Interactive Result Visualization on the Grid

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GUP

University Linz

Grid Computing for Complex Problems

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AUSTRIAN GRID

Contents

- Visualization for Grid Computing

- glogin

- The Visualization Pipeline

- VTK-based Visualization

- Video Transmission over the Grid

- Applications

  - Disaster management

  - Medical

  - Astrophysics

Motivation

- Grid applications commonly operate on large datasets / generate large result datasets
- Visualization supports the users understanding
- Crucial for large datasets
- Clients cannot cope with these large datasets
- Idea: Do visualization on the Grid
- Requires lots of effort transferring visualization to UI (Client)
- Control your grid running App interactively

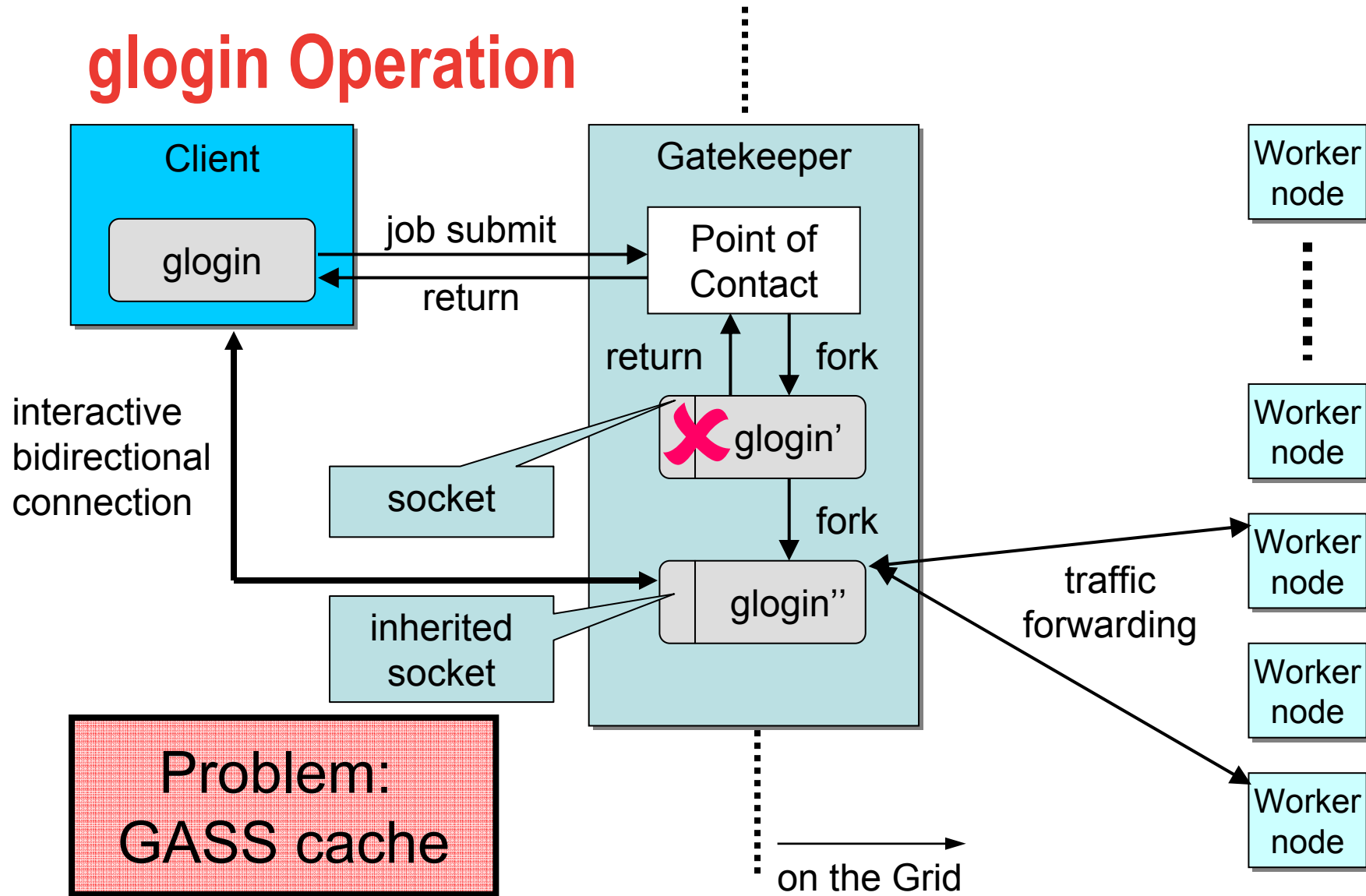# Interactivity - „Putting the user into the loop"
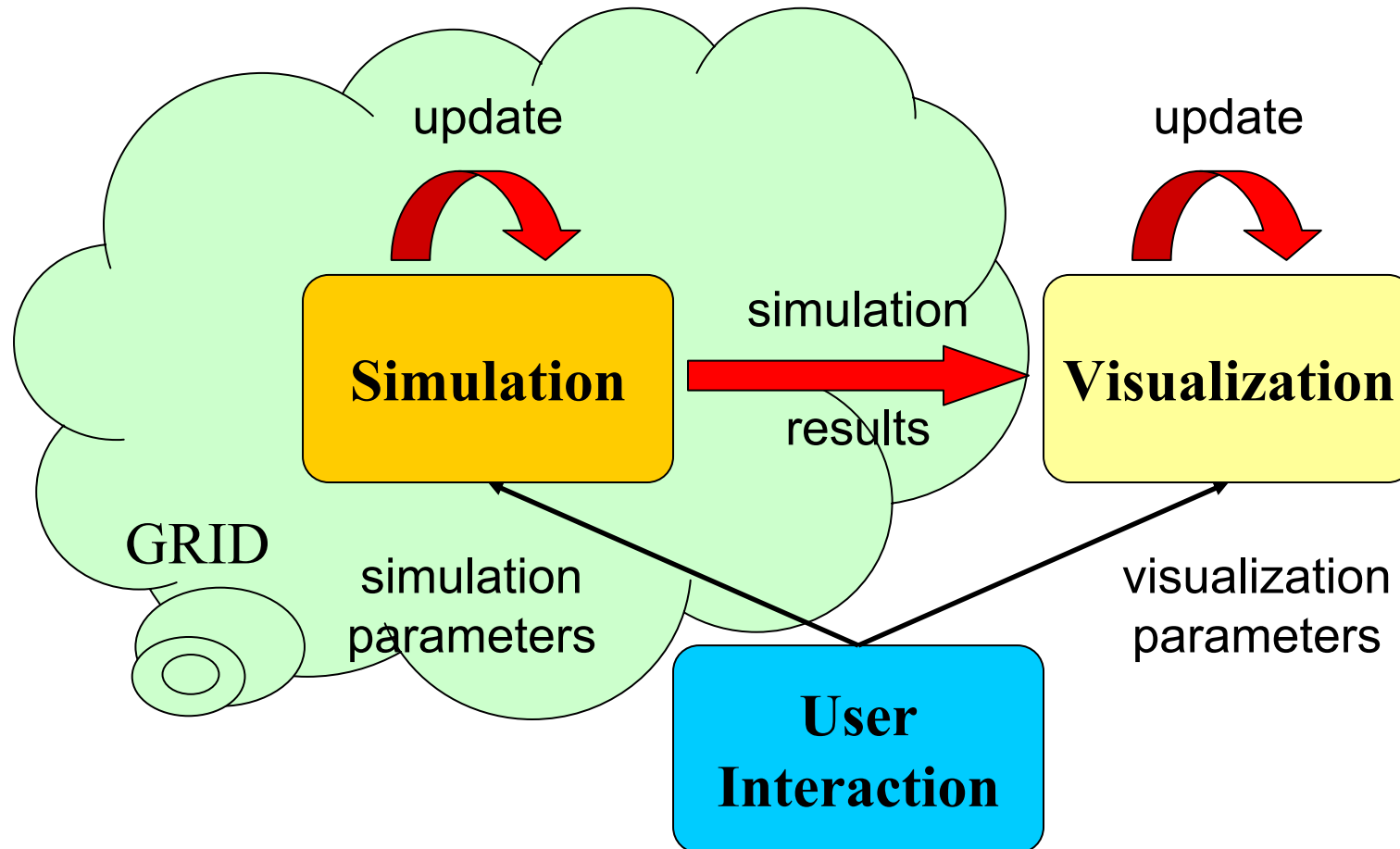
glogin

- … enables online communication between nodes on the Grid and off the Grid

- … provides shell functionality for access to Grid nodes

- … is a standard (lightweight) Grid job

- … is easy to install and use

- … supports GSS-based encryption

glogin Functionality

- Basic
  - Low level grid communication
  - glogin provides unnamed pipes for stdin/stdout/stderr redirection
- Advanced
  - Grid shell
 - Traffic forwarding
  - VPN support

glogin Operation

Client

glogin

job submit →
← return

Gatekeeper

Point of Contact

return ↑   ↓ fork

✗ glogin'

fork

glogin''

socket

interactive
bidirectional
connection

inherited
socket

Worker node

Worker node

Worker node

traffic
forwarding

Worker node

Worker node

Problem:
GASS cache

on the Grid

7

glogin – Shell Access

```
hr@clio$ grid-proxy-init -cert .globus/AustrianGrid.crt -key .globus/AustrianGri
d.key
Your identity: /O=AustrianGrid/O=JKU Linz/OU=GUP/CN=Herbert Rosmanith
Creating proxy ...................................................... Don
e
Your proxy is valid until: Wed Nov 17 03:05:49 2004
hr@clio$ glogin hydra
hr@hydra hr $ pwd
/home/gup/hr
hr@hydra hr $ id
uid=227(hr) gid=201(gup) groups=201(gup)
hr@hydra hr $ hostname
hydra
hr@hydra hr $ 
```

