Some Salient Results of the HAVnet Project

Stanford University

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The project goal was to create a national testbed to determine whether network-aware, scalable applications could operate over a national, high-performance network. The project also required determination of the impact of such applications to the individual, the enterprise and on current technology.

1. Our collaborative team (Stanford University and the Universities of Wisconsin and Michigan) successfully constructed, evaluated and deployed a Scalable Information Infrastructure for Medical Education.

2. One salient achievement was establishing a distributed learning environment for one of our testbeds, Clinical Anatomy, linking two medical campuses in Northern Ontario (NOSM) with the Stanford University Medical School campus. NOSM represents the learning of the future, with a scattered student population joining lectures and discussions from locations hundreds of miles apart. The faculty draw on unique rich media and numerically-intensive simulations from Stanford and Wisconsin, and teach simultaneously at two locations of their far-flung campus.

3. We have established that medical students at Michigan, Stanford and Northern Ontario value highly the ability to view, interact and learn with rich image sets that provide stereoscopic 3D viewing of detailed anatomy.

4. We have determined that effective human interactions utilizing transmitted data also requires the support of video feeds so that students and teacher are able interact visually and audibly. We have further determined that high definition video significantly enhances the sense of presence at remote locations, improving the effectiveness of the learning interaction.

5. The middleware developed by Steven Senger, our subcontractor at the University of Wisconsin, La Crosse, enabled highly immersive interaction between students and media resources. The middleware helped define the features of the network required for high-performance collaborative learning environments.

6. Participation in the Internet2 forums by Steven Senger and Parvati Dev significantly influenced the focus of the organization on the importance of End-to-End Performance. The team effort was recognized by the granting of the CENIC 2007 Award for Innovation in Networking. The importance of high-performance networking in medical education was highlighted in a presentation by W. LeRoy Heinrichs to the FCC Commissioner, Michael Copp, at a demonstration in Washington DC attended by Michael Ackerman.

7. We have also determined some unexpected limitations in current advanced networks. Serious collaborative learning environments in medicine require network features such as multicast, that have proved extremely unreliable and difficult to provision in most regional and local networks though it is routinely available on the backbone national network. We have also established that commercial networks do not provide, except at extremely high prices and with significant provisioning delay (months), the high bandwidth (10 Mbps and above) for real-time simulation and video transmission for meeting today's educational expectations.

8. Developing our online test-bed for Clinical Skills using SPRING, an open-source software released by the Stanford-NASA Biocomp Center, effectively united a community of users of SPRING, and of other open-source platforms, both nationally and internationally. A low-cost, haptically-enabled, laparoscopic Suturing Trainer that is networked with other similar trainers was demonstrated in September 2007 at a Simulation Laboratory at an international surgical meeting. Fundamental research at SUMMIT determined the diversity of haptics perception among users, including surgeons, and the level of 50msec as the break-point in latency at which users begin having to accommodate to the network performance.

9. A haptically-enabled tele-dermatology diagnostic probe was developed (patent application submitted) using a master-slave robot arm configuration for remote palpation of skin lesions. The sensor probe includes pressure sensors and accelerometers for fine sensing of skin textures e.g. fingerprint ridges, smooth versus rough surfaces, and irregularities. This promising research is seeking further funding.