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Computing Division Two-Year Operational Plan FY 1982-1983

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Los Alamos National Laboratory
Los Alamos, New Mexico 87545

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Computing Division Two-Year Operational Plan FY 1982-1983

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EXECUTIVE SUMMARY

This plan provides users of the Los Alamos Integrated Computing Network with the Computing Division's (C Division) software and hardware plans for fiscal years 1982 and 1983. We want users to know what we are working on, what it looks like, and when it will be ready. Our implementation of this plan is equally simple on the surface; that is, we will do what is outlined in this plan as promised. Our list of FY 1981 accomplishments (Sec. 1.6) is evidence of our belief in this planning and implementation process and of our commitment to provide our users with the best possible computing facilities.

PLANNING FOR FY 1982

Regardless of the excellence of any computing center, there are always opportunities for quantitative and qualitative improvements in the computing resources. To identify user needs, we solicit information from individuals in other Divisions, from advisory committees, and from C-Division personnel. The recommendations of these individuals and these committees provide significant contributions to our planning. After collecting all their input, we attempt to make it coherent and use it as the basis of planning for our hardware, software, and service projects. It is a standing policy of C Division to provide new resources by acquisition, rather than by development, whenever possible. This applies to hardware, software, and services.

HARDWARE

Our hardware plans for FY 1982 include the acquisition of a 4-million-word Cray-1, doubling the capacity of the Common File System in early FY 1982 and doubling its throughput by late FY 1982, and a network switching system that will replace the present file transport computers and improve file transport capabilities. Other projects include initial production hardware for the Advanced Interactive Display System, new graphics output devices for the Print and Graphics Express Station, a backup controller for the Facility for Operations Control and Statistics, and intelligent terminals.

SOFTWARE

In our software planning, we are seeking to stabilize, standardize, and harden the systems; we will standardize and stabilize the user interface; and we will use software engineering techniques to make our software easy to use, more portable, and easy to maintain. Our primary goals for our operating systems are system stability and reliability, and enhancements are performed to achieve these goals.

Fortran is and will continue to be the most heavily used Laboratory computer programming language. Vendors provide Fortran compilers, and C Division provides additional support for the LTSS and CTSS compilers. We plan to

acquire and support ANSI Standard Fortran 77 compilers as they become available. C Division maintains an awareness of state-of-the-art languages and will seek a modern programming language for use in C-Division efforts in multiprocessing, portability, and structured programming.

We plan to support a common set of system, mathematics, and graphics libraries across all systems. We have taken major steps in that direction in the past year and expect to complete most work on the mathematical and graphics libraries this year.

We are defining a standard set of utilities that are common to all systems that we support. The core version for CTSS and LTSS is now nearly complete. We are also defining a standard utility syntax and assembling software tools. In our work on utilities, we are striving for as much compatibility and cooperation with Lawrence Livermore National Laboratory as possible.

Our plans also include software for support of office automation, document preparation, data management, Computer-Aided Design/Computer-Aided Manufacture (CAD/CAM), and business data processing.

NETWORK

We are continuing to improve and expand the network. During FY 1982 we plan to increase the number of ports available to users and increase data transmission rates. We are providing software and consulting support for Distributed Processor users and are working with the VAX Local Users Group to define and meet the needs of distributed processor users. A guide for System Managers of Distributed Processor sites has been developed that details steps necesssary for purchase, site preparation, installation, and operation of a Distributed Processor. We have defined and are using a standard set of protocols for communicating between all the computers in the Integrated Computing Network, and we are looking for ways to connect our network with outside networks, such as Telenet, Tymnet, and ARPANET.

To improve network communications, we have formed a Communications Group that combines many of the ongoing communications activities of the Laboratory. This group will provide better communications services for the Laboratory, streamline the processing and installation of communications requests, and provide better communications planning and management.

USER SERVICES

Our user services have expanded to include consulting help for new and casual users and for Distributed Processor users. We now have a Computing Education Coordinator whose responsibility is to provide computing education courses for all types of users.

RESEARCH

In FY 1982, C Division will have about 20 FTEs engaged in research on parallel processing, satellite graphics, audio I/O, numerical analysis, and applied mathematics. We have begun design of an inexpensive parallel processor and expect it to be running early in FY 1983. C-Division research in parallel processing includes development and testing of algorithms, study of languages, and providing a CTSS-like operating system.

We are developing better numerical techniques. Research in analytical and numerical techniques will be done in three areas of numerical analysis: dynamic mesh selection, solution of large, sparse linear systems, and numerical solution of integral equations of the first kind.

We are working on audio I/O for computer operations and for intelligent terminals.

Satellite graphics research is continuing. The main research issues are data access by remote computers, data compression to conserve intercomputer communications bandwidth, division of work among the computers, and good human-interactive techniques.

SUMMARY

Our planning is driven by user needs as defined by users, advisory committees, C-Division personnel, and by rapidly changing technology. We will expand our software support efforts across the Integrated Computing Network to provide users with a standard set of high-quality software tools and consulting services. At the same time, we are creating a state-of-the-art distributed computing network. Generally, all of our activities are aimed at assembling a very powerful distributed computing network, the best available software tools, and state-of-the-art hardware to allow our users to select the type of computing that best suits their needs.

COMPUTING DIVISION TWO-YEAR OPERATIONAL PLAN FY 1982-1983

by

R.H. Ewald and B.L. Buzbee

ABSTRACT

This report is an operational plan for the Computing Division of the Los Alamos National Laboratory for fiscal years 1982 and 1983. Subjects discussed include the planning process, continuing projects, major software projects, new development projects, direct user services, research projects, and budgets. Recommendations from the Technology Information Panel and the Terminal Network Planning Committee are included, and one section is devoted to the Computing Division responses to the User Satisfaction Measurement Survey.

1 INTRODUCTION

1.1 PURPOSE AND SCOPE OF THE PLAN

The purpose of this plan is to provide the users of the Integrated Computing Network (ICN), Computing Division (C Division) personnel, and other interested people with computing planning information for the next two fiscal years (FY 1982 and 1983). This plan was developed by the Computing Division Leaders and Group Leaders with contributions from many other members of the Division.

The Computing Division operates one of the largest, if not the largest, scientific computing facilities in the world. The ICN integrates this equipment and all of our projects. Because of their interrelationship, our hardware and software projects are very complex; however, we want the use of our facilities to be as easy as possible.

We want our users to understand more about the projects on which we are working and we need to better understand their requirements. Both parties in

this arrangement have made great progress in FY 1981; more is expected in FY 1982. Toward this end, the purpose of our plan becomes very simple:

> We want you to know what we are working on, what it looks like, and when it will be ready.

Our implementation of this plan is equally simple on the surface:

> We will do what is outlined in this plan as promised.

This plan begins by describing our mission, organization, and some of our FY-1981 accomplishments. During FY 1981 we received a considerable amount of guidance concerning our FY-1982 plans; that input is reviewed in Section 2. Sections 3-7 give our plans for hardware, software, services, and research in FY 1982 and 1983, and Section 8 describes our budget to accomplish these activities.

1.2 COMPUTING DIVISION MISSION

The Computing Division mission is to provide hardware, software, and services to allow the Laboratory to carry out its programmatic mission in a timely fashion. We are assembling a wide variety of hardware, software, communication facilities, and services from which our users may select and tailor the set best suited to match their requirements. In carrying out our mission we seek to maximize first the Laboratory's people productivity and second its hardware.

Consumers of our services are drawn from all ranks of Laboratory employees and from every Laboratory organization and function. Although our users are engaged in a wide spectrum of applications ranging from document preparation to large-scale scientific simulation, they have the following basic needs in common: suitable hardware, convenient access to hardware, state-of-the-art software, easy use of capabilities, support services, and security and privacy of data. Because C Division's only reason for existence is to deliver computing resources to the user, these items constitute our primary objectives, and virtually every activity of the Division is in support of at least one of them.

1.2.1 Suitable Hardware

Los Alamos has a long history of requiring hardware suitable for large-scale computation. As evidenced in Sec. 2.2, large-scale computation dominates the use of our computing facilities. In today's technology, support of scientific computation includes provision for both supercomputers and general-purpose computers, online storage of information, a variety of online output options, and high-speed graphics.

In FY 1982 and FY 1983 we will procure additional Cray-1 computers and equip them with the largest memories available. We expect the first Class VII computers to be parallel processors and to be available by 1985. Preparation for them is driving much of our research. Continued acquisition of supercomputers necessitates expansion of our Common File System (CFS). A challenge

the next two years is to expand it while preserving its high standards of performance. Due to our completion of the Print and Graphics Express Station (PAGES), we have the requisite technology on hand for the next two years. Our task is to realize its potential for new standards of quality as well as to expand it if necessary. There is an increasing demand for high-speed graphics. Today we support a number of high-speed Tektronix terminals, and completion of the Advanced Interactive Display System (AIDS) will provide a significant augmentation of them. In our research, we are exploring the potential of computer-based terminals to provide additional capability. Overall, providing high-speed graphics in sufficient quantity is one of the most challenging tasks facing C Division.

New applications of computers continue to appear. Thus, we plan to provide hardware and software for support of office automation, document preparation, data management, Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM), business data processing, and general-purpose scientific computing.

1.2.2 Convenient Access to Hardware

Data communication combined with diminishing hardware cost has revolutionized computing. The result is that today all of our operating systems are time-sharing systems, and virtually all of our users access computing resources from terminals located in their offices. As evident in the report from the Terminal Network Planning Committee (Sec. 2.6), throughout the 1980s C Division must provide a diversity of communication capabilities and provide them in quantity. Probably the most severe requirement will be to provide the requisite connectivity; for example, we must add an average of 200 ports to the network per year. We must provide an array of bandwidths within these ports and perhaps make bandwidth a user-selectable parameter. We must support a large number of computer-based terminals, local area networks, and high-speed graphics devices. We need accessibility from external networks and from other Department of Energy (DOE) laboratories. While doing all of this, we must increase the efficiency of the network by making effective throughput commensurate with the physical bandwidth in use. We must also maintain our current standards of reliability and security. The foundation blocks for this expansion include the formation of the Communications Group (see Sec. 1.3), development of the Data Communications Center, development of a new network switch, specification of a new front end, and enhancements to the Extended Network Access System (XNET).

1.2.3 Easy Use of Capabilities

We must make computing at Los Alamos easier and make computer users more productive. In providing needed capabilities, all C-Division projects are addressing the characteristics of these capabilities: How does the user do this on a computer? Is it easy to learn, to remember, to use, to find information? Is it consistent with itself and with other capabilities? How well does this capability satisfy the user?

1.2.4 State-of-the-Art Software

For scientific applications, we must provide state-of-the-art software for code development and debugging, for analysis of results, and for display of

results. These requirements are met through specialized collections of software for graphics, mathematics, languages, database management, etc. We must also provide software for a variety of other Laboratory applications, such as information management and document preparation. In the next two years we will complete our automated information management project. This will provide electronic mail; integrate our standalone word processors into the network; and enable us to electronically prepare documents, including screen editing and formatting equations and figures. For our new family of computer-based terminals (CBT-2s), our research will study the potential to enhance the man-machine interface on these terminals through the use of audio I/O, local editing, electronic tablets, color graphics, and interactive graphics. Support of CAD/CAM will include selection of appropriate software.

1.2.5 Support Services

Supporting a broad spectrum of applications necessitates a number of services including operations, education, documentation, consulting, accounting, procurement, and research. In the next two years our user education program will reach maturity with classes ranging from new employee orientation to vectorization. Computer-aided education will be introduced and evaluated. We will complete the Facility for Operation Control and Utilization Statistics (FOCUS) project, providing additional efficiency in operations, automatic load leveling, and performance data that has been unavailable heretofore. We are investigating techniques for providing interactive access to the documentation for all major systems. A benchmark for interactive systems will be developed. As new capabilities appear in terminals, we will enlarge our set of standard terminals and complete associated procurement arrangements.

1.2.6 Security and Privacy of Data

Security and privacy of data in the ICN is mandatory and extensive. In the next two years we will provide audit trails in XNET. The Network Security Controller (NSC) is reaching its limit of growth. It will accommodate the expected growth through FY 1982. During FY 1982 a new NSC will be designed and will be implemented in FY 1983. A security assurance machine will be added to the ICN.

1.3 COMPUTING DIVISION ORGANIZATION

Effective October 1, 1981, the Computing Division was given an expanded role in Laboratory communications, and we established a Communications Group (C-4) to serve as a single focal point for that area. This new group will provide better communications services to the Laboratory by streamlining the processing of requests for communication equipment and services and by providing better communications planning and management.

The Communications Group comprises personnel from the Electronics Division's Telecommunications Group (C-9) and from two sections of the Computing Division's Network Engineering Group (C-9), the Data Communications Engineering Section and the Data Communications Support Section.

In a related action, Group C-9 was disbanded. Its Hardware Engineering, Hardware Support, and Software Engineering Sections are now the core of the Computer Network Engineering Group (C-5). The group is responsible for network hardware engineering, network software, and network support.

The Computing Division organization chart is shown in Fig. 1. The Division is staffed with approximately 325 people, organized into 8 groups plus the Division Office. All of our projects span group boundaries; however, projects are listed with the group that has major responsibility for them.

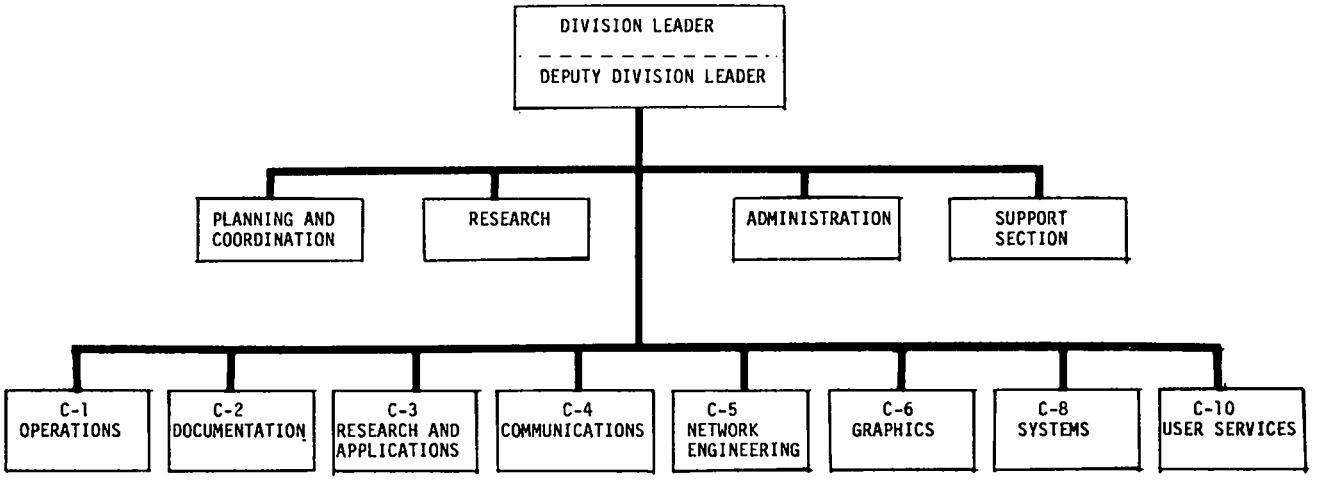


Fig. 1. C-Division organization.

1.3.1 Group C-1 - Computer Operations

Functions

C-1 is the largest group in C Division, with approximately 80 employees. This group operates the worker computers and graphics systems of the Central Computing Facility (CCF) 24 hours per day, 7 days per week, the year round except for a brief annual building maintenance shutdown in February and a holiday shutdown at Christmas/New Year. C-1 operates with 12-hour work shifts, with shift changes occurring at 0630 and at 1830.

Major Projects

- Continued operation of all CCF resources.

1.3.2 Group C-2 - Computer Documentation

Functions

The Computer Documentation Group generates and maintains user documentation for C-Division software. The staff edits and produces the C-Division News, the ICN Change Bulletin, technical reports, presentations for technical

conferences, and special documents such as the Los Alamos site input to the "DOE ADP and Data Communications Long-Range Plan," the "Computing-Division Two-Year Operational Plan," and public information brochures. The group provides word processing, data input, and graphics production services for C Division and for other Los Alamos organizations on a Form-B basis.

Major Projects

- Maintain user documentation for the Common File System (CFS) and for our operating systems: Cray Time Sharing System (CTSS), Livermore Time Sharing system (LTSS), Network Operating System (NOS), and Virtual Memory System (VMS).
- Produce new graphics and network documentation.
- Continue production of the C-Division News and ICN Change Bulletin.
- Edit C-Division technical reports and planning documents.
- Continue word processing, graphics, and data input operations.
- Develop Automated Information Management System (AIMS).

1.3.3 Group C-3 - Computer Research and Applications

Functions

Group C-3 provides computer programming on a Form-B basis; performs benchmarking of new acquisitions and existing systems; offers special expertise in vectorization programming, numerical analysis, applied mathematics, and Multi Picture System (MPS) development; develops and maintains the mathematical subroutine library; and provides specialist services in database and project management systems. The Group performs research in advanced computer architectures, numerical algorithms, and applied mathematics.

Major Projects

- Continue the standard math library for all systems.
- Benchmark Laboratory and external high-performance computers.
- Custom programming for the Laboratory.
- Research in high-performance computing, numerical analysis, parallel processing, and applied mathematics.
- Consultation on database and project management systems for Laboratory users.
- Methods development for weapons physics.

1.3.4 Group C-4 - Communications

Functions

The Communications Group combines many of the ongoing communications activities of the Laboratory. The group operates Laboratory data communications, telecommunications, and video and radio systems. It coordinates communications requirements with users and performs technical design of new systems and system changes.

Major Projects

- Prepare strategic and operational plans for Laboratory voice- and data-communications facilities and services.
- Coordinate voice- and data-communications requirements with users.
- Upgrade, operate, and maintain Laboratory communications facilities.
- Design, implement, and maintain communications systems for distributed and standalone user systems.
- Provide liaison with DOE, Mountain Bell, and other vendors of communications services and equipment.
- Complete the Data Communications Test Center.
- Administer the Laboratory's communications recharge activities.

1.3.5 Group C-5 - Computer Network Engineering

Functions

Group C-5 designs and builds specialized interfaces necesssary to meet the unique requirements of the ICN. The group also provides new communications concentrators as needed; writes and maintains the software necessary to operate switch, concentrator, status, and security machines; and maintains all the ICN switches and concentrators. C-5 is continuing to develop the Extended Network Network Access System (XNET).

Major Projects

- Continued support of ICN hardware.
- Design and development of High Speed Parallel Interface (HSPI) connections for CDC 7600 and CDC 6000-series computers.
- Continuation of software and hardware support for XNET.
- Addition of new file-transport machines and remote-worker connections.
- Design and development of a high-speed network switch.
- Support for terminal switching equipment.
- Support for the FOCUS project.
  Support for the CBT-2 project.

1.3.6 Group C-6 - Computer Graphics

Functions

Group C-6 specializes in computer graphics software. It writes or imports the needed routines or systems to provide all black-and-white and color graphical output. The group supports high-level graphics packages, low-level graphics device software, and operating-system graphical interfaces. C-6 emphasizes easily maintained, system-independent software with a common user and system interface. Group C-6 is upgrading the Print and Graphics Express Station and is developing the new high-speed Advanced Interactive Display System. C-6 also performs research in satellite graphics, addressing such issues as distribution of labor and good human factors.

Major Projects

- PAGES upgrade.
- Support for the graphics libraries, postprocessors, and high-level graphics utilities for all systems and graphics devices.
- Research in satellite graphics.
- Development of the Advanced Interactive Display System.
- CAD/CAM integration into the ICN.

1.3.7 Group C-8 - Computer Systems

Functions

Group C-8 provides operating system maintenance and development support for major CCF computers, including CTSS for the Cray-1 computers, LTSS for the CDC 7600s, NOS for the Control Data Corporation (CDC) 6000-series computers, VMS for the Digital Equipment Corporation (DEC) VAXs, UNIX operating system for the DEC PDP-11s, and the OS-VS1 operating system and production program for the IBM-based Common File System. C-8 also supports automated computing recharge and production control systems.

Major Projects

- Continued support and development of CTSS and LTSS.
- Continued maintenance of NOS and UNIX.
- VMS: Protocol development for direct SEL and XNET connections; development of auxiliary communications software and Distributed Processor support software.
- CFS: implementation of Multiple Virtual System (MVS) operating system to allow further expansion of capacity; implementation of new user functions; and maintenance.
- MODEL system development language: continued maintenance and enhancement for joint work with Lawrence Livermore National Laboratory (LLNL).
- Acquisition and installation of a local terminal switch.
- Planning and design of future operating systems, including support of administrative needs.
- Support of the automatic accounting functions.
- Modeling of the ICN, CTSS, and user jobs.
- Support and enhancement of the automated production controller, including study of Central Computing Facility (CCF) tape needs.
- Research in operating-systems applications of parallel processors and audio I/O.

1.3.8 Group C-10 - Computer User Services

Functions

Group C-10 provides direct user services in consulting, education, and documentation distribution. It supports utilities, languages, and system libraries and is responsible for quality assurance (QA), coordinating

change control, and for chairing the Standards Working Group (SWG). The group also performs research in programming languages, addressing such issues as portability and parallel processing.

Major Projects

- Continued consulting services.
- Continued support of Fortran Extended (FTN) and Cray Fortran (CFT) compilers, implementation of FTN5 for NOS and LTSS, and acquisition of American National Standards Institute (ANSI) standard Fortran 77 compilers and their run-time libraries for all systems.
- Maintenance of FTNLIB/CFTLIB (system libraries that contain I/O routines, elementary mathematical functions, and various service functions) and development of a common system library.
- Continued development and support of the standard utilities.
- Coordination of the casual user project.
- Development of a comprehensive user education program.
- Research in programming languages.
- Computing information distribution and consultation.
- Maintenance of a viable user's area.

1.3.9 C-Division Office

Functions

In addition to management of the Division, C-Division Office (C-DO) is responsible for other activities that are administered by the C-Division Support Section, CDSS. CDSS serves as the focal point for the Laboratory's regulatory responsibilities and authorities in the areas of computing and word processing, supervises CCF allocations, and manages C-Division procurements and property.

Major Projects

- Management of C Division.
- Oversight of Laboratory compliance with automatic data processing (ADP) and word processing (WP) regulations.
- CCF allocations.
- CCF recharge rate determination.
- Procurement.
- Property management

1.4 REVIEW OF FY 1981

FY 1981 was a very productive year for the Computing Division. We installed a considerable amount of new hardware and software, initiated several new major projects, and generally completed our projects as planned and on schedule. Following are some of our specific accomplishments during FY 1981.

- We upgraded the memory of our second Cray-1 (Machine W) to 2 million words in February 1981. This machine became the first 2-million-word Cray-1 in operation.
- We installed a third Cray-1 (Machine X) under a rental agreement with Cray Research in April 1981. This computer is used for Augmented Test Program activities.
- We received approval for two additional Cray-1s, one each for FY 1982 and FY 1983.
- We expanded our user-information activities considerably by conducting the User Survey; publishing our first Two-Year Plan; initiating the ICN Change Bulletin, online documentation, and the casual user project; and starting a computing education program.
- We defined levels of support for software and completed the core of the supported set of utilities for CTSS and LTSS. Work is nearing completion for VMS and NOS.
- We provided utilities and libraries for Distributed Processors so that the VAXs have many of the same software tools that are on CCF computers.
- We instituted a change control procedure to better test our software.
- We expanded our consulting efforts to include distributed processing, numerical analysis, graphics, and word processing.
- PAGES came into full production and allowed us to increase our film production capacity by 2 to 4 times; individual jobs may run up to 10 times faster.
- We defined two more standard ICN terminals: the DEC VT-100, an alphanumeric video terminal, and the Advanced Electronic Design (AED) 512, a color graphics terminal.
- We added approximately 400 new ports to the ICN and began using the TA-3 protected distribution system.
- The Common File System achieved its reliability goals and currently holds over 5 trillion bits of information.
- We made our versions of CTSS and LTSS very stable and as similar as possible.
- We began using our standard, internal ICN communications protocols within the CCF.
- We automated our accounting system.

2 PLANNING FOR FY 1982

2.1 OVERVIEW

Computing technology is continually changing and existing services are never perfect. Hence, there are always opportunities for quantitative and qualitative improvements. Exploiting and coordinating these opportunities requires careful planning. To support our users' needs, we strive to plan our activities as carefully as possible, and we solicit input for our planning from a wide variety of sources.

Several computing advisory committees contribute to the formulation of C-Division plans and the setting of priorities for C-Division projects.

CUP. The Computer Users' Priorities Task Force is an ad hoc committee chartered by the Associate Director for Engineering Sciences to assess the relative importance of proposed and existing C-Division projects for the upcoming fiscal year.

SWG. The Standards Working Group is chartered by the C-Division Leader and staffed with both users and C-Division personnel. It is responsible for recommending standards for software and the user interface.

TAC. The Technical Advisory Committee is a standing committee chartered by the C-Division Leader to advise him on the requirements of the users and how the authorized C-Division projects can best be implemented to meet these needs. The TAC generally is consulted when projects within a fiscal year may be changed.

TIP. The Technology Information Panel is composed of non-Laboratory computing experts who meet annually to review specific projects and to advise the C-Division Leader of new opportunities to increase the productivity of the CCF by taking advantage of recently introduced computer technology.

TNPC. The Terminal Network Planning Committee is an interim committee chartered to identify required improvements to the network throughout the 1980s. A summary of its preliminary report is given in Sec. 2.6.

Several Laboratory divisions also have internal computing advisory committees, including the Applied Theoretical Physics (X) Division Computer Liaison Committee and the Theoretical (T) Division Computer Committee. In addition to discussing internal computing topics, these committees communicate with the other committees noted above and directly with C Division.

2.2 PROGRAMMATIC UTILIZATION

The major user of the Laboratory's extensive computer network has been, and is expected to be, the nuclear weapons program. Because underground tests are

very expensive and the current Threshold Test Ban limitation requires that some weapons be tested at less than maximum yields, computer simulation is vital. It is critical that each test be carefully designed using the best possible computational tools and that the number of performance uncertainties be reduced to a minimum. Although major emphasis is on weapons design calculations, considerable effort is also directed towards weapons test calculations and investigations into experimental diagnostics. Both require large-scale computer simulations.

The second largest user of computing resources, though small compared to the Weapon's Research and Development (R&D) activity, is the Inertial Confinement Fusion (ICF) program. ICF computing is devoted almost entirely to the design of targets and the analysis of target interactions. The 8-beam Helios laser system and the new Antares laser system require computer-generated designs for several target concepts. These designs must be in step with other phases of the complex developmental processes for the systems. Similar computing needs apply to the growing effort under way on targets for the full spectrum of possible drivers, including targets for electron-beam, light-ion, and heavy-ion accelerators. All of these must be tailored to the characteristics of the particular driver.

The third major user of computer resources is the reactor safety program of the Nuclear Regulatory Commission (NRC). Among the functions performed by the Laboratory for NRC is the development of two codes, TRAC and SIMMER. TRAC will analyze all pertinent types of postulated accidents in light-water reactors and SIMMER will model hypothetical core disruption accidents for the liquid-metal fast breeder reactor.

Clearly, our computer usage is dominated by scientific computation--a fact that is abundantly clear from even a cursory examination of our computing resources and projects. The trend in usage of CCF resources by program is given in Fig. 2, and CCF usage by division is shown in Fig. 3. Continued support of these critical Laboratory programs has been and will continue to be the key factor in all of our planning.

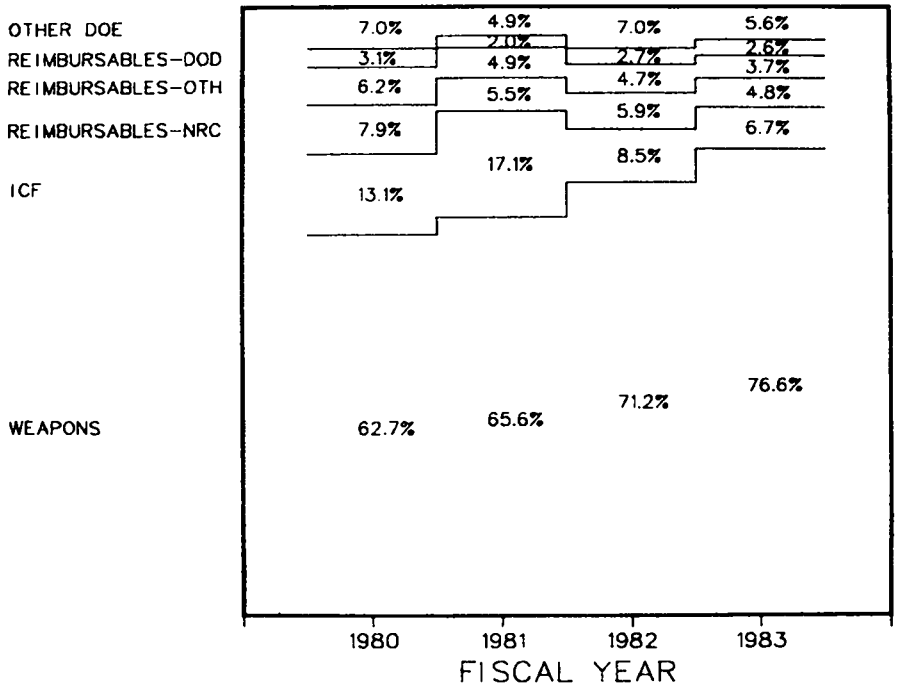


Fig. 2. Trend in usage of CCF resources by program.

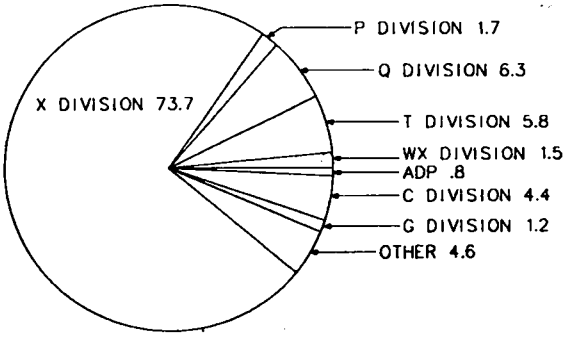


Fig. 3. Percentage of CCF usage by Division - FY 1981.

