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**GENERAL-PURPOSE COMPUTER NETWORKS
and
RESOURCE SHARING in ERDA**

MASTER

**VOLUME 3
REMOTE RESOURCE-SHARING EXPERIENCE and FINDINGS**

JULY 15, 1977

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Working Group on Computer Networking
Mathematical and Computer Sciences (EE-03-04),
Office of Engineering, Mathematical and Geo-sciences,
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**GENERAL PURPOSE COMPUTER NETWORKS
and
RESOURCE SHARING in ERDA**

Volume 3

REMOTE RESOURCE SHARING EXPERIENCE and FINDINGS

July 15, 1977

**Compiled by the ERDA Network Investigator's Panel
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PREFACE

This volume brings together one part of the results of a networking study by investigators at ANL, BNL, LBL, LLL, LNS-MIT, NYU-Courant and UCLA. The work started approximately four years ago and was supported by the Division of Physical Research through its Mathematics and Computer Science Research Program.

The investigation focused on heterogeneous networks in which a variety of dissimilar computers and operating systems were interconnected nationwide. Homogeneous networks, such as MFE net and SACNET, were not considered since they could not be used for general purpose resource sharing.

Issues of privacy and security are of concern in any network activity. However, consideration of privacy and security of sensitive data arise to a much lesser degree in unclassified scientific research than in areas involving personal or proprietary information. Therefore, the existing mechanisms at individual sites for protecting sensitive data were relied on, and no new protection mechanisms to prevent infringement of privacy and security were attempted. Further development of ERDA networking will need to incorporate additional mechanisms to prevent infringement of privacy.

The investigation itself furnishes an excellent example of computational resource sharing through a heterogeneous network. More than twenty persons, representing seven ERDA computing sites, made extensive use of both ERDA and non-ERDA computers in coordinating, compiling, and formatting the data which constitute the bulk of this report.

Volume 1 summarizes the entire four year investigation into computational resource sharing through heterogeneous computer networks and makes recommendations for the future.

Volume 2 discusses technical and financial issues involved in connecting ERDA computer sites to a geographically distributed heterogeneous network.

Volume 3 analyzes the benefits and barriers encountered in actual resource sharing experience, and provides case histories of typical applications.

Volume 4 provides the basic information necessary to access and use the ERDA sites currently on the ARPANET.

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INTRODUCTION

The first goal of the ERDA investigation into computer networks was to connect the participating sites to the ARPANET. By mid 1975 the technical problems were understood, and implementation effort was well underway. However, whether the network could provide the benefits of resource sharing in the specialized environment of ERDA computing was still debated. To resolve this issue, the ERDA Network Investigators Panel was formed in October 1975 to gain first-hand experience in using the network for energy research. A series of meetings were held in which the following approach was agreed upon:

- To explore and develop network based facilities for conducting scientific research.
- To encourage exploration of remote computational resources by scientific staff.
- To monitor and analyze typical applications of network technology to energy research.

To accomplish the first objective, extensive exploratory use of the network was carried out by panel members. New resources were found, and network contacts were made. Improved user interfacing software was developed, and in some cases the host operating systems were modified to make the network more usable.

The second objective was realized in several ways. Network Primers and documentation of local resources were collected from each site, and distributed among the panel members. These documents provided the basic information required to access remote ERDA resources through the network. Panel members also provided consulting assistance to new users, and in some cases, guest accounts were opened to remove funding barriers.

The third objective was realized as a set of case histories of actual resource sharing by ERDA sites. These were drawn from ongoing projects at the various laboratories and universities, and are detailed in the appendices. This summary, compiled by the ERDA Network Investigators Panel, attempts to put into perspective what has been learned from this experience.

PROGRAMMING LANGUAGES AND COMMAND LANGUAGES

To describe the technical problems of resource sharing, it is necessary to review the steps involved in creating and executing a computational task at a single host. A computer may be viewed as a device that performs lengthy mathematical computations which could not be done by any other means. ERDA scientists prescribe the computational steps in a programming language such as FORTRAN, and these are made machine readable either by keypunching or by direct entry from an interactive terminal. For

most applications it is also necessary to provide formatted data to the program. Most often these are supplied by automatic collection devices, or by very large online data bases.

To cause the computation to be performed, the scientist must also specify the operating system services needed. Examples of these include input/output and data handling services, job and task control, security and protection, accounting information, and network access facilities. In short, these are all the operating system resources which are not selectable in the programming language itself. Specification is done in what has come to be called a "command language" or "job control language", and must also be made machine readable by keypunching or interactive terminal entry.

The separation between programming languages and command languages is not a clean one. Some, but not all operating system requests may be specified in a programming language. However, what may be specified in a given programming language at one host may have to be specified in the command language at a different host, and vice versa. This is a continual source of difficulty in the development of exportable software, and is encountered repeatedly in network applications.

BARRIERS TO RESOURCE SHARING

The effort required to learn enough of a command language to invoke a given task is called the "startup barrier" for that task. In some cases, where there is a high degree of inter-system uniformity such as the network commands, the startup barrier is small. However, this obviously depends on the experience of the person involved. Full mastery of a command language usually requires several months of exposure to the system. This effort is distasteful since it is entirely tangential to the energy research itself. At best, learning a new command language is tolerated as a necessary evil. On top of this, there are no accepted command language standards. Therefore, knowledge of a local command language is of little use when transporting a task to a remote host. In the ARPANET community alone there are eighteen major operating system command languages. A similar diversity is found in the ERDA sites participating in this study.

In addition to technical barriers, there are economic barriers which must be recognized. One important use of the network is to offload large scale computing tasks from smaller machines to the more powerful machines at the larger sites. At sites where computer costs are recovered on a usage basis, these tasks represent a major source of operating funds. Widespread offloading could have a serious economic impact, possibly resulting in layoffs at some sites, and surpluses at others. Moreover, these tasks form the basic justification for acquisition of new computing hardware at all sites. In light of this, the high degree of cooperation among the ERDA laboratories

participating in this study is both remarkable and encouraging.

THE RESOURCE SHARING HYPOTHESIS

It is important to recognize that scientists engaged in energy related research are reluctant to spend valuable time overcoming the barriers to resource sharing unless the associated benefits are relatively high, or the penalties for not doing so are severe. While it is not yet possible to assign quantitative values to the terms "benefits" and "barriers", it appears certain there is an underlying principle involved, which may be stated as follows:

Resource sharing will occur if and only if the associated benefits are significantly greater than the effort required to overcome the startup barriers.

This we called the resource sharing hypothesis. As a corollary, if startup barriers are negligible, resource sharing will occur spontaneously. Convincing evidence for this is provided by the network applications monitored to date.

SELECTED CASE HISTORIES

Low startup barrier applications

The network as a high quality telephone data link

Initial use of the network was primarily as a mechanism for visiting scientists to maintain contact with their home computers. Basically, this was using the network as a high-quality, high-speed telephone connection (see fig. 1). Learning to use the network in this fashion required only a few minutes of instruction, meaning the startup barrier was negligible, and the benefit (access to a familiar system) was high. This type of use was invariably the first reported as each ERDA host became operational on the network. A typical example is "Gamma Detector Efficiency Code" [LBL-3] in which the Rutherford computer complex was accessed from LBL exactly as if it were local, instead of eight thousand miles away in England.

A similar application, but technologically more complex is the ARPANET to Magnetic Fusion Energy net (MFE net) gateway [LLL-1]. This facility, developed at LLL, allowed scientists to access the MFE net and hence the CDC 7600 through the ARPANET (see fig. 2). Again, startup barriers were small, since learning to use the ARPANET in this fashion took only minutes of instruction. Benefits were high (access to a familiar system) with the added advantage of a substantial saving in commercial telephone charges.

It is interesting that a high-quality, high-speed telephone connection is the only service supplied by many commercial networks, and recent cost studies at ANL (1) indicate there is already sufficient traffic in this type of use to justify ARPANET costs. However, there is considerably more benefit to be gained from application of computer networking to energy related research, as the following examples demonstrate.

Scientific Collaboration - Electronic Mail

A much more interesting class of applications began to emerge as network exposure continued. These applications were labeled "scientific collaboration", and came about from a software development called electronic mail (see fig. 3). Initial use of this facility was to exchange information such as experimental results and discoveries. Again, startup barriers were low, since electronic mail was either already understood, or simple to learn. A typical example of an early application is the TST Collaboration [LBL-4]. The benefit to the scientists was the ability to maintain routine contact with collaborators, plus the added advantage of a continuous transcript of each information exchange.

(1) "Computer Networks and Resource Sharing in ERDA" Vol 2 fig. 6

USING THE NETWORK AS A HIGH-QUALITY,
HIGH-SPEED TELEPHONE CONNECTION

Figure 1

USING THE LLL GATEWAY TO CONNECT
THE ARPA NET TO THE MFE NET

Figure 2

USING THE NETWORK AND ELECTRONIC MAIL
FOR SCIENTIFIC COLLABORATION

Figure 3

Teleconferencing

As the value of scientific collaboration through the network became evident, so did the need for better communications software. Electronic mail was clearly inadequate for maintaining the type of contact required by members of the ERDA Network Investigators Panel. A more conversational mode of communication was needed which would allow immediate sharing of information among the twenty or so members and observers. A teleconferencing system called PLANET, appeared very promising (see fig. 4). PLANET was developed at the Institute for the Future and was available on the ARPANET. Further investigation revealed that startup barriers were low. Access procedures could be learned in minutes, and the teleconferencing commands were simple and well documented. The benefit to the investigators was "access to a unique software system" which greatly increased the communication level of the group. Arrangements were made with the Institute for the Future to try PLANET on an experimental basis.

The results were immediate and spectacular. Information exchange picked up rapidly, and other teleconferences on ERDA related research were opened. Although the Investigators Teleconference is by far the most active of the twenty six current conferences, it is clear that teleconferencing represents a breakthrough in resource sharing potential. Perhaps the most significant use to date is the coordination and preparation of this report which has made extensive use of PLANET with remote contribution from all seven ERDA sites. Details of this and other teleconferencing applications are described in [UCLA-1].

As impressive as PLANET is, there are still areas that need improvement. For example, problems arose in reviewing private messages, adding new members and so forth. This is by no means unique to teleconferencing. It can be expected routinely in any resource sharing environment. We have labeled this type of difficulty "Lack of refinement in remote software" to draw attention to its existence. Because of the central role of teleconferencing in network investigation, alternative systems were assessed as well. The results of this survey are provided in [LNS-9].

Reduction of duplicate effort

As contact between scientists continued, even more sophisticated applications of network technology to energy research began to emerge. In one case [LBL-7] it was noticed that complementary software existed at two of the collaborating sites. This meant that data could be processed through a program at one site and the results input to a second program at the other site (see fig. 5). Once again startup barriers were small. Each scientist was

Figure 4

Figure 5

familiar with his local system which meant neither had to learn the other's command language beyond what had already been learned in establishing initial communication. In this case the penalties for failure to share resources were severe. The alternatives would have been either to write the complementary programs from scratch or to import them from the remote host, and deal with the host dependent variations in the programming languages. This type of benefit was labeled "reduction of duplicate software development effort" for obvious reasons. It is emphasized that the impetus for this application came from the physicists themselves, which is typical of low startup barrier situations. Again we see resource sharing occurring spontaneously in the absence of startup barriers.

Access to unique resources

The Cal-ERDA investigation [ANL-2] provides another example of scientific collaboration through the network, and introduces two additional networking benefits, "access to unique hardware systems", and "access to unique data". Computer programs which minimize the heating and cooling requirements for a given building design are currently under joint development at several ERDA sites. Part of the input for these programs is a ten year history of weather data for the building location. Nationwide weather data of this magnitude is enough to swamp the storage facilities of even the largest ERDA sites. An experimental data storage machine called the Datacomputer was available on the network for testing purposes, and an investigation of the feasibility of using this machine as an integral part of the building design program was initiated.

A sample of weather data was successfully stored on the Datacomputer, and access was achieved by all cooperating sites. Because of this demonstration, it appears likely that the National Oceanic and Atmospheric Administration will establish a national weather history data base on the Datacomputer for other projects requiring similar information. This would be an enormous benefit to ERDA related research in energy conservation, solar energy, atmospheric physics, and environmental health and safety. This extremely valuable data would be accessible by every ERDA site on the ARPANET.

The ILLIAC IV experience [ANL-7] provides another example of how the network can be used to access unique hardware systems, and demonstrates the ease with which offloading can occur when the remote site is set up to handle the problem. The ILLIAC IV at NASA-Ames is a large parallel processor specially designed to handle numerical problems in which many operations can be carried out independently. Molecular dynamics codes fall in this category, and scientists at ANL were eager to expand their simulation model from a 7000 particle case (the limit of the

370/195) to a 70000 particle case (the assumed limit of the ILLIAC IV).

Using the network, researchers at ANL transferred a 4000 particle test case to the ILLIAC IV, made the required code changes, and carried out timing studies. Results were disappointing. The ILLIAC IV was only fifty percent faster than the 370/195. Follow up review by NASA-Ames staff indicated that the proper code changes had been made, and no additional optimization was possible.

The important thing is that no travel to the remote site was required. Manuals were supplied by NASA-Ames, and the ILLIAC IV consulting staff were highly experienced with the problems of network users. As a result, testing was straightforward, and efficient. Although the startup barriers were not negligible, the potential benefits were sufficiently high to cause resource sharing to be attempted.

High Startup Barrier Applications

The applications summarized so far have all been characterized by high benefits with low to moderate startup barriers. We now turn to another class of applications in which startup barriers were high, but the benefits justified the extra effort. The important features of these applications are first, the user was not familiar with the remote system (the fundamental problem of resource sharing), and second, file transfer capability was essential.

Offloading - Nuclear Reactor Code

The first attempt at offloading through the network was not successful. Resource sharing was not accomplished, and considerable effort was expended in the attempt. However, a great deal was learned in the process, and this must be made clear if the problems of offloading are to be understood. A large nuclear reactor code (VARR) was needed by a doctoral candidate in the MIT Department of Nuclear Engineering. This code was written expressly for the CDC 7600 at LBL. To investigators at LNS with only a 360/65 at their disposal, this was an ideal opportunity to experiment with offloading. The details of this application are summarized in [LNS-7]. Briefly, the following problems were encountered: First, the consulting staff was not experienced in use of the network, and documentation was sketchy. Our term for these are "Insufficient remote consulting facilities", and "Insufficient remote documentation". Second, file transfer protocol was not yet operational at LBL, which made transfer of results difficult and costly. This illustrates the problem of "Insufficient network software support". It eventually became clear that the barriers were simply too great, and the project was abandoned. In retrospect it is clear that this attempt at load leveling was

premature. The following example is much more representative of current usage.

Offloading - Hartree Fock Computation

Physicists at LNS-MIT comparing theoretical densities of deformed nuclei to recent experimental measurements from the LINAC needed a large Hartree-Fock code developed for the CDC 7600 at LASL [LNS-1]. Although this code could be converted to run on the IBM 360/65 at LNS, the local discrepancies in programming language (FORTRAN) were substantially greater than between LBL and LASL. Moreover, a single run required up to ten hours of 360/65 time. Such gross consumption of computing power was obviously detrimental to other groups at LNS who depended on the 360/65 for their own research programs. This obviously provided high motivation for accomplishing offloading. It is instructive to review the problems encountered. As before, remote documentation and network consulting services were insufficient. To help alleviate the problem, LBL sent a consultant to LNS who spent two days teaching classes in the LBL command language, and assisting the users with their problems. This was immensely helpful, but obviously cannot be considered a realistic long term solution. Standardized software, consistent documentation, and online network consulting are necessary before startup barriers can be reduced significantly.

Reliability of the network software was also a continuing problem. There were roughly ten one-to-two day periods during the six month development when the network could not be used. These were all due to bugs or system saturation in the host computers, and had nothing to do with the network itself. Transmission bandwidth was also less than optimum for effective offloading. Modification of software at both ends produced a significant improvement, and planned upgrading of the LBL file system is expected to improve the situation further. These problems are referred to as "Insufficient remote software support", and "Saturation of remote and local systems". While these problems can be expected in the early development stages, we emphasize that they are undesirable in a production environment.

Difficulty in obtaining funds was another problem encountered. To help overcome local budgetary objections, M&CS funds were used to start the process and establish feasibility. Preliminary results were sufficiently encouraging to warrant commitment of \$17000 of LINAC funds to finish the project. Use of outside computers to this extent attracted the attention of the LNS Directors. Fear was expressed that money needed to support the LNS computer facility would be diverted to LBL and other large ERDA installations. This is a serious problem for all ERDA sites, and must be addressed before widespread offloading can occur.

The lesson in all this is that in spite of the many barriers, offloading was accomplished: High quality physics results were obtained, and are due to be published in Physical Review C. These results would have been significantly delayed had the physicists been forced to use their local computing facilities.

Network related research and development

As a final example of a high startup barrier application, we review the use of the TENEX operating system for development of the ELF network interface at NYU and BNL [NYU-2, BNL-1]. Although the needed software development tools were available for direct use in ELF, several factors made TENEX a more effective choice. These were faster turnaround, larger disk storage, and most importantly the ability to keep abreast of concurrent development at the Speech Research and Development Laboratory (SCRL).

On the other hand, the investigators were not familiar with the TENEX command language. This meant that before effective development could begin, substantial effort had to be invested in learning the TENEX system. Once this was accomplished, however, significant benefits were derived. File management was done routinely on the TENEX system. Source codes were edited and assembled on TENEX, and the resulting object codes were downloaded to ELF through the network. Contact with developers at SCRL was maintained, allowing the necessary ELF extensions and modifications to be made compatibly. Development would have been considerably more difficult had the developers been forced to rely on local facilities.

FINDINGS

The Network Investigators Panel has found by direct observation that the following benefits of computer networking are achievable within the ERDA computing environment:

- Access to a familiar system by visiting scientists
- Scientific collaboration and communication
- Access to unique software systems
- Access to unique hardware systems
- Access to unique data
- Reduction of duplicate software development
- Offloading
- Network related research and development

The following technical difficulties were also observed:

- Dissimilarities in command languages
- Dissimilarities in programming languages
- Lack of refinement in remote software
- Insufficient network software support
- Insufficient remote consulting facilities
- Insufficient remote documentation
- Saturation of remote and local systems

The benefits of networking promise a significant enhancement to the overall coherence and efficiency of ERDA research into the energy problems facing the nation and the world. However, merely interconnecting ERDA hosts with a packet switched network is not sufficient. There are technical, and economic issues that must be addressed before resource sharing can become widespread. The technical problems are difficult, but perhaps the simplest to solve. Development of standardized software, consistent documentation, and improved network consulting services would reduce the startup barriers dramatically. The economic problems, however, are more difficult. In particular, unless the issue of funding is handled carefully, resource sharing is unlikely to become commonplace.

It can be predicted with confidence that if the technical and economic barriers are sufficiently reduced, resource sharing will occur spontaneously. This can only be accomplished through an ongoing commitment by ERDA management and technical staff to the long term goals of resource sharing.

INDEX TO RESOURCE SHARING CASE HISTORIES

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ANL-1 p. 27 (1976-)

LNS Molecular Dynamics Study

Resources: LNS: Dr. A. Rahman; ANL: IBM 370/195

Benefits: Load balancing and collaboration accomplished; planned production use

Barriers: Early development stage of ANL FTP.

ANL-2 p. 30 (1976-)

Distributed National Weather Data Base Experiment

Resources: CCA: Datacomputer, Ampex trillion bit memory, Datalanguage; ANL; LBL.

Benefits: Weather data base now accessible through network; planned production use.

Barriers: Early development stage of ANL FTP.

ANL-3 p. 33 (1976-)

University of Chicago, Oxford Joint Fermi Lab Experiment & Data Analysis

Resources: University of Chicago: Dr. H. Anderson; Oxford; RHEL; ANL: IBM 370/195

Benefits: Load leveling and scientific collaboration at very distant host demonstrated; in production use.

Barriers: Two terminal RHEL FTP; Lack of RHEL documentation.

ANL-4 p. 36 (1977-)

Joint Oxford, Argonne Resource Sharing Experiment

Resources: ANL: Dr. B. Smith; Oxford U: Dr. B. Ford; RHEL.

