CrossGrid

Development of a Grid Environment for Interactive Applications

Authors: CrossGrid consortium

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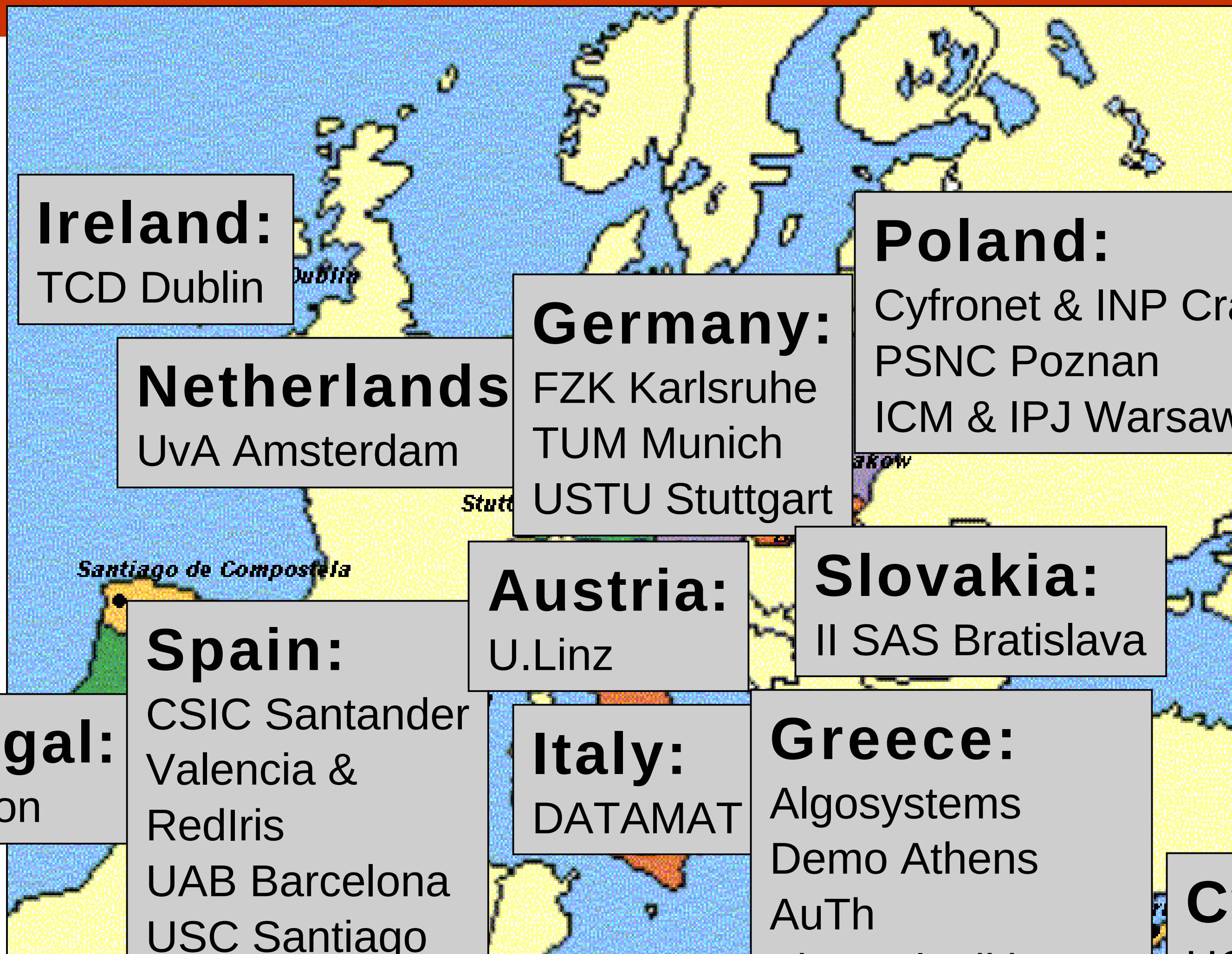
CrossGrid Collaboration



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UvA Amsterdam

Germany:
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TUM Munich
USTU Stuttgart

Poland:
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PSNC Poznan
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RedIris
UAB Barcelona
USC Santiago
& CESGA

Austria:
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Slovakia:
II SAS Bratislava

Italy:
DATAMAT

Greece:
Algosystems
Demo Athens
AuTh
Thessaloniki

Cyprus:
UCY Nikosia

21 institutions, 11 countries

Main Objectives of CrossGrid

- New category of Grid enabled applications
  - computing and data intensive
  - distributed
  - near real time response (a person in a loop)
  - layered
- New programming tools
- Grid more user friendly, secure and efficient
- Interoperability with other Grids
- Implementation of standards

Structure Overview

APPLICATIONS

Interactive simulation and visualisation of a biomedical system
Flooding crisis team support
Distributed Data Analysis in High Energy Physics
Weather forecast and air pollution modelling

TOOLS

- Remote Data Access Optimization
- Monitoring
- Schedulers
- Portals
- Grid Visualization Kernel
- Benchmarks
- Roaming Access
- ....

Grid SERVICES

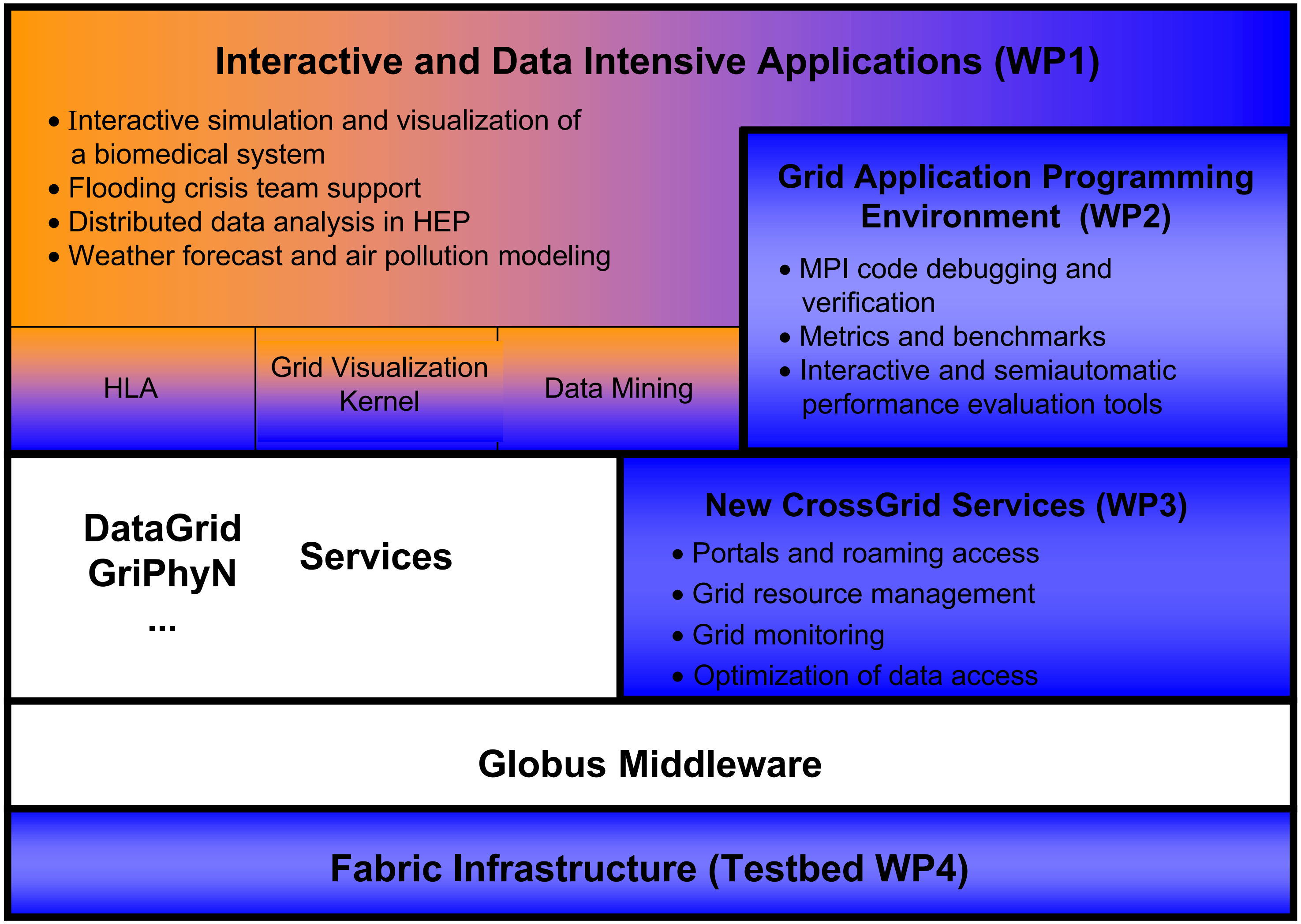
DATAGRID SET OF TOOLS

GLOBUS TOOLKIT , Condor-G, ...

FABRIC INFRASTRUCTURE

Network infrastructure, archivers, HPC/HPV systems,
Labour instruments, etc.
Local domain services

Layered Structure of CrossGrid



CrossGrid Application Development

Interactive simulation and visualisation of a biomedical system

- Grid-based system for pre-treatment planning in vascular interventional and surgical procedures through real-time interactive simulation of vascular structure and flow.

Flooding crisis team support

Distributed data analysis in HEP

- Focus on LHC experiments (ALICE, ATLAS, CMS and LHCb)

Weather forecast and air pollution modelling

- Porting distributed/parallel codes on Grid
- Coupled Ocean/Atmosphere Mesoscale Prediction System
- STEM-II Air Pollution Code

Grid Application Programming Environments

MPI code debugging and verification

Metrics and benchmarks

Interactive and semiautomatic performance evaluation tools

Objectives:

- specify
- develop
- integrate
- test

tools that facilitate the development and tuning of parallel distributed high-performance and high-throughput computing applications on Grid infrastructures