2.3 COMPUTER USERS' PRIORITIES TASK FORCE REPORT

The Computer Users' Priorities (CUP) Task Force report for FY 1982 gave a summary, general observations, and specific projects. The summary stated

> "The Task Force is pleased to report significant general satisfaction with the performance of C Division on the part of the Laboratory computer user community. C Division is to be commended for its continuing emphasis on improving the quality of the services it provides. The importance and far-reaching effects of its complex major projects warrant special emphasis during FY 1981-1982, so that the resulting systems and networks provide the most technically sound foundation for new developments in later years."

The 1981 CUP task force was made up of the following members.

Otis Farmer, BUD-2
Jim Newell, WX-12 (Chairman)
Dennis Perry, C-5 (formerly MP-1)
Hans Ruppel, T-3
Brooks Shera, P-3
Buck Thompson, X-6 (Vice Chairman)
John Vigil, Q-DO

2.3.1 General Observations

Observation 1

C Division should continue with its Automated Information Management System (AIMS) and assume that administrative applications will continue to require the ICN.

Response

We will continue the prototyping of AIMS and we will continue to assume that administrative applications will require the ICN. Our plans are given in Sec. 4.7.3.

Observation 2

The Task Force recognizes the utility and growing use of project management systems at Los Alamos, and recommends that the associated software support and user consulting be funded by means other than through the C-Division recharge budget.

Response

We believe that the project management activities will become an increasingly more important tool for Laboratory management. Currently, about 80% of our project management work is performed on a Form B contract basis.

Observation 3

C Division should continue with its plan to develop a common Fortran 77 compiler across systems with the collaboration of X Division on performance criteria.

Response

This is part of our plan, and we will proceed as indicated in Sec. 4.2. We currently do not have the personnel in C Division to perform this work, and we are planning to contract for such a compiler.

Observation 4

The value of XNET should not be underestimated.

Response

We too believe that XNET is a very important activity. See Secs. 2.3.2 (Priority Project 3) and 3.8.

Observation 5

The CUP endorses the Casual User Project but would like the focus changed. For example, the focus on once-a-year users, such as Visiting Staff Members, should be broadened to include the needs of permanent employees who use CCF facilities on an occasional basis.

Response

Our focus is currently the same as the CUP recommends. See Sec. 6.14.

Observation 6

The CUP is encouraged by and supports our research activities, and rates Audio I/O the lowest priority.

Response

We plan to aggressively continue all our research as indicated in Sec. 7. The audio I/O work has two large potential payoffs that should not be overlooked. It may improve C Division's operational efficiency with our new operational controller FOCUS, remedial maintenance, and network problems. It may also have a large potential benefit to users in the way they write, control, and receive information concerning their jobs. We believe it should be continued.

Observation 7

C Division should maintain an awareness of the Department of Defense programming language Ada for possible future use.

Response

This is also part of our planned activity, and we will attempt to secure an experimental Ada compiler for use by ICN users and C Division (see Sec. 4.3.3).

2.3.2 Priority Projects

The CUP recommends that we continue with all the projects listed in the Two-Year Operational Plan for FY 1980-1982, with the possible exception of project management. In addition, they provided input on priority projects.

Priority Project 1

Enhance the ICN terminal network. This recommendation calls for continued support of existing facilities, plus more user involvement in terminal selection, X-on, X-off support for VT-100s, hardware to minimize vendor system modifications, X.25 protocol support, and high-bandwidth channels.

Response

All of these efforts are already completed or are included in our plans. We have formed the Terminal Network Planning Committee to provide additional guidance. Their report is given in Sec. 2.6. Other network plans are given in Sec. 3.3.

Priority Project 2

Provide new PAGES graphics output devices, including the items listed below. Funds for the purchase of this equipment have been requested of the Weapons Program.

a. 8.5- by 11-inch black-and-white camera,
b. video disk recorder,
c. 4- by 5-inch color camera,
d. 60-inch pen plotter,
e. small plotters, and
f. color plotter.

Response

We have requested weapons equipment funds for Items a-d. Item d is also of interest to the CAD/CAM project. Item e will probably be a CBT-2 option.

Priority Project 3

Enhance XNET to provide reliable and efficient file shipping, job submission, minimum data rates of 1.544 Mbit/s, local CBT-2 networks on Distributed Processors, and terminal message passthrough.

Response

XNET will be made more reliable. Job submission and terminal message passthrough are scheduled to be available in April 1982. Efficiency problems are inherent in DECnet. In fact, if we provide 1.0-Mbit data rates, our studies indicate that the effective throughput would be less than 0.1 Mbit. As soon as we complete terminal passthrough and job submission, we will improve transmission efficiency.

The data rates suggested by the CUP cause some problems. The hardware interfaces available from DEC that we use to communicate with XNET are much slower. We now are using DMC-11 interfaces at 56 kbit/s. DMC-11s will run up to 1 Mbit/s for short distances, but are rated by DEC to run up to 250 kbit/s for our distances. We are currently testing 250-kbit/s transmission on the coaxial cable system and will upgrade when the coaxial rates are upgraded; this is the maximum data rate promised in the XNET development plan. A more worrisome problem is the number of Distributed Processors that an XNET access machine can support as a function of the data rates to the Distributed Processors. DEC has announced a new interface, DMR-11, that will run up to 1 Mbit/s for our distances. However, we will not commit to using it until we are sure that we have adequate switch capacity to do so. See Sec. 3.8 for further discussion of XNET.

Priority Project 4

Continue graphics development with emphasis on

a. a smaller version of DISSPLA,
b. PSCAN for Distributed Processors,
c. three-dimensional graphics, and
d. a graphics editor.

Response

Item a would require us to rewrite a vendor package, which we do not believe we should do. We and others will continue to press the vendor, ISSCO, for a small DISSPLA. PSCAN for Distributed Processors has been available since October 1, 1981.

We have a committee for high-level graphics and will be developing a new graphics library to provide improved graphics generators (such as MAPPER and SLIDES), improved documentation support for new graphics devices, increased Common Graphics System capability (particularly in the area of characters), increased compatibility between the Common Graphics System and DISSPLA, and support of new PAGES devices.

We have started work on a graphics editor and will continue that project through FY 1982. Our general graphics plans are given in Secs. 4.4.3 and 4.6.

Priority Project 5

Provide better text-formatting tools.

Response

Better text-formatting tools will be provided within the AIMS project (Sec. 4.7.3). We are already working with the Information Services Division to determine how a phototypesetter might be connected to the ICN. Users will be involved in AIMS specifications at the appropriate time.

Priority Project 6

Provide better support for the CIVIC compiler.

Response

CIVIC is the CHAT compiler on the Cray-1s. Currently, we do not support CIVIC, but rather rely on Lawrence Livermore National Laboratory. We treat CIVIC as Level-3 software (see Sec. 4.), just like many of the Livermore utilities. We believe that we should keep our version of CIVIC strictly compatible with Livermore.

Priority Project 7

Provide increased Distributed Processor software support for applications and consulting and software for systems.

Response

A substantial effort is under way to provide additional software functionality for Distributed Processors. See Sec. 3.8.4 and Schedule 5 for details.

Priority Project 8

Provide additional support for the Data Retrieval System (DRS) and funds to purchase additional DRS licenses.

Response

We have allocated an additional one-half point for DRS support, but, again, this is a vendor product and we should rely on the vendor for support. We are pushing the vendor to provide better documentation and tools.

The Laboratory contract for DRS calls for 10 licenses at a cost of $89,250. We have the option of purchasing 10 more licenses for the same amount of money, after which point any future licenses will be free. We believe that user sites should budget for their licenses.

Priority Project 9

Establish a CAD/CAM project.

Response

We have initiated a CAD/CAM project as discussed in Sec. 5.1. Most of the FY 1982 effort will be preparation for a much larger effort in FY 1983.

2.4 USER SATISFACTION MEASUREMENT STUDY

In October 1980, Pearson and Associates, Springfield, Virginia, conducted a computer user survey for the Laboratory. Goals and objectives for the study included the following.

- Identify areas of greatest potential improvement in computing services provided by the Computing Division.
- Establish a baseline of satisfaction with the computing services provided by the Laboratory.
- Establish the factors that are most important to the Laboratory users.
- Provide data to aid in the establishment of service goals for the Computing-Division staff.

Over 3,000 questionnaires were distributed, and 1,121 completed questionnaires were returned. The results of the questionnaires highlighted a number of areas that required additional investigation through follow-up interviews with users. Members of Pearson and Associates conducted the interviews with 52 users from 17 organizations within the Laboratory. The interviews were based on each individual's specific responses to the questionnaire. The focus of the interview was almost entirely on areas of dissatisfaction. This was done

deliberately to identify the elements of greatest potential improvement. The complete report is available in the Computing Information Center.

2.4.1 Study Results

One user remarked that "It is amazing that the whole thing works." Pearson's comment was

> "Indeed it is. The computing power that is resident at Los Alamos National Laboratory is awesome and by its nature extremely complex. The technical environment is both diverse and innovative. The great majority of users [who responded to the survey] (918 out of 1,121) have found the service provided by C Division to be satisfactory."

The results given here are greatly summarized, and only the key results are included. A more exhaustive and comprehensive discussion of the results is contained in the final report. No significance is attached to the order in which they are listed in this summary.

Pearson and Associates listed the following key positive areas that were identified by the users.

- CCF operations and operators are well regarded.
- Common File System is an outstanding capability.
- Graphics power is exceptional.
- Fiche output is a big saver.
- Response to documentation requests is outstanding.
- Dispatcher desk service is very good.
- Access to the computing resource is very convenient and easy.
- Total computer capabilities regarded as some of "the best in the world."
- In general, good consulting staff.
- Users feel that C Division has greatly improved overall during the past two years.
- Users indicated that the C-Division services have a positive effect on their own personal jobs.

Negative key areas identified by users include the following.

- Response to change requests is not adequate.
- Training needs a lot of improvement.
- There is little commonality of utilities across systems, especially editors.
- Casual users feel that their requirements are superseded by the large heavy users.
- The effect of system changes is entirely too severe and negative.
- The bank point system is regarded as oversubscribed. Users feel that more bank points are allocated than can be accommodated on the systems during the time period involved.
- There is no consultant assistance provided for conceptual system design.
- Interactive response time is unacceptable (users were almost totally split on this issue).
- There is no formal system for tracking and feedback on requests for consulting assistance.

- Response to tape mount requests is frequently very slow (over 1-5 hours in some cases).
- Users feel that they are used to debug new systems.
- C Division is "hostile" to user-developed and other non-C-Division software.
- The lack of available ports restricts many users in their use of the computing facilities.

2.4.2 Recommendations

Based on the survey, Pearson and Associates made the following recommendations.

Recommendation 1

C Division should conduct new user orientations periodically, probably every month. These should include an overall presentation, tour, documentation packages, introduction to key C-Division personnel, etc.

Response

We agree. The Casual User Project has developed a New User Orientation Program. See Sec. 6.14.

Recommendation 2

A common editor syntax should be developed and supported on all systems (this recommendation does not include the elimination of all other editors).

Response

We agree, and have adopted the common text editors FRED and ED for CTSS, LTSS, VMS, and NOS. See Sec. 4.5.

Recommendation 3

A formal suggestion system (manual and online) should be implemented.

Response

We are investigating procedures for a formal suggestion system and are considering both manual and online procedures. If a formal system is desirable, we recommend a procedure similar to the following be adopted.

> It is essential that the users make their requests in writing, stating what needs to be changed, indicating clearly what the existing programmatic impact is on their programs, and why the change should be made.
>
> This written request should be presented to the Consulting Office. It should be reviewed with a consultant, not for the purpose of making changes to the user's request, but to make sure that the consultant understands exactly what the user is requesting.

The change request should then be taken by the consultant to the appropriate group in the Division. The consultant should initial the change indicating that he/she has seen it and understands it. The responsibility then passes to the group to whom the change was given. The group shall respond to the user in writing, with a copy to the Consulting Office and the C-10 Group Office, within two weeks as to the disposition of the change, either giving an approximate time when the change will be scheduled or implemented, or the reasons why the change will not be made.

Recommendation 4

A single point of contact should be designated for all training issues.

Response

We agree. We have hired a staff member to coordinate computing education for users. The Coordinator assesses user needs, plans and schedules live courses, and provides videotape and computer-aided-instruction courses. See Sec. 6.13.

Recommendation 5

A schedule of training courses should be developed.

Response

Our Computing Education Coordinator has developed a schedule of computing training courses and will continue to evaluate user needs and adjust that schedule accordingly. See Sec. 6.13 for details.

Recommendation 6

A schedule of training courses should be published periodically.

Response

A schedule of computing courses has been published. Future schedules will be published periodically and will be available online. See Sec. 6.13.

Recommendation 7

A suggested sequence of training courses should be developed.

Response

We agree. We conducted a survey to determine the types of computing courses that are needed, and we identified 48 courses, falling into 5 main categories. These categories are (1) Network Organization and Hardware Design, (2) Operating Systems, (3) Programming Languages, (4) Graphics, and (5) New Systems. Our computing education catalog for 1981/82 contains planning charts to help users select courses in each of these categories. Prerequisites for each course are given. An ongoing needs assessment of users is being conducted to determine course priorities.

Recommendation 8

A program to use the software development capability resident in the user organizations should be implemented. This should include the publication of guidelines for developing common software and the formation of a Software Review Council for determining what software will be accepted and supported by C Division.

Response

Procedures do exist for adoption of user-developed software. If users have software they want C Division to adopt, they must propose it to the Standards Working Group. The Standards Working Group will evaluate the proposed software and decide whether to recommend it to C Division. If they do recommend that C Division adopt the software, then C Division makes the final decision. In every case, however, the software must be documented according to the requirements given in Chapter 3 of the Programmer's Information Manual-2 (PIM-2).

Recommendation 9

There should be longer periods of dual operation (where feasible) for major system changes.

Response

It is very difficult to have dual operation on all major system changes. Our policy through Change Control is to first bring the system changes up on one Secure and one Open LTSS machine, on one Cray machine, and on one NOS machine; one week later, we bring them up on the other machines of that class. This schedule is normally sufficient to shake down any errors that may have crept into the system, and is designed to have minimal impact on the user community.

Recommendation 10

There should be a clear articulation of C Division's management goals. They should be divided into those that are computer-science-research related and those that are user-service related.

Response

The Computing Division's management goals are articulated in this plan. Although the plan delineates research and user services, the two are dependent.

Recommendation 11

There should be a formal tracking system with feedback and clear evaluation procedures for user requests and proposals.

Response

Improved procedures for handling user requests and proposals should be

integrated with those for handling suggestions as described under Recommendation 3.

Recommendation 12

The results of this study should be widely distributed among users.

Response

We agree. The Executive Summary of the results of the study was sent to all users as an attachment to the March 1981 C Division News. The full report is available in the Computing Information Center.

Recommendation 13

C Division should formally and publicly respond to the findings of this study to the user community.

Response

This section of the "Two-Year Plan" provides a comprehensive, detailed discussion of our response to the study, and the hardware and software project schedules in Secs. 3 and 4 emphasize our commitment to respond to user needs.

2.5 TECHNOLOGY INFORMATION PANEL

The Computing-Division Technology Information Panel II met at Los Alamos December 16-19, 1980. The panel consisted of

James Browne, University of Texas at Austin
Albert Erisman, Boeing Computer Services
Sidney Fernbach, Control Data Corporation
Richard Hamming, Naval Postgraduate School
Bert Herzog, Herzog Associates
Ivan Saddler, Motorola Corporation
Howard Wactlar, Carnegie-Mellon University
Frank Westervelt, Wayne State University

The panel was asked to make recommendations for future directions in number crunching, networking, and distributed computing based on their assessment of technology trends, Los Alamos computing needs, and Computing-Division activities. While at Los Alamos, the panelists reviewed these activities with C-Division management and personnel, and each panelist prepared a written report of his observations. The following recommendations are based on a synopsis of these observations. Following each recommendation are quotes from panelists to give insight into the basis of the recommendations and our response to them.

2.5.1 General Comments by Panelists

"C Division has now established a far greater degree of control over its development and destiny than was the case a few years ago. This degree of control rests on analysis and planning."

"The user community admits to the evident improvement in C Division's services, but many complaints persist, some of which appear to be real, and others are long lasting grudges (initially well earned)."

"Although it has been only four months since the last meeting of TIP, significant changes in the User Divisions-C Division relationship are noticeable. There seems to be a much better attitude on both sides, a real interest in getting on with the work to be done. The C-Division people seem to be happier also. Planning is proceeding at a rapid pace, and there seems to be more togetherness among the participants."

2.5.2 Recommendations

Number Crunching - Recommendation I.A

C-Division research in parallel processing should be continued and enlarged, emphasizing physical models, algorithms, languages, systems, and university-Los Alamos-industry cooperation.

> "The ability of scalar processors of the future to satisfy the computational needs of Los Alamos is rapidly decreasing. Even the innovative Josephson Junction techniques will yield less than an order of magnitude increase over today's and forthcoming scalar and vector processors."
>
> "Los Alamos needs to do nothing to advance the state of parallel-processor hardware realizations. In fact, if the gigaflop capability is to be achieved in the next decade, considerable efforts must be made by the labs in their software instead. The vendor supplying the processor cannot be expected in the next five years to provide adequate complementary software."
>
> "The greatest long-term payoff, but the one with highest cost for the Laboratory overall, is in reconsideration by the physicists and mathematicians of the physical model and the introduction of entirely new algorithms."
>
> "I should like to see more effort going into simulating the parallel-processor systems and in checking out the test algorithms being developed. ... The collaboration of X Division personnel in any experiment carried out is crucial; these are the people with the number crunching requirements. They, along with C Division personnel must jointly model the real problems to be done in the next decade from initial physical principles with the assumption that the Class VII Computer System will be a pipelined parallel processor."

Response

Our FY-1981 research included all areas of the recommendation except systems. We have obtained funding in FY 1982 to explore ways to provide a CTSS-like

interface to a parallel processor and to do so in a fashion that allows users convenient access to the parallel processing capabilities. We were not successful in obtaining additional funds with which to enlarge our work in algorithms and languages. Details of our plans for FY 1982 and FY 1983 are contained in Secs. 7.1.1-7.1.3.

Number Crunching - Recommendation I.B

Assembly of a parallel processor at Los Alamos should be pursued with caution and limited to providing a hands-on test bed for algorithms and software.

> "There is clearly an issue as to whether Los Alamos should construct its own parallel processor for experimentation. It could be a costly diversion. At best, Los Alamos should replicate an existing system but not engage in engineering innovation. It should consider only those with an expandable number of processors. Its primary value may be to provide a hands-on test bed for the physicists and mathematicians of various divisions to validate and benchmark their modified algorithms and models."

> "Certainly, if parallel-processor hardware does exist anywhere, it should be made use of for testing purposes. There should be some actual systems available for use in a reasonable short time. The S-1 might be available for test, the Dynelcor HEP is coming along, and the AFP and the Carnegie-Mellon systems exist now."

Response

We believe that access to a processor-rich system is critical; none of the existing or planned systems will be processor rich. Consequently, we have decided to proceed with the assembly of an inexpensive, processor-rich parallel-processing system at Los Alamos. The system will be based on microcomputers. Details are given in Sec. 7.1.4.

Networking - Recommendation II.A

C Division should formulate and document functional specifications of the network, current and future.

> "One document, which is somewhat lacking among the many good ones that were present, is a functional specification of what the network will be expected to provide. Not just how much, but rather what kind of services it must provide."

> "It is difficult to decide anything about the implementation of the network without a functional description and specification of the required resource sharing."

> "I find an atmosphere of 'rushing into implement features' as driving the situation. Clearly, I believe an overall plan is required. I also recognize the need to get started given the eternal delays presented by nontechnical obstacles."

"The computing field is changing rapidly and so are user needs and wants. For this reason it would seem wise to pause long enough to study the needs. This recommendation is not intended to stop development or at least prototyping of some elements believed to be needed, such as broad-band lines and the network switch."

"Network stability is a point of accomplishment for C Division."

Response

In the spring of 1981, the Division Leader commissioned a Terminal Network Planning Committee with the charter to "help plan the needed improvements to the terminal network portion of the network." This charter was subsequently expanded to encompass the short- and long-term functional needs and plans for the entire network. Details are given in Sec. 2.6.

Network - Recommendation II.B

In the absence of functional specifications for the network, and because the existing SEL configuration is extendable, the panel recommends further analysis and study before committing to build the network switch.

"There has been much debate within this committee regarding the validity and necessity of the network switch design. It provides an increased number of ports for forthcoming worker machines and DPs [distributed processors] plus reliability enhancements, both of which have alternate approaches. The commitment to building it in-house at this time represents a long-term resource allocation that does not seem prudent, particularly in light of the lack of a more complete network functional specification. ... A valid approach may be to go ahead with the switch design only if it can be done concurrently with designing and building a port multiplexer and with an in-depth study of network alternatives, such that if nothing better results from the study within one year there will at least be an existing design with which to proceed."

"The proposed new switch does represent a possibly desirable course of development. C-9 should be allowed to maintain some of its momentum toward this option by establishing a limited scale of not more than 2 or 3 FTE's design effort. There is much need for C-9 effort in other areas, such as measurement and documentation of SEL software. C Division should utilize the next two years for a continuing in-depth analysis of networking needs based on goals and clearly established functionality."

"Much of the discussion that we had centered on the proposed addition of a switch in the network. ... I am not qualified to judge whether this is the best solution to these problems, but I was convinced that not enough questions had been answered. More attention should be paid to the use of a standard component solution."

Response

After a lengthy discussion within the Division, we decided to proceed with building the network switch. We did so because the network switch approach

- increases ICN connectivity for future expansion,
- provides enhanced data integrity and error control,
- allows efficient communications between machines with different I/O speeds,
- provides large data buffers and has the potential for data blocking and deblocking in the network,
- provides higher total throughput than other methods, and
- requires little change in worker machine software and causes minimal disruption to users.

In addition, current network architecture works well. We understand it, and security procedures, proposals, and approvals already exist for this architecture. See Sec. 3.5.2 for additional information.

Distributed Computing - Recommendation III.A

The VAX 11/780 Distributed Processors are still reaching for maturity and warrant further review. They provide a fortuitous opportunity to explore and develop CBT-2 related functions.

> "The scientists might find significantly greater satisfaction with their DPs if they gave them a capability they cannot otherwise have. They may be willing to sacrifice complexity in the prototype problem solutions if they have real-time, local graphics to deal with. Color displays ... should be part of every VAX procurement if the Laboratory is to explore the potential of CBT-2s and DPs."
>
> "We interviewed three different VAX sites and found three very different views of the way to utilize these facilities. None of the ways, in my opinion, were inappropriate in any sense, but the very fact that they were so different leads me to believe that this local 'tailoring' ('control') may well offset the added incremental cost. As long as the local 'control' results in greater productivity, and better science, the distributed computing will have been a success.'"

Response

Distributed Processors were subjected to considerable review throughout the Laboratory, including the Director's Office, in the spring of 1981. The conclusions were as follows.

- Distributed Processors have the potential to provide interactive computation to a relatively large number of people and to do so at modest cost.
- If used for number crunching, the cost on a Distributed Processor is comparable, though higher, to that on CCF workers.
- The extended network provides ready connection to the ICN from laboratories throughout the country.
- The experience gained from XNET will be directly transferrable to the CBT-2 project.

- VAXs are being acquired by virtually every university in this country. Thus the VAX will become our software window to the scientific computing community.

In view of these positive points, we are pressing to complete the project by spring 1982. A schedule and discussion of related activities is given in Sec. 3.8.

Distributed Computing - Recommendation III.B

C Division should continue its development of the CBT-2. Perhaps more emphasis should be given to a CBT-2 with VAX 11/780 class performance, high-speed graphics, and high-bandwidth network connection.

> "Believing the 25-30% yearly cost-performance improvement curves, it is apparent that by the mid-80s (certainly by the late 80s) what are today's VAX 11/780 DPs will be the CBT-2s of the day. Secondary storage will not scale at the same rate, but local stores on the order of 20 megabytes, network connections on 10-Mbit networks, and attached integrated 1000 x 1000 pixel raster displays will all be available as a packaged CBT-2 for approximately $10-20,000. It is expected that the volume sales may drop the price significantly further."
>
> "These machines will ultimately be the ones distributed to every office, hopefully taking the place of today's dumb terminals. At Los Alamos, they will be used for document generation, multimedia electronic mail (text/graphics/digitized audio), and program preparation. When suitably networked, they will provide the terminal access to any of the worker computers, if not the front-end to them."
>
> "In order to provide both explicit file transfer and terminal pass-through capability to the workers, I would recommend (with just minimal computation) a number of broadcast contention, network loops running at 10 megabits and having roughly 200 CBT-2s each. The Ethernet will be a commercially available standard in use by DEC, Xerox, and HP by 1982 and should be considered for this use. Interfacing it to existing ICN facilities may be done via gateways. In fact, DP owners interviewed say their present 56-kbaud XNET link is one of the greatest impediments to effective utilization and satisfaction."
>
> "A model for distributed computing needs to be reestablished in the light of current user experiences and developing technology."

Response

One of our prototype CBT-2s was chosen because its performance begins to approach that of a VAX 11/780. We believe that initially these machines will be used to perform functions that are not readily obtained from CCF workers and that the associated communication will not require high bandwidth. However, for scientific applications, our studies confirm that extremely high bandwidth and throughput efficiency would be required for CBT-2s to gain user acceptance. For a fuller discussion of this subject, see Sec. 3.2.2.

2.6 TERMINAL NETWORK PLANNING COMMITTEE

A Terminal Network Planning Committee was chartered in FY 1981 to "help plan the needed improvements to the terminal portion of the network." With the concurrence of the C-Division Leader, the charter was expanded to encompass the short- and long-term needs and plans for the entire Integrated Computing Network. Members of the committee are

D. Bailey, OS-4
J. Blaylock, X-7
B. Buzbee, C-DO (Chairman)
J. Clifford, C-8
R. Earley, C-2
R. G. Lee, X-1
F. Maestas, C-10
F. Parker, Q-DO
D. Perry, C-5
C. Slocomb, C-8
V. Trujillo, C-5
M. Vigil, C-6
J. Worlton, C-DO

The Committee identified the nature of future requirements and options for providing them and recommended associated actions to C Division and the Laboratory. The Committee's planning was based on a number of assumptions, including the following.

- A Central Computing Facility will continue to be needed by the Laboratory.
- The trend toward distributed computing will continue.
- The trend toward increased usage of computers in administrative applications will accelerate.
- The trend toward automated offices will accelerate.
- The trend toward preparation of documents on computers will accelerate.
- The trend toward national and international network communications will accelerate.
- Graphics will continue its growing role of importance in both scientific and administrative computation.
- Both security and privacy will be required.
- A centralized on-line storage facility will continue to be needed.
- Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) resources will be required in the Laboratory.

Terminal Access Paths - Requirements

Terminal access paths (TAPS) consist of dedicated ports, dial-up ports, and terminal passthrough paths on Distributed Processors, CBT-2s, and auxiliary networks. Currently, approximately 1350 ports provide access to the Integrated Computing Network for more than 3000 users. The Committee expects the demand for ports to increase during the 1980s for two reasons: increase in number of authorized users and increase in the ratio of ports to users. These two causes will lead to a need for several thousand more ports. The Committee feels that a pool of ICN ports should be available at all times from which ports could be supplied upon request--for the existing Laboratory staff

as new needs arise, for new employees as soon as they are hired, and for visitors who are here for only a short time.

Port Capabilities - Requirements

The Committee believes that in this decade we will need ports capable of supporting three types of devices: terminals, processors, and high-speed graphics. Processors include distributed processors and CBT-2s. High-speed graphics devices include the 150-kbit/s Tektronix terminal, the Multi Picture System, and the Advanced Interactive Display System.

The current input bandwidth from dumb terminal ports is either 300 bit/s or 1200 bit/s, and the Committee believes this will continue to be adequate. Output bandwidth options are 300, 1200, 4800, and 9600 bit/s. Most of the present set of ports are 300 bit/s in, 300 bit/s out. The trend in normal asynchronous terminal bandwidth requirements is toward greater speed with 19.2 kbit/s expected to become standard. The ICN should develop in a way that predominately supports the high end of bandwidth requirements.

The Committee believes that intelligent terminals (CBT-2s) will become the dominant type of ICN terminal in the 1980s, with several thousand CBT-2s in use by the end of the decade. However, this growth will be driven to some extent by the cost of such terminals. If the cost per terminal remains at, say, $20,000, then 1000 such terminals would cost $20 million; growth beyond (and perhaps even to) this level would not seem likely. If the cost drops below $5,000, a much larger number and variety of CBT-2s can be expected. The Committee believes the figure of several thousand CBT-2s by the end of the decade is appropriate to use for planning purposes.

The need for high-speed graphics terminals will grow to several hundred, with bandwidth requirements in excess of 1 Mbit/s. These need capabilities at least as great as the current high-speed (150 kbit/s) Tektronix terminal.

Distributed processors have the potential to play an important part in general-purpose computing at Los Alamos. To realize this, network throughput must be increased, with port bandwidth to 1 Mbit/s available. Job submission and terminal passthrough facilities also must be provided.

External Networks

Within the next year, the ICN will be connected to both ARPANET and a commercial network. We now have 350-400 non-Los Alamos users authorized to use the ICN; there is a mix of visitors who use the ICN exclusively while they are at Los Alamos, visitors who use the ICN both on site and off site, and other users who use the ICN only off site. The number of off-site users will grow, perhaps dramatically, and we should expect to have at least 1000 off-site users by the end of the decade. The number of dedicated lines to other sites is expected to increase by several in the near term as other DOE sites, such as Livermore, begin using the computers in the Open partition. There is an increasing need for secure data communications with Livermore and perhaps other DOE laboratories.

Thirty-four host computers at other sites are used by Los Alamos personnel (see p. 24 of the Los Alamos "ADP and Data Communications Plan, FY 1984" for a

list). These ad hoc communications connections should be included in the planning for external networks to reduce communications costs and provide convenient access for the Laboratory.

Dial-Out Capability

The network should offer its users the ability to easily connect with computers remote from Los Alamos. Connections to national and international networks, such as ARPANET, Telenet, and Tymnet, will considerably broaden the services available. However, some users will need to access computers that allow dial-up access but are not available through one of the larger networks. To provide easy access to these services, the network should provide a dial-out capability executable on one or more network computers. Two important applications for dial-out are

- users can access online databases through service bureaus and cooperating institutions that permit dial-up access, and
- users can purchase time on computers outside the local network for special applications that cannot be handled locally.

By providing dial-out capability, the kinds of services requiring local support could be limited to what is manageable without denying users specialized services or services needed for only a limited time.

