GRID Structure Based Processing of Geographical and Environment Data

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- MedioGRID project
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- Greenland Application – satellite image processing
- Vegetation indices based classification
- Virtual geographical space modeling and visualization
- GIS and LBS Kernel

Research objectives

- Computer Graphics and Interactive Systems Laboratory
  - Computer Science Department, Technical University of Cluj-Napoca
- GRID computing
  - Graphical processing of geographical and environment data
  - MedioGRID Software Platform
- Satellite image processing
  - GRID based processing
  - Huge data management
  - Data processing and visualization
- Active Object Model based modeling and simulation
  - Virtual geographical space
  - Distributed data
  - Distributed processing
  - Flexible structure and behavior
  - User interaction
- GIS and LBS platform and application development
- Graphics modeling and interaction
  - 3D surface modeling and simulation – particle based
  - 2D and 3D space user interaction

MedioGRID Project

MedioGRID

Parallel and distributed graphical processing on GRID structure of geographical and environment data, 19CEEX-I03 (2005-2008)

- The MEDIOGRID project aims to accomplish a pilot program to process the images acquired in real time from meteorological and resource satellites, in order to extract the meteorological and environment parameters that characterize the atmospheric and terrestrial state.

  Web site: http://mediogrid.utcluj.ro

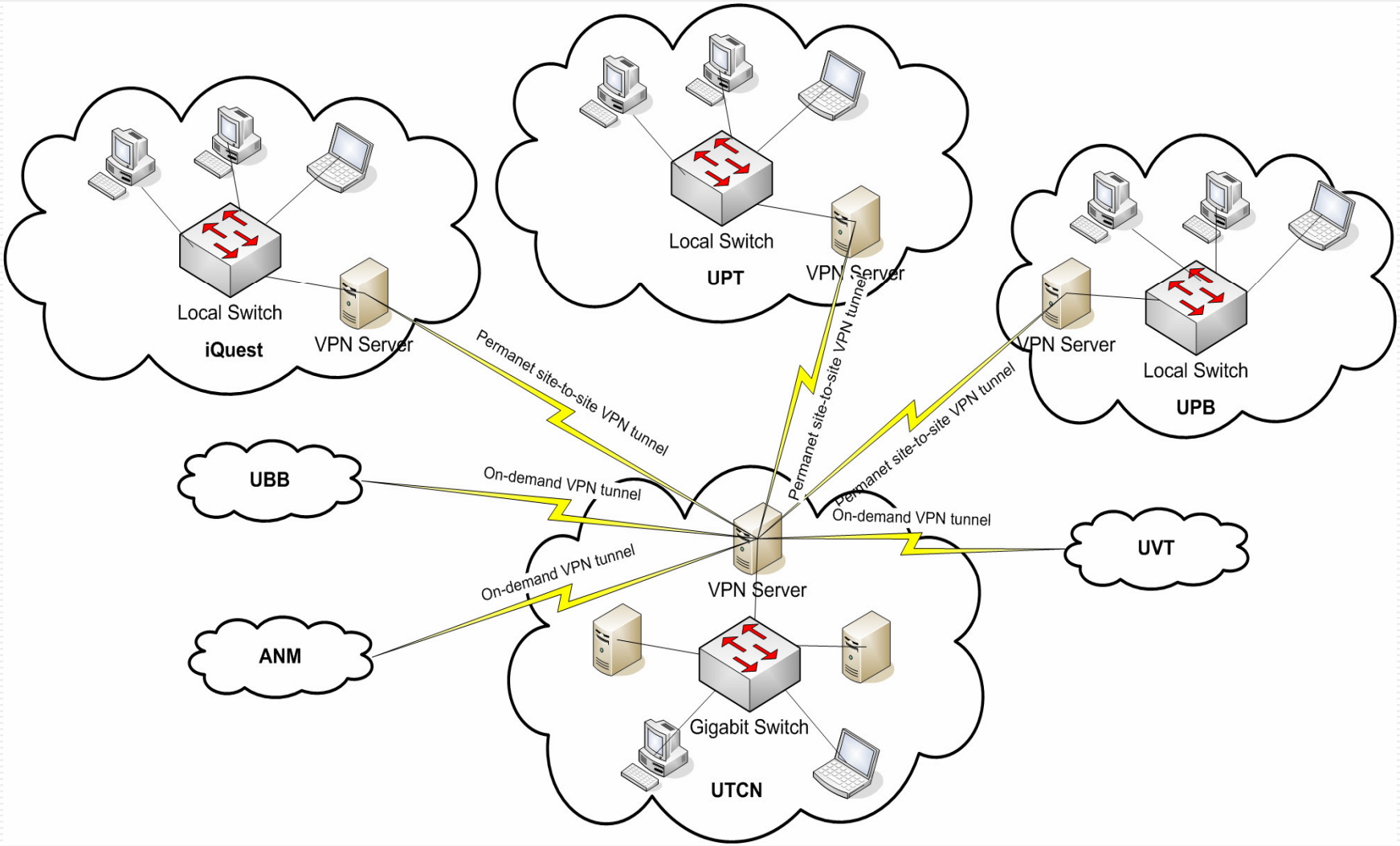
MedioGRID Project

- The project schedule:
  - 1st year achieves and experiments the grid infrastructure, and analyzes the raw data and the processing techniques.
  - 2nd year develops the Software Platform Kernel consisting of fundamental algorithms and components for image segmentation, and parallel and distributed data processing. It follows the kernel system experimentation over the grid by test and real input data.
  - 3rd year develops and tests a pilot application specific for the analysis of social and ecological systems.
- Project consortium:
  1. Computer Science Department, Technical University of Cluj-Napoca, coordinator
  2. Faculty of Geography, Babes Bolyai University, Cluj-Napoca
  3. iQuest Company , Cluj-Napoca
  4. National Administration of Meteorology, Bucharest
  5. Computer Science Department, Politehnica University of Bucharest
  6. Informatics Department, West University of Timisoara
  7. Computer Science Department, Politehnica University of Timisoara

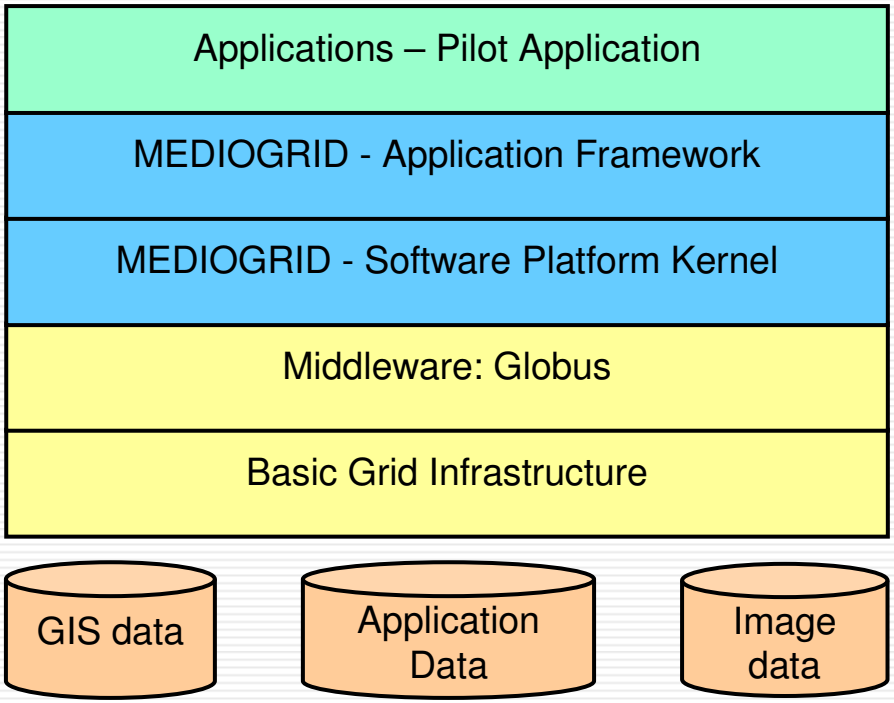
MedioGRID Project

- Main objectives
  - Develop GRID structure to support the parallel and distributed processing of huge data (geographical and environment)
  - Develop algorithms for GRID based processing of satellite images
  - Develop and experiment environment supervising applications with data extracted from satellite images
  - Model and visualize the virtual geographical space
- Outcomes (2005-2006):
  - Functional MEDIOGRID network (experimental GRID of 6 servers - Cluj, Timisoara, Bucharest and more than 50 workstations)
  - Software applications: Image processing MODIS (NASA), Cloud detection, Vegetation classification, MedioGRID Software Platform Kernel v1
  - Modeling and visualization of the virtual geographical space, GIS and LBS Kernel (Location Based Services)
  - GRID and Web services based architecture
  - Conferences and workshops: GridCAD2006/SYNASC, ISPDC2006, IPSI2005, MEDIOGRID-Cluj2005

VPN based MedioGRID architecture

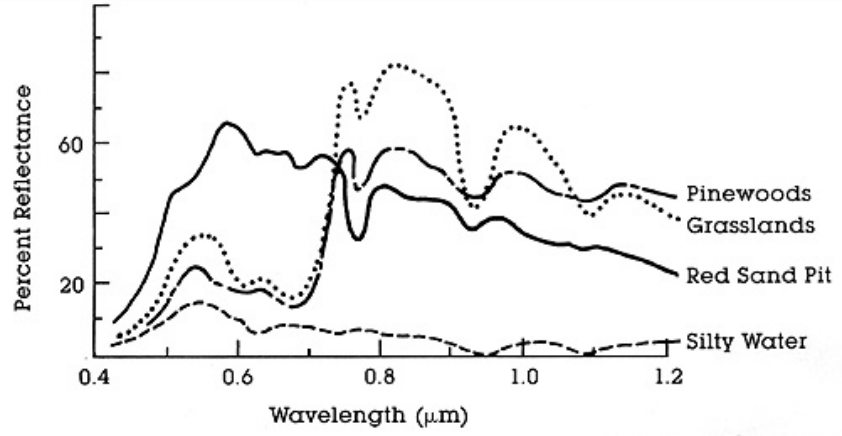


Functional MedioGRID layers



MedioGRID Software Platform

- QuickBird, Ikonos, Modis, Aster, Landsat
- Processing parameters: time window, spatial area, features, …
- Detection and supervision: vegetation, flood, wood fire, …
- Spectral signature



Data Management System

- Data Mirroring and Indexing Component

  Creates a local cache for the MODIS data granules corresponding to a specified area of interest (Romania and Cluj-Napoca surroundings).

  - Split each data granule into the 36 composing spectral bands.
  - Index the associated XML metadata.
  - Generate a full color representation for the MODIS data granules.