http://www.gup.uni-linz.ac.at/glogin

The Visualization Pipeline
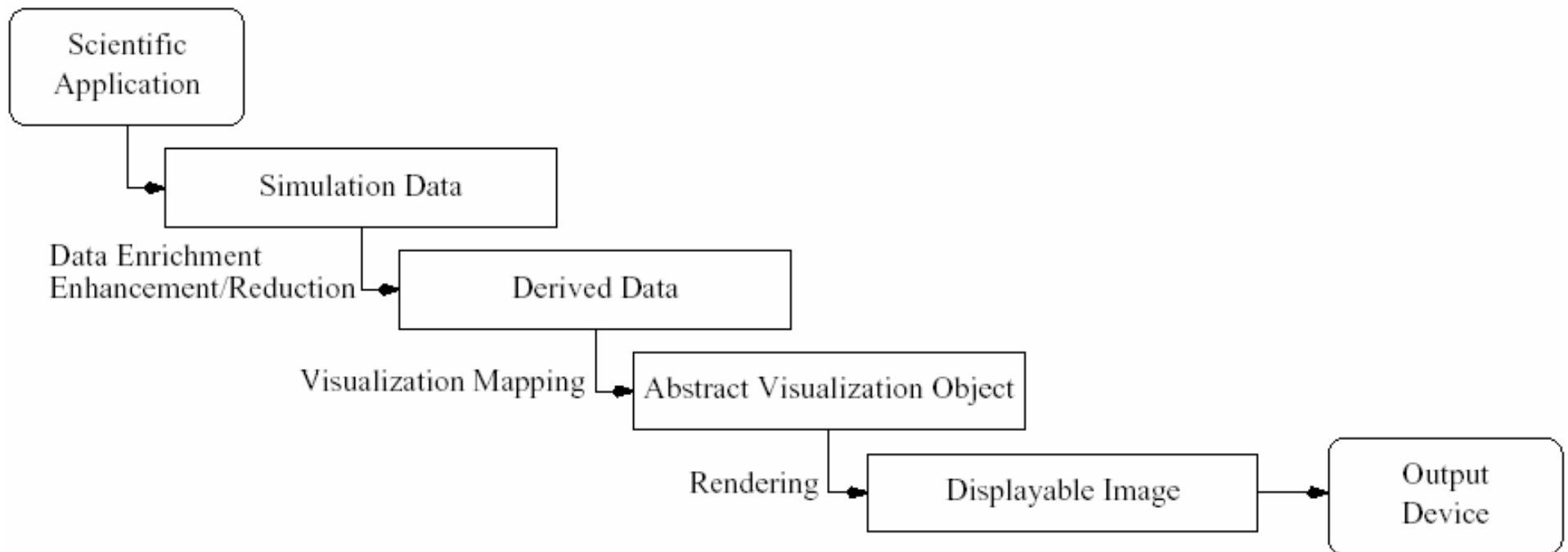
Visualization on the Grid

- Grid application uses Visualization Toolkit (VTK)
- Visualization data is transparently sent to the client
- Client displays data
- Interaction is transferred from client to grid application
- Data transfer over glogin

