Network Status and Objectives

April 12, 2000

This report summarizes the present status and future objectives of Clemson University in developing infrastructure and applications consistent with the objectives of Internet2.

1 Infrastructure

Infrastructure improvements are proceeding in two areas. Existing 100 Mbps FDDI backbone services are being phased out and replaced by Gigabit switched Ethernet backbones. Routers serving both the Department of Computer Science and several Engineering departments are now connected directly to the Gigabit backbone. Service to the backbone is via 100 Mbit fast Ethernet trunks. This 100 Mbit service is being incrementally extended to the desktop as end-systems and hubs are replaced. These improvements provide low-latency paths with minimal routing hops. As shown in the *traceroute* output below, packets transmitted from end-systems in the Department of Computer Science can reach the SoX gigapop in 3 hops.

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1  130.127.48.1 (130.127.48.1)  1.040 ms  0.844 ms  0.970 ms
2  border-atm-r01.clemson.edu (130.127.12.6)  0.929 ms  1.227 ms  0.594 ms
3  sox-atl.clemson.edu (130.127.3.6)  16.642 ms  16.751 ms  17.085 ms
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A parallel, research-only ATM network has also been established. It reaches research labs in both the Dept. of Electrical and Computer Engineering and the Dept. of Computer Science. Additional switches have been purchased in the past year and will be used to extend this network into other research facilities.

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1  poole-7500.clemson.edu (130.127.4.1)  0.989 ms  0.848 ms  0.821 ms
2  border-atm-r01.clemson.edu (130.127.12.6)  0.950 ms  1.254 ms  0.855 ms
3  sox-atl.clemson.edu (130.127.3.6)  17.871 ms  17.480 ms  17.205 ms
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2 Participation in a Gigapop

Clemson University, the Medical University of South Carolina, and the University of South Carolina submitted a joint HPC/Internet2 connection proposal which was funded by the NSF. TogEther, we share an OC-3 link from Columbia, SC to the SoX Gigapop near Atlanta.

3 Development of Advanced Applications

Our Internet2 connection proposal to the NSF identified a diverse group 10 applications that included areas such nanotechnololgy and the engineering of artificial human joints in addition to applications in network protocol development. In the remainder of this section we describe in some detail one application that is ongoing and another that is in the proposal stage.

3.1 The Clemson/NASA Regional Application Center

NASA and Clemson University have formed a collaborative effort for the establishment of a remote sensing Regional Applications Center (RAC) to service the southeastern regions of the US. The primary purpose of the RAC is to allow

NASA to test and transfer its remote sensing technology to the outside community. Through the RAC, universities, private industry and federal agencies have the ability to retreive and use localized satellite data on a routine basis.

In the system presently operating at Clemson, a GOES ingest system receives geosynchronous weather data via satellite downlink on a continuous basis at a rate of about 1GB of raw data an hour. Ongoing research efforts include development of high performance methods for processing the raw data, archiving it, and presenting it for retrieval by customers at remote locations. Because of the enormous volume of data involved and the need to present it in image form, high performance networking is a critical enabling technology. The principal investigator of this project is Prof. Walter Ligon of Electrical and Computer Engineering.

3.2 Distributed Virtual Environments

In the past decade researchers at Clemson and elsewhere have created a large body of knowledge in the building and projection of immersive virtual environments. These environments have proven very useful in facilitating the understanding of complex physical systems. However, the usage of such systems is typically confined to the physical site where the graphics super-computer that provides the virtual environment is located.

Availability of high speed networks offers the potential for building distributed virtual environments that could significantly facilitate the collaboration of researchers at different sites. An ideal system of this class would provide real-time, photo-realistic rendering and include cues to presence such as the proprioceptive feedback offered by an ability to see oneself and others within the environment. However, to successfully deploy such a system, it is necessary to overcome both the the obvious challenges in the graphics domain, and significant network-related obstacles. Principal among the network related issues are:

- quality-layered video encoding: Video (pixel level) encoding for transmission is preferable to model encoding in that it allows local site model independence and reduces local site hardware demands. However, quality layers, typically generated through transform encoding, must be provided to allow communication protocols to adapt to network congestion.
- adaptive network protocols: Even with Internet 2 speeds, the proposed interactive traffic must compete for bandwidth with conventional TCP traffic. User perception of delays (psychophysics of time duration) must be integrated into protocol design. Further, users object to signal quality transitions as well as simple delays and quality degradation. Although UDP-based alternatives to TCP, e.g., the Rate Adaptation Protocol designed at USC, have been proposed, such protocols only serve as a base on which other constraints may be added. Quality-based constraints to enforce smooth layer transitions and buffer handling will be essential.

Researchers at Clemson University and the University of Southern California are collaborating in a joint proposal requesting funds to develop a prototype of such a system. The proposed project is an activity of Clemson University's Center for Advanced Engineering Fibers and Films (CAEFF),recently designated a national Engineering Research Center by the NSF. Professor Robert Geist of the Dept. of Computer Science is the Principal Investigator at Clemson.