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Personal Access Grid nodes for Immersive Collaboration

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Proposal Theme: **Technologies for Collaboration, Visualization, or Analysis**

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Personal Access Grid nodes for Immersive Collaboration

Proposal for FY 2004 HPCC Funding

Prepared by: Phyllis J. Stabeno

Executive Summary:

We propose to demonstrate how inexpensive PC-based systems can be utilized for realistic collaboration among oceanographers in general, and modelers in particular. We will achieve this by utilizing 1) Personal Access Grid software and 2) native features of ubiquitous operating systems such as Windows XP. Compact, passive stereo display systems, already installed within individual offices at low cost, will provide the hardware for immersive collaboration through shared control of 3D graphical applications. Effectively, this will create a vivid telepresence of researchers and their data in each other's office, without requiring the high cost of a full-fledged Access Grid node. Our testbed for use of Personal Access Grid software will be the collaborative work between Al Hermann at PMEL and Kate Hedstrom at the Alaska Region Supercomputer Center (ARSC). Both PMEL and the ARSC are on the NGI.

This proposal fits within HPCC's theme of "Technologies for Collaboration, Visualization, or Analysis". A central objective of this project is the development and melding of two new technologies (low-cost immersion and the Personal Access Grid node) which can facilitate the sharing of applications and data over multiple sites using high-speed networks. This approach will complement existing software used by a broad range of scientists within NOAA, and will be easily deployable within the organization. As with previous projects undertaken by our group, this project will emphasize **low-cost alternatives to high-end visualization**.

Problem Statement:

As the data available to scientists expands, the need for collaboration increases. This is especially true in the realm of numerical modeling, used as a tool for multidisciplinary environmental research. Multiple researchers at different institutions are typically involved with any one project. Conferences provide a venue for personal interaction and exchange of ideas, but with limited access to model results. Conversely, the individual can explore model output in depth at his/her own workstation, but without the benefit of interaction with faraway colleagues. The problem is compounded by the wide variety of software tools and file formats used by individuals to render their results. The challenge is as follows: **how best to facilitate the collaborative exchange of many individuals in an environment which allows full access to stored data, and allows the shared use of each individual's preferred software.** Ideally, each collaborating scientist would have full access to each other's computer screen, and each would be able to interact with that screen, to explore and discuss model features through personal interaction with colleagues. Firewalls and other digital security measures typically pose obstacles to such effective interaction between computers at remote sites.

The issue of personal interaction is not trivial. While the simple phone conference allows verbal exchange, it is generally recognized that nonverbal cues such as facial and hand gestures also communicate in the scientific enterprise. Equally important, such nonverbal cues establish a social bond among scientists, and familiarity is the typical path to further collaboration among individuals. It has long been possible for individuals at different institutions can separately peruse model output or discuss a shared picture (typically a shared gif or postscript file) by e-mail or over the phone. Nonetheless, the very act of pointing at a feature, or spontaneously commenting on some segment of an animation as it unfolds, is a powerful part of what makes a personal presence more effective than a telephone call.

What is sought, ultimately, is some low-cost means to create a vivid telepresence among researchers, akin to the experience of being in someone else's office. This is different than the typical experience of today's teleconference, where individuals gather in a room far removed from their own office. Ironically, even in the case of a "paperless office", distance from that office tends to limit access to data and other materials, due to distance from the platform running the software.

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Proposed Solution:

We believe we can achieve our goal of low-cost immersive collaboration by modestly extending and enhancing existing commodity hardware and software. Under FY 2003 HPCC funding, we have installed a commodity-based passive stereo display system within a single user's office (Figure 1), and have the equipment on hand to outfit another office in similar fashion. This system provides a vivid immersion of the researcher in his/her model output, similar to that found with the Immersadesk, while retaining all the benefits of the personal office (access to telephone, word processing, document display software, and other data). We have wired this system for maximum flexibility (Figure 2), allowing it to display from either a Windows or Linux host contained within the office, and allowing it to use any of several stereo display formats (OpenGL frame flipping, OpenGL clone mode, DirectX frame flipping). The versatility of this system renders it compatible with the widest array of stereo software, from professional applications to VRML browsers.