Supercomputer Capability

We expect Class VI computers--20 to 60 million floating point operations per second (MFLOPS)--to be used at Los Alamos throughout the decade. We expect Class VII computers (60 to 200 MFLOPS) to be installed at Los Alamos about the middle of the decade. We do not expect to have Class VIII computers (greater than 200 MFLOPS) installed until the next decade. The Class VII computers will require high network bandwidth for the file-transport section of the ICN, and they will also affect the terminal-access section of the ICN, particularly for high-speed graphics files. It will be necessary to upgrade the network transmission capabilities of both CTSS and LTSS to provide the transmission rates needed by users.

Functional Requirements

The Committee sees a substantial growth in diversity of functions that the network must support. We believe the single most important requirement for the network in this decade is flexibility. The network must accommodate a variety of computers and a variety of operating systems, including commercial systems. It must accommodate communication with external networks, and it must be possible to make all of these connections relatively fast. This implies such things as transparent data and flow control.

A second important criterion for the network of the 1980s is efficiency. We see a need for a hierarchy of bandwidths with throughput commensurate with line speed. Particular attention must be paid to high-speed graphics. User equipment should be able to access any node in the ICN through a single physical connection, and the user interface should have some degree of extensibility.

A third criterion is reliability. The network should be self-diagnosing and robust with respect to failure. It should provide appropriate status and performance measurement data. It must provide appropriate accounting information and security. At the same time, security must not be an obstacle to computing; for example, our current Protected Outlet Boxes are an impediment to human productivity.

For the long term, the ICN should become a switched digital data network. This implies the ability to transmit many forms of data, including voice and video. It may also imply a conceptual model of the ICN with respect to specific functions and even the composite of network functions.

2.7 C-DIVISION EXTERNAL COOPERATION ACTIVITIES

C Division collaborates with several organizations external to the Laboratory, including the following.

ACC. The DOE Advanced Computing Committee is chartered by the DOE Office of ADP Management to recommend actions needed to advance the interests of users of supercomputers. Their primary task thus far has been the definition of a DOE Fortran.

AESOP. The DOE Association for Energy, Systems, Operations and Programming is chartered by DOE Headquarters as a vehicle for the exchange of information between DOE and DOE-contractor computing centers. AESOP meets once each year.

ANSI. The American National Standards Institute has several committees working on standards of interest to the Laboratory. C-Division people work with the following committees: X3 (Information Systems), X3H1 (Operating Systems Command and Response Language), X3H3 (Computer Graphics), X3J3 (Fortran), and X3T9 (Computer Hardware Interface Standards).

Computer User Groups. Several vendors of computer systems sponsor user organizations, and C-Division personnel participate in the meetings of user groups for Control Data Corporation (VIM), Cray Research (CUG), Digital Equipment Corporation (DECUS), IBM (SHARE), and Integrated Software Systems Corporation (DISSPLA Users Group).

DOE Graphics Forum. Personnel from DOE contractor sites who work with computer graphics meet once each year to exchange information and software for graphics systems; Los Alamos is a regular exporter of graphics software through the Forum.

Professional Societies. C-Division employees participate extensively in professional societies, including the American Mathematical Society, Association for Computing Machinery, the Institute of Electrical and Electronics Engineers, the Society for Industrial and Applied Mathematics, the Society for Technical Communication, and the International Word Processing Association.

SCIE. The Scientific Computing Information Exchange is a group of DOE contractors whose computing is largely scientific. This group meets in conjunction with the AESOP meetings and holds separate topical meetings on an ad hoc basis.

SLATEC. The Sandia, Los Alamos, Air Force Weapons Lab Technical Exchange Committee meets three times a year to exchange information on plans and problems. During the past year, this committee was expanded to include the Lawrence Livermore National Laboratory Computing Center, the Magnetic Fusion Energy Computing Center, and Sandia National Laboratories Livermore computing center.

3 CONTINUING PROJECTS

The Integrated Computing Network is a complex interconnection of computing resources, including worker computers that execute user codes, communication computers that enable users to access the worker computers and other ICN services, the Common File System, the Print and Graphics Express Station and the Extended Network Access System. The network also includes many communications resources, such as concentrator computers, message switches, file-transport switches, the network status machine, and the network security controller. Figure 4 shows the major units that make up the ICN; Fig. 5 provides a more detailed view. In this chapter we discuss our equipment, activities, and plans for the ICN units.

3.1 EQUIPMENT

3.1.1 FY 1981

Equipment additions in FY 1981 having purchase values in excess of $100k were the upgrade of Cray-1 Machine W to a 2-million-word system; two high-speed printers to provide printed output through PAGES; the processor that will serve as the FOCUS controller; a second Distributed Processor for C-Division support activities; and a replacement alphanumeric microfiche recorder that, unlike the older unit, will be connected to PAGES.

Other new acquisitions included communications controllers and equipment; memories and peripherals for the processors that provide the switch, data transmission, and control functions for the network; and hardware for prototyping the new CBT-2 series of intelligent terminals.

Because Cray-1 Machines V and W were operating at saturation and because the arrival of a 4-million-word Cray was still many months away, the need of the Weapons Program for additional Class VI computing capacity to prepare for a higher level of test activities in 1982 was accommodated by an arrangement whereby time was purchased as needed on a Cray-owned system (Machine X) installed in the CCF and connected as an ICN worker.

3.1.2 FY 1982

Included in C Division's requests for funding in FY 1982 by the Weapons Program and by the Laboratory's General Indirect and Recharge Equipment Committee are

- a 2-million-word Cray-1 system (Machine Y) delivered in October 1981;
- the upgrade of the Common File System, including more capacity for the IBM 3850 mass storage system and the disk file subsystem, and replacement of the obsolescent IBM 370/148 backup controller with an IBM 4341;
- an "electronic swapping system," a term applied to storage equipment needed for Class VI computers to provide several times the transfer rate

of conventional moving-head disk files in the swapping of jobs between active execution in main memory and secondary storage;

- network switching systems including (1) packet switch equipment to provide general interconnectability between the CBT-2 series of intelligent terminals as well as access to the CCF, (2) a terminal circuit switch to serve as a cross-bar between ICN terminals and the various CCF ports, and (3) components for a prototype network switch, which will eventually replace the existing file transport machines;
- new graphics output devices for PAGES;
- a back-up FOCUS controller; and
- initial production hardware for AIDS.

3.1.3 FY 1983

Included in the Laboratory's Weapons Program budget submission for FY 1983 are

- a fourth Cray-1 system, Machine Z, with four million words of memory, scheduled to be installed in November 1982;
- the first phase of a Los Alamos CAD/CAM facility; and
- an administrative computer.

3.1.4 FY 1984 through FY 1987

Table I reflects major ADP acquisitions through FY 1987 as projected in the Laboratory's budget submission to the Weapons Program and its input to the DOE ADP and Data Communications Long-Range Plan.

Table I
MAJOR ADP LEASES AND PURCHASES

		FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88
CRAY-1 (2nd)	PURCHASE (LEASE)	(2900)	7500 (500)					
CRAY-1 (3rd)	(LEASE)	(2600)	(3400)	(3400)	(3400)	(3400)	(600)	
CRAY-1 (4th)	(LEASE)		(3200)	(3200)	(3200)	(3200)	(3200)	
CLASS VII COMPUTER (1st)	PURCHASE (LEASE)				(2300)	(4500)	13500 (1100)	
CLASS VII COMPUTER (2nd)	(LEASE)						(2300)	(4500)
ADMINISTRATIVE COMPUTER	PURCHASE (LEASE)		(185)	(370)	710 (95)			
MASS STORAGE UPGRADE (1st)	PURCHASE (LEASE)	500 (110)	290 (40)					
MASS STORAGE UPGRADE (2nd)	PURCHASE			1600				
MASS STORAGE UPGRADE (3rd)	PURCHASE					3000		
MASS STORAGE UPGRADE (4th)	PURCHASE							1300
ELECTRONIC SWAPPING SYSTEM	PURCHASE (LEASE)	(40)	410 (40)					
OUTPUT STATION UPGRADE (1st)	PURCHASE				1500			
OUTPUT STATION UPGRADE (2nd)	PURCHASE							1500
PERIPHERAL STATION	PURCHASE			1000				
CAD/CAM FACILITY *Construction Funds	PURCHASE			6000*	7000*	7000*		

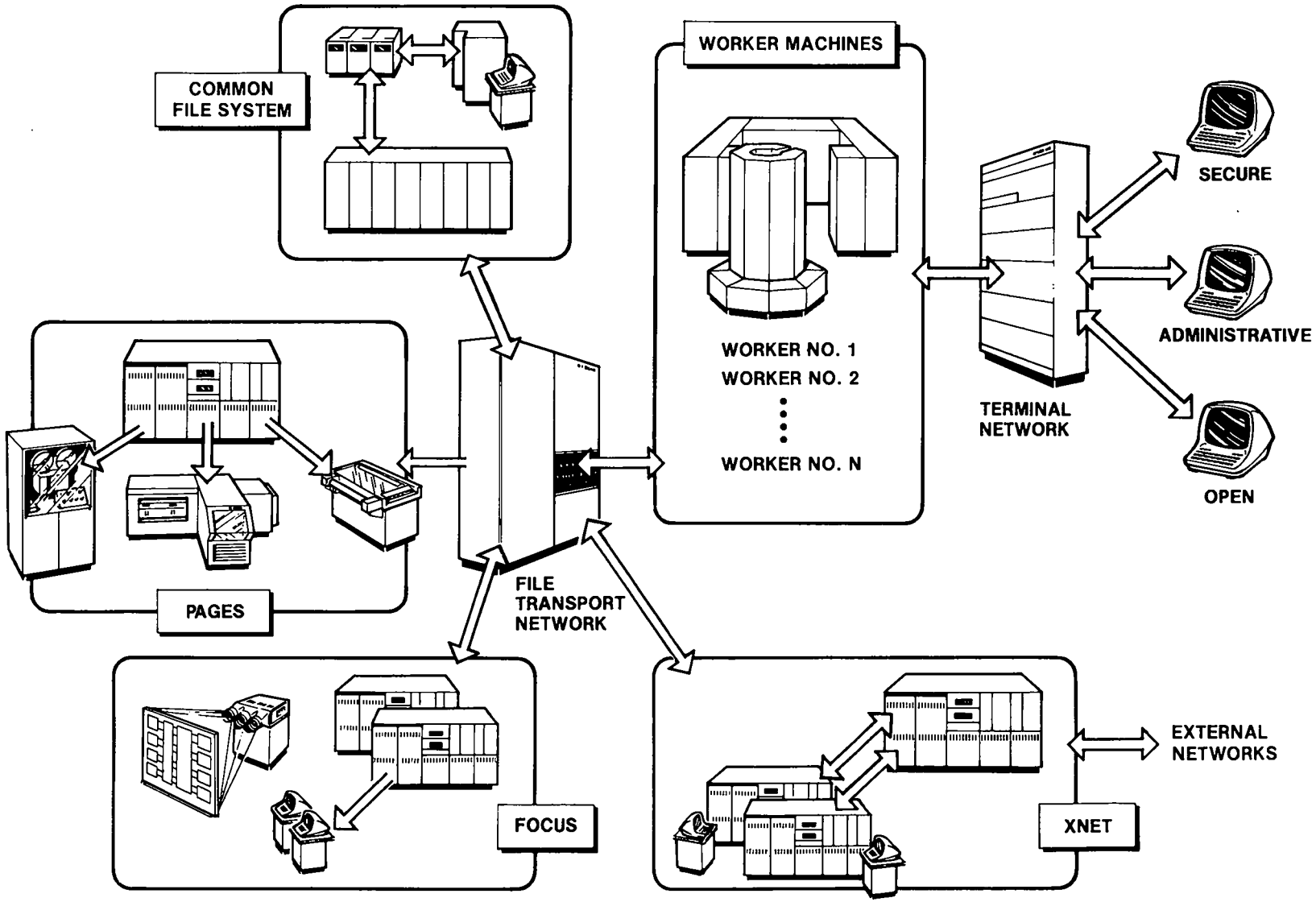


Fig. 4. Simplified ICN configuration.

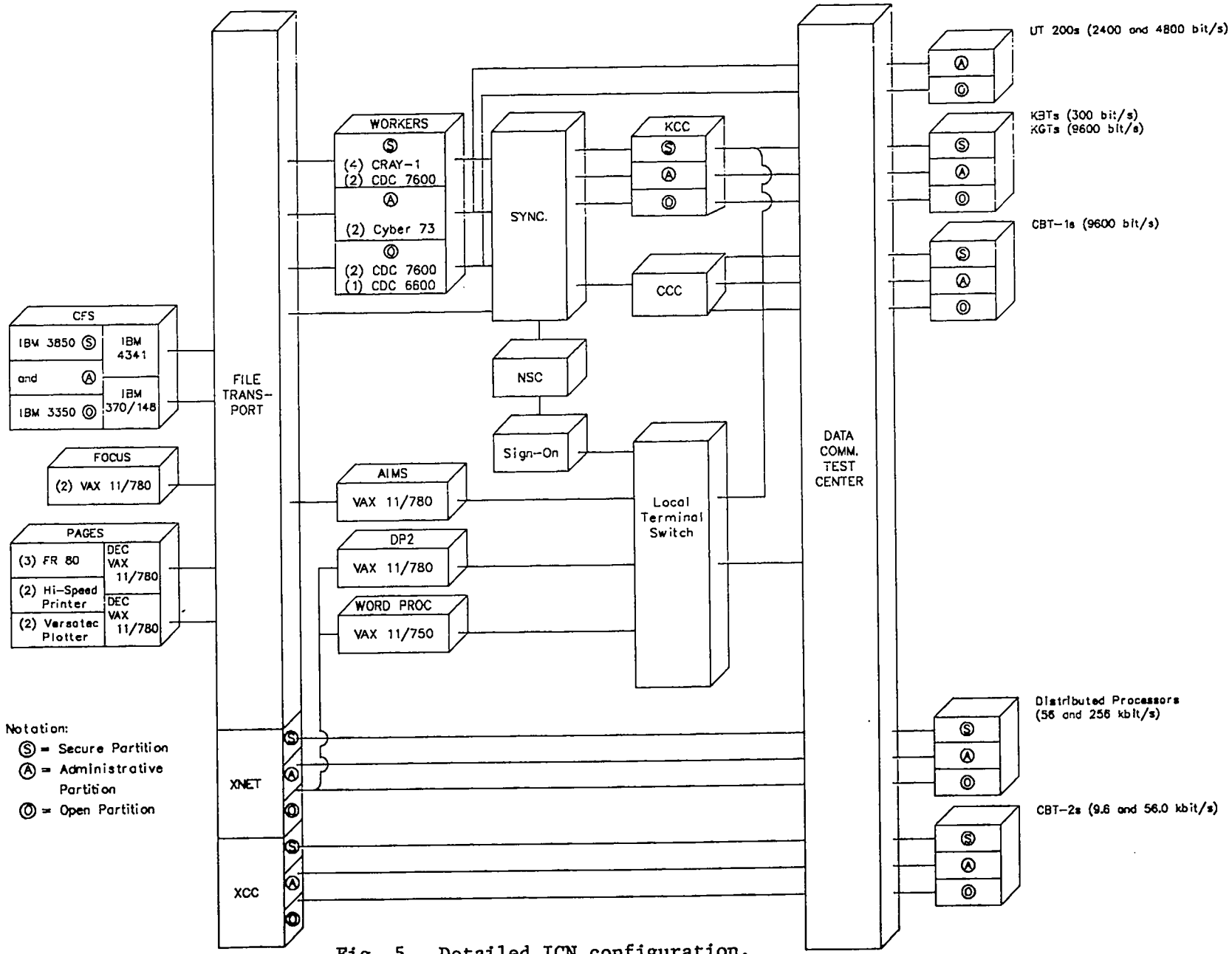


Fig. 5. Detailed ICN configuration.

3.2 TERMINALS

3.2.1 Existing Standard Terminals

During FY 1982 we will define new sets of standard ICN terminals as required to meet changing user requirements and to take advantage of newer technologies. Existing standard terminals are as follows.

KBT - Keyboard Terminal. The Texas Instruments hardcopy terminal family, currently operable up to 1200 bit/s, and including portable models for dial-up use and units with tape cassettes for data storage.

KCT - Keyboard CRT Terminal. The Digital Equipment Corporation VT-100 family of alphanumeric video terminals operable up to 9600 bit/s. This terminal became the standard KCT terminal in FY 1981. A graphics option is available for the VT-100 that allows it to emulate a Tektronix 401x terminal.

KGT - Keyboard Graphics Terminal. The Tektronix 401x family of monochromatic graphics terminals and associated hardcopy devices and the AED-512 color graphics terminal, which became an ICN standard terminal in FY 1981.

KTT - Keyboard Typewriter Terminal. The Data Terminals and Communications DTC-300 terminal that have as their primary attribute the capability of producing high-quality printed output.

CBT-1 - Computer-Based Terminal. This is a remote job entry station based on a DEC PDP-11 configuration.

3.2.2 Computer-Based Terminals

Large-scale integration technology has made possible desk-top, "personal" computers. The mass market for these devices has resulted in low-cost hardware. It is also producing a broad spectrum of quality low-cost software for applications such as engineering and financial analysis. C Division anticipates accelerating use of these devices for functions that are not readily obtainable from CCF workers and has initiated a project to provide the necessary hardware and software for network communication. The project involves installation and experimentation with two prototype personal computers that can operate either in a standalone mode or as an adjunct to the ICN. Because we already have one type of computer-based terminal (a remote job entry and print station), we refer to these devices as CBT-2s.

Objective

Our objective is to connect CBT-2s to the ICN to access the resources of the CCF. Providing the requisite hardware and software requires careful planning because of the variety of available CBT-2 hardware and operating systems. To keep the task manageable, we will select standard communication protocols, and C-Division software will use a common interface to the vendor operating system obtained by implementing subsets of the Software Tools. This will enable us to develop our software so that it is transportable, maintainable, and reasonably efficient.

We must devise techniques for connecting a large number of CBT-2s to the ICN. We also must implement the necessary communication protocols and utilities that CBT-2 owners are likely to need; for example, file transport to and from the Common File System, graphical output to PAGES, and terminal passthrough to worker computers.

C Division recognizes that users may require CBT-2s other than those defined as standard terminals. To accommodate this need, levels of support for CBT-2s have been defined. The Level-1 CBT-2 will be supported as a standard terminal. Levels 2 and 3 will allow for user implementations. We intend to support at least one Level-1 CBT-2 by February 1983.

Prototype CBT-2s

For prototype CBT-2s we have chosen the Apollo from Apollo Computer Corporation and a locally configured CBT-2 based on the Digital Equipment Corporation LSI-11/23. The Apollo was chosen because it has a large virtual address space and a network operating system. The LSI-11/23 was chosen because much compatible equipment is already in use at Los Alamos. To assess their potential for distributing scientific computations, we will investigate their performance on editing, compiling, graphics, and floating point computation. We have chosen the X.25 protocol for use with the two prototypes. Because we have no direct experience with X.25 at Los Alamos, the effective throughput that can be obtained as a function of bandwidth must be evaluated to see if X.25 can meet both short- and long-term requirements.

Portability and Maintenance

To achieve portability and maintainability of our software, we will implement it on top of the Software Tools. A critical issue is the overall efficiency of the software when implemented on top of these tools.

Connectivity

To enable connection of many CBT-2s to the ICN, we will explore concentrators that support transmission rates from 9600 to 56,000 bit/s, and possibly high-bandwidth, bus technology. Communication with the ICN will be through the file transport part of the ICN.

A design goal of the file transport network is to enable source and destination machines to operate at their own channel speeds. To handle a mismatch of data rates between the CBT-2s and the file transport, we will develop a new communications concentrator for CBT-2s called an XCC. The XCC will be implemented on a VAX-11/780 computer connected to the file transport as shown in Fig. 5. We will use the standard C-Division protocols to communicate between the ICN and the XCC. The X.25 protocol will be used for low-level communication between the XCC and CBT-2s.

To implement high-level ICN protocols before the XCC is operational, an interim communications capability will be developed. Subsequent to operation of the XCC, we will procure data communication hardware to multiplex many CBT-2s onto the XCC.

XCC Software

The communication functions to be supported by the XCC will initially be the same as those for XNET access machines, namely, file shipping, job submission, and terminal passthrough. Thus we will take the software for the XNET access machines, modify it to accept X.25, and integrate it with software to support CBT-1s. Our schedule for implementing the XCC depends upon timely availability of X.25 by vendors.

Communication Utilities

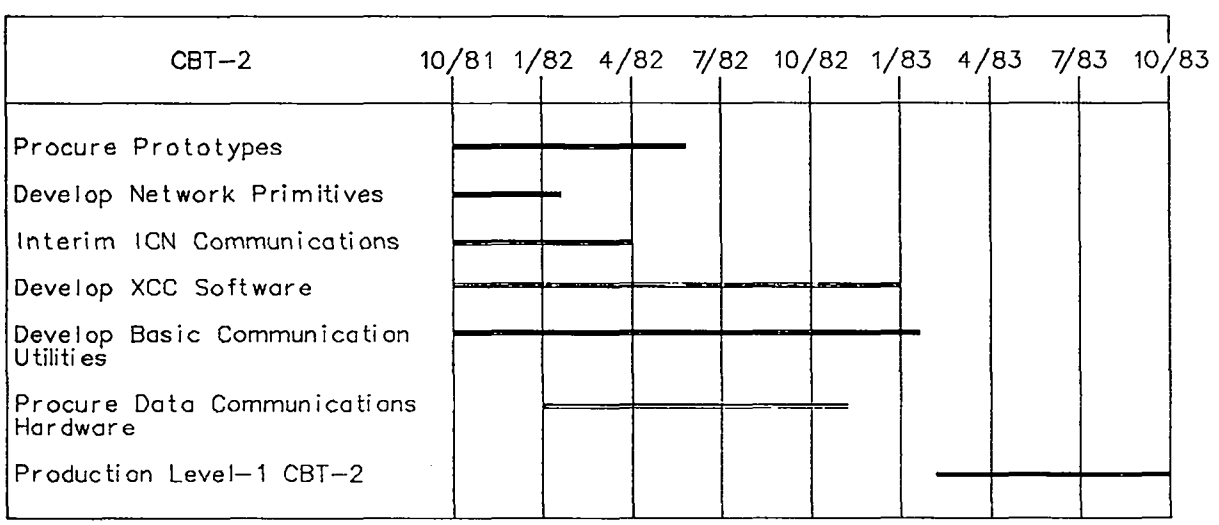
We are investigating strategies that will provide the functionality of existing communications utilities (such as MASS and MAGIC) without excessively burdening the limited resources of CBT-2s. This may require a substantial effort. By February 1, 1983, we will provide communications access to the ICN workers and facilities such as CFS and PAGES.

Security

CBT-2s initially will be limited to use in the Open partition. Experience gained in this partition will help us identify and resolve security issues.

Summary

Critical issues for CBT-2s include communications protocols, efficiency, software portability and maintainability, and connectivity. The primary thrust of this project is to explore these issues using prototype processors and communications. We plan to offer full support to at least one CBT-2 by February 1983. However, because the associated technology and marketplace are changing rapidly, and as a consequence of what we learn from prototyping, our plans may change rapidly.



Schedule 1. CBT-2s.

3.3 TERMINAL NETWORK

The terminal network consists of terminals; ports; communication lines; concentrators; ICN terminal switches, which switch messages between the concentrators and the worker computers; the Network Security Controller, which checks the security authorization of requested services; and the Network Status Machine, which monitors and displays the status of the network nodes.

3.3.1 Terminals and Ports

User terminals are connected to the ICN through ports. During FY 1982 we plan to increase the number of ports available to the user. We also plan to upgrade existing ports to allow more flexibility to the user in the area of port speeds. C-Division's plans for port availability on the network are summarized in Table II.

Currently, 48 300-bit/s ports and 16 1200-bit/s ports provide dial-up terminal access to the Open partition of the ICN. The 300-bit/s ports are heavily used, and use of the 1200-bit/s ports is expected to increase rapidly as users receive the many new terminals and modems that are on order. We will monitor the use of these ports and install additional ports as required.

TABLE II

USER PORT AVAILABILITY PLANS FOR THE ICN

Type of Port[a]	Number of Ports Available 10/1/81	Number of Ports Available 10/1/82	Difference in Number of Available Ports
Secure/Classified			
300 bit/s	219	152	- 67
9600 bit/s	120	264	+144
150 kbit/s	12	24	+ 12
Secure/Unclassified			
300 bit/s	292	304	+ 12
9600 bit/s	120	188	+ 68
Administrative			
300 bits	180	150	- 30
9600 bit/s	30	60	+ 30
Open			
300 bit/s	280	352	+ 72
9600 bit/s	99	140	+ 41
Total			
300 bit/s	971	958	- 13
9600 bit/s	364	652	+283
150 kbit/s	12	24	+ 12

[a]The port data rate is the output data rate limit. The actual port data rate may be lower because of terminal limitations.

3.3.2 Concentrators

For greater efficiency, many ports share a single communication line to the worker computers through the use of a "concentrator." Each type of concentrator is discussed below.

Keyboard Communication Concentrators (KCCs). Each KCC provides ports for 73 300-bit/s terminals and 30 9600-bit/s terminals. During FY 1982, C Division will be able to convert ports to support higher speed KBTs. A study will be initiated to determine if the number of ports per KCC can be increased. If this proves feasible, the existing KCCs will be upgraded as resources become available.

CBT Communication Concentrators (CCCs). The CCCs serve CBTs. C Division plans to continue to provide CBT services for the foreseeable future.

Extended Communications Concentrator (XCC). The XCC is a follow-on subsystem that is being developed to support CBTs. For further information, see Sec. 3.2.2.

Keyboard Graphics Concentrators (KGCs). The KGCs are designed to serve a small number of high-speed Tektronix terminals. The KGC is limited to 12 high-speed Tektronix ports, and at present the memory buffers in the KGCs are limited to 990 bytes. A 6-month experiment began in October 1981 to examine the throughput variation caused by increasing the KGC buffer space by using a nonrotating secondary storage media. The experiment will provide data necessary to determine if the buffer expansion is cost effective. If the experiment is successful, money for FY 1983 purchase of additional solid-state disks will be requested.

3.3.3 Terminal Control

The terminal control portion of the ICN consists of KCCs, switches, and the Network Security Controller. The KCCs will be upgraded during FY 1982 with the replacement of obsolete communication multiplexers and the addition of more multiplexers on each KCC. The new multiplexing equipment will permit each KCC to serve more users and will permit upgrading more low-speed ports to medium-speed ports. Upgrading the KCCs with new multiplexers and new software will permit the addition of automatic port selection equipment.

A major activity during FY 1982 will be the investigation of the possible elimination of the split-speed requirements for input/output rates (300/9600 bit/s). If the investigation indicates feasibility, the split-speed requirement will be eliminated in favor of identical input/output speed. The recommended standard speeds will be 300/300 and 9600/9600 bit/s.

The new VT-100 and AED-512 terminals have intelligent controllers that require flow control software. Flow control will be implemented in FY 1982 in the KCCs to provide correct data flow to these terminals. In addition, the design of new concentrator software will be completed in FY 1982 that will provide a conversational mode between the terminal and concentrator. The conversational mode will allow terminal characteristics to be identified so that a wider variety of terminals can be served.

3.3.4 Local Terminal Switch

During FY 1982, we plan to acquire and install a Local Terminal Switch. The proposed switch will be initially configured to provide transparent access to several computer systems by any one of approximately 200 terminals. Most of the terminals will run at 9600 bit/s with a small number running at 300 bit/s. Before accessing the ICN computers, users will be authenticated through the Network Security Controller. As we gain experience with this new type of switch and if it works satisfactorily, this type of device may well supplement the KCCs in future years.

3.4 WORKER COMPUTERS

The ICN now contains 11 worker computers, all of which are accessible in interactive mode. Table III summarizes the general characteristics of each type of computer system.

TABLE III

WORKER COMPUTERS AT LOS ALAMOS

Quantity	Type	Relative Power	Memory Size (M words)	Operating System	Fortran Compiler	Machine Designation
1	CRI Cray-1	4	2	CTSS	CFT	W
1	CRI Cray-1	4	2[a]	CTSS	CFT	Y
2	CRI Cray-1	4	1	CTSS	CFT	V,X
4	CDC 7600	1	0.577	LTSS	FTN (LTSS)	R,S,T,U
1	CDC 6600	0.2	0.131	NOS	FTN	M
1	CDC Cyber 73	0.1	0.131	NOS	FTN	N
1	CDC Cyber 73	0.1	0.065	NOS	FTN	L

[a]Scheduled to be upgraded to four million words.

In FY 1981, the memory capacity of Cray-1 Machine W was upgraded to 2 million words, and we installed Machine X, which is rented from Cray Research on an as-needed basis for the Weapons Program. We also received approval to acquire two more Cray-1s. The third Cray-1, Machine Y, was installed in October 1981 as a 2-million-word system. Plans call for upgrading it to a 4-million-word system during March 1982. The fourth Cray-1, Machine Z, with four million words of memory is scheduled to be installed in November 1982. The major peripherals attached to the worker computers are shown in Table IV.

TABLE IV

WORKER COMPUTER PERIPHERALS

Machine	Disks	Total Disk Capacity (M words)	Tapes	Printers
CRI Cray-1 (V)	16 DD 19 Disks 4 DCU-2 Controllers	595 (64 bit)	None	None
CRI Cray-1 (X)	16 DD 19 Disks 4 DCU-2 Controllers	595 (64 bit)	None	None
CRI Cray-1 (W)	8 DD 29 Disks 2 DCU-3 Controllers	600 (64 bit)	None	None
CRI Cray-1 (Y)	8 DD 29 Disks 2 DCU-3 Controllers	600 (64 bit)	None	None
CDC 7600 (U)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	1 CDC 580
CDC 7600 (T)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	1 CDC 580
CDC 7600 (S)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	1 CDC 580
CDC 7600 (R)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	1 CDC 580
CDC Cyber 73 (L)[a]	5 844 Disks 1 7154 Controller 1 7054 Controller	-	2 CDC 669 2 CDC 667	1 CDC 580
CDC Cyber 73 (N)[a]	17 844 Disks 1 7154 Controller 4 7054 Controllers	198 (60 bit)	2 CDC 677 6 CDC 679	1 CDC 580
CDC 6600 (M)	6 844 Disks 11 844 Dual-Density Disks 3 7154 Controllers 3 7054 Controllers	231 (60 bit)	2 CDC 677 6 CDC 679	2 CDC 580

[a]In addition, Machines L and N share seven 844 disks and four 844 dual-density disks.

3.5 FILE TRANSPORT NETWORK

The file transport network handles the large data-block transfers in the local network environment, and allows users to ship files between worker computers, the Common File System, XNET, and the XNET switches.

