Multimedia Supercomputing: Using Supercomputers to Drive Virtual Environments

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What is the CAVE ?

- Multipassenger high-end virtual environment
- Immersive realtime interactive
- Designed for large-scale applications
- Designed to interface to supercomputers
- Handful of CAVEs under development

Argonne Demonstration Applications

- Interactive molecular modeling and docking (Bash et al.)
- Metal casting and transparent mold (Domanus et al.)
- Interactive grinder with heat model (Canfield et al.)
- Dynamic mesh generation w/FEM model (Freitag, Plassmar
- Interactive reactor vessel (EBR) (Hudson et al.)
- Molecular Dynamics Algorithm (Disz, Stevens, Taylor)
- others under development

How the CAVE fits into NII

- Improved output bandwidth for supercomputing apps
- Expands user interface for non-computing people
- Supports virtual prototyping
- Supports remote training and education
- Supports telepresence applications
- New user interface frontier

Notes on the ANL NII Roadmap

- Collaborative Modeling (first row)
- Collaborative Analysis and Design (second row)
- Virtual Environments and Multimedia (third row)
- Telepresence (fourth row)

CAVE Technology Research Issues

Recording and play back of CAVE experiences

Integration of video as texture maps

Improved linkage of the CAVE to parallel supercomputers

CAVE-to-CAVE communications

Support for more than one virtual viewpoint

Heads up display and user sampling of 3D fields

Support for 3D menus and icons

Help systems and support for "Guided Tours"

Improved navigation paradigms for virtual spaces

Improved tracking and control, sonic imaging, and feedback

Improvements of display technology (support for HDTV)

Collaborative Modeling

- Traditional scientific applications boosted to grand challenges (science on steroids)
- Dominated by "proof of principle" computations, science benchmarks, "curiosity driven" research agenda, "limited" use in engineering
- Challenges are primarily in algorithms, performance of architectures, etc.
- Impact: Order 10,000 people (professional users of supercomputers)

Collaborative Analysis

- Combining CAD/Optimization/Databases with "post-state-of-the-art" applications technology to build a new generation of engineering tools
- Dominated by design and analysis of physical systems (CFD, structures, etc.)
- Challenges are software interfaces, numerical stability of coupled models, software engineering, databases and distributed computing
- Impact: 500,000 (professional computer literate engineers)

Virtual Environments and Multimedia

- Changing the user interface to remove the computer to enable direct interaction with modeled systems using virtual environments and multimedia interfaces
- Build new interactive computing environments to support human-computer interaction and also human-human interaction
- Impact: 20,000,000 (industrial technical workforce)

Telepresence

- Now that we have hidden the computer we need to remove the necessity of physical proximity
- Build the tools to support computer mediated work (human-computer, human-human, human-environment) anywhere at anytime thereby removing physical location as an issue
- Challenges are to develop telepresence technologies, including sensor fusion, realtime management of high volume low latency tolerance data, multisense datastreams, time slipping and bandwidth flexibility
- Impact: 1,000,000,000 (future planet wide info-tech workforce)

Argonne Digital Infrastructure

- ATM desktop and back bone networks
- FCS streaming data channels for RT data
- Central data stores (AFS service, archival service, database & indexing services)
- Digital/analog video distribution/switching
- ISDN integration (LAN extensions, end user PTP WANs)
- Wireless LANs (integration with wired networks)
- WAN (smds, atm, etc.)

- Goal: to run teraFLOPS applications in the `National Machine Room` with interactive immersive visualization via CAVEs @ San Diego Supercomputing Conference in December 1995.
- Needs:
  - distributed parallel applications
  - parallel programming tools ported to the NMR
  - performance monitoring tools
  - interactive immersive virtual environments
  - interactive application benchmarks
  - SW tools for managing cluster computing applications
  - SW tools for parallel/distributed I/O mapped on NMR
  - HIGH PERFORMANCE LOW LATENCY "`superVROOMnet`"
  - ideas and algorithms for managing latency
  - 30 site gang scheduling mechanisms
  - wide area implementations of collective communications

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- CAVE technology originally developed at the Electronic Visualization Laboratory, UIC