VTK-based Pipeline

- Distributed Pipeline
- VTK-based
- Glogin for communication
- VR representation
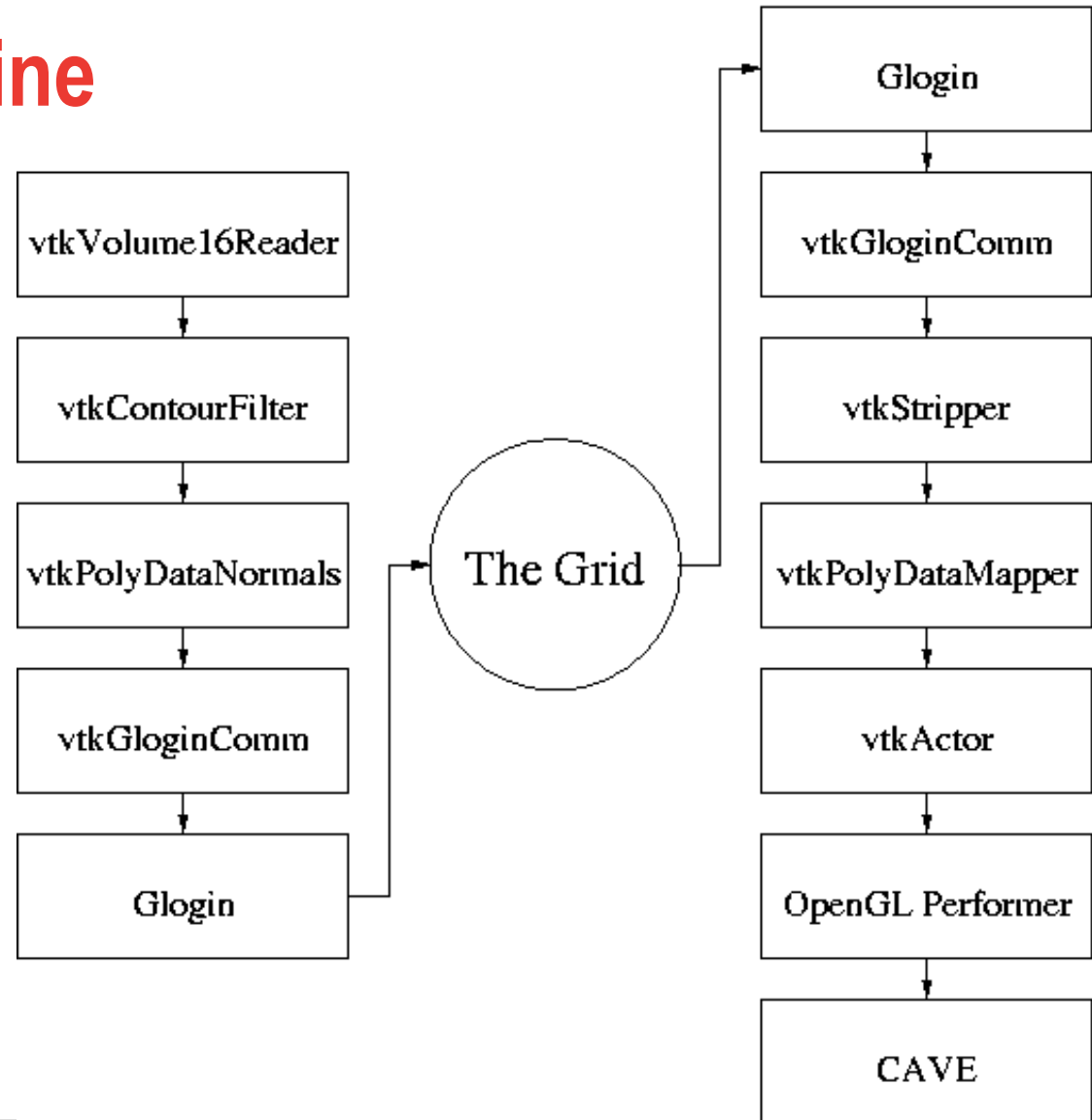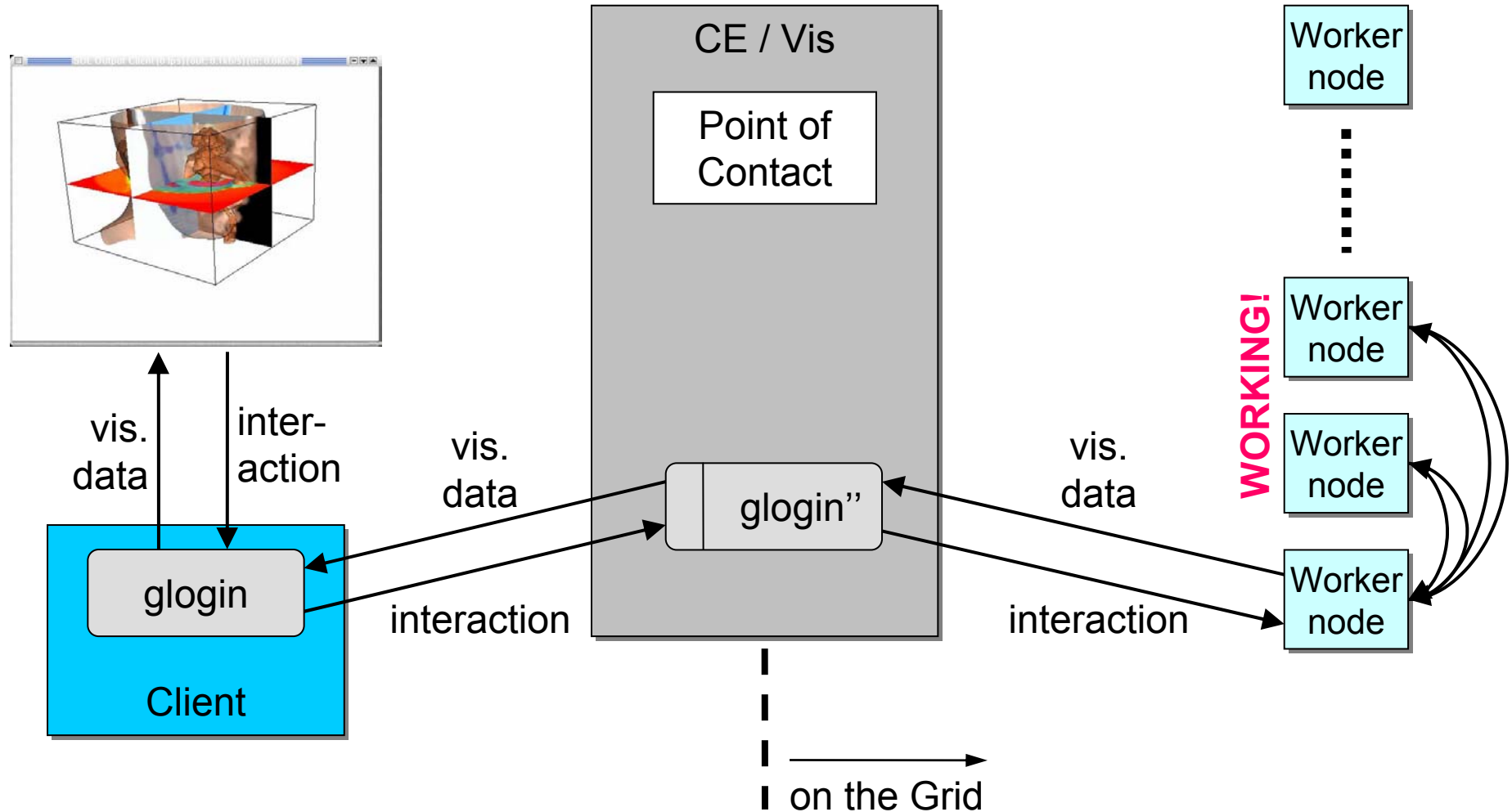
VTK-based Visualization –
VR integration
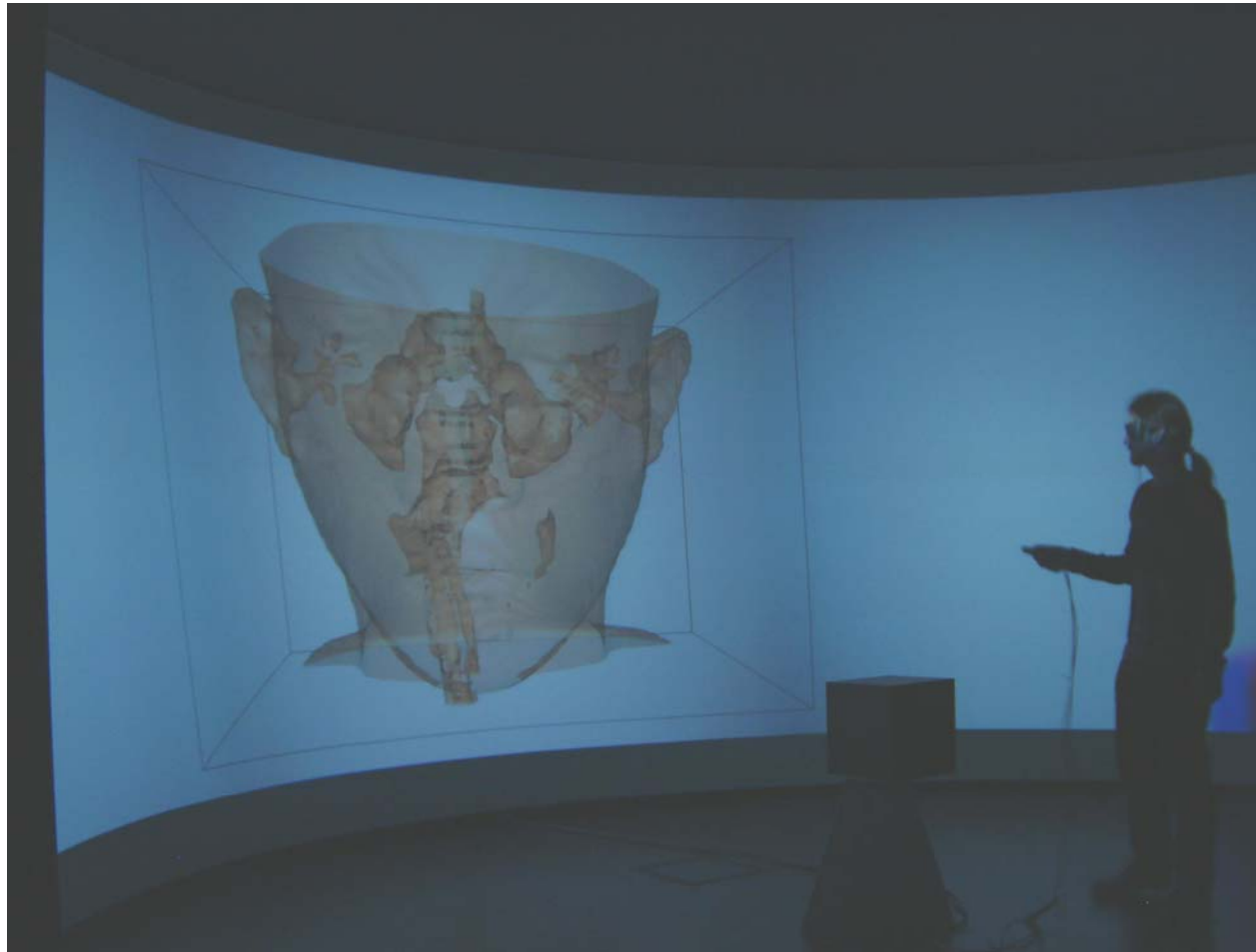
Gvid –
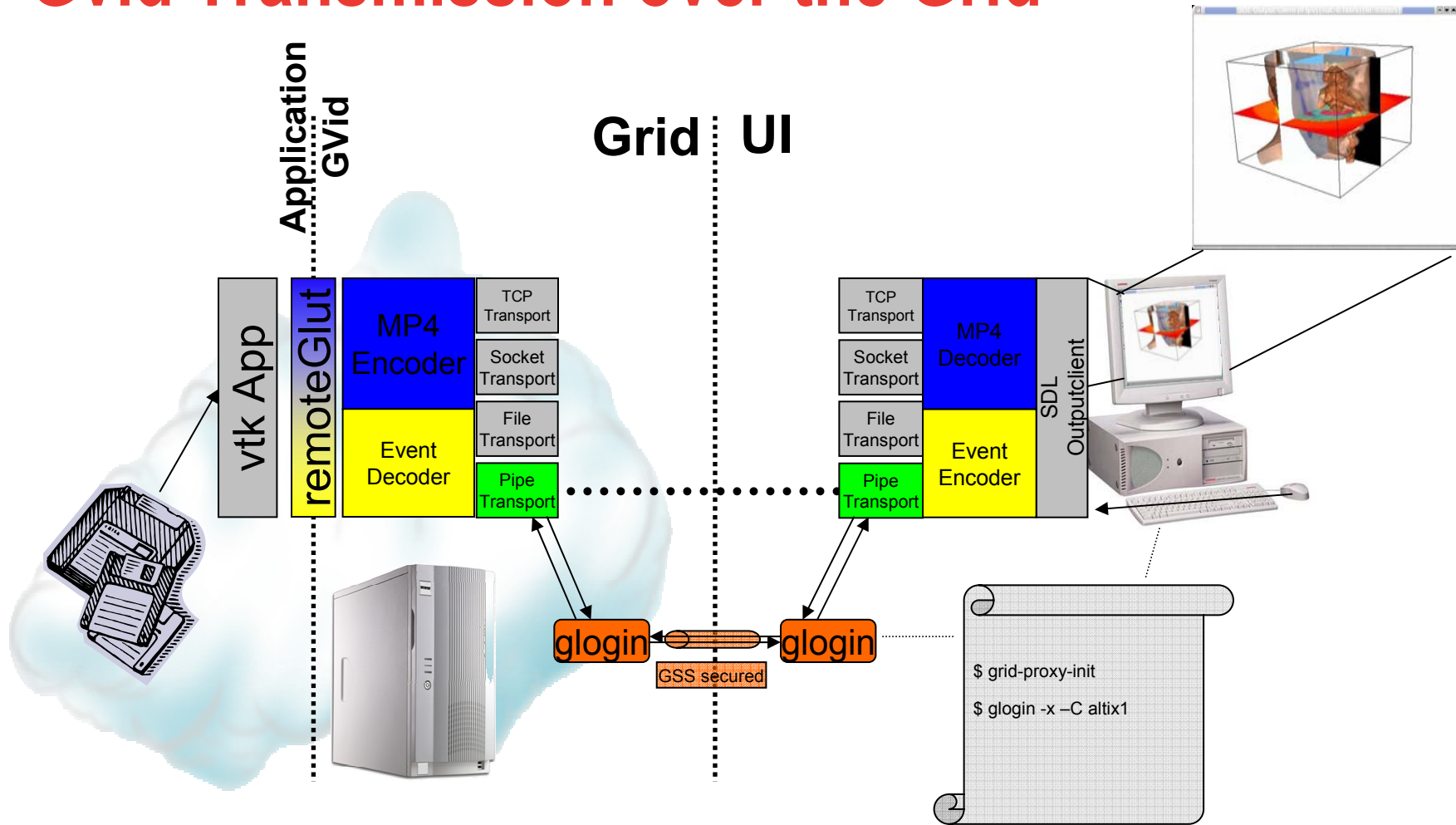# Video Transmission over the Grid