3.5.1 File Transports

The data in the file transport network are characterized by several small control messages followed by large (25-kbyte) data blocks. To support this traffic we use file transports (FTs) containing large memory for transient data and many high-speed channels. To be effective, the FTs must match the

worker-computer channel speeds or a bottleneck may develop that would cause the workers to go idle.

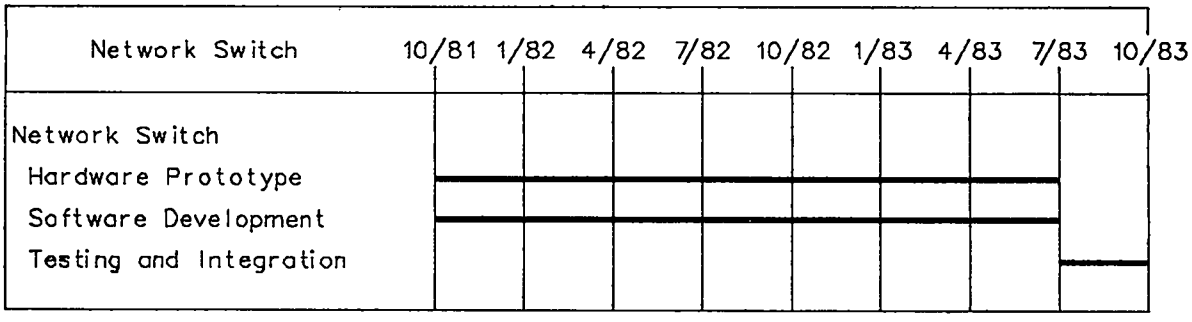
By June 1982 we will add a fifth file transport that will provide additional ports to the file transport network to support more worker computers and services. To connect workers to the file transport network, we are developing a standard communications interface (the High-Speed Parallel Interface, HSPI) capable of operation at speeds up to 50 Mbit/s. We have already developed and are currently running HSPIs for connections to the IBM 370/148 and IBM 4341, VAX and PDP-11 family, FR-80s, SEL 32/55s, and Cray-1s. In FY 1982 we will be putting the CDC 7600 HSPIs into production and will be developing an HSPI for the CDC 6600 and Cyber computers. The HSPIs will provide the users with faster file transport time and more reliable operations.

3.5.2 Network Switch

In FY 1982 and 1983 we will be developing a replacement for the file transport computers, the network switch. This switch will provide users error-free transfer of files between the growing number of worker computers. The network switch is an evolutionary, rather than revolutionary, step for the ICN. It is designed to increase the number of connections and improve capability with minimal impact on current operations. As in the file transports, the network switch will be implemented using store-and-forward message switching. The network switch will use high-speed full-duplex paths to a central memory with attached minicomputers providing message routing and error control. Extensive error-correction and maintenance functions are included. Modularity and standardization provide easy phase-in of the new hardware and potential for future growth.

The network switch will provide the same functions as the file transport. In addition, it will

- increase ICN connectivity for future expansion;
- improve data integrity with data-transmission error detection and correction;
- provide new features for performance measurements, error, and security logging, status displays, and dynamic control; and
- provide a hardware/software system that is easy to diagnose, maintain, and modify.



Schedule 2. Network switch.

3.6 COMMON FILE SYSTEM

The Common File System (CFS) is a large online centralized storage system for the ICN. It has two controllers, an IBM 4341 and an IBM 370/148. The storage devices are an IBM 3850 mass storage system of about 2.7 trillion bits and an IBM 3350 disk system of approximately 50 billion bits. IBM 3850 cartridges are taken offline to provide archival storage. The CFS is organized as a hierarchical storage system. Active files are stored on disk, less active and large files are stored on the IBM 3850, and archival files are stored offline. Files are moved between these classes of storage by a migration program that analyzes file activity. The result is a cost-effective system that provides both fast access and large data storage capacity.

3.6.1 CFS Performance

The following usage metrics show CFS activity.

- June 1, 1979
  Began using CFS
- October 1, 1980
  2.6 trillion bits stored
  250,000 files
- October 1, 1981
  4.7 trillion bits stored
  450,000 files
- Current Yearly Growth
  2.5 trillion bits
  240,000 files
- Daily Activity
  12,000 file accesses
  60 billion bits data transferred
  1000 file deletions
  3000 LISTs
  100 MODIFYs
- 50% of files are less than 1/2 million bits
- Size of average stored file: 9.3 million bits
- Size of average access file: 5 million bits

In October 1981, CFS contained over 450,000 files, which represented 4.7 trillion bits of data; 80% of this data was stored offline. Of the 12,000 file accesses per day, about 85% are to disk, whereas only about 1% are to offline storage (see Table V).

TABLE V

CFS STORAGE HIERARCHY

Type of Storage	Percentage of Total Information Stored	Percentage of Total Files Accessed	Typical Response Time
Disk	1	85	5 seconds
Mass Storage System	19	14	1 minute
Offline	80	1	5 minutes

3.6.2 Hardware Projects

The following projects are scheduled for FY 1982.

Large Disk System. We plan to add an IBM 3380 disk to the CFS storage system. This will improve file-access response for users by storing a greater percentage of the active files on disk.

Control System Upgrade. We plan to replace the obsolete IBM 370/148 control processor with an IBM 4341. Then both IBM 4341 control processors will be upgraded from Model 1 to Model 2.

3.6.3 Software Projects

Most of the systems work on CFS is dedicated to maintaining reliability and improving performance and uptime. The software projects planned for CFS are given below.

Maintenance and Support. We maintain the IBM operating system, the MASS Storage System software, and our locally developed software. Our support activities include system and data recovery, space management, and operations support.

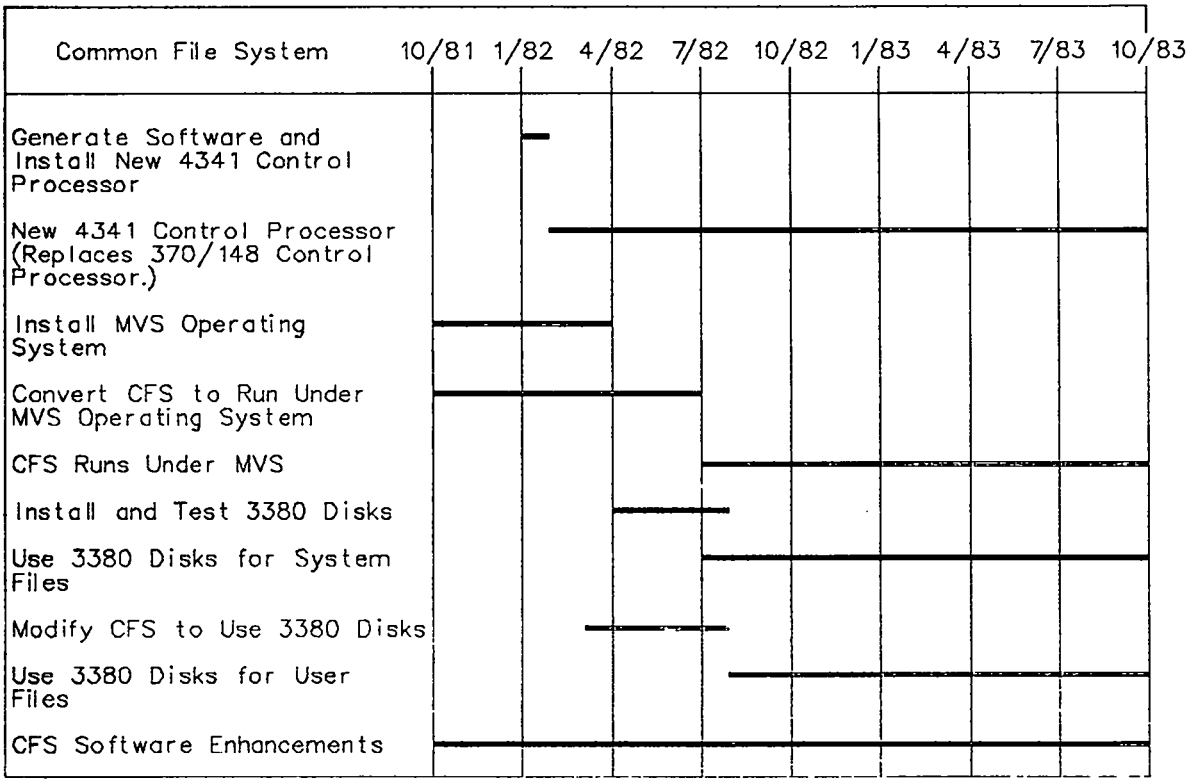
CFS Software Enchancements. We will continue to improve CFS performance, the file transport mechanism, and file migration. As resources permit, new user functions and features will be implemented.

Multiple Virtual System (MVS) Operating System. We plan to install the IBM MVS operating system and convert the CFS software to run under MVS. The IBM VS1 operating system (which CFS now uses) does not support the newer IBM storage system hardware and software. We anticipate that IBM will phase out VS1. This change will not require any user changes and will not result in disruption of services.

3.7 PRINT AND GRAPHICS EXPRESS STATION

The function of the Print and Graphics Express Station (PAGES) is to provide a centralized location for all ICN-generated passive output. In addition to the obvious benefits of sharing output resources, this centralization allows the quality of output to be monitored more closely than would be possible otherwise. Figure 6 shows the quantity of output generated by ICN users.

The quantity of user output on PAGES has continued to increase this past year. PAGES now routinely processes over one billion bytes of user data every day. This load is expected to double during FY 1982 because of the increased number of computers and users as well as the additional print capability provided by the laser printers.



Schedule 3. Common File System.

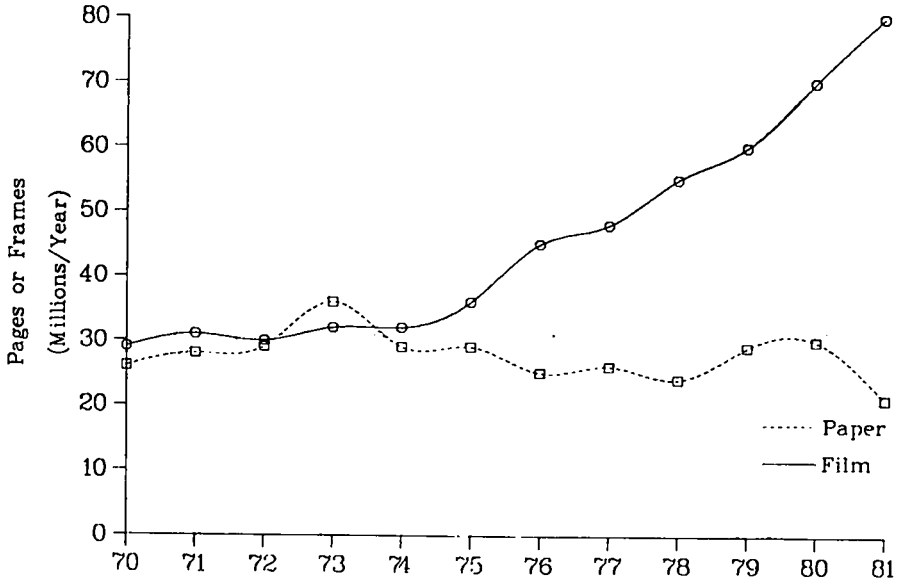


Fig. 6. Computer output at Los Alamos.

3.7.1 Hardware and Output

The output devices used by PAGES include three FR-80 film recorders, two Versatec electrostatic plotters, and two XEROX 9700 laser printers. These devices are currently generating the following types of output.

Film	Paper
16-mm color	11-inch roll (electrostatic)
35-mm color, black and white	36-inch roll (electrostatic)
105-mm (microfiche) black and white	36-inch vellum (electrostatic)
	8 1/2- by 11-inch bond (xerographic)

An additional film recorder will be installed in February 1982 and will go into production in June 1982.

We are constantly monitoring the market for graphics output devices that can provide needed services as recommended by the CUP committee. Some examples are given below.

High-Quality Black-and-White Hardcopy. We are evaluating possible devices for copying directly from 16- and 35-mm black-and-white film to 8 1/2- by 11-inch paper. We are also investigating alternative ways to generate high-quality hardcopy.

Video Disk. The necessary devices (reasonably priced recorders) are not currently available but should become available in a very few years. We are formulating plans to include this new medium so that users may take advantage of its unique capabilities.

Large-Format Color Camera. Large-format color cameras are on the market and we have requested funds to purchase one.

Plotters. We have also requested funds to purchase new plotters and are evaluating various models. We continue to interact with the user community on requirements for this output.

Color Fiche. This medium is not currently available, but it has been demonstrated in prototype form. We expect that color fiche will be a popular medium when it becomes available.

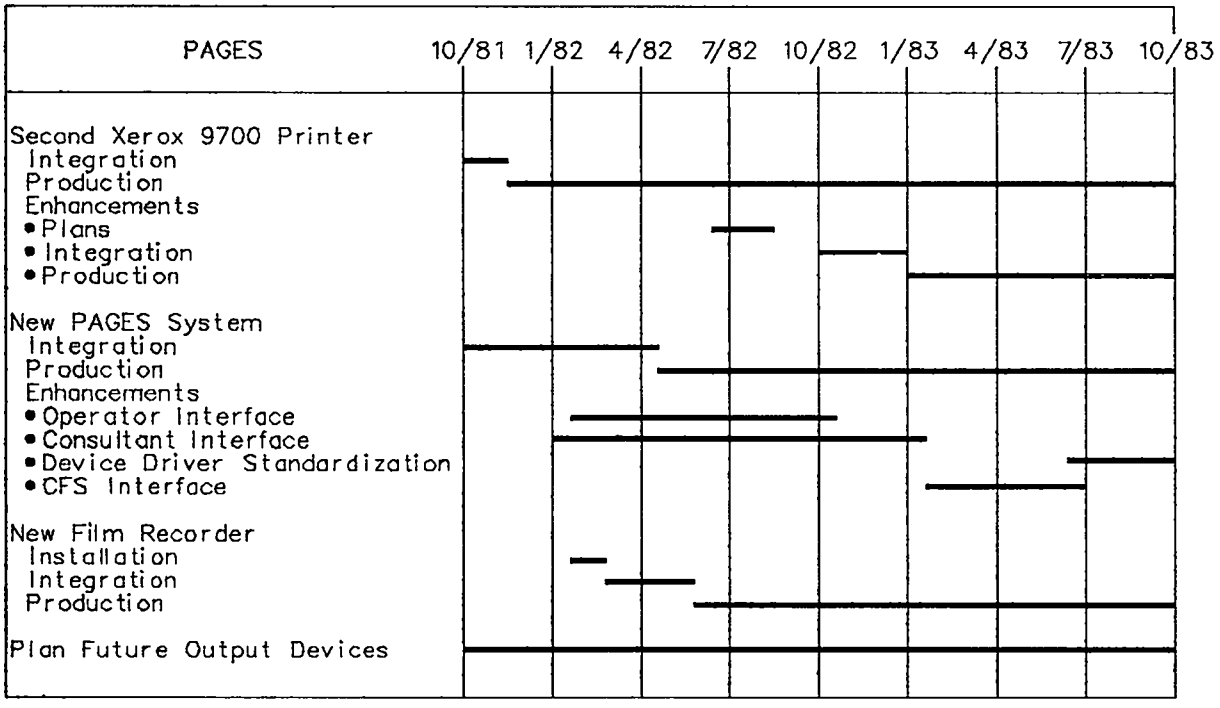
Other devices include pen plotters and large-format film recorders (some of our users have expressed a need for higher resolution output for use in manufacturing micro electronic parts).

3.7.2 Software Projects

The current PAGES system has not proven tolerant of various needed enhancements and has required more maintenance than we desire. For these reasons, an upgraded, much simplified, PAGES system will be introduced in FY 1982. This new system will provide the same user services that are currently available. It will not require any user changes and will not result in any disruption of services.

One of the primary enhancements of this new system will be a more complete and easy-to-use operator interface with quality control and distribution as integral functions. Although the average quality this past year has been good, FY 1982 will see a large effort to define and automate a more complete set of quality control procedures. These procedures will ensure a uniform high level of output. A special interface will allow consultants to answer user questions quickly and more completely than is now possible.

A large effort will be put into Xerox printer enhancements beginning in May 1982. Our goal will be to provide a consistent and easy-to-use interface for the user. Such things as single-sided printing, unpunched paper, and portrait formats will be available by December 1982.



Schedule 4. Print and Graphics Express Station (PAGES).

3.8 EXTENDED NETWORK ACCESS SYSTEM

In the 1980s distribution of functions throughout the network is likely to become the hallmark of computing at Los Alamos. The Los Alamos Extended Access Network (XNET) provides access to ICN services from remote computers (Distributed Processors) in the Laboratory. This project began in 1979 and is defined in "Development Plan for XNET and Extended Network Access Systems," Network Engineering Group, Computer Science and Services Division, July 1979. Functionally, the objective of the project is to provide file shipping, job submission, and terminal passthrough between remote computers and the ICN.

Terminal passthrough will enable a terminal that is physically attached to a remote computer to be used for interaction with the Central Computing Facility worker computers. We are pressing to complete this portion of the project by April 1982. By that time, we will have provided the functionality promised and will begin enhancement and maintenance of it.

This system is now reaching maturity with our major effort being directed toward supporting terminal passthrough from/to the remote sites to/from the ICN workers. By October 1981 more than 20 Distributed Processors were ordered or installed at Los Alamos. At present all Distributed Processors are VAX computers running the VMS operating system. This distribution of computing is tantamount to an extension of the present CCF. Thus, our objectives for XNET include policy, procurement and installation, security, functionality, reliability, efficiency, and recharge.

3.8.1 Policy

The VAX/VMS Local Users Group (LUG) and C Division have agreed to the following policies for XNET.

- We will make minimum changes to VMS.
- All Distributed Processor sites will use the same version of VMS. Schedules for changing to new versions will be mutually determined.
- C Division will guarantee XNET operation only for Distributed Processor sites using C-Division/LUG specified versions of VMS and DECnet.
- C Division will provide and support core libraries that are CCF compatible.
- C Division will subject Distributed Processor software to change control procedures.
- C Division will provide consulting, documentation, and education in support of XNET.
- C Division will collaborate with the VAX/VMS user group.

In addition to the above and because C Division's resources are limited, we must develop a policy for approving new types of computers for use as Distributed Processors and a procedure to determine what level of support to give approved equipment.

3.8.2 Procurement and Installation

Although acquisition of Distributed Processors is proceeding steadily, there have been instances of confusion about the division of responsibility between C Division and the Distributed Processor owner. Thus C Division and the LUG are developing a Distributed Processor System Manager's Guide detailing the steps necessary for purchase, site preparation, installation, and operation of a Distributed Processor.

3.8.3 Security

XNET is subject to security partitioning with each Distributed Processor connected to only one of the security partitions. This means that Distributed Processor terminal users are limited to the ICN services available in this

partition, whereas ICN terminal users may access services in several partitions if authorized. The goal is to provide Distributed Processor terminal users with all the options of ICN terminal users. Thus, we must identify and resolve security issues involved with interpartition computing.

For security and accounting purposes, we need the ability to produce audit trails. This requires logging of all activities within each XNET partition.

3.8.4 Functionality

Distributed Processor functionality implies utilities for terminal passthrough, file shipping and job submission, a database management system, CCF compatible libraries, consulting, documentation, and education.

Terminal Passthrough

The current implementation of XNET requires Network Security Controller authentication for every transaction. This will degrade passthrough efficiency and perhaps overload the Network Security Controller. Thus, we are under way with a major renovation of XNET software to provide terminal passthrough. The renovation changes XNET from a datagram system to a path system. It requires development or alternation of 14 software modules in three C-Division groups. Our initial implementation will have the following important limitations.

- Some <CTRL-E> functions cannot be used; for example, <CTRL-E>A, B, C, D, or E is used to change suffixes, and <CTRL-E>I is used to interrupt a program.
- Operator messages cannot be sent or received.
- Response time is degraded by the load/schedule time of an additional controller.

These limitations will be removed upon completion of the KCC upgrade (Sec. 5.2.3).

The XNET development plan included a B-port capability that would enable ICN terminal users to access Distributed Processors. A prototype B-port is operational but has proven expensive and inefficient. Terminal passthrough is being implemented so that the B-port function may be available through it.

File Shipping and Job Submission

File shipping has been available since XNET became operational. The XNET software renovation for terminal passthrough will make possible job submission with a user interface identical to that on the CCF workers.

Database Management System

We have purchased the Data Retrieval System from Advanced Data Management. The system is operational and no additional capability is planned. We are

working with the vendor to obtain improved documentation and training procedures.

Utilities

The VMS utilities are discussed in Section 4.5; the graphics utilities are discussed in Section 4.6.

Graphics Libraries

The Common Graphics System (CGS) and DISSPLA libraries are available on Distributed Processors. CGS will be kept current with its worker computer counterpart.

Math Libraries

VAXMATH is operational on the Distributed Processors and will be kept current with its worker computer counterparts.

Consulting, Documentation, and Education

Two FTEs of consulting are available to users of Distributed Processors. All user-visible software supplied by C Division is documented. The VAX/VMS user group is developing a primer for using Distributed Processors, and it will be a part of the C-Division VMS New User Package. In addition, the Computing Information Center stocks DEC manuals. C Division also provides a variety of locally produced educational materials and classes, computer-aided instruction, and vendor-supplied classes (recharged).

3.8.5 Reliability

Reliability implies status information, recovery, change control, and collection of performance data.

Status Information

Status of XNET is included in the daily CCF Production Summary and on the dispatcher's monitor.

Recovery

Not available. However, this appears acceptable to users because of the high reliability of the system, namely, mean-time-to-failure is about two weeks.

Change Control

The VAX/VMS LUG agreed that Distributed Processor sites will use the latest versions of VMS as well as C-Division supplied software. Master copies of Distributed Processor software are maintained in the CFS with write access limited to change control personnel and Distributed Processor managers. Distributed Processor managers are responsible for monitoring the Change Control Bulletin and for maintaining contact with appropriate C-Division personnel.

Performance Data

The XNET Development Plan promised measurement of effective data rates, system reliability, and system availability. Crashes are documented and analyzed.

3.8.6 Efficiency

Efficiency implies high throughput, non-VAX computers in the network, and gateways.

Throughput

Installed Distributed Processor hardware and software will support 256-kbit/s bandwidth, which is consistent with the development plan. In FY 1982 we will offer XNET bandwidth of 256 kbit/s. We are currently operating at 56 kbit/s. Later we will improve transmission efficiency (throughput) and perhaps offer megabit bandwidth as an option.

Non-VAX Computers in the Network

There are a large number of DEC computers in the PDP-11 family at Los Alamos and interest in connecting some of them to XNET. This will require some experimentation to explore software compatibility and performance.

Gateways

Our efforts to provide the XNET interface to a spectrum of computers are based on the X.25 protocol, an international standard interface between a communications system or network and a computer. Field test of the nonintegrated X.25 product manufactured by Digital Equipment Corporation was begun in September 1981 to investigate the market for local data circuit terminating equipment. Additional hardware will also be required for X.25 support. In mid-1982, field testing of an integrated X.25 product will begin. After successful field testing, X.25 support can be added to the current XNET processors.

Initially, we cannot predict the ease of implementing C-Division software on a Distributed Processor with X.25. Determination of what will be supported awaits first-hand experience in this area.

3.8.7 Capacity Planning

Communication with XNET Distributed Processors is through the file transport via concentrators that we call XNET access machines. These machines are VAX-11/780s and currently we have one of them for each of the three security partitions. There is clearly an upper limit on the number of Distributed Processors that a single access machine can support as a function on the bandwidth at which the Distributed Processors are communicating. Provision of megabit data rates and the algorithm for additional access capacity await resolution of this limit.

3.8.8 Summary of Planned Enhancements

FY 1982 will see us complete the major development phases of the XNET project. Planned enhancements include the following items.

Policy Action Item. Develop policy for approval and support of new equipment.

Procurement and Installation Action Item. Develop a Distributed Processor System Manager's Guide.

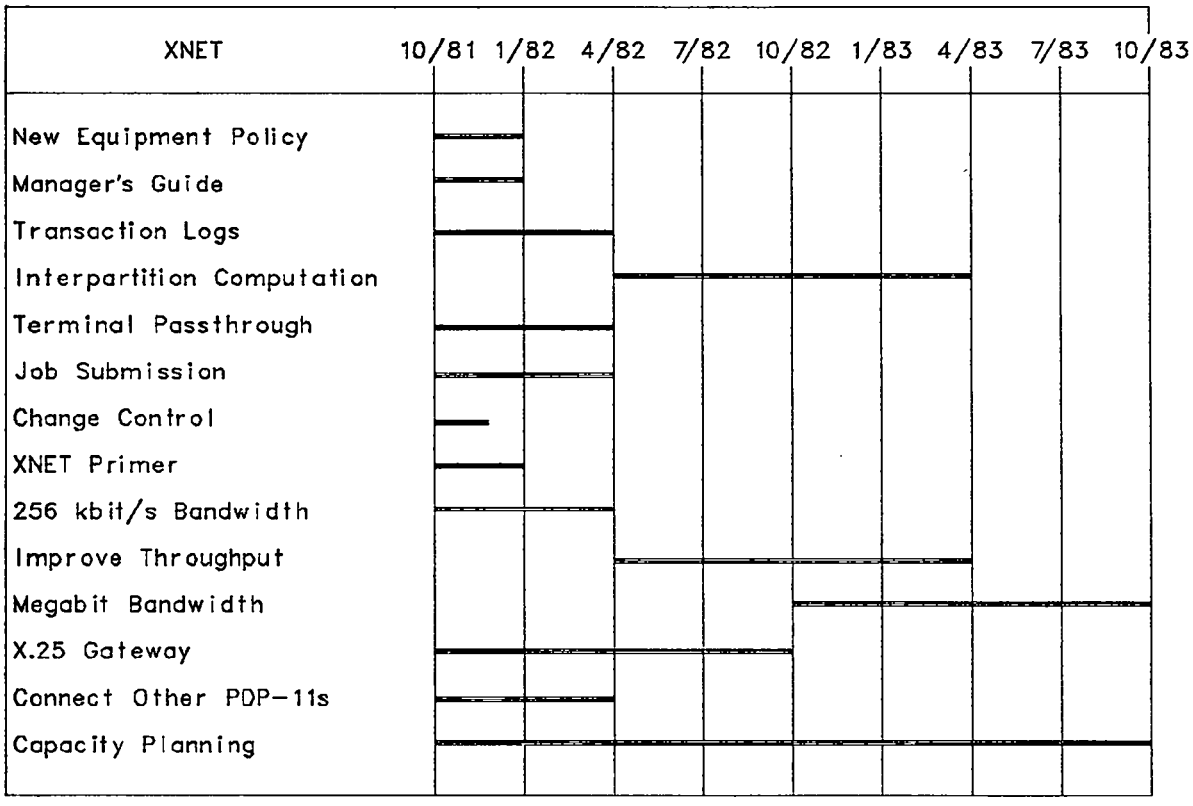
Security Action Items. Provide transaction logs; identify and resolve security issues in interpartition computation.

Functionality Action Items. Renovate XNET software for terminal passthrough and job submission; develop an XNET primer.

Reliability Action Item. Coordinate new versions of Distributed Processor software, including VMS, through C-Division Change Control.

Efficiency Action Items. Increase bandwidth to 256 kbit/s; improve throughput; prototype and test an X.25 gateway; determine whether any non-VAX PDP-11 should be connected to XNET.

Capacity Planning Action Item. Determine the capacity of an access machine as a function of Distributed Processor bandwidth and schedule acquisition of additional access machines as needed.



Schedule 5. Extended Network Access System (XNET).

3.9 DATA COMMUNICATIONS TEST CENTER

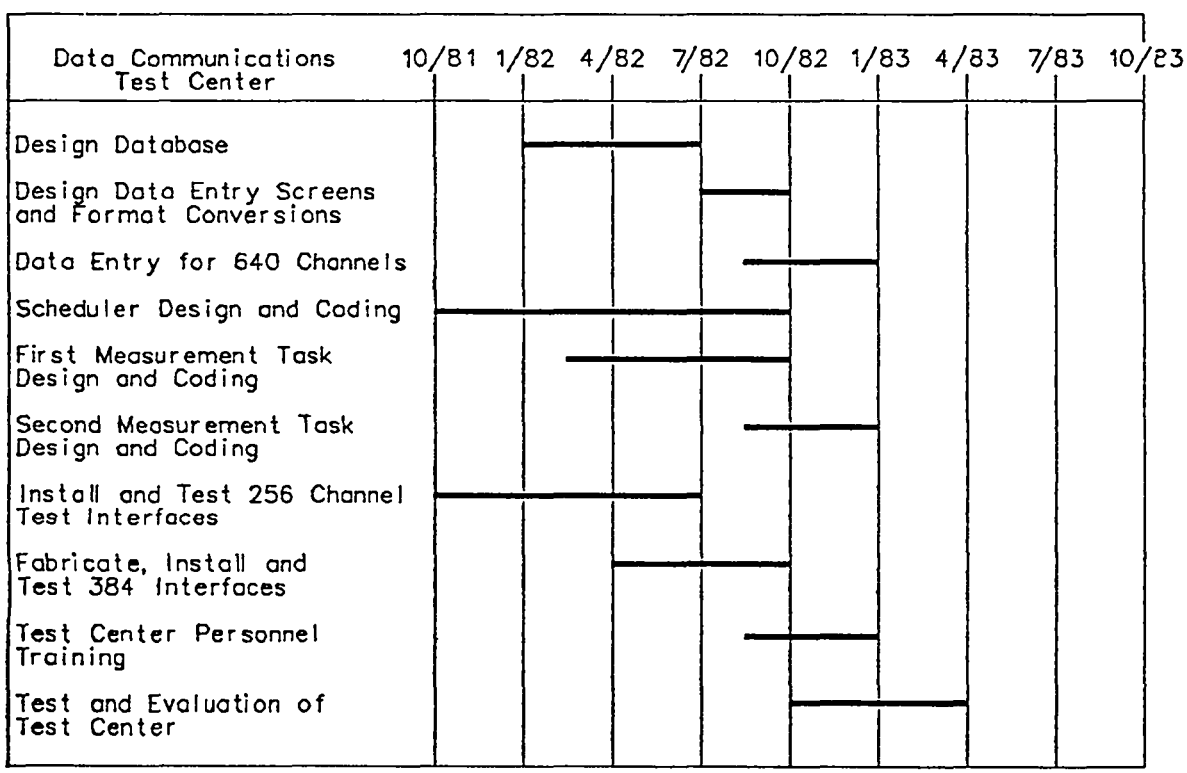
The Data Communications Test Center is a computer-based diagnostic system for testing data-communications channels to the CCF. It can select any one of over 1000 channels for diagnostic testing. It can test synchronous or asynchronous channels with data rates over one million bits per second, and can handle dial-up, dedicated, and multiplexed channels. The operator controls the system through two color graphics terminals. The testing includes noninterference monitoring of digital and analog signals and testing of ports, modems, and transmission lines. Security measures are included in the functional design. The control computer selects the channel through a diagnostic bus switch circuit, configures it for a particular test, and performs the diagnostic tests using computer-controlled test equipment.