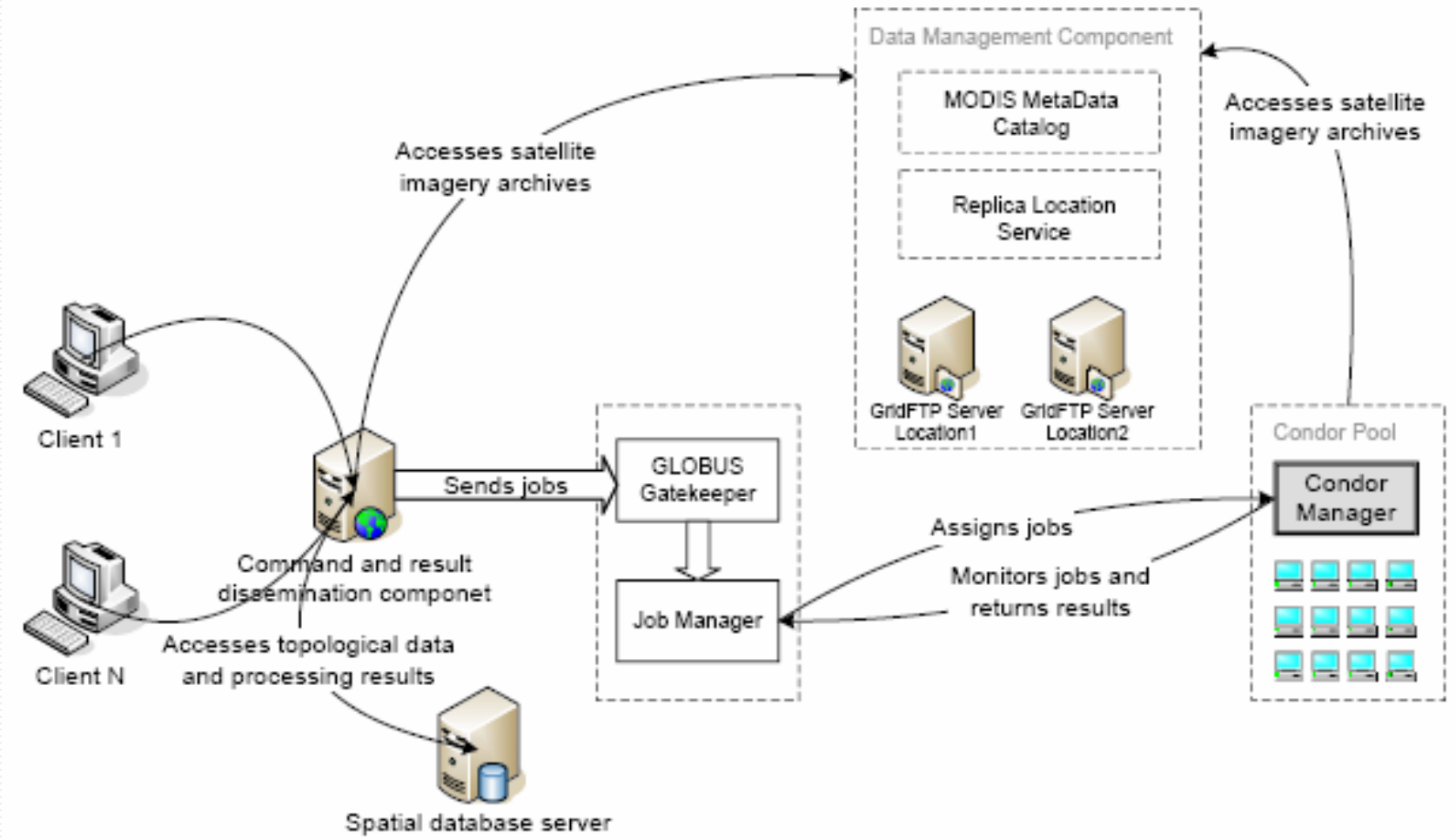
- Metadata Catalog Service

  Describe MODIS data granule characteristics such as: image type (spatial resolution, size), location (spatial extent), timeframe, satellite characteristics.

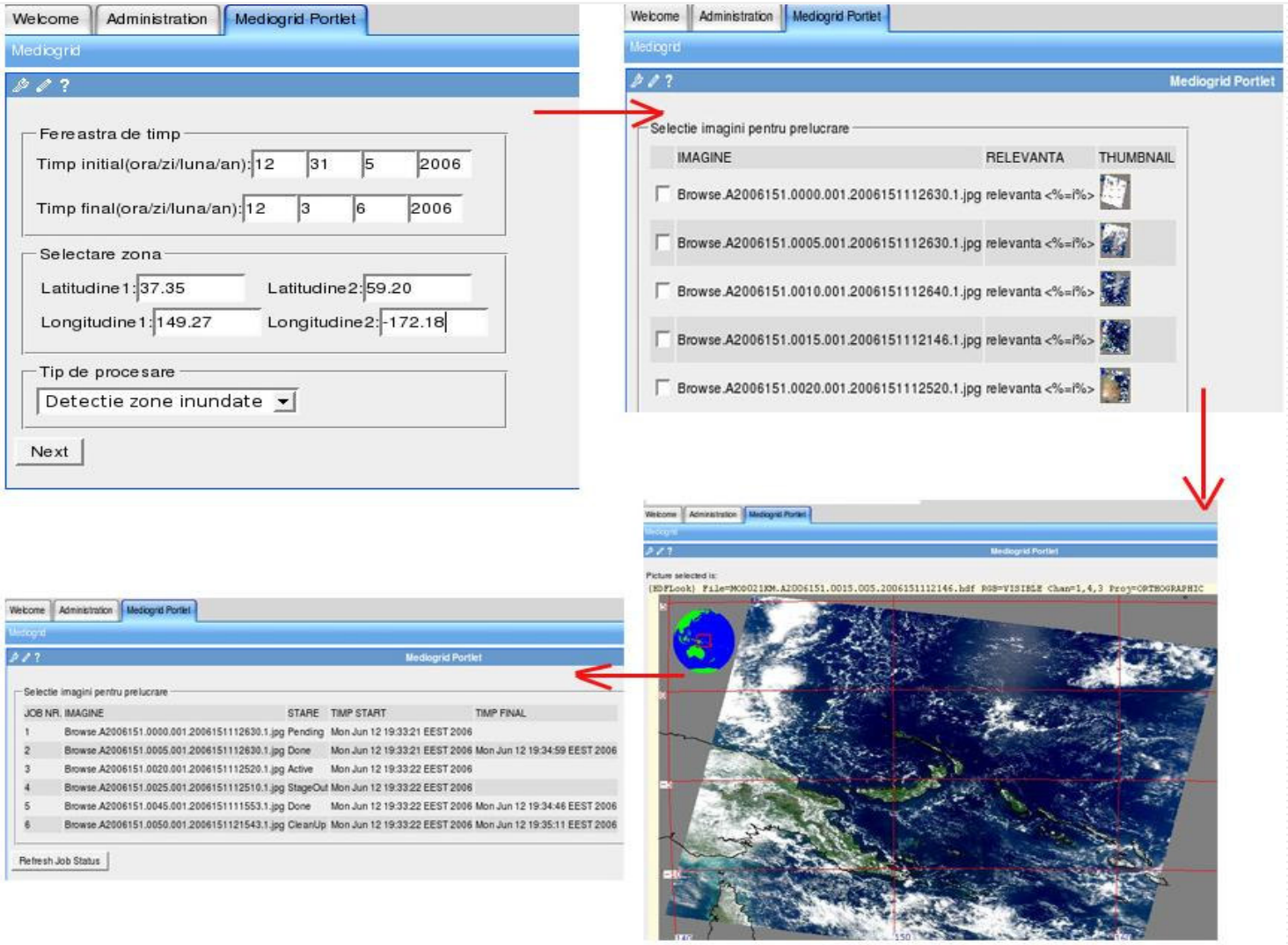
- Data Access Component

  Provides access to MODIS data granules which are used as input for the GRID processing nodes

GRID processing application



Greenland Application

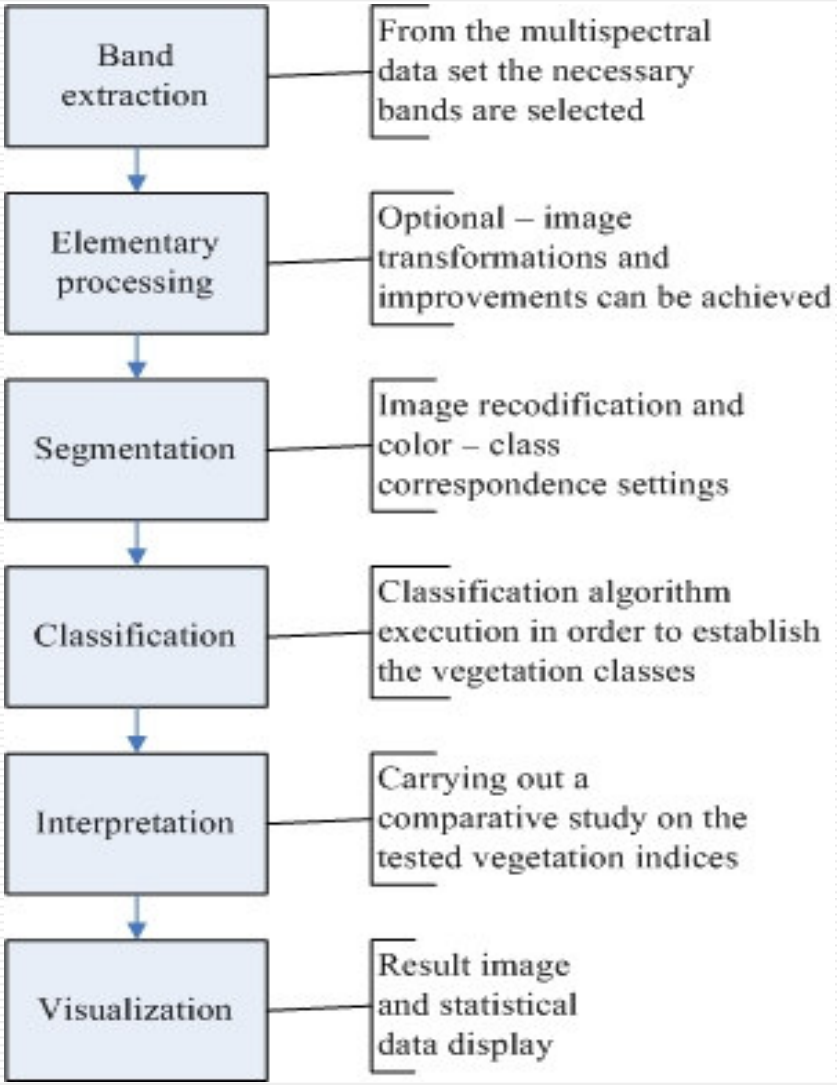


Vegetation indices computation

- PIMS Project – Multispectral Image Processing Tool for Semantic Information Detection Based on Vegetation Indices
- Subject:

  uses the medium and high spatial resolution satellite images to study the extent and structure of the vegetation cover for a certain geographic area
- Approach:
  - Computes vegetation indices by processing multispectral satellite images
  - Classifies vegetation based on vegetation indices
    - DVI - difference vegetation index
    - RVI - ratio vegetation index
    - NDVI - normalized difference vegetation index
    - SNDVI - scaled vegetation index
    - TVI - transformed vegetation index
    - IPVI - infrared percentage vegetation index
    - OSAVI - optimized soil adjusted vegetation index
    - GEMI - global environmental monitoring index
  - Statistical analysis
  - Updates geodatabase

