High-Performance Networking Tasks of Terascale Supernova Initiative

The terascale supernova initiative involves a wide spectrum of tasks that are cooperatively performed over wide-area networks by a group of domain experts distributed at various national laboratories and universities. The tasks range from the cooperative remote visualization of massive archival data to the interactive steering of a supernova computation. In both cases, the data is to be rendered and presented on-line to the participant sites with different end-devices that range from visualization caves through high-end workstations to personal desktops. Typical data transfer rates needed over the networks are of the order of several hundred megabits per second. The networks over which such collaborations can be carried out could be quite varied, with national laboratories connected over the ESnet, and the universities connected via Internet2 and the Internet. In the most challenging case, the computation itself is to be interactively visualized and at the same time controlled over the network by the experts in various fields such as hydrodynamics, radiation transport, and nuclear physics, who are themselves geographically dispersed across the country.

Two important classes of high-performance networking capabilities are critical to a successful execution of the above tasks. First, large volumes of data must be *transported* to various end nodes over the networks of disparate and varying capacities and traffic. Such data transports might be required in an off-line mode for data archiving or post processing, or in an on-line mode for interactive visualization. Second, the visualizations and computations must be *controlled* remotely over wide-area networks to ensure the responsiveness as well as the stability of control loops. This task requires the higher-order moments of delays be kept suitably bounded: high levels of jitter in the control signals can destabilize and steer the remote process into unwanted regions. This problem is particularly acute when the computation is guided by a number of remote experts, each with a different process view and different parameters to control.

A number of current SciDAC and base high-performance networking projects can contribute significantly to various components of the needed networking tasks. The high performance transport modules can be provided by the base project at LANL, and also the Net100 project at ORNL, PSC, NCAR and LBL. Both of these transport efforts rely on tuning the TCP parameters to achieve optimal throughputs. While both efforts utilize their individual measurements, such as Web100 instruments in the Net100 project, complimentary measurements of available bandwidth across the network can also be measured by the SciDAC project at USCD, LBL and U. Delaware. Furthermore, bandwidths of the tuned streams can be augmented by the multiple path methods of the Net100 project. The data transport can be enhanced by the infrastructure of data depots deployed under the logistical networks framework being developed at UTK. The application-level performance of data transport can be enhanced by utilizing the source filtering methods developed at GaTech, wherein non-useful data is screened out before being passed on to the transport modules.

The needed network control functionality can be provided by the multiple path controls developed at ORNL. The multiple paths are utilized to increase the bandwidth, which is then traded off by an end filter to reduce or eliminate jitter. Another method employs independent throttles with the streams over multiple paths; the streams are individually monitored for the level of dynamics and are adjusted to balance out the jitter. This task requires detailed traffic monitoring and estimation, which is performed by the SciDAC project at Rice University, LANL and SLAC.

While several existing networking projects can provide components, a complete solution to the networking needs of the terascale supernova initiative requires additional efforts, such as customizing the transports for remote visualization and control, and integrating the networking modules into the application.

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