During FY 1981 the major hardware-design effort was completed. The first 10 user-channel test interfaces were installed, and software that selects a channel for testing was completed. In addition, fabrication of 256 interfaces was completed. These interfaces will be tested and installed in FY 1982. An additional 384 interfaces will be fabricated, tested, and installed during the latter part of FY 1982.

Diagnostic testing is only a part of the data communications job. Maintaining wiring information and record keeping on trouble calls and restoration actions are also major tasks. The Test Center will contain a database system that will aid in these record-keeping tasks and will also allow statistical reports on data-communication channels to be generated.

A major design feature of the Data Communications Test Center is the extensive use of software to control the selection of channels for testing and to control measurements on the selected channels. The design of this software is being conducted using hierarchical, top-down techniques. The software-requirements document is complete. The software modules to be completed during FY 1982 include the Test Center database, a measurement control task, and the scheduler, which will serve as one of two Test Center software executives.

The above modules are expected to be completed by the end of FY 1982, at which time the Test Center will begin a 6-month evaluation test period. During this period, not only will the Test Center equipment be thoroughly tested, but the Test Center approach to automated testing for data communications will be reappraised. In addition, the impact of new technologies and changes in the ICN environment on the Test Center will be evaluated.



Schedule 6. Data Communications Test Center.

3.10 PHYSICAL PLANT UPGRADES

The physical plant of the CCF provides the space, power, and environmental controls required to house and operate the ICN equipment. The maintenance of this physical plant is the responsibility of the Site Engineering Division. Changes to the physical plant are continually being made for the installation of new equipment and the improvement of computer operations.

In FY 1981 we relocated the tape library from Rm. 260 to a smaller area in Rm. 280. This move was made possible by the reduction in use of half-inch magnetic tapes as a result of the development of the CFS and PAGES systems. The number of reels of half-inch tape stored in the tape library has decreased from a maximum of approximately 54,000 to less than 17,000. We also relocated the COM/PAGES systems to Rm. 260 to provide a more efficient distribution of user output.

We upgraded the second Cray-1 (W) to two million words of memory, installed new modules and power supplies, and relocated disks. We also installed the third Cray-1 (Machine X).

In FY 1983, we will install another Class VI computer. This will require some modification of the CCF floor plans, power supplies, and environmental controls to accommodate them, but no new floor space is planned.

Additional electrical capacity (about 15%) will be attained when transformer cooling fans are installed in Substation F. Backup capability will be increased when 480-volt ties between Substation D and Substation A and/or C are installed.

A study of the Central Computing Facility's chilled water system is in progress. The data collected in this study will be used to create a model of our system. The model will facilitate any cooling system additions and modifications to accommodate the projected acquisition of new computers through 1985.

We also plan to consolidate user services and educational functions, including the move of the Computing Information Center to SM-200. This should provide users with easy access to courses and materials in a central location. The people who were transferred from Group E-9 to Group C-4 are housed in leased space at Tri-Square. We plan to move them to SM-132 as soon as sufficient space becomes available so that all parts of C-4 can be in one location.

3.11 SECURITY

No major security changes are planned for the ICN in FY 1982. The TA-3 protected wireline (PWL) will be extended to include SM 39, SM 123, and SM 422. The partitioning of the network is now complete.

4 MAJOR SOFTWARE PROJECTS

C Division provides a variety of software across the network. We support vendor software, software developed at other installations, and software developed locally. We provide graphics software, libraries, and special utilities across CTSS, LTSS, NOS, and VMS operating systems. For Laboratory-developed software, we have been and will continue to stabilize the user interface across operating systems where feasible. For vendor-supported software, such as NOS and VMS, we are faced with the conflicting goals of providing services that are unique to the Laboratory (such as KCC support, CFS, and PAGES) and also keeping up with the latest developments of the vendor. We will be searching for new techniques to satisfy these goals.

Generally our software projects are characterized by the following.

1. We are seeking to stabilize, standardize, and harden the systems.
2. We continue to standardize and stabilize the user interface.
3. We will use software engineering techniques to make our software easy to use, more portable, and easy to maintain.

Several efforts improve the quality of our products: change control procedures, quality assurance, and the Standards Working Group. Change control procedures for the CCF systems were implemented in FY 1981. In December 1981 we extended those procedures to include changes made to XNET and Distributed Processors (Sec. 3.8.5). The Quality Assurance section of the User Services Group will continue to verify software and documentation. In FY 1982, we will develop techniques for evaluating Fortran compilers. These techniques will include use of the compiler validation tests of the National Bureau of Standards and the Los Alamos benchmarks of the Computer Research and Applications Group. The Standards Working Group recommends standards for software and the user interface. We will continue to support this group.

We have adopted the four support levels for our software shown in Table VI.

4.1 SYSTEMS

4.1.1 Protocols

A protocol is a set of rules for accomplishing some action. We use protocols to communicate between all the computers in the CCF. Protocols exist at different levels for communicating different types of information. At the lowest level are the electrical protocols, such as RS 232, and at the highest level are user-level protocols, such as the file transport protocol (called AFT) that is used by the MASS utility to send information to and from the CFS.

TABLE VI

SUPPORT LEVELS FOR SOFTWARE

Level	Explanation
Level 1 (full support)	C Division will either develop the software in-house or bring it in from other places (such as Lawrence Livermore National Laboratory or Magnetic Fusion Energy Center. If brought in from outside, we will make all changes necessary to make the software run correctly on our systems. We will document the software and provide consulting. We will fix bugs as found and add or subtract features as needed.
Level 2 (partial support)	C Division will maintain the software in its current state, provide consulting, and, if possible, fix bugs. We will make only such changes as are absolutely necessary to make the software run on our systems. We will modify existing documentation where needed. In those cases where the software is being fully maintained elsewhere and our users agree that the most up-to-date version is desirable, we will try to keep our version up to date.
Level 3 (minimal support)	C Division is responsible for file contents. We assume no responsibility for documentation, do not consult, and will not (cannot) make changes.
Level 4 (user support)	Users outside C Division are responsible for file contents, documentation, and consulting.

In planning the distributed processing network and a more distributed operating system, we have defined a standard set of protocols in the CCF. Following is a list of the standard higher level protocols that we have defined and are using. Table VII gives their status.

SIMP - a Simple Interface Machine Protocol that is used to create a communication path between computers.

AFT - a File Transport protocol that is used to transmit files in the ICN.

PTP - a Process-to-Process protocol that will allow a process (task) on a computer to communicate with a process on another computer.

DECnet - Digital Equipment Corporations's standard intermachine protocol that we use between XNET and the distributed processors.

X.25 - an international standard protocol, something like DECnet, that we will use for communication with CBT-2s and, possibly, external networks.

To permit portability of programs that use the SIMP protocol, we will provide a common interface to SIMP, an interface that is the same on all systems.

TABLE VII

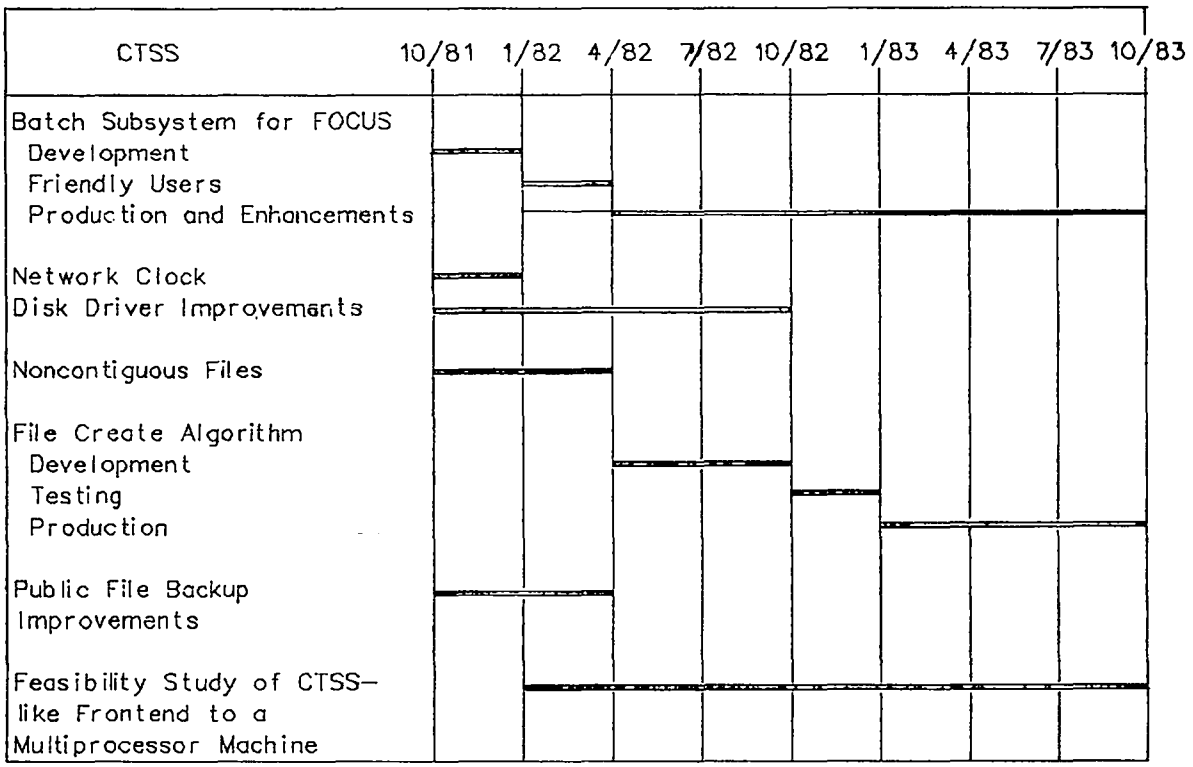
STATUS OF PROTOCOLS

	LTSS	CTSS	NOS	VMS (Worker Connections)	VMS (Distributed Processors)	UNIX
SIMP	Completed	Completed	Not Planned	Completed	4/82	Completed
AFT	Completed	Completed	Not Planned	11/82	Not Planned	Completed
PTP	Completed	Completed	Not Planned	Completed	Completed	10/82
X.25	Not Planned	Not Planned	Not Planned	Not Planned	9/82	Not Planned
DECnet	Not Planned	Not Planned	Not Planned	Installed by Vendor	Installed by Vendor	Not Planned

4.1.2 CTSS

CTSS is the operating system that runs on all Los Alamos Cray-1 computers. System stability and reliability are of primary concern in the software support of CTSS. To this end, maintenance and enhancement are performed from the standpoint of improving future maintainability of the system.

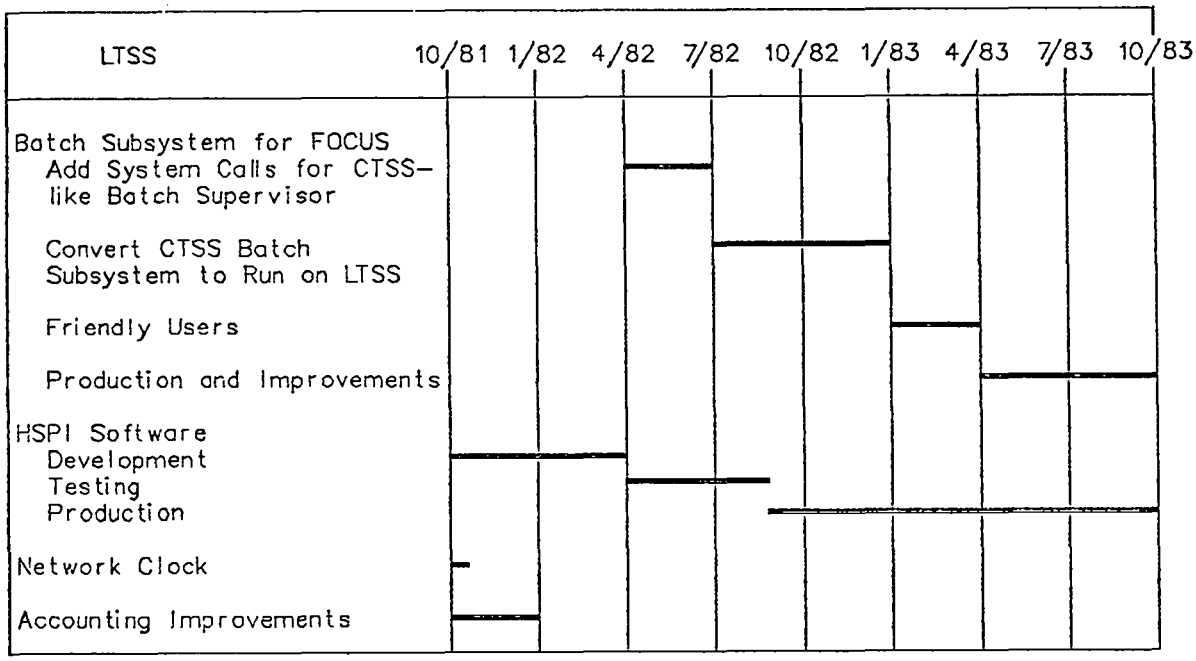
As FOCUS control of the batch facility is implemented, new features will be added. The use of a "production number" to run batch jobs will become invisible to the user. The effect of this will be that a command file will run the same in batch as it will when executed by a user from a terminal. The network clock will be used as a source for date and time when CTSS is deadstarted. This feature will synchronize all CTSS machines and provide a reliable time. The disk drivers will be improved to take advantage of hardware corrections. Planned improvements include better error recovery and error logging as well as decreasing CPU overhead. The CTSS restriction on contiguous file allocation will be removed. It will be possible to allocate disk file space in noncontiguous blocks or segments. This will allow users to create large files even though contiguous space is not available. Users also will be able to increase the size of and append data to an existing file without copying all the existing data. The public file maintenance and backup procedures will be changed to allow machine-dependent files in a multimachine environment. In addition, a feasibility study on a CTSS-like frontend to a parallel processor machine will be performed.



Schedule 7. CTSS.

4.1.3 LTSS

LTSS is the operating system for all the Los Alamos CDC 7600 computers. The current batch control procedure requires significant operator interaction. Use of FOCUS for production control will automate LTSS production. The high-speed parallel interface will be completed. This interface will improve error detection for the LTSS network channels. Several improvements made to the CTSS accounting will be implemented on LTSS. The major user-visible change will be the recording of the security level for terminal connect time.



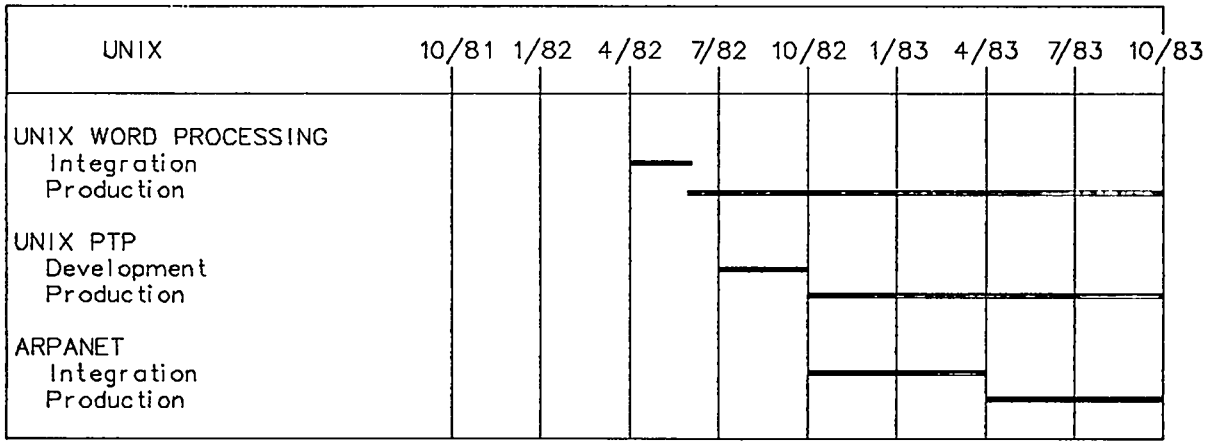
Schedule 8. LTSS.

4.1.4 NOS

NOS is a timesharing operating system supplied by Control Data Corportation for their 6600 and Cyber series of computer systems. Three Control Data computers at Los Alamos run NOS: one CDC 6600 is dedicated to the general-purpose scientific user and two Cyber-73s are dedicated to administrative computing. We are not currently considering any major upgrades to the operating system.

4.1.5 UNIX

UNIX, an operating system marketed by Western Electric, runs on Laboratory Digital Equipment Corporation PDP-11 and VAX-11 machines. UNIX is currently running on a PDP-11/70 and is used for word processing in C Division and for some advanced development activities. In FY 1982, we plan to have at least two machines running UNIX: A PDP-11/70 for network research and software development and a VAX-11/750 for word processing. Software development plans for UNIX machines include a process-to-process (PTP) protocol module from UNIX to other workers and an ARPANET connection.



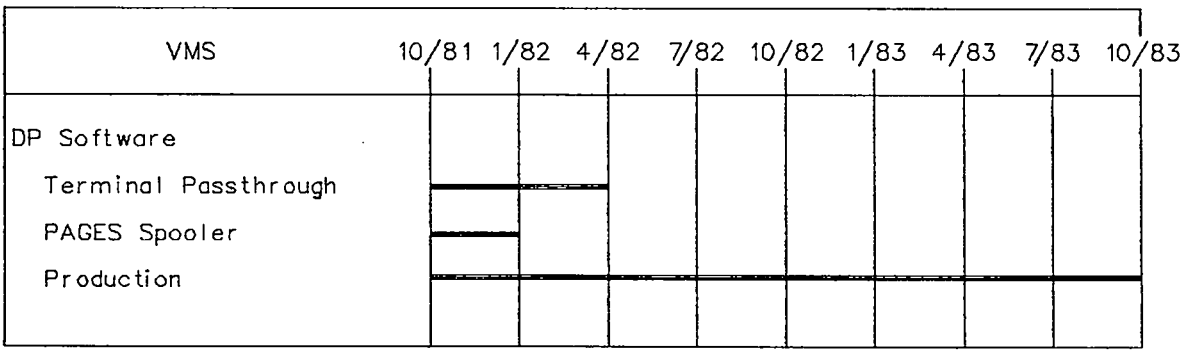
Schedule 9. UNIX.

4.1.6 VMS

VMS is the operating system supported by Digital Equipment Corporation for their VAX family of computers. C Division has written software under VMS for internal work (such as FOCUS) for our Distributed Processor users and has developed much of the protocol software necessary for a VMS worker connection to the ICN. Our support philosophy for VMS is to provide the latest vendor software with a minimum of local changes.

Software development and support projects include protocol software between the ICN and VAXs (both connected to XNET and to SEL file transport computers), protocol library support (SIMPLIB), and Distributed Processor support software (PAGES spooler, terminal passthrough software, help utilities, ICN accounting utilities, security modules). In addition, we will continue to work with the VAX Local User's Group, provide system manager support for our local VAX computers, and consult on user system problems.

We are currently operating a VMS system that is available to a limited number of users on an experimental basis and is serving as a testbed for communications to external networks (MFE, Telenet). Delivery of the Local Terminal Switch should provide a more reasonable terminal access to this machine and may eventually enable us to offer access to a wider range of users (Sec. 5.2.1).



Schedule 10. VMS.

4.1.7 Future Systems

When the first Class VII supercomputer arrives at Los Alamos, it must be made operational as rapidly as possible and it must be upward compatible with today's CTSS/LTSS systems. We are planning for such a computer in 1985 and are studying several alternatives for its implementation.

Among those alternatives are three that will provide a CTSS user interface on future supercomputers: (1) convince vendors to adopt CTSS and equip future machines with that user interface, (2) port CTSS to the next machine ourselves, and (3) develop a system for the next (and future) machines that will be portable and that contains the CTSS user interface at least as a subset.

We are investigating all three alternatives. We have contacted vendors encouraging them to adopt CTSS. As system modifications to CTSS are made, areas of the system are cleaned up with the intention of making the system less hardware dependent and more portable. Several areas are being investigated in an attempt to increase our knowledge of operating system basic concepts, for example, front-ending and UNIX experience. This knowledge is critical for development of a newer system. In Sec. 7.1.3, we discuss our research in this area.

4.2 OPERATING ENVIRONMENT

An operating environment is any specific combination of computer, operating system, compiler, and supporting libraries. Table VIII describes the Fortran operating environments and their levels of support.

C Division and Laboratory users have been moving toward a more standard operating environment over the past two years. In the late 1970s, that environment was based on ANSI standard Fortran 66. A new standard Fortran (Fortran 77) has been developed. A Fortran 77 environment was provided for NOS and LTSS in FY 1981 when the FTN5 operating environment became available on those systems. Existing components include compiler (Sec. 4.3.1); system library (Sec. 4.4.1); TIDY and INDEX programming tools (Sec. 4.5); consulting;

education; and documentation. In FY 1982, math and graphics libraries will be made available (Secs. 4.4.2 and 4.4.3) and RATFOR compatibility will be addressed (Sec. 4.3.3). The user interface of these libraries will be consistent with that in the Fortran 66 environment. In FY 1982, we will address user interfaces that are consistent with the Fortran 77 environment, for example, CHARACTER data type.

We plan to provide a common Fortran 77 environment on all systems. Users need to be able to move their Fortran software across existing systems and to future systems. To facilitate technology transfer, they also need to be able to share Fortran software with the rest of the computing world. A common environment will enhance portability of application programs and will enable us to provide a compatible environment on future systems. Components of the common Fortran 77 environment include compiler and run-time library; system, math, and graphics libraries; RATFOR, TIDY, and INDEX programming tools; consulting; education; and documentation. This project will take several years. Scheduling depends on the availability of vendor products and funding. In FY 1982, we will investigate vendor capabilities.

TABLE VIII

FORTRAN OPERATING ENVIRONMENTS

System	Compiler	Library	Level of Support
CTSS	CFT	CFTLIB	1
CTSS	CIVIC	FORTLIB/ BASELIB	3
LTSS	FTN5	FTN5LIB	1
LTSS	FTN	FTNLIB	1
LTSS	CHAT	ORDERLIB	3
NOS	FTN5	FTN5LIB	1
NOS	FTN	SYSLIB	1
VMS	FORTRAN	STARLET/ VMSTRL	3

4.3 LANGUAGES

The languages available at Los Alamos are discussed in the following sections, and their status and level of support are shown in Tables IX-XIII.

4.3.1 Fortran

Fortran is and will continue to be the most heavily used programming language at Los Alamos.

Fortran 77 is available as FTN5 (LTSS, NOS), FORTRAN (VMS), and CFT (CTSS). We expect Cray Research, Inc. (CRI) to enhance CFT to full Fortran 77 in FY 1982-1983. CRI is training a compiler specialist who will be located in Los Alamos, starting in FY 1982, to provide better support of CFT. Fortran 66 is available as FTN on LTSS and NOS. We expect CDC to freeze FTN by April 1982.

LRLTRAN is a Lawrence Livermore National Laboratory (LLNL) dialect of Fortran available as CIVIC (CTSS) and CHAT (LTSS). This language is available for compatibility with LLNL. In FY 1982, we expect CIVIC to support the 2-million-word Cray memory.

In FY 1982-1983, we expect CRI to change the subroutine protocol on CTSS. This will be a major change that will affect all stored relocatable binary files. The new subroutine protocol will result in improved efficiency. Affected components include CFT, CIVIC, and CAL compilers and assemblers; all system, math, and graphics libraries; and all user libraries. All libraries must be recompiled under the new compilers. Nonstandard routines written in CAL must be modified.

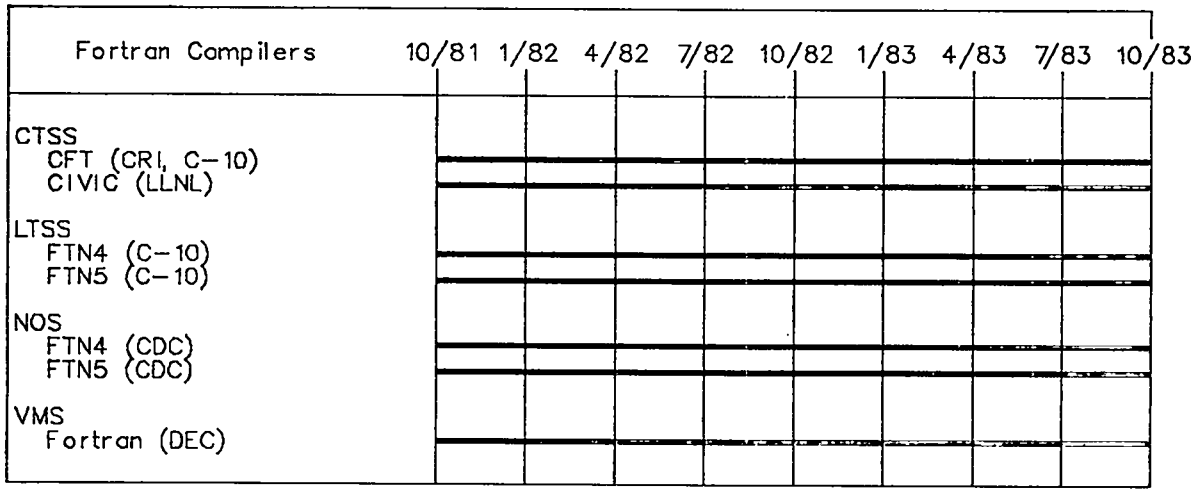
Our schedule for the new CRI compiler depends on the availability of CRI and LLNL products. We plan: two months to check out the CFT and CIVIC compilers; two months to recompile and check the system, math, and graphics libraries; and three months for users to recompile and check their own libraries. Thus, we expect production to occur seven months after the compilers are received. We do not yet have a firm date from Cray Research for the new compiler.

In support of a common Fortran 77 environment on all systems (Sec. 4.2), we plan to acquire a common ANSI-standard Fortran 77 compiler for all systems. Existing Fortran 77 compilers supplied by our computer vendors do not provide a common environment and are inadequate as a foundation upon which a common environment could be built: each compiler has different non-ANSI extensions; each compiler is a system-dependent implementation and cannot be converted to a future system.

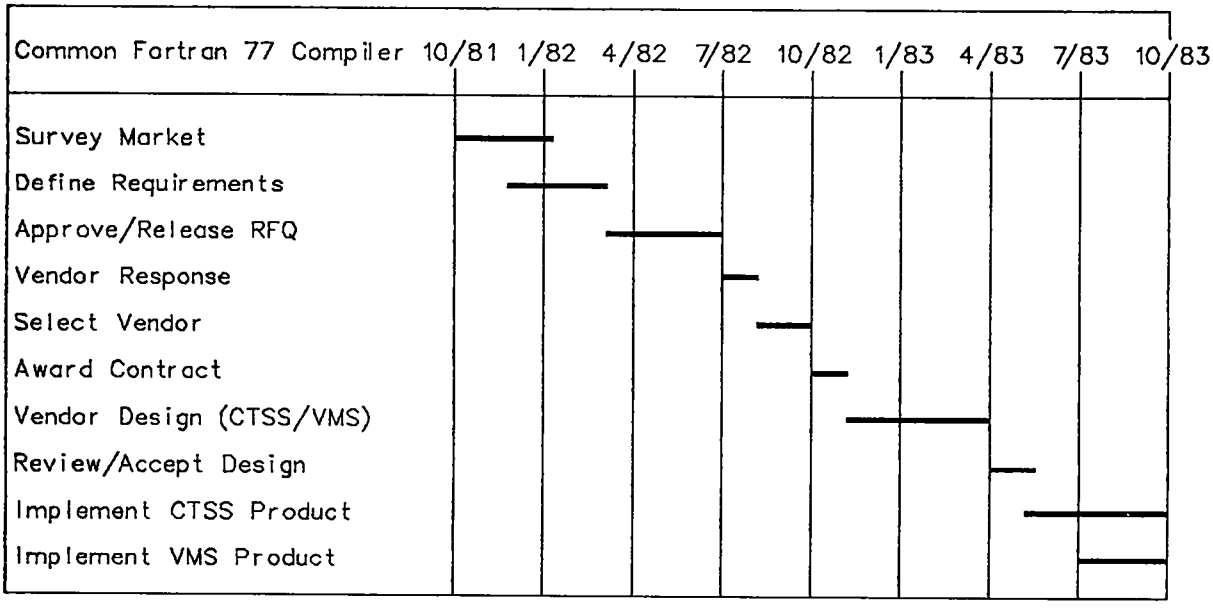
Recognizing that standard Fortran may not provide all the features required by Los Alamos codes, we will support enriched Fortran on the supercomputers. An enriched Fortran for future systems will not be activated until the common Fortran 77 project is well underway.

We will remain active in the ANSI X3J3 and DOE Fortran standardization efforts. We must influence those committees so that Fortran will continue to meet our needs.

We urge all of our users to convert to standard Fortran and to our common libraries and utilities as rapidly as possible. By doing so, users are assured of continued C-Division support for this software and a minimization of conversion problems when switching to new computers.



Schedule 11. Fortran compilers.



Schedule 12. Common Fortran 77 compiler.

4.3.2 Assembly Languages

The use of assembly language is discouraged by C Division because of portability and programmer productivity issues. However, it is recognized that certain routines are best coded in assembly language. Assembly languages include CAL (CTSS), COMPASS (LTSS, NOS), MACRO (VMS), and AS (UNIX).

In FY 1982-1983, we expect CRI to change the subroutine protocol macro definitions of CAL (Sec. 4.3.1).

Assemblers	10/81	1/82	4/82	7/82	10/82	1/83	4/83	7/83	10/83
CTSS CAL (CRI)									
LTSS COMPASS (CDC, C-10)									
NOS COMPASS (CDC)									
VMS MACRO (DEC)									
UNIX AS (Bell Labs)									

Schedule 13. Available assemblers.