Vegetation indices – Experiments

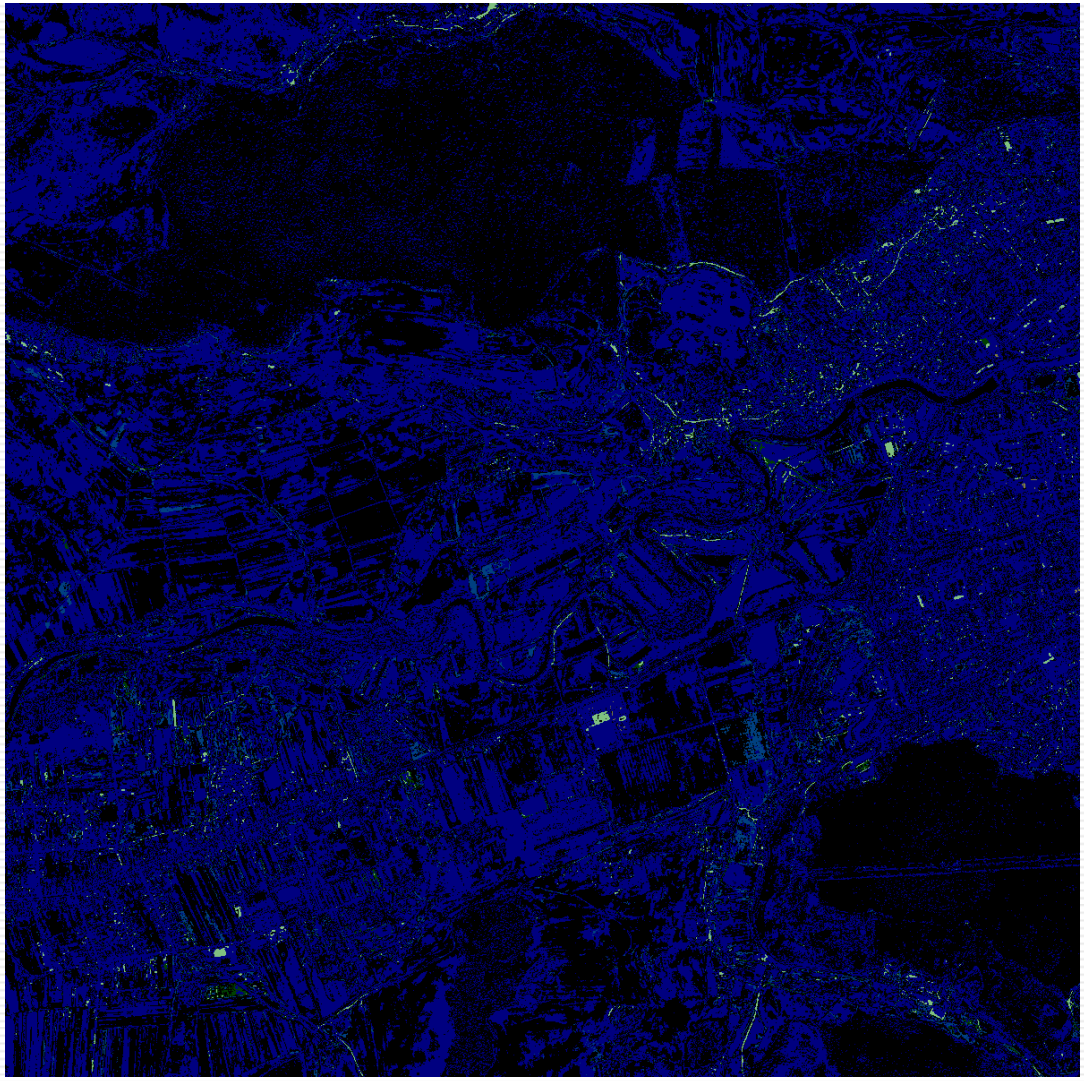


Vegetation indices oriented processing

Vegetation indices – Experimental results

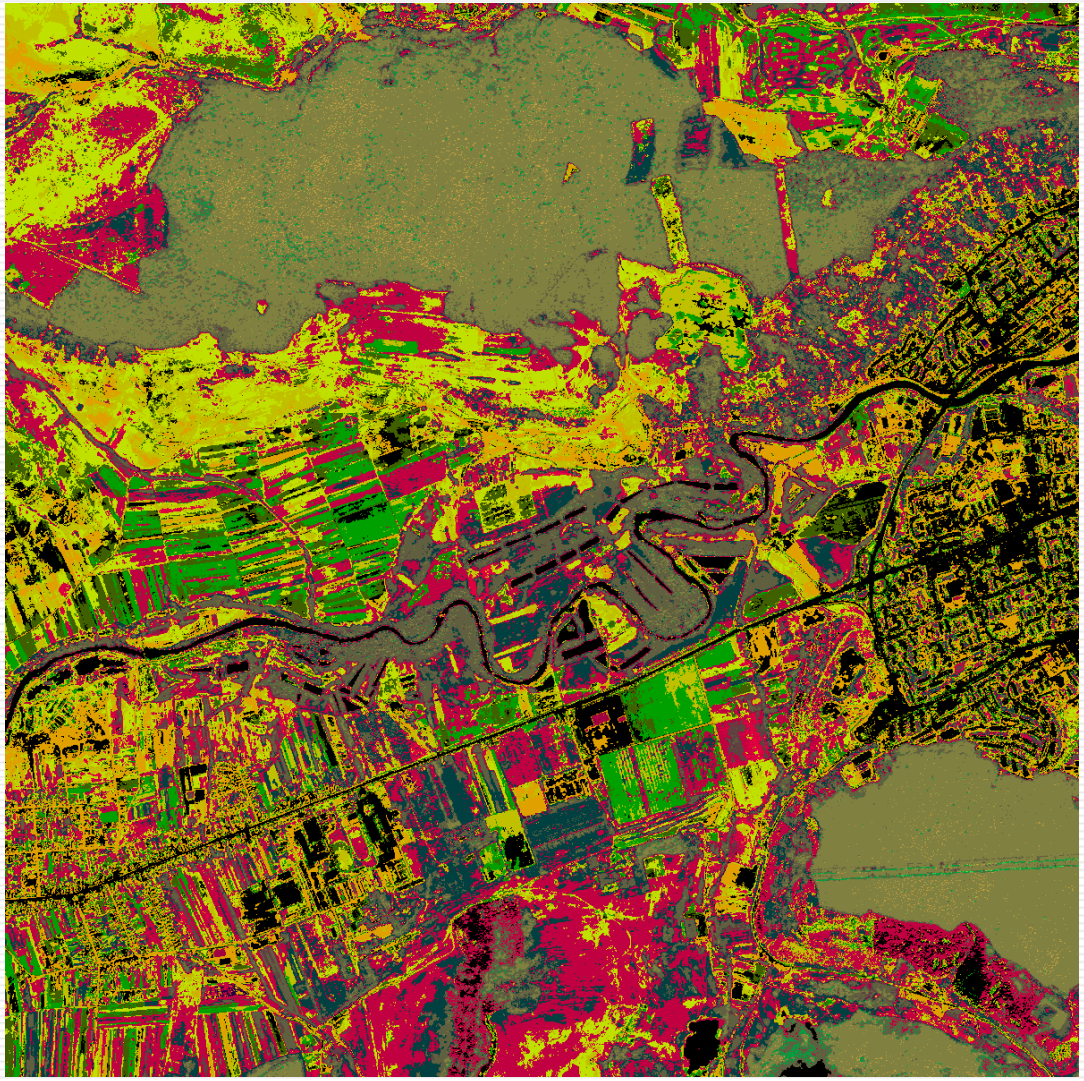
"False color" image
(bands 1,2,3)

Vegetation indices – Experimental results



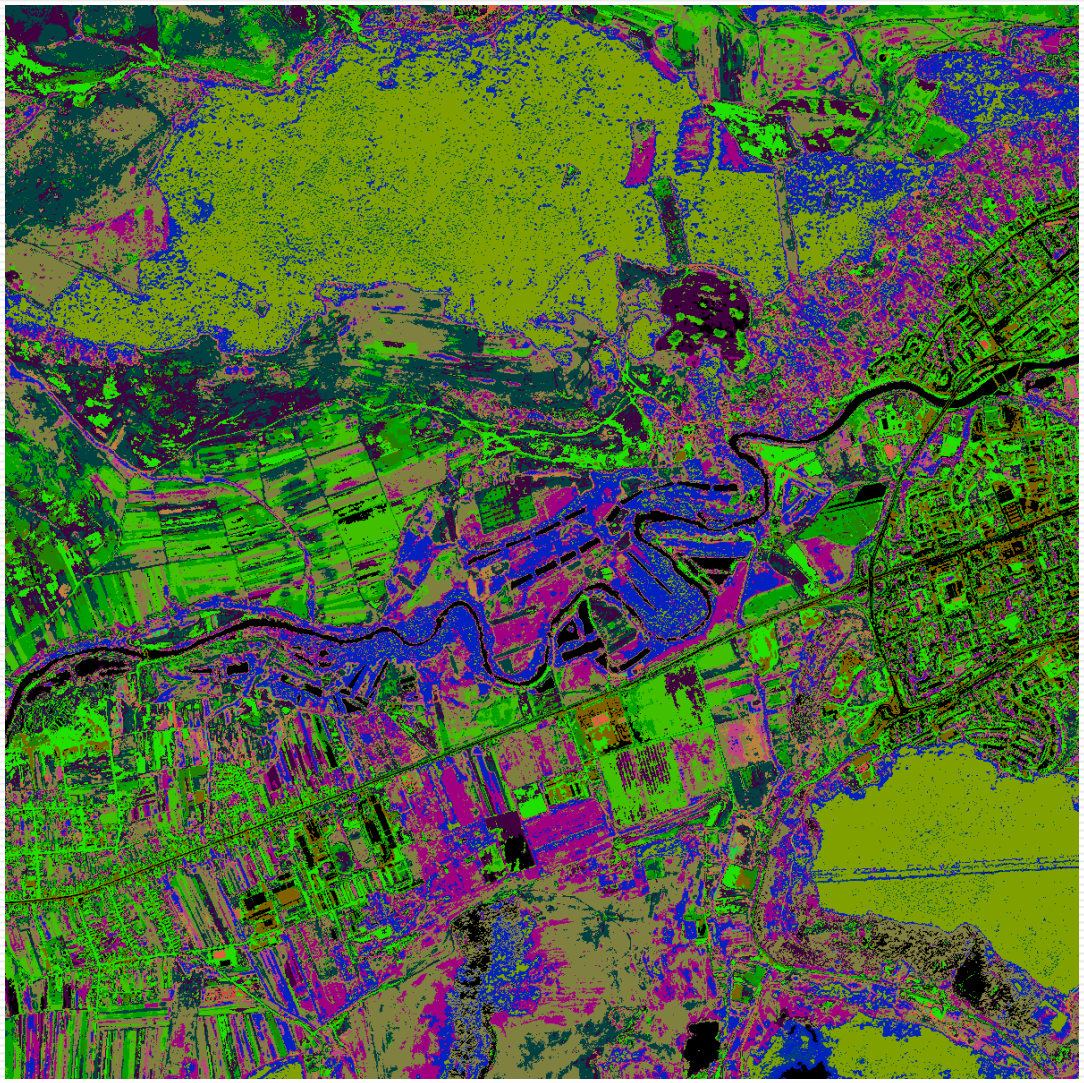
DVI (difference vegetation index) based classification algorithm