Benefits: Scientific collaboration accomplished; experiment continuing.

Barriers: Difficulty in establishing accounts.

ANL-5 p. 39 (1975-)

Network Documentation Distribution Experiment

Resources: ANL: SCRIPT and PLAP documentation processors, Argonne Code Center; BBN; LBL.

Benefits: Quarterly report distributed; procedure validated; experiment continuing.

Barriers: Insufficient Argonne Code Center funding.

ANL-6 p. 41 (1976-)

Environmental Data Base And Network Graphics

Resources: LBL: demographic data base & device independent graphics program; ANL

Benefits: Demonstrated graphics capabilities; limited use.

Barriers: Saturation of LBL system.

ANL-7 p. 43 (1975-)

Molecular Dynamics Study of Liquids on ILLIAC-IV

Resources: NASA-AMES: ILLIAC-IV; ANL

Benefits: ILLIAC IV tested on ANL codes; no production use.

Barriers: ILLIAC IV not appropriate resource

ANL-8 p. 45 (1975-)**Mathematical Software Portability****Resources:** LBL: CDC 7600, 6600; ANL**Benefits:** Software economically transported to LBL; planned production use.**Barriers:** Server FTP not available at either ANL or LBL.**ANL-9 p. 47 (1976-)****MFE Research Use of MACSYMA System****Resources:** MIT-MC: MACSYMA Algebraic manipulation package; Northwestern U; ANL**Resources:** Benefits: Convenient and economic access to MFE Software.**Barriers:** None.**ANL-10 p. 48 (1976)****Cooperative Modeling of Open Cycle MHD Power Systems****Resources:** ANL: Dr. Amend, Dr. Sistinó; LNS: Dr. Louis, Dr. Baron**Benefits:** Scientific collaboration and code transported; experiment continuing.**Barriers:** No ARPANET/LNS-IBM connection.**ANL-11 p. 49 (1976-)****Environmental Health Mortality Studies****Resources:** LBL: environmental health programs and data base on CDC 7600; ANL**Benefits:** Access to LBL environmental data base; in production use.**Barriers:** Server FTP not available at either ANL or LBL.**ANL-12 p. 50 (1976-)****Remote Use of Data Files at Carnegie Mellon U.****Resources:** CMU: data base; Illinois Institute of Tech.; ANL**Benefits:** Data base at Carnegie Mellon accessed; in production use.**Barriers:** None.**ANL-13 p. 51 (1976)****Seismic Data Management Study****Resources:** LBL: Seismic data base and data management systems; U.S. Geological Survey; ANL**Benefits:** Seismic data base accessed at LBL; IN production use.**Barriers:** None.**ANL-14 p. 53 (1975)****Use of Partial Differential Equation Programs at UCLA****Resources:** UCLA: PDEL partial differential equations package; ANL**Benefits:** Economic and convenient access to PDEL at UCLA; Experiment completed.**Barriers:** UCLA application software bug.

ANL-15 p. 54 (1977)

Fermi Lab Use of MACSYMA at MIT-MC for High Energy Physics Analysis

Resources: MIT-MC: MACSYMA algebraic manipulation package; Fermi Lab; ANL

Benefits: Economic and convenient use of MACSYMA at LNS; in production use.

Barriers: None.

ANL-16 p. 55 (1977-)

ANL Electric Data Base Use

Resources: ANL: Electric data base; LBL

Benefits: Access to ANL electric data base.

Barriers: None.

ANL-17 p. 56 (1976-)

ANL-Reading University Chemical Engineering Collaboration

Resources: ANL: Dr. Blanders & Assoc.; Reading U: Dr. R. Hockney; RHEL: IBM 360/195

Benefits: Scientific collaboration and communication; Reduction of software development.

Barriers: None

ANL-18 p. 57 (1976-)

ANL Use of Magnetic Fusion Center at LLL

Resources: LLL: MFE center programs; ANL

Benefits: Economic and error free terminal use of MFE/LLL system; experiment continuing.

Barriers: LLL node temporarily disconnected; insufficient access lines.

ANL-19 p. 58 (1977-)

Resources Management System

Resources: LBL: Resource management system; ANL.

Benefits: LBL resource management system useable by ANL scientists; production use planned.

Barriers: None.

ANL-20 p. 59 (1977)

Export of Kinetic Diffusion Package

Resources: LBL: CDC 6600's, 7600, CDC operating system and MORTRAN preprocessor; ANL

Benefits: Avoided development of kinetic diffusion program; experiment continuing.

Barriers: None.

ANL-21 p. 60 (1976-)

ATMES Simulation and Optimization of Energy Plant Configuration for Demands Imposed by Communities

Resources: LBL: ATMES programs, CDC 7600, 6600's; ANL

Benefits: Remote compilation and test of ATMES program; in production use.

Barriers: ANL/ARPANET connection only available at night.

ANL-22 p. 61 (1977)

LINPACK Linear Equations Package Development Collaboration
Resources: U. of N.M.: Dr. C. Moler; ANL: J. Dongarra,
 LINPACK

Benefits: Collaboration in quality software development; in
 production use.

Barriers: None.

BNL-1 p. 63 (1976)

ELF Maintenance and Development

Resources: SRI-KA: ELF maintenance and development tools,
 Tenex operating system; BBN; NYU; CCA: TBM.

Benefits: Used network operating system maintenance and
 development tools.

Barriers: Remote site saturation.

BNL-2 p. 66 (1976)

Development of Portable Software

Resources: UCLA-CCN: PL-I compiler; BBN.

Benefits: Transported and tested programs on different
 systems.

Barriers: Insufficient local file transfer facilities at
 that time.

BNL-3 p. 67 (1976)

Software Distribution

Resources: ILL-NTS: Source code for DIFSUB; BNL

Benefits: Received software distribution otherwise
 unavailable.

Barriers: Insufficient local file transfer facilities at
 that time.

BNL-4 p. 68 (1976)

MACSYMA

Resources: MIT-MC: MACSYMA; BNL

Benefits: Access to uniquely powerful software package,
 MACSYMA.

Barriers: None.

BNL-5 p. 69 (1976)

Microfiche Listings

Resources: SRI-KA: ELF maintenance tools; LBL: Microfiche
 printer; BNL

Benefits: Selected material to be printed on LBL microfiche
 printer.

Barriers: Low network data rates for large program
 listings. Insufficient FTP protocol.

BNL-6 p. 70 (1976)

Code Conversion Assistance

Resources: Unknown; BNL; LBL

Benefits: Checked converted code against original at LBL.

Barriers: None.

BNL-7 p. 71 (1976)**Database Exchange**

Resources: LBL: county encoding data base; LBL: code for access to interchange format tapes; BNL

Benefits: Was able to access unique data base at LBL.

Barriers: Insufficient local software and network data rates.

BNL-8 p. 72 (1976-)**Teleconferencing**

Resources: BBN: PLANET-2; BNL; BBN-B; BBN-C; and others.

Benefits: Enhanced collaboration through teleconferencing.

Barriers: Remote site saturation.

LBL-1 p. 73 (1975)**Three Dimensional Magnet Design**

Resources: RHEL: ELECTRIC, GFUN, electronic mail; LBL: CDC 7600

Benefits: Used magnet design code at RHEL instead of developing new one.

Barriers: Command language dissimilarities.

LBL-2 p. 75 (1976)**Kolmogorov-Smirnov Tabulation**

Resources: MIT-MULTICS: APL; LBL

Benefits: Access to familiar system and unique software-Multics debugging environment.

Barriers: Bug in network interface software (repaired)

LBL-3 p. 76 (1975)**Gamma Detector Efficiency Code**

Resources: RHEL: ELECTRIC, MUGWUMP, Electronic mail; LBL

Benefits: Access to familiar system

Barriers: None.

LBL-4 p. 77 (1975)**TST Collaboration**

Resources: RHEL: ELECTRIC, MUGWUMP, Electronic mail; LBL; Torino

Benefits: Active collaboration, comparison of analysis procedures and results.

Barriers: Large initial cost to learn foreign command languages.

LBL-5 p. 79 (1976)**Remote Analysis of 184 Inch Cyclotron Data**

Resources: LBL: SESAME, CDC 7600, Data; UCLA

Benefits: Reduction of duplicate software development. Lack of necessity for travel.

Barriers: File transfer rates too slow.

LBL-6 p. 81 (1976-)**Remote Use of SEEDIS**

Resources: LBL: SEEDIS, 1970 U.S. Census data base, U.S. State and County Cartographic Data Base; LASL
Benefits: Access to unique software and data.
Barriers: Need to communicate with computer not on network.

LBL-7 p. 82 (1976-)

PBAR-P Partial Wave Analysis
Resources: LBL; RHEL; CERN; BNL.
Benefits: Avoid duplication of software development; collaboration.
Barriers: Required communication computer not on network.

LBL-8 p. 84 (1976-)

Particle Data Group Combined Data Bases
Resources: LBL; RHEL; Caltech; Durham.
Benefits: Access to unique data and unique software; active collaboration.
Barriers: None.

LBL-9 p. 86 (1976)

Intel 8080 Compiler Access
Resources: LBL: Intel 8080 BASIC and BASICFP; UCLA
Benefits: Avoid duplicate software development.
Barriers: None.

LBL-10 p. 87 (1977-)

ERDA Standard Command Language study Group
Resources: BBN: PLANET teleconferencing system; LBL; LLL; UCLA; BNL; LNS-MIT; AMI.
Benefits: Small learning effort. Very active collaboration.
Barriers: No private message review. Wasted file space.

LBL-11 p. 88 (1977)

Text Formatter Access MRUNOFF
Resources: SRI: Geoff Goodfellow; BBN: Tenex; LBL
Benefits: Avoided duplicate software development.
Barriers: None.

LBL-12 p. 89 (1977-)

Author Maintained Software Policy Formation
Resources: SRI: Bulk mailer (SNDMSG), network liaison group mailing list; All ARPA net hosts.
Benefits: Broadcast of user software organization. Access to policy level information.
Barriers: None.

LLL-1 p. 91 (1976)

MFE Telephone Gateway
Resources: LLL: J.E. Donnelley, PDP-11/45, dialers, MFE CDC 7600
Benefits: Communication cost savings.
Barriers: Slow transfer rates.

LLL-2 p. 92 (1977)

MFHE High Speed Gateway

Resources: LLL: J.E. Donnelley, PDP-11/70, high speed link, MFE CDC 7600.

Benefits: Higher transfer rates.

Barriers: Transfer rate limitation; gateway machine core limitation; ARPANET protocol limitation.

LLL-3 p. 93 (1977)

MFE PDP-10 Gateway

Resources: LLL: Barry Howard, MFE-CC PDP-10, MFE Network

Benefits: No observation yet.

Barriers: No observation yet.

LNS-1 p. 95 (1976-)

Density Dependent Hartree-Fock Calculations

Resources: LNS-MIT; LBL

Benefits: Reduction of duplicate software development. Off loading of large jobs. Community debugging effort.

Barriers: Lack of standard command language; Insufficient remote consulting; Lack of refined network software; Lack of funding.

LNS-2 p. 101 (1974)

Early Learning Experiences in Using CCN Facilities

Resources: UCLA: TSO on IBM 360/91; LNS-MIT

Benefits: Access to powerful hardware off loading.

Barriers: Lack of reliable hardware.

LNS-3 p. 103 (1974)

Remote Job Entry to Brookhaven

Resources: MIT: UT 200; BNL: CDC 7600;

Benefits: Access to unique hardware. Remote verification of data analysis.

Barriers: Unreliable hardware.

LNS-4 p. 104 (1975)

Conventional Remote Job Entry

Resources: NYU: CDC 6600; LNS: CDC 200 UT; NYU

Benefits: Off loading of large jobs.

Barriers: Cost of long distance phone use. Lack of standard command language. Compiler differences.

LNS-5 p. 105 (1975)

FERMI, Load Leveling Test Run

Resources: MIT: Multics; LBL: CDC 7600

Benefits: Off loading. Comparison of compilers.

Barriers: Minor syntax variations in programming languages.

LNS-6 p. 106 (1975)

Heat Flow Code, VARR

Resources: MIT: Multics; LBL: CDC 7600

Benefits: Reduction of duplicate software development.
 Barriers: Lack of standard command language, Insufficient remote consulting. Lack of accounting information.

LNS-7 p. 107 (1976)

Molecular Dynamics, Collaborations with Argonne Scientists
 Resources: MIT: Multics; ANL: IBM 370/195
 Benefits: Off loading of large jobs. Access to unique hardware collaboration.
 Barriers: Limited times of access. Remote site saturation. Unreliable network software.

LNS-8 p. 108 (1976-)

Time Dependant Hartree-Fock, Continuation of Remote Site Use
 Resources: MIT: Multics; LBL: CDC 7600
 Benefits: Remote use of LBL 7600
 Barriers: Non standard command language.

LNS-9 p. 109 (1976)

TDA Message Service, Comparison Study and Critique
 Resources: CCA: Message system: PDP 11's
 Benefits: Evaluation of message services.
 Barriers: Insufficient documentation. Insufficiently powerful software.

LNS-10 p. 110 (1976)

Performance Analysis Experiment
 Resources: LBL: PSS storage system, user FTP; MIT-Multics: Server FTP metering system.
 Benefits: Measured typical user charges, compared charges at two sites.
 Barriers: Lack of software; limited precision and increased complexity.

NYU-1 p. 115 (1976-)

Equilibrium and Stability Problems in Plasma Physics-Load Leveling
 Resources: LBL: CDC-7600; User service personnel; NYU.
 Benefits: Access to unique hardware.
 Barriers: Insufficient network bandwidth. Need to use dissimilar systems.

NYU-2 p. 121 (1975-)

NYU ARPANET Access Software Development and Maintenance-unique software
 Resources: SRI: PDP-10 TENEX system, ELF source files, ELF authors, consultants; BBN.
 Benefits: Reduced software development by collaboration to transport and install new systems.
 Barriers: Saturation at the remote site with no reasonable alternative

NYU-3 p. 125 (1976)

Magnetohydrodynamics Code-MFE CDC 7600 at LLL

Resources: LLL: CDC-7600; NYU.

Benefits: Access to powerful hardware. Off loading from saturated site.

Barriers: Insufficient Bandwidth; lack of direct connection to ARPA network; Lack of file transfer capability.

NYU-4 p. 126 (1976)

Calculation of Parametric Instability MIT/ML MACSYMA

Resources: MIT: MACSYMA; NYU

Benefits: Reliable access to MACSYMA for plasma research.

Barriers: None.

NYU-5 p. 127 (1976-)

Teleconferencing-Unique software

Resources: BBN: TENEX, PLANET teleconferencing system; All ERDA sites.

Benefits: Access to unique software.

Barriers: Resource saturation.

UCLA-1 p. 129 (1975)

Distributed Report Generation

Resources: ANL; BBN; CCN; CCA; LBL; LNS-MIT; LLL; BNL; NYU; MIT-MC; MIT-MULTICS; MIT-AI: XGP.

Benefits: Fewer face-to-face meetings required; immediate dissemination of corrected text.

Barriers: Dissimilarities between editors, formatters. Lack of standard command language.

UCLA-2 p. 132 (1975)

PL/I Program Portability: IBM to Multics

Resources: UCLA-CCN: IBM 360/91; MIT: Multics.

Benefits: PL/I Program successfully moved.

Barriers: Variations between "standard languages" compilers; operating systems and languages.

UCLA-3 p. 135 (1977-)

ISP to PL/I Translation

Resources: UCLA-CCN: IBM 360/91; UCS-ISIB: PDP 10; CMU 10A: PDP 10; UCLA-Security: PDP 11/45.

Benefits: Used unique software on 3 machines to create simulation.

Barriers: Unusual blocksizes force artifact into file transfer process.

UCLA-4 p. 137 (1975-)

Particle Physics Research Radiative Pion-Nucleon Scattering

Resources: LBL: CDC 7600

Benefits: Analysis on machine close to cyclotron experiment.

Barriers: Cost of transmission prevented choice of most

economic computer.

UCLA-5 p. 139 (1976-)

Plasma Physics Simulation

Resources: LLL: MFE-7600.

Benefits: Access to MFE computer.

Barriers: None.

UCLA-6 p. 140 (1975-)

Development of Life Code for Reactor Fuel Pin Performance

Resources: LBL: CDC 7600

Benefits: Access to AI codes at LBL.

Barriers: None.

UCLA-7 p. 141 (1977)

Remote SARA System Demonstration at Symposium

Resources: NASA-AMES: TIP; UCLA-CCN: SARA design system software; UCLA: R. Razouk.

Benefits: Successful demonstration of unique software.

Barriers: Terminal unreliability; hotel telephone system design.

RESOURCE SHARING CASE HISTORIES

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Network Experience Report
ANL-1

ERDA Program: Basic Energy Sciences (EE)

Title: Molecular Dynamics Study By Network Remote Job Entry

Cooperating Sites: ANL, MIT

ANL Contact: R. Bare

Resources Accessed:

ANL--Dr. A. Rahman

ANL--Dr. Rahman's Molecular Dynamics Programs

ANL--IBM 370/195

Motivation:

The kinetic theory group in the Nuclear Engineering Department at MIT has as one of its objectives development of an accurate solution to the Boltzmann equation for various classical time correlation functions. They have in their possession several very complex computer codes which they believe provide such accurate solutions.

Their goal is to determine exactly how accurately the Boltzmann equation can predict the properties of actual fluids. A comparison of the Boltzmann equation solution with experimental measurements may depend sensitively upon the nature of the inter-molecular potential for the molecules under study. Because of this fact, they have decided to use the technique known as Computer Molecular Dynamics (CMD) to do preliminary studies before going to the laboratory to do detailed experiments. In the CMD method, one directly solves Newton's equations for an assembly of atoms with a given inter-molecular potential and boundary conditions, thus producing an accurate time history from which all properties of the simulated fluid can be determined. This procedure is important because it allows one to directly test the Boltzmann equation for a given potential, unlike the situation in a laboratory experiment where there are often two unknowns, i.e., the validity of the Boltzmann Equation and the potentials in fluids.

Dr. Aneesur Rahman of Argonne's Material Science Division is well known for his work in Computer Molecular Dynamics and for his unique insights into the nature of fluids. For this reason, the MIT group, composed of Dr. S. Yip, Dr. J. O'Dell, and their associates, chose to perform their study in collaboration with A. Rahman and S. Chen

of Argonne. In addition, the reduction of a CMD problem involves the expenditure of a considerable amount of high speed computer time. This time is consumed mainly in generation and subsequent analysis of the trajectory inherent in the Computer Molecular Dynamics. The choice of Argonne as the site to perform these computations also provided them with unique hardware in terms of the cost effectiveness for this type of work.

When they became aware of the existence of ARPANET connections at both Argonne and MIT, the possibility of doing their computations from the MIT campus was considered. Argonne had implemented a Remote Job Entry (RJE) facility under the ARPANET File Transfer Protocol (FTP). This facility allows a user at another system on the network to send a program from that system across the network and into Argonne's IBM 370/195 to be executed as a job. It also provides the capability to retrieve printed and punched output back to the user's system. The MIT group decided to experiment with using the RJE facility to perform the CMD studies remotely from the MIT campus.

Procedure:

The first Argonne RJE connection was established in late 1976 and tended to be sporadic; but as time progressed, all of the difficulties in communicating were removed. The process of running jobs remotely at Argonne was started by placing one of the programs in a file on the MIT MULTICS system. There it was edited to include the job control language necessary for a job to run on Argonne's IBM 370/195. Then the standard ARPANET File Transfer Protocol (FTP) was used to transfer a copy of the file to Argonne and send it to the input reader on the 370/195. The job ran on the 370/195 while accessing several of A. Rahman's programs and data files. The people at MIT were able to track the job as it moved through processing on the Argonne system by using the console inquiry facilities. When the job was complete, FTP was used again to transfer the output back to the MIT MULTICS system where it was examined using the MULTICS editor. A utility program on the MULTICS system was then used to print the output. Since the first successful run, the process has been repeated many times using different programs of interest. Several hours of 370/195 time have been used by these jobs. Some of the time has been used for checking out the process but much of it also has been to produce preliminary production results.

