Grid-based Collaborative Workspace for Engineering Applications

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Agenda

• Paradigm shift in remote collaboration
• Trends and new requirements
• IHPC’s effort and experience on collaborative workspace
• Summary
Background Info on IHPC’s Work

- IHPC’s core R&D activities: computational science and engineering (modeling, simulation, visualization)
- Visualization activities
  - CAVE™ set up in 1998 (powered by SGI Onyx2)
  - Numerous VR applications in various domains, including tele-immersive project
  - COVE (Cluster Operated Visualization Environment) tiled display facility set up in 2004 → foundation for remote collaboration framework
- New thrust: collaborative workspace to support remote multi-party interactive collaboration
Selected Visualization Projects

- Facility design evaluation
  - Warehouse, ammo storage
- Missile flight simulation
- Ergonomics design evaluation
  - Military vehicle
- Virtual Prototyping
  - Pager drop test
- Engineering Visualization
  - Esplanade concert hall
  - Visualization of turbine engine
- Bio-imaging
- Architectural Walk through
  - Fullerton Hotel
- Virtual Heritage
  - Chang’An Daming Palace
Paradigm Shift

• Globalization changes the ways we interact with partners (research, industry)
• Advances in IT technology accelerated the change
• Going beyond
  – Silo technologies (e.g. distributed PDM tools, visualization-centric tools, basic video-conferencing, shared whiteboard)
  – Proprietary standards in products
  – Navigation of static models (e.g. CFD data)
  – 2-party collaboration
Collaborative Workspace Over Access Grid on Tiled Display

Video and Audio Conferencing
- Video Conferencing

Engineering
- Visualization Panel
- Engineering Workflow
- Remote Data Exploration

Data
- Data Sharing Drop Box(es)

Application-Sharing
- Remote Application Viewer
- White Board
- Recording

Textual
- Text Billboard
- Agenda Viewer

Dependent on GRID Technologies

Data-centric framework
Collaboration Workspace Components

- Scalable tiled display for large-scale high-resolution data visualization ✔
- Access Grid for video-conferencing and shared applications ✔
- Augmented with capabilities in:
  - distributed data sharing and management with transparent and user-friendly browsing and manipulation WIP
  - remote visualization capability WIP
  - parallel rendering of large data set WIP
  - techniques for multi-party real-time interactive visualization
  - “stateful” collaboration
  - engineering workbench for workflow composition and execution WIP
- Web services based
IHPC’s Tiled Display Facility
COVE: Cluster-Operated Visualization Environment

**Server**
- PC cluster (4 rendering nodes and 1 head node)
- Dual 2.0GHz AMD Opteron CPUs in node
- 8GB memory for head nodes, 16GB for client nodes
- NVIDIA Quadro FX3000G 256MB graphics cards
- 64-bit SuSE Linux→ FC2, CAVElib, Chromium
- 3D Spaceball

**Projection subsystem**
- 2x2 tiled display wall
- Christie LX25 LCD projectors
- Stewart filmscreen (AeroView 100, 25x18.22 m)
- Cyviz edge blending module
- Cyviz shelf and 6 DOF positioner

**Software tools**
- C, C++
- OpenGL, OpenGL Performer
- CAVElib, Chromium
- DMX
- SGI VizServer client, VNC
Access Grid Architecture

**PC Hardware**
- Workstation PC (using one of the head nodes in the COVE cluster)
- 1x 4 Channel Video Capture Card (iEi IVC-200G)

**Video Hardware**
- 2x Video Camera (Sony EVI-D31 (PAL))
- 1x DVD Harddisk Recorder (for recording AG sessions)

**Audio Hardware**
- 2x Shotgun Microphone (Audio Technica)
- 1x Behringer Audio Input Mixer
- 1x Audio Amplifier (actually a DVD Player)

**Software**
- Access Grid Toolkit version 2.3
Integrated Architecture for CAVE & COVE
Lessons and Future Work

Tiled Display
• Software based edge blending technology needs to be developed
• Blending LCD images are more challenging (black level, uniformity)
• For small/medium data visualization, CAVELib approach is convenient
• For large scale data visualization, Chromium approach needs to be further explored
  – integration with high-end libraries such as Performer and VTK
  – integration with 3D input devices such as SpaceBall and wanda

Access Grid
• Setting up AG was straight forward, skills in managing audio and video equipment were also needed to integrate the various components
• Performance analysis of different mechanisms (VizServer, VNC etc.)
Remote Visualization Service

- In collaboration with Cardiff University (RAVE)
- RAVE portal to manage workflow for selection of data service, rendering service, render client; specification of data files and RAVE sessions;
- Next step: integration of RAVE portal (GridSphere-based) into COVE
- Research challenge: multi-party, interactive visualization (multi-resolution, bandwidth constraints, QoS, parallel rendering, more efficient data service)
Parallel Rendering

- For quick rendering of large data sets
- Scalable and distributed framework that leverages on grid middleware technology (e.g. IHPC’s IS and EMS)
- Geared towards interactive visualization (e.g. CFD streamline, cut-plane, iso-surfaces etc.)
Data Management Service

• Wide range of data transfer and manipulation services (GT4-based):
  – Large file delivery from/to URL
  – Third-party transfer (file/directory)
  – Statistic feedback (number of files/bytes have been transferred, error reports)
  – File / directory deletion
  – Lifetime control
  – Authentication of GFTP servers; GSI security; Data channel authentication (DCAU)
  – Parallel transfer; TCP buffer and Block size control
  – Failed transmission resumption, retry times & transmission duration configuration
  – Group operations (transfer for multiple pairs of source and destinations)
  – Group archival and compression

• Other challenges: virtual data directory and repository, user-friendly browsing (c.f. explorer), drag-n-drop capability, security (authorization)
Conclusion

• An integrative platform is necessary for an effective and pleasant remote collaboration experience.

• Collaborative Workspace concept is suitable for engineering and manufacturing industry. It is potentially useful for digital media and medical applications too.

• Data-centric framework is needed for effective integration.

• IHPC has started work on various components of the Collaborative Workspace. Many research areas to investigate. Looking for partners.
Questions? Feedback?