Figure 1. Office-based immersive visualization. Left panel shows an oceanographer (A. Hermann) using large-screen immersive hardware to visualize data in his office at PMEL. Note the use of a pull-down projection screen. Right panel shows projection equipment at the back of the office.

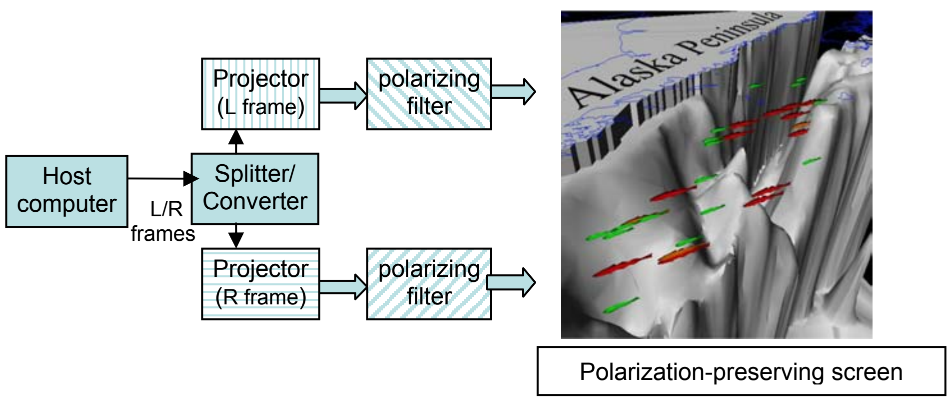

Figure 2. Schematic of host computer (commodity PC running Windows or Linux), splitter/converter, projectors, filters, and projection screen of the implemented visualization system. Thick arrows denote light path.

Software developed at NCSA and other institutions has demonstrated remote collaborative tools through Access Grid (AG) nodes. The AG technology was developed by the Futures Laboratory at Argonne National Laboratory and is deployed by the NCSA PACI Alliance. High-end nodes entail multiple cameras and microphones, large-screen display systems and powerful hosts. The Access Grid system provides a means for large-scale distributed meetings, collaborative work sessions, seminars, lectures, tutorials, and training. Its effectiveness has been demonstrated on numerous occasions at NCSA meetings, where nationally distributed participants interact with the main lecture hall. The Access Grid is now used at over 150 institutions worldwide. Recently, Personal AG software has made AG utilities accessible to individual PCs running Linux or Windows XP. As with a full-fledged AG node, users equipped with such software (especially when multicasting abilities are available) can share video images and other applications over the web. In parallel with these developments, a growing community of researchers has been implementing low-cost passive stereo display systems, commonly known as "Geowalls". These allow immersion in data using dual projectors and passive polarizing filters. Over 250 institutions now have access to Geowalls.

There have been fledgling attempts to meld these two threads; some Geowalls have been referred to as AGAVEs (Access Grid Node Virtual Environment). The overall concept behind the AGAVE project is to append a low-cost PC-based graphics workstation to an AG node; stereoscopic computer graphics allow collaborators to immersively share 3D content. We seek to bring NOAA into this larger community effort, by melding the Personal AG software and Geowall hardware for use within a single researcher's office.

It is significant to note that many PCs may already have the capability for remote collaboration without the use of Personal AG software. Windows XP Remote Assistance (a built-in feature of this operating system) offers the ability to remotely control another PC, such that two individuals can simultaneously view the same screen. This ability far transcends simple "screen scraper" programs, an aspect of some significance to the shared viewing of 3D objects. Instead of simple screen images being sent, the system takes advantage of OpenGL and related APIs to send compact information about visual images. This allows both collaborators to make full advantage of local graphics hardware, for quick rotation and manipulation of jointly viewed objects.