- Video streaming over the grid

- Rendering can be done on grid resources

- Full interactivity support

- Communication over glogin
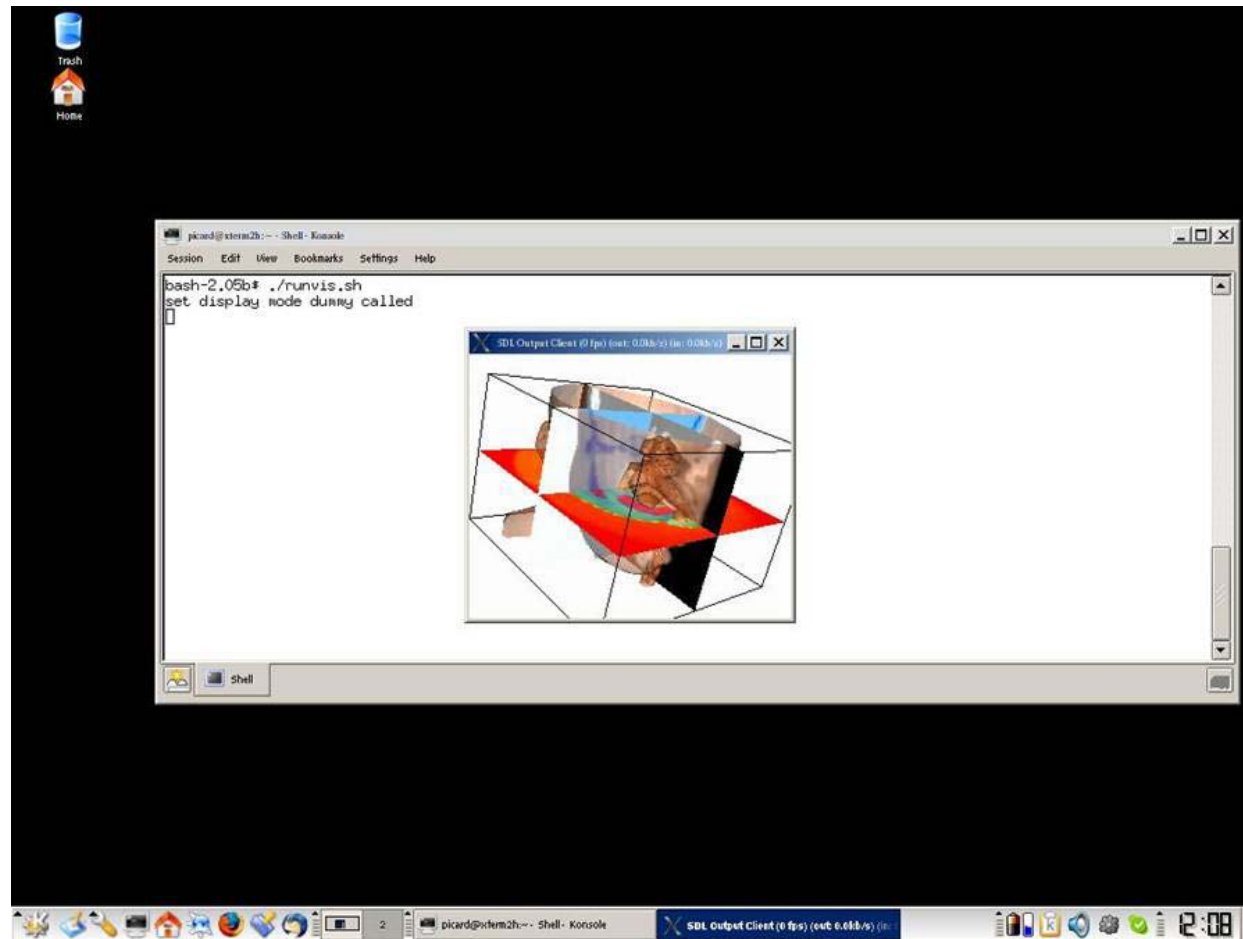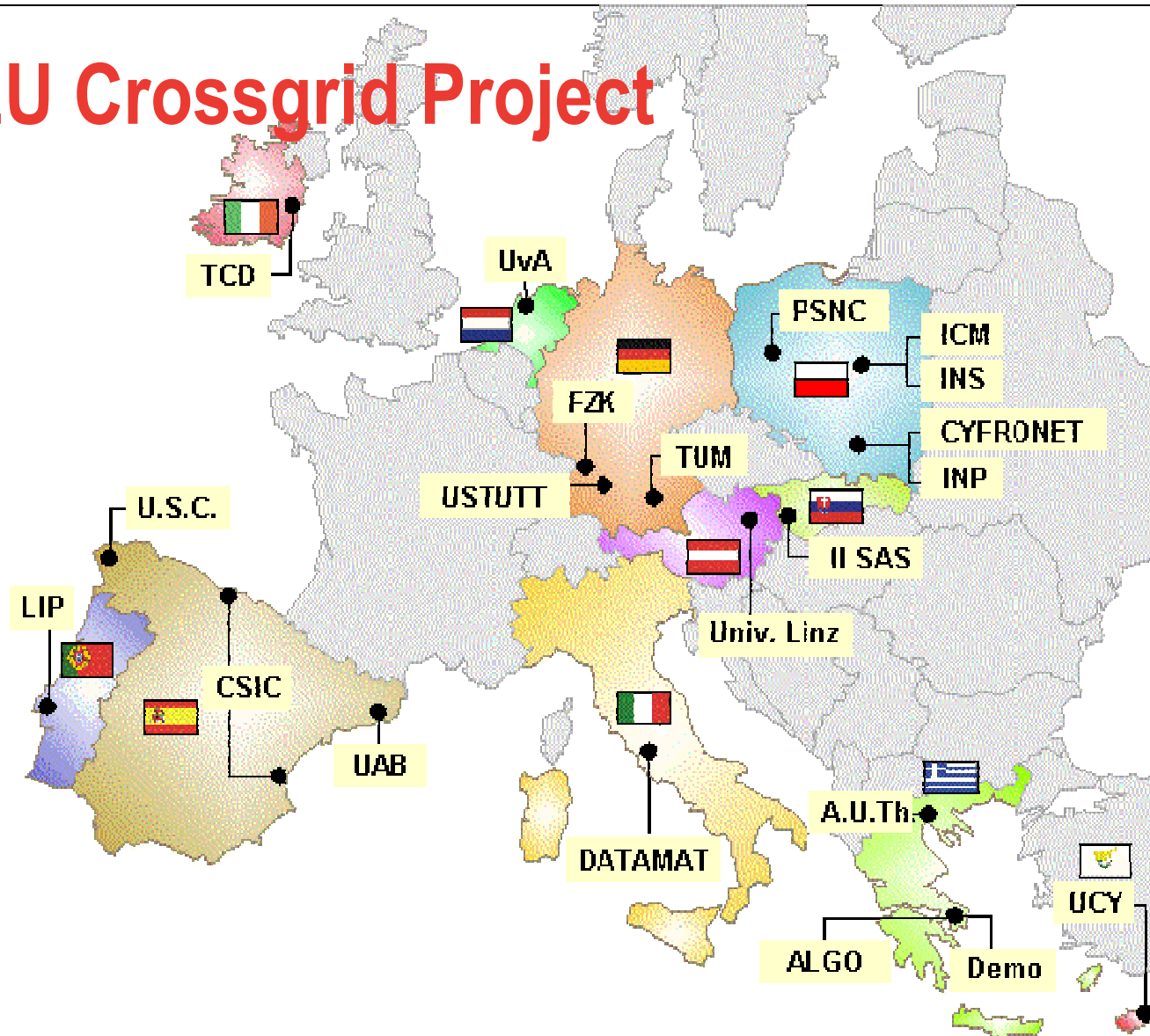
- Based on Video-Codec

Gvid Interaction

CE / Vis

Point of Contact

Worker node

Worker node

Worker node

Worker node

Worker node

WORKING!

vis. data

inter-action

glogin

Client

vis. data

glogin''

vis. data

interaction

interaction

on the Grid

14

Gvid Transmission over the Grid

Interactive Control of a Remote Application

The EU Crossgrid Project

TCD
UvA
PSNC
ICM
INS
FZK
CYFRONET
USTUTT
TUM
INP
U.S.C.
II SAS
LIP
Univ. Linz
CSIC
UAB
DATAMAT
A.U.Th.
UCY
ALGO
Demo

17

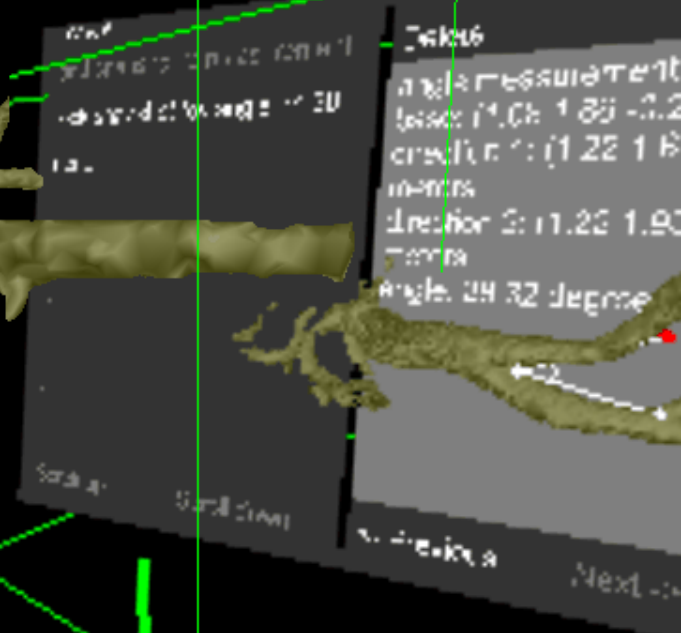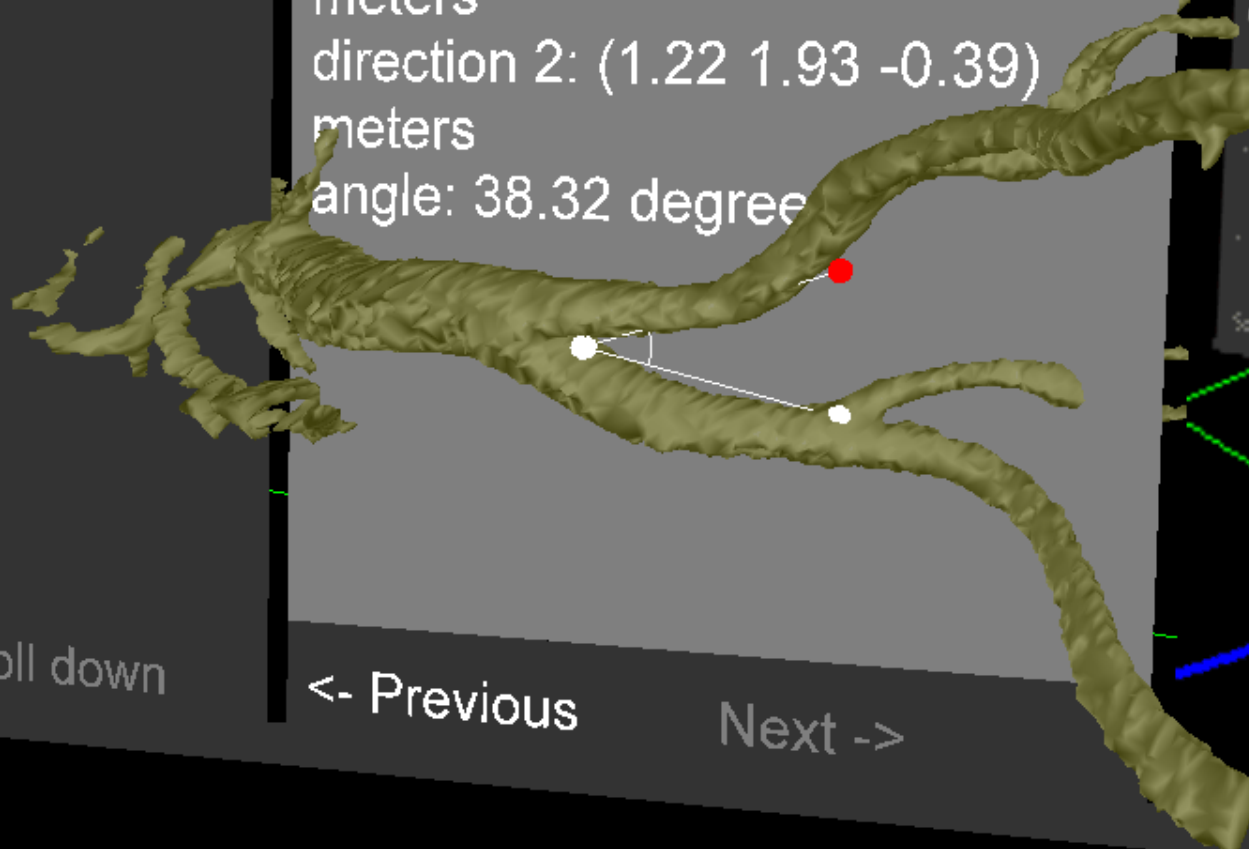# Bloodflow Visualization – Biomedical Application