4.3.3 Other Languages

Other languages available at Los Alamos include Fortran-based languages (RATFOR), general-purpose languages (APL, BASIC, C, COBOL, PASCAL, PL/I, SNOBOL), command languages (COSMOS, CTL), and special-purpose languages (APT, MACSYMA, SIMSCRIPT).

In support of Fortran 77 environments (Sec. 4.2), we will address RATFOR compatibility in FY 1982. RATFOR is an effective programming language within Fortran environments and is widely used for the implementation of common software for all systems. Output of the RATFOR preprocessor must be compatible with ANSI-standard Fortran 77 and must permit the use of the full Fortran 77 language.

We plan to acquire an implementation of Ada, the new Department of Defense programming language. This will provide the opportunity for hands-on experience with this important new language.

We are investigating common command languages and are active in the ANSI X3H1 effort to establish a national standard. We are working with LLNL to establish an interlaboratory standard command language for CTSS. We are investigating the UNIX command language and its portable implementation, the SHELL. These investigations also pertain to research relating to the parallel processor operating system (Sec. 7.1.3).

4.3.4 State-of-the-Art Languages

C Division will maintain an awareness of state-of-the-art languages and will seek a modern programming language for use in C Division efforts in parallel processing, portability, and structured programming. As such facilities become available, people may use the languages at their own risk, but there is no quarantee that the languages will be stable or supported. In conjunction with LLNL, we will continue maintenance and enhancement of the MODEL system-development language.

TABLE IX

CTSS LANGUAGES

Language	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
Fortran					
CFT	1	Yes	Yes	Yes	FY 1982
Assembly					
CAL	1	Yes	Yes	Yes	No
Fortran-Based					
CIVIC	3	Yes	No	Yes	No.
RATFOR	3	Yes	Yes	Yes	No
RAT4	2	Yes	Yes	Yes	No
General-Purpose					
MODEL	4	No	Yes	No	No
PASCAL	4	No	Yes	No	No
Command					
BCON	4	Yes	Yes	No	No
COSMOS	1	Yes	Yes	Yes	No
CTL	4	Yes	Yes	Yes	No
MONITOR	4	Yes	Yes	No	No
SH	4	Yes	Yes	No	No
XEQ	4	Yes	Yes	No	No

TABLE X

LTSS LANGUAGES

Language	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
Fortran 66					
FTN	1	Yes	Yes	Yes	FY 1982
Fortran 77					
FTN5	1	Yes	Yes	Yes	FY 1982
Assembly					
COMPASS	1	Yes	Yes	Yes	No
Fortran-Based					
CHAT	3	Yes	Yes	Yes	No
CHATR	3	Yes	Yes	Yes	No
RATFOR	3	Yes	Yes	Yes	No
RAT4	2	Yes	Yes	Yes	No
Command					
BCON	4	Yes	Yes	Yes	No
COSMOS	1	Yes	Yes	Yes	2/82
CTL	4	Yes	Yes	Yes	No
MONITOR	4	Yes	Yes	Yes	No
ORDER	4	Yes	Yes	Yes	No
SH	4	Yes	Yes	Yes	No
XEQ	4	Yes	Yes	Yes	No

TABLE XI

NOS LANGUAGES

Language	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
Fortran 66					
FTN	1	Yes	Yes	Yes	FY 1982
Fortran 77					
FTN5	1	Yes	Yes	Yes	FY 1982
Fortran-Based					
RATFOR	3	4/82	Yes	Yes	No
RAT4	1	4/82	Yes	Yes	No
Assembly					
COMPASS	1	Yes	Yes	Yes	No
General-Purpose					
APL	3	Yes	Yes	Yes	No
BASIC	3	Yes	Yes	Yes	No
COBOL	3	Yes	Yes	Yes	No
PASCAL	3	Yes	Yes	Yes	No
PL/I	3	Yes	Yes	Yes	No
SNOBOL	3	Yes	Yes	Yes	No
Special-Purpose					
APT	3	Yes	Yes	Yes	No
GPSS	3	Yes	Yes	Yes	No
GASP IV	3	Yes	Yes	Yes	No
SIMSCRIPT	3	Yes	Yes	Yes	No
SYMPL	3	Yes	Yes	Yes	No

TABLE XII

VMS LANGUAGES

Language	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
Fortran 77					
Fortran	3	Yes	No	Yes	No
Assembly					
MACRO	3	Yes	No	Yes	No
Fortran-Based					
RATFOR	3	Yes	Yes	Yes	No
RAT4	1	Yes	Yes	Yes	No
General-Purpose					
BASIC	4	Yes	No	Yes	No
BLISS	4	Yes	No	Yes	No
COBOL	4	Yes	No	Yes	No
PASCAL	4	Yes	No	Yes	No
PL/I	4	Yes	No	Yes	No
Special-Purpose					
MACSYMA	3	No	No	No	No
Command					
SH	4	Yes	Yes	Yes	No

TABLE XIII

UNIX LANGUAGES

Language	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
Fortran 77					
F77	3	Yes	Yes	Yes	No
Assembly					
AS	3	Yes	Yes	Yes	No
Fortran-Based					
RATFOR	3	FY 1982	FY 1982	FY 1982	No
RAT4	1	FY 1982	FY 1982	FY 1982	No
General-Purpose					
APL	3	Yes	Yes	Yes	No
C	3	Yes	Yes	Yes	No
LISP	3	Yes	Yes	Yes	No
PASCAL	3	Yes	Yes	Yes	No
Special-Purpose					
BC	3	Yes	Yes	Yes	No

4.4 LIBRARIES

We plan to support a common set of system, mathematics, and graphics libraries across all CCF systems. We have taken major steps in that direction in the past year and expect to complete most work on the mathematical and graphics libraries this year.

4.4.1 System Libraries

System libraries provide run-time support for Fortran compilers and provide additional user-callable functions, such as character and bit manipulation, character set conversion, ability to get system parameters, error and interrupt handling, file handling, and interprocess and intermachine communication.

Tables XIV-XVII describe system library status and level of support. Also indicated is the associated compiler.

We will continue to maintain existing system libraries. In FY 1981, we implemented FTN5LIB on LTSS, providing the FTNLIB user interface under FTN5. In FY 1982-1983, we will provide full run-time support of FTN5. When the new subroutine protocol is available from Cray Research in FY 1982-1983, updated Cray system libraries will be made available. As Cray Research enhances CFT to full Fortran 77 in FY 1982-1983, we will provide full run-time support. In FY 1982 we expect Lawrence Livermore National Laboratory to support the 2-million-word Cray memory in their BASELIB and FORTLIB libraries.

We plan to acquire run-time support with the common ANSI-standard Fortran 77 implementation (Sec. 4.2).

For user-callable functions, we plan to provide a common user interface across all systems. Common user-callable functions save conversion costs incurred by the user; save maintenance, documentation, and consulting costs incurred by C Division; and facilitate quick implementation in new operating environments. In addition, commonality permits the writing of major Fortran programs that are portable.

During the next three years, we will develop this common system library to supplement Fortran 77 functions. We recognize that this interface would be especially useful for new software development efforts, such as the intelligent terminals (CBT-2), the common Fortran 77 environment, and SIMP communication.

We will investigate the functions and user interface provided by the Software Tools library. This library has a user interface that is popular in the Fortran 66 computing world. We will also investigate local enhancements that provide special functions, such as SIMP communication. In FY 1982-1983, we will establish the level of support appropriate for the Software Tools library.

TABLE XIV

CTSS SYSTEM LIBRARIES

Library	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
BASELIB (CIVIC)	1	Yes	No	Yes	No
CFTLIB (CFT)	1	Yes	Yes	No	No
FORTLIB (CIVIC)	3	Yes	Yes	Yes	No
STACKLIB (CIVIC)	3	Yes	Yes	Yes	No
STLIB (CFT)	3	Yes	Yes	Yes	No

TABLE XV

LTSS SYSTEM LIBRARIES

Library	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
BASELIB (CHAT)	3	No	Yes	Yes	No
FTNLIB (FTN)	1	Yes	Yes	No	No
FTN5LIB (FTN5)	1	Yes	Yes	No	No
ORDERLIB (CHAT)	3	Yes	Yes	Yes	No
STLIB (FTN)	3	Yes	Yes	Yes	No

TABLE XVI

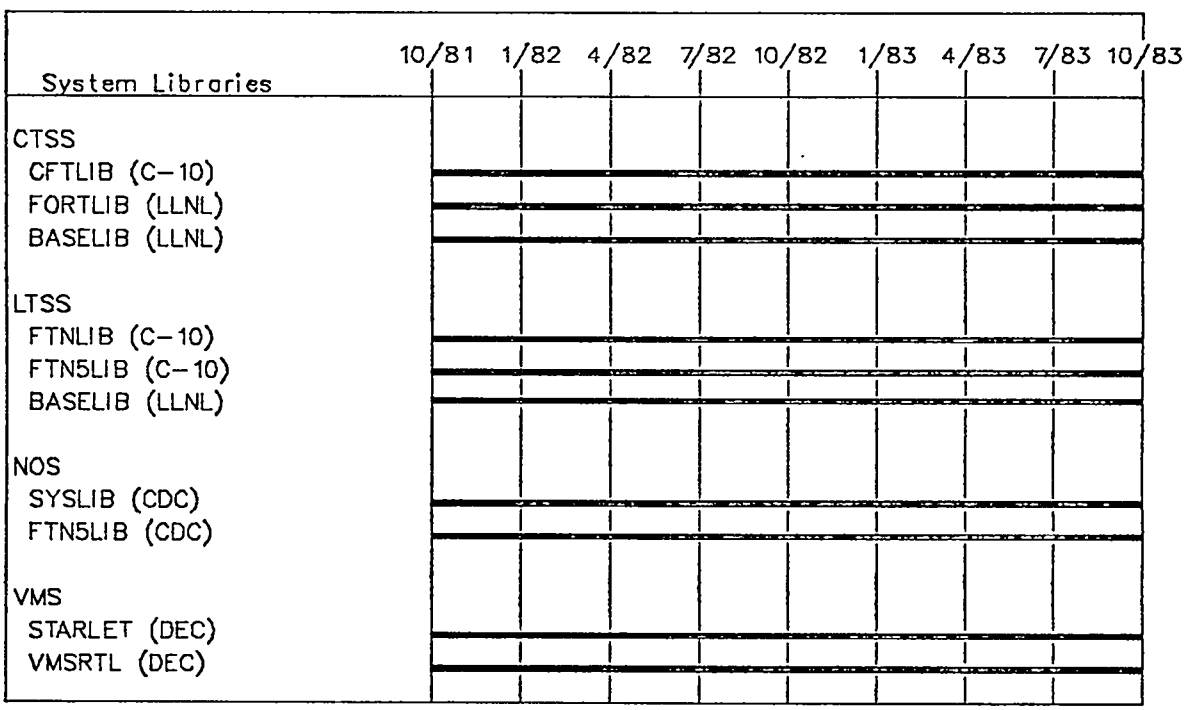
NOS SYSTEM LIBRARIES

Library	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
FTN5LIB (FTN5)	1	Yes	Yes	No	No
TOOLS (FTN5)	3	Yes	Yes	Yes	No
SYSLIB (FTN)	1	Yes	Yes	No	No

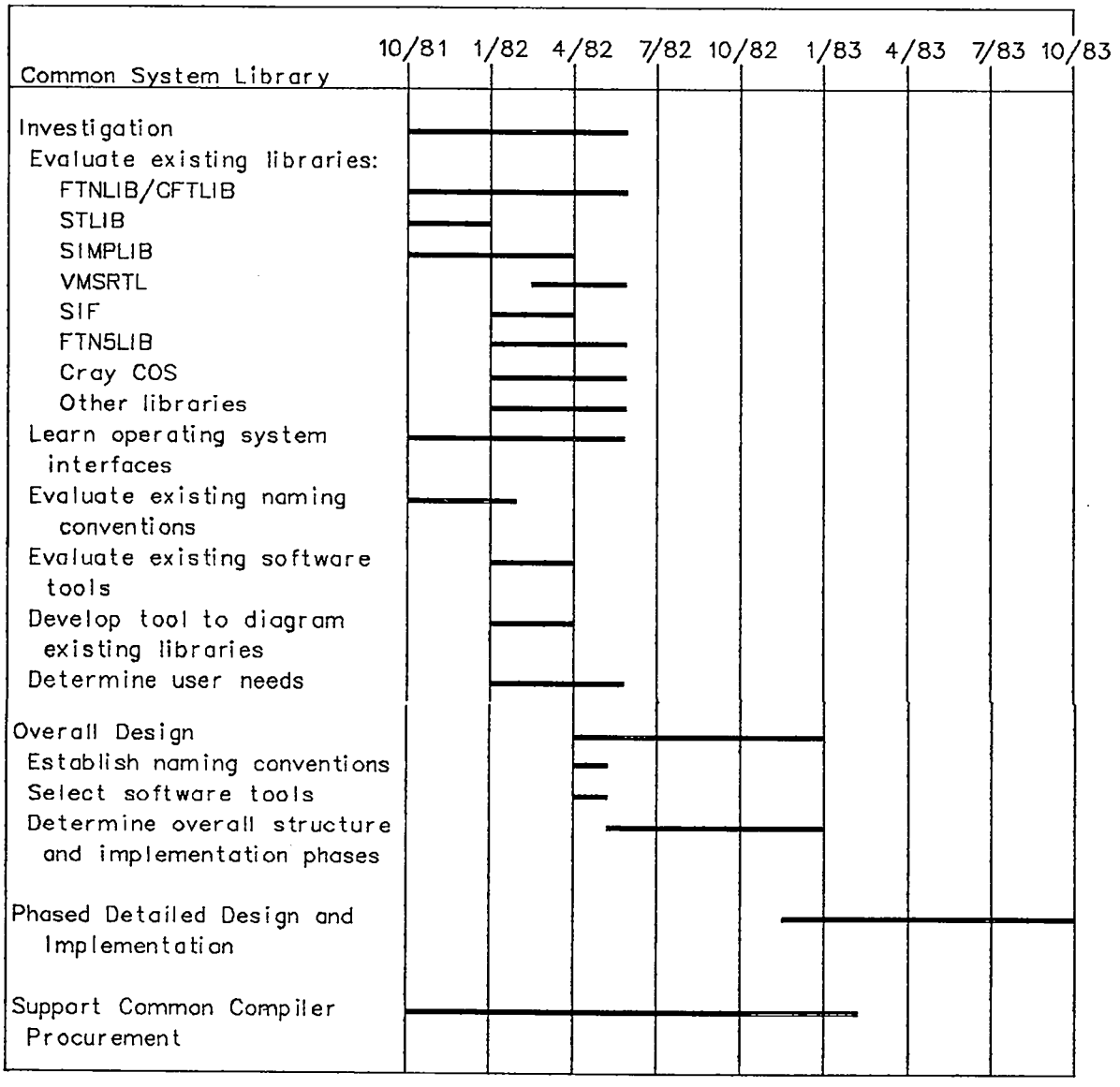
TABLE XVII

VMS SYSTEM LIBRARIES

Library	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
STARLET (Fortran)	3	Yes	No	No	No
RLIB (Fortran)	3	Yes	Yes	Yes	No
VMSRTL (Fortran)	3	Yes	No	Yes	No



Schedule 14. System libraries.



Schedule 15. Common system library.

4.4.2 Common Mathematical Software

The mathematical software project at Los Alamos has as one of its basic goals the production and maintenance of a common mathematical library. In producing the library, we will

- maintain a common source library for all supported mathematical routines,
- support "identical" math libraries (for example, FTNMATH) across all major ICN systems, and
- provide users with modern, powerful computational software applicable to Laboratory problems.

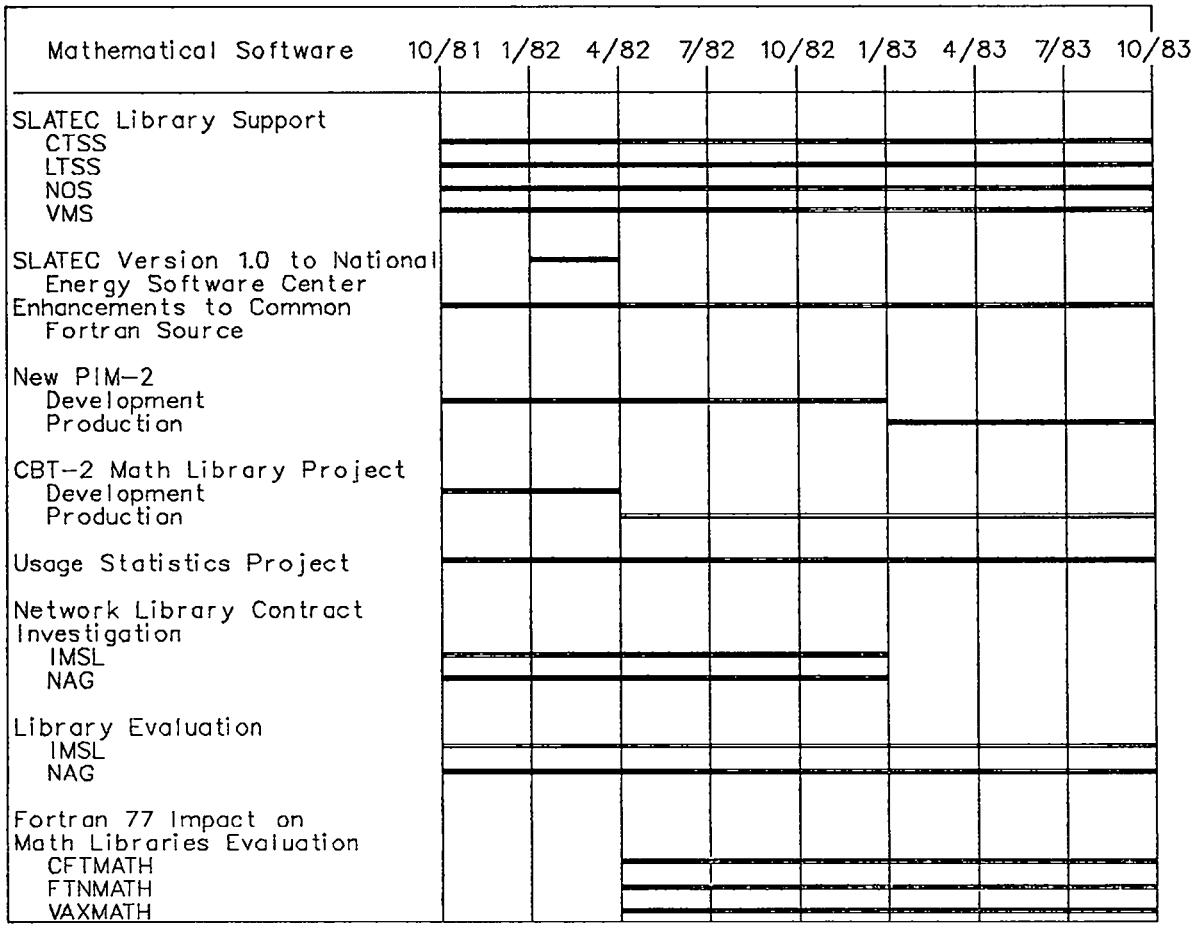
Our primary objective will be to provide a stable and portable base for mathematical computation at Los Alamos. There are a number of advantages to a common mathematical library of high-quality, reliable, and robust procedures. In code development the user is able to concentrate on those parts of the code that are unique to the specific application. Historically, the "building block approach" has proven to be a cost-effective technique. Also, the user is able to move major codes from one machine environment to another with little or no conversion costs.

During FY 1982, much of our effort in this area will be in collaboration with the common math library committee of SLATEC. Los Alamos is the distribution point for all interested sites, which now include the Los Alamos National Laboratory, Air Force Weapons Laboratory at Kirtland, Lawrence Livermore National Laboratory, Magnetic Fusion Energy Computing Center, National Bureau of Standards, Sandia National Laboratories Albuquerque, and Sandia National Laboratories Livermore. Our objective is to share the effort in assembling a quality library and to make it available at all participating sites.

The SLATEC effort should continue to grow and we will see its impact in several areas. Already, the committee has designed and written several pieces of software. This developmental effort should grow as the committee responds to specific DOE needs, particularly in the area of vector and distributed processing. We should also see software vendors being influenced by the SLATEC library, and such things as machine constants and standard error handling may become commonplace.

This fiscal year, we will continue to evolve toward a common source/common library. With new systems coming on board, it is essential that a simple, accurate source facility be maintained for the math libraries. This will require a substantial effort. Our primary objectives will be to complete integration of the SLATEC collection into the on-site mathematical libraries and to upgrade the documentation to reflect the new holdings. This documentation will include a second version of the SLATEC online documentation program and a new Programmer's Information Manual (PIM-2). The projected date for completion of the PIM-2 is January 1983.

Several new projects will be begun during FY 1982. These include an attempt to negotiate a network library contract for the International Mathematical and Statistics Libraries (IMSL) and Numerical Algorithm Group (NAG) software libraries with IMSL, Inc. and NAG, Inc., respectively. The IMSL library is already installed on the major mainframes and we plan to make a preliminary evaluation of it. Initially the evaluation will concentrate on the quality of selected routines. Users will also be surveyed for their opinions. A similar evaluation of the NAG library will be started. The Usage Statistics Project will enable us to determine which routines are being used and by whom. Finally, we plan to devote some effort to the development of software for boundary value problems, integral equations, linear least squares problems, partial differential equations, and optimization using existing technical expertise. These last two projects will be continued into FY 1983.



Schedule 16. Mathematical software.

4.4.3 Graphics Libraries

Graphics libraries provide Fortran-callable subroutines for plotting user data. Users select a graphics library depending on their own needs. Graphics libraries provide a common user interface across all operating systems, which makes it easier for a user to convert to a new system.

We support three graphics libraries on all operating systems: the Common Graphics System (CGS), DISSPLA, and SC-4020 emulation libraries. CGS provides subroutines supporting device-independent graphics primitives. CGS also provides the device initialization, control, and termination functions for all the graphics libraries and utilities. DISSPLA is a graphics system that supports high-quality plotting and text capabilities. SC-4020 is a graphics library that consists of routines that were written for the SC-4020 COM recorder. It is maintained for compatibility with older application codes; it is not recommended for use by new codes. The NCAR graphics library, which is a high-level graphics library from the National Center for Atmospheric Research, is supported only on CTSS and LTSS.

A new high-level graphics library is being developed. This library will provide high-level graphics capabilities that are not currently supported. It will also provide commonly needed features in a consistent and predictable manner. A users group was formed to help develop the user requirements for this library; this group has provided valuable input for the high-level library. In FY 1982, we plan to complete the functional requirements and begin working on the functional specifications for the library.

Graphics output may be generated directly while the application program is running on the following graphics devices: Tektronix 401X series terminals, AED-512 color terminals, VT-640 raster terminals (Tektronix emulation), and ZETA plotters. Graphics output for the FR-80 microfilm recorders and Versatec plotters requires that a CGS Metafile be generated. The Metafile is sent to PAGES using one of the graphics utilities (Sec. 4.6). The Metafile can also be postprocessed to local devices, such as interactive graphics terminals. The CGS Metafile is a device-independent representation of graphics data that can be postprocessed for any particular device.

Our plans for next year are based on user needs that have been identified to the Division. Our plans include partial support of the graphics libraries for FTN5. The libraries will be load compatible with FTN5 application programs but may impose some restrictions on application programs. Plans will be generated for full support of the graphics libraries under FTN5.

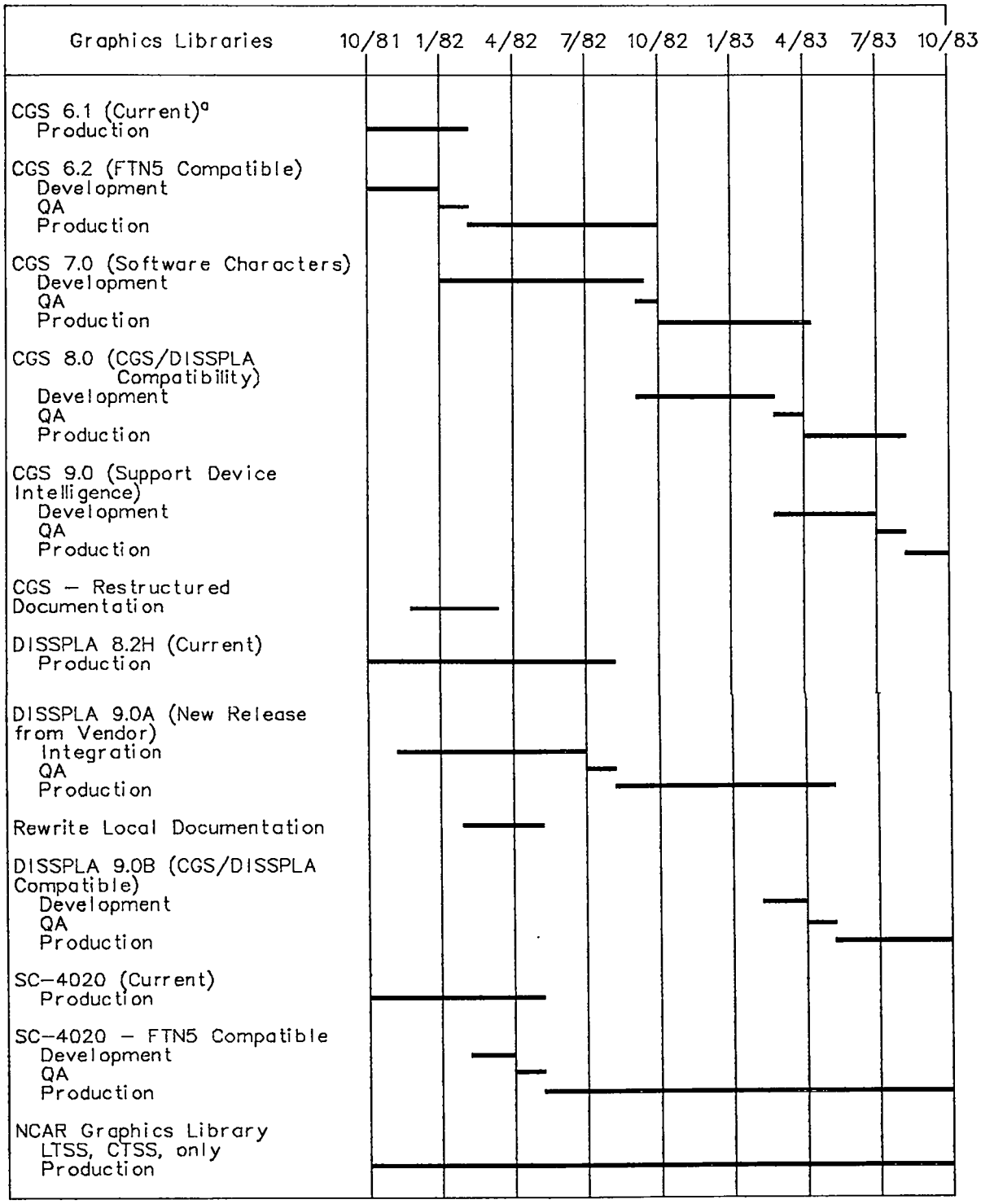
Plans for CGS include making it FTN5 load compatible and adding new features, such as software characters and inquiry functions. We also plan to restructure the CGS device driver interface to make the CGS and DISSPLA libraries load compatible. Restructuring of the CGS device drivers will give us required flexibility to implement new capabilities in the future.

Plans for DISSPLA include integrating new releases on all systems. DISSPLA 9.0 will provide new features, such as unlimited blanking capabilities and three new shaded character fonts. We will be working with the vendor to support the DISSPLA library under FTN5.

We will continue support of the SC-4020 and NCAR libraries and continue development of our new high-level graphics library. SC-4020 will also be partially supported for FTN5.

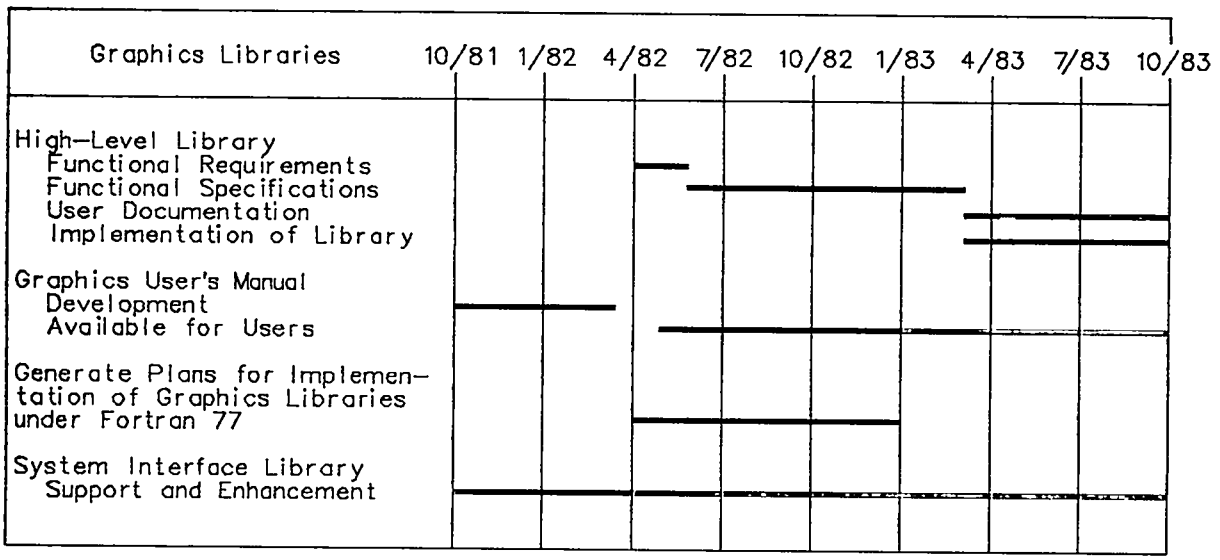
We are preparing an overview of our graphics systems that should help answer many questions on the structure and use of the graphics capabilities available at Los Alamos. Other graphics documentation is constantly updated to include the latest additions in graphics capability.

We will continue to support and enhance our system interface library. This is a very powerful tool that helps minimize conversion and maintenance costs for all our graphics software.



[a]Major enhancement for each release is in parentheses.

Schedule 17. Graphics libraries (continued on next page).



Schedule 17. Graphics libraries.

4.5 SYSTEM UTILITIES

About 60% of the utilities effort is spent in maintaining existing utilities software. This software consists of approximately 200 utilities on four operating systems, a total of about 400,000 lines of code.

Utilities exist, and will continue to exist, whose functions have value only on certain operating systems. These will be written and maintained as needed. Existing utilities that are not standard across systems, but have stood the test of time and continue to be heavily used, will continue to be supported. As similar functions become available in new, standard, and often superior utilities, we urge users to migrate to these new utilities.