Observed Benefits:

- Scientific collaboration and communication
- Access to unique software--Dr. A. Rahman's computer molecular dynamics programs
- Access to hardware not locally available --ANL'S IBM 370/195
- Load balancing

Observed Barriers:

Initially the MIT group encountered several difficulties. Among these difficulties were the following. First, the connection was not being established quickly enough, and the MIT system was closing the connection before it was completed. Second, when someone at MIT made a connection to an outside site, the link in the MIT system was not released at completion. These links accumulated and locked all further attempts at connection. Third, once output was transferred back to MIT, there was a problem with the code structure on the MIT system that caused the output to be misinterpreted and printed in octal instead of display characters. Fourth, entering a CLOSE command too quickly after the completion of a transmission caused the Argonne system to loop. However, all of these problems were resolved relatively quickly.

Evaluation:

- Successful. Production use planned.

The MIT group completed their trial usage in a reasonable period of time. They succeeded in linking to Argonne over the ARPANET, submitting jobs to run, accessing data and programs resident at Argonne, performing analysis, and transferring the results back to MIT for their perusal. They, therefore, concluded the experiment had been successful and decided to make the necessary arrangements to use the ARPANET facility for production. It is planned that during the months to come an increasingly large fraction of their computations will be performed at Argonne via the ARPANET and the Remote Job Entry Facility.

Network Experience Report
ANL-2

ERDA Program: Buildings And Community Systems (HD)

Title: Distributed National Weather Data Base Experiment

Cooperating Sites: ANL, CCA, LBL

ANL Contact: R. Bare

Resources Accessed:

CCA--Datacomputer, Ampex Trillion Bit Memory
--Datalanguage

Motivation:

One of the studies underway by the CAL-ERDA project is the development of programs that will use weather data and building characteristics to determine efficient building designs to minimize energy use. One of the characteristics of these programs is the necessity to have access to large data bases consisting of files of previously recorded weather information for various geographical locations. Since this is a cooperative study with interest from several institutions, including ANL and LBL, there is an interest in being able to access a common data base from several geographically dispersed locations.

The Datacomputer is a large-scale data management and storage utility at the Computer Corporation of America (CCA) in Cambridge, Massachusetts. It has a large Ampex trillion bit mass storage device for memory and is interfaced to the ARPANET by a PDP TENEX system. CCA has developed their own unique language, Datalanguage, which is used for all communications with the Datacomputer. The language provides a flexible way of manipulating and searching data bases. The language is not, however, an ARPANET standard protocol.

The characteristics of the CCA facility uniquely meet the requirements of the CAL-ERDA study. The CCA storage capability provides a unique hardware resource for storing all of the weather data base and access via ARPANET, making it available to all those who are scientifically collaborating on the project. The weather data would be stored on the Datacomputer and transferred to Lawrence Berkeley, Argonne, and other laboratories, as it was required. It was hoped the Datalanguage would allow the easy selection and transfer of select pieces of data or whole sections of files as needed.

Procedure:

Weather data for sixteen U.S. cities was available at Argonne. The initial plan was to build a file on the Datacomputer and transfer the weather data over the ARPANET from Argonne to CCA. The initial ARPANET activity involved use of a standard TELNET connection invoked from a teletype compatible terminal. The connection was established successfully, and the Datacomputer was found ready to receive standard Datalanguage requests. However, since Datalanguage was designed more for interaction with a user program than with a user directly, many lines of bothersome synchronization messages would print out. After becoming familiar with the system, it was possible to define files and ports (formats) and store and retrieve test data to and from the files. This approach was found, however, to be too slow for a large amount of data.

The ARPANET standard File Transfer Protocol (FTP) was then considered. The Datacomputer, however, did not have a standard FTP implementation. It was found that, by using the proper Datalanguage and FTP commands, a data connection was possible. A Datalanguage CONNECT command allowed a port to be attached to a specific socket and, thereby, data could be transferred over that socket as in FTP.

Several weather data files were transferred from the Argonne IBM 360/195 to the Datacomputer. Each file contained weather data for a year for one city. This data consisted of hourly readings for 365 days per year for a total of 8760 records. The transferred data was manipulated using Datalanguage and retrieved in various formats. Several different selection criteria were used to retrieve the data. The capabilities of the Datalanguage for selection and editing of data were found to be quite flexible and very powerful. With new port descriptions, different formats of output were easily obtained.

Observed Benefits:

- Access to unique hardware--CCA'S Ampex Trillion Bit Memory
- Access to unique software--CCA'S Datalanguage

Observed Barriers:

The File Transfer Protocol at ANL was in an early stage of development when the initial tests were made. As a

result, some problems were encountered in transmission. One of the early problems encountered was the time required for a transfer. To send a six page listing of a file run on the 370/195 to the Datacomputer required nearly twenty minutes of transmission time. This problem was due to the limited core space then available for the Argonne ARPANET interface program. Additional memory was installed, and significant increases in transfer time were obtained.

Evaluation:

- Successful. Production use planned.

These tests convinced the experimenters that the Datacomputer would be an ideal system for an application like the weather data base. The characteristics of the application are the following: 1) a very large amount of data to be stored; 2) only small portions of the data required at a time; 3) many different and varying output forms are needed; 4) and access is needed from widely separated locations. The Datacomputer proved to handle all of these characteristics nicely. Its presence on the ARPANET provides access from many locations around the country. Furthermore, the interconnection between the ARPANET and other data communications networks, such as the connection at Argonne of ARPANET and TELENET, provides an even larger degree of accessibility.

A meeting was recently held at CCA's headquarters. Present at the meeting were representatives of several ERDA laboratories and contractors and also the National Oceanic and Atmospheric Administration (NOAA). Following this meeting, NOAA expressed a high degree of interest in establishing a National Weather History Data Base on the Datacomputer for use by other projects that have the need to use weather data. Possible project areas that could benefit by having easy access to such data would include areas, such as energy conservation like CAL-ERDA, solar energy, atmospheric physics, and environmental health and safety.

Plans are currently underway to build and maintain this National Weather History Data Base on the Datacomputer as a cooperative effort between ERDA, NOAA, and CCA.

Network Experience Report
ANL-3

ERDA Program: High Energy Physics (EC)

Title: U. Of Chicago, Oxford Joint Fermi Lab Experiment & Data Analysis

Cooperating Sites: U. Of Chicago, ANL, Oxford, RHEL-England

ANL Contact: R. Bare

Resources Accessed:

U. Of Chicago--Dr. H. Anderson

Oxford--Collaborators

Rutherford High Energy Lab, England--IBM 360/195

Motivation:

A cooperative experiment on Deep Inelastic Muon Proton Scattering was done at the Fermi National Accelerator Laboratory. The experiment was Fermi National Accelerator Laboratory Experiment Number 398. It was intended to extend measurement of the inelastic u-p and u-d scattering cross sections and to study hadron production for incident energies up to 225 GEV. It is necessary to do extensive data processing on the raw data of the particle tracks before basic physics information can be obtained. This processing as well as analysis program development is done simultaneously at the University of Chicago as well as at Oxford University, England.

An important aspect of this study is the necessary collaboration between the scientists who took part in the experiment. All of the collaborators must have access to a common data base consisting of the experimental data, and it is important to have access to all of the analysis programs which are collectively available. Communication among the experimenters is highly important to disseminate and describe the work and results of each member of the team.

Since a connection to the ARPANET existed at both Argonne and Oxford, it was found appropriate to utilize the network to carry out this collaboration. The network provided the capability to exchange messages, run analysis programs on a common data base, and retrieve output files describing results.

Dr. Herbert Anderson, Enrico Fermi Institute, University of Chicago, was the local collaborator who used Argonne's ARPANET connection. Dr. Anderson and his associates used

the Argonne ARPANET host to communicate with University College, London, the British Isles network gateway, and the Rutherford High Energy Laboratory (RHEL). Rutherford has an IBM 360/195 System interfaced to the ARPANET which was not running at full utilization.

Procedure:

Personnel from the University of Chicago and Oxford used the ARPANET TELNET protocol to exchange messages via a mail facility at RHEL. They also prepared, submitted and reviewed batch jobs for the RHEL 360/195 system. They used the File Transfer Protocol (FTP) to retrieve files from RHEL to Argonne.

Since the experiment was the first to make use of the Argonne file transfer facility, several problems occurred during the early phases; 1) the connection to RHEL was occasionally broken while work was in progress; 2) there were difficulties with file transfer between RHEL and Argonne, in which files were prematurely truncated. Once both of these problems were identified and corrected, communications became excellent; and no further problems were encountered.

Observed Benefits:

- Scientific collaboration and communication
- Load balancing

Observed Barriers:

There were limitations which were not due to the network but to the host computer at Rutherford which limited the ease of use of the networks considerably. For example, the usage of the RHEL 360/195 was hampered by inadequate documentation. On-line documentation would have been valuable. The FTP at RHEL required the use of two separate terminal connections and a data connection in order to initiate a file transfer. This made file transfers from RHEL a somewhat cumbersome process. London and RHEL are currently implementing a new version of FTP that will require only a single terminal connection in addition to the data connection.

Evaluation:

- Successful. In production use.

Despite the difficulties, the experiment has been successful and useful to the project. Dr. Anderson lists, among the advantages of using the network, the following: 1) the ability to access the data bases and analysis programs of their collaborators at Oxford; 2) the ability to use the non-recoverable resources of another computation center, such as CPU-time during time of under-utilization for the execution of jobs producing physics results; 3) the ability to conveniently exchange messages with collaborators and other users via network mail facilities. The collaborators are presently conducting other experiments at the Fermi and Los Alamos laboratories and are continuing to use the ARPANET to analyze results.

Network Experience Report
ANL-4

ERDA Program: Basic Energy Sciences (EE)

Title: Joint Oxford, Argonne Resource Sharing Experiment

Cooperating Sites: ANL, Oxford, RHEL

ANL Contact: R. Bare

Resources Accessed:

ANL--Dr. B. Smith and Mathematics And Computer
Science Section
Oxford U.--Dr. B. Ford And Numerical Algorithms Group
Rutherford High Energy Lab, England--IBM 360/195

Motivation:

A collaborative research venture is underway between the Numerical Algorithms Group (NAG), Oxford University and the Mathematics and Computer Sciences Section of the Applied Mathematics Division of Argonne. The aims of the investigations are to:

- 1) explore the role of computer networking in the development of numerical software;
- 2) establish the technical and operational problems of installing and maintaining a numerical software library remotely; and
- 3) examine the usage of a numerical software library in a heterogeneous machine environment.

Resource sharing via computer networks is recognized as a potential method for dramatically reducing future software development costs by eliminating duplication of effort and by focusing scarce and geographically scattered expertise on areas of greatest need.

Numerical software libraries will be central to this usage of networks. The experience gained in this usage of the ARPANET, if successful, will not only make numerical software libraries more readily accessible but will also contribute to solving the problems inherent in more complex collections of software. The trans-Atlantic usage provides more realistic tests of remote usage, since geographical separation is a significant deterrent to effective communication via tape mailings, document exchange, telephone conversations, etc.

The ARPANET is the only truly heterogeneous computer

network accessible to NAG and ARGONNE for testing the hypothesis that computer networks will fundamentally change the functions of numerical software library distribution, maintenance, and utilization. Pursuit of these experiments on a homogeneous network would evade one of the central issues, transportability.

Procedure:

Although this ARPANET experiment is in its infancy, several initial activities have been accomplished. One initial goal was to provide a communication path whereby the Argonne and NAG investigation could collaborate by exchanging messages and other information. Beginning in October 1976, the group successfully established a mail facility using the TENEX-C system at BBN over the ARPANET. This has proved useful as the principal medium for information exchange among the group.

The Oxford and RHEL facilities connect to the ARPANET through a node at London. The London node thus acts as a gateway which switches messages and files to various facilities (such as Oxford and RHEL) which connect to it. Early attempts were made to use the Oxford system as an information center for messages between the collaborators, but the gateway link to Oxford was found to be too tenuous to be useful. Problems in this link were finally corrected, and now both the BBN and Oxford systems are used.

The second goal was to transfer data files consisting of numerical software between the sites. The first such transfer to RHEL was a Fortran source file which had been developed at Argonne.

It is intended that the goals of the experiment will also be increased to encompass transporting and testing of numerical software on machine architecture other than the IBM equipment now being used at ANL and RHEL. An experiment is planned to use the CDC 7600 at the University of London Center (ULCC) as well.

Observed Benefits:

- Scientific collaboration and communication
- Reduction of software development effort
- Network related research

Observed Barriers:

- Early development stage of ANL FTP
- Inadequate remote site documentation (RHEL)
- Budgetary: difficulty in establishing accounts

Several problems occurred which were related to software problems in an early version of the file transfer protocol implemented at ANL. Other problems which inhibited the experiment related to the improper use of time-sharing versus batch accounts on the RHEL system.

Evaluation:

- Partial success. Experiment continuing.

Although the experiment is still in the initial phases, the users have gained a great deal of knowledge and experience with the ARPANET. It is believed this experiment will provide the groundwork for a very productive effort in the development of numerical software. In addition, it should provide information on the viability of resource sharing among heterogeneous computers via networks.

Network Experience Report
ANL-5

ERDA Program: Liquid Metal Fast Breeder Reactors (KG)
Weapons Activities (NM)

Title: Network Documentation Distribution Experiment

Cooperating Sites: ANL, BBN, LBL

ANL Contact: R. Bare

Resources Accessed:

ANL--SCRIPT Text Processor
--PLAP Documentation Processor
--Argonne Code Center

Motivation:

To investigate innovations in program interchange which are made possible by network communications. In addition, experiments are being conducted with both PLAP and SCRIPT documentation processors. The purpose is to determine their potential usefulness in the ARPANET environment for the distribution of documentation.

Procedure:

Argonne's MATHLAB project, developing exportable software, needed a CDC installation to check out PLAP, a page layout and documentation preparation program. Because they were already familiar with LBL procedures, the code was transferred to LBL, compiled and made operational through the ARPANET.

SCRIPT is a powerful text-formatting program written at the University of Waterloo for use on IBM equipment. SCRIPT was used to prepare ANL's last ARPANET status report in machine-readable form on the ANL system and then FTP was used to send a copy of it over the ARPANET to the BBN system. ANL plans to update the report as the status of its system or experiments change. Then, anyone who is interested in the information can use FTP to retrieve the current report over the ARPANET.

The Argonne Code Center is the ERDA-wide computer program exchange and information center for computer programs and systems developed in ERDA program areas. Since its inception, over one thousand program packages have been processed for inclusion in the Center's library. Over the past years, methods and means for effective program

interchange have been investigated and developed. Innovations in program interchange which are made possible by network communications will be examined utilizing ANL's connection to ARPANET.

Observed Benefits:

- Access to unique software--SCRIPT at ANL.
- Reduction of duplicate software development and maintenance--PLAP implemented at LBL.

Observed Barriers:

- Budgetary--Argonne Code Center funds inadequate for proper investigation.

Evaluation:

- Partial success. Experiment continuing.

This effort established the ease with which new software could be implemented at a distant host.

The implementation of PLAP at LBL also was considered to be very beneficial by LBL. As it happened, the LBL documentation program BARB was very hard to use. In fact, the Systems Group at LBL had been trying for some time to obtain a copy of PLAP.

Network Experience Report
ANL-6

ERDA Program: Environmental Research And Development (RK)

Title: Environmental Data Base And Network Graphics

Cooperating Sites: ANL, LBL

ANL Contact: R. Bare

Resources Accessed:

LBL's Demographic Data Base

LBL's Device Independent Graphics Programs

Motivation:

An attempt was made in the past, by ANL's Energy and Environmental Systems Division, to use LBL's graphics capabilities in connection with an environmental data base.

Procedure:

LBL had written a program to produce a graphics test plot. The program was tested with a terminal located at LBL and found to work successfully using ARPANET. However, when an attempt was made to use a terminal at ANL, connected through the network, a problem was encountered. The problem resulted from an incompatibility between the ANL and LBL TELNET implementations and was corrected.

Further tests of the LBL network graphics capabilities were conducted. The MAPEDIT mapping program was executed and documented. MAPEDIT is an interactive graphics program designed to support a variety of mapping operations. To run MAPEDIT from Argonne, a Tektronix graphics terminal was used.

When entering the LBL system, it was necessary to use the highest job priority to get reasonable response times at the terminal. In running MAP interactively, frustrating time lags in computer response were experienced, even when logged on at top priority. In general, the response times on the terminal were found to be usually very slow; and waiting periods of ten minutes were experienced. A map of the entire United States, with standard metropolitan statistical areas, was eventually obtained.

A second attempt was made to use the MAPEDIT program,

this time to obtain graphs for a proposal. The same slow response at the terminal was observed. However, this time the requested graph failed to be drawn. After consultation with Dennis Hall, the network liaison at LBL, and the author of the MAPEDIT program, it was determined that a program change had been made and the program did not work anymore. The author fixed the problem, and we were again able to produce the graph needed without problems.

Observed Benefits:

- Access to unique data--LBL'S Demographic Data Base.
- Access to unique software--LBL's device independent graphics programs.

Observed Barriers:

- Inadequate remote site hardware--LBL's slow system responsiveness.

Evaluation:

- Successful. Limited use planned.

Network Experience Report
ANL-7

ERDA Program: Basic Energy Sciences (EE)

Title: Molecular Dynamics Study Of Liquids On ILLIAC-IV

Cooperating Sites: ANL, NASA-AMES

ANL Contact: R. Bare

Resources Accessed:
NASA-AMES--ILLIAC-IV Computer.

Motivation:

Dr. Aneesur Rahman of Argonne's Solid State Science Division has performed some tests using the ARPANET to send his molecular dynamics programs to run on the ILLIAC-IV at NASA- AMES. The purpose was to determine how parallel processing could expedite work on the molecular dynamics studies of liquids and solids. If he were successful in using the ILLIAC-IV, it would be possible to investigate new domains in the theory of liquids which are impractical on other computers.

Procedure:

The initial attempts were to learn how to use the machine and to get an idea of the gain in computational speed that is possible.

He did encounter a couple of problems. However, all the problems in communicating with the ILLIAC were resolved in a reasonable period of time. When Dr. Rahman completed his first successful runs on the ILLIAC, he reported run times only slightly faster than on the Argonne IBM 370/195 for his 4,000 particle test case. He can extrapolate to a 7,000 particle production problem, and he believes it would run only fifty percent (50%) faster than on the 370/195. He expected an order of magnitude improvement in running times.

As a result, Dr. Rahman has stopped using the ILLIAC because this modest increase in speed is not sufficient to justify the additional effort required to use the ILLIAC IV.

Observed Benefits:

- Remote access to unique hardware--Dr. Rahman was able to investigate the ILLIAC-IV while remaining at Argonne and continuing with his other research activities. It was not necessary for him to travel to NASA-AMES for a 4-6 week period to make the evaluation.

Observed Barriers:

- Inadequate remote hardware--ILLIAC-IV was not an appropriate resource.

Evaluation:

- Successful. No production use.

Network Experience Report
ANL-8

ERDA Program: Basic Energy Sciences (EE)

Title: Mathematical Software Portability

Cooperating Sites: ANL, LBL

ANL Contact: R. Bare

Resources Accessed:

LBL--CDC 7600, 6600

Motivation:

During the development of Mathematical Software Packages, considerable effort goes into making the software portable. By gaining direct access to other computing machines via ARPANET, this task could be greatly facilitated.

Procedure:

The first effort to test this theory was to run a particular MINPACK routine, Davidon's Optimally Conditioned Optimization Routine, on the CDC 6600 at LBL. The participants also used FTP to transmit a source program file from LBL to Argonne's TSO time-sharing system. They used OS ASP control cards and the remote job entry facility, under FTP, to accomplish this task. The transfer had to be done in two steps, because neither Argonne nor LBL had a server FTP implementation. It was necessary to first transfer the file from LBL to UCLA, which has a SERVER FTP facility, and then transfer the file from UCLA to Argonne. The transfer of the file to UCLA was controlled remotely by the participants from Argonne over an ARPANET TELNET connection to LBL. Once the file was transferred, they closed the connection from LBL to UCLA and logged off the LBL system.