We propose to implement and test the Personal AG software, built-in XP software, and other commodity software for remote PC access, as candidates for low-cost collaboration using our commodity hardware immersive display system. As an extension of simple video streaming, and to take full advantage of the stereo display system, we will explore the use of low-cost dual cameras for a more vivid (that is, stereoscopic) telepresence with collaborators. Cameras will be set up for display of the users and blackboards within their offices. As we already have the immersive displays on hand, hardware requirements are approximately: stereo camera system and webcams, echo-cancelling microphones, video capture card, and host PCs.

The first target group for the proposed system is the distributed group of collaborators running nested physical and biological models of the Northeast Pacific under NOAA/NSF-funded GLOBEC support. One of the PIs (Hermann at PMEL) is a leading PI of the GLOBEC effort, and a second PI (Hedstrom at ARSC) is a major collaborator. They will serve as the initial testers of the inter-laboratory system; ARSC is already equipped with an AG node, and both laboratories are on the NGI. A second target group is the users of the TeraGrid and the proposed NOAAgrid, currently in development between NOAA/PMEL and NOAA/FSL. The proposed system would allow collaborative remote visualization of widely distributed datasets produced on the Teragrid and NOAAgrid. A third target group is the NCSA-based MEAD project, as described in the analysis section.

Major activities planned under this proposal are as follows:

1. Add necessary hardware to our existing stereo display systems at PMEL.
2. Implement Personal AG and related software on hosts running the display systems.
3. Use these systems to demonstrate telepresence between offices within PMEL

4. Explore alternatives (firewall issues and logistics) for extending this capability across laboratories. This phase will be undertaken with support from NOAA/CNSD.
5. Implement the chosen approach between PMEL and ARSC laboratories, in collaboration with ARSC.

Analysis:

The proposed system offers the possibility of affordable remote collaboration among modelers, from their native habitat. In past research we have explored collaborative immersion using specific software, such as the Cortona VRML viewer. This goal proposed here is more general, as it entails collaborative use of **any** application through the use of a remote desktop. A portion of the funds requested will be applied to CNSD at PMEL to deal with security issues, e.g. the need for putting hosts electronically "outside the firewall", while physically retaining them within the individual office.

The proposed melding the Personal AG and passive stereo technologies at NOAA complements NCSA's MEAD (Modeling the Environment for Atmospheric Discovery) Expedition, with which two of us (Hermann, Moore) are actively involved. The goal of the MEAD expedition is the development/adaptation of cyberinfrastructure that will enable simulation, datamining/machine learning and visualization of hurricanes and storms utilizing the TeraGrid. Under MEAD, portal grid and web infrastructure will enable launching of hundreds of individual WRF (Weather Research and Forecasting), Regional Ocean Modeling System (ROMS), or WRF/ROMS simulations on the grid in either ensemble or parameter mode. Metadata and the resulting large volumes of data will then be made available through the MEAD portal for further study and for educational purposes. MEAD includes a Collaborative Analysis and Visualization component, in collaboration with the Scientific Workspaces for the Future Expeditition; we will draw on the expertise of this group in our development work.

The MEAD project itself will benefit from this work, as it is a collaboration of 15+ scientists spread across the US. Several of the home institutions of these scientists (NCSA, Rutgers, UChicago) are equipped with AG nodes; our proposed work will expand this community at low cost. NCSA meetings are routinely broadcast over the AG network; with their own Personal AG, PMEL collaborators will be able to participate in these meetings.

Finally, the proposed work will also advance the goal of immersive collaborative research directly within the NOAAGrid proposed by Dan Schaffer and colleagues at NOAA/FSL. Both Hermann and Moore are actively involved with present TeraGrid work funded by HPCC (in collaboration with Schaffer).

Performance Measures:

We would consider this project successful if it enables us to create an effective, data- and application-sharing telepresence within and between laboratories, and encourages others to acquire similar capabilities at their laboratories.

Milestones

Month 01 - research and order hardware
Month 03 - configure and deploy new hardware with existing PCs and workstations
Month 04 - implement system between nodes within one laboratory (PMEL)
Month 06 - implement system between nodes at different laboratories (PMEL and ARSC)
Month 12 - develop web pages describing our experience; demonstrate system at conferences

Deliverables

- Web pages describing our experience
- A portable version of the completed system, for use by this laboratory

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