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, Plassman)
- 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.)

SuperVROOM 1995

- 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