The second step was to connect from Argonne to UCLA and retrieve the file to Argonne under the remote job entry facility of FTP into the OS job stream on the IBM 370/195. It was necessary to insert OS and ASP job control cards in front of the file in order that it would execute a standard utility program to create a copy of the file on one of the shared disks for the TSO system. The process, although somewhat cumbersome, worked quite well. It saved a large amount of time, as compared with shipping the file on a tape from LBL to Argonne. That type of transfer has taken up two weeks in the past, when

it has been successful at all.

Observed Benefits:

- Reduction of software development effort.

Observed Barriers:

- Server FTP software not available at either LBL or ANL.

Evaluation:

- Successful. Planned production use.

The participants feel this experiment demonstrated the usefulness of the ARPANET for this type of work.

Network Experience Report
ANL-9

ERDA Program: Magnetic Fusion (ED)

Title: MFE research use of MACSYMA system

Cooperating Sites: Northwestern U. , ANL, MIT-MC

ANL Contact: R. Bare

Resources Accessed:

MIT-MC--MACSYMA Algebraic Manipulation Package

Motivation:

The purpose of this experiment is to use the MACSYMA system in relation with research under the division of MFE. Professor Denavit is a member of the staff of the Mechanical Engineering Department at Northwestern. He has been funded for the past several years, through ERDA, to work on some aspects of the Magnet Fusion Energy program. He is interested in experimenting with symbolic manipulation systems, to determine their potential to his research.

Procedure:

Professor Denavit has started to use the ANL ARPANET interface to gain access to the MACSYMA system at MIT.

Observed Benefits:

- Access to unique software--economic and convenient use of MACSYMA at MIT.

Observed Barriers:

- None.

Evaluation:

- Partial success. Experiment continuing.

**Network Experience Report
ANL-10**

ERDA Program: Coal (BA)

Title: Cooperative Modeling of Open Cycle MHD Power System

Cooperating Sites: ANL, MIT

ANL Contact: R. Bare

Resources Accessed:

ANL--Dr. Amend, Dr. Sistino

MIT--Dr. Louis, Dr. Baron

Motivation:

The Engineering Systems Modeling group of ANL's Engineering Division has agreed to cooperate with the Energy Laboratory of Massachusetts Institute of Technology in the development of a computer simulation of open cycle MHD power systems. An investigation is being made as to the desirability of using the ARPA network as a media for exchanging software modules as they are developed and to allow MIT to use certain of ANL's executive codes for their systems studies.

Procedure:

FTP was used to transfer to Argonne a copy of a new MHD Seed Recovery Program developed at MIT. Since the program was originally developed on the MIT IBM 360/65 which is not interfaced to the ARPANET, it was necessary to first copy the program to tape. The tape was then taken to the MIT Honeywell System, where the program was unloaded to a disk file. FTP was then used to accomplish the transfer to Argonne. At Argonne, it was both listed and loaded on the ANL TSO time-sharing system for future use.

Observed Benefits:

- Scientific collaboration and communication.

Observed Barriers:

- Inadequate remote site hardware--no ARPANET/MIT-IBM system connection.

Evaluation:

- Partial success. Experiment continuing.

Network Experience Report
ANL-11

ERDA Program: Life Science Research And Biomedical Applications (RV)

Title: Environmental Health Mortality Studies

Cooperating Sites: ANL, LBL

ANL Contact: R. Bare

Resources Accessed:

LBL--Environmental Health Programs And
Data Base On CDC 7600

Motivation:

Several people have been using ARPANET, in the TELNET mode, simply to continue to use programs and data files they first became familiar with while they were at other sites. Now that they have relocated to the Chicago area, they find it more efficient to continue to use those other resources rather than go through the costly and time-consuming process of conversion. Some of these people are now at Argonne--others are with other universities and government agencies in the Chicago area.

One such person is Robert Lunde of Argonne's Biomedical and Environmental Research Division, formerly with the Lawrence Berkeley Laboratory. He is continuing to use his programs at LBL to do environmental health mortality studies.

Procedure:

Robert Lunde uses the ANL/ARPANET connection and TELNET and FTP to prepare and submit jobs at LBL which use his programs and LBL's environmental data base.

Observed Benefits:

- Access to unique software--R. Lunde's Environmental Health programs.
- Access to unique data--LBL's Environmental Data Base.
- Reduction of duplicate software development.

Observed Barriers:

- Inadequate local and remote site software--Server FTP not available at either ANL or LBL.

Evaluation:

- Successful. In production use.

Network Experience Report
ANL-12

ERDA Program: Oil Shale and In-Situ Technology (BC)

Title: Remote Use of Data Files at Carnegie Mellon University

Cooperating Sites: Illinois Institute Of Technology, ANL, CMU

ANL Contact: R. Bare

Resources Accessed:
CMU--Data Base

Motivation:

Several people have been using ARPANET, in the TELNET mode, simply to continue to use programs and data files they first became familiar with while they were at other sites. Now that they have relocated to the Chicago area, they find it more efficient to continue to use those other resources rather than go through the costly and time-consuming process of conversion. Some of these people are now at Argonne--others are with other universities and government agencies in the Chicago area.

One such person is Charles Wienstock of the Illinois Institute of Technology, formerly with Carnegie Mellon University. He is continuing to use his programs and a data base at CMU.

Procedure:

Charles Wienstock uses the ANL/ARPANET connection and TELNET to prepare and submit jobs which use the data files at CMU.

Observed Benefits:

- Access to unique data--data files at CMU.

Observed barriers:

- None.

Evaluation:

- Successful. In production.

Network Experience Report
ANL-13

ERDA Program: None

Title: Seismic Data Management Study

Cooperating Sites: U.S. Geological Survey, ANL, LBL

ANL Contact: R. Bare

Resources Accessed:

LBL--Seismic Data Base And Data Management System

Motivation:

Several people have been using ARPANET, in the TELNET mode, simply to continue to use programs and data files they first became familiar with while they were at other sites. Now that they have relocated to the Chicago area, they find it more efficient to continue to use those other resources rather than go through the costly and time-consuming process of conversion. Some of these people are now at Argonne--others are with other universities and government agencies in the Chicago area.

One such person is James Herriot of the U.S. Geological Survey, Chicago, formally with the USGS at Menlo Park, California. He is continuing to use their SEISMIC Data Management System and SEISMIC Data Base at the Lawrence Berkeley Laboratory.

The USGS is in the process of constructing an automated earthquake prediction system using data telemetered in from a variety of field sites and sent to the LBL 7600 and 6600 (CDC) computers. This work includes both processing and program development.

Procedure:

James Herriot uses the ANL/ARPANET connection and TELNET to use the SEISMIC Data Management System at LBL.

Also, the interactive graphics system at LBL has been used to obtain graphical output at ANL of tiltmeter data.

Observed Benefits:

- Access to unique data--SEISMIC Data Base.
- Access to unique software--SEISMIC Data Management System.

Observed Barriers:

- None.

Evaluation:

- Successful. In production use.

Since this USGS project is heavily committed to the LBL computer system, the high speed reliable service realized through the ARPANET is vital to the project.

Network Experience Report
ANL-14

ERDA Program: Basic Energy Sciences (EE)

Title: Use of Partial Differential Equation Program at UCLA

Cooperating Sites: ANL, UCLA

ANL Contact: R. Bare

Resources Accessed:

UCLA--PDEL Partial Differential Equations Package

Motivation:

UCLA's facility was used to compare features of what were believed to be two versions of a partial differential equations solution package. A summer visitor was evaluating a version of the package at Argonne. He understood that a version of the package with certain error corrections was available at UCLA.

Procedure:

It was decided to use ARPANET to access the UCLA version of the package. A test program was prepared and eventually run. It indicated that the UCLA version did not correct the problems encountered in the ANL version, so that the goal of the investigation was reached.

Observed Benefits:

- Reduction of software development effort
economic and convenient access to PDEL at UCLA.

Observed Barriers:

- UCLA application software bug.

Evaluation:

- Successful. Experiment complete.

Network Experience Report
ANL-15

ERDA Program: High Energy Physics (EC)

Title: Fermi Lab Use of MACSYMA at MIT for High Energy Physics Analysis

Cooperating Sites: FERMI LAB, ANL, MIT-MC

ANL Contact: R. Bare

Resources Accessed:

MIT-MC--MACSYMA Algebraic Manipulation Package

Motivation:

To use the MACSYMA Algebraic Manipulation Package at MIT-MC to expedite high energy physics analysis.

Procedure:

Fermi Lab has used the ANL/ARPANET connection and TELNET to access the MIT-MC system and the MACSYMA package.

Observed Benefits:

- Access to unique software.
- Economic and convenient use of MACSYMA at MIT.

Observed Barriers:

- None.

Evaluation:

- Successful. In production use.

Network Experience Report
ANL-16

ERDA Program: Electric Energy Systems (HA)

Title: ANL ELECTRIC Data Base Use

Cooperating Sites: LBL, ANL

ANL Contact: R. Bare

Resources Accessed:
ANL--ELECTRIC Data Base

Motivation:

Several geographically dispersed people want to use the ANL ELECTRIC Data Base and management system.

Procedure:

They will call their local ARPANET connection and then be connected to ANL where they will be able to use the TSO time-sharing system to access the ELECTRIC Data Base and Management System.

Observed Benefits:

- Access to unique data--ANL ELECTRIC Data Base.

Observed Barriers:

- None.

Evaluation:

- Experiment in initial phase. No results demonstrated to date.

Network Experience Report
ANL-17

ERDA Program:

Title: ANL--Reading University Chemical Engineering Collaboration

Cooperating Sites: Reading U., England, ANL, RHEL

ANL Contact: R. Bare

Resources Accessed:

ANL--Dr. Blanders & Associates

Reading U.--Dr. R. Hockney

Rutherford High Energy Lab--IBM 370/195

Motivation:

To collaborate on the development of computer programs for a study of fused salts.

Procedure:

Use the ARPANET and FTP to transfer versions of programs as they are prepared.

Use TELNET for the exchange of messages for the collaboration.

A copy of a new program named P3M, for the analysis of fused salts, was file transferred to ANL from RHEL.

Observed Benefits:

- Scientific collaboration and communication.
- Reduction of software development effort.

Observed Barriers:

- None.

Evaluation:

- Experiment in initial phase.
- Initial collaboration established

Network Experience Report
ANL-18

ERDA Program: Magnetic Fusion (ED)

Title: ANL Use Of Magnetic Fusion Center At LLL

Cooperating Sites: ANL, LLL

ANL Contact: R. Bare

Resources Accessed:
LLL--MFE Center Programs

Motivation:

Economic and error free terminal use of magnetic fusion energy system at Lawrence Livermore Laboratory

Procedure:

To use ANL's ARPANET connection and TELNET to connect to LLL's Research in Secure Operating Systems (RISOS) ARPANET Terminal System (RATS) which provides connection to the MFE system.

Observed Benefits:

- Access to unique software--LLL MFE center programs.

Observed Barriers:

- Inadequate remote site hardware--LLL ARPANET node temporarily disconnected; insufficient access lines to MFE system.

Evaluation:

- Partial success. Experiment continuing.

Network Experience Report
ANL-19

ERDA Program: Coal (BA)

Title: Resources Management System

Cooperating Sites: ANL, LBL

ANL Contact: R. Bare

Resources Accessed:
LBL--Resource Management System

Motivation:

A collaborative effort is planned with other scientists at Argonne to apply resource management to a strip mining operation in order to minimize associated adverse environmental effects.

Procedure:

An experiment was made utilizing the Resource Management System at LBL. The Resource Management System makes use of a source library routine to solve a certain class of linear programming problems. The only copy of the library routine is a CDC version which is available at LBL. The routine was copied from the Berkeley Library into our private PSS Library through the use of ARPANET. A successful test run was subsequently made.

Observed Benefits:

- Access to unique software--
LBL-Resource Management System. A tool to manage resources is now at the disposal of ANL scientists.

Observed Barriers:

- None.

Evaluation:

- Successful. Production use planned.

Network Experience Report
ANL-20

ERDA Program: Basic Energy Science (EE)

Title: Export Of Kinetic Diffusion Package

Cooperating Sites: ANL, LBL

ANL Contact: R. Bare

Resources Accessed:

LBL--CDC 6600's, 7600

--CDC Operating System and MORTAN preprocessor

Motivation:

To develop and test a CDC version of the DISPL Kinetic Diffusion package for export to other computer centers. This package consists of approximately 5000 statements in MORTAN and FORTRAN.

Procedure:

FTP was used to transfer the package from ANL to LBL. Then TELNET was used to modify the programs and submit them to run on the LBL CDC 7600.

Observed Benefits:

- Access to hardware not available locally--CDC 7600 & 6600.
- Access to software not available locally--CDC Operating System and MORTAN preprocessor on CDC 7600.
- Reduction of software development effort--use of CDC 7600 from Argonne.

Observed Barriers:

- None.

Evaluation:

- Partial success. Experiment continuing.

Network Experience Report
ANL-21

ERDA Program: Building And Community Systems (HD)

Title: ATMES Simulation And Optimization Of Energy Plant Configuration
For Demands Imposed By Communities

Cooperating Sites: ANL, LBL

ANL Contact: R. Bare

Resources Accessed:

LBL--ATMES Programs
--CDC 7600, 6600's

Motivation:

To use ARPANET to aid in the testing of the ATMES code at LBL until an IBM version of the code is implemented. The codes written for ATMES deal with the simulation and optimization of energy plant configuration used to satisfy demands imposed by communities.

Procedure:

ARPANET was used to construct and test a (150-200 statement) control program which will compile and test the system of programs written for ATMES. The control program is invoked by a job (containing data from the simulation) submitted via the Argonne Code Export Terminal. During evening hours, the ARPANET is used to run the code using data files currently at LBL instead of using the Export Terminal.

Observed Benefits:

- Access to unique software--LBL-ATMES programs.
- Access to hardware not locally available--LBL-CDC 7600.

Observed Barriers:

- ANL/ARPANET connection only available for use at night

Evaluation:

- Successful. In production use.

Network Experience Report
ANL-22

ERDA Program: Basic Energy Sciences (EE)

Title: Linpack Linear Equations Package Development Collaboration

Cooperating Sites: University Of New Mexico, ANL

ANL Contact: R. Bare

Resources Accessed:

U. of N.M.--Dr. C. Moler

ANL--J. Dongarra

ANL--LINPACK Linear Equations Package

Motivation:

Collaboration on the software development of linear equations package routines.

Procedure:

Dr. Moler uses the ARPANET to participate in the development of LINPACK routines on the ANL 370/195.

Observed Benefits:

- Reduction of software development effort.
- Scientific collaboration and communication.

Observed Barriers:

- None.

Evaluation:

- Successful. In production use.

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Network Experience Report
BNL-1

ERDA Program: EE

Title: ELF Maintenance and Development

Cooperating Sites: BNL, SRI-KA, BBN, Datacomputer, NYU

BNL Contact: G. Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:

ELF Maintenance and development tools - SRI-KA, BBN
Tenex operating system - SRI-KA, BBN
TBM (Terabit Memory) - Datacomputer

Motivation:

The ELF system is an ARPANET interface system running in a PDP-11. The standard system offers User Telnet and a Server FTP using the PDP-11 disk as the file storage medium. This system is used by many installations and the master copy of the source code is maintained at SRI-KA (located in Menlo Park, CA). A cross assembler, loader, and other utilities running under TENEX are used to generate the PDP-11 systems. These systems are then sent over the network to the users installation.

Procedure:

The development task we faced was to create a Server Telnet and a Server FTP that would communicate with the Central Scientific Computing Facility (CSCF). Initially we started using the SRI-KA system via the existing User Telnet and a free account provided by SRI. This worked well and was a simple remote access use of the network. However the SRI machine soon became heavily loaded and our free account was restricted to use only between the hours of 2300 and 0800 PST. Although this allowed us access until 1100 EST, it was clearly inadequate for a heavy development schedule.

We then established an account at BBN-C (located in Cambridge, Mass.) for which we were charged at standard rates. Since this is another TENEX system we could easily move the necessary files across country using the network. This worked so well that in one day's time we were in full production on a different machine. However when the bills for computer usage started coming we quickly realized that we had a problem. We then tried to minimize the cost by using SRI-KA until 1100 EST and then shifting to BBN, moving files as necessary across the network. Again this worked well, the additional delays

of file movement being quite acceptable. In fact we were then able to minimize our impact on the SRI facility (as a good guest should) by using primarily BBN storage facilities, since one of the most critical resources at SRI was the disk storage space.

The development work was considerably eased by use of an ELF facility called USERLOAD. This allows a load module, created in another system, to be loaded across the network into an operational ELF. The process of creating a totally new ELF system requires taking down ELF and running a special stand-alone program to bring the new system back to the local PDP-11. Use of the USERLOAD capability meant we could check out new modules while still keeping ELF running for other users (of course this was at the expense of degraded stability at those times).

A majority of the development work was done in this mode of operation. However the project soon fell well behind schedule (the ELF system was relatively buggy and a lot of effort was spent in fixing problems in the basic system - but that is another story) and we were again faced with budgetary problems. At this point a joint ERDA account was set up on the BBN-B system. This account is a "pie-slice" account which, for a fixed cost, receives a fixed percent on the machine time (plus any available idle time) Our BBN-C account is a "demand" account where charges are based on usage. At the time of writing we are in the process of learning how to use an existing system (RSEEXEC - Resource Sharing EXecutive) that will let us use the ERDA account (on BBN-B) for the CPU intensive parts of our computing while dynamically using disk storage from our account on the BBN-C system. This system maintains a unified directory of files and automatically invokes FTP to move the files as necessary.

Another network usage is in the development stage which should reduce our disk storage charges substantially. We have been granted a DFTP node on the Datacomputer. The Datacomputer is a system located at CCA (also in Cambridge, Mass.) which has a large mass memory (the Ampex TBM) and operates as a network data-storage and retrieval facility. DFTP is a specialized use of this facility for storing and retrieving files. Since storage there is currently free (although even if charges were levied they would be substantially less than on-line disk storage charges) use of this facility should significantly lower our costs at BBN.

If these attempts are successful we will then be using 3 or 4 computer systems simultaneously during ordinary system development tasks. Using the CPU at either SRI-KA or BBN-B (or both), using on-line disk storage at BBN-C and second level storage at the Datacomputer.

Observed Benefits:

- Reduction of software development effort.
- Network related research and development.
- Load balancing.

Observed Barriers:

- Remote site saturation.

Evaluation:

Successful--continuing.

Network Experience Report
BNL-2

ERDA Program: EE

Title: Development of Portable software

Cooperating Sites: BNL, UCLA-CCN

BNL Contact: G.Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:

PL-I Compiler - CCN

Motivation:

To assist in development of a readily portable software system for data access. It was hoped that almost simultaneous checkout of program modules on both an IBM and the local CDC systems would reduce incompatibilities in the resultant program.

Procedure:

As program modules were developed at BNL they were entered into CCN by TELNET access. They were then compiled and tested at CCN.

Observed Benefits:

- Access to unique software
- Reduction of software development effort

Observed Barriers:

- Inadequate local facilities (FTP)

Evaluation:

It was helpful but the amount of work necessary was incommensurate with the benefits derived. If a local FTP implementation had been available at that time, it would have been worthwhile.

Network Experience Report
BNL-3

ERDA Program: EE

Title: Software Distribution

Cooperating Sites: BNL, ILL-NTS

BNL Contact: G. Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:

Source code for DIESUB - ILL-NTS

Motivation:

To explore the feasibility of network usage for software distribution.

Procedure:

The Illinois group offered to distribute the code by net-mail. Since there are no mail handling facilities at BNL we requested that it be made available via FTP. This was done and the file transferred.

Observed Benefits:

- Access to unique software
- Reduction of duplicate software development

Observed Barriers:

- Inadequate local facilities

Evaluation:

This is a very promising technique for rapid dissemination of non-proprietary software.

**Network Experience Report
BNL-4**

ERDA Program: EE

Title: MACSYMA Access

Cooperating Sites: BNL, MIT-MC

BNL Contact: G. Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:
MACSYMA - MIT-MC

Motivation:

To explore the assistance a very sophisticated algebraic manipulation system can provide to mathematical research.

Procedure:

Standard TELNET access was used to explore a variety of problems. The typical problems involved the symbolic solution to moderate sets of linear equations, looking for anomalous behavior of the solutions in some parameter domains.

Observed Benefits:

- Energy Related Scientific Research
- Access to unique software

Observed Barriers:

None.