- Cooperation with University of Amsterdam (UvA)

- UvA

  - Parallel bloodflow simulation

  - VR Visualization for surgical planning

- GUP Linz

  - Grid-enabled visualization

  - Interactive Visualization control through DesktopVRE

measurement

Delete

ngle on 30

angle measurement:
base: (1.08 1.86 -0.28) meters
direction 1: (1.22 1.81 -0.40)
meters
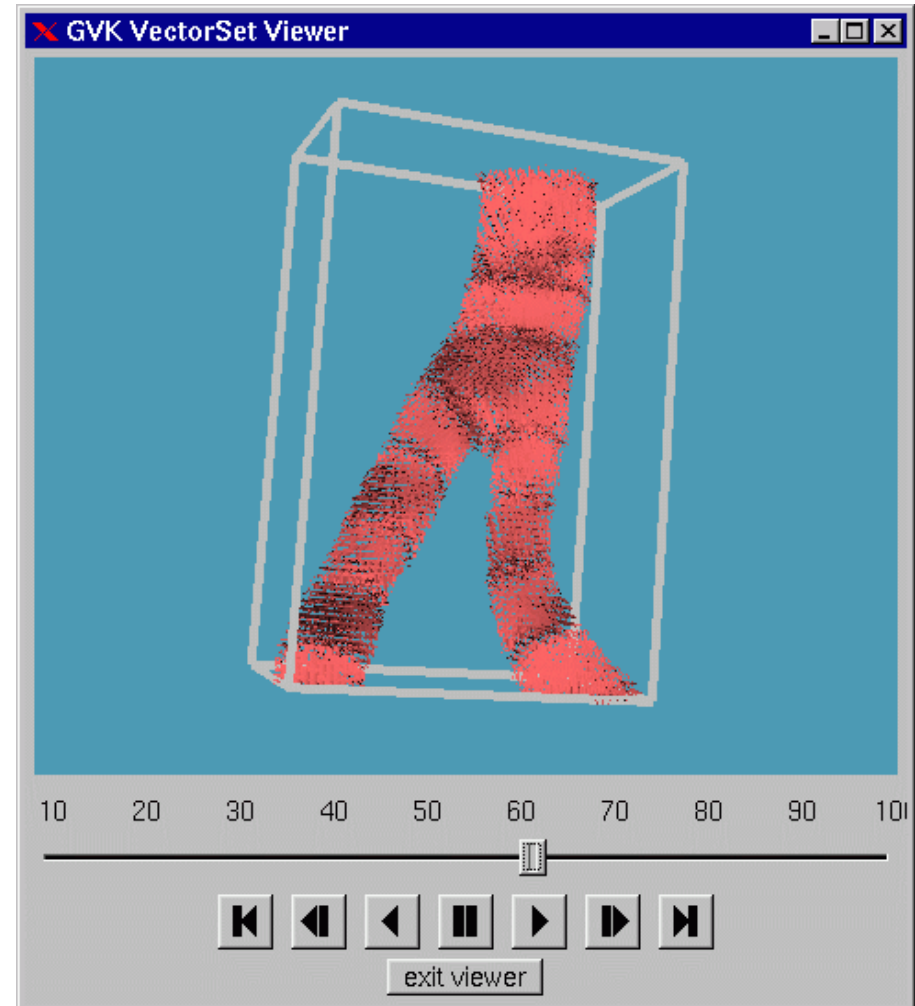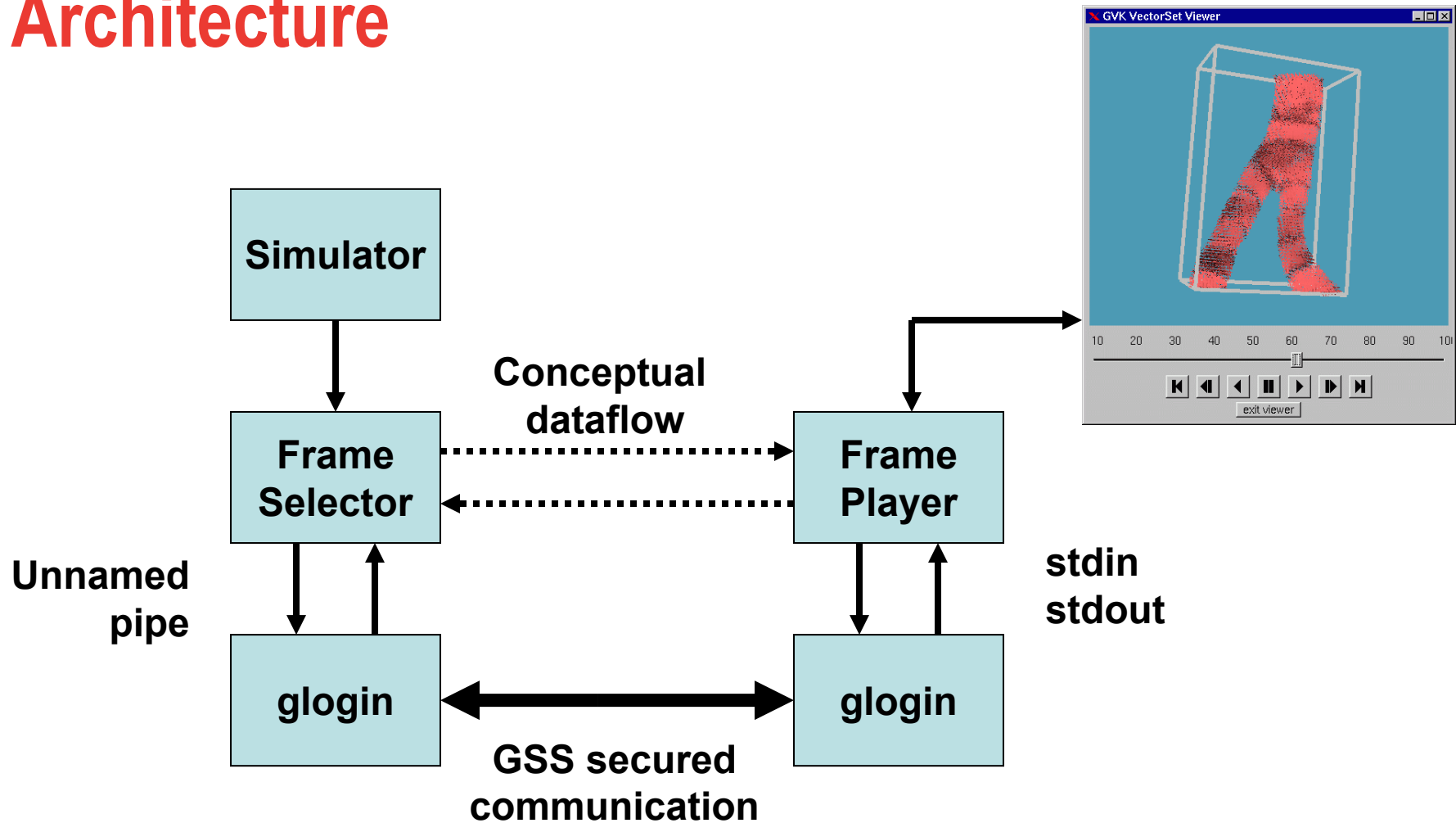direction 2: (1.22 1.93 -0.39)
meters
angle: 38.32 degree

Interactive Visualization Steering

- Medical Application

- Bloodflow visualization

- Interactive Glyph Rendering on the Grid

- Using glogin

20

Interactive Visualization Steering – Architecture

Simulator

Conceptual dataflow

Frame Selector

Frame Player

Unnamed pipe

stdin stdout

glogin

glogin

GSS secured communication

Desktop VRE with GVK Extensions

- Parallel simulation on the grid
- Online visualization on the desktop machine
- Rendering on the grid
- The grid is „invisible"