Vegetation indices – Experimental results



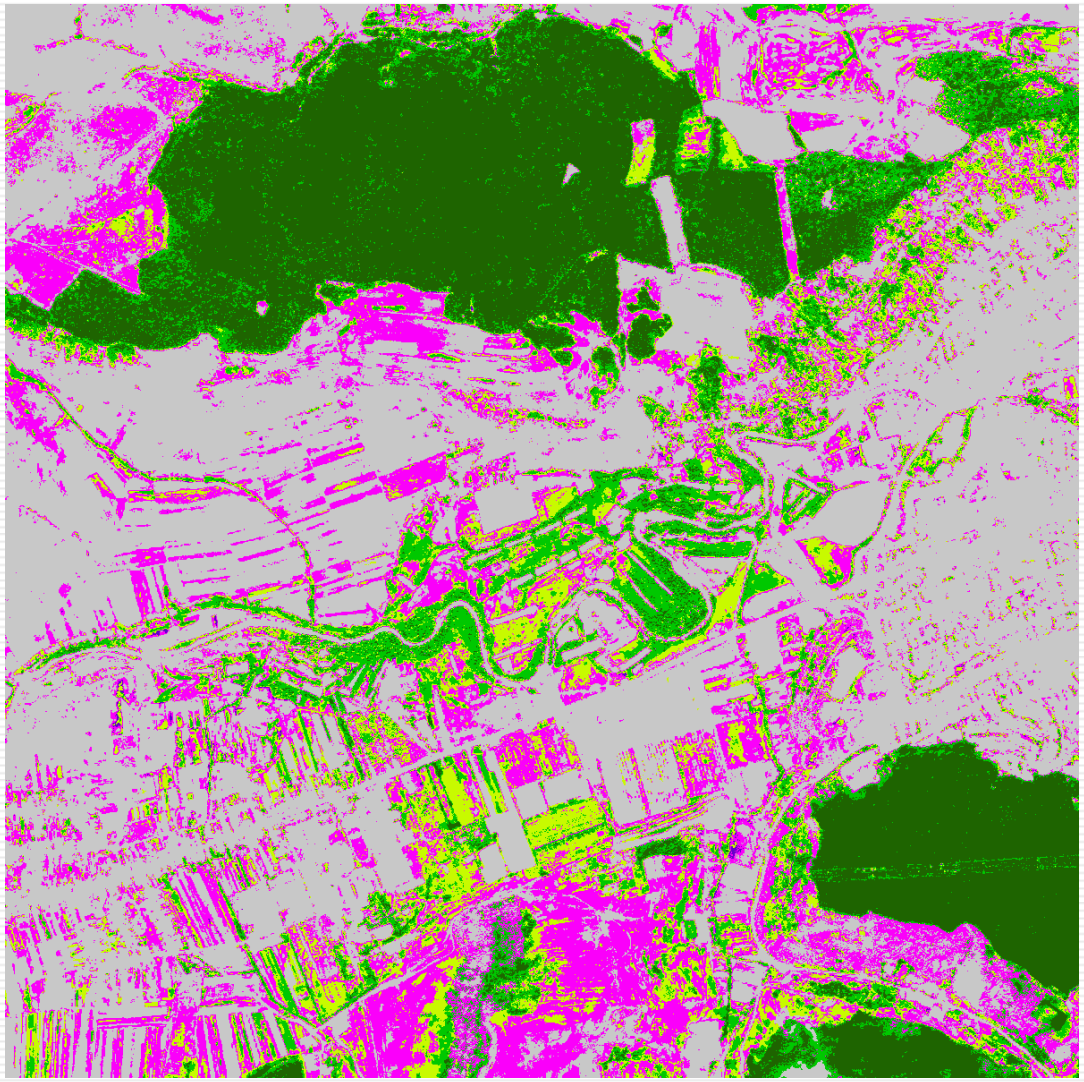
TVI (transformed vegetation index) based classification algorithm

Vegetation indices – Experimental results



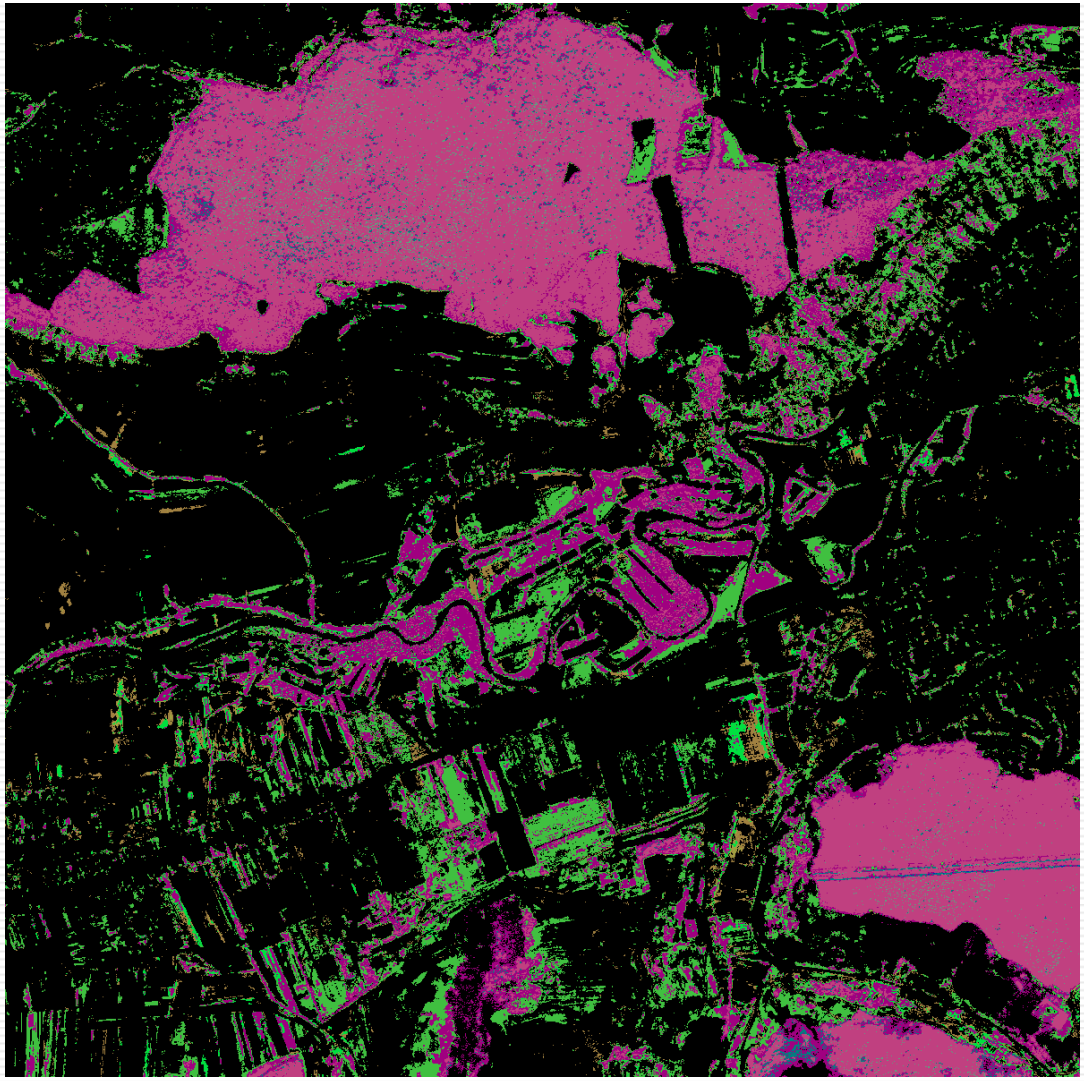
RVI (ratio vegetation index) based classification algorithm

Vegetation indices – Experimental results



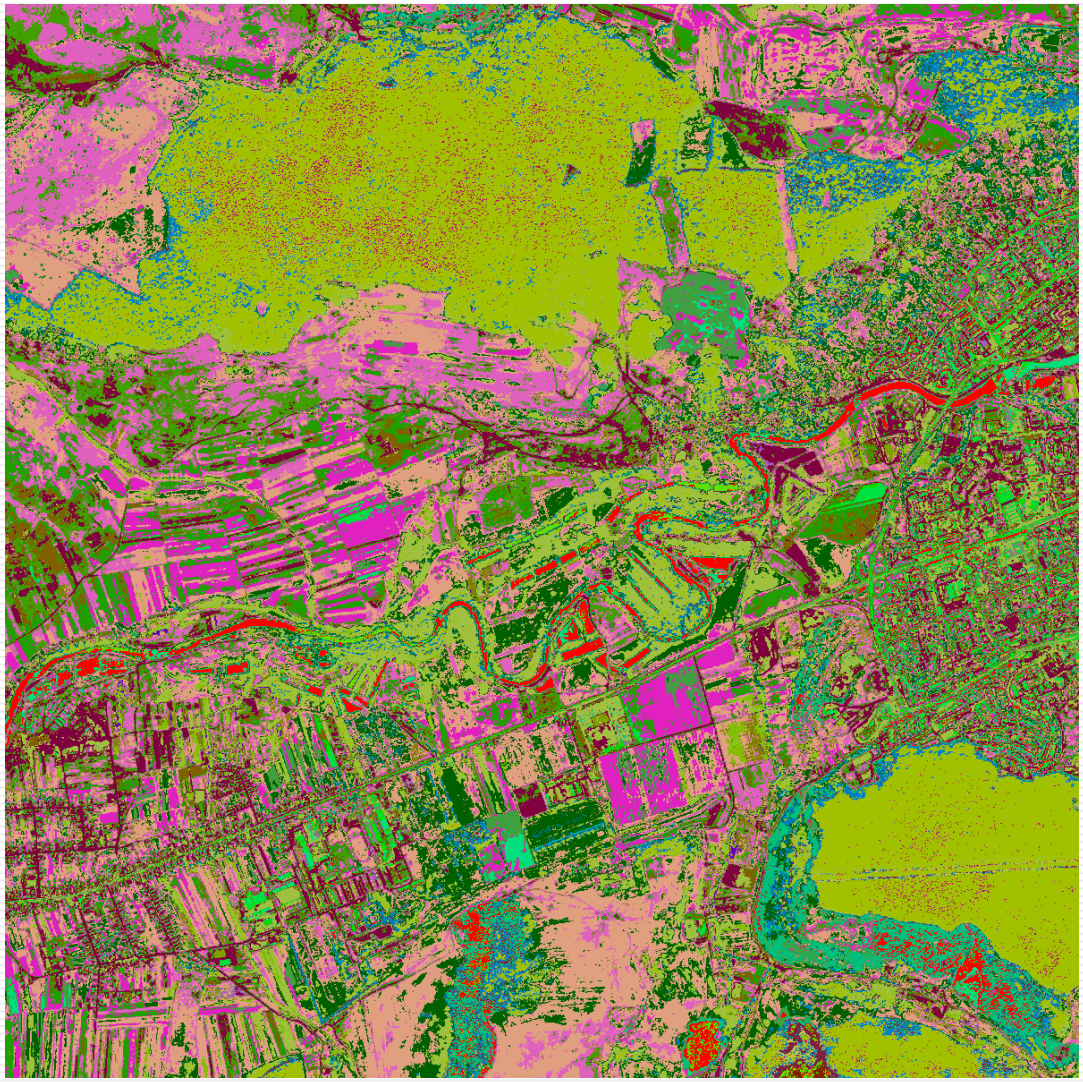
NDVI (normalized difference vegetation index) based classification algorithm

