Argonne National Laboratory high-performance network support of APS experiments

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Argonne National Laboratory is currently positioned to provide access to high-performance regional and national networks. Much of the impetus for this effort is the anticipated needs of the upcoming experimental program at the APS. Some APS Collaborative Access Teams (CATs) are already pressing for network speed improvements and security enhancements. Requirements range from the need for high data rate, secure transmission of experimental data to the desire to establish a "virtual experimental environment" at their home institution. In the near future, 155 Megabit/sec (Mb/s) national and regional asynchronous transfer mode (ATM) networks will be operational and available to APS users. Full-video teleconferencing, virtual presence operation of experiments, and high-speed, secure transmission of data are being tested, and in some cases, will be operational. We expect these efforts to enable a substantial improvement in the speed of processing experimental results as well as an increase in convenience to the APS experimentalist.

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I. INTRODUCTION--THE DATA EXPLOSION

The Advanced Photon Source (APS) will enable scientists to study more complex systems, faster reactions and processes, and to gather data at a greater rate and level of detail than has been possible to date. Each of these factors has the independent potential of increasing by a large degree the amount of experimental data collected. This data could be stored at the experiment site or in an APS or Argonne data storage facility, or it could be stored on optical disks and transported to the scientist's home institution for storage and use. However, the continuing growth and increasing speed of regional and national networks will make possible the quick relocation of the data and will open possibilities for rapid interaction of the expose/analyze/modify/expose cycle for certain types of experiments.

In addition, as more and faster data networks become available, other uses of these networks, not normally thought of, will become realizable and even attractive for the APS experimentalists. Network-based teleconferencing, remote monitoring and control of some portion of the experiment itself, and even educational experiences based on display of the data from a running experiment will all be within the realm of possibility.

II. APS NETWORK INFRASTRUCTURE

To provide for adequate security, initial bandwidth and bandwidth growth, and user-to-user separation, the APS is installing a network infrastructure based initially on FDDI (100 Mb/s) service to each lab office module (LOM). Each user group, known as a Collaborative Access Team (CAT) can receive Ethernet (10 Mb/s) or FDDI service from the router and hubs located in each LOM. An average of three network subnets per sector can be provided with the APS Class-B license to allow for address separation between CATs and their beamlines.

Figure 1 shows the APS FDDI network as a ring network. It is physically a "collapsed ring" and will allow an upgrade to switched FDDI in the future to gain higher aggregate data throughput. Dark fibers are available for special CAT needs. Also shown in Figure 1 is an asynchronous transfer mode (ATM) switch connected to all LOMs. This switch will be utilized by those CATs which require very high data transfer rates -- initially up to 622 Mb/s. The ATM protocol allows data, voice, and video to be intermixed while providing priority and "class-of-service" to be maintained.

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MASTER

Figure 1

III. LABORATORY-WIDE NETWORKS

The Argonne network topology consists of a hierarchy of networks, including local area networks based on Ethernet or FDDI encompassing buildings or programs, a Lab-wide network currently based on FDDI, and gateways to national and regional networks. Argonne is currently starting to deploy ATM technology and the APS ATM switch will be directly connected to the Argonne campus ATM switch, shown in Figure 2, which in turn will provide connections to Argonne's central computing and file services.

Figure 2

Perhaps more important to CATs based outside of Argonne is that the Argonne ATM switch will provide direct, high-bandwidth connections to several regional and national networks, most of which will also provide high-bandwidth ATM service in the near- or long-term.

IV. NATIONAL AND REGIONAL NETWORKS

Argonne National Laboratory is positioned to provide high-performance national and regional network connectivity for support of APS experiments. The Laboratory provides computer users with state-of-the-art connectivity to ESnet, CICnet, and MREN and is working with the major carriers (e.g., Ameritech, AT&T, MCI, and Sprint) to further develop the Laboratory networks as commercial network services are deployed. The following sections describe these programs.

ESnet

The U.S. Department of Energy's (DOE) Mathematical, Informational and Computational Sciences Division (MICS) operates a national network called the Energy Sciences network (ESnet). ESnet provides connections to a number of DOE backbone sites, including Argonne. ESnet is an ATM network that is run by the National Energy Research Supercomputer Center (NERSC) at Lawrence Livermore National Laboratory in California. Argonne is working with NERSC to upgrade its ESnet connection from 45-Mb/s to 155-Mb/s in FY1996. Sprint is the national ATM carrier for ESnet. The ESnet national backbone network is shown in Figure 3.

Figure 3

CICnet

The Consortium for Institutional Cooperation (CICnet), which provides data communication links to many Midwestern regional universities and other regional sites, is shown in Figure 4.

MCI is the carrier for CICnet and provides network services to CICnet via a 45-Mb/s connection to the MCI national network. Argonne is

a member of CICnet and connects to CICnet over four 1.544-Mb/s links.

We are working to keep bandwidth of CICnet just ahead of need.

Figure 4

MREN

The Metropolitan Research and Education Network (MREN) is an interorganizational high-performance network that interconnects the University of Chicago, Argonne National Laboratory, Fermi National Accelerator Laboratory, Northwestern University, and the University of Illinois at Chicago via the Ameritech Public Data Network (APDN). The APDN runs over an optical carrier 48 (OC48 - 2.488 Gigabit/sec) backbone. Argonne National Laboratory connects to the APDN backbone at OC3 - 155 Mb/s as shown in Figure 5.

Figure 5

Commercial Network Services

Argonne is working with Ameritech, AT&T, MCI, Sprint, and other communications providers to allow Argonne to connect to the commercial network services as it is deployed. There is a business case that is being formulated to allow APS CATs to reach their APS experimental facilities over a high-performance network from their home sites. The MCI example shown in Figure 6 is an example of the connectivity options being discussed with the carriers.

Figure 6

V. NETWORK SECURITY

Argonne runs a laboratory networking environment that includes Kerberos V4 and the Andrew File System. In addition, Argonne chairs an ESnet authentication project that deals with authenticating users working at autonomous sites who need to share data. By using Kerberos V5 security services, a working environment can be established across a wide-area network without using passwords across the network. Security options are dependent upon the CAT team's home site security. The following security options are available to the APS user community:

- Sites can be responsible for their own security by using encryption hardware as needed
- Andrew File System using access control lists and Kerberos V4
- Kerberos V5
- Open Software Foundation (OSF) Distributed Computing Environment (DCE) with Kerberos V5 plus extensions

- Standard operating system security features (more security features are being added to standard operating system products)

VI. RECOMMENDATIONS

As the APS network infrastructure, the ANL Laboratory Network, and external networks continue to evolve, the CATs can get updated information on these networks through the APS WWW at URL <http://www.aps.anl.gov/welcome.html>

VII. RECOMMENDED PUBLICATIONS

The final report and recommendations of the ESnet Authentication Pilot Project is on the WWW at URL <http://www.es.net/pub/esnet-doc/auth-and-security>

VIII. ACKNOWLEDGMENTS

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