22
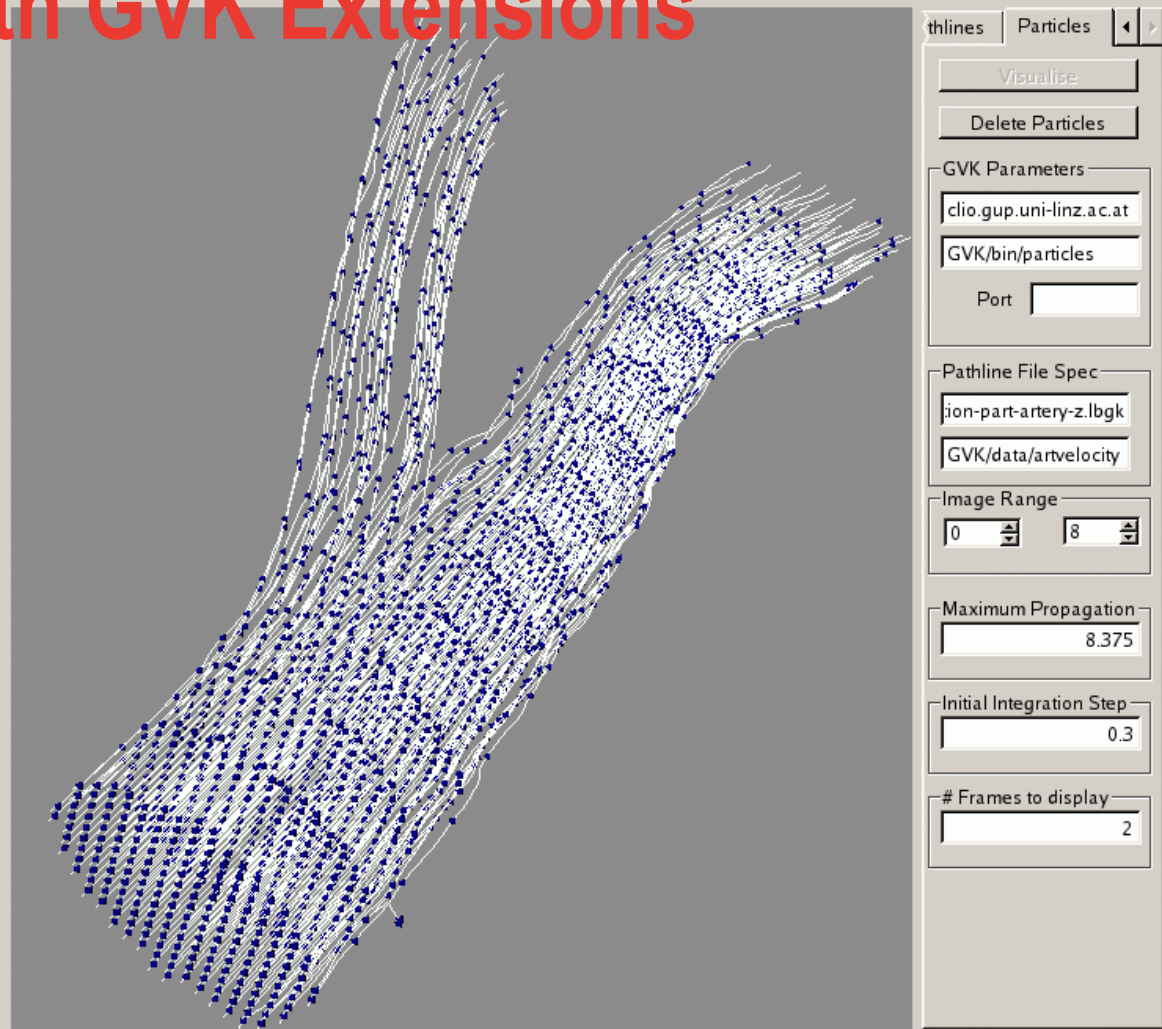
Desaster Management –
VR Flooding Visualization

- Cooperation with
  Institute of Informatics, Slovak Academy of
  Sciences (II SAS)

- II SAS
  - Simulation Cascade
  - Data Models
  - ...

- GUP Linz
  - VR Visualization

Desaster Management – VR Flooding Visualization

- Flooding simulation is done by II SAS

- Data can be transmitted over the grid

- Visualization in VR is done in Linz
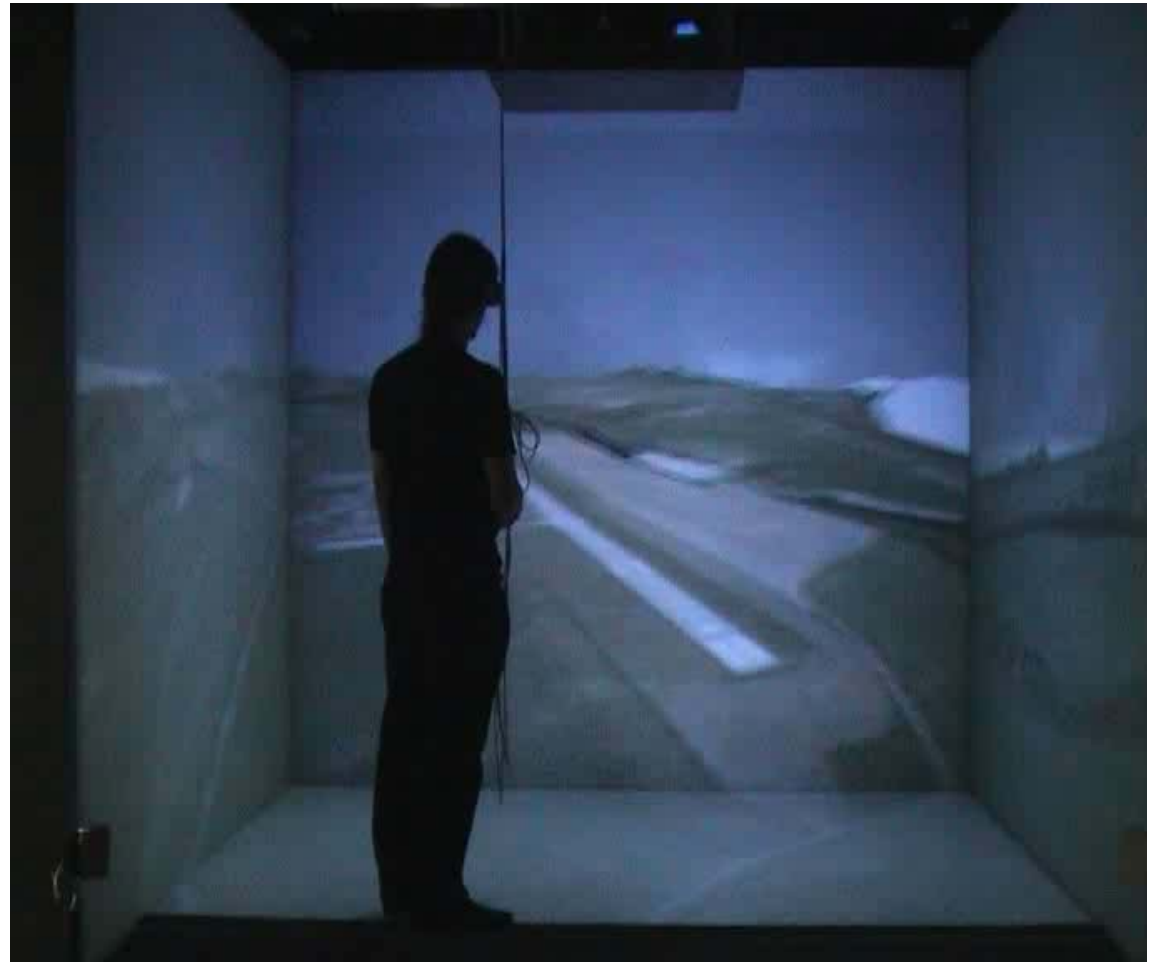
Desaster Management –
VR Flooding Visualization

- Different output devices
 for VR visualization

The Austrian Grid Project

Volume Visualization of Astrophysical Data

- Cooperation with
  Institute of Astrophysics, University Innsbruck

- Institute of Graphics and Parallel Processing
  University Linz (GUP)
  - Genetic Algorithm
  - Parameter Study

- Institute of Astrophysics
  University Innsbruck
  - Galaxy Cluster Data for Rendering
  - User Interface Evaluation

Rendered Gas Distribution
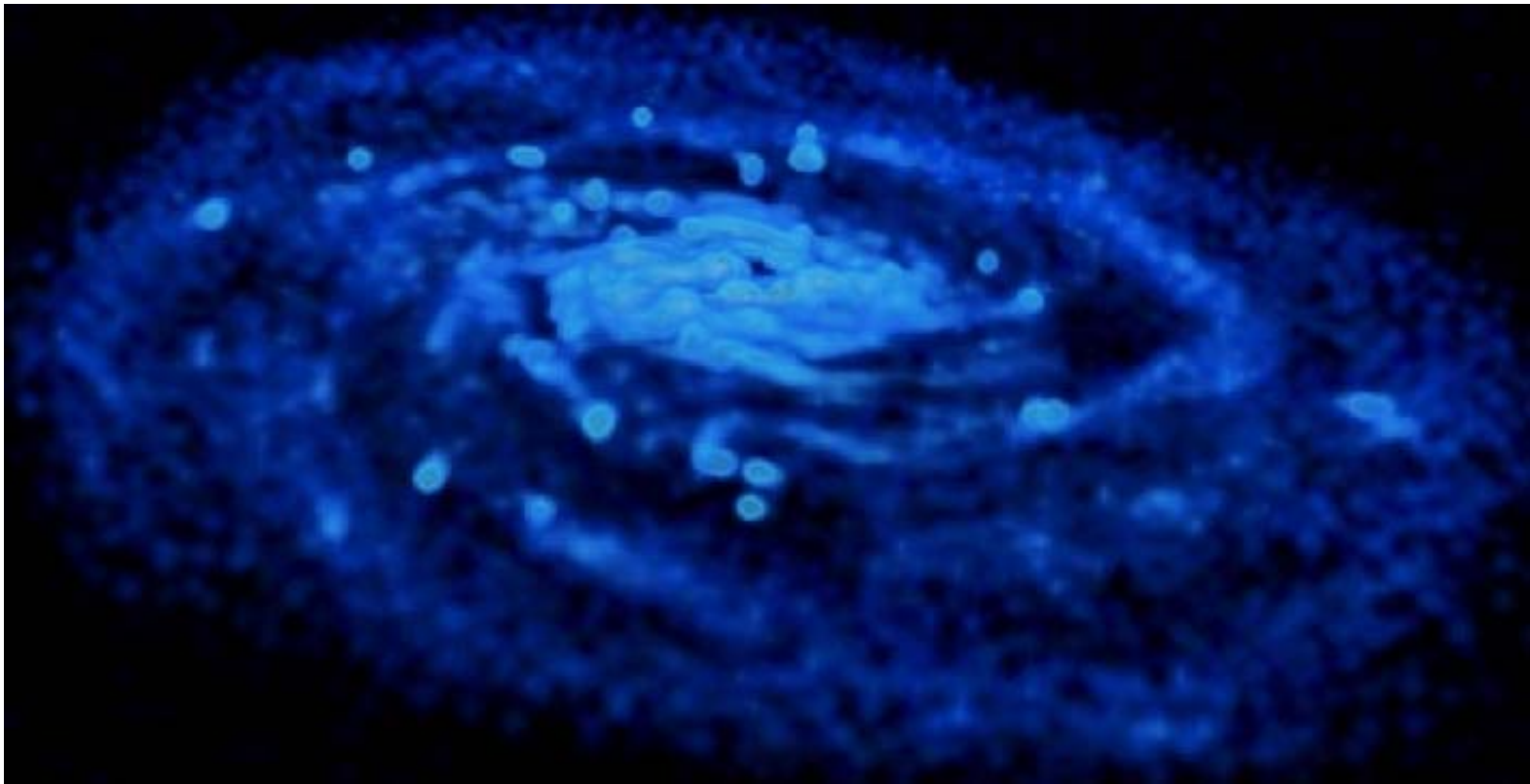
Searching for a Transfer Function for Volume Rendering