Vegetation indices – Experimental results



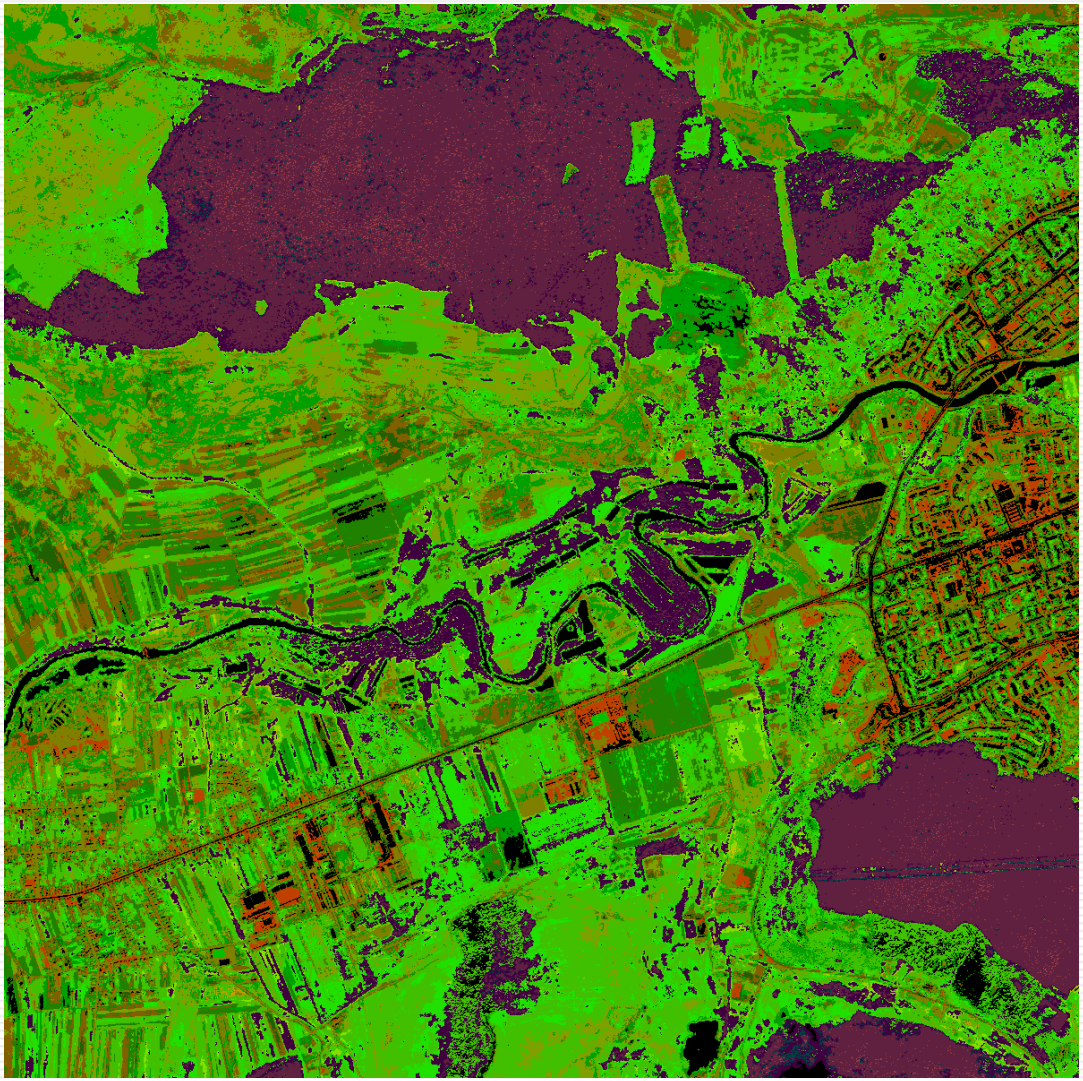
SNDVI (scaled vegetation index) based classification algorithm

Vegetation indices – Experimental results



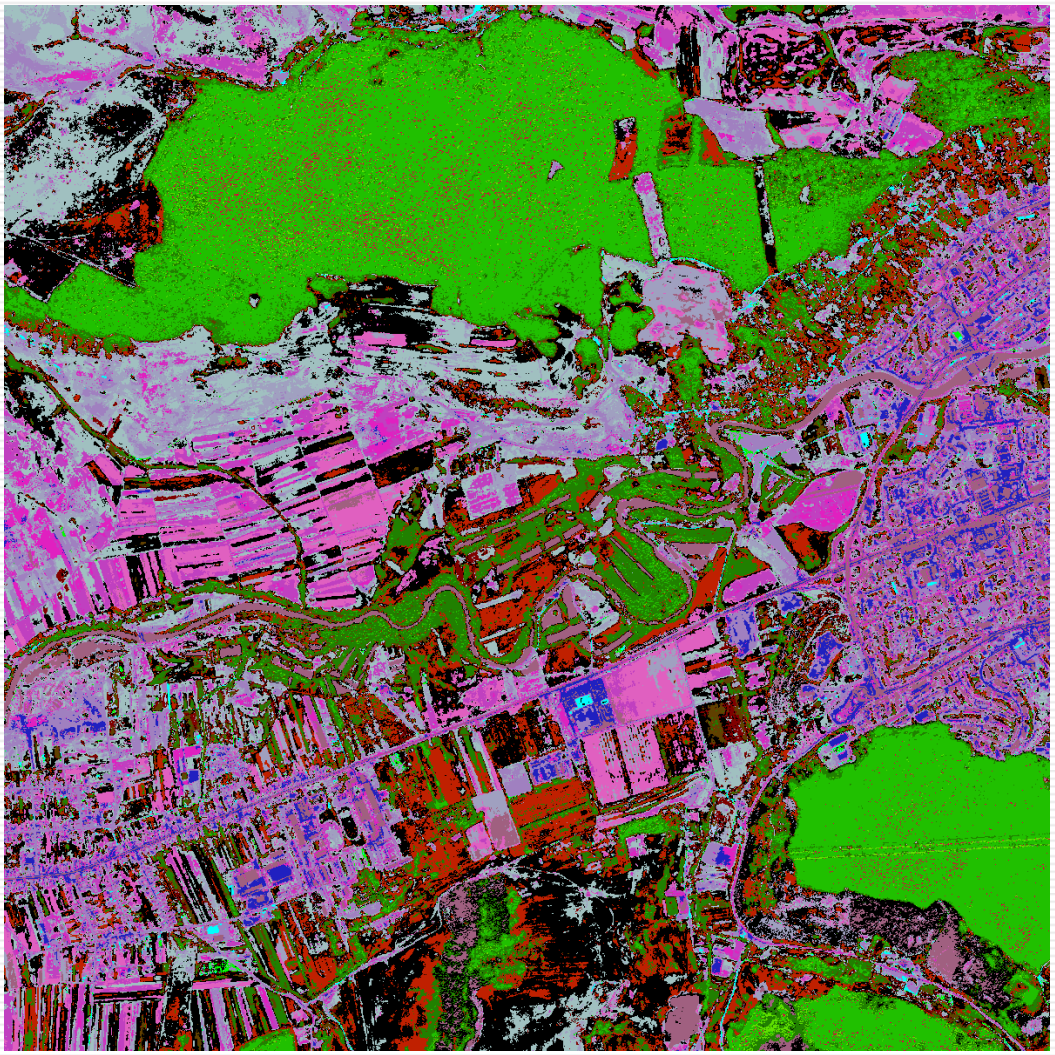
GEMI (global environmental monitoring index) based classification algorithm