New Grid Services and Tools

Portals and roaming access

Grid resource management

Grid monitoring

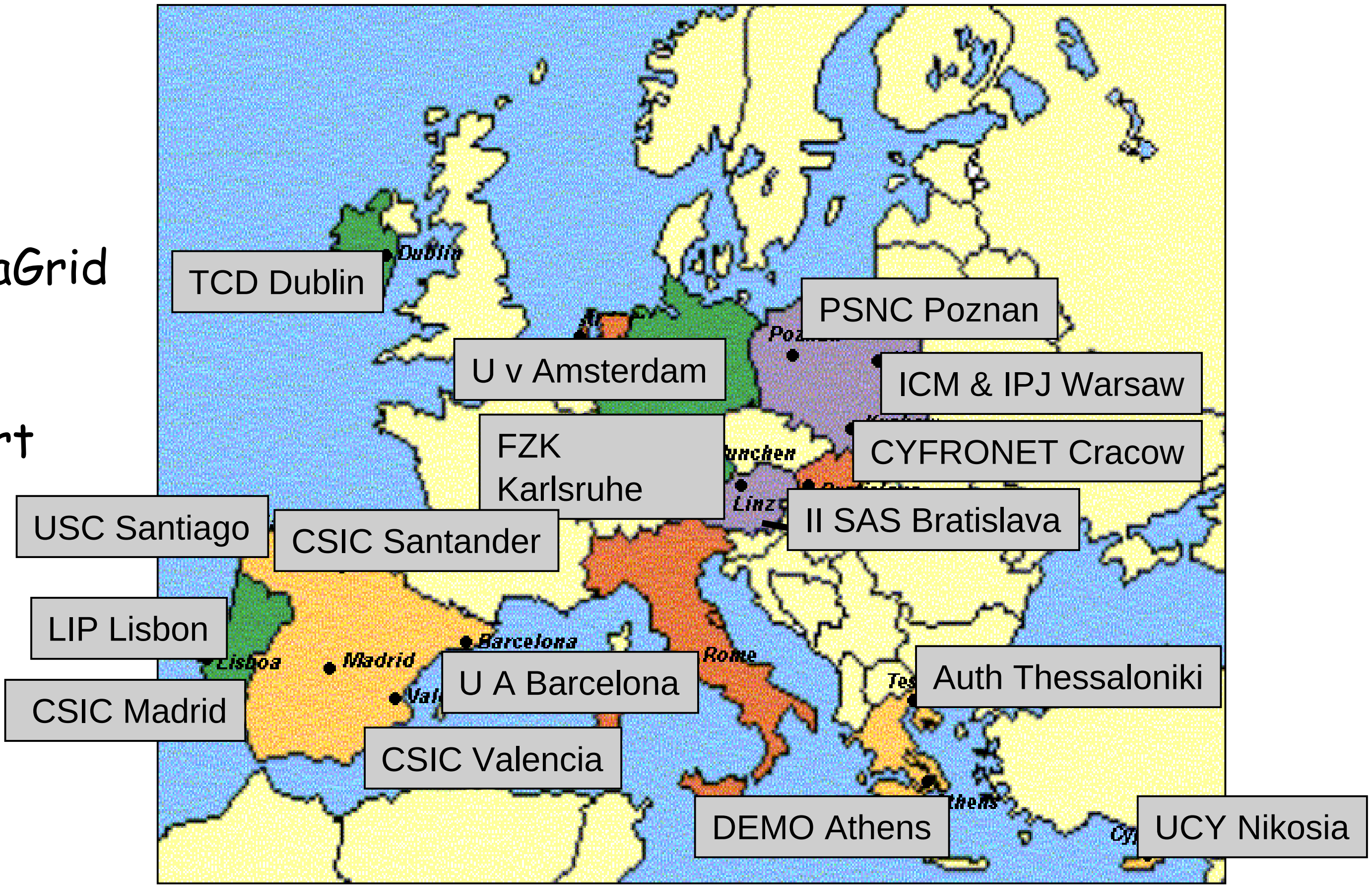
Optimisation of data access

Objectives:

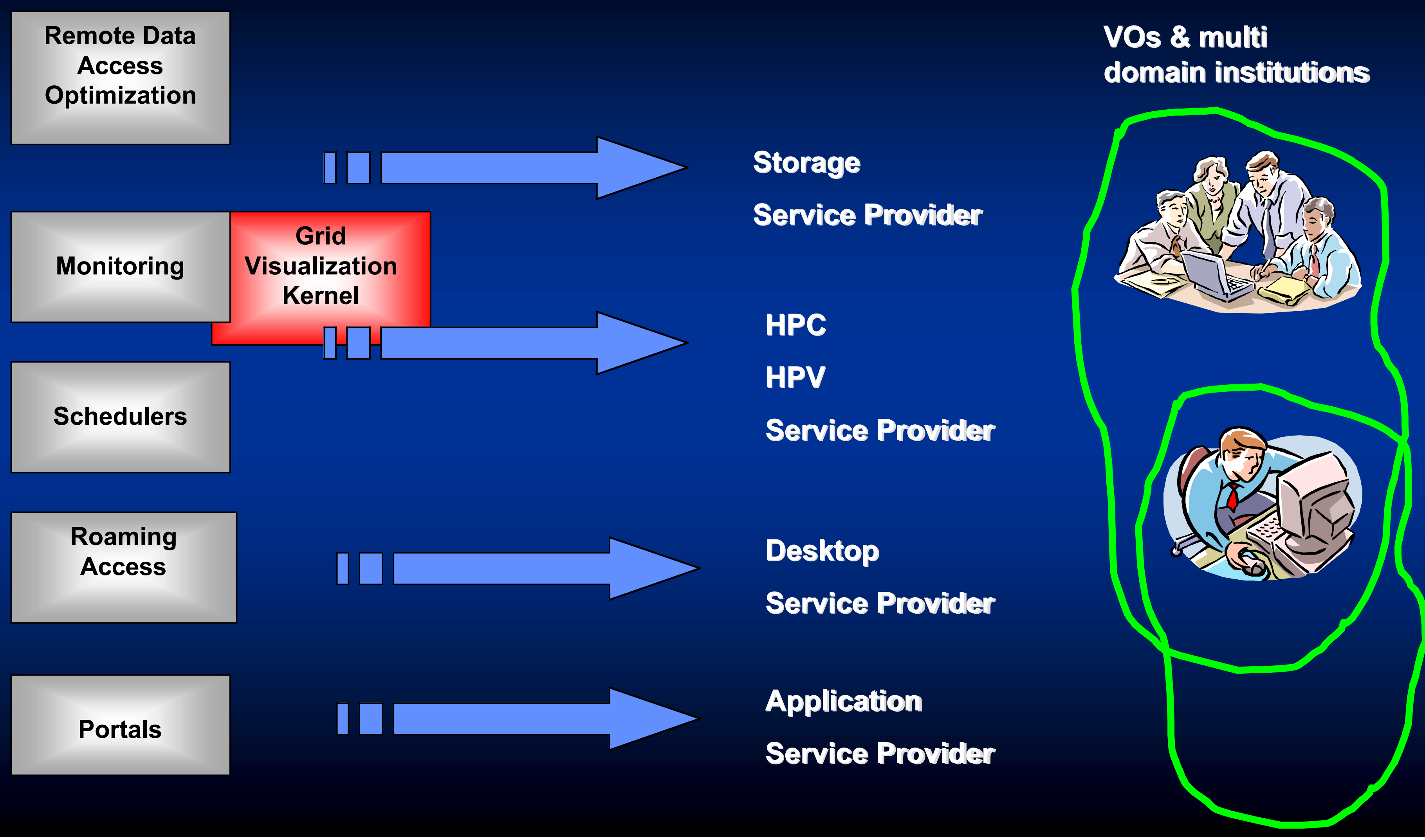
- To develop of interactive compute- and data-intensive applications
- User-friendly Grid environments.
- Easy access to the applications and Grid.
- Reasonable trade-off between resource usage efficiency and application speedup
- To support management issues while accessing resources

International Testbed Organisation

- Testbed setup & incremental evolution
- Integration with DataGrid
- Infrastructure support
- Verification & quality control



