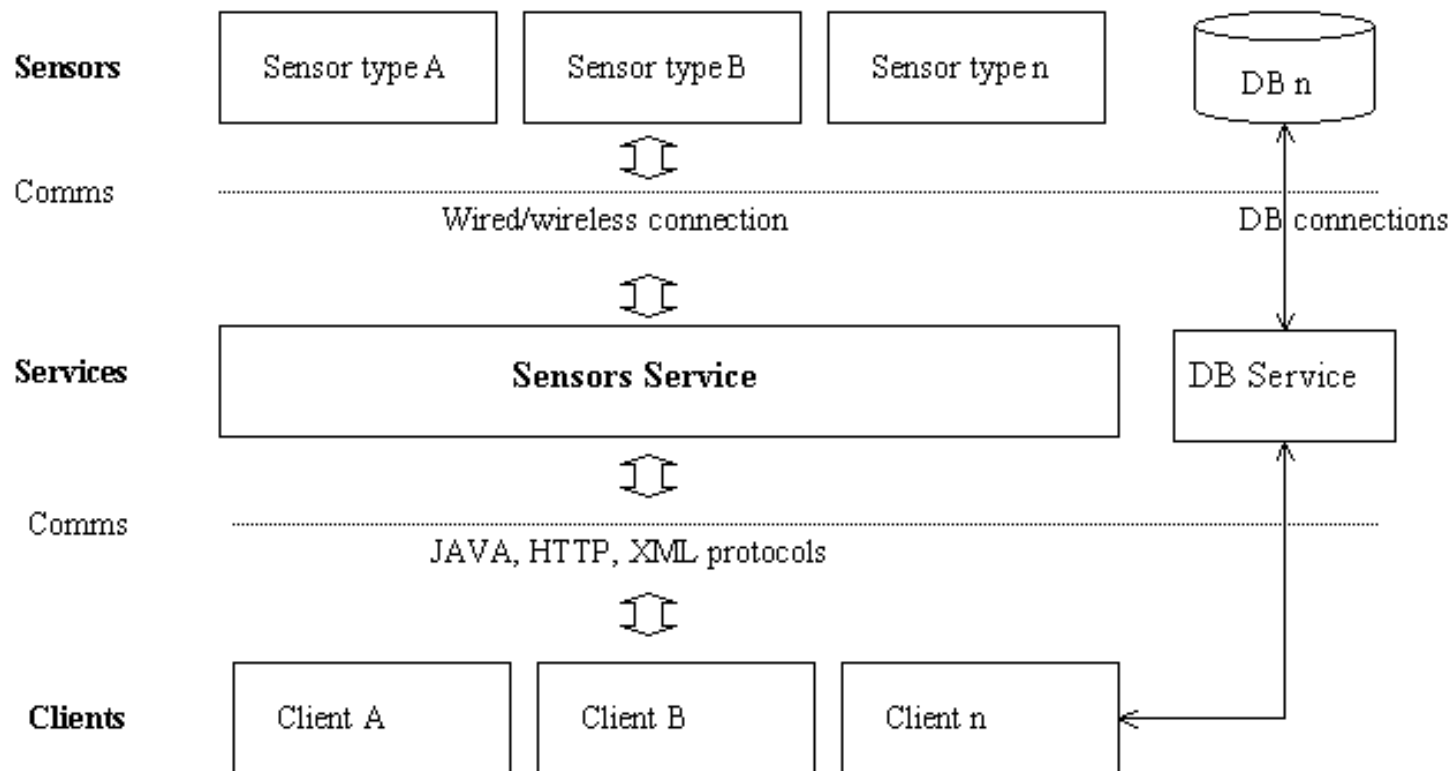
Relevant in our application:

- ***GPS*** - positions, together with their timestamps
- ***Total stations*** – positions plus other geodetic measurements
- ***Digital cameras*** - images showing changes of terrain appearance
- ***Laser scanners*** – terrain points for reconstructing digital elevation models (DEM) ,...
- ***Extensometers*** – gaps expansions of the ditches in which they are installed