Vegetation indices – Experimental results



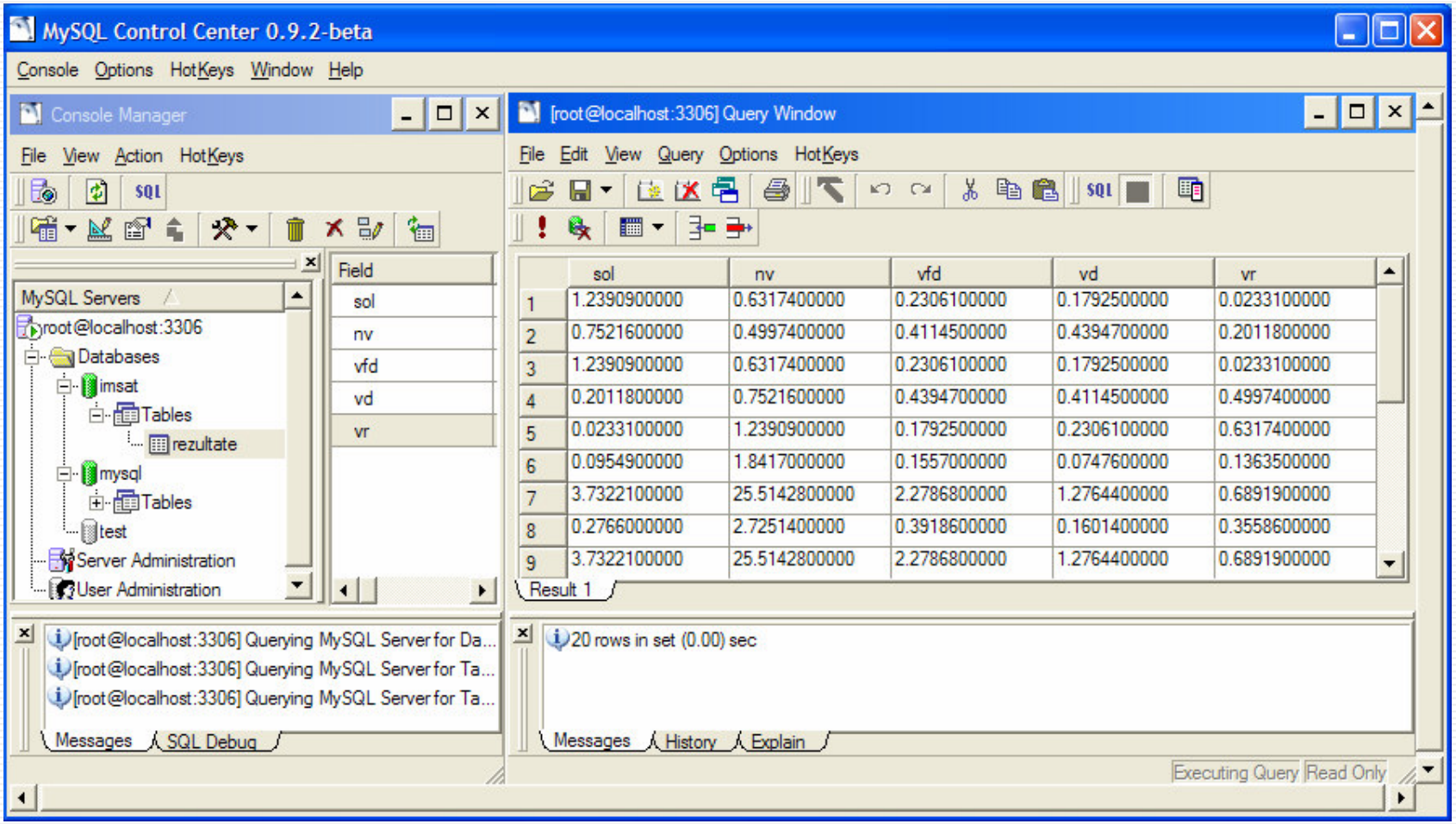
IPVI based classification algorithm

Vegetation indices – Experimental results



OSAPI based classification algorithm

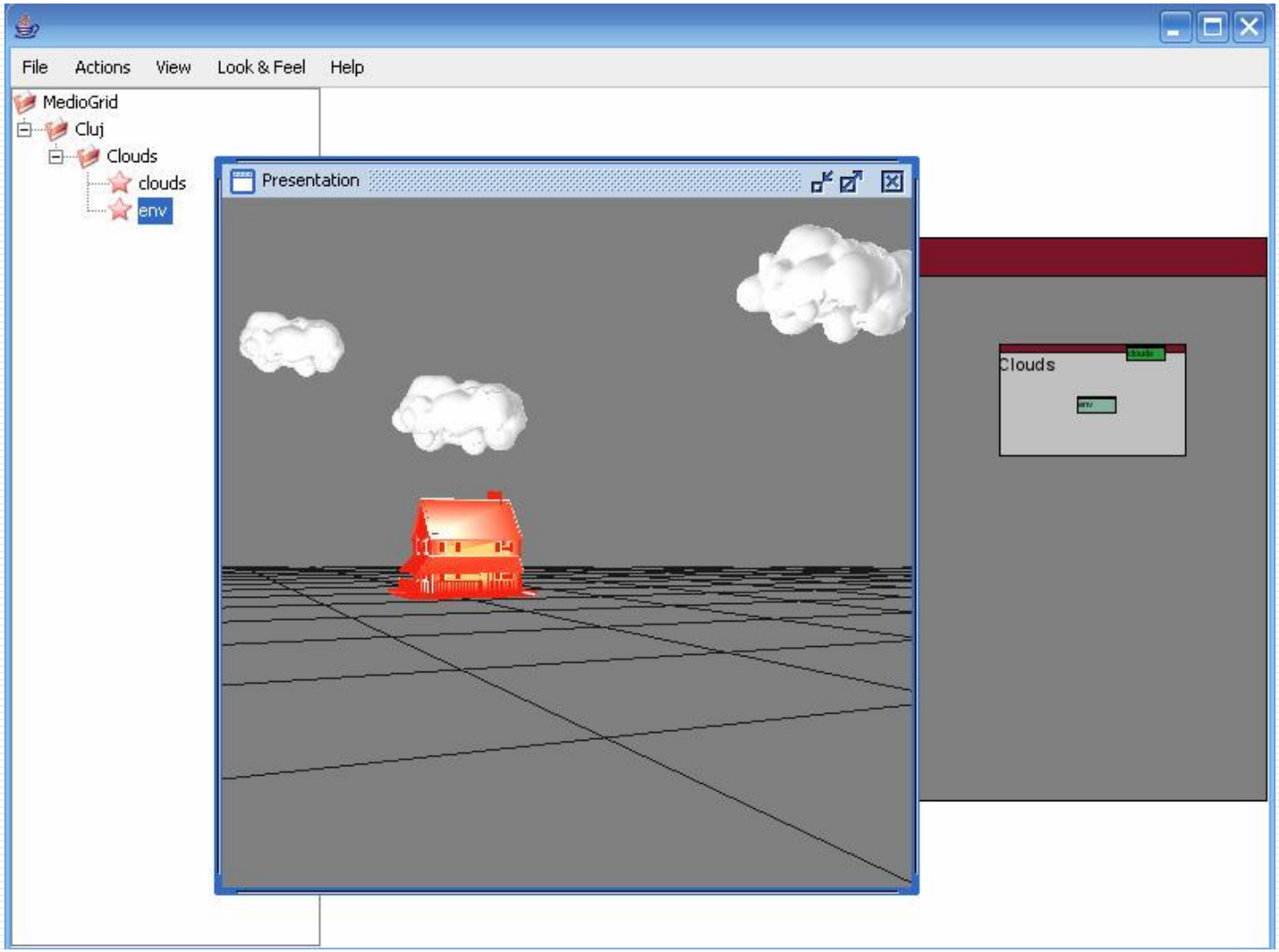
GeoDatabase



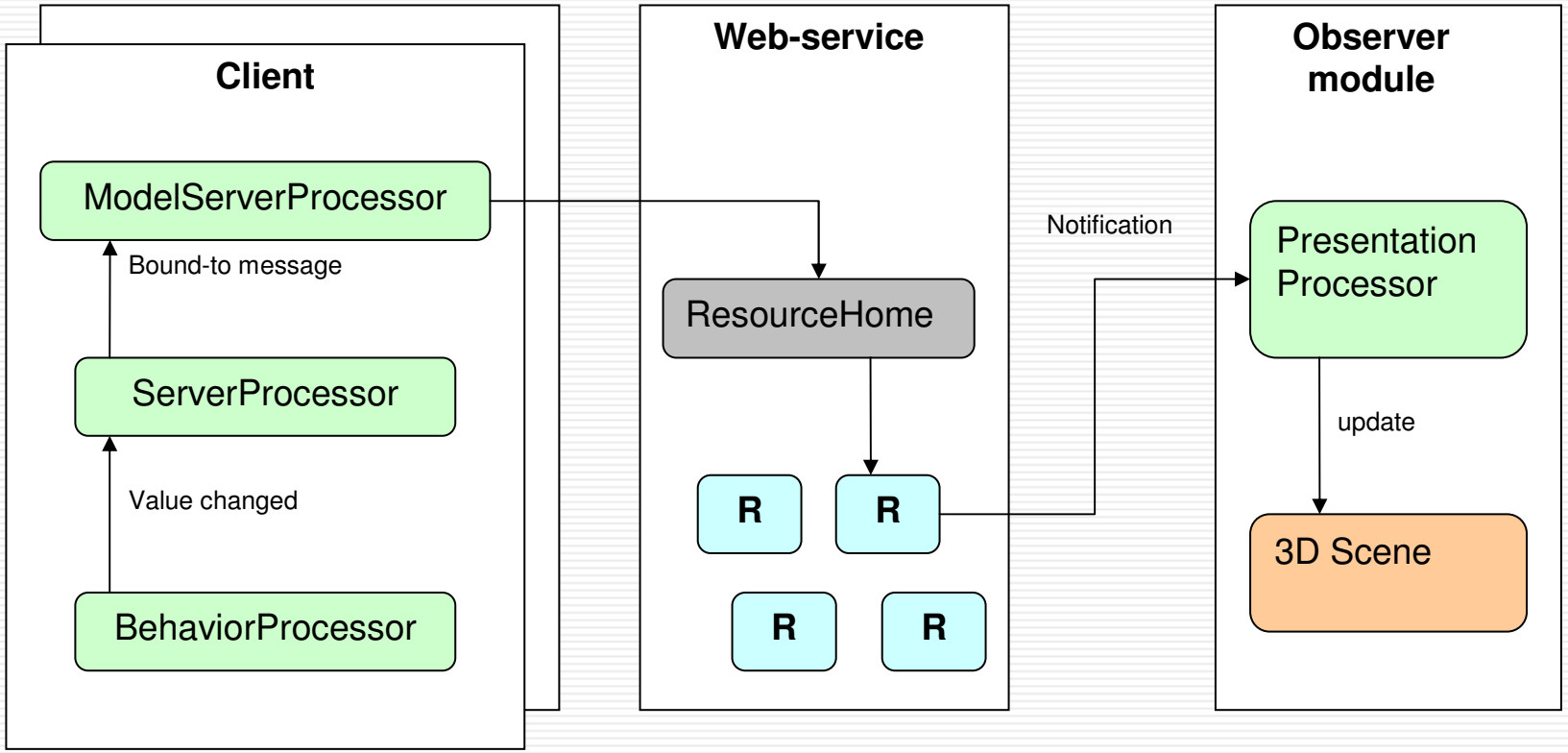
Active Objects Based Apps over Grid Environment

- Theoretical model intended for the simulation and presentation of real world systems
- Active Objects Model
  - Accurate represention of real objects with structure and behavior
  - Flexible structure and behavior
  - Message based communication
  - Visual programming based development techniques
  - Dynamic and graphical presentation
  - High computing requirements
  - Implementation on grid network