Evaluation:

MACSYMA is a very impressive system. It should be of substantial benefit to many scientists.

Network Experience Report
BNL-5

ERDA Program: EE

Title: Microfiche Listings

Cooperating Sites: BNL, SRI-KA, LBL

BNL Contact: G. Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:

ELF Maintenance tools - SRI-KA
Microfiche printer - LBL

Motivation:

To obtain bulky printouts on microfiche when there were no such facilities available locally.

Procedure:

Listings generated at SRI-KA were transferred to LBL via FTP. They were then modified with a text editor to insert the required printer control characters. The resulting microfiche was then sent to BNL by U.S. Mail.

Observed Benefits:

- Access to unique hardware

Observed Barriers:

- Inadequate remote software
- Inadequate network protocols

Evaluation:

Network data rates impose a limit on this type of activity since program listings tend to be large. In addition the FTP protocol was discovered to be inadequate that it has no provision for description of the file type in local storage, and thus not allowing FTP processes to perform necessary data transformations.

Network Experience Report
BNL-6

ERDA Program: EE

Title: Code Conversion Assistance

Cooperating Sites: BNL,LBL

BNL Contact: G.Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:
Unknown

Motivation:

During conversion of a large program package, various anomalies were encountered. It was desired to check these against the version at LBL which was considered operational.

Procedure:

Normal TELNET access to LBL was used to run test cases.

Observed Benefits:

- Reduction of software development effort

Observed Barriers:

None.

Evaluation:

Helpful in reducing the total time to completion of the project.

Network Experience Report
BNL-7

ERDA Program: RK

Title: Database Exchange

Cooperating Sites: BNL, LBL

BNL Contact: G. Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:

County encoding data base - LBL

Code for access to interchange format tapes - BNL

Motivation:

To provide rapid interchange of computer data and programs.

Procedure:

FTP was used in each direction for transferring the data and code.

Observed Benefits:

- Access to unique software
- Access to unique data
- Reduction of duplicate software development.

Observed Barriers:

- Inadequate local software

Evaluation:

Helpful for small to moderate amounts of data, however network data rates will limit the size of databases to be exchanged in this manner.

Network Experience Report
BNL-8

ERDA Program: EE, RK, and possibly others

Title: Teleconferencing

Cooperating Sites: BNL, BBN-B, BBN-C and Others

BNL Contact: G. Campbell (516)345-4168 or FTS 664-4168

Resources Accessed:
PLANET-2 - BBN

Motivation:

Explore the use of teleconferencing to enhance communication between scientists at physically separate locations.

Procedure:

Normal TELNET access to BBN.

Observed Benefits:

- Scientific collaboration and communication

Observed Barriers:

- Remote site saturation

Evaluation:

Very popular with the participants.

Network Experience Report
LBL-1

ERDA Program: High Energy Physics (EC)

Title: Three Dimensional Magnet Design

Cooperating Sites: LBL, RHEL

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

ELECTRIC, GFUN, Electronic Mail - RHEL CDC 7600 - LBL

Motivation:

A three dimensional magnet design code was needed at LBL for design studies in an accelerator proposal. Such a code (GFUN) already existed at RHEL on the IBM 360/195. It would have been foolish to write a new version from scratch, and time consuming to convert to the LBL CDC-7600.

Procedure:

When the network connection became available, GFUN was used directly at RHEL, avoiding the tedious problem of converting the code from IBM to CDC FORTRAN. Recently, the RHEL scientists responsible for developing GFUN visited LBL and decided to install the program on the CDC 7600 themselves. Their goal was to make it available to other CDC sites which did not have network access. Development proceeded smoothly to completion, with regular communication through the electronic mail facility at RHEL.

Observed Benefits:

Energy related scientific research and development.
Reduction of duplicate software development.
Access to unique software - GFUN.

Observed Barriers:

Dissimilarities in command languages:

The RHEL scientists experienced some difficulty in learning the command language for the LBL CDC-7600. This was alleviated considerably by consultation with the LBL physicists familiar with CDC software and GFUN.

Evaluation:

Successful - continuing.

This type of network use illustrates the ease with which resource sharing can be accomplished when consulting facilities at the remote site are available. Had the RHEL scientists not been able to communicate easily with an expert on the LBL system, the project would not have

been attempted.

Network Experience Report
LBL-2

ERDA Program: High Energy Physics (EC)

Title: Kolmogorov-Smirnov Tabulation

Cooperating Sites: LBL, MIT

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:
APL - MIT

Motivation:

An LBL physicist needed values of the Kolmogorov - Smirnov statistic for an untabulated region of the independent variable. No known programs existed for this task so it was necessary to write one from scratch. The APL programming language is vastly superior to FORTRAN for this kind of development, and since APL was not available at LBL, it was decided to access the APL system at MIT-Multics over the network.

Procedure:

The physicist learned how to use the network in about three minutes. No further instruction was necessary, since he was already thoroughly familiar with APL. The code was written and debugged in two, one hour sessions at an interactive terminal.

Observed Benefits:

- Energy related scientific research
- Access to unique software system
- Access to a familiar system

Observed Barriers:

Insufficient Network Software Support:

A single difficulty was encountered during the debugging phase, when the partially developed code got into an infinite loop. The attempt to send a TELNET interrupt caused the network connection to be broken, producing considerable user anxiety that the looping program would exhaust his entire computing budget. Fortunately, multics killed the job automatically when the broken connection was detected. The problem was traced to a bug in the LBL Network Control Program and corrected.

Evaluation:

Successful - completed.

Network Experience Report
LBL-3

ERDA Program: High Energy Physics (EC)

Title: Gamma Detector Efficiency Code

Cooperating Sites: LBL, RHEL

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

ELECTRIC, MUGWUMP, Electronic mail - RHEL

Motivation:

A physicist who transferred to LBL for a two year appointment, needed to complete development of his gamma detector efficiency code at RHEL. To accomplish this it was necessary to access ELECTRIC on the RHEL 360/195.

Procedure:

Instruction in use of the TELNET protocol required less than five minutes, and access to the 360/195 was obtained exactly as if the users terminal were located at RHEL instead of 8000 miles away at LBL. Program development continued smoothly, and both numerical and graphical results were retrieved without difficulty using MUGWUMP at RHEL. The Rutherford electronic mail facility was used to communicate results to colleagues, and the task was completed without difficulty.

Observed Benefits:

Energy Related Scientific Research and Development
Access to a familiar system

Observed Barriers:

None.

Evaluation:

Successful - completed.

This use of the network is equivalent to a high-quality, high-speed telephone link. Ordinary low-quality, low-speed links cost about \$200 per hour between Berkeley and Rutherford. This work could not have been completed without a network connection.

Network Experience Report
LBL-4

ERDA Program: High Energy Physics (EC)

Title: TST Collaboration

Cooperating Sites: LBL, RHEL, Turino

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

ELECTRIC, MUGWUMP, Electronic mail - RHEL

Motivation:

A Track Sensitive Target (TST) is a plastic box of liquid hydrogen immersed in a neon-hydrogen bubble chamber. The TST provides isolated protons as targets for the incident particle beam. Escaping gamma radiation is captured by the surrounding neon-hydrogen mixture.

A joint LBL, RHEL Turino experiment using such a device was performed on the NIMROD accelerator at RHEL. Film from this experiment was divided three ways with each laboratory receiving a third of the pictures. It was necessary to isolate any biases produced by the three separate analysis systems, so close collaboration was required throughout the analysis process. The long delays inherent in the postal system (a minimum of ten days) tend to produce undesirable shortcuts and oversights.

Procedure:

Using the electronic mail facility, and the capability of transmitting graphical displays over the network, LBL and RHEL were able to maintain routine communication. In contrast, Turino had to send two physicists to RHEL for several months to complete their work.

Observed Benefits:

Energy related scientific research
Scientific Collaboration and Communication

Observed Barriers:

Dissimilarities in command languages:

The LBL physicists were completely unfamiliar with the Rutherford system. Therefore, some effort was required to teach them to use the network, ELECTRIC, and MUGWUMP. Considerable distaste for this task was expressed, since it had nothing to do with the physics involved.

Evaluation:

Successful - completed.

This exercise, which was one of the first applications of network technology to energy related research, shows that when startup costs are moderate, resource sharing will occur when the payoff is sufficiently attractive.

Network Experience Report
LBL-5

ERDA Program: High Energy Physics (EC)

Title: Remote Analysis of 184 Inch Cyclotron data

Cooperating Sites: LBL, UCLA

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

SESAME, CDC 7600 - LBL

Motivation:

A medium energy physics experiment was performed by UCLA physicists on the LBL 184 inch cyclotron. Data was stored in the LBL tape library, and was partially analyzed during the course of the experiment. When data collection was completed, the physicists returned to UCLA. Rather than recode the analysis programs for the UCLA 360/91, it was considerably more efficient to continue processing at LBL through the network.

Procedure:

Jobs were submitted to the LBL CDC-7600 through SESAME, the LBL interactive system, and output was retrieved using file transfer protocol (FTP). Since the scientists were already familiar with the LBL system, startup cost was negligible, and analysis was completed without interruption.

Observed Benefits:

Energy related scientific research
Reduction of duplicate software development

Observed Barriers:

Inadequate network software support:

Early file transfer rates were too slow. An output file (80 pages of text) was retrieved from LBL at an observed transfer rate of 1200 Baud. The file contained roughly three million bits, required forty minutes to transfer and cost \$17 at LBL alone. The cost was roughly equivalent to a one way air fare from Los Angeles to Oakland, and the delay was extremely frustrating to the users. Examination of the file transfer software at LBL revealed a factor of four improvement could be achieved by simply increasing buffer sizes. This was done, and the expected improvement to cost and speed was observed. However, this still left LBL a factor of two slower than most network hosts. Planned upgrading of the LBL file system is expected to correct this.

Evaluation:

Successful - completed.

This use of the network promises a significant breakthrough in high energy physics applications. Leaving the experimental data at the collection site makes sense in terms of reducing data handling costs. Furthermore, these sites usually have larger storage facilities and more powerful computers. Network access to these facilities would allow physicists to return to their home sites as soon as the data collection phase was completed. No interruption of analysis would occur, and parallel software development would be avoided. It is conceivable that networking may someday be sufficiently advanced to allow remote setup and control of the data collection phase as well.

Network Experience Report
LBL-6

ERDA Program: Environmental Research and Development (RK)

Title: SEEDIS

Cooperating Sites: LBL, LASL

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

SEEDIS - LBL

1970 U. S. Census - LBL

U. S. State and County cartographic data base - LBL

Motivation:

SEEDIS is the LBL Socio-Economic Environmental Demographic Information System which contains a variety of data bases and software systems. It is used for such energy related projects as environmental impact studies and energy policy studies. The Regional Studies Programs at ANL, BNL, and LASL would benefit considerably from access to this system, and the high bandwidth requirements of graphical displays make networking an attractive solution.

Procedure:

A feasibility experiment was performed in which the LASL group was able to access the geographic data bases and the map editing programs over the network (via the Kirkland TIP). Map outlines were displayed on Tektronix terminals located at LASL.

Observed Benefits:

Feasibility of network access to SEEDIS established.
Access to unique software.
Access to unique data.

Observed Barriers:

Insufficient network software support: LASL is not an ARPANET host. Therefore, access is somewhat inconvenient in that arrangements for a high speed telephone link to the Kirkland TIP had to be made, and no file transfer capability was available.

Evaluation:

Successful. This application has great potential for future work in cooperative efforts to share and maintain geographical and other data bases. All ERDA laboratories can benefit by network access to SEEDIS. Connection of LASL to the network as a full service host would probably be necessary for production use.

Network Experience Report
LBL-7

ERDA Program: High Energy Physics (EC)

Title: PBAR-P Partial Wave Analysis

Cooperating Sites: LBL, RHEL

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

- Experimental data - RHEL, CERN, BNL.
- Partial wave generator code - RHEL
- Electronic mail, MUGWUMP - RHEL
- Cluster analysis code - LBL
- Continuity fitting code - LBL
- Pole extraction code - RHEL
- Graphics display code - RHEL

Motivation:

Physicists using the network as a mechanism for maintaining communication discovered that complementary software existed at their respective sites which would allow a highly sophisticated processing chain to be constructed for analysis of proton antiproton annihilations. Transporting either set of software to the other site would have been considerably more effort than merely transferring output at each stage of the process.

Procedure:

Data from previous experiments by many groups was formatted and transmitted to RHEL (currently, CERN uses an RJE link and BNL uses air mail, but the potential for data acquisition over the network is obvious).

Next, the partial wave generation code at RHEL was used to produce many sets of partial wave coefficients as possible solutions. These coefficient sets were transmitted to LBL (using FTP) for further analysis.

The cluster analysis program at LBL was invoked to separate the possible solutions into several groups. This is an iterative process which requires judgment on the part of the physicist. The separation process is currently underway with physicists from both sites communicating by electronic mail.

When cluster analysis is completed, the results will be passed to a continuity fitting code also at LBL, which will further eliminate unlikely solutions.

The results of the continuity fit will then be transferred to RHEL (again by FTP), which will further eliminate unlikely solutions.

The results of the continuity fit will then be fed to the RHEL pole-extraction program which will use them as weak constraints to limit the number of possible solutions still further.

These results will then be fed to a graphics display code (MUGWUMP) at RHEL for final checking and publication.

Observed Benefits:

- Energy related scientific research and development
- Scientific collaboration and communication
- Reduction of duplicate software development.

Observed Barriers:

Insufficient network hardware support:

File transfer speed between RHEL and the network is limited by the 1200 Baud telephone link from the London TIP to RHEL. For this application, file transfers typically require two hours to complete. It is significant that the physicists are sufficiently interested in the results to be willing to come in nights and weekends to perform the transfers when network traffic and the LBL file system are relatively quiescent.

Evaluation:

Successful - continuing.

This impressive procedure was initiated by the physicists themselves, which is typical in high payoff situations. Familiarity with their local command languages and programming languages meant that neither group had to learn the other's system, beyond what had already been learned in establishing initial contact. The fact that slow file transfer speeds was deemed acceptable is further evidence of the importance attached to the application. In general, however, 1200 Baud is too slow for most resource sharing applications.

Network Experience Report
LBL-8

ERDA Program: High Energy Physics (EC)

Title: Particle Data Group - Combined Data Bases

Cooperating Sites: LBL, RHEL, Caltech, Durham

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

- Bibliographic data base of HEP experiments - LBL, RHEL
- Particle properties data base - LBL, RHEL
- PLANET teleconferencing system - BBN
- Electronic mail - RHEL
- Berkeley Data Management System (BDMS) - LBL, RHEL

Motivation:

LBL's Particle Data Group is an ERDA Information Analysis Center. Its goal is to collect, verify, and distribute data on high-energy physics experiments, nuclear reactions, and particle properties. The group works closely with physicists at RHEL, Caltech, and the Durham Laboratory in England. Before networking was available, the group relied on ordinary mail to distribute tapes and written documentation for installation on the Berkeley Data Management System (BDMS). The connection of LBL to the ARPANET offered a major advantage to this international collaboration.

Procedure:

The use of networking initially provided routine contact through electronic mail at RHEL, and more recently through the PLANET teleconferencing system at BBN. The Caltech group uses the network to access BDMS at LBL under which all three data bases are stored. When BDMS was installed on RHEL's 360/195, the network became essential in debugging the system, allowing the authors to assist directly in the debugging process. Currently, data files are transferred over the network (using FTP) for updating and maintaining consistent data bases on the two systems.

Observed Benefits:

- Energy related scientific research and development
- Scientific collaboration and communication
- Access to unique software - BDMS, PLANET
- Access to unique data
- Reduction of software development effort

Observed Barriers:

None.

Evaluation:

Successful - continuing.

In the future, these data bases will be available to any site on the network, providing for direct access by scientists as well as automatic systems currently under consideration.

Network Experience Report
LBL-9

ERDA Program: High Energy Physics (EC)

Title: Intel 8080 Compiler Access

Cooperating Sites: LBL, UCLA

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

Intel 8080 BASIC and BASICFP - LBL

Motivation:

The BASIC and BASICFP compilers for the Intel 8080 were needed by developers at UCLA for the microprocessor network access machine project (PEANUTS).

Procedure:

A network broadcast from UCLA asking about the existence of these codes was noticed by LBL and promptly answered. The source code was retrieved by UCLA using network file transfer protocol (FTP).

Observed Benefits:

Reduction of duplicate software development

Observed Barriers:

None.

Evaluation:

Successful - completed.

Network broadcast messages are a very powerful tool for locating existing software packages. This provides a fast poll of all network hosts, often resulting in elimination of software development entirely.

Network Experience Report
LBL-10

ERDA Program: High Energy Physics (EC)

Title: ERDA Standard Command Language Study Group

Cooperating Sites: LBL, LLL, UCLA, LNS-MIT, BNL, ANL

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

PLANET Teleconferencing System - BBN

Motivation:

Startup cost is perhaps the greatest single technical barrier to resource sharing in ERDA. In the restricted class of applications called load leveling, this reduces to the problem of dissimilarities in command languages. Recognizing this, investigators at LBL, LLL, UCLA, LNS-MIT, BNL, and ANL decided to explore the possibility of creating a standard command language for the ERDA subnet.

Procedure:

A teleconference on this subject was opened under the PLANET system at BBN. Initial effort concentrated on development of a universal view of the operating system environment, with significantly different views being expressed by the participants. Not surprisingly, attitudes ranged from cautious optimism to outright pessimism regarding the practicality of such a development.

Observed Benefits:

Network related research and development.

Observed Barriers:

Remote software needs refinement:

PLANET does not allow review of private messages, and is rather wasteful of file space. An improved teleconferencing system would be helpful.

Evaluation:

Continuing.

If this development is successful, it will represent a major breakthrough in resource sharing. Startup cost for load leveling will be reduced significantly, which will produce spontaneous offloading of large scale computing tasks among ERDA sites on the network.

Network Experience Report
LBL-11

ERDA Program: High Energy Physics (EC)

Title: Text Formatter Access - MRUNOFF

Cooperating Sites: LBL, SRI, BBN

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

Geoff Goodfellow - SRI
TENEX - BBN

Motivation:

The LBL Real Time Systems Group had planned to develop a text formatting program for use on MODCOMP, PDP-11, and CDC 6000 series computers. The code was to be written in BCPL, a machine independent systems programming language, and would have required at least six months to develop.

Procedure:

A questionnaire to the LBL Newsletter distribution list requesting ideas for the design of the proposed software was noticed by the LBL Network Investigators representative. Through network contact with Geoff Goodfellow of SRI, a writeup of MRUNOFF was located in a matter of minutes. MRUNOFF is written in BCPL, and meets most of the design requirements of the Real Time Systems Group. Testing was done using the M&CS account at BBN. Although some changes will be necessary, the effort involved is expected to be minimal. Negotiations are underway to obtain a copy of the source code from BBN.

Observed Benefits:

Reduction of duplicate software development effort.

Observed Barriers:

None.

Evaluation:

Successful - continuing.

This use of the network illustrates the speed and simplicity with which resources can be located and accessed. Duplication of software is an unavoidable problem when computing sites are highly isolated. The existence of a computer network greatly reduces the frequency of parallel development effort.

Network Experience Report
LBL-12

ERDA Program: High Energy Physics (EC)

Title: Author Maintained Software - Policy Formulation

Cooperating Sites: All ARPANET hosts

LBL Contact: D.Hall (415)843-2740 x6053 or FTS 451-6053

Resources Accessed:

Bulk Mailer (SNDMSG) - SRI

Network Liaison Group Mailing List - SRI

Motivation:

In view of the benefits of resource sharing, LBL decided to review its policy toward maintaining a centralized clearing house for author maintained software. Many network hosts already had such a facility, and hence could be expected to have experienced some of the pitfalls in such a scheme.

Procedure:

A questionnaire was prepared and sent to the Network Liaison Group via the network standard mailer (SNDMSG). Responses were immediate. Although limited in number, (only about ten percent of the hosts responded) quality of response was very high. The policy best suited to the LBL environment was that of MIT-Multics, and work began on incorporating the minor changes appropriate to LBL.

Observed Benefits:

Access to policy level information

Observed Barriers:

None.

Evaluation:

Successful - completed.

