Interactive Result Visualization on the Grid

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Grid Computing for Complex Problems
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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“

Simulation

Visualization

User Interaction

update

simulation

results

update

visualization parameters

simulation parameters

update
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
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.

http://www.austriangrid.at

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**glogin Operation**

Client

```

Interactive bidirectional connection
```

Gatekeeper

```
glogin
```

```
Point of Contact
```

```
return
```

```
fork
```

```socket```

```
inherit socket
```

```
traffic forwarding
```

Worker node

```
Worker node
```

Problem: GASS cache

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glogin – Shell Access

hr@clio$ grid-proxy-init -cert .globus/AustrianGrid.crt -key .globus/AustrianGrid.key
Your identity: /O=AustrianGrid/O=JKU Linz/OU=GUP/CN=Herbert Rosmanith
Creating proxy ......................................................... Done
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
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Gvid Interaction

CE / Vis

Point of Contact

glogin

Client

vis. data

interaction

vis. data

interaction

on the Grid

WORKING!

Worker node

Worker node

Worker node

Worker node

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Gvid Transmission over the Grid

GSS secured

$ grid-proxy-init
$ glogin -x --C altix1
Interactive Control of a Remote Application
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The EU Crossgrid Project
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
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Delete

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

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Interactive Visualization Steering – Architecture

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Simulator

Frame Selector

Frame Player

glogin

Unnamed pipe

stdin

stdout

Conceptual dataflow

GSS secured communication

stdin

stdout
Desktop VRE with GVK Extensions

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

User Interface → Transfer Function Generator → Resource Selection → Job Submission

Images
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Graphical User Interface
Results
Results
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