- Based on a Genetic Algorithm
- Population of Transfer Functions
  - Images are rendered on the grid
  - Quality of transfer function is judged by the user
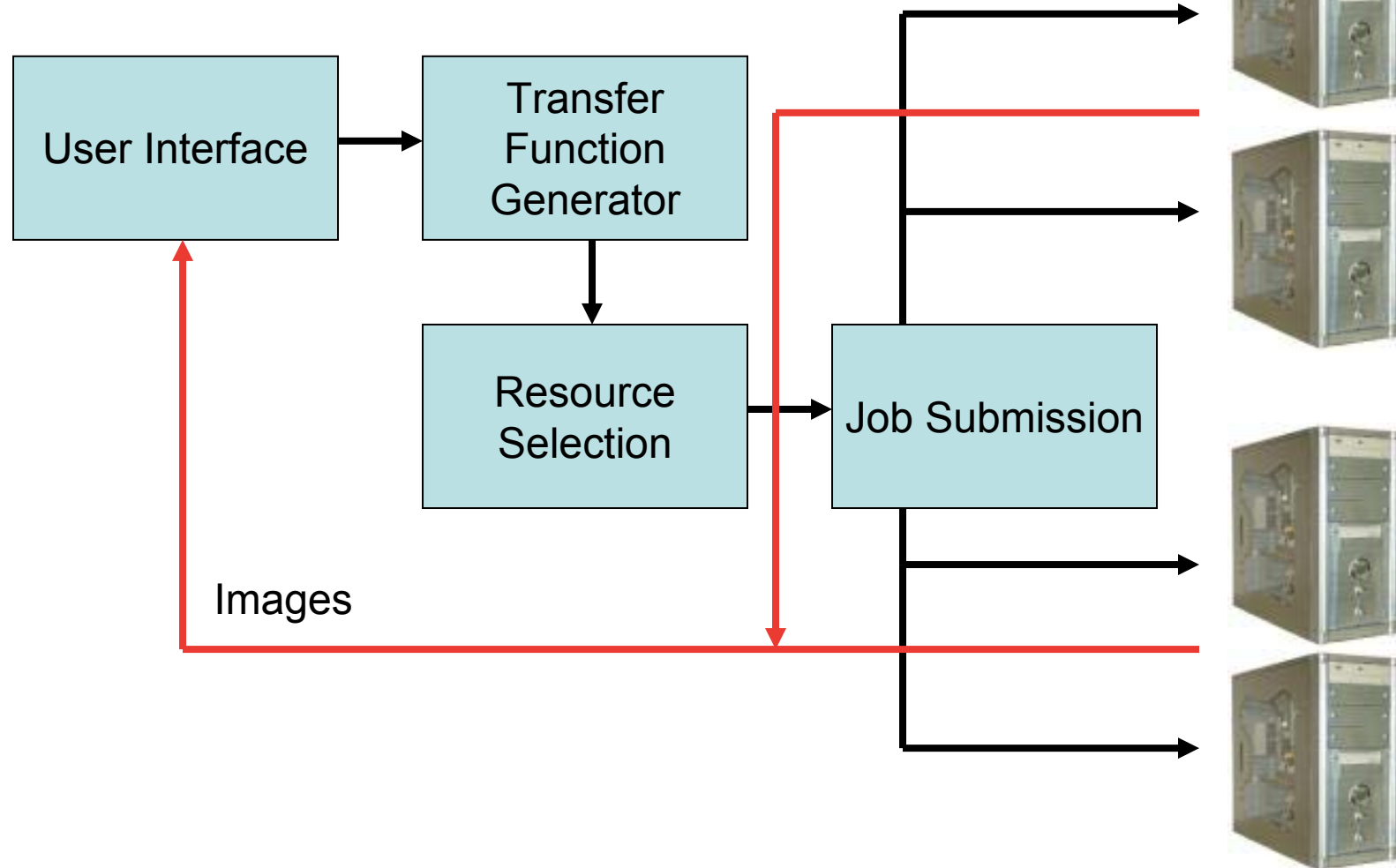 - Parameter study

The Genetic Algorithm

- Generation of initial population based on histogram of input data

- The fitness of each genom is judged by the user

- Selection of the best candidates

- Crossover

- Mutation

- Iteration till desired quality is achieved

Austrian Grid is a project funded by the bm:bwk (Federal Ministry for Education, Science and Culture) after recommendation by the Austrian Council for Research and Technology Development.
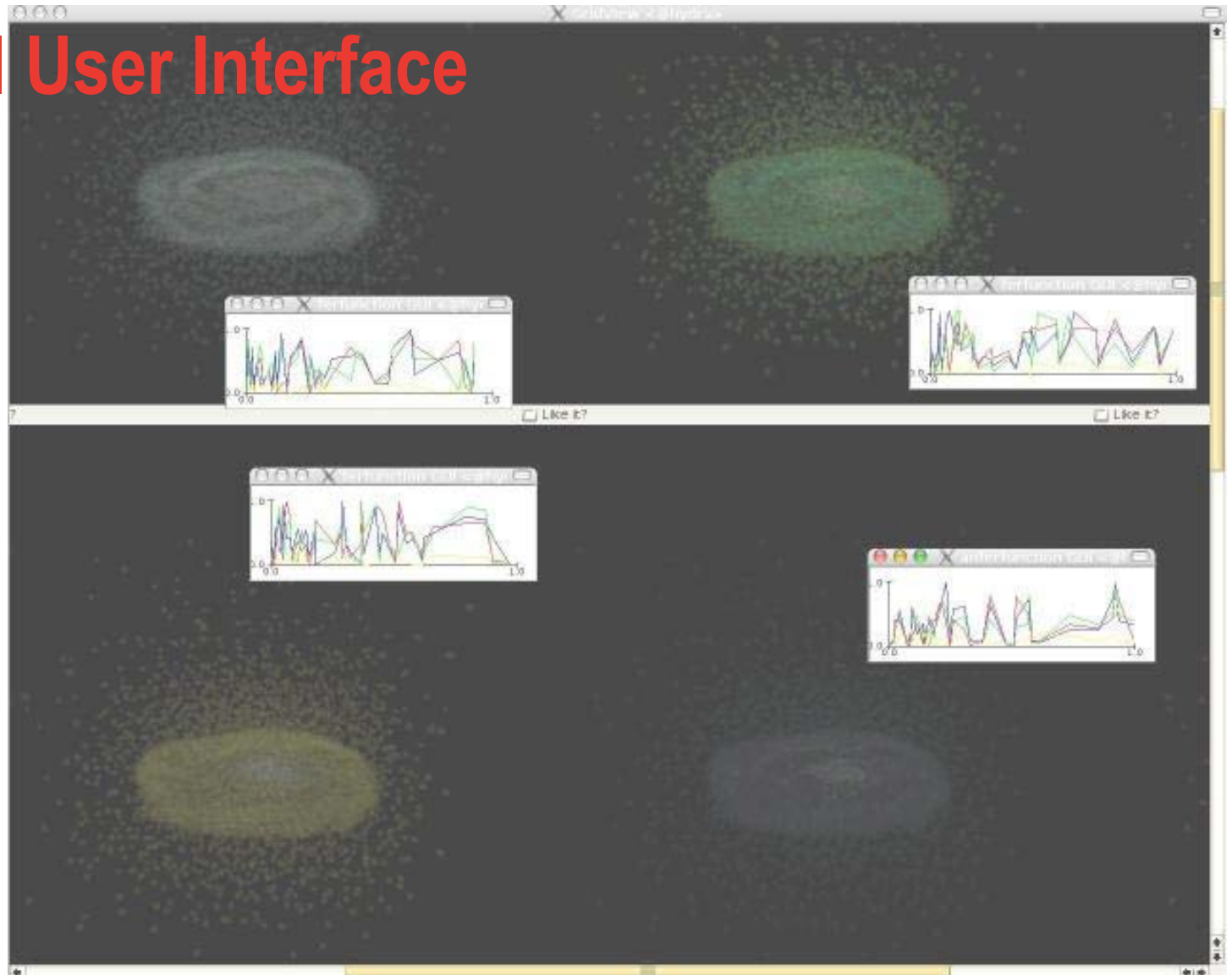
30