Development of a local clearing house for author maintained software is expected to begin in the near future.

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Network Experience Report
LLL-1

ERDA Program: Magnetic Fusion Energy

Experiment name: ARPANET - MFE net telephone gateway

Cooperating sites: MFE users from NBS, UCLA, MIT, ANL, NYU, etc.

LLL Contact: Jed Donnelley

Resources accessed: MFE's CDC 7600 system

Motivation:

To use existing ARPANET communication facilities (available for other purposes [RISOS project]) to substitute for long distance telephone calls.

Procedure:

1. Get on an ARPANET host (e.g. a TIP)
2. TELNET to LLL
3. Execute the "Call CTR" command to call the MFE telephone concentrator on the telephone.
4. Proceed as if the call were direct (essentially).

Observed benefits:

MFE users without access to FTS saved an average of \$2700/month on telephone bills during the months between March and June 1976.

Observed disadvantages:

Character echo was slower than with direct dial. Connection required three more steps than direct dial. TELNET and CALL escape characters took extra steps to send.

Observed barriers:

The shortage of auto dial telephones (2) was a serious limitation. Often users connected to LLL but were unable to get a telephone to call the CDC 7600. The 30 chr/sec limit on transfer rates also constrained some MFE users.

Evaluation:

Highly successful for those users who were able to get lines. Users who knew nothing about the communication mechanisms that they were using were able to use the 7600 with only a few lines of documentation. The slow echo was the only disadvantage over direct dialing that was noticeable. When users learned that they could type ahead, this ceased to be more than a minor irritant.

Networking Experience Report
LLL-2

ERDA Program: Magnetic Fusion Energy

Experiment name: ARPANET - MFE net terminal concentrator gateway

Cooperating sites: MFE users at MIT, Durham, Utah, NBS, UCLA, etc.

LLL Contact: Jed Donnelley

Resources accessed: MFE's CDC 7600 system

Motivation:

To use the ARPANET as a cost effective means of giving MFE users with access to ARPANET access to the MFE CDC 7600.

1. Get on an ARPANET host (e.g. a TIP).
2. TELNET to LLL
3. Execute the "MFE" program to connect to the MFE terminal concentrator via a multiplexed 1200 baud line.
4. Proceed as if a direct call had been placed to the MFE telephone concentrator.

Observed benefits:

1. Higher speed access (1200 baud aggregate)
2. More logical lines (more than 10)
3. Fewer errors (no telephone link)

Observed disadvantages:

Same as MFE telephone gateway plus some minor functional differences due to the fact that the terminal concentrator functions must be simulated (e.g. broadcast messages are not yet properly handled).

Observed barriers:

Transfer is limited to an aggregate of 1200 baud. Core size limitation on the gateway machine may cause some thrashing slow down. The MFE CDC-7600 cannot act as a host in the ARPANET due to limitations in the ARPANET protocols.

Evaluation:

Use of this facility has been steadily increasing. Considering the London users, the savings over equivalent telephone access is considerably greater than the \$2700/month observed in the telephone link experiment. Even without the London users, use is about the same as the old telephone link and still increasing.

Networking Experience Report
LLL-3

ERDA Program: Magnetic Fusion Energy

Experiment name: ARPANET - MFE net host gateway

Cooperating sites: MFE users

LLL Contact: Jed Donnelley

Resources accessed: The MFE network

Motivation:

To provide full host for an MFE PDP-10 on the ARPANET. This will allow higher speed throughput from the MFE network to the ARPANET, will allow file transfers more conveniently between the two networks, and will free the concentrator gateway machine from its gateway role.

Procedure:

Normal ARPANET protocols to the MFE PDP-10 which is directly on the MFE network.

Observed benefits:

The hardware and software for this experiment are still in the procurement cycle.

Observed disadvantages: None.

Observed barriers: None.

Evaluation: Not appropriate yet.

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Network Experience Report
LNS-1

ERDA Program: Basic Energy Sciences (EE)

Title: Density Dependent Hartree-Fock Calculations -
Load Leveling

Cooperating Sites: LNS-MIT - LBL

LNS Contact: Betty Campbell, Lyman Hazelton

Resources Accessed:

- Multics-MIT
- CDC7600-LBL

Motivation:

- To compare the cross sections obtained from theoretical predictions of the density of deformed nuclei in the Rare-Earth and Actinide regions with the results of a series of electron scattering experiments recently completed at the Bates Linear Accelerator at MIT. Data was collected for (150)Nd, (156)Gd, (166)Er, (176)Yb, (232)Th and (238)U. (1) The physicists involved were using the density matrix expansion (DME) interactions, a zero-range approximation to the finite range interaction, proposed by Professor John Negele of the MIT Center for Theoretical Physics.
- To monitor network performance in converting and offloading a large-scale, scientific computation: a large (2500 lines) density dependent Hartree-Fock code, originally developed at LASL, was to be converted and modified to send intermediate results to MIT. Because this code was developed at LASL for a CDC 7600, it was hoped that the modification and conversion tasks would be considerably easier if done on CDC equipment than on IBM equipment. Moreover, for a complete nucleus it was established the program would require up to ten hours on the IBM 360/65 at LNS. Such a gross consumption of computing power would obviously be detrimental to other groups at LNS who depend on the IBM 360/65 for their own research. Therefore, use of the LBL CDC 7600 was not only interesting as a resource sharing application, but was very nearly mandatory because of the limited CPU

(1) To facilitate use of computer generated documentation, we have adopted the following notation for specification of nuclear specie:

(<nuclear mass>) <atomic name>

for example, (238)U refers to the isotope of uranium having 146 neutrons.

capacity of the 360/65.

Procedure:

- Professor Negele had obtained the code while he had been visiting LASL to work with physicists there. When the physicists assigned to do the density calculations approached the staff of the LNS computer facility for assistance in converting the program, the group investigating ERDA network use suggested that they join in the experiments on resource sharing at LBL by trying to run the code on the CDC 7600 there. Because of the potential long-term impact on ERDA computing, it was decided to provide funds from the network study contract to assist in the conversion and modification task. The program, as received from LASL, was placed on a disk file at MIT-Multics, and shipped to LBL via the network. At LBL, substantial modification was carried out by the physicists themselves using the network to access the LBL time sharing and batch job submittal facility SESAME. They spent most of the summer and fall of 1976 learning the LBL system, converting the code and modifying it to store intermediate results of the interactive process used to compute the theoretical densities. These intermediate results were returned to MIT and examined for convergence. Once convergence was reached, the calculated densities were then used as input data to the HEINEL code being run on the LNS 360/65 to compute cross sections from the theoretical densities. The calculated cross sections were then compared to experimental ones measured on the LINAC. Comparison was made by hand-plotted curves. Other calculations were performed at LBL in order to produce curves showing the sensitivity of the Hartree-Fock calculations to the physical parameters involved. The physicists are now in the process of preparing a paper, "Electron Scattering Studies of Some Permanently Deformed Nuclei in the Rare-Earth and the Actinide Regions: (150)Nd, (156)Gd, (166)Er, (176)Yb, (232)Th and (238)U", to be published in the Physical Review C, definitely this year, hopefully in early fall. In the paper, they plan to play down the old method of analysis, and stress the new method on which their calculations were based. This method is the microscopic approach from realistic nuclear forces rather than phenomenological parameterization of nuclear densities. They are willing to give the program that does this to anyone interested in using it.

Observed Benefits:

- Energy related scientific research
- Reduction of software development effort
- Off loading
- Network related research

Observed Barriers

- Lack of standard command language
CDC command language differs considerably from the IBM command language (JCL) which the LNS physicists normally use. In addition, to submit jobs remotely to LBL, it is necessary to learn SESAME, the LBL interactive system. Since LNS operates a batch system, their users do not have extensive experience with time-sharing systems. The LBL SESAME system is quite different in design from the systems with which they do have some familiarity, i.e. the Multics system and IBM's TSO system. This meant valuable time had to be spent in learning SESAME, which in turn prolonged the development effort. The existence of an ERDA standard command language is essential if widespread resource sharing is to occur for similar applications.

- Inadequate remote consulting facilities

With the present differences in operating systems, new users of a remote system need more help than can be provided by consultants via the telephone. Because of the long-term importance to ERDA computing, the LBL computing center sent a consultant to LNS who spent several days becoming familiar with the problem and assisting the physicists with the calculation. While this was of great benefit to the project, it is obviously an expensive way to solve the problem in general. Development of better remote user guides, a standard command language, and a more standard method of accessing the network are among the things we must do to make network access to remote resources attractive to the end user.

- Need for refinement of network software

The physicists were plagued with many problems with the network software. One of the most frustrating of their experiences was finding the network inaccessible due to the host or host interface at either end being down. There were two periods of seven days each, during which the network could not be used. However, these occurred under circumstances that are not likely to be repeated. The first instance occurred during the period of August 4-11 when LBL could not be accessed because of problems with a newly installed version of server_telnet. The second period of inaccessibility occurred when the MIT-Multics model 316 TIP was being replaced by a model 516 IMP and the Multics host number was changed from 44 to 6. There were approximately ten other one- to two-day periods during six months when the network could not be used. Since most of the network implementations are in the developmental stage, some down time is expected.

However, since it would be a less frustrating situation if network host status information was more readily available to network users, Lyman Hazelton of the LNS staff, has written a short guide on how to obtain any available information on the status of the ARPANET and any of the hosts. His guide describes also how to obtain for Multics the daily schedule of planned shutdowns for maintenance, testing, etc.

Probably the major problem encountered was the difficulty in transferring large files. At first, the only way it could be done successfully, was to segment the file into approximately 10,000 characters each and recombine the segments at LBL. Finally, Lyman Hazelton, investigating the problem, found the cause. When transferring files via the new user_ftp protocol, it appeared that the buffer size in Multics limited the size of the file to $2^{*}18$ bits. Lyman devised a successful bypass to the problem by transferring files from LBL to the MIT MC host (the Macsyma's Consortium's PDP-KL10), using the new protocol, and then from the MC to Multics using the old protocol. Having diagnosed the problem, Lyman submitted a Multics trouble report to have it repaired. This has been done.

Another problem was in the slow transfer rate between LNS and LBL. In transferring files of admissible size, the transfer rate was about 500 bits per second. Between LBL and the MC machine, four to five kilobaud rates were obtained.

- Budgetary

Because one of LNS's major problems is that of obtaining funding to use other computers, the funding of this particular experiment is of interest. Throughout the summer and until the expiration date of the then current Mathematics and Computing Contract (December 14, 1976), the network study funded most of the work. In addition, the physicists spent \$17,000 to \$18,000 to finish up the production work.

As can be imagined, use of an outside computer to this extent attracted the attention of the LNS Directorate. Fear was expressed that money needed to support the LNS Computer Facility, might be diverted to LBL and other ERDA sites. The program was converted to run on the LNS IBM 360/65 in order to compare cost and time. Two additional nuclei, $(180)\text{Hf}$ and $(28)\text{Si}$ are currently being calculated on the 360/65. The probable outcome is that future production running will be split between LNS and LBL. The physicists have \$7000 remaining in their LBL account, which they believe will carry them through FY77,

as they do not plan to begin extensive calculations until next fall. They are working on modifications in the design of their program in order to do calculations on odd mass nuclei.

Evaluation:

- This experience was highly successful in two ways. First, the results obtained were highly-significant physics. Second, and most important, it proved that our method of accessing LBL via the ARPANET could be adapted to the end user and that practical production work, leading to the solution of current physics problems, could be done. Due to the persistence of our staff and the physicists doing the calculations, the difficulties with network access were resolved and use of the LBL system via Multics and the ARPANET became quite stable. We now have two enthusiastic users spreading the gospel of using the network. Interest in the LNS network research has been sufficiently aroused to make some of the LNS project leaders think of networking as a present solution to part of computer overload and suppressed computational needs, not as a solution for five or ten years from now. The experience established that off-loading is practical for a certain class of jobs, i.e., large theoretical calculations requiring a fast central processor and large memory to run efficiently. The physicists have been encouraged to attempt additional calculations. They wish to investigate the use of several of the phenomenological Skyrme interactions and to study the sensitivity of the calculations to various parameters of the theory. These calculations, combined with their data, should go far towards advancing our knowledge of the basic nuclear interaction and the nuclear many-body system.

As was stated above, the code was converted to run on the LNS IBM 360/65. Since it was relatively easy to then run it on the 370/168 at the MIT Information Processing Services, we did so. It was also run on Argonne's IBM 370/195. The following table summarizes the time and cost to do five iterations of a twelve space calculation for the four systems on which the code has been run.

LBL CDC 7600
 \$ 38.00 (945 CU's)
 \$ 5.50 To print results on Multics
 \$ 10.32 To transfer the results from LBL to Multics,
 3.92 for Multics, 6.32 on LBL end.
 Total \$ 53.82 (Regular priority weekdays)
 Total cost for deferred priority weekdays or regular priority
 weekends was \$31.58.
 Total cost for deferred priority weekends was \$20.00.
 Time: 42 seconds per iteration

LNS IBM 360/65
 \$ 36.36 CPU time
 \$ 1.44 Lines printed
 \$ 2.04 I/O calls
 Total \$ 39.84
 LNS does not have either special priority or weekend rates.
 Time: approx. 510 seconds per iteration.

IPS IBM 370/168
 \$ 45.07 CPU time
 \$ 6.54 I/O, Disk
 \$ 44.90 Memory charges
 \$ 6.66 Lines printed
 Total \$103.17 (Regular priority)
 Run on their lowest priority (Sunday only), cost would be \$51.58.
 Time: approx. 116 seconds per iteration.

ARGONNE IBM 370/195
 \$ 10.53 CPU and Memory charges
 \$ 5.50 Multics print
 \$ 3.92 Transfer charges for Multics, none for Argonne
 Total \$ 19.95 (Regular priority)
 Time: approx. 49 seconds per iteration.

Network Experience Report
LNS-2

ERDA Program: Basic Energy Sciences (EE)

Title: Early learning Experiences in Using CCN
Facilities via the ARPANET

Cooperating Sites: LNS-MIT - UCLA

LNS Contact: Betty Campbell

Resources Accessed:

- TSO on IBM 360/91 - UCLA

Motivation:

- To perform the following four experiments between two operational hosts on the ARPANET, Multics at MIT and CCN at UCLA, in order to become familiar with network use.
- Using TSO at CCN by a remote user at MIT
- Sending files between Multics and CCN
- Sending mail between Multics and CCN
- Submitting a batch job to CCN from MIT

Procedure:

- The programmer logged into Multics, requested Multics to establish a connection to the UCLA-CCN computer for interactive use, requested TSO service from CCN, tested the various TSO commands at CCN and then edited and compiled a short FORTRAN program.
- Files were transferred back and forth by requesting a network connection via "user-FTP" and using "send (filename) -to (filename)" and "get (filename) -from (filename)".
- "net_mail" was used to send a message to a friend at UCLA.

Observed Benefits:

- Network related research
- Access to unique software

Observed Barriers:

- None.

Evaluation:

- The TSO experience was very successful. The programmer was familiar with TSO on the 370/168 at MIT and found only minor differences in the TSO at CCN. Elapsed time connected to CCN TSO was 30 minutes. Cost accrued at CCN was \$9.00. Of this \$6.00 was used for compilation of the FORTRAN program (700 cards). Cost accrued at MIT was \$4.00, making the total cost for the half hour session \$13.00.

- The Multics cost of transferring a 1.275 million bit file was \$4.88, the elapsed time was 855 seconds and the transmission speed was 1490 bits per second.
- The Multics cost for using net_mail to send a 112 word message was \$0.57. Cost to login and prepare the letter was about \$2.00.

Network Experience Report
LNS-3

ERDA Program: High Energy Physics (EC)

Title: Remote Job Entry to Brookhaven

Cooperating Sites: LNS-MIT - BNL

LNS Contact: Betty Campbell, Michael Ford

Resources Accessed:

- UT 200 - LNS
- CDC 7600 - BNL

Motivation:

- To confirm that a working normal job using only card input could be transmitted to BNL for execution and returned in a reasonable time.
- To verify that analysis of Professor Ting's data, stored on a tape at Brookhaven, could be initiated from MIT.

Procedure:

- A visit to the BNL Computation Facility was made by members of the LNS systems staff to familiarize themselves with the use of the CDC 6600 and 7600 computers there and to get acquainted with the BNL facility personnel.
- The UT 200 at LNS was used to transmit the program over regular telephone lines.

Observed Benefits:

- Load balancing
- Access to unique hardware

Observed Barriers:

- Reliability of UT 200 was variable

Evaluation:

Successful in establishing the following:

- The test job was performed easily with good turnaround. It was a test of accuracy of double precision on the IBM 360/65. It indicated that the CDC single precision gave 10 significant figures versus 8 using double precision on the IBM 360/65.
- For members of the Ting group, the experiment demonstrated that it was possible for them to initiate computations from MIT and to have output from jobs at BNL returned to MIT.

Network Experience Report
LNS-4

ERDA Program: Basic Energy Sciences (EE)

Title: Conventional Remote Job Entry

Cooperating Sites: LNS-MIT - NYU

LNS Contact: Muriel Kannel

Resources Accessed:

- CDC 6600 - NYU
- CDC 200 UT - LNS, NYU

Motivation:

To gain experience in using a remote location with a system quite different from the IBM MFT/IIASP in use at LNS.

Procedure:

- Using a simple FORTRAN program, we followed the instructions in the "Short Guide to NYU Facilities" for submitting a job via the CDC 200 UT.
- Peter MacLean of the NYU staff was consulted via the telephone when problems occurred.

Observed Benefits:

- Network related research

Observed Barriers:

- Cost of using conventional phone lines.
- Poor phone connections between New York and Boston.
- Difficulty knowing if CDC 6600 was up or if our RJE equipment was malfunctioning.
- Lack of standard command language
- Lack of truly standard compilers
- Inadequate remote consulting facilities

Evaluation:

- Successful in that we did what we set out to do. We learned the problems arising from using an off-site computer and the difficulties involved in consulting over the phone versus face to face.
- Difficulties with the terminal indicated that the UT 200 was an inadequate way to access the CDC 6600 at NYU.

Network Experience Report
LNS-5

ERDA Program: High Energy Physics (EC)

Title: FERMI, Load Leveling Test Run

Cooperating Sites: LNS-MIT - LBL

LNS Contact: Muriel Kannel

Resources Accessed:

Multics-MIT
CDC 7600-LBL

Motivation:

- To determine the difficulties involved in running remotely a well-debugged production program, relatively small in size, and to test the scenarios being developed for use at LBL.

Procedure:

- The Multics file was shipped to LBL via the network using LBL UFTP plus Multics SFTP, where minor code conversion was carried out at LBL.
- Program was run using Sesame, the LBL interactive and batch submittal facility.
- Results transferred back to MIT-Multics, examined, then printed off-line.

Observed Benefits:

- Load leveling possible for standard well-debugged program not involving large files

Observed Barriers:

- Minor syntax differences in IBM FORTRAN and CDC FORTRAN
- High cost of prime time at LBL
- Cost of Multics for file transfer of programs and output

Evaluation:

- Successful in establishing the ability to run remotely at LBL well-debugged programs not involving large file transfers.

**Network Experience Report
LNS-6**

ERDA Program: Liquid Metal Fast Breeder Reactors (K6)

Title: Heat Flow Code, VARR

Cooperating Sites: LNS-MIT - LBL

LNS Contact: Muriel Kannel

Resources Accessed:
Multics-MIT
CDC 7600-LBL

Motivation:

- To assist the Nuclear Engineering Department in modifying and running on the CDC 7600 at LBL a heat flow program, VARR, which had been originally written by Science Applications, Inc. expressly to be run at LBL

Procedure:

- The scenario in the LNS Guide to Remote Batch Submittal to LBL via the ARPANET" was used.
- The program was at first transferred to LBL via LBL UFTP and Multics SFTP. Then it was discovered that the original version existed on the disk at LBL.
- Attempts were made to modify and debug the original version using Sesame, the LBL interactive and batch submittal facility.
- Results were returned to MIT via LBL UFTP and Multics SFTP.

Observed Benefits:

- Energy Related Scientific Research

Observed Barriers:

- Lack of a standard command language
- Lack of truly standard compilers
- Inadequate local and remote consulting facilities
- Inadequate LBL documentation
- Budgetary (difficult to get accounting information to prevent overspending in any one month).