Services & Providers



Applications

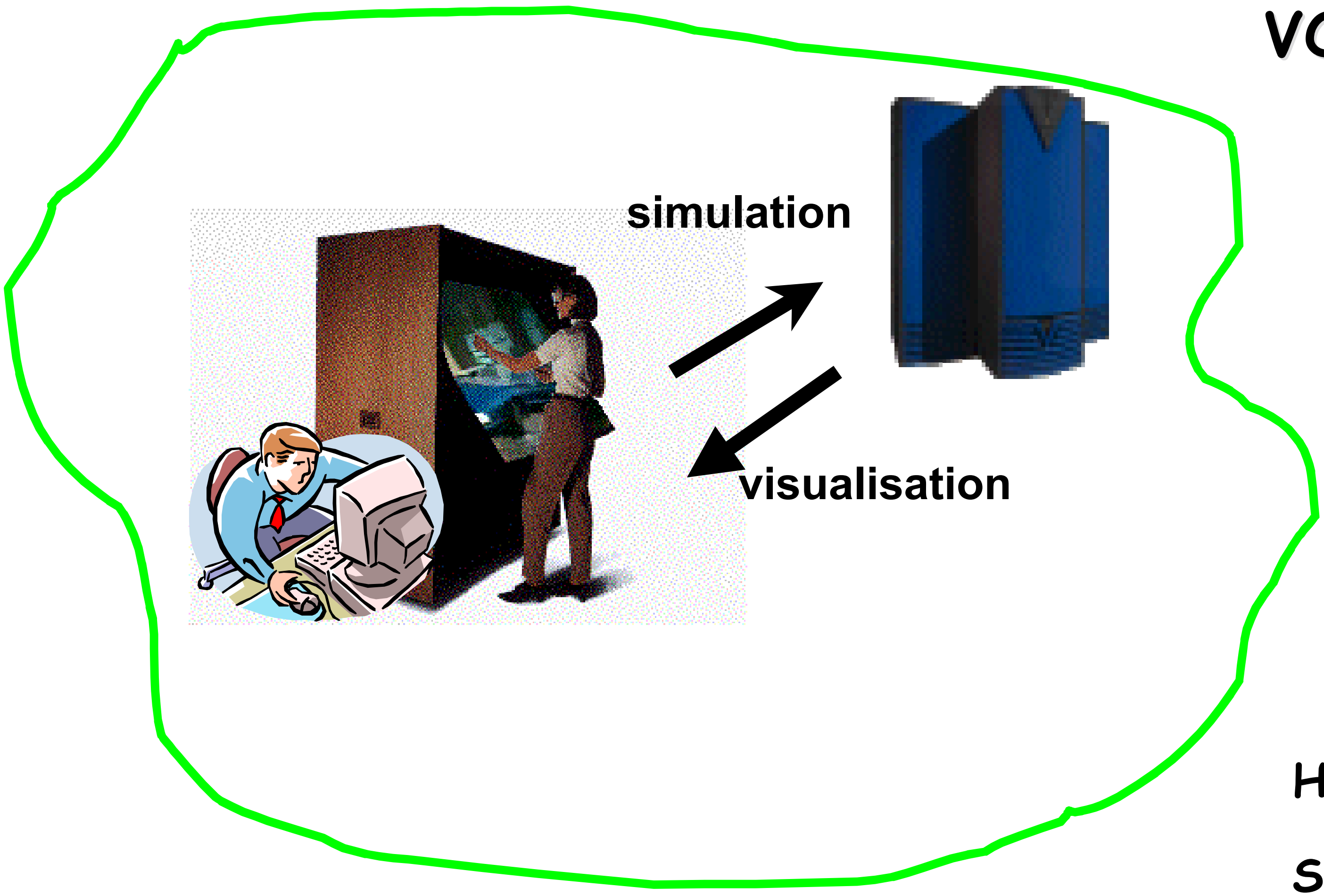
End user driven

... drives the middleware

Locally available

Location

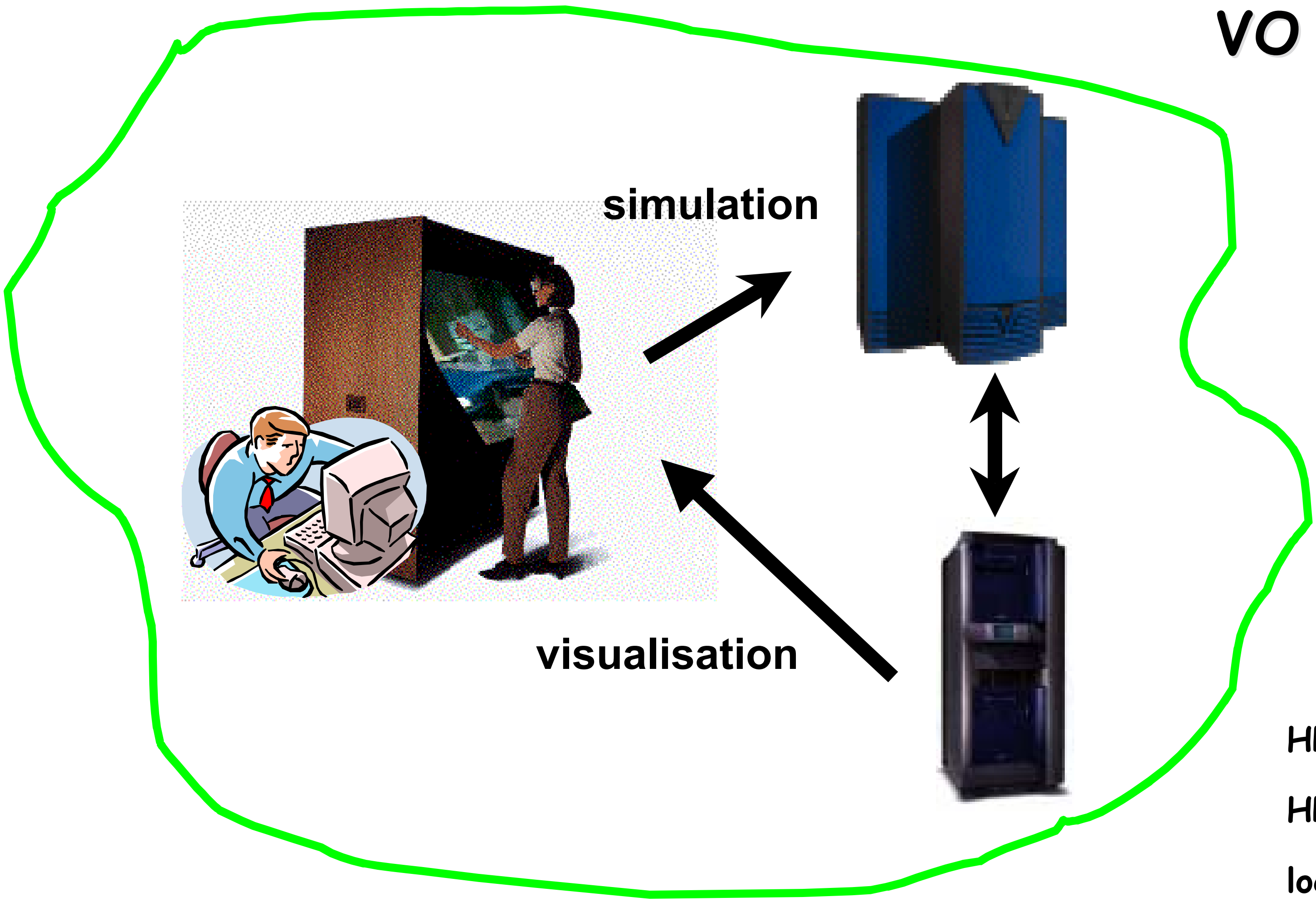
VO



HPC/HPV

Single system

Location



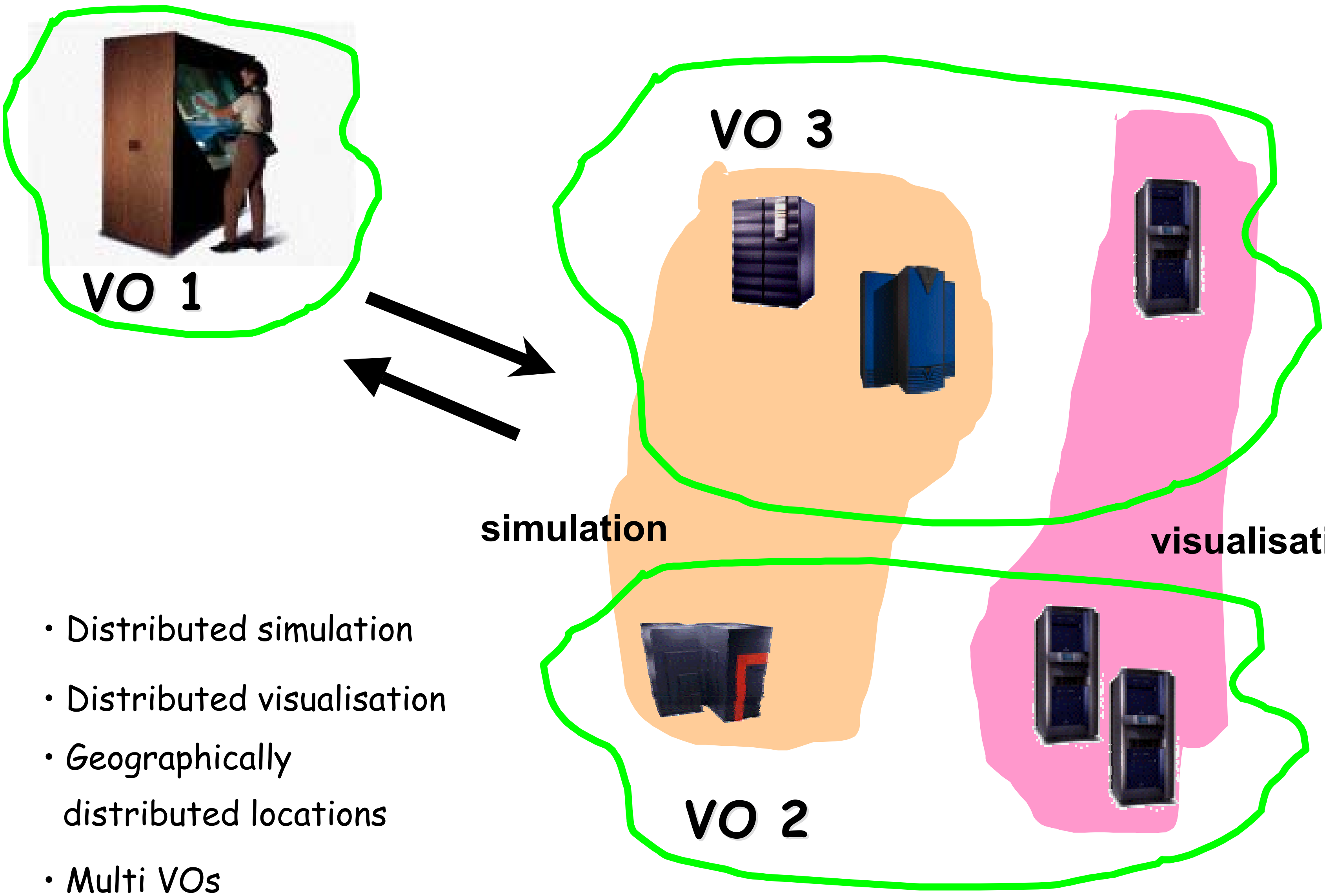
HPC

HPV

locally distributed

... but 1 VO

What we would like to achieve



- Distributed simulation
- Distributed visualisation
- Geographically distributed locations
- Multi VOs

Goals of Applications

- Applications in health and environment
  - Data gathering, processing and interpretation in geographically distributed locations
  - Fast, interactive decision making

- Interactive access to distributed
  - Databases
  - Super computers and High Performance Clusters
  - Visualisation engines
  - Medical scanners
  - Environmental data input devices

Three central functionalities

- Data gathering
  - Data generators and data bases geographically distributed
  - Selected on demand
- Processing
  - Needs large processing capacity on demand
  - Interactive
- Presentation
  - Complex data require versatile 3D visualisation
  - Support interaction and feedback to other components

Interactive simulation and visualisation of a biomedical system

•Grid-based prototype system for treatment planning in vascular interventional and surgical procedures through near real-time interactive simulation of vascular structure and flow.

•The system will consist of a distributed near real-time simulation environment, in which a user interacts in Virtual Reality (VR) and other interactive display environments.

•A 3D model of the arteries, derived using medical imaging techniques, will serve as input to a simulation environment for blood flow calculations.

•The user will be allowed to change the structure of the arteries, thus mimicking an interventional or surgical procedure.

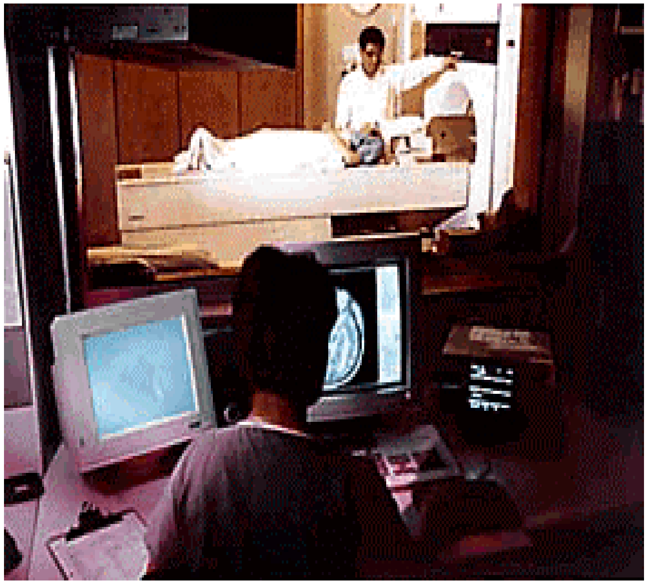
The work in this task is embedded in the research on medical applications at the UvA and will be performed in close collaboration with the Leiden University Medical Centre (LUMC).