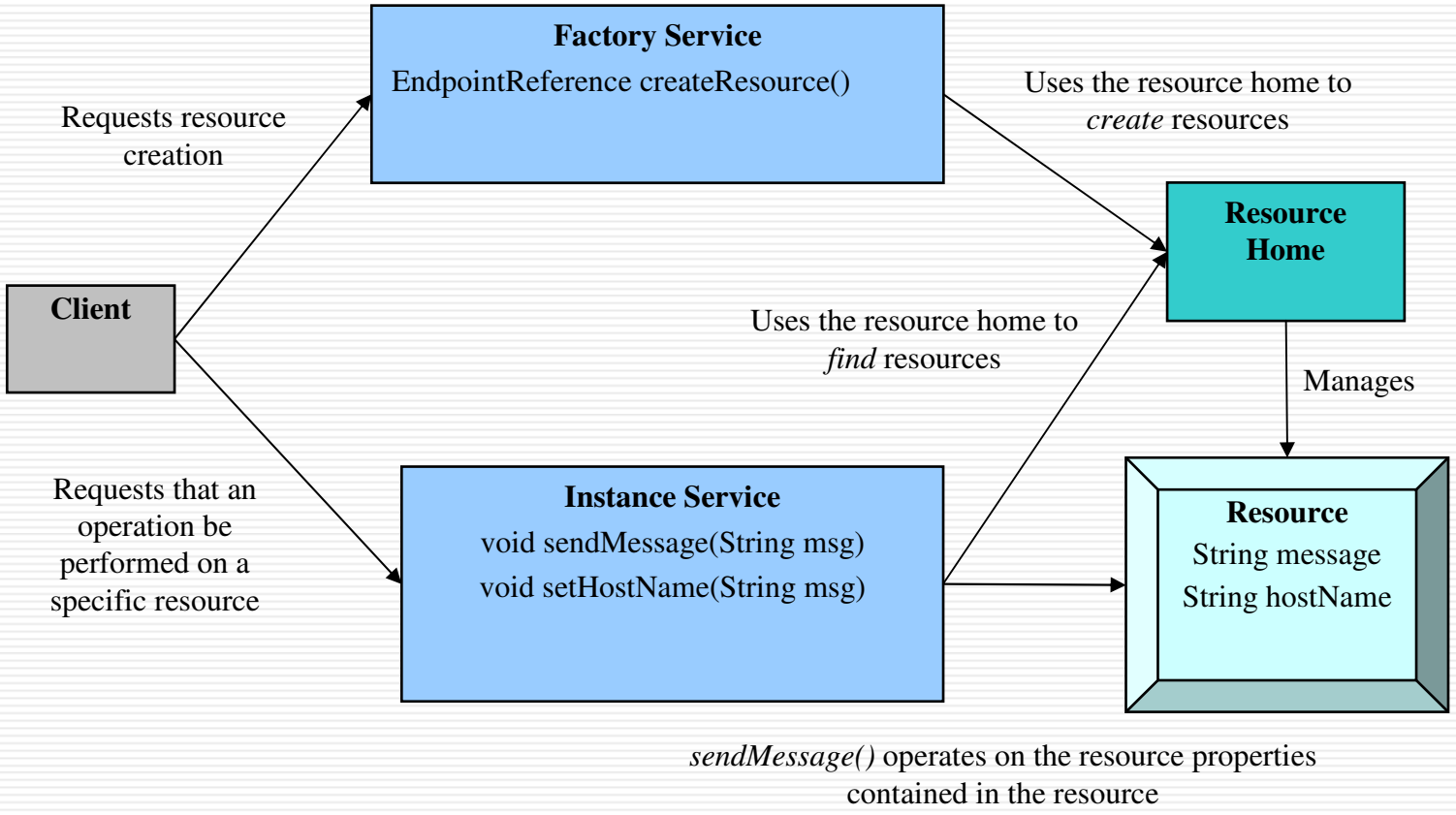
3D visualization of the model's presentation



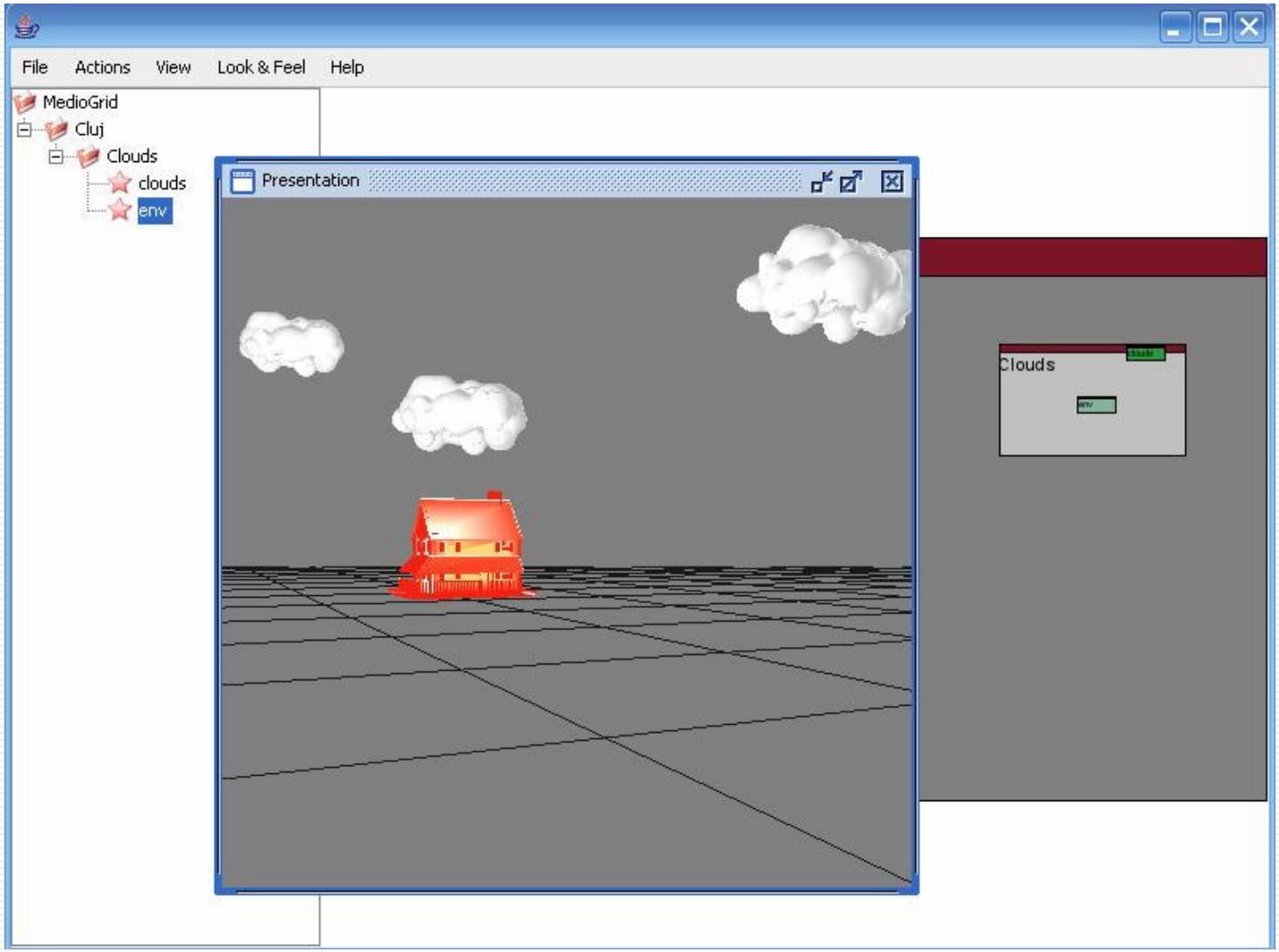
AOM - Framework architecture



Web Service Architecture



3D visualization of the model's presentation

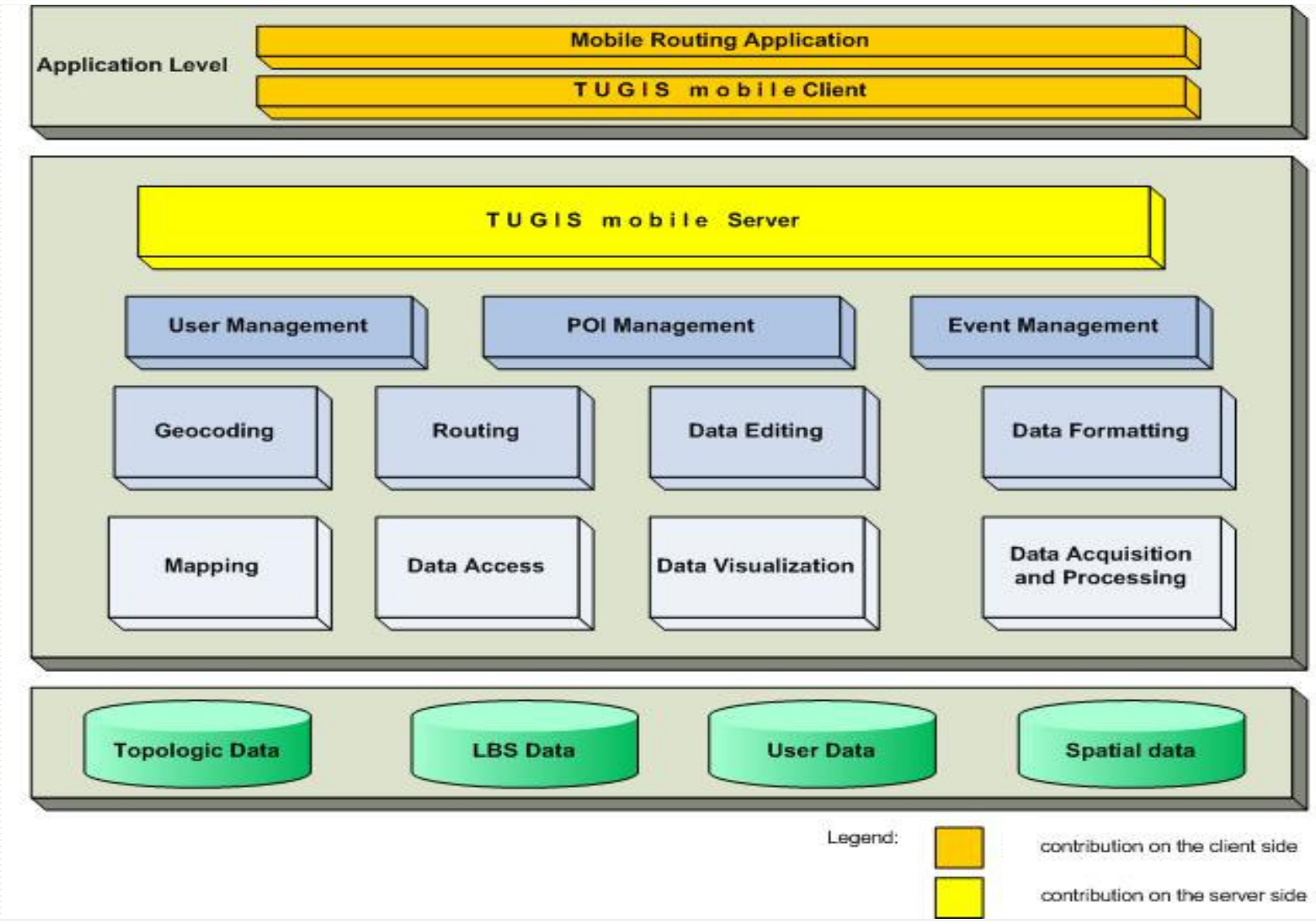


Location Based Services (LBS)