Evaluation:

- Not successful in getting the job done as it was found easier to modify and then convert the program to run on the LNS 360/65. Cost was not a factor as the professor in charge of the project was willing to pay extra in order to save development time.
- Successful in that we learned the human factors involved, the importance of the user interface to the network and the need to access human resources.

Network Experience Report
LNS-7

ERDA Program: Basic Energy Sciences (EE)

Title: Molecular Dynamics, Collaboration with Argonne Scientists

Cooperating Sites: LNS-MIT - ANL

LNS Contact: Lyman Hazelton, James O'Dell

Resources Accessed:
Multics-MIT
IBM 370/195-ANL

Motivation:

- The invaluable help of Dr. Rahman of Argonne in the use of the CMD method and his unique insight into the nature of fluids.
- Computer time at Argonne least expensive of any available site
- Need for high-speed computer with large memory

Procedure:

- Contact was made with Ron Bare who supplied LNS with the user guide for Argonne and procedures for using FTP to transfer the program to ANL.

Expected Benefits:

- Access to unique hardware
- Scientific collaboration and communication
- Budgetary (least expensive place to run)

Observed Barriers:

- Access can be gained from MIT to ANL only after 4 PM, since more on-site hardware is needed at ANL.
- Remote saturation
- If the network crashes during FTP, the run is lost.
- There was no connect to the Argonne time sharing services at the time of the experiment.

Evaluation:

- Successful, especially for the future, to the following extent. The user is now at the point where he can begin some trial usage of the link to access data resident at Argonne, perform simple analysis and transfer the results to MIT for his perusal. At this point in time it seems unwise for him to expend large amounts of time on jobs submitted via Multics as he is still unsure of the interaction with ANL over the network, but it is expected that over the next few months he will perform an increasingly large fraction of his computations at Argonne.

Network Experience Report
LNS-8

ERDA Program: High Energy Physics (EC)

Title: Time Dependent Hartree-Fock,
Continuation of Remote Site Use

Cooperating Sites: LNS-MIT - LBL

LNS Contact: Betty Campbell, Lyman Hazelton

Resources Accessed:
Multics-MIT
CDC 7600-LBL

Motivation:

- To allow Professor Negele of the MIT Center for Theoretical Physics to continue to run a program on the LBL CDC 7600 developed during his visit at LBL last summer and to give him the opportunity to use the network.

Procedure:

- The scenario developed in the LNS Users' "Guide to Batch Submittal to LBL via the ARPANET" was used along with consulting help from both the LNS systems group and the LBL consultants.
- The IRL HFTP and the Multics SFTP were used to transfer results back to MIT.

Observed Benefits:

- Access to unique hardware
- Access to already existing software
- Conversion of program avoided

Observed Barriers:

- Lack of standard command language
- Difficulty in learning and using Sesame
- Budgetary (Lack of funds to continue)

Evaluation:

- Professor Negele has been able to do a fair amount of the production running he required. He uses both a terminal at home and in his office, a style he much prefers to batch submittal at the LNS Computer Facility. The most successful aspect of this experiment was that it involved a member of the faculty of the Physics Department. Originally he was a skeptic, believing the network to be feasible only in five to ten years. Now he sees it as a means of satisfying the suppressed need for large-scale theoretical physics computations that cannot be accommodated on the LNS IBM 360/65.

Network Experience Report
LNS-9

ERDA Program: Basic Energy Sciences (EE)

Title: TDA Message Service, Comparison Study and Critique

Originating Sites: LNS-MIT - CCA

LNS Contact: Muriel Kannel, Betty Campbell

Resources Accessed:

TDA Message System: PDP 11's at CCA

Motivation:

To study TDA Message service as an alternative to the Multics mail system and to gain experience with systems other than Multics or PLANET.

Observed Benefits:

- Network related research
- Access to unique software

Observed Barriers:

- Inadequate CCA documentation in that it was too verbose.
- Built-in context editor is nice but frustrating to use.
- Facility to send messages to user-related distribution lists is not available to the general user.

Evaluation:

- Experiment allowed us to evaluate the system.
- Our first reaction to the TDA system was a very favorable one. It is a very simple one to enter and use for the first time. Messages can be read and responded to in short order. There are elements in its basic design that make it attractive. It was designed from scratch, not imbedded in another system. Being on dedicated computers, it is probably secure. Assuming the cost is competitive (at the time of the experiment, we had no price information) and a dedicated mail system is needed, the TDA message service would fill the bill nicely.
- In comparing TDA with PLANET and the Multics message systems, our conclusions are rather straightforward. TDA serves best as a dedicated mail service. PLANET-2 is most useful for group discussion or teleconferencing. Multics offers the flexibility of the other two systems, but requires a more sophisticated user and more documentation on the facility. Multics probably has the most potential for the development of new subsystems such as teleconferencing. We need more information about the costs of the various systems in order to make a recommendation on their cost effectiveness.

Network Experience Report
LNS-10

ERDA Program: Basic Energy Sciences (EE)

Title: Performance Analysis Experiment

Cooperating Sites: MIT-Multics, LBL-B (CDC-6600)

LNS Contact: Lyman Hazelton

Resources Accessed:

- PSS storage system at LBL
- User FTP at LBL
- Server FTP at MIT-Multics
- MIT-Multics Metering system

Motivation:

- To measure actual performance of systems during a typical task for the network, specifically the transfer of a file from one site to another.
- To measure the relative charges at two sites for accomplishing the same task.

Procedure:

- This experiment was done twice, once with only one file, and again with a set of four files, to get some information concerning the savings accrued by transferring more files per invocation of the ftp program.
 - The output from a large Hartree-Fock nuclear model was in a medium/large (~500,000 characters, 183 PRU on LBL's PSS) file at LBL-B. The file was to be transferred to MIT-Multics for output on a local line printer.
- The transfer was accomplished with the LBL user FTP and the Multics server FTP because LBL's server was not yet available. At MIT, the experimental version of the server FTP was used, which had the fix for the 2**18 bug.

Costs of various parts of the experiment:

	Login	After Libcopy of file	After editing out EOR's and EOF's	After completion of FTP transfer
CP Seconds	.022	1.001	5.870	265.009
Monitor Requests	32	126	1010	1265
TTY Min	1	3	10	45
Total CU's	2	7	36	271
Cost + Overhead	(1) \$.84	\$1.19	\$3.22	\$19.67

Real time for the transfer (as determined by receipt of 250 message from MIT): 12 minutes 22 seconds.

Characters transferred: (484349) (5318 lines)

Load at MIT-Multics: 46 of a possible 60 users active

Multics Configuration: 1 cpu down, 1 memory box down

Cost at MIT-Multics: 45 CPU seconds, 271 memory units
\$6.52 including connect time.

Transfer rate: 6527.6 bits/second.

- Second part: four file transfer.

Procedure:

- The four files to be transferred are

JNOUT, 108 PRU

JNOUT1, 76 PRU

JNOUT4, 60 PRU

LIST, 73 PRU

We will attempt to transfer all four files with a single invocation of uftp and record the time for each transfer separately, but give the cost of the whole.

(1)

based on 10 CU's for overhead plus the November 1976 rate of \$.07 per CU

File Name	Lines	Time to X-fer	size in Chars	baud rate
JNOUT	3594	370.8	275863	7439.7
JNOUT1	2558	336.8	188288	5590.5
JNOUT4	2185	198.3	149243	7525.1
LIST	2465	257.4	193009	7498.4

Result of TIM command after transfer complete:

CP sec	Monit. Requests	TTY MINS	Total CU's	Cost + Overhead
465.185	2147	85	481	\$34.37

Multics Configuration: Full system.

Multics usage: CPU 79 seconds; Memory usage 100.7 units.

Cost: \$4.32

Cost to print the files at Multics:

JNOUT	\$5.39
JNOUT1	3.98
JNOUT4	3.42

Observed Benefits:

- Useful information concerning the feasibility of transferring large amounts of output data was gathered.
- Measurement of the charges accrued by a typical user during a common task was accomplished.
- A comparison of the charges at two different sites to accomplish the same task was made.

Observed Barriers:

- Lack of more sophisticated measurement software at one of the sites prevented more accurate determination of the data.
- Lack of a server FTP at one of the sites made the task more complicated (i.e., necessitated telnetting to foreign site, invoking the on site user FTP back to the local site, and then doing the transfer.

Evaluation:

- Successful. Measurement of performance and cost of tasks running in a distributed environment can be accomplished.
- This experience seems to indicate that further study in

this area would be of use. Further work on the development of tools to help in the measurement of distributed processing performance seems to be needed.

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Network Experience Report
NYU-1

ERDA Program: Basic Energy Sciences (EE)

Title: Equilibrium and Stability Problems in Plasma Physics -
Load Levelling

Cooperating Sites: NYU, LBL

NYU Contact: E. Franceschini

Resources Accessed:

- CDC-7600 at LBL
- User services personnel at LBL

Motivation:

Scope

Among the resource sharing problems potentially available to networking solutions, one of major concern to the ERDA community at this time is that of utilization of available computer time across laboratory boundaries. We have chosen this as a major focus of our experimental effort at this time.

In the recent past the computer industry has seen remote computing practiced with a good deal of success. However, it is important to distinguish this kind of activity from the more complex activity suggested by the notion of sharing among the ERDA laboratories.

Current practice consists typically of a number of geographically dispersed users with either conversational or remote job entry terminals, accessing a single centrally located computer. These users seldom have any significant local computing power or data storage media other than punched cards or printed paper.

Such a situation is quite different from that at the ERDA laboratories. Here we see large clusters of users with a great deal of local computing power, with familiar software to provide many program development support functions, such as, editors, compilers, data managers, and subroutine libraries. In addition they have established working relationships with user services

personnel at their own computing centers.

If these users are to use similar, but different, facilities at other sites, many questions are raised. Some are mentioned here by way of example. First, what is the impact on these users of the need to learn two or more sets of dictions for specifying similar functions at different sites. In cases when the programs are "identical", such as with the CDC Fortran Extended compiler, how should we deal with the fact that different sites may have the compiler at different release levels, and therefore containing different error populations. Secondly, if these users are to run at more than one site (even if one of these is their own) how should they manage their program and data libraries: shall they keep multiple copies or single copies to be shipped as needed. How difficult will it be to maintain multiple copies. Even among CDC sites there are important differences in the internal forms of data; a central issue here is that of the means of data transport. The economics and response times of different methods should be evaluated, all the way from station wagons to packet switched networks. A third issue is that of special hardware, such as graphic output devices. Is it more convenient, or even necessary in some cases, to do plotting at home or at the site where the associated computations are done. If at home, what compatibility issues are raised between remote software and local hardware.

All questions raised may be viewed as instances of a general question relating to the distribution of labor over a distributed collection of resources. Whereas, in the traditional remote computing activity, the answers are pretty much dictated by the rigid distribution of resources between the central site and the remote terminals, the situation of the ERDA laboratories is something quite different that has not received any but ad hoc attention in the computing community at large, and which is deserving of serious study and experimentation.

In order to begin to answer this question we are performing some of our typical large scale calculations on the Lawrence Berkeley Laboratory CDC-7600 using the ARPANET as the prime data communications method. For comparison and in order to investigate compatibility issues we expect to try running some of these programs at the Brookhaven facility by standard remote job entry methods.

Problem Description

This project is concerned with equilibrium and stability problems in Plasma Physics. We have already developed two

different codes to analyze this problem for general three dimensional toroidal devices.

The first code uses a sharp boundary model with currents restricted to the interface between the plasma and vacuum regions resulting in a free boundary problem in potential theory.

The second one considers diffuse pressure profiles with distributed currents. The constraints are such that in regions where the pressure gradient is zero, we solve for force free fields so that we obtain a pressureless plasma solution.

We have done extensive equilibrium and stability calculations for Scyllac like devices including comparisons with the Los Alamos and Garching experiments. We have obtained some very interesting stability results for the pressureless plasma case which indicate that the $m=1$, $k=0$ mode can be stabilized by shaping the outer wall appropriately.

We are now developing a new code which is a combination of the two other codes. For this model, we have a diffuse plasma region, separated by a sharp free boundary from a surrounding vacuum region. This will allow us to study the effect of the pressureless plasma on our stability results.

Since these codes are for three space dimensions, and truncation errors are significant for crude mesh sizes, long runs with a large core space are required for reasonable mesh sizes. It is hoped that use of the CDC-7600 at LBL and BNL via the ARPANET will permit the consideration of problems larger than can be run on the NYU CDC-6600.

Procedure:

Adaptation of Codes to the Foreign Site

A program and associated data set for which correct results had been obtained on the CDC-6600 was chosen for the first run. Although the same CDC Fortran compiler is available at both NYU and LBL, the two were not at the same revision level at the time of this run. Thus, the first matter of interest was to see whether they would both give the same results on the same problem.

The first run was done using only the small core memory of the CDC-7600. The results were identical to those obtained on the NYU system. The execution was observed to

be some five times faster. On a second run using the large core memory, the results were also correct. However, the execution time was only two times faster than on the CDC-6600. In order to use the large core memory several small changes to the program were needed, since this memory must be managed explicitly by the program.

After the first trials, which were useful in smoothing the procedures of running under a new operating system, the program working storage requirements and running times were increased to permit finer mesh sizes. Typical runs at this time use some two hours of CDC-7600 cpu time and about 75 percent of the available large core memory, or about three times as much memory as is available on the CDC-6600.

Network Operational Procedures

All work is being done via the ARPANET. Source program files and data are transmitted from the NYU CDC-6600 disk storage units to LBL using the File Transfer facilities. Minor changes to programs and data have been made at LBL in time sharing mode, using the LBL editing facilities. Again, the access is through the Telnet facilities of the ARPANET. Execution is ordered by submittal of job files to the CDC-7600 batch queue under control of the interactive job. Print files are transmitted to the output queue of the NYU CDC-6600, and subsequently printed.

Both scientist-users and applications programmers have been shielded from direct impact by both network protocols and LBL operating system dictions. All transactions over the network have been handled by a job "runner". This person is a member of the networking project staff and thus has familiarity with network procedures. This seemed a better way to get a good amount of experimentation done in a short time. To expect users to undertake the task of familiarization with so many things merely for a possibly short term experiment seemed unreasonable. In addition, this method facilitated the monitoring of the experiments by the network research staff.

Observed Benefits:

Scientific

Using the Berkeley CDC-7600 with our "diffuse" code we were able to settle two very important questions.

1. The validity of the stability results with our

modified outer wall for different wavelengths was satisfactorily resolved. With a mesh of $16 \times 16 \times 192$ we were able to study a straight helix with as many as twelve periods in the v direction. This required some 300,000 words of memory. The machine time for each iteration is 8.4 seconds. With the CDC-6600 at the Courant Institute we were not able to consider more than 4 periods which required a mesh of $16 \times 16 \times 64$.

2. We were also able to ascertain the reliability of our stability results for a High Beta Stellerator by increasing the mesh size from $16 \times 32 \times 32$ (CDC-6600) to $24 \times 48 \times 60$. The large mesh size requires almost 400,000 words of memory.

Operational

A number of successful runs were made with useful results obtained.

Observed Barriers:

1. Bandwidth is too low and recovery procedures inadequate to permit the routine transfer of very large files.
2. The well-known disadvantages of remote computing caused by the increased complexities over local batch operations are compounded by another order of complexity introduced by the heterogeneous network. The consequence is that there are so many things to go wrong that the effective "up time" is significantly affected. We have not enough experience to quantify this matter yet, and to easily distinguish the problems of design from those of implementation or operation.
3. Lack of network software to effectively transmit graphic plotter output.
4. Operations with the current level of network capabilities is just too complex for the ordinary user or applications programmer to be expected to deal with. Special operational personnel or the study and design of simpler user interfacing procedures are needed.

Evaluation:

This experiment is the first in a long term attempt to make a comparative evaluation among the methods of local computing, traditional remote computing, and networks as a means of off-loading for a medium scale scientific center engaged in large scale computation. Evaluation beyond that, implicit above in the sections on Benefits

and Barriers, would be premature.

Network Experience Report
NYU-2

ERDA Program: Basic Energy Sciences (EE)

Title: NYU ARPANET access software development and maintenance -
Unique Software.

Cooperating Sites: NYU, SRI, BBN

NYU Contact: E. Franceschini

Resources Accessed:

- PDP-11 TENEX system
- SRI - ELF source files
- ELF authors, consultants

Motivation:

- To provide an ARPANET connection to the NYU CDC-6600.
- To monitor network experience by undertaking a major software development using the ARPANET exclusively.

During the early period of software development there was considerable hesitation to undertake any sizable experimental usage of the network. It was feared that the disruptions of service, erratic availability of the system, transitory inefficiencies, and other operational difficulties typical of a developing environment might be seriously discouraging both to investigators and implementors. Therefore, experimental usage was deliberately limited.

However, due to the particular choice of implementation design, the network was used extensively as a primary development tool. Therefore, the implementation activity itself has provided a considerable experience in the use of the ARPA network.

The method of implementing the ARPANET connection was to provide certain extensions to a program which was concurrently being developed by the Speech Research and Development Laboratory (SCRL) under ARPA sponsorship. This program, called ELF, was being written using a PDP-10 at the Stanford Research Institute. However, the target machine was the PDP-11 minicomputer with a suitable hardware interface to the ARPANET.

Although the needed program development software tools (editor, assembler, loader, etc.) are available for direct use on the PDP-11, several factors made the PDP-10 a more effective choice. For example, the faster processor insured more rapid turn around time for the frequent runs needed during the periods of intensive debugging. In addition, the files required were so large as to require considerably more disk storage capacity than could be justified for the relatively short development period. However, the most important reason was the need to keep abreast of the concurrent development at SCRL. This meant using the SCRL source files and, in particular, the latest available. These large files would have to be sent from SRI on magnetic tape by mail whenever they changed, since we did not yet have the network file transfer facilities available. Fortunately, the basic ELF system was sufficient to provide time sharing access for us to the SRI PDP-10. Thus we used the basic ELF system to access the PDP-10, which in turn we used to develop the ELF extensions.

Procedure:

- The NYU ARPANET development consisted of extensions to a user-oriented network access system concurrently being developed at SRI.
- Source program files are maintained by SRI and stored on their PDP-10.
- NYU staff use both the SRI PDP-10 and a BBN PDP-10. Files are transferred as needed.
- NYU access is through their ELF network access system on their PDP-11. This system was extended to become an ARPANET front-end for the NYU CDC-6600.
- Print files are sent to NYU by FTP.

In a typical debugging session, implementation programmers at NYU access the SRI computer from an interactive terminal connected to the NYU PDP-11. Files at SRI are managed and edited, source codes of individual modules are assembled, and a new ELF system is generated. Then a copy of the complete load module is transmitted to the PDP-11 and is stored on a disk for subsequent loading. Once loaded, the new module may be tested.

In the early summer of 1976 we were advised by the ARPA Information Processing Techniques Office that our usage of the SRI PDP-10 would be considerably restricted.

We then made arrangements with BBN to use one of their PDP-10s. In this arrangement, the NYU ELF files are kept at BBN and SRI ELF files are transferred by ARPANET to

BBN as needed. The previously described debugging session then takes place at the BBN computer.

Observed Benefits:

- Access to unique software.
- Scientific collaboration and communication.
- Reduction of duplicate software development and maintenance.

A substantial software development, involving several man years of effort, several people, and some 18 months of calendar time, has been successfully undertaken. This activity, involving three sites, would not have been practical without the ARPANET.

Observed Barriers:

- Remote saturation.

Evaluation:

- Successful remote collaboration on a complex development project.
- Substantial reduction in duplicate software development was achieved.
- The usability of the network as a production tool, particularly for time sharing activities, was demonstrated.

The Elf project has been a substantial software development conducted entirely over the ARPANET. An interesting complication is that we were making extensions in New York to a complex base system concurrently being developed in California.

Written documentation, although well suited to describing the SCRL system for general understanding, was not detailed enough for the kind of specific knowledge needed to actually program it.

In effect, although not so arranged administratively, this was a collaborative effort between geographically dispersed people. Much communication between these workers was by network mail. The telephone was used when complicated interactions were needed. The network mail facility, of course, provided quick delivery of hard copy, without the problem of synchronization imposed by the telephone.