crossgrid

Current Situation

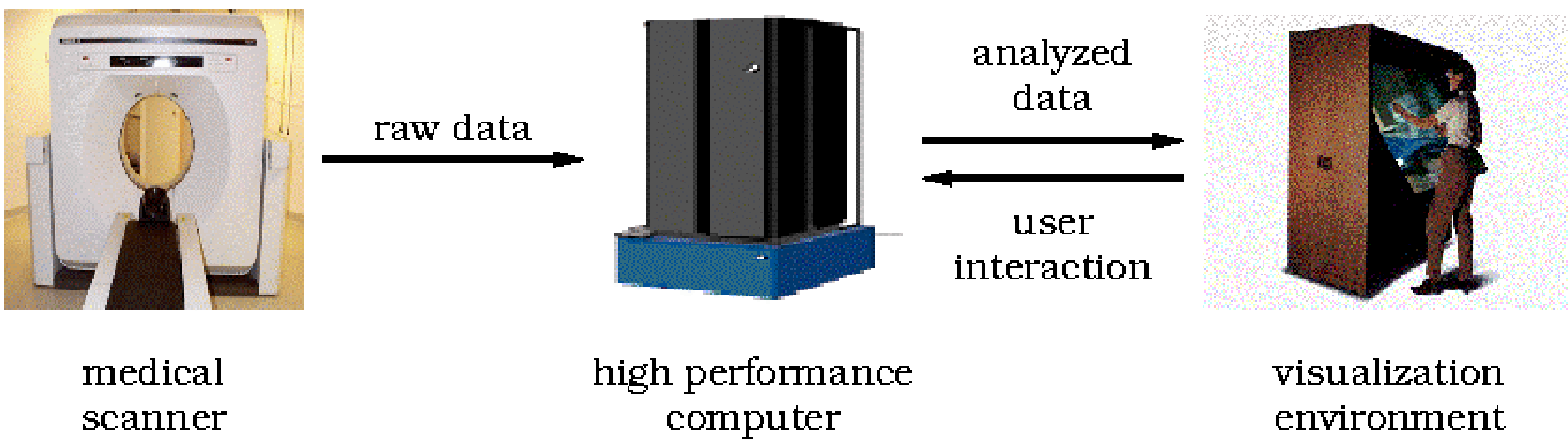
Diagnosis & Planning

Treatment

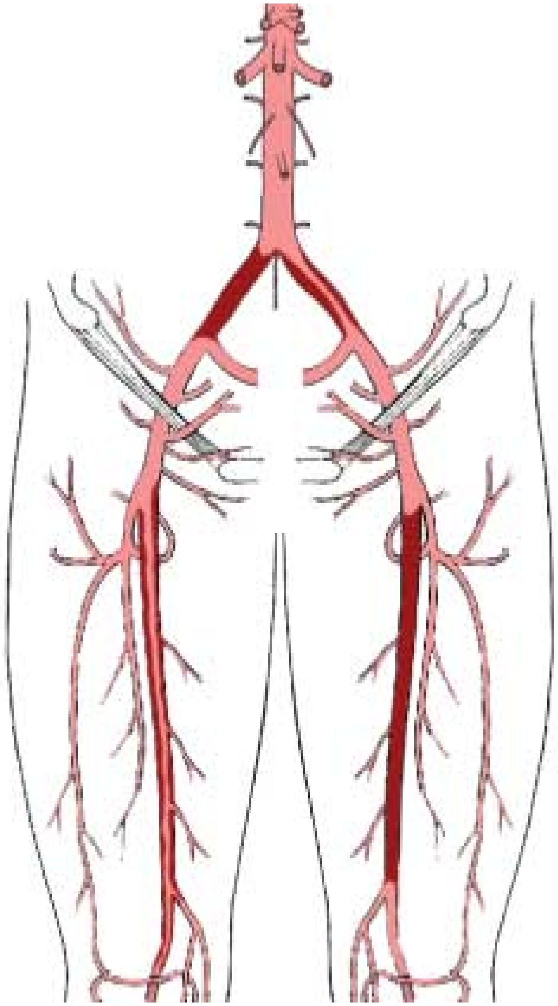


Observation

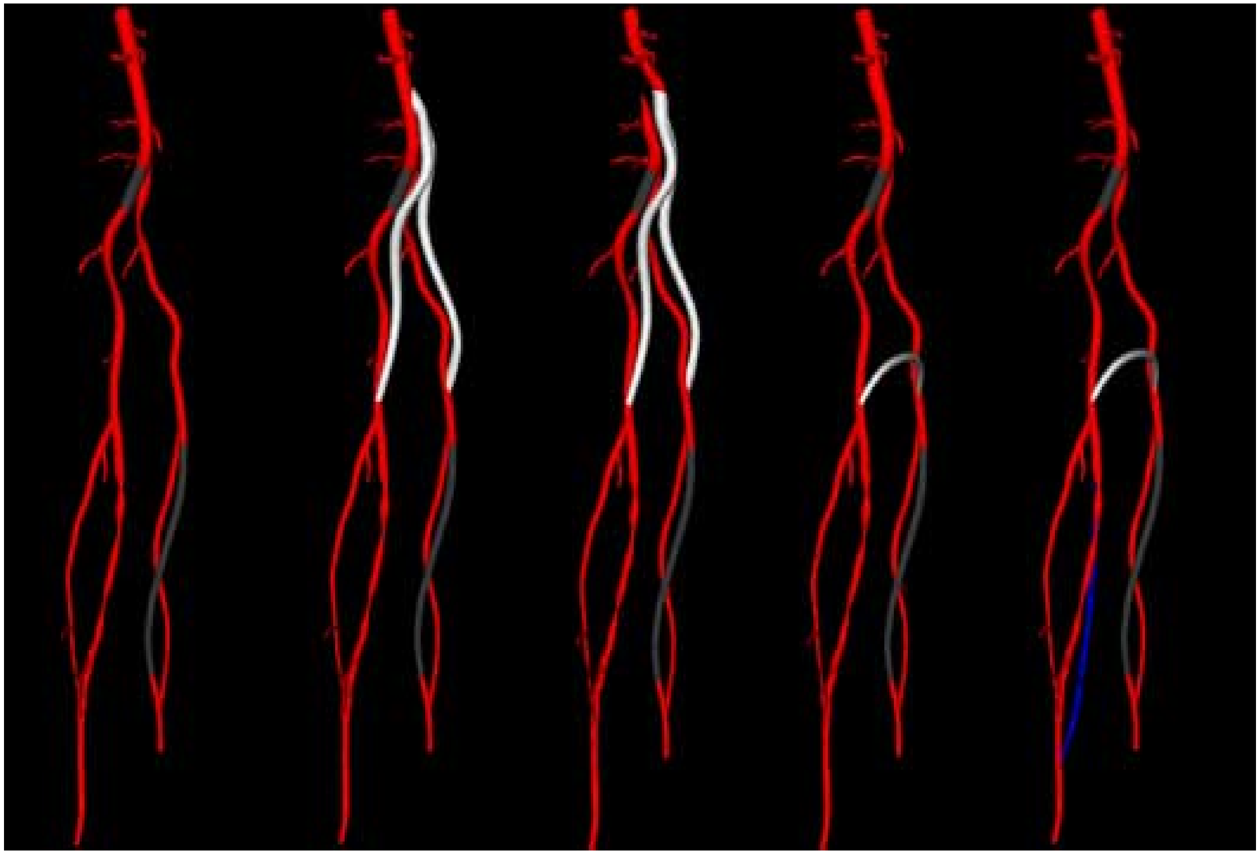
Experimental set-up



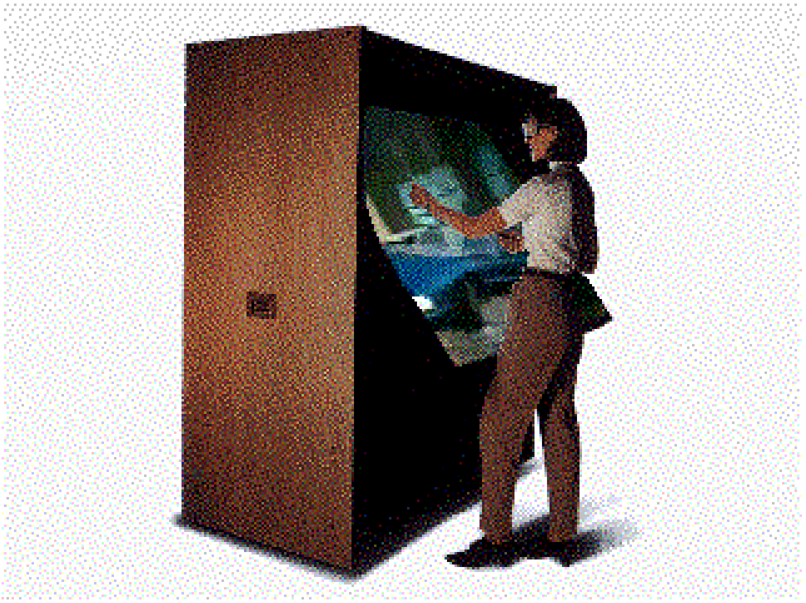
Simulation Based Planning and Treatment

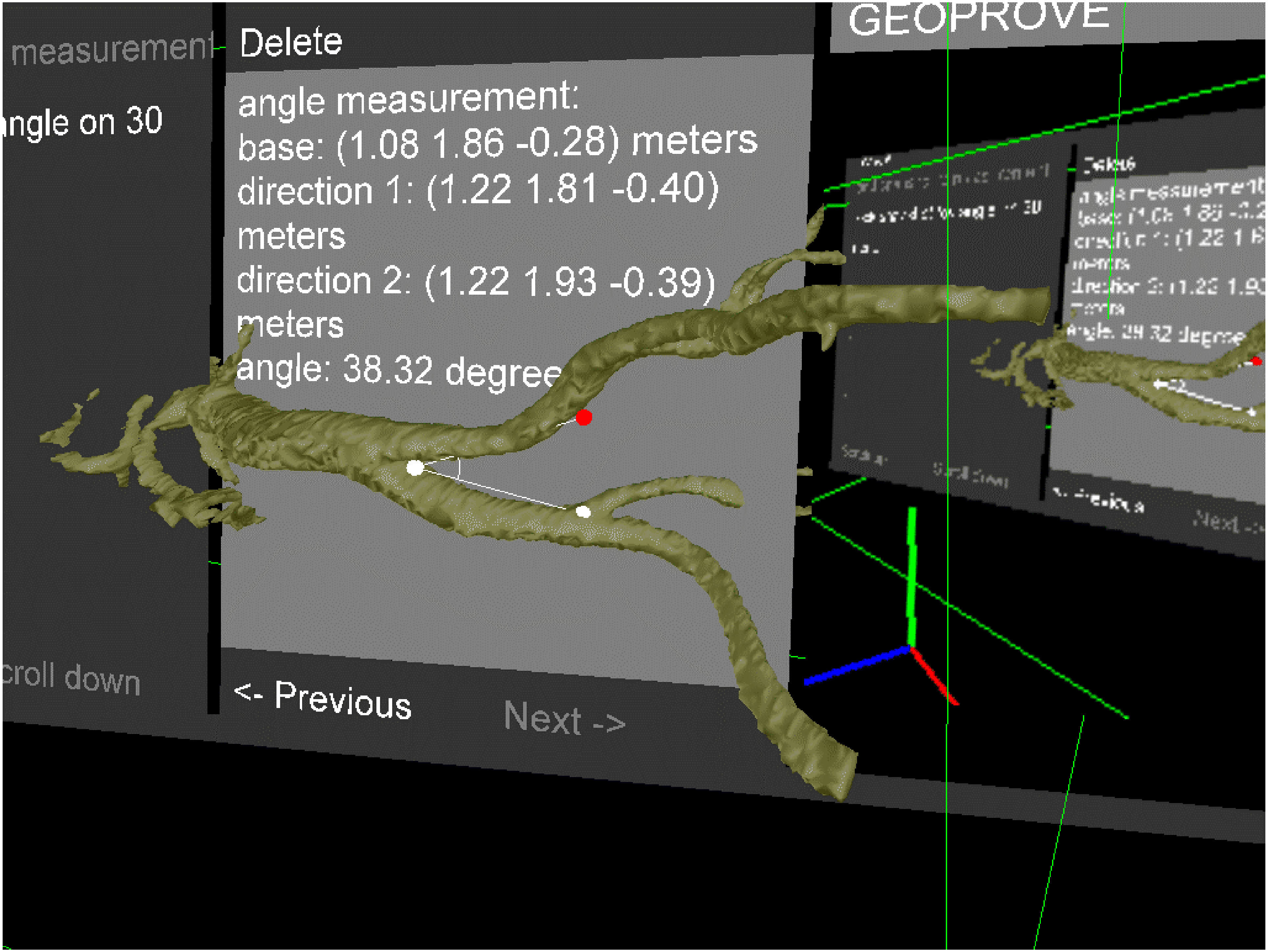


Alternate Treatments



Immersive Environments




measurement
Delete
ngle on 30
angle measurement:
base: (1.08 1.86 -0.28) meters
direction 1: (1.22 1.81 -0.40) meters
direction 2: (1.22 1.93 -0.39) meters
angle: 38.32 degree
croll down
<- Previous
Next ->
GEOPROVE

Flooding crisis team support

•Support system for establishment and operation of Virtual Organization for Flood Forecasting associating a set of individuals and institutions involved in flood prevention and protection.

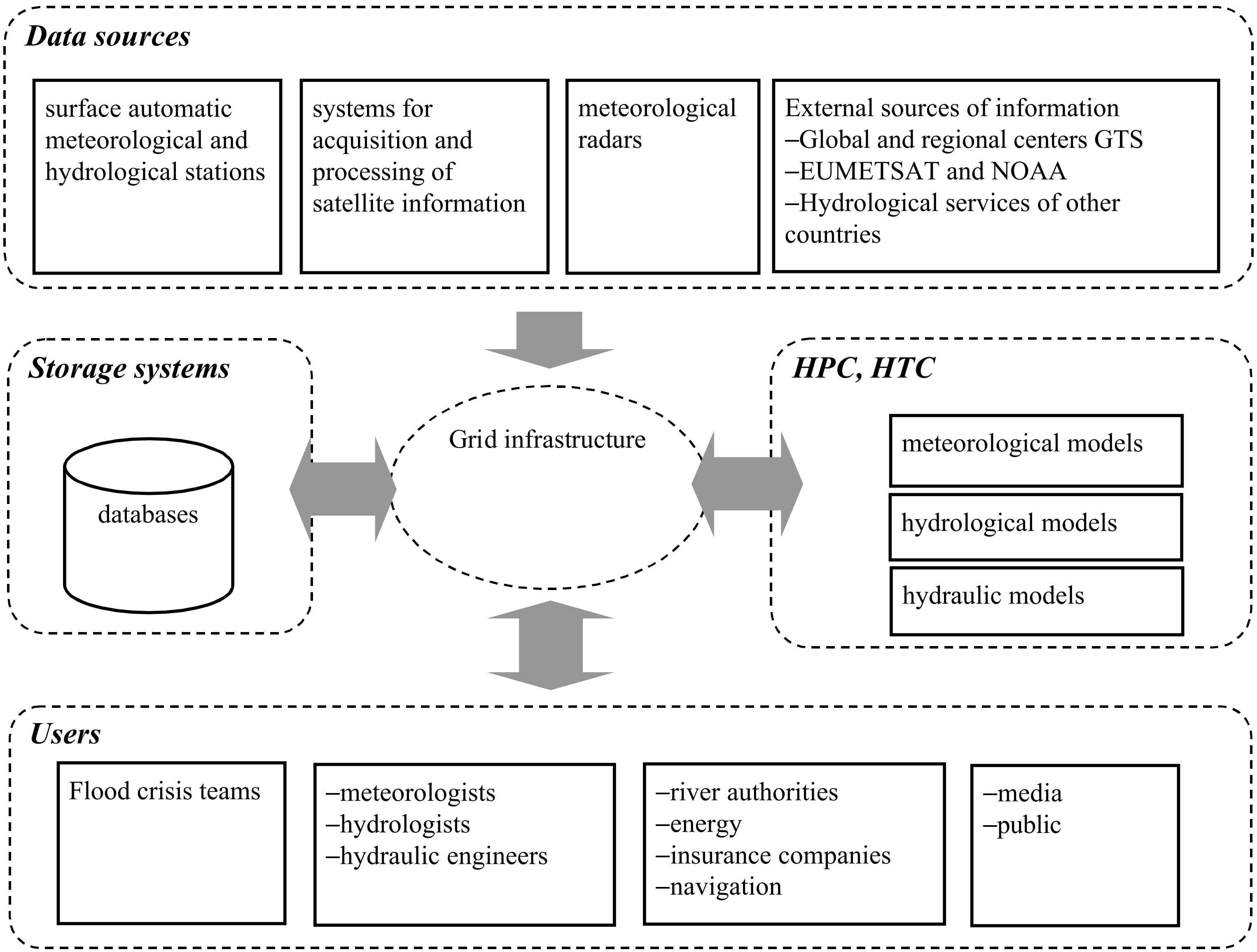
•The system will employ a Grid technology to seamlessly connect together the experts, data and computing resources needed for quick and correct flood management decisions.