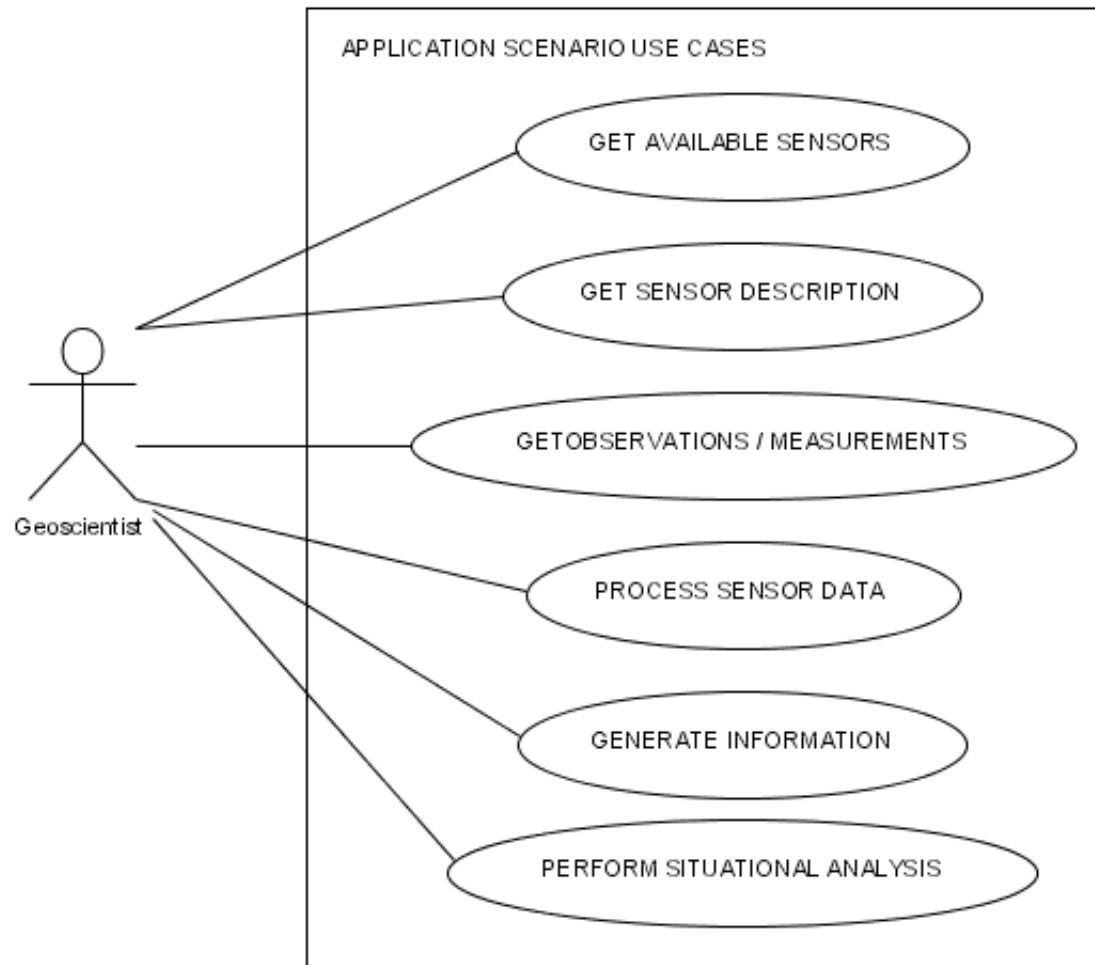
In general

- **Various types, image sensors and others**

# Architecture



# Sensor user scenario



# Sensor Framework

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- Each geodetic sensor should be able to describe itself (i.e. behaviour, characteristics,...) in a common way and also publishes it's capabilities. Sensors are accessible via Web – *as suggested by the SensorWeb*.
- Wireless (e.g. Bluetooth, WLAN) and wired (e.g. serial cables) connections can be established for the purposes of communicating with the in-field sensor network.
- Access to different sensor types via standard interfaces – for the purposes of data retrieval and as well manipulation of these sensors.
- Different data from different sensors can be processed on-the-fly and transformed into useful information. This is a very challenging task and requires highly sophisticated services.
- Sensors data may be stored in databases using standard format (e.g. using O& M for encoding)
- Alert / alarm should be generated if certain thresholds are reached or exceeded.



