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OAK RIDGE Y-12 PLANT

LOCKHEED MARTIN

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Final CRADA Report
for
CRADA Number ORNL 91-0069 and ORNL 92-0124

TESTING OF HIGH SPEED NETWORK COMPONENTS
(RNET PROJECT), WITH IBM AND BELL SOUTH
(91-0069), AND TESTING OF HIGH SPEED NETWORK
COMPONENTS (CAMPUS LAN PROJECT) WITH IBM
(92-0124)

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FOR THE UNITED STATES
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Abstract: The Gigabit network project was established to demonstrate ATM technology in a realistic metropolitan environment running realistic applications, which would stretch its capacity. Despite considerable obstacles, both technical and logistical, the Gigabit Network project succeeded in establishing a network infrastructure that has served the Oak Ridge complex well during the last two years, and will continue to serve it in the future. The project did not, however, succeed in demonstrating the showcase applications on an ATM network. Development and delivery of a working ATM switch ultimately became the pacing item in the project, and after a number of delays, the project was terminated without placing a switch in service.

Statement of Objectives: As described in the abstract, this CRADA was established to demonstrate ATM technology in a realistic environment. It was a part of a multi-lab-coordinated effort to demonstrate a variety of gigabit networking technologies. Related projects existed at LLNL (Wave Division Multiplexing), Sandia CA (Fiberchannel), and Los Alamos (HiPPI).

The objective of placing an ATM switch into service was not met.

Benefits to the Department of Energy/Defense Programs: Despite the fact that our partners failed to deliver a working switch, the benefits to DOE were substantial. Both the Y-12 and X-10 sites had previously spent General Plant Project (GPP) funds to build backbone fiber networks within their respective campuses. In parallel with this, the Oak Ridge Federal Integrated Communications Network project (ORFICN) was installing fiber to interconnect the three Oak Ridge sites. However, neither the GPP nor the ORFICN projects provided (or had any plans to provide) fiber that would connect to the outside world. In addition, the ORFICN fiber wasn't scheduled to become available for use until the summer of 1996. Thus, at the time of this project, there were no facilities available for high-speed network connections between Oak Ridge sites, to other DOE sites, or to the Internet. This project installed fiber that supported those connections. At the time this project was started, the total unclassified network bandwidth connecting the Oak Ridge to the rest of DOE (and to the Internet) was 3 Megabits per second, provided by two T1. Because there was no fiber leading off-site, there was no practical way to increase this capacity to support improved connections to the Western Labs, to Headquarters, to the Internet, and even (then) between the sites in Oak Ridge. Starting in the spring of 1994, fiber installed by this project allowed Oak Ridge's connection to ESnet (and to the Internet) to be improved from 3 Megabits/sec (2 x T1) to 45 Megabits/sec (T3). Today that external connection has been improved again, this time to OC3 (155 Mb/s). It is still being carried on fiber installed by this project, and will continue to be for some time to come. In addition, the high-speed SecureNet connection between Y-12 and the Western Labs is also being carried on this fiber today.

Work Accomplished: Understanding the work accomplished requires some background and context. At the inception of this project, a battle was being fought between computer oriented networking technologies and telephone oriented technologies. The telecommunications industry wanted to standardize on Asynchronous Transfer Mode (ATM) as the technology of choice for carrying all cross-country traffic. The computer industry, or at least IBM and its allies, proposed to use Packet Transfer Mode (PTM). The chief distinction between these is that ATM is based on fixed-size, small (48-byte payload) cells. In contrast, packets can have varying sizes, with as much as 8 kilobytes of payload available in some implementations. Switches able to deal with packets would be significantly more expensive than switches designed for handling cells. Small, fixed size cells provide an optimal framework for transmitting real-time data (primarily voice and video) and the telecommunications industry, which was and is still heavily focused on voice saw cells and cell switches as the optimal approach to network expansion. However, computer data can be handled much more efficiently with packets, and the

computer industry preferred not having to slice big data packets into tiny cells. Thus both groups were focusing on solutions optimized for their own needs. Since all cross country traffic (including voice) is digital today, the issue was fundamental. IBM had invested considerable effort in developing a PTM switch which it felt was demonstrably superior to ATM. Both BELLSouth and IBM were looking for a test site which would offer a tightly controlled, high-technology environment, where the PTM and ATM technologies could be tested in near real world conditions. They needed a location with computer networks supporting sufficiently demanding loads to provide a realistic test, where there were sophisticated network experts who could participate in the tests, and finally, which covered a sufficiently large geographic area to provide a good simulation of a metropolitan environment. Since ORNL has research staff with joint ORNL-UT appointments, a network spanning the complete reach from K-25 to the UT campus in Knoxville was easily justifiable and would more than provide the required metro-scale test. IBM and BELLSouth approached us in the early summer of 1991 to ask if we would be interested in participating. The CRADA negotiations extended over the next year and a half, with the CRADA finally being signed in the spring of 1993. By the time the CRADA was signed, much of the discussion of ATM vs. PTM was moot. ATM had won, IBM saluted, and promised to deliver a high-performance ATM switch (which, however, still was to be capable of switching packets and needed a test site).

Shortly after the CRADA was signed, IBM shut down the switch development effort at their T. J. Watson research center. Much of the project and most of the people were spun off to a subsidiary services company, Advantis. Advantis was still very interested in potential applications which would require a broadband, gigabit network to support (and which they could supply) and since this was easily within the scope of the proposed work we shifted our attention to development of distributed, high-performance applications (while still working on improving the Oak Ridge fiber infrastructure).

This fit nicely with BELLSouth's needs, which had also evolved during the year and a half of negotiations. BELLSouth was looking for applications, which required broadband high-performance network technology. They needed showcase applications, which could help stimulate or otherwise demonstrate the benefits of high-performance networking.

After exploring several alternatives, we settled on an application that models groundwater transport. This is a complex modeling problem that requires a high-performance computer like the Paragon or IBM SP2. Proper visualization of the results requires a high-performance network between the modeling computer and the display site or workstation. Finally, given the large number of sites needing remediation, modeling, and cleanup, it seemed clear that it represented an attractive business opportunity. Groundwater transport modeling had been identified as one of the DOE "Grand Challenge" high-performance computing efforts, and was an on-going development project at ORNL. Enhancing the code to work well in a distributed model-visualizer environment was a natural way to leverage both projects.

In parallel with this software development, we proceeded building network infrastructure. Working with BELLSouth, an OC12 (600 Megabit/sec) Synchronous Optical Net (SONET) ring was installed from the BELLSouth Central office in Oak Ridge to the Y-12 and X-10 sites. In December of 1994 the Oak Ridge external connectivity was upgraded from T1 to T3 using this fiber.

Meanwhile, IBM once again committed to producing high-performance switches, this time through their development lab in Research Triangle Park in North Carolina. We negotiated with IBM to test an early version of their Nways ATM switch design, but delivery was delayed, and in late summer of 1995, the project was terminated.

Inventions Made or Reported: None.

Assessment of Commercialization Possibilities: The FEMWATER code (and its enhanced distributed parallel version, PFEM) will not be commercialized.

Plans for Future Collaboration: None at Present.

Conclusions: One could legitimately conclude that this project suffered from side effects of the re-engineering efforts of corporate America in the early 1990's.

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