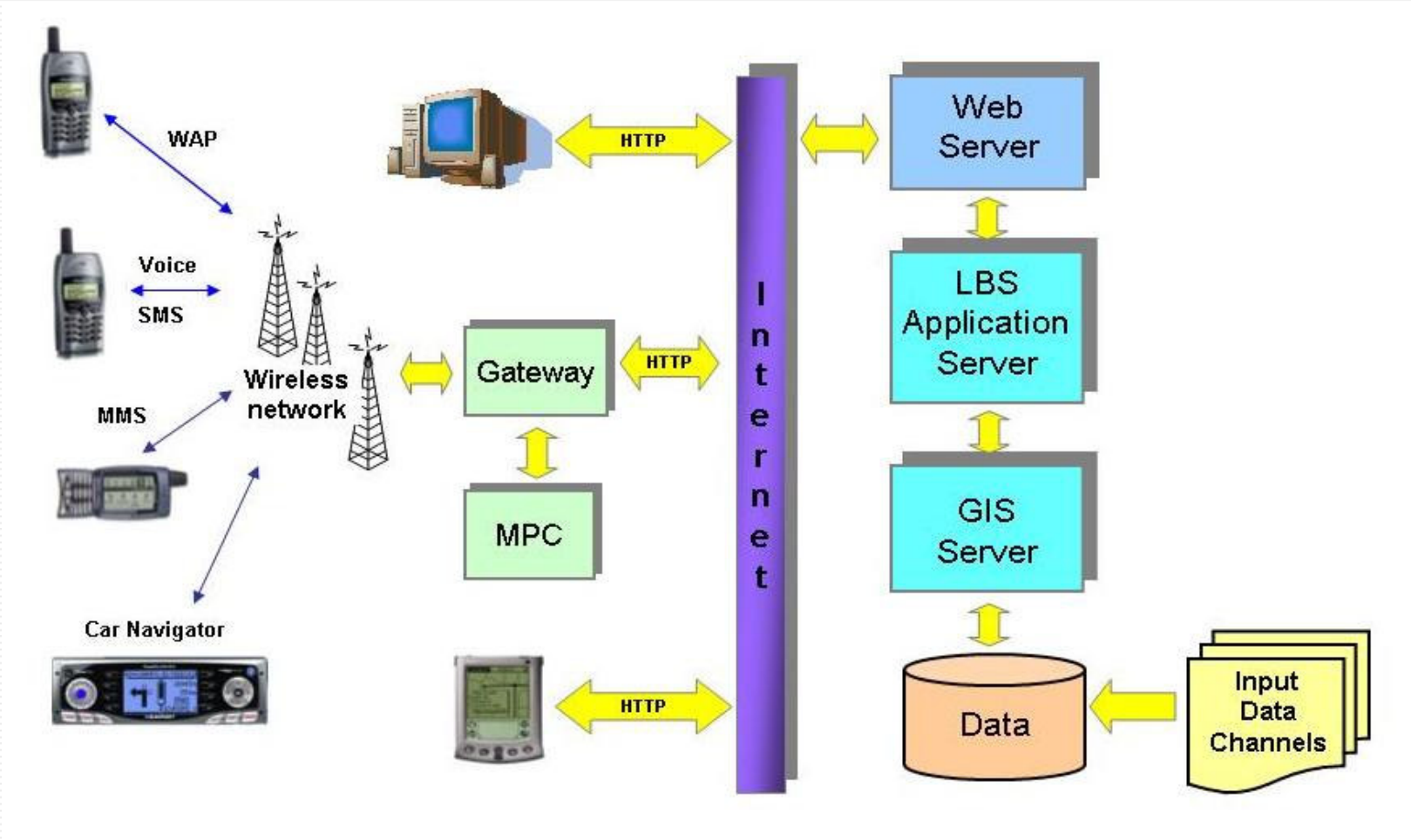
- Objectives:
  - Develop spatial database
  - LBS Software Platform
  - Desktop and wireless aplications
  - Development tools
  - Web services

- MedioGRID extension
  - Develop distributed topological database
  - Support parallel and distributed grid computing
  - Improve the spatial data from various data sources
    e.g. satellite images, data providers, etc.
  - Support LBS oriented processing
    e.g. routing, geocoding, mapping, etc.
  - Develop distributed LBS applications
  - Provide geographical and environment information
    Web services
    Wireless handheld devices

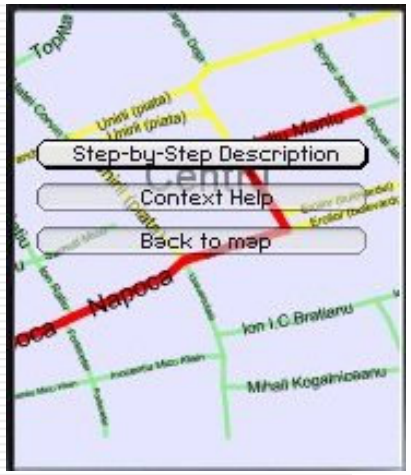
LBS Platform

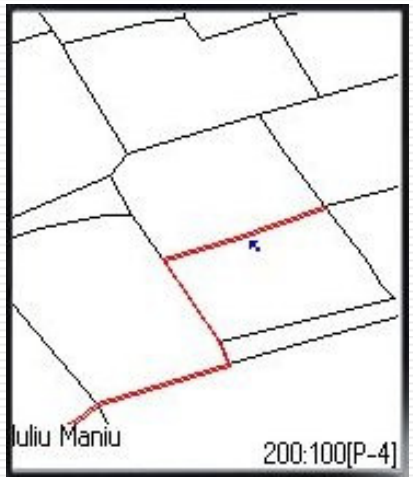


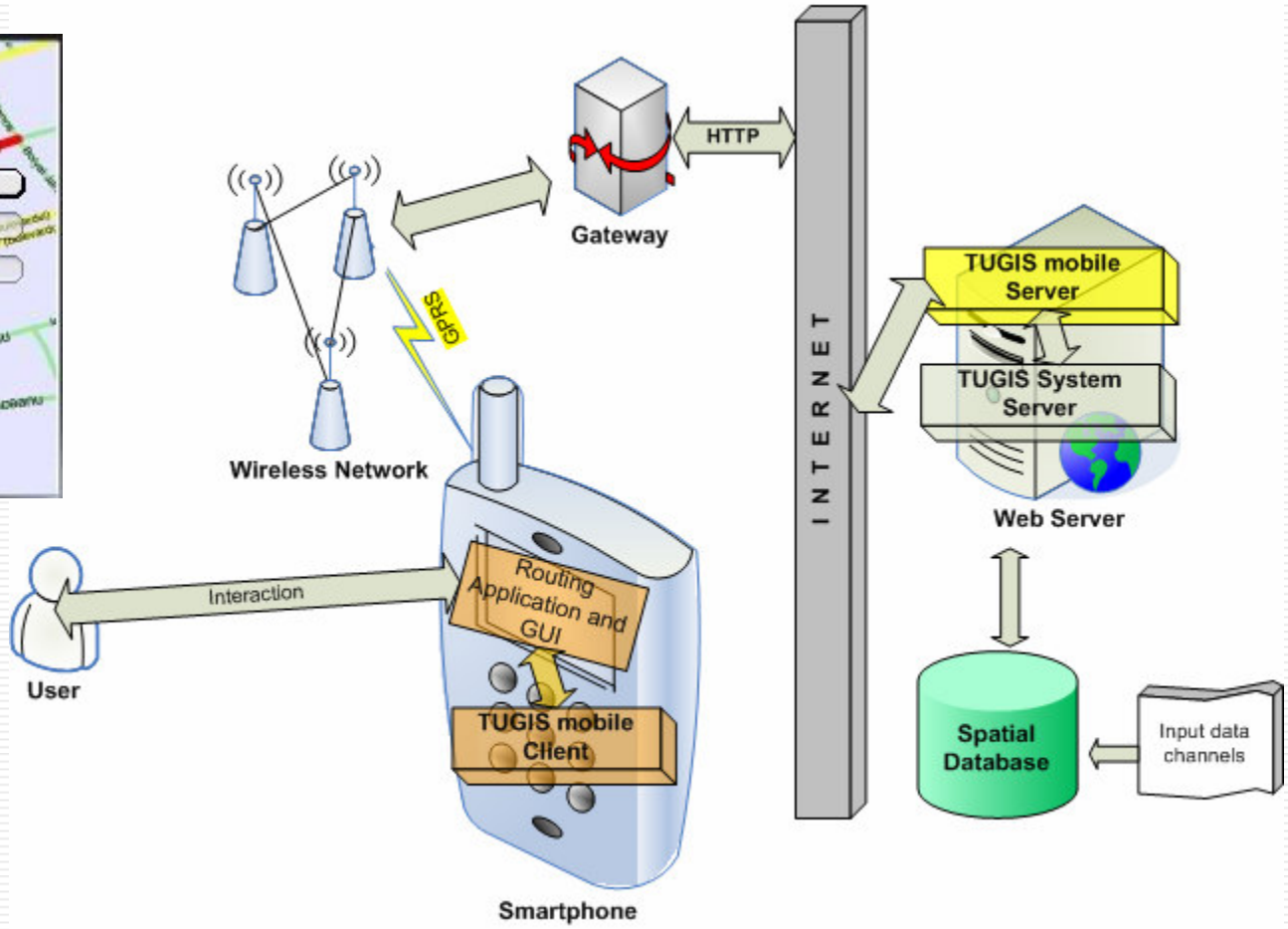
LBS Architecture



Wireless application







Extention of the TUGIS platform by a software package based on SVG and JavaScript to support the development of the interactive web applications

Dissemination

- GridCAD 2006 - Workshop on Grid Computing Applications Development, 28 Sep. 2006, (SYNASC) Timisoara
- ISPDC Conference, 6-7 July 2006, Timisoara
- MEDIOGRID Workshop, 8-9 Dec. 2005, Cluj-Napoca

Dissemination

- Publications: MEDIOGRID vol1&2, more than 30 papers
  - Gorgan D., Melenti C. (ed): Prelucrarea grafica paralela si distribuita pe structura grid a datelor geografice si de mediu, vol 2, ISBN: 978-973-713-092-1, Ed Mediamira, 2006, pp. 232
  - Bacu V., Muresan O., Gorgan, D.: MODIS Image Based Computation of Vegetation Indices in MedioGRID Architecture. SYNASC 2006 Proceedings, GridCAD Workshop, 28 September, 2006, Timisoara
  - Barbantan R., Gorgan, D.: Active Objects Based Application over Grid Environment. SYNASC 2006 Proceedings, GridCAD Workshop, 28 September, 2006, Timisoara
  - Melenti C., Safta D., Gorgan, D.: PIMS – Multispectral Image Processing Tool for Semantic Information Detection Based on Vegetation Indices. SYNASC 2006 Proceedings, GridCAD Workshop, 28 September, 2006, Timisoara
  - Muresan, O., Pop, Fl., Gorgan, D., Cristea, V. : Satellite Image Processing Applications in MedioGRID. ISPDC 6-7 July, 2006, Timisoara
  - Ordean M., Melenti C., Gorgan D.: MEDIOGRID System in Meteorological and Environment Applications. International Conference on Advances in the Internet, Processing, Systems and Interdisciplinary Research, IPSI - 2005 Amalfi, Italy, 17-20 Feb, 2005, ISBN: 86-7466-117-3, pp: 203-207
  - Melenti C., Ordean M., Gorgan D., Oancea S.: Grid computing-based Satellite Image Processing for Fire Detection, International Conference on Advances in the Internet, Processing, Systems and Interdisciplinary Research, IPSI 2004, 11-14 Dec. 2004, Prague, Czech Rep, pp.101-107, ISBN: 86-7466-117-3. and mentioned in NASA *Scientific and Technical Aerospace Reports* (*STAR*), Vol 43(18), 9 Sept 2005.

Thanks

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