A REPORT ON PLANS FOR A TERAGRID

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1. INTRODUCTION

The TeraGrid is a plan to advance the cyberinfrastructure for 21st century science and engineering. It is a response to the pressing need for greater computational power to enable experimentation, modeling, data analysis, and visualization activities that often involve large volumes of data and use of an expanding national computational grid. It is a vision to develop and deploy a comprehensive computational, data management, and networking infrastructure of unprecedented scale and capability that couples distributed scientific instruments, terascale and petascale computing facilities, multiple petabyte data archives, and gigabit and beyond networks, all widely accessible by researchers including those in the atmospheric sciences, oceanography, and hydrology.

The TeraGrid is an outgrowth of the NSF PACI program that has two leading edge sites, NPACI in San Diego, CA and NCSA in Champaign/Urbana, IL. Facilities and resources from these and affiliate sites have been used by a growing number of geoscientists during the last decade. Over the past several years there has been increased emphasis within PACI on use of the national grid in support of distributed computation, distributed data access and processing, distributed datamining, and distributed collaboration. Infrastructure developments in support of this emphasis have included Globus middleware for authentication and security and the Access Grid for collaborative group meetings and distributed presentations. The TeraGrid is a natural extension of these and other developments. It will provide the geoscience community (including atmospheric science, oceanography, and hydrology) an infrastructure for actively and daily pursuing new research problems where location of resources being used and of people participating does not inhibit progress.

2. THE TERAGRID

The Teragrid plans call for provision to the national research community of multiple teraflop computing capabilities in the form of Linux clusters that support multi-teraflop model simulation, petabyte data analysis capabilities, high-performance visualization on remote platforms, and high resolution wall displays. Further, the software infrastructure necessary to support research productivity in this environment will be enhanced. The foundational support for the TeraGrid comes from a recently funded NSF proposal entitled “The TeraGrid: Cyberinfrastructure of 21st Century Science and Engineering.”

The TeraGrid facility will be deployed among four major institutions, NCSA, SDSC (San Diego Supercomputing Center), Argonne National Labs and Caltech. In partnership with IBM, Intel, Qwest, Oracle and SUN, the facility will consist of terascale Linux clusters that use Intel’s next-generation McKinley microprocessor, large-scale storage archives and data management software and a 40 Gb/s optical network to interconnect the components. This facility will increase PACI computing, storage and communication capability by an order of magnitude. The aggregate computing power will be 13.5 teraflops with roughly 600 terabytes of disk storage. Tertiary storage will be in the multiple petabytes. Operating as a distributed resource that can be co-allocated and scheduled, the TeraGrid will support traditional scientific computing and emerging disciplinary scientific groups. A unified TeraGrid Operations Center will coordinate management, user support, and access.

Fig. 1 shows the proposed TeraGrid layout. It will be augmented by facilities at the various sites. For example, at NCSA there will be more than 10 teraflops of computing capability including the current teraflop IA32 (Platinum) and IA 64 Linux clusters (Titan) along with NUMA SMP capability. By the end of 2002 there will be 240 terabytes of secondary disk storage and nearly 1.5 petabytes of archive storage. A large display wall (see 12.8 in this preprint volume) and Access Grid capabilities are already present.
Fig. 1. This figure shows the various components of the TeraGrid as currently envisioned. The network between the sites will be 40 Gbits per second, over 10 times the bandwidth of the Abilene network (OC-48, 2.5 Gbits per second). The aggregate computing power will be 13.5 teraflops with roughly 600 terabytes of disk storage. Tertiary storage will be in the multiple petabytes.

3. 21st CENTURY TERASCALE APPLICATIONS

There is an unending need for computing power in the geosciences directed at modeling efforts that include data assimilation, model simulation, data analysis, and visualization. Equally important are the power needs for data collection, processing, and visualization. With the increase in power and data handling capabilities available across national and international networks that is achieved through use of distributed architectures (e.g. Linux clusters, distributed data repositories), researchers in all fields including the geosciences are becoming more dependent on the development of community codes and data handling tools that can fully tap into this infrastructure. For example, the developers and users of emerging terascale application codes face many challenges including the efficient usage (both computing and I/O) of parallel computing systems (and collections of these systems). Other users are creating or mining multi-terabyte data sets data from multiple sources to extract scientific insights. Still others are coupling scientific instruments (e.g., Doppler radar, radio telescopes, electron microscopes, beam lines) for near real-time data processing and analysis. Some applications embody all three aspects – these Grid-enabled applications will couple geographically separated computing, storage systems, and instruments to achieve breakthroughs. For example, the LHC (Large Hadron Collider) experiments will require filtering of petabytes of data to detect “one in a trillion” events. Such codes embody common usage models for high-end applications and exemplify “community toolkits” used by many more researchers than just the developers. The PACI partnerships plan to work with the developers of these community codes and domain toolkits to optimize their performance for the distributed terascale facility and its TeraGrid, immediately broadening the research base for terascale infrastructure.

The Weather Research and Forecasting Code (WRF) is an example of one geoscience code being ported to the TeraGrid including enhancements for use with emerging portal, visualization, and

http://www.wrf-model.org
D2K: Data To Knowledge is a next generation workspace architecture for the creation of data analysis applications in any domain area. It is a visual programming environment that allows users to easily connect software modules together in a unique data flow environment to form an application.

The NCSA tiled wall and its use is described in preprint 12.8 in this volume.

http://www.ncsa.uiuc.edu/News/Access/Stories/IAB/NEESgrid.html

Acknowledgements

Text from the TeraGrid proposal (PI: Dan Reed) is edited and used in this preprint. Thanks to all those who contributed. This preprint can be found at http://redrock.ncsa.uiuc.edu/AOS/home.html under publications.