•The main component of the system will be a highly automated early warning system based on hydro-meteorological (snowmelt) rainfall-runoff simulations.

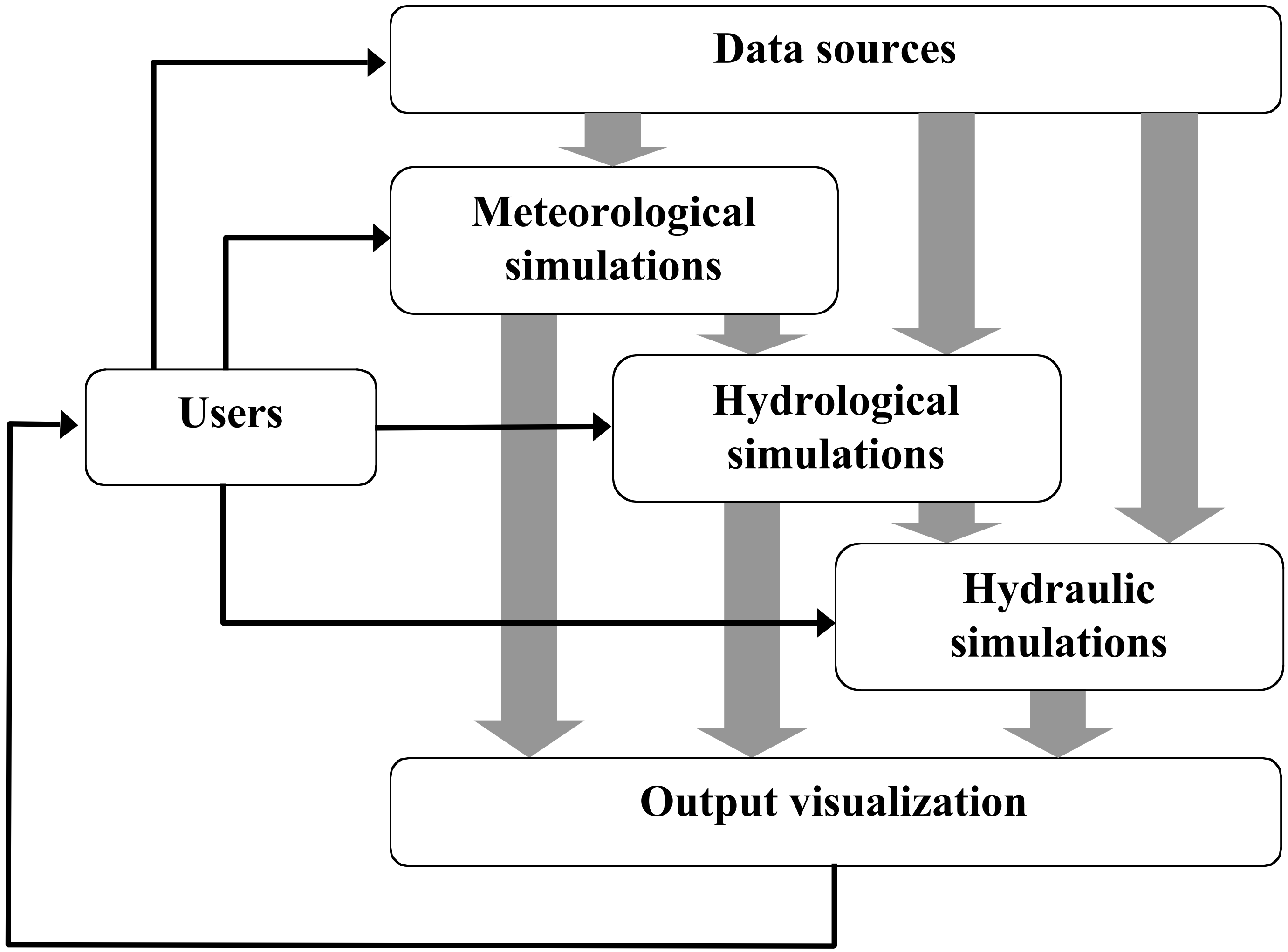
•System will integrate the advanced communication techniques allowing the crisis management teams to consult the decisions with various experts. The experts will be able to run the simulations with changed parameters and analyze the impact.