Parameter Study on the Grid

- Povray for Raytracing

- Raytracing as grid job

- Type: Parameter Study

- Execution on the Austrian Grid infrastructure

  - User selects resource

  - Parallel Job Submission

  - Data transfer: GridFTP

- Best images are selected by the user
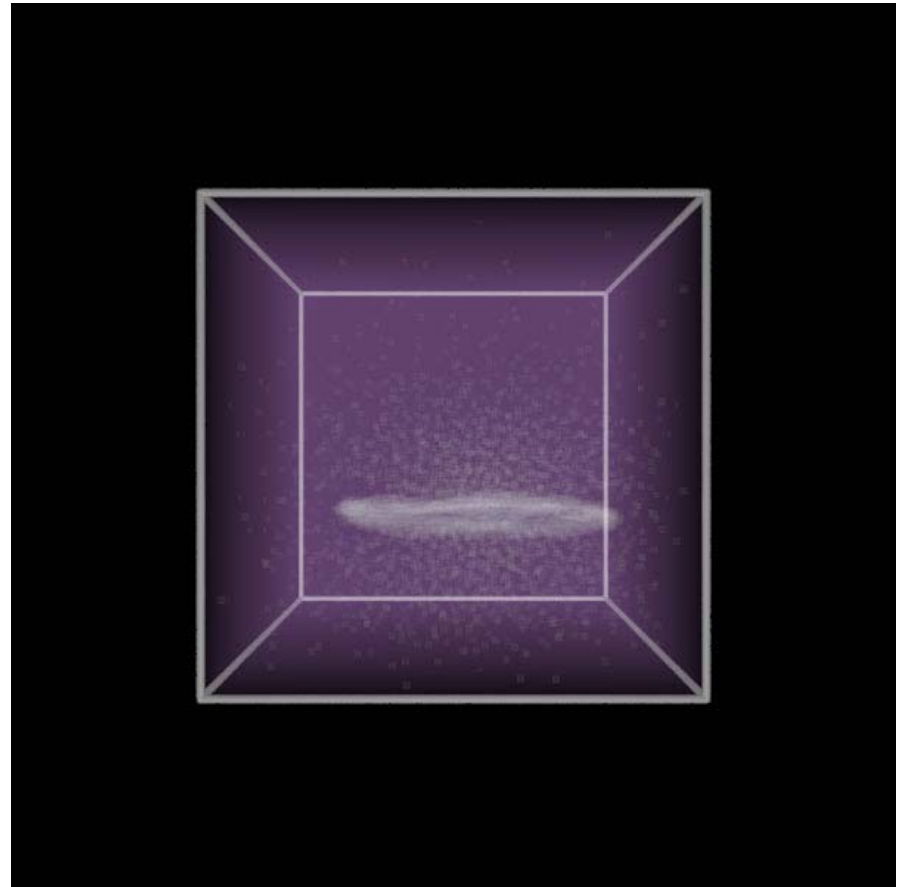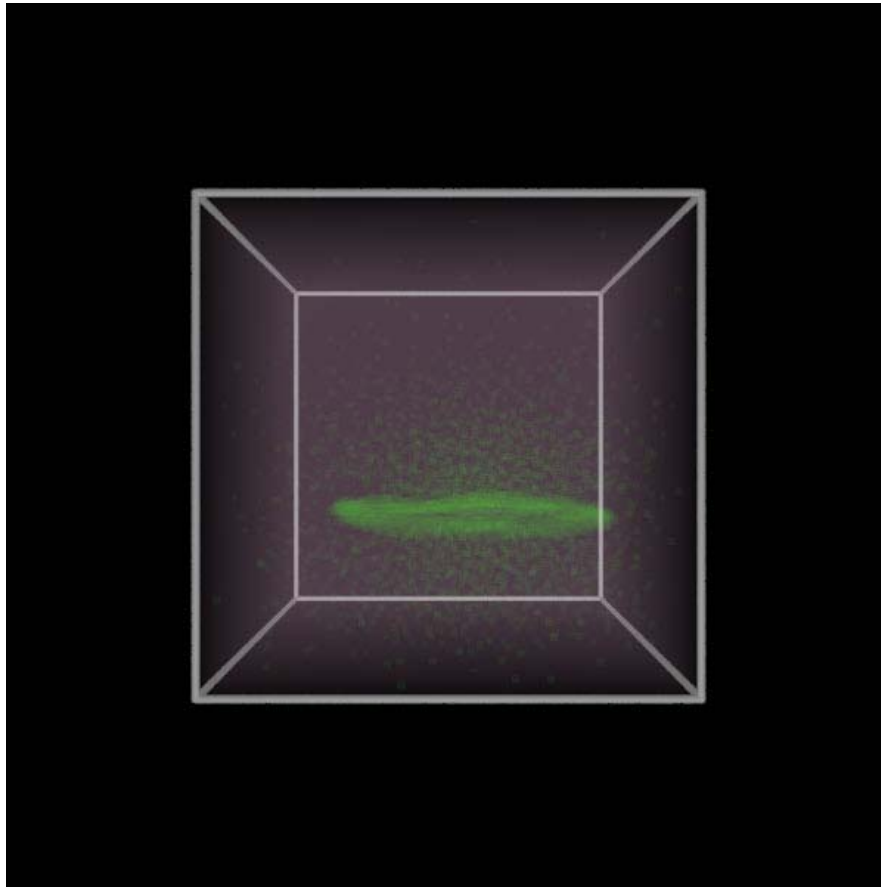 = Selection for the genetic algorithm
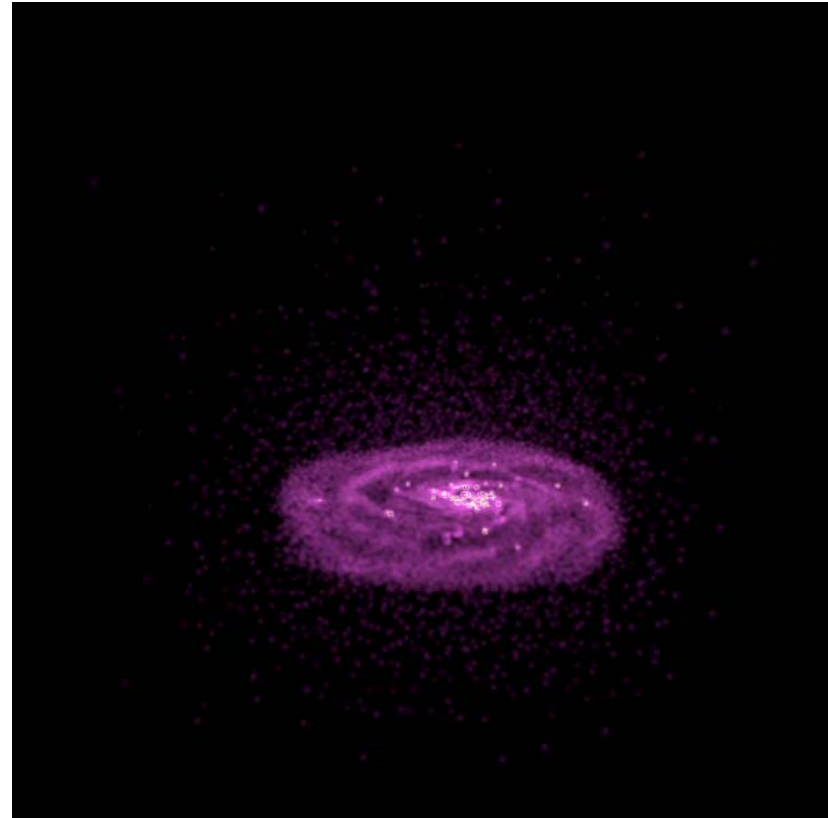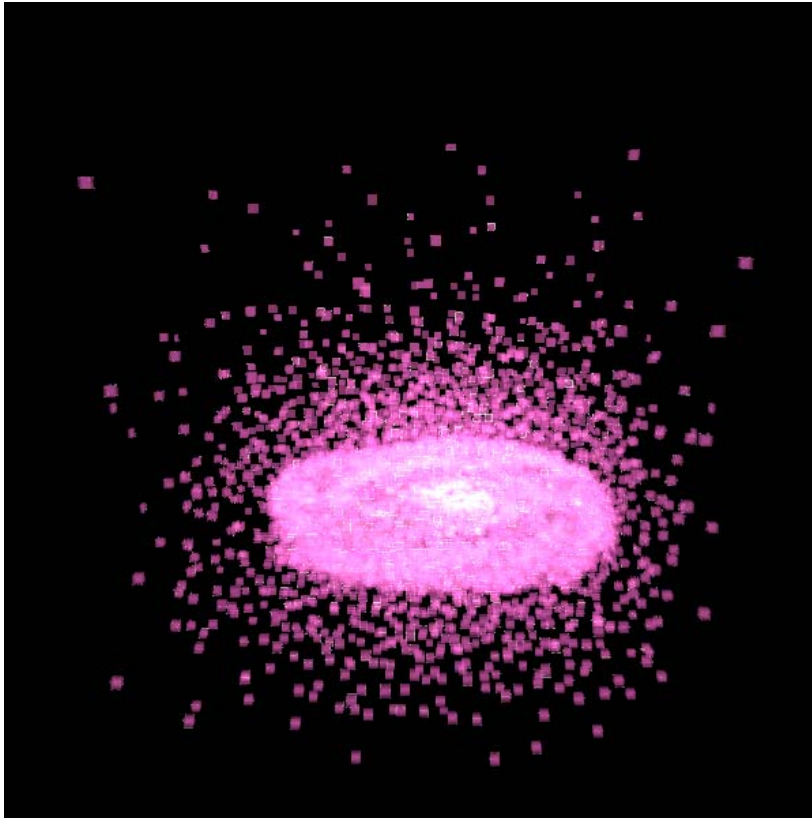
Parameter Study on the Grid

Graphical User Interface

33

Results

Results

Austrian Grid is a project funded by the bm:bwk (Federal Ministry for Education, Science and Culture) after recommendation by the Austrian Council for Research and Technology Development.

35

Thanks to ...

- Dieter Kranzlmüller
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