To the extent possible, all new utilities are designed and written to be available on, and common across, all systems that we support. We also strive for as much compatibility and cooperation with Lawrence Livermore National Laboratory as possible. To make new utilities portable and easier to maintain, as well as easier to use, we are defining a standard utility syntax and are implementing standard software tools on which to build these products.

We are investigating desired functionality and user interface of a common linker/loader for linking relocatable modules into a load module. Incompatible differences between existing linker/loaders increase conversion costs.

In FY 1981, we enhanced TIDY and INDEX to accept the Fortran 77 language. This was completed on CTSS, LTSS, and NOS, and is yet to be completed on VMS.

In FY 1981, we established ED and FRED as the common text editors. ED provides commonality with the outside world as well. These are available on CTSS and LTSS and will be available on VMS and NOS.

In FY 1981, we produced the error diagnostic tools ERGO and AUTOPSY. We continue to work closely with Lawrence Livermore National Laboratory on the maintenance and enhancement of the interactive debugger DDT.

Tables XVIII through XXI show the status of the supported utilities for CTSS, LTSS, NOS, and VMS. As the intermachine process-to-process communication protocols are completed, we will plan user-level utilities to facilitate their use.

TABLE XVIII
CTSS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
ABORT*	1	Yes	Yes	Yes	FY 1982
ALLOUT	1	Yes	Yes	Yes	Yes
AUTOPSY	1	Yes	Yes	Yes	Yes
AUTOSUM	1	Yes	Yes	Yes	Yes
BUILD	1	Yes	Yes	Yes	Yes
CBT	1	Yes	Yes	Yes	FY 1982
CHECK	3	Yes	No	No	No
COMPARE	1	Yes	3/82	Yes	Yes
CONVERT	1	Yes	Yes	Yes	Yes
COPY	1	Yes	Yes	Yes	Yes
CSUM	3	Yes	No	No	No
DDT	1	Yes	Yes	Yes	Yes
DELETE*	1	Yes	Yes	Yes	FY 1982
DESTROY	1	Yes	Yes	Yes	Yes
DISKEDIT	3	Yes	Yes	No	No
DJ	3	Yes	Yes	No	No
ED	1	Yes	Yes	Yes	FY 1982
EDIT	2	Yes	Yes	Yes	Yes
ERGO	4	Yes	Yes	No	No
EXE	2	Yes	Yes	Yes	Yes
FICHE	1	Yes	Yes	Yes	Yes
FILES	1	Yes	Yes	Yes	Yes
FRED	1	Yes	Yes	Yes	Yes
GIVE	1	Yes	Yes	Yes	Yes
HELPME	1	Yes	Yes	Yes	Yes
HISTORN	1	Yes	Yes	Yes	FY 1982
HSP	1	Yes	Yes	Yes	Yes
INDEX	1	Yes	Yes	Yes	Yes
INFO	1	Yes	Yes	Yes	Yes
JPRIO*	1	Yes	Yes	Yes	FY 1982
LCBT	1	Yes	Yes	Yes	FY 1982
LDR	1	Yes	Yes	Yes	Yes
LFICHE	1	Yes	Yes	Yes	Yes
LHSP	1	Yes	Yes	Yes	Yes
LIB	1	Yes	Yes	Yes	Yes
MAGIC	1	Yes	Yes	Yes	Yes
MASS	1	Yes	Yes	Yes	Yes
MEETINGS	1	Yes	Yes	Yes	Yes
MOVE	1	Yes	Yes	Yes	Yes
NTEXT	1	Yes	Yes	Yes	Yes

(continued on next page)

PARSER	1	Yes	Yes	Yes	Yes
PROD*	1	Yes	Yes	Yes	FY 1982
QED	3	Yes	Yes	Yes	No
QPRIO*	1	Yes	Yes	Yes	FY 1982
QUO	1	Yes	Yes	Yes	Yes
ROFF	4	Yes	Yes	Yes	No
SNOOPY	1	Yes	Yes	Yes	Yes
SPRINT	1	Yes	Yes	Yes	Yes
ST	4	Yes	Yes	Yes	No
STATUS*	1	Yes	Yes	Yes	FY 1982
STEXT	1	Yes	Yes	Yes	Yes
SUBMIT*	1	Yes	Yes	Yes	FY 1982
SWITCH	1	Yes	Yes	Yes	Yes
SYMGEN	4	Yes	Yes	No	No
TALLY	1	Yes	Yes	Yes	Yes
TIDY	1	Yes	Yes	Yes	Yes
TRANS	1	Yes	Yes	Yes	Yes
TRIXGL	2	Yes	Yes	Yes	No
WHO	1	Yes	Yes	Yes	Yes
WHT	2	Yes	Yes	Yes	Yes
X0007-10*	1	6/82	6/82	6/82	FY 1982

*FOCUS utilities.

TABLE XIX

LTSS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
ABORT*	1	Yes	Yes	Yes	FY 1982
ALLOUT	1	Yes	Yes	Yes	Yes
AUTOPSY	1	Yes	Yes	Yes	Yes
AUTOSUM	1	Yes	Yes	Yes	Yes
BATCH	1	Yes	Yes	Yes	No
CBT	1	Yes	Yes	Yes	FY 1982
COMPARE	1	Yes	3/82	Yes	Yes
CONVERT	1	Yes	Yes	Yes	Yes
COPY	1	Yes	Yes	Yes	Yes
COSMO (BATCH)	1	Yes	Yes	Yes	Yes
DBCOL (BATCH)	1	Yes	Yes	Yes	No
DBCTRL	4	Yes	Yes	Yes	No
DDT	1	Yes	Yes	Yes	Yes
DELETE*	1	Yes	Yes	Yes	FY 1982
DESTROY	1	Yes	Yes	Yes	Yes
ED	1	Yes	Yes	Yes	FY 1982
EDIT	2	Yes	Yes	Yes	No
FICHE	1	Yes	Yes	Yes	Yes
FILES	1	Yes	Yes	Yes	Yes
FILES99	1	Yes	Yes	Yes	3/82
FRED	1	Yes	Yes	Yes	Yes
GIVE	1	Yes	Yes	Yes	Yes
HELPME	1	Yes	Yes	Yes	Yes
HISTORN	1	Yes	Yes	Yes	FY 1982
HSP	1	Yes	Yes	Yes	Yes
INDEX	1	Yes	Yes	Yes	Yes
INFO	1	Yes	Yes	Yes	Yes
JPRIO*	1	Yes	Yes	Yes	FY 1982
LCBT	1	Yes	Yes	Yes	FY 1982
LFICHE	1	Yes	Yes	Yes	Yes
LHSP	1	Yes	Yes	Yes	Yes
LIB	1	Yes	Yes	Yes	Yes

(continued on next page)

LIX	1	Yes	Yes	Yes	Yes
LOD	1	Yes	Yes	Yes	No
LODF	1	Yes	Yes	No	No
LODF5	1	Yes	Yes	No	No
MAGIC	1	Yes	Yes	Yes	Yes
MASS	1	Yes	Yes	Yes	Yes
MEETINGS	1	Yes	Yes	Yes	Yes
MOVE	1	Yes	Yes	Yes	Yes
NTEXT	1	Yes	Yes	Yes	Yes
PARSER	1	Yes	Yes	Yes	Yes
PROD*	1	Yes	Yes	Yes	FY 1982
QED	3	Yes	Yes	Yes	No
QPRIO*	1	Yes	Yes	Yes	FY 1982
RDRT11	1	Yes	Yes	No	FY 1982
RDRSX	1	Yes	Yes	No	FY 1982
ROFF	4	Yes	Yes	Yes	No
RTAPE	1	7/81	7/81	Yes	2/28/82
SHIPPER (BATCH)	1	Yes	Yes	Yes	FY 1982
SNOOPY	1	Yes	Yes	Yes	Yes
SPRINT	1	Yes	Yes	Yes	Yes
ST	4	Yes	Yes	Yes	No
STATUS	1	Yes	Yes	Yes	Yes
STATUS*	1	Yes	Yes	Yes	FY 1982
STEXT	1	Yes	Yes	Yes	Yes
SUBMIT*	1	Yes	Yes	Yes	FY 1982
SWITCH	1	Yes	Yes	Yes	Yes
TALLY	1	Yes	Yes	Yes	Yes
TAPECONV	1	Yes	Yes	No	FY 1982
TIDY	1	Yes	Yes	Yes	Yes
TRANS	1	Yes	Yes	Yes	Yes
TRIX	3	Yes	No	No	No
TRIXAC	3	Yes	No	No	No
TRIXGL	2	Yes	Yes	Yes	No
WHO	1	Yes	Yes	Yes	Yes
WHT	2	Yes	Yes	Yes	Yes
WRRSX	1	Yes	Yes	No	FY 1982
WTAPE	1	7/81	7/81	Yes	3/82
X0007-10*	1	6/82	6/82	6/82	FY 1982

*FOCUS utilities.

TABLE XX

NOS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
ED	1	3/82	Yes	Yes	FY 1982
FRED	1	No	No	Yes	FY 1982
HISTORN	1	Yes	Yes	Yes	FY 1982
LCBT	1	Yes	Yes	Yes	FY 1982
LFICHE	1	Yes	Yes	Yes	Yes
LHSP	1	Yes	Yes	Yes	Yes
MAGIC	1	Yes	Yes	Yes	Yes
MASS	1	Yes	Yes	Yes	Yes
NTEXT	1	Yes	Yes	Yes	Yes
PARSER	1	Yes	Yes	Yes	Yes
SPRINT	1	Yes	Yes	Yes	Yes
STEXT	1	Yes	Yes	Yes	Yes
TIDY	1	Yes	Yes	Yes	Yes

TABLE XXI

VMS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
ABORT*	1	Yes	Yes	Yes	FY 1982
AR	4	Yes	Yes	Yes	No
DELETE*	1	Yes	Yes	Yes	FY 1982
ED	1	Yes	Yes	Yes	FY 1982
FRED	1	8/82	8/82	8/82	No
HISTORN	1	Yes	Yes	Yes	FY 1982
INCL	4	Yes	Yes	Yes	No
JPRIO*	1	Yes	Yes	Yes	FY 1982
LFICHE	1	Yes	Yes	Yes	FY 1982
LHSP	1	Yes	Yes	Yes	Yes
MAGIC	1	Yes	Yes	Yes	Yes
MASS	1	Yes	Yes	Yes	Yes
NETON/ NETOFF	1	4/82	4/82	4/82	No
NTEXT	1	Yes	Yes	Yes	Yes
PARSER	1	Yes	Yes	Yes	Yes
PROD*	1	Yes	Yes	Yes	FY 1982
QPRIO*	1	Yes	Yes	Yes	FY 1982
ROFF	4	Yes	Yes	Yes	No
SPRINT	1	Yes	Yes	Yes	FY 1982
STATUS*	1	Yes	Yes	Yes	FY 1982
STEXT	1	Yes	Yes	Yes	Yes
SUBMIT*	1	Yes	Yes	Yes	FY 1982
X0007-10*	1	6/82	6/82	6/82	FY 1982

*FOCUS utilities.

4.6 GRAPHICS UTILITIES

We support a standard set of graphics utilities across operating systems. These utilities are developed using software engineering techniques and are constantly upgraded to take advantage of new features. Graphics utilities consist of general- and special-purpose graphics programs and CGS Metafile postprocessors.

General-purpose postprocessors are programs that take the CGS Metafile as input and direct the output to specific graphics devices. The Metafile can be generated by using any of the graphics libraries and graphics utilities. The CGS Metafile postprocessors, PFILM and PESP, provide the only way to obtain graphics output through PAGES.

Our plans for FY 1982 are to enhance the current utilities as well as to add new utilities. Some of the enhancements planned for PSCAN include the capability to display, write, and generate hard copy for a range of frames. MAPPER enhancements include upgrading to take advantage of new DISSPLA features, such as blanking capabilities and additional shaded character fonts. PFILM and PESP will be enhanced to support a keep option.

The new utilities to be added next year include MAPEDIT, PCAED, and PCBT. MAPEDIT allows users to interactively generate MAPPER input files using an

interactive graphics terminal. PCAED will translate a CGS Metafile for display on an AED color graphics terminal. PCBT will send a CGS Metafile to a specified CBT. The Metafile will be sent to a staging computer that will translate it to a Versatec file. The staging computer will then send the Versatec output file to the specified CBT for output on a Versatec plotter. Tables XXII-XXV give the status of the supported graphics utilities.

TABLE XXII

CTSS GRAPHICS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
GAS	1	Yes	Yes	Yes	Yes
MAPEDIT	1	2/82	Yes	2/82	Yes
MAPPER	1	Yes	Yes	Yes	Yes
MOVIE	2	Yes	Yes	Yes	No
PCAED	1	4/82	Yes	4/82	3/82
PCBT	1	4/82	Yes	4/82	3/82
PESP	1	Yes	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes	Yes
PSCAN	1	Yes	Yes	Yes	Yes
PTEKT	1	Yes	Yes	Yes	Yes
PZETA	1	Yes	Yes	Yes	Yes

TABLE XXIII

LTSS GRAPHICS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
DRAW	4	Yes	Yes	Yes	Yes
FRME	1	Yes	Yes	Yes	Yes
GAS	1	Yes	Yes	Yes	Yes
GRAPE	2	Yes	Yes	Yes	Yes
MADEDIT	1	2/82	Yes	2/82	Yes
MAPPER	1	Yes	Yes	Yes	Yes
PCAED	1	4/82	Yes	4/82	3/82
PCBT	1	4/82	Yes	4/82	3/82
PESP	1	Yes	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes	Yes
PLYDRAW	4	Yes	Yes	Yes	Yes
PSCAN	1	Yes	Yes	Yes	Yes
PTEKT	1	Yes	Yes	Yes	Yes
PZETA	1	Yes	Yes	Yes	Yes
QUADRAW	4	Yes	Yes	Yes	Yes
SLIDES	1	Yes	Yes	Yes	Yes

TABLE XXIV

NOS GRAPHICS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
ANIMATE	1	Yes	Yes	Yes	Yes
DRAW	4	Yes	Yes	Yes	Yes
MAPEDIT	1	2/82	Yes	2/82	Yes
MAPPER	1	Yes	Yes	Yes	Yes
PCAED	1	4/82	Yes	4/82	3/82
PESP	1	Yes	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes	Yes
PTEKT	1	Yes	Yes	Yes	Yes
PZETA	1	Yes	Yes	Yes	Yes
SLIDES	1	Yes	Yes	Yes	Yes

TABLE XXV

VMS GRAPHICS UTILITIES STATUS

Utility	Level of Support	In Production	Source Code Available	User Documentation Available	Quality Assurance Complete
MAPEDIT	1	2/82	Yes	2/82	1/82
MAPPER	1	Yes	Yes	Yes	Yes
PCAED	1	4/82	Yes	4/82	3/82
PESP	1	Yes	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes	Yes
PSCAN	1	Yes	Yes	Yes	Yes
PTEKT	1	Yes	Yes	Yes	Yes

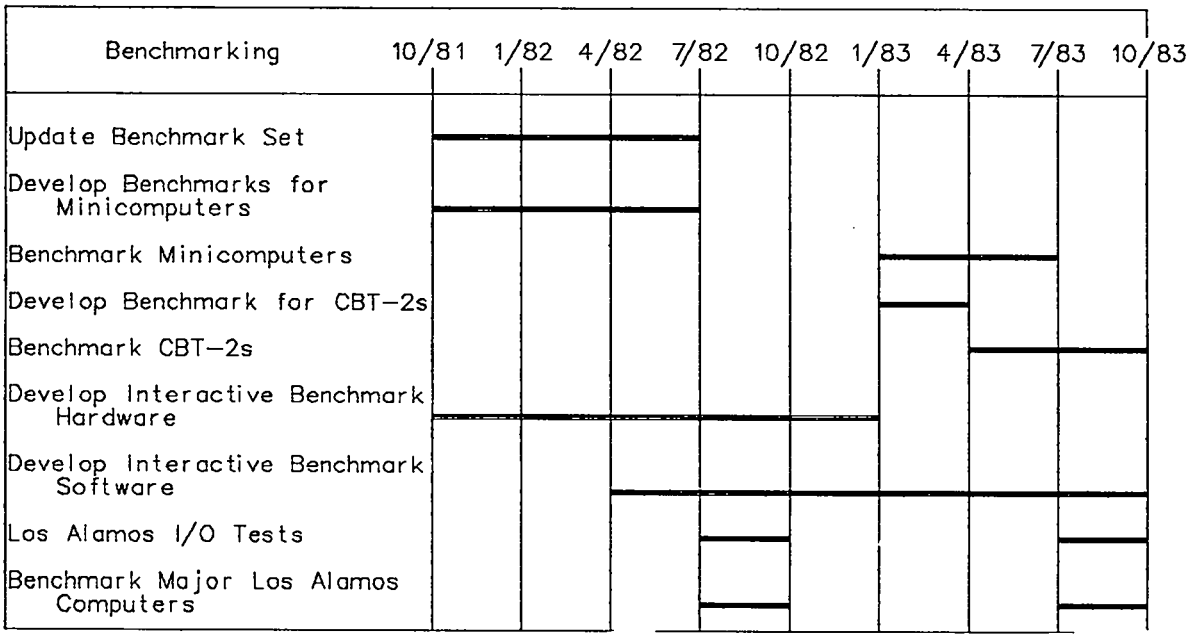
4.7 OTHER PROJECTS

We also have other software projects in the development stages that support our activities. Among those projects are our work on future systems, benchmarking, performance measurement and evaluation, and automated information management.

4.7.1 Benchmarking

We have a continuing benchmarking effort to test existing Laboratory computers and new computers of potential interest to the Laboratory. This work provides the basis for decisions on future computer procurements. During FY 1982 we plan major updating of our benchmark programs, including new programs and test programs for Fortran 77. We will study the workload of minicomputers, assemble a special benchmark set for them, and in 1983 benchmark a number of minicomputers of interest to us. We will also develop an appropriate set of benchmarks for CBT-2s and run them on CBT-2 prototypes.

In our effort to develop a benchmarking tool for interactive systems, we will design and assemble hardware and software for a portable terminal emulator. We will study the interactive workload and design scripts appropriate for evaluating interactions with nonintelligent terminals as well as CBT-2s. During both years we will test computing and I/O speeds of major Los Alamos computers and benchmark several new machines that are expected to reach the market. Our general plans for the benchmark effort are shown in Schedule 18.



Schedule 18. Benchmarking.

4.7.2 Performance Measurement and Evaluation

Performance measurement and evaluation is a continuing effort to characterize the ICN services and to report them in the various forms required by operations, system tuning, equipment acquisition, management planning, etc. Three projects are being planned for this effort: (1) continued modeling of CTSS and the ICN, (2) machine-independent description of the CCF job load, and (3) the development of an improved network measurement function.

CTSS Modeling

Our CTSS modeling efforts include preparing a validated model of CTSS and the Cray-1 hardware, developing Laboratory workload characteristics, investigating alternate CTSS software and Cray-1 features, and preparing a validated model of the ICN switching function.

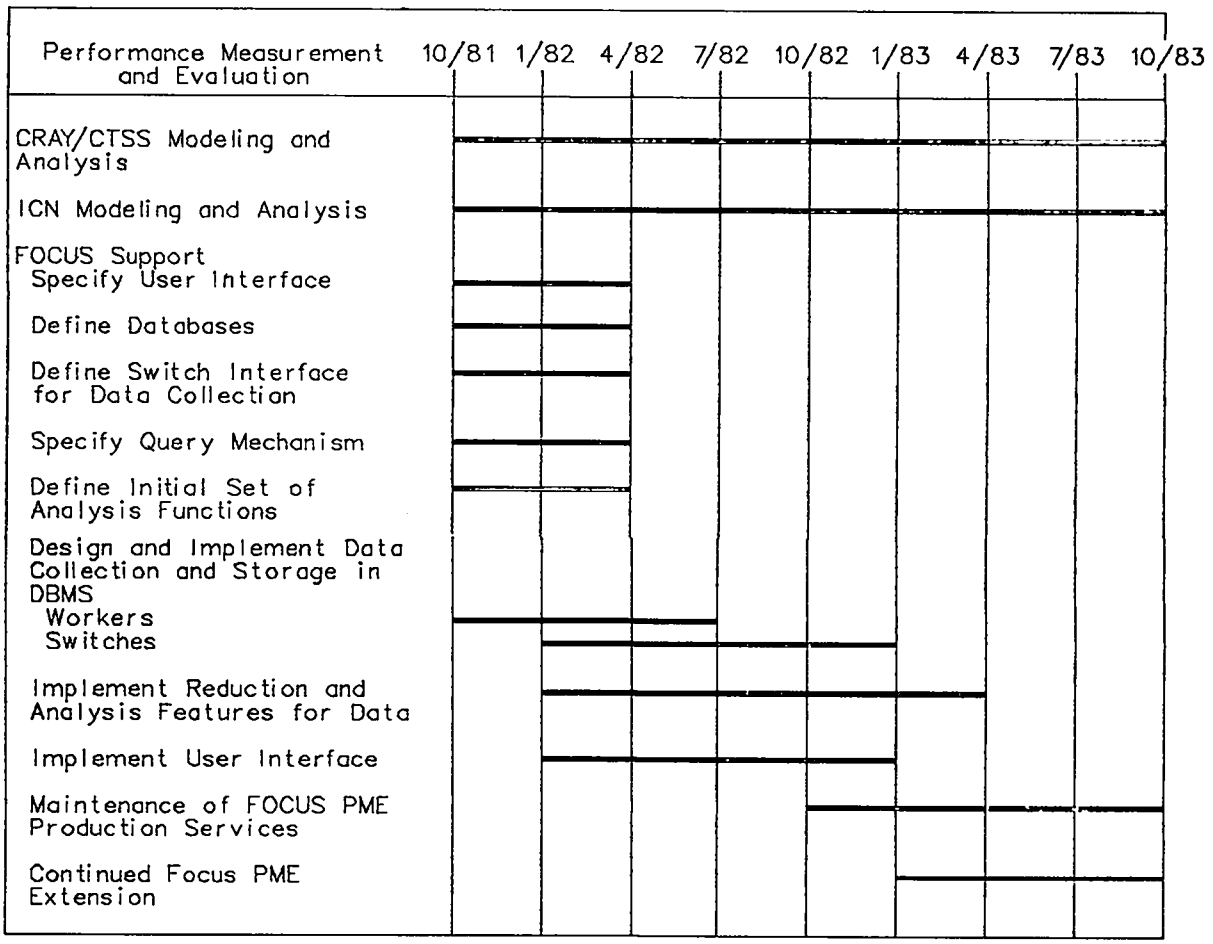
Machine-Independent Description of CCF Job Load

This project will seek means to report data such as number of batch versus interactive jobs; ratio of CPU- to I/O-bound jobs; origin (KCC ports versus

CBT versus XNET, etc.); number of compilations, edits, executions of common utilities; number, size, and lifetime of local files; number, size, and route of file transports; and running time of jobs.

Improved Network Measurement Function

FOCUS will provide a centralized means for measuring data flow in the network and for collecting workload data from the workers. These data will be used to support the CTSS modeling effort and the CCF workload characterization effort. This project requires that mechanisms be defined and implemented to collect, store, query, and analyze the data collected from worker computers and network switches. As part of the project it will be necessary to define and implement data collection facilities in the workers and in the switches. The data storage and query work will be done on FOCUS.



Schedule 19. Performance measurement and evaluation.

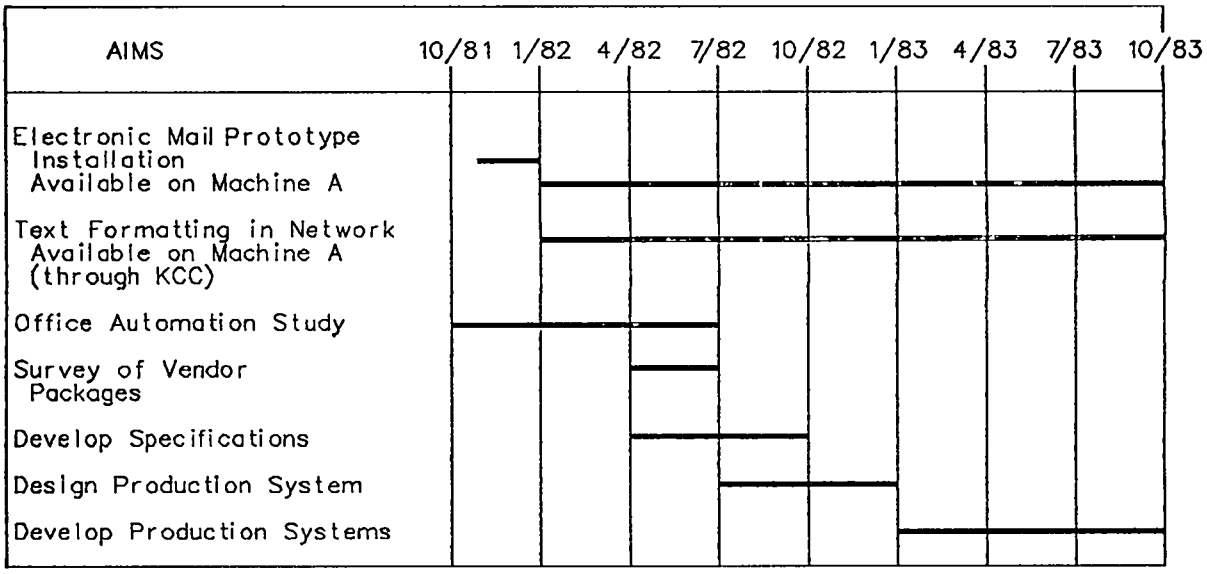
4.7.3 Automated Information Management System

The Automated Information Management System (AIMS) is a computer-based system for integrating information management requirements. The purpose of AIMS is to provide efficient means of creating, transmitting, storing, and retrieving both technical and administrative information. It includes such functions as document production, word processing, database management/information retrieval, data entry, access to external networks, and electronic mail and other office management tools.

Bell Northern Research of Palo Alto, California, is conducting an office automation study for us on how professionals and managers at the Laboratory work and the information needs they have. In the meantime, we are developing information management tools on the AIMS machine, Machine A, which is connected as a worker in the Open partition of the ICN. Machine A is a VAX 11/780 currently running UNIX.

The initial prototype system now available on Machine A currently features electronic mail; text formatting (through a KCC); and office management tools (calendar, desk calculator, and phone directory). This prototype system represents only an initial capability; production AIMS functions will be selected based on the results of the office automation study and the initial installation. Major areas to be addressed include electronic mail and filing, word processing, activity management, and information retrieval. Planning, development, and implementation of these features will not be trivial efforts; extensive efforts must be directed toward the establishment of a comprehensive, cohesive, and friendly user interface.

Related activities include procurement of a data entry system for the Computer Documentation Group, access to external networks such as Telenet and ARPANET, and selection of a standard word processing system. We are currently in the process of expanding our user community to include friendly users in other divisions.



Schedule 20. Automated Information Management System (AIMS).

4.7.4 Advanced Interactive Display System

The objective of the Advanced Interactive Display System (AIDS) is to provide high-speed, high-quality interactive display of both graphical and textual data on inexpensive display equipment within users' offices. AIDS will be an enhancement to our current graphics system, providing an interface to the Common Graphics System and to a text editor.

In FY 1981, the Multi Picture System (MPS) was successfully upgraded and tested, and plans for remoting to X-Division were completed. Cray-VAX file-transport effective rates of 0.8-1.3 Mbit/s and Cray-MPS rates of 200 kbit/s were achieved. An AIDS experimental system was designed, hardware procured, and experiments begun. Software developments included vector-to-raster conversion, a Common Graphics System interface, and communication hardware drivers. In addition, a broadband distribution system for the Administration Building was designed and the associated security proposal drafted.

The thrust of the work during FY 1982 will be to implement and operate a prototype AIDS system. The objectives of this work are to

- provide a basic capability;
- gain experience in installing and operating the system;
- develop skills necessary to diagnose, maintain, and modify the equipment and software;
- determine ways to improve performance; and
- model throughput and usage before full-scale implementation.

Experimental System

We will continue the experimental system to develop a multiuser protocol, test communication hardware, and optimize system software that will become the core

of the prototype system. A VAX with a secure file-transport connection is needed for this work.

Prototype System

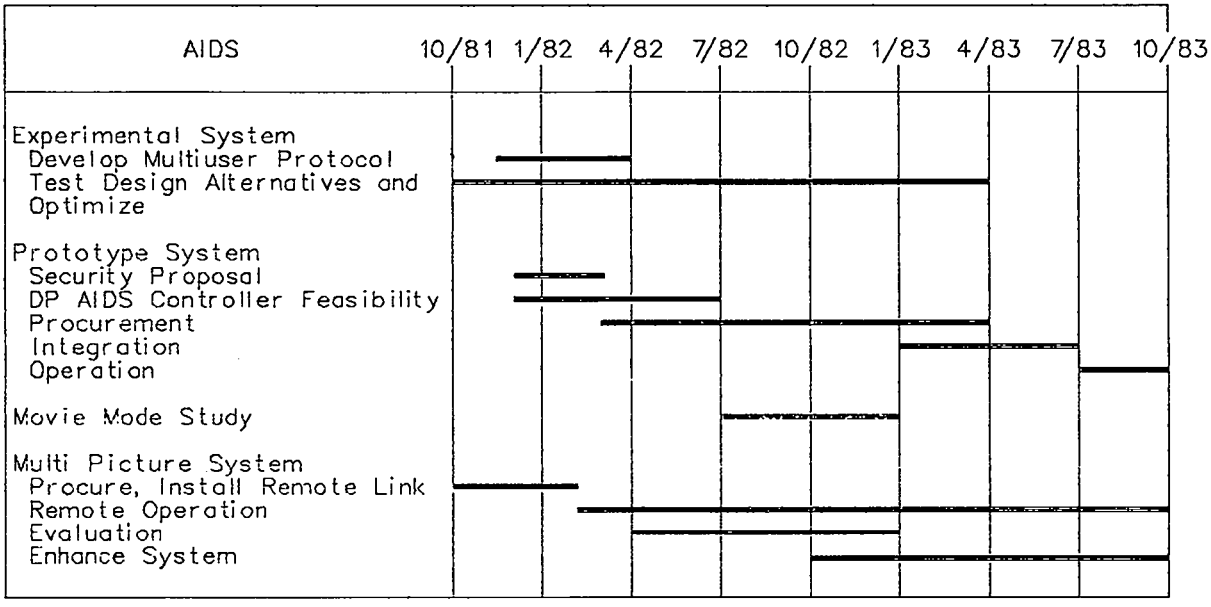
Components of the proposed prototype system include a communications controller that interfaces to the ICN, digital- and video-communications interface equipment, a frequency multiplexed coaxial cable distribution system, and a number (≤20) of end-user displays. The major expense of the prototype design is the cost of the controller. As an alternate prototype design, we will investigate the feasibility of using a Distributed Processor as an AIDS controller. Current funding uncertainties indicate that FY-1982 prototype implementation may be delayed until FY 1983.