Developped by the Slovak Academy of Sciences, Institute of Computer Systems

Virtual Organization for Flood Forecasting



Cascade of flood simulations



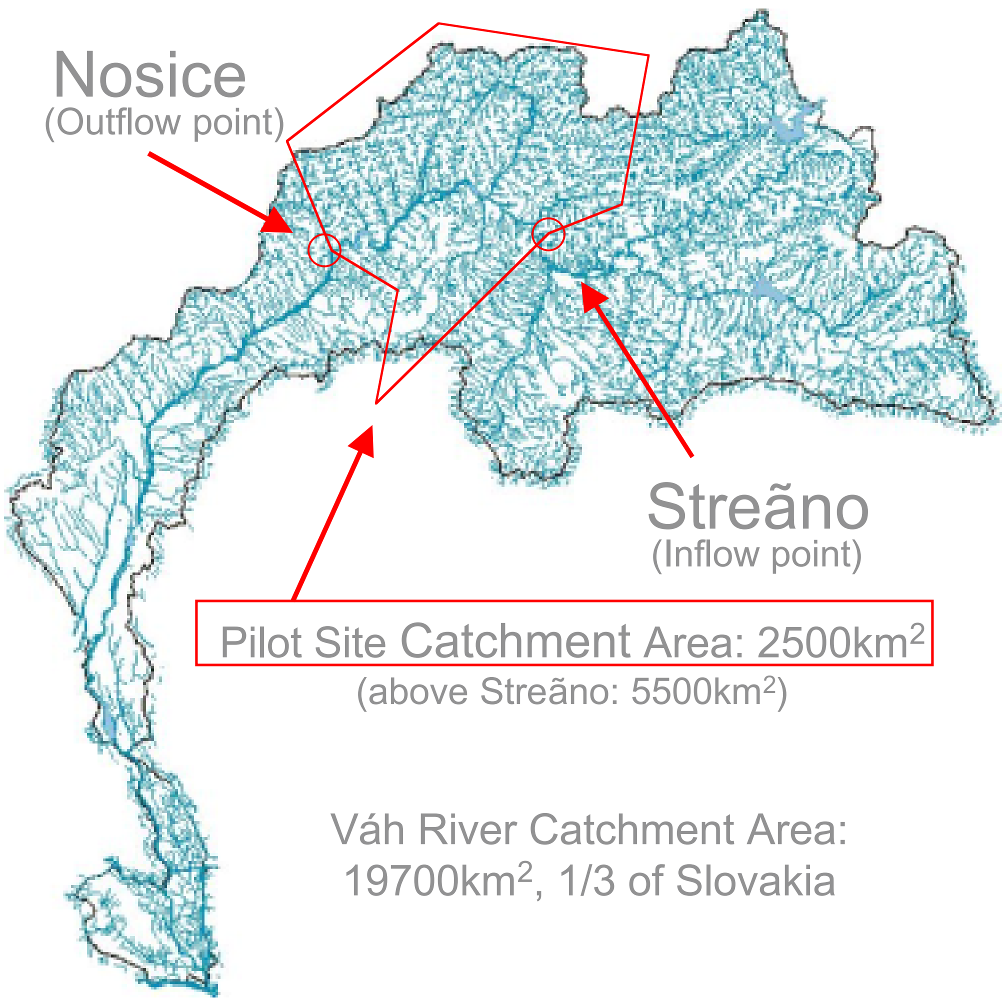
flood simulations- results

- Water stages/discharges in the real time operating hydrological stations

- Mapping of the flooded areas

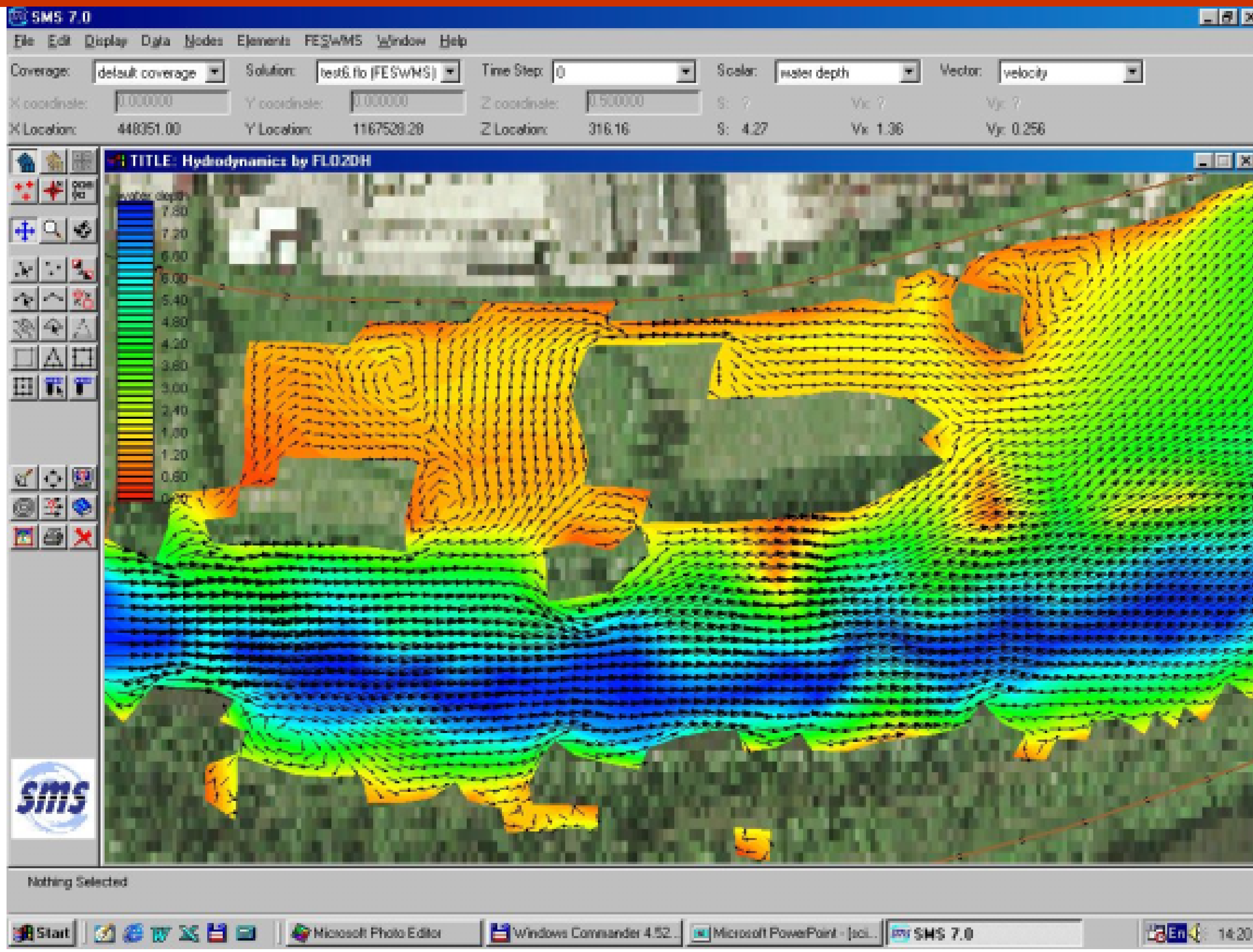
flood simulations- results

Váh River Pilot Site



flood simulations- results

Flow + water depths



Common issues

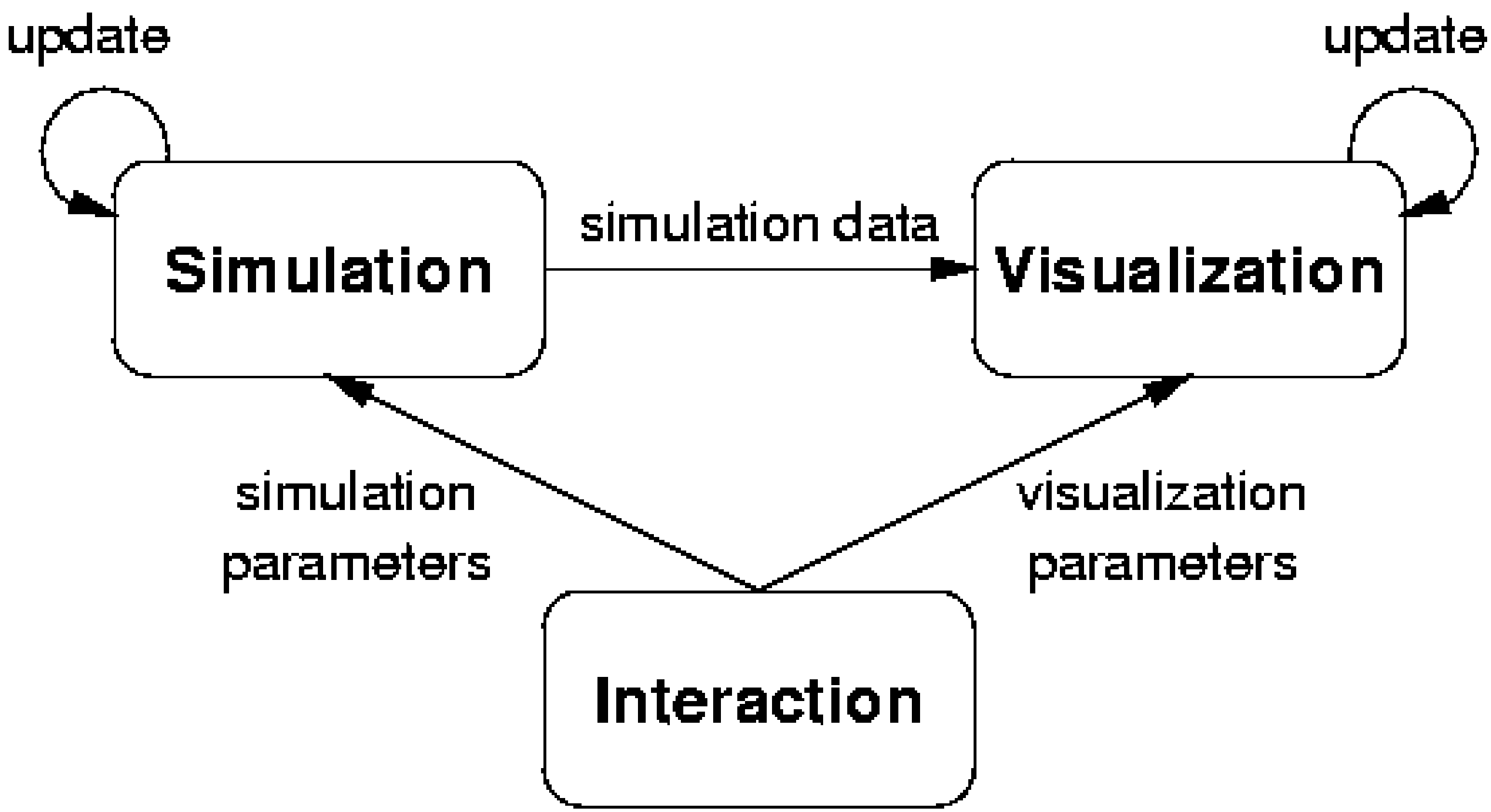
Current state (briefly):

- simulation done on a single system or local clusters
- visualisation on a single system, locally

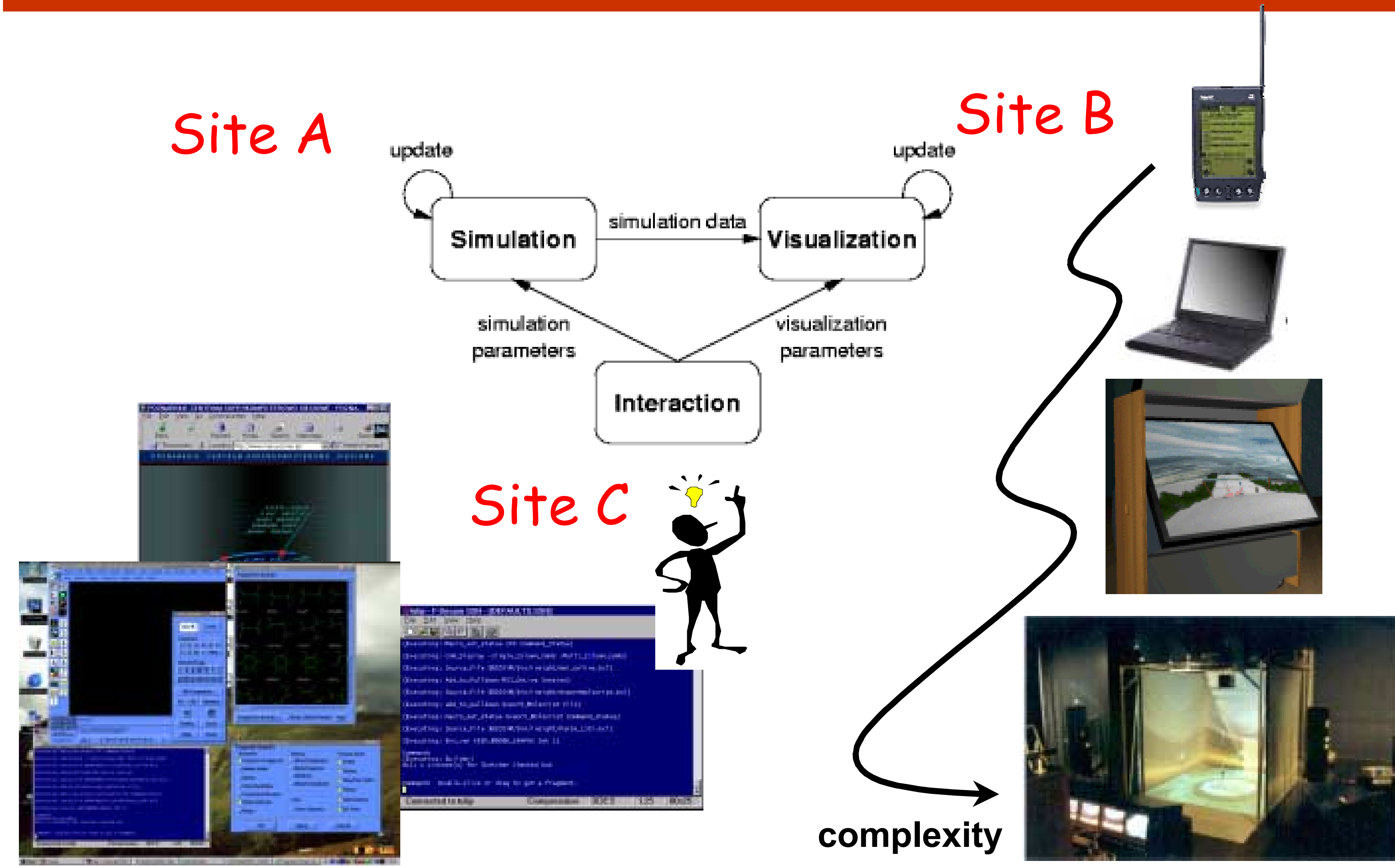
What we are going to achieve:

- HPC, HTC, HPV in geographically distributed environment
- improved interaction with the end user
- near real time simulations
- different visualisation equipments (adaptive according to the end-user needs), like
  - PDA
  - workstations
  - VR studio (e.g. CAVE).

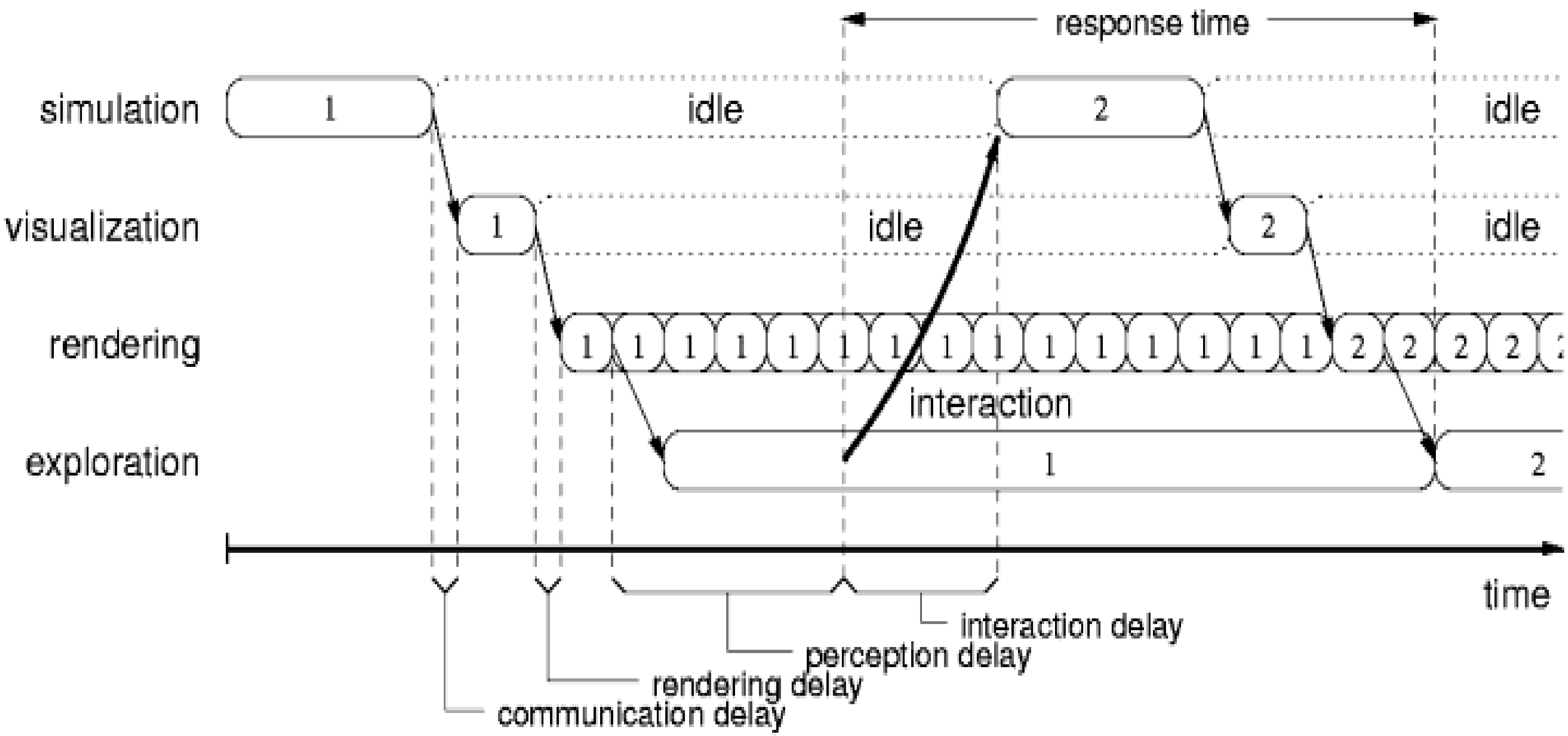
Design Considerations



- Distributed Resources and Data


Site A
Site B
Site C
update
update
Simulation
simulation data
Visualization
simulation parameters
visualization parameters
Interaction
complexity