Over a period of 12-18 months, NYU workers used the network heavily. Thirty or forty sessions per week ranging from a few minutes to two hours in length were typical. Program listings up to three thousand lines in length were transmitted to NYU several times per week. Program source files being transferred between the SRI and BBN computers may be as long as 20,000 cards in case of a total system generation. Load modules transmitted to NYU for direct loading are binary files equivalent to about 70,000 bytes in length. During periods of intense debugging, transfers of this kind would occur some three to seven times per week.

These activities have shown the ARPANET to be serviceable as a production facility, particularly with regard to time sharing services. File transfer for low volume support of time sharing activities (printing of files too long for interactive devices, or data sets inconvenient to enter on line, etc.) is adequate.

The three-site procedures employed in this project could not have been implemented practically by conventional remote access means.

Network Experience Report
NYU-3

ERDA Program: Magnetic Fusion (ED)

Title: Magnetohydrodynamics Code - MFE CDC-7600 at LLL

Cooperating Sites: NYU, LLL

NYU Contact: E. Franceschini

Resources Accessed: CDC-7600 + LLL

Motivation:

- To make the MFE-dedicated CDC-7600 at LLL available to MFE researchers at NYU.
- Load levelling.

Procedure:

- The MFE CDC-7600 is not on the ARPANET.
- A PDP-11 based system (RATS) at LLL is on the ARPANET and has a dial-out capability.
- The user at NYU (or other network site) connects to the RATS system and requests connection to the MFE CDC-7600.

Observed Benefits:

- Energy related scientific research.
- Off-loading.

Observed Barriers:

- The links between the RATS system and the MFE CDC-7600 were few in number and slow in speed.
- No file transfer capability was provided.

Evaluation: This is a solution to the problem of access to the MFE net for off-net users. Direct dial via commercial carrier is impractical from long distances due to transmission errors. Unfortunately, the RATS service was discontinued for a long time and is only now being resumed.

Network Experience Report
NYU-4

ERDA Program: Magnetic Fusion (ED)

Title: Calculation of Parametric Instability - MIT-ML MACSYMA

Cooperating Sites: NYU, MIT-ML

NYU Contact: E. Franceschini

Resources Accessed: MACSYMA - MIT-ML

Motivation: It is intended to automate the calculation of parametric decays and instabilities in warm magnetoplasma using symbolic manipulation techniques, so that a systematic survey over a multi-dimensional parameter space can be made.

Procedure: Researchers at the Stevens Institute of Technology use the NYU facilities to access the MACSYMA system at MIT.

Observed Benefits:

- Access to unique software.
- Reliable transmission medium.

Observed Barriers: None

Evaluation: Network usage for a period of ten months consists of about 15 to 25 hours per week. This is exclusively in time sharing mode and has been very successful.

Network Experience Report
NYU-5

ERDA Program: Basic Energy Sciences (EE)

Title: Teleconferencing - unique software.

Cooperating sites: BBN, all ERDA sites

NYU Contact: E. Franceschini

Resources Accessed: PLANET Teleconferencing system - BBN TENEX

Motivation: To evaluate computerized conferencing for ERDA use, particularly for scientific information exchange.

Procedure:

- The PLANET system is accessed both through the ARPANET and TELENET.
- Bulk data may be transferred from the ERDA sites by FTP.

Observed Benefits:

- Scientific collaboration and communication.
- Access to unique software.

Observed Barriers:

- Budgetary: expensive to use.
- Remote saturation.

Evaluation: About a dozen collaborators (the Network Investigators Panel) have successfully kept in close contact despite only occasional face to face meetings.

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Network Experience Report
UCLA-1

ERDA Program: BES - M&CS

Title: Distributed Report Generation

Cooperating Sites: ANL, BNL, LBL, LLL, LNS, NYU, UCLA

UCLA Contact: G. Estrin

Resources Accessed:

ANL, BBN, CCN, CCA, LBL, MIT-MULTICS, LLL, BNL, NYU, MIT-MC, MIT
XGP

Motivation:

Producing this report required the participation of ERDA sites which were widely distributed geographically. Each site was involved in determining what information should be in the report, who should be responsible for which parts, and how they should be organized. Each site was to prepare their own set of appendices, which would eventually be merged into one set. In addition, individuals were charged with coordinating certain sections and writing portions of the main body. From the first discussion of the report, it was clear that computer teleconferencing could be an extremely valuable communication and coordination tool. Later it became even more clear that a great deal of time could be saved during the production phase of the report if network resources were fully utilized. In addition, the use of text formatting and editing programs, and a Xerox Graphic Printer, promised the possibility of a better report than could have been produced using conventional manual methods. Perhaps the most important motivation was the prospect of distributing portions of the report for review as soon as they were written, and at electronic speeds. Distributing changes was equally important.

Procedure:

It was agreed that the report would be produced using text formatting programs at MIT-MULTICS and MIT's Xerox Graphic Printer. A new directory was established in the MULTICS Storage System for files associated with this report. In some cases, portions of the report were generated at an author's local host and then transmitted, using a File Transfer Program, to MULTICS. In other cases, MULTICS was accessed remotely using a network connection and text files created there using one of the MULTICS text editors. Since MULTICS is connected to both ARPANET and TELENET, the report authors (and staff) could establish a connection by dialing a local TELENET port, using an ARPANET TIP, or going through their local host

and establishing a telnet connection. It should be mentioned that there are a wide variety of text editing programs in existence, and the network gives authors the freedom to choose one which they like. Frequently, a remote host was accessed purely because that host had a "better" text editor than the one available on the local host. All participants were given access to the files being accumulated at MULTICS so everyone could review and comment, as well as see visible signs of progress. The PLANET teleconferencing system at BBN was used extensively during the report writing period to facilitate dissemination of procedures, guidelines, status, etc, and as a message board for participants to solicit help in accomplishing a particular task, such as moving a file from one host to another. Other remote resources were used in preparing this report as well. A facility at MULTICS for storing all of the user input and system output from an interactive terminal session on a file was used in preparing some of the scenarios in Appendix F, which show how to use some of resources at each of the participating laboratory sites. A procedure established to aid in communicating suggested changes to a portion of the report. Once the author had placed the section draft on-line, he would send a message to whoever he wanted to review the section, stating the name and location of the file, as well as any necessary access control information. Then the reviewer(s) would print the section locally and annotate changes on their own copy. Then they would make a copy of the file and, using a text editor, incorporate their suggested changes in this copy of the file. The convention was established that all changes would be made in upper case, so that they would easily stand out when the author was perusing the modified file. Deletions were indicated by a series of "X"s. After the suggested modifications were made, the author--and whoever else was involved in that section--was given the name and location of the modified file. The modified file was then printed locally by the interested parties for further review. Once the initial versions of each section were available at MULTICS, they were grouped into larger sections and additional format control information was inserted. The text was then processed by a text formatting program called RUNOFF and the output directed to a Xerox Graphic Printer. At this point a meeting was held to review the initial version of the report in its printed form, make additional revisions, and merge graphical information. After all revisions had been made to the text, the entire report was processed once again by the RUNOFF program and printed on the XGP. During the period when files were being accumulated at MULTICS, procedures were established for periodically making backup copies of all files and storing them on the CCA DATACOMPUTER. Also, since it was

important for all the participants to have access to all the files, procedures were established to make sure that one person making changes to a file did not wipe out the changes made by someone else.

Observed Benefits:

A much higher quality report was produced than could have been possible using conventional methods (i.e. typewriters and the Post Office). In addition, the work was accomplished in a much shorter time than would have been possible otherwise. Only three face-to-face meetings were required from inception to completion (a period of about 6 months). This was largely due to the effectiveness of the PLANET teleconferencing system as a coordination tool. PLANET also minimized the number of lengthy phone calls between participants. From the time the decision was made to use network facilities to produce the report, to the printing of the first version of the completed report, was less than 3 weeks.

Observed Barriers:

Becoming familiar with the various network resources, such as text editors, formatters, file transfer programs, etc, required additional learning for many of the participants. While not an insurmountable barrier, this cost can be minimized only through greater standardization of key network resources (e.g. command languages) and better educational tools, including consultants, self teaching programs, and improved documentation-- both on-line and conventional.

Additional problem areas related to differences in writing style and format of the several co-authors, and the problems associated with controlling font changes on the XGP printer. The former problem provided strong evidence that time spent in establishing standards for style and format --before anyone starts writing-- is more than worthwhile. In fact, the development of text editor macros which define a standard format for, say, experiment results, is an excellent idea. The difficulties associated with font changes on the XGP were due to limitations of the text formatting program. Escape sequences were defined which would later be translated to XGP font change commands. These escaped sequences proved to be confusing and cumbersome to work with.

Evaluation:

Successful.

Network Experience Report
UCLA-2

ERDA Program: BES - M&CS

Title: PL/I Program Portability: IBM to Multics

Cooperating sites: UCLA, MIT

UCLA Contact: T. Gray

Resources Accessed:

UCLA-CCN IBM 360/91

MIT - MULTICS

Motivation:

This experiment relates to:

- access to resources not locally available
- reduction of duplicate software development
- load leveling
- reduction of computation costs.

Program portability has to do with moving programs from one host to another. Moving a program to a new host would be done either because the destination machine is cheaper, less saturated, or has associated with it needed peripherals or data which are not available locally (e.g. a microfilm plotter). Being able to move a program avoids the cost of duplicate software development.

The motivation for moving an example program from one host to another is to better understand the difficulties and costs associated with program portability.

Procedure:

Source code for a PL/I text formatting program was compiled, linkage-edited, and executed on UCLA-CCN's IBM 360/91. The source code was then transmitted over the ARPANET to MIT-MULTICS. This was accomplished by establishing a TELNET connection to MULTICS, then using the MULTICS user-FTP program and CCN's server FTP program to transmit the file from CCN to Multics. Once at MULTICS, the source code was converted to a form acceptable to the MULTICS PL/I compiler, compiled and executed.

Observed Benefits:

Program was successfully moved. It was learned that converting the source code took considerably more time than anticipated (partly because of a bug in the MULTICS

compiler which was uncovered) and that differences in job control languages are a large obstacle to effective code sharing.

Observed Barriers:

There are three: a) the variations between ostensibly standard programming languages such as PL/I, FORTRAN and ALGOL, and their compilers, b) the differences between compilers and operating systems, as in file naming conventions, and c) the utter and complete lack of any standardization of command or job control languages.

Evaluation:

The experiment was quite successful in that it did identify key problem areas in program portability. The results suggest that additional program portability experiments would be desirable in order to identify and catalog differences between compilers and operating systems at different hosts. Further, and probably more importantly the experiment highlighted the need for a standard command language.

Several of these portability problems may be classified from a language definition point of view. Categories might include:

1. Programs that violate the language standard. For example, parameter passing in Fortran. The FORTRAN standard forbids writing a subroutine in which a storage location which is associated with two names is assigned to. For instance; the following code violates the FORTRAN standard:

```
SUBROUTINE X (A,B)
A = 3
RETURN
```

```
CALL X (C,C)
```

Unfortunately, it is impossible to mechanically check for this violation at compile time, and nearly impossible to check it at run time. Consequently, such illegal FORTRAN programs which depend upon a particular compiler's method of argument to formal parameter binding, do exist and complicate the portability issues.

2. Programs that try to do things which are not supported by the language. For example, since terminal I/O is not defined in FORTRAN or PL/I, one

shouldn't really expect to be able to write a transportable FORTRAN or PL/I program which does terminal I/O. Nevertheless, it's easy to fall prey to the notion that a GET or a READ should do the same thing at any site - regardless of what kind of device one is getting or reading from.

3. Compilers that don't live according to the language standard. Example: The PL/I standard (ANSI/ECMA standard programming language PL/I Basis/1-12, July 74, paragraph 4.3.6.3 append system defaults page 82.) specifies that all variables will be FIXED BINARY unless declared otherwise explicitly or by DEFAULT statement; hence the IBM PL/I compiler violates the standard in this regard. Someone familiar with the differences could correct the problem by putting a DEFAULT statement in the program, but its one more thing that militates against portability. IBM's F level and X level PL/I compilers are not completely compatible either, and one can get into trouble going between them.
4. Programs that use implementation dependent features of a language or language characteristics which are left unspecified by the standard. Example: The PL/I standard lists 39 different "implementation defined features" including the meaning of UNSPEC, OPTIONS, ENVIRONMENT, ONCODE; external character representations (as in use of upper vs. lower case), a collating sequence for the character set, and the results of numeric conversions.

Additional details on this experience are available in a UCLA Computer Science Department Internal Memorandum, Number 175.

Network Experience Report
UCLA-3

ERDA Program: BES-MACS

Title: ISP to PL/I translation.

Cooperating sites: UCLA-CCN, USC-ISI, CMU-10A, UCLA-Security

UCLA Contact: T. Gray

Resources Accessed:

UCLA-CCN	IBM 360/93
USC-ISIB	PDP 10
CMU-10A	PDP 10
UCLA-Security	PDP 11/45

Motivation:

This experiment involves the translation of an ISP description of the NOVA machine and some of its I/O devices into PL/I code. The final goal is the simulation of machines from their ISP descriptions. The motivation for the experiment was to uncover difficulties involved in the translation process.

Procedure:

In the procedure described below, all accesses to ARPANET were performed through the UCLA-SECURITY PDP 11-45. ISP descriptions for the NOVA machine were sent from ISI to CMU using ISI's FTP program. CMU's translator was then used to transform the ISP descriptions into intermediary representations called GDB trees. These GDB trees were then back to ISI using the same FTP program. ISI's translator (written in LISP by Charles Hayden, and modified by William Overman) was then used to transform the GDB trees into PLIP code (PLIP is a superset of PL/I). The PLIP code for the NOVA and its I/O devices was then sent to CCN using ISI's user-FTP program. The files containing the PLIP code were then concentrated to form a complete PLIP description of the NOVA. This PLIP code was then run through the SARA PLIP translator to generate simulatable PL/I code.

Observed Benefits:

All programs ran correctly except for the PLIP to PL/I translator which failed due to a bug. We also learned that since the 360/91 does not recognize ASCII characters the ISP descriptions had to be generated at ISI.

Observed Barriers:

Files sent to UCLA via the FTP program are given unusual block sizes. This forces the files to be copied before they can be edited.

Evaluation:

The experiment was mostly successful. As soon as the bug is uncovered in the PLIP translator, we expect to run the diagnostic tapes of the NOVA machine in the SARA simulation environment.

Network Experience Report
UCLA-4

ERDA Program: Nuclear Physics (EF)

Title: Particle Physics Research:
Radiative Pion-Nucleon scattering

Cooperating sites: UCLA, LBL

UCLA Contact: R. Gardner

Resources Accessed:

LBL CDC-7600

B. Nefkins (UCLA)

D. Smith

Motivation:

Investigation of the magnetic dipole of the Delta(1232) resonance.

Procedure:

Data was collected from cyclotron experiments performed at LBL.

The investigators at CDC-UCLA perform the raw analysis of the cyclotron data on LBL CDC-7600, occasionally via the net, more usually by having a contact at LBL run the program.

The net is used to transmit selected samples of the output from LBL CDC-7600 to UCLA; bulk output is via mail.

Final analysis is performed at UCLA-CCN, on a relatively small data sample.

Observed Benefits:

Energy related scientific research.
Access to unique hardware.

Observed Barriers:

Budgetary. More output from LBL CDC-7600 would be sent to UCLA via the net if the cost of transmission (UCLA-CCN charges) was lower.

Evaluation:

The network was used only occasionally in this

experiment, but it did provide easy access to the LBL.
CDC-7600.

Network Experience Report
UCLA-5

ERDA Program: Magnetic Fusion (ED)

Title: Plasma Physics Simulation

Cooperating sites: UCLA, LLL-MFE

UCLA Contact: R. Gardner

Resources Accessed:

UCLA: Dr. J. Dawson
LLL MFE CDC-7600

Motivation:

Investigation of a two-dimensional relativistic plasma model.

Procedure:

Simulation programs are developed interactively from UCLA on the MFE CDC-7600 at LLL, including editing, compiling, debugging.

Simulation programs are run and some output is sent back to UCLA. Bulk output is mailed.

The usual interconnection between UCLA and LLL for this work is the University dedicated tie-line. Researchers working off-campus have used the ARPANET to reach the MFE CDC-7600, and have recently begun using it again, through the RATS gateway.

Observed benefits:

Energy related scientific research.

Access to unique hardware.

Observed barriers:

None.

Evaluation:

The network is used only occasionally in this experiment because of the availability of University telephone network, but at times is very useful.

Network Experience Report
UCLA-6

ERDA Program: Nuclear Energy Development (K)

Title: Development of life code for reactor fuel pin performance.

Cooperating sites: LBL, Atomics International, Canoga Park, CA.

UCLA Contact: R. Gardner

Resources Accessed: LBL CDC-7600

Motivation: Use of codes at LBL CDC-7600

Procedure:

A.I. uses the LBL CDC-7600 remotely via network through the TIP at USC.

Program development, data modification, program submission via network.

Some codes used by AI are available at LBL, which provides a shared file.

Bulk output mailed to AI.

Observed Benefits:

Energy related scientific research.

Access to unique hardware.

Scientific collaboration and communication.

Observed Barriers:

None.

Evaluation:

Successful.

Network Experience Report
UCLA-7

ERDA Program: Basic Energy Sciences (EE)

Title: Remote Sara system demonstration at symposium

Cooperating sites: UCLA, Stanford University.

UCLA Contact: T. Gray

Resources Accessed: AMES TIP, unique software at UCLA-CCN:
R. Razouk, UCLA.

Motivation: To support several symposium talks presented at
the IEEE symposium on design automation for
Microprocessor Based Systems, Palo Alto,
Feb. 25-27, 1977.

Procedure:

The SARA design system provides a collection of modeling
and analysis programs that are useable over ARPANET at
UCLA.

A user connects to UCLA-CCN, to TSO and then initiates
the SARA system, connecting to its monitor, called the
SELECTOR. A translator subsystem of SARA, allows
description of a relatively abstract model of control
flow and of data flow. A simulator subsystem of SARA
allows experiments to be done with observation of flow
control and flow of data through the system being
modeled. A preprocessor permits PL/I interpretation to
be associated with the data models. The nature of the
models and information returned to the terminal are shown
in the UCLA scenario writeup in Volume 4.

Observed Benefits:

Successful demonstration of unique software. The
transfer of technology is much more effective when a
complex system can be experimented with by a user.

Observed Barriers:

Many hotel telephone systems were not designed with
computer terminals in mind; terminal unreliability.

Evaluation:

Successful after initial difficulties.

Acknowledgements

It is often forgotten that computer based systems cannot function without the involvement of human beings. Many people contributed to this investigation. The current panel members are listed on the inside front cover. On this page we wish to acknowledge all others who made significant contributions. If anyone has been left out it was inadvertent.

Harvey Baumel	LNS
Jerome Becker	ANL
Herbert Bernstein	BNL
Robert Braden	UCLA-CCN
Bertram Bussell	UCLA
Irving Cohen	UCLA
Robert Daley	MIT
Y. Feinroth	NYU
Anna Fisher	LNS
Michael Ford	LNS
Sheldon R. Furst	LBL
Robert I. Gardner, Jr	UCLA
Charles Gear	U of I
Robert Harvey	LBL
Robert Healy	LBL
Bradford Heckman	LBL
April Heiberger	ANL
S. Heller	BNL
Steve Kelem	UCLA
Roger B. Lazarus	LASL
P. Maclean	NYU
F. McGirt	LASL
Robert McMahon	ANL
Deane W. Merrill	LBL
A. Milonas	NYU
B. Miller	MFE
M. Nihalani	NYU
Doris Pahis	ANL
Beverly Robertson	UCLA
W. Russell	NYU
Kalman Saffran	LNS
Steven Scholbrock	ANL
M. H. Schwartz	ERDA
Marsha Joyce Shapiro	UCLA
Y. Shimamoto	BNL
L. Smith	SLAC
T. Stuart	NYU
T. Tsun	NYU
B. Wells	LASL
Joseph Wells	SLAC
Steven Wolfe	UCLA-CCN
Jack Worlton	LASL
L. Yeh	BNL