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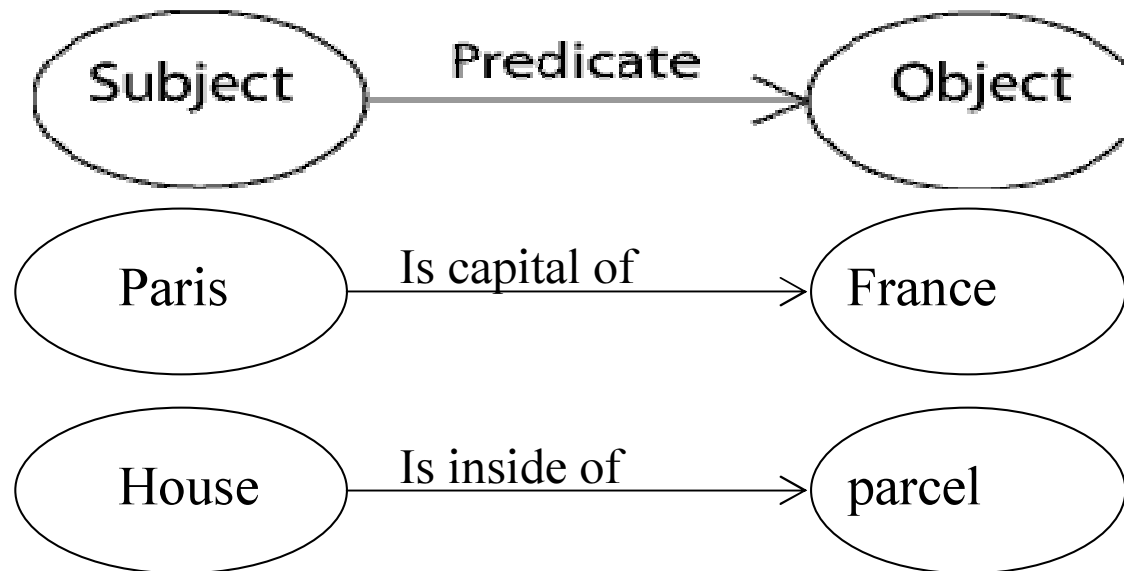
# Examples of recently started work

## 2. Example: Aspects of quality Management

# Define rules for quality management

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- **RDF - Ressource Description Framework (w3C standard)**
- Application in semantic web field
- Allows for declarations in {Subject/Predicate/Object} form
- Predicate is a oriented graph from subject to object



**Problem: description of semantics depends on author**

# RDF-XML example

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2 Final//EN">
<html>
  <head>
  </head>
  <body>
    <h1>Stadt: Paris </h1>
  </body>
</html>
```

**HTML- declaration with implicit semantics**

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:my="urn:city#">
  <rdf:Description rdf:about="http://www.paris.fr/">
    <my:capital rdf:resource="http://de.wikipedia.org/wiki/Frankreich/" />
  </rdf:Description>
  <rdf:Description rdf:about="http://de.wikipedia.org/wiki/Frankreich/">
  </rdf:Description>
</rdf:RDF>
```

**Declaration of a resource**

**Relations to resources**

**Assignment of a resource**

**RDF-XML declaration**

# Ontology web language - OWL

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- Also W3C Standard, 2/2004 used in semantic web
- Formal description of ontologies
- Based on XML and RDF/Schema vocabulary
- More possibilities to describe classes and properties / characteristics:
  - Relations between classes (e.g. „disjointness“)
  - Cardinalities (e.g.. "exactly one") & equalness
  - Typs (e.g.. „symmetry“, „inverseOf“)
  - Enumerations (e.g. „oneOf“)
- First „trials“ in our application

# Thanks to AGIS staff

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- **Stephan Mäs**
- **Fei Wang**



**Thank you!**  
**Questions?**