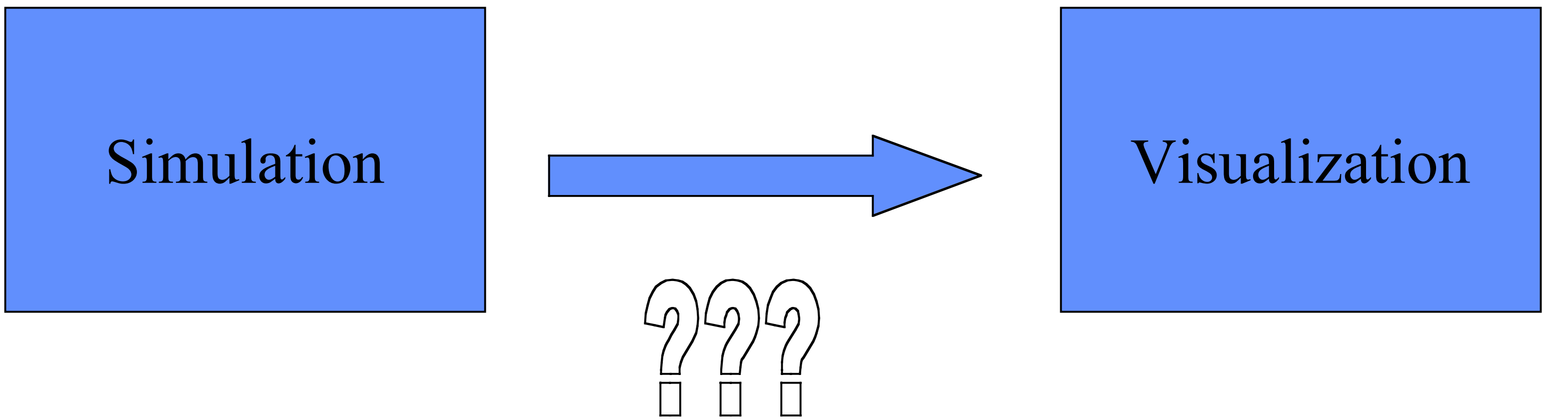
Communication - Problem ? Network-Delay ?



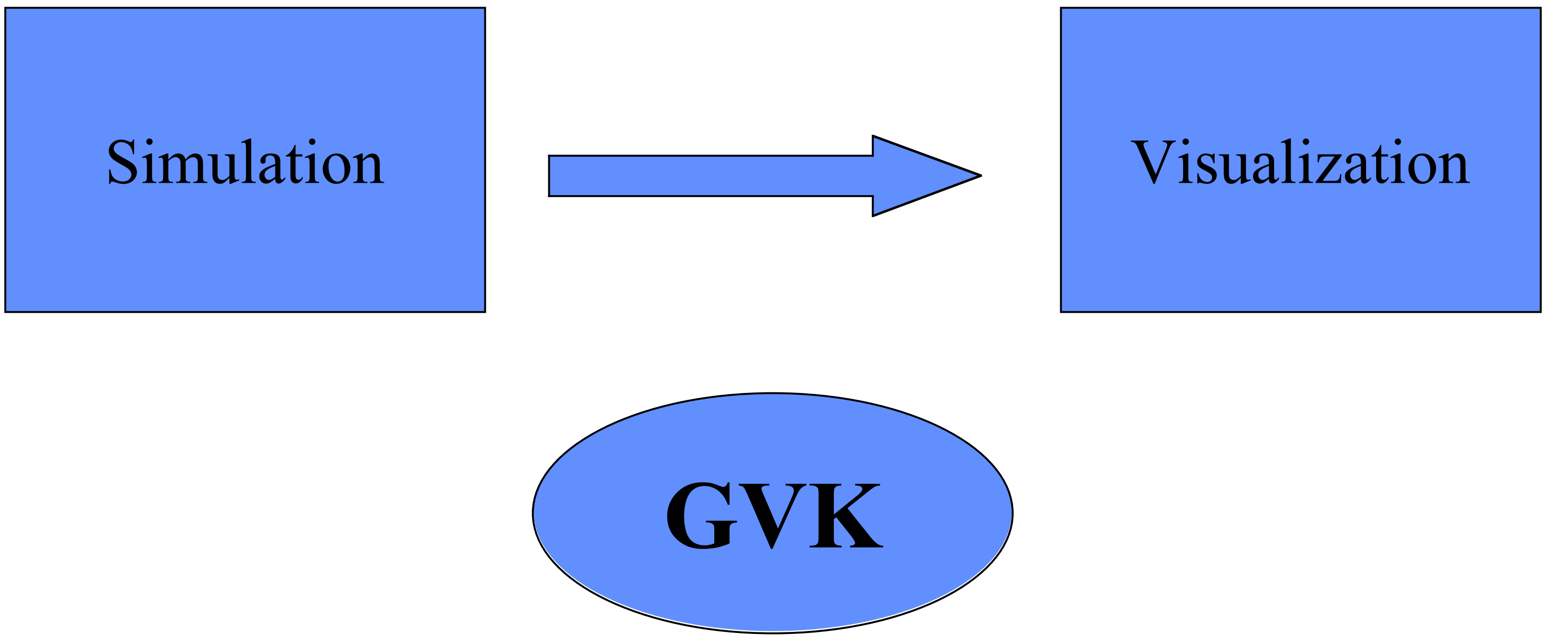
Connection ?

- Simulation:
  - At some place in the Grid
  - Possibly moving around?
- Visualization
  - Anywhere
  - Anytime
  - Anyhow

Connection?



Connection



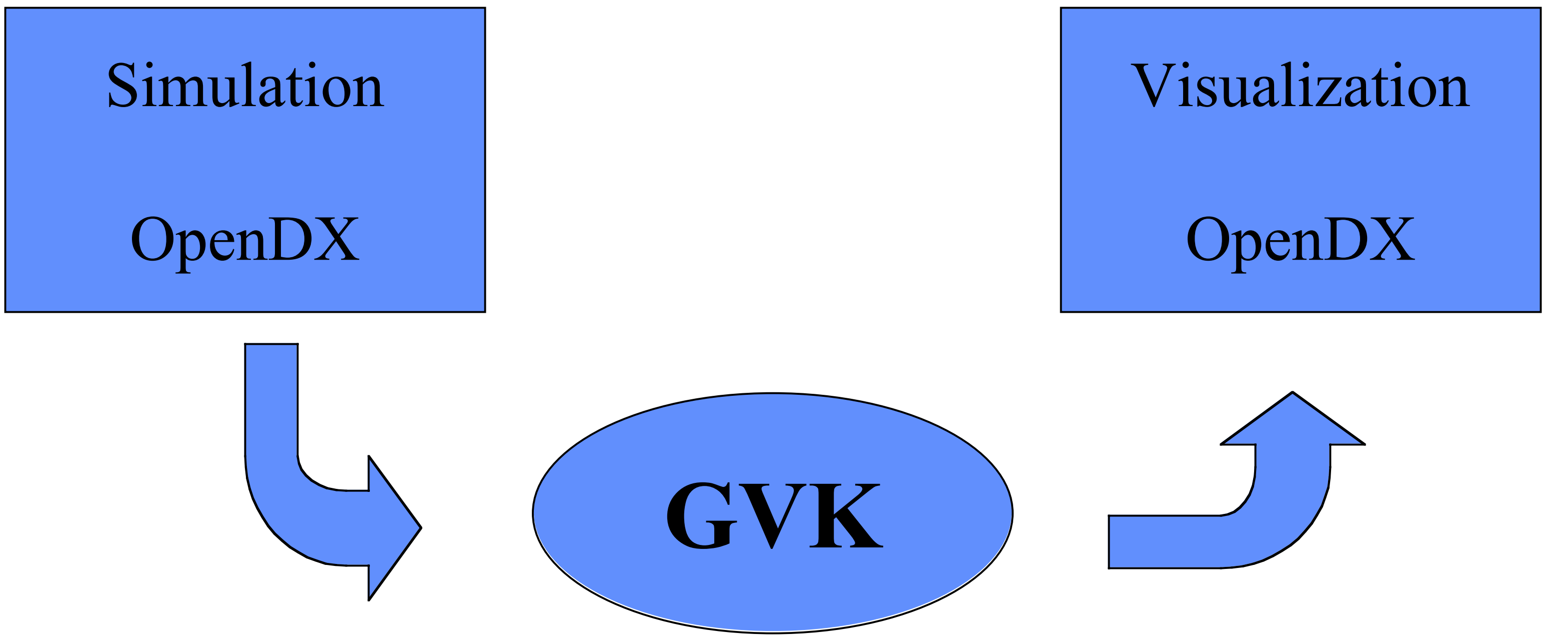
Grid Visualization Kernel

GVK Goal

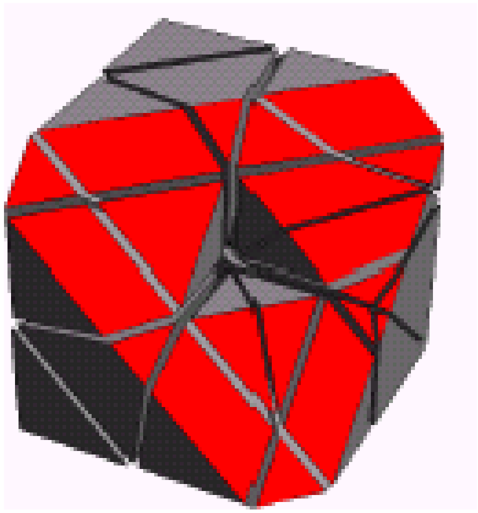
– Connection: Simulation – Visualization

– 2 Tasks:
  - Input/Output Interfaces:
    existing technology (HLA, OpenDX, AVS, ...)
  - Network connection:
    decrease communication delay

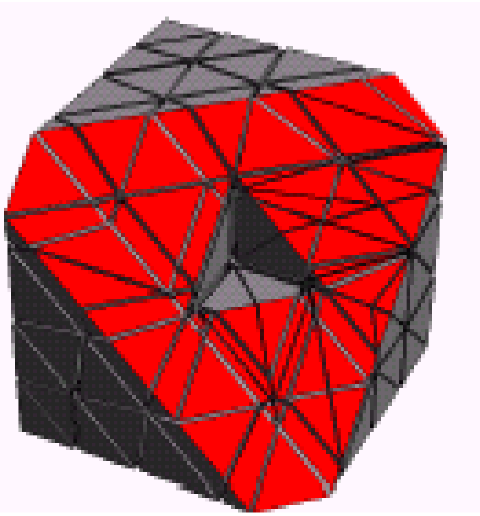
Visualization on the Grid



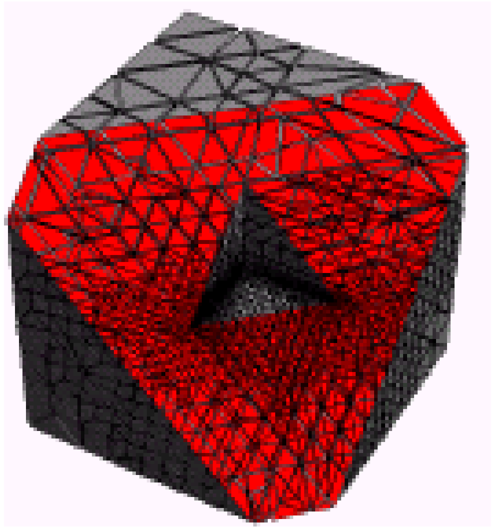
Speedup?



33 tetrahedrons

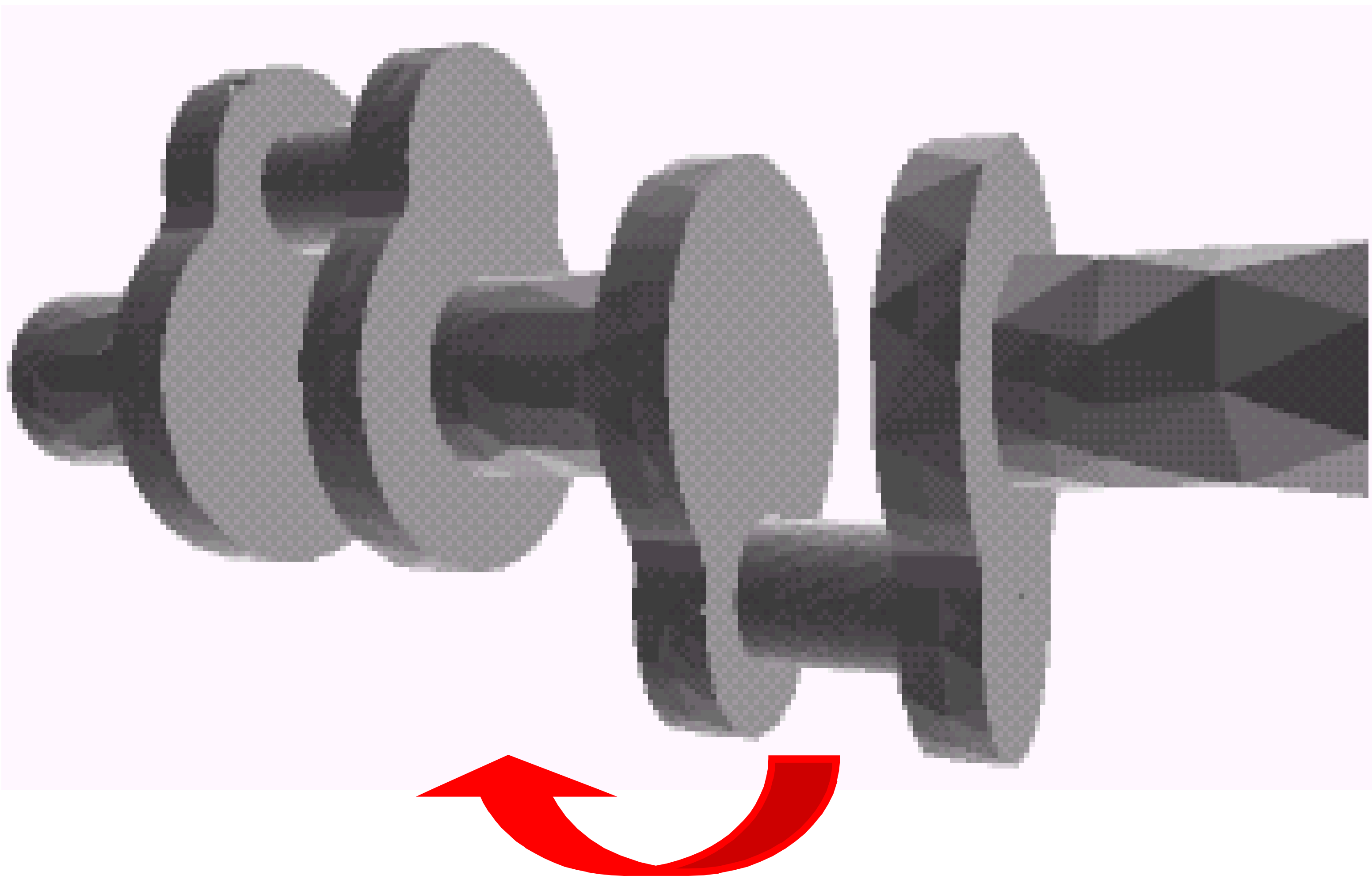


264 tetrahedrons

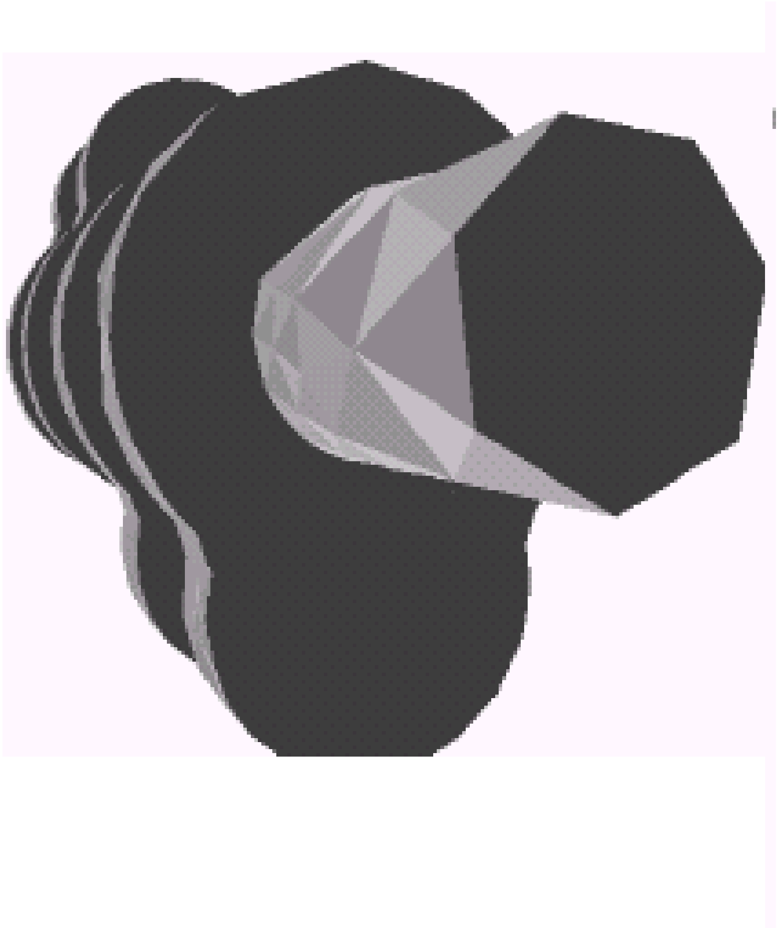


36452 tetrahedrons

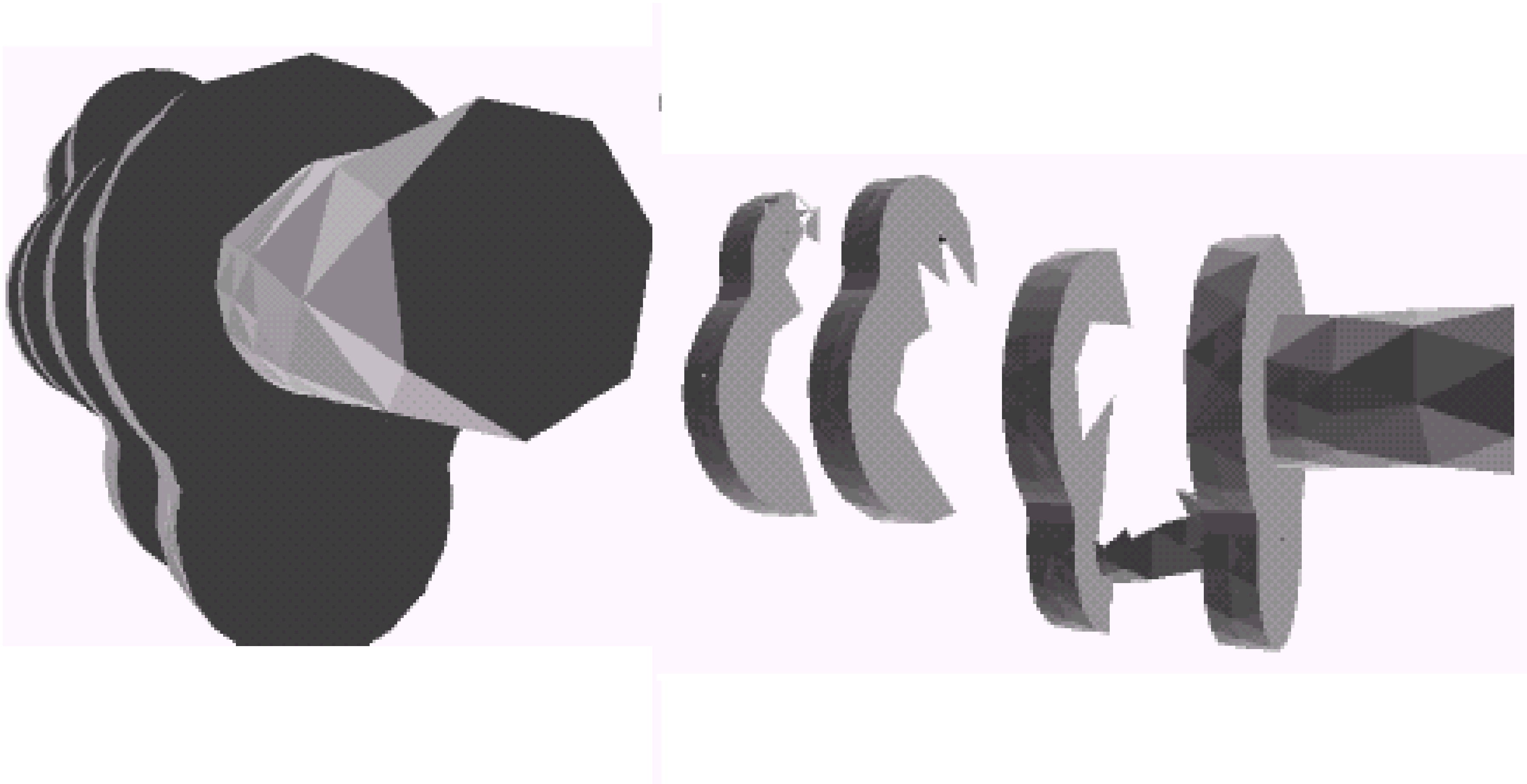
Speedup ?



Speedup ?



Speedup ?



Grid Visualization Kernel

- Use Visualization on the Grid
  - With traditional visualization kits

What do you use?

- Reduce communication delay in the Grid
  - With content-based filtering/compression/...

What performance do I get?

GVK - Design Consideration

- Addressing the problem of interconnecting distributed simulation sources with visualisation clients
- Providing a middleware layer extension for scientific visualisation, which allows interactive, near real-time visualisation of running grid applications on arbitrary visualisation devices

- The GVK consists of three distinct modules:
    1. An input interface for delivering the simulation data to the GVK
    2. An output interface for delivering the visualisation data from GVK to the output device
    3. The GVK itself, which connects the simulation and the visualisation via their respective interfaces

- GVK will provide sophisticated compression and abstraction mechanisms, depending on the available network throughput.

GVK - Design Consideration (cont.)

As for the GVK compound, a user can differentiate between two types of interaction:

- local interaction within the visualisation device
- interaction affecting the simulated data.

Summary (GVK and Visualization)

- GVK is a grid middleware extension for interactive visualisation addressing
  - the visualisation of 2D and 3D data grids and triangle meshes
  - problems of distributed visualisation on a set of heterogeneous devices.
  - network delay problems.
- Improved interaction with the end user
- Near real time simulations
- Different types of the visualisation device (PDA, workstation, VR centre).
- HPC,HTC, HPV in distributed environment (far-away sites).
- Additional middleware supporting the visualization process (e.g. monitoring, scheduling, portals).
- Testbed environment.

Thank you

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Poznań Supercomputing and Networking Center