Movie Mode Study

An investigation will be made of existing technologies and development costs for a processor-based workstation to provide users with a movie mode capability. The objective of this system is to provide at least 6-12 frames/s on a medium-to-high resolution display. Data to be viewed will be staged to a local storage source before display.

Multi Picture System

The Multi Picture System (MPS) will provide weapons designers with a high-performance graphics system to be used initially for viewing and interacting with weapons codes. The MPS has been installed on the X-4 VAX. Installation of the SEL-to-X-4 VAX communication link awaits hardware component delivery. User evaluation will provide direction for future work. Efforts to enhance interaction, increase throughput, and develop a multiuser protocol are planned.



Schedule 21. Advanced Interactive Display System (AIDS).

4.7.5 Facility for Operations Control and Utilization Statistics

The Facility for Operations Control and Utilization Statistics (FOCUS) is a production control subsystem that has been under development for the Central Computing Facility and that will become operational in FY 1982. It will integrate and automate such functions as production control, load leveling, status reporting, and performance measurement for the large supercomputers at the Laboratory. The result will be a significantly higher level of computer utilization efficiency and a standardization of the production user interface across CTSS, LTSS, Distributed Processors, and CBT-2s. The system performs the functions of a general, automated production-control system, an operator status and control system, and a performance measurement system.

The various ICN status-reporting components will be consolidated to minimize the number of terminals with which the operations staff must deal in performing their functions, thereby providing a more unified interface for monitoring major ICN nodes.

Status reporting and performance measurement functions include an early warning system for detection of hardware and software problems, interrogation of network and worker computers for workload and performance data, maintenance of a network-wide workload and performance history, and production of network performance summaries. Production control functions include scheduling tasks on the worker computers according to allocations and priorities, load leveling production among worker computers, and providing operators with status and manual override capabilities. The development is being done in two phases.

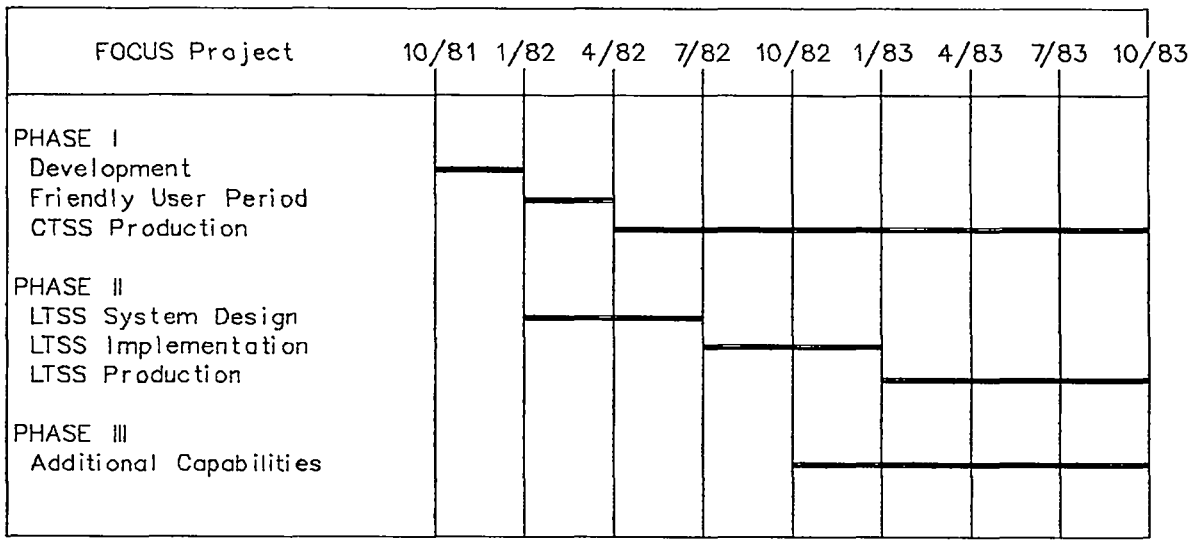
Phase 1

- Production job control will be moved from CTSS worker computers to the FOCUS computers.
- Scheduling decisions will be made based on Laboratory allocations, job characteristics, user input, and worker machines status.
- Common production queues will be maintained for CTSS.
- Users will be able to inquire about CTSS production job status from a centralized point.
- Operators will be able to manually run CTSS production jobs in a degraded mode when FOCUS is unavailable.
- Status and utilization will be displayed for each CTSS worker machine and the Common File System. Production job information will be displayed for CTSS.
- Operators will be able to specify which display is to be on which screen.
- Utilization data will be gathered from workers.
- Data will be available to status modules for display.
- Operator help package will be available to describe commands.

Phase 2

- Production job control will be extended to include LTSS.
- Users will be able to submit ordered jobs (a job that will not be executed until another specified job completes).
- Load leveling will optimize the use of the CTSS and LTSS worker computers.

- Graphical display of the entire ICN showing which nodes are up or down along with a rough indication of load or traffic.
- Status and utilization will be extended to provide displays for network switches, XNET, and PAGES.



Schedule 22. Facility for Operations Control and Utilization Statistics (FOCUS).

4.7.6 Automated Accounting

In FY 1981, the two main automated accounting tools, AUTOLOG and AUTOSUM, were put into operation. Now all CCF services are being automatically tracked with associated records filed in the CFS AUTOLOG database. Also, through AUTOSUM, CCF users can access this data to determine such things as their utilization to date in the current month, how and by whom their charges were made in past months, and trends in their computer utilization.

This past year has also seen the start of the drive to move the accounting programs from NOS to CTSS. This should cut the accounting cycle from four days to two while allowing the addition of raw data checking routines that were too time consuming to be done on the NOS version. In FY 1982 we will move the remaining NOS-based processes to CTSS.

Future work will include providing more extensive back-up of critical accounting data sets and automating the routine checking of month-to-date accounting records.

5 NEW DEVELOPMENT PROJECTS

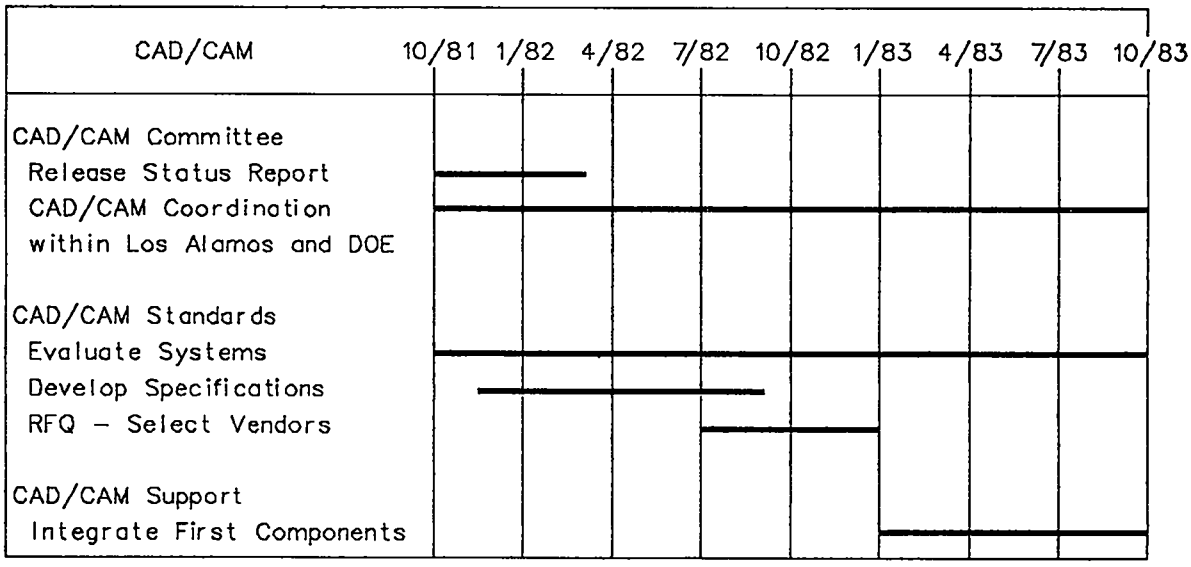
5.1 COMPUTER AIDED DESIGN/COMPUTER AIDED MANUFACTURING

Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) is a system containing computer hardware and software elements to assist the engineer, designer, and draftsman in the definition and development of a technical design. CAD/CAM assists the manufacturing engineer, tool designer and/or industrial engineer in implementing various phases of the manufacturing or production process. A CAD/CAM system usually will include capability for engineering design, analysis, drafting, database control, process planning, part nesting, numerical control machining, and other related computerized data utilization.

This effort will focus on the integration and support of CAD/CAM technology for many diverse applications at Los Alamos and will be done in cooperation with the Los Alamos CAD/CAM committee. We have identified needs in three areas and formed teams to generate functional specifications for systems in those areas. Because these systems will be used in diverse applications and geographical locations and will need to be integrated with existing CCF capabilities, the specifications will place strong emphasis on the capability to be integrated.

We anticipate that the heaviest use of CAD/CAM will be in the area of mechanical design and drafting, with its associated numerical control manufacturing, engineering analysis, and physical modeling. A second area of anticipated heavy use is electronic design and drafting. A third area is facilities management, including planning, space allocation, utility locations, electrical distribution systems, piping systems, communication systems, alarm systems, and architecture.

As a result of this effort, users will be able to easily acquire a standard, supported CAD/CAM system either as a dedicated resource or as a shared resource within the ICN. Users also will be able to easily exchange design data with other users.



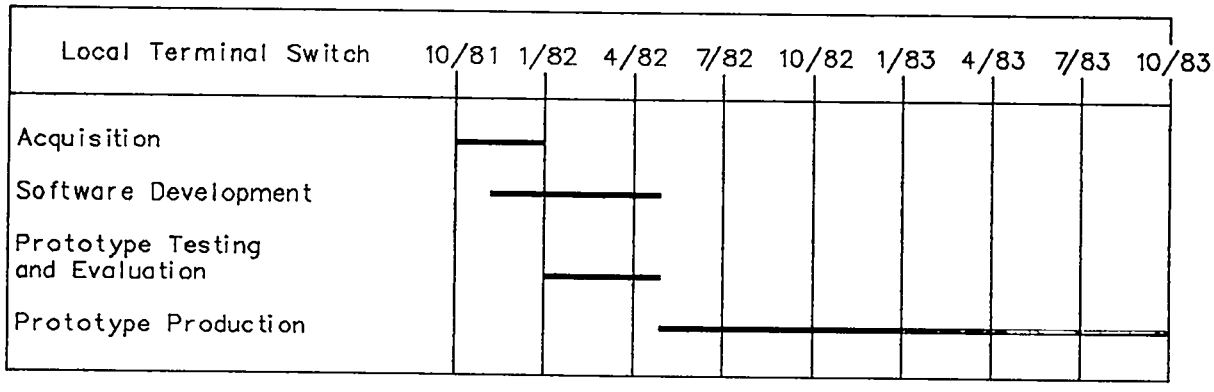
Schedule 23. Computer Aided Design/Computer Aided Manufacturing (CAD/CAM).

5.2 NETWORK UPGRADES

5.2.1 Local Terminal Switch

The Local Terminal Switch is a commercially available device that will provide access from any of a number of terminals to any one of a number of computers. The terminal user, through a dialogue with the Switch, chooses the desired resource and is then connected to it as though his/her terminal were a local terminal to the selected computer system.

The Digital Equipment Corporation VMS system and future releases of the NOS system from Control Data will preclude our current type of KCC communications without extensive operating system modifications. We are planning to acquire a prototype switch to examine its usefulness for vendor systems in the ICN environment. The Local Terminal Switch will allow us to evaluate the benefits associated with providing these tools to software developers as well as minimize the associated data communication costs.



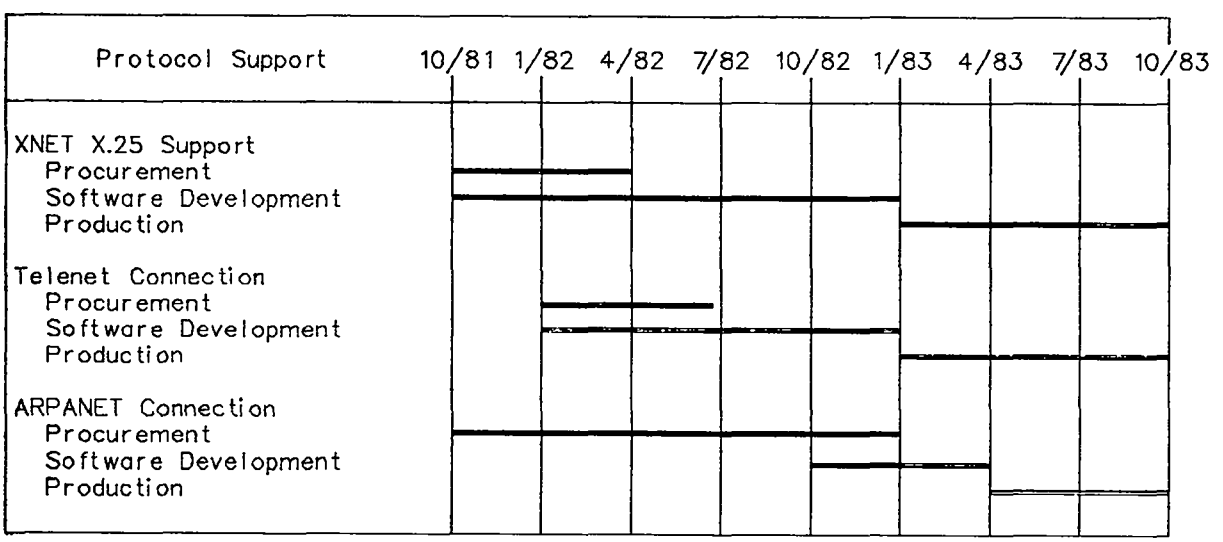
Schedule 24. Local Terminal Switch.

5.2.2 X.25 Protocol Support

Software support for the X.25 protocol will be tested in the XNET switches during FY 1982. This protocol will be tested as part of new product support available under DECnet. The X.25 protocol will allow us eventually to have connections to outside services such as Telenet and Tymnet. In addition, intelligent terminals that provide support for X.25 can potentially be connected to the ICN through an X.25 gateway switch.

Telenet and Tymnet are commercial services that provide circuit connections from one location to another. A user may subscribe to these services for a monthly fee based on a connect charge plus a measured service charge. These charges are based on the number of packets or the number of bytes sent. Such services provide the remote user with a much cheaper connection to the ICN than a dedicated telephone company line.

ARPANET is an operational resource-sharing network linking a wide variety of computers at research centers sponsored by the Defense Advanced Research Projects Agency and Department of Defense (DoD) and non-DoD centers in the continental United States, Hawaii, Norway, and England. Among the services available to users on ARPANET are terminal access to remote hosts, intercomputer file shipping, and a network-wide electronic mail system. Cost for this service is distributed and is based on the total ARPANET cost and the total number of subscribing sites.



Schedule 25. Protocol support.

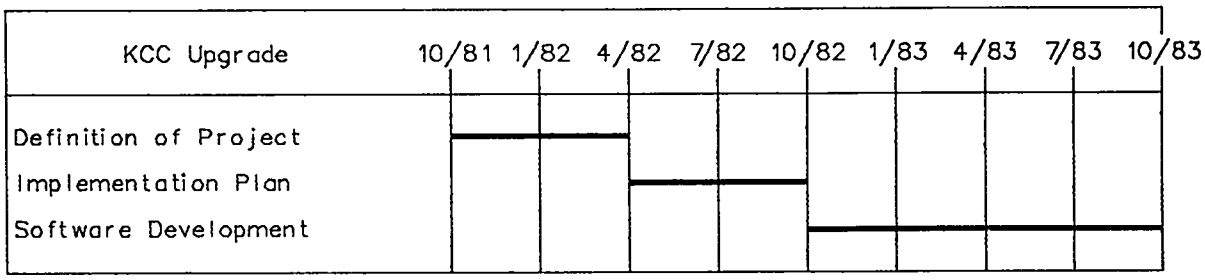
5.2.3 KCC Upgrade

The phrase "KCC upgrade" describes a loosely coupled set of improvements that are needed in various areas of the ICN. By April 1982 we will determine the scope of this project. The projects may include

- symmetry between KCC protocols and file transport protocols,
- flow control from the KCCs,
- more intelligible KCC messages, and
- a better structuring of worker network software so that protocol levels and actions need not be presented to the system as user code.

Symmetric protocols are needed to provide full terminal passthrough functions for Distributed Processors and CBT-2s. Flow control is required to support higher data rates and larger amounts of data and to prevent high-speed devices from overflowing lower speed devices. Improved KCC messages are needed because many of our current messages are ambiguous. A better structuring of system software would result in improved efficiency of the process-to-process protocol when used in terminal passthrough and various other functions.

After the project is defined, we will have to plan its implementation carefully because it affects almost every node of the ICN. We will complete plans for the implementation by October 1982 and then spend FY 1983 developing the KCC upgrade. Implementation is not likely to occur before FY 1984.



Schedule 26. KCC upgrade.

6 DIRECT USER SERVICES

Direct user services are those services that involve a person-to-person interaction rather than a person-to-machine interaction. These are special services provided by C Division to help users in areas such as consulting, slide preparation, custom programming, equipment acquisition, documentation, data communications, and project management.

6.1 CONSULTING OFFICE

The Consulting Office's primary function will continue to be that of providing consulting service to ICN users on all supported major computers, operating systems, and libraries. Approximately 50% of each consultant's time is spent in such direct consulting. Consultants will continue to construct, maintain, and enhance a large variety of utility programs, subprograms, and library routines. These utility programs fall largely, but not exclusively, into the area that facilitates the editing, updating, storage, retrieval, and execution of source programs. The Consulting Office will help to ensure the integrity of new versions of a system and associated utilities before they are installed. Finally, the consultants will, from time to time, participate in the Computing Education Program by conducting tutorials on such things as editors, debugging tools, and mass storage devices.

6.2 NUMERICAL CONSULTING

A major activity of many scientists at the Laboratory is the mathematical modeling of physical processes. Often these models take the form of differential or integral equations and are sufficiently complicated to require numerical solution. C-3 is providing consulting and research services designed to increase the effectiveness of these models. This involves collaboration between Laboratory groups skilled in modeling and Group C-3, which is skilled in problem-solving techniques, both analytic and computational.

6.3 DOCUMENTATION

The Computer Documentation Group provides new user documentation and maintains current documentation for CTSS, LTSS, NOS, CFS, XNET, the network, and VMS utilities and software changes. Documentation assistance is also provided to the Computer Graphics Group. The Group also publishes the ICN Change Bulletin and the Computing Division News. Both of these publications are currently undergoing extensive redesign. Planned major documentation projects include complete updating of LTSS documentation; a network overview document; AIMS documentation, as required; additional XNET documentation; revision of the CFS PIM and Primer; updating the Computing Division Glossary; and an online keyword index of all user documentation.

The Group is developing a comprehensive Documentation Plan for the Division's computer services. This plan will propose a standard set of documents, with the function and content of each document type described in detail.

6.4 COMPUTING INFORMATION CENTER

The Computing Information Center offers a comprehensive collection of computing information for distribution to network users. This information includes vendor- and locally-written manuals, subroutine and utility writeups, introductory documentation packages, and reference cards. The Center maintains mailing lists for distribution of the C-Division News, the ICN Change Bulletin, and revisions of popular documents.

The Center provides access to libraries of software available through outside sources. Additional computing information is available for reference.

In FY 1982, we will investigate a uniform catalog system for all computing information. This will enable people to know what information is available and where to find it. We also will update and distribute "User Visible Software," a document identifying network software that interfaces to the user.

6.5 CUSTOM PROGRAMMING

Programming services are provided by the Computer Research and Applications Group (C-3) for other groups throughout the Laboratory. The work is performed by a pool of programmers and data analysts whose abilities extend over all ICN systems and computers. The variety of personnel and depth of their programming knowledge enables C-3 to provide professional service to diverse requests in a relatively short time.

Projects range from short-term duration to maintenance and consulting services on a semipermanent basis. Work assignments include scientific programming, code conversion, database jobs, data analysis, project management, and systems programming. Many of C-3's staff perform their tasks at the user's site, thereby providing on-site participation.

6.6 DATA COMMUNICATIONS SUPPORT

The Data Communications Group provides service to Distributed Processor sites and all ICN-connected terminal users. The section provides engineering, equipment specification and ordering, installation, and maintenance. Working with the Computer Communications Office, Data Communications provides all the support to carry requests for new service through to complete operational status. The Data Communications personnel are also cleared for work on encryption and all protected wireline systems. These systems are engineered and installed following a consistent methodology that meets National Security Agency requirements for security protection.

6.7 COMPUTER COMMUNICATIONS SUPPORT

The Trouble-Call Office (TCO) provides services to users having problems with existing communications ports and channels.

The Communications Coordinating Office (CCO) provides a single point of contact for users desiring new communications facilities or services and changes and relocations for existing communications facilities. This office gathers information about a requested project and provides the requester a written proposal that details the requirements. Once a project proposal is accepted by the requester, a project plan is developed. The project plan is coordinated with the requester and results in a detailed PERT chart with due dates and project deadlines. This service is also extended to include design, installation, and maintenance of remote terminal distribution systems and other related data communications requirements.

6.8 GRAPHICS PRODUCTION SERVICE

The Computer Documentation Group provides a graphics production service to generate 35-mm slides and viewgraphs for presentations by Laboratory personnel. These computer-generated graphics can be in color or in black-and-white and can range from simple text to complex graphs, charts, and drawings. The high quality of these graphics also makes them suitable for journal and report illustrations. This service is available on a Form-B basis.

6.9 PROJECT MANAGEMENT

Group C-3 maintains project-management information and support systems for ongoing Laboratory R&D projects including standard critical path method (CPM) network scheduling; manpower planning and leveling; integrated cost/schedule reporting; and graphic display of networks, bar charts, manpower curves, and cost curves. The software packages used are Andrew Sipos Associates project management system (ASA) for scheduling and EZPERT for graphical representation of project data. Consultation services are provided for ASA/EZPERT users at the Laboratory. After a reasonable testing and evaluation period, C-3 plans to either upgrade the current ASA/EZPERT software package or purchase a new project management system. The need for classified reports and graphics is apparent and will be a requirement in a new or revised system.

6.10 DATABASE MANAGEMENT

Group C-3 also provides and maintains database management software on the NOS machines (System 2000) and for the Distributed Processors (Data Retrieval System, DRS). Limited consultation will be provided for the FRAMIS database system. Consulting and short-term programming help is provided on an as-needed basis.

6.11 PROCUREMENT CONSULTING AND REVIEW

The Laboratory depends heavily on both general-purpose and special-purpose computers as well as Word Processing (WP) equipment. More than 400 computer systems and 200 word processing systems have been installed at the Laboratory, and the number continues to grow.

In 1967, federal legislation was enacted aimed at assuring that all ADP equipment and/or related services would be acquired as economically as possible and still fulfill the stated requirement. Since 1978, similar regulations have applied to WP equipment and services. The Laboratory must comply with these requirements and regulations before orders can be placed for ADP equipment, WP equipment, or related services. The scope of these requirements is so broad that no individual requester can be expected to be familiar with all of them. One of C Division's functions is to help all Laboratory requesters acquire computing equipment, WP equipment, and services.

Historically, requirements for acquisition of ADP and WP equipment and services have tended to grow with time and this trend is likely to continue. C Division will continue to work with approval agencies to simplify and expedite procedures.

C Division, through the C Division Support Section (CDSS), will continue to assist requesters with acquisition of ADP and WP equipment and services. Any organization with a requirement for ADP or WP equipment is asked to contact the CDSS as soon as needs are identified.

6.12 USERS AREA

The Users Area provides a variety of equipment for short-term use. Equipment includes terminals, microfilm and microfiche viewer/printers, and keypunch. If the FY-1982 budget permits, we will replace the microfiche viewer/printers with better quality equipment, and we will provide needed equipment, such as Tektronix graphics terminals and color graphics terminals. We also will provide experimental and demonstration equipment, including intelligent terminals (CBT-2s).

6.13 COMPUTING EDUCATION

The Computing Education Program focuses on Los Alamos-specific computing and is targeted at both new and experienced users of the Los Alamos computing network. The program was initiated in FY 1981 to complement courses from the Laboratory Training Office. Instructors are drawn from all C-Division groups and from throughout the Laboratory. Instruction is available in a live lecture/discussion mode or in a self-study mode.

Many users enrolled in the live courses offered in Fall 1981. Table XXVI shows the courses and enrollment figures.

TABLE XXVI

1981 COMPUTING EDUCATION COURSES

Courses	Number of Attendees	Number on Waiting List
CFT-Dependent Fortran	40	0
FRED	35	15
MAPPER Workshop	20	54
VAX/VMS for Users	30	42
Software Design, Reliability & Testing	25	5
Tools of Structured Analysis	64	0
Introduction to CFS	60	0
Introduction to MASS	74	0
Advanced MASS	87	0
Controllers for MASS	41	0

Winter/Spring 1982 courses will include Interactive Graphics, DISSPLA, Dynamic Debugging Tool, Cray Fortran and Vectorization, Fortran 77, PASCAL and Ada concepts, and Computer Security. In FY 1982-1983, we are planning additional courses in Math Libraries, Graphics at Los Alamos, MAPPER, LTSS, and CTSS.

Self-study course media include videotape and computer-assisted instruction (CAI), available in the Learning Center. The existing C-Division videotape library was reviewed; of the 45 courses available, all but three were found to be out of date. In FY 1981, we acquired 11 new videotaped courses on computing topics. In addition, 23 computing courses are available for users on the CAI system PLATO. We plan to produce videotaped courses in-house and to acquire videotaped courses from other sources. Pilot testing of the CAI system, PLATO, began in October 1981 and will continue to October 1982. Many computing courses authored by Control Data Corporation are available on PLATO, and we are designing lessons for new users that will be programmed and available in 1982. The Computing Division Lecture Room will be equipped with video equipment so that computer terminal displays can be shown to the students.

We plan to provide an on-line registration/reservation/suggestion system. This will provide current information on courses and on student requirements and will streamline course registration procedures so that we can handle the heavy load.

6.14 CASUAL USER PROJECT

The Casual User Project focuses on how to make computing at Los Alamos easier and how to make computing users more productive. It was established in October 1980 to identify the needs of the occasional or inexperienced user. The recommendations of the project were published in November 1981 and address the following areas: orientation of new users, location of user services areas, documentation, consulting, and the user interface to the network.

Highlights of FY 1981

The User Satisfaction Measurement Study, discussed in Sec. 2.4, was one of the first tasks undertaken by this project. It provides a base line that

quantifies users' perceptions. A follow-up survey will be done in the next three years.

In July 1981, we implemented an orientation program for new users. This program is designed to provide a good initial impression of our computing facilities and services. The Personnel Division's New Hire Packets now include a questionnaire for new employees to indicate their computing needs. Within a week of the first day of employment, we personally contact each new user, explaining C-Division services and offering a short tour of our service areas. Each new user receives introductory documentation especially designed to meet his/her needs. In June of each year when a large influx of new users occurs, we will hold group orientations. Since July 1981, we have contacted over 400 new hires, of whom 25% were new users.

Starting January 1982, the Operations Group will conduct regularly scheduled tours of the Central Computing Facility. To supplement these tours, we have prepared an orientation film about the Los Alamos computing network. It is available as a film for group orientation and as a videotape in the Learning Center.

We initiated our Computing Education program, and we prepared reference cards and introductory documentation packages that are available to all users (Sec. 6.13).

The user interface to the network is being improved through commonality. To supplement existing common libraries and utilities, we established two common editors in FY 1981 (Sec. 4.4).

Plans for FY 1982-1983

We are planning a physical consolidation of user service areas to make the services more effective and the users more productive. User service areas include the Computing Information Center, Users Area, Learning Center, Consulting Office, Lecture Room, CCF dispatcher, and computer output distribution area. We will investigate a uniform catalog system for all computing information (Sec. 6.4).

We are investigating procedures for soliciting and reviewing user feedback. Under consideration is a utility common across the major systems through which users can provide comments and suggestions to the Computing Division. This input would be routed to specific Computing Division groups as appropriate. The input and the Computing Division replies would be stored in a database for future reference.

The Computer User Services Group is preparing an informational card describing the services it offers. The card, to be ready for distribution in the second quarter of 1982, will direct users to the appropriate people for consulting, educational needs, documentation, and other frequent computing questions.

We are planning improvement to the user interface to the network, including common Fortran 77 language and common system library (Secs. 4.2 and 4.3.1), improved debugging and software tools (Sec. 4.5), and improved network interface (Sec. 3.8). We will investigate significantly better network interfaces (Sec. 2.6) and common command languages (Sec. 4.3.3).

7 RESEARCH

Computing has always been in a state of rapid change. There is no indication that the pace will slacken in the 1980s; in fact, it may even increase and change. For example, during the past 15 years there has been a steady trend toward increased parallelism in supercomputer architecture with a result that today's state-of-the-art supercomputers incorporate vector processing. By the mid-1980s, we expect this trend to culminate in commercial parallel processors, systems in which several processors will simultaneously compute different parts of a single numerical simulation. Successful use of these devices will require discovery of algorithms that require relatively little communication between processors and development of system software that is efficient in interprocessor communication.

Very large scale integration technology (VLSI) is already revolutionizing computing. By 1985, we may have desk-top computers with performance comparable to today's minicomputers. These devices will support a broader spectrum of input and output media than can be supported by today's timesharing systems. Further, there will be some redistribution of work from the central processor to these devices. Successful exploitation of them will require research in the man-machine interface and in distributed computing.

Since the infancy of electronic computation, much effort has been given to algorithmic efficiency, that is, development of algorithms that require the minimum number of arithmetic operations to obtain a particular result. In fact, gains in algorithmic efficiency over the past 25 years have often equalled gains in hardware speed. There is still opportunity and need for further gains in algorithmic efficiency. To obtain them requires continuing research in numerical analysis in applied mathematics.

In FY 1982, C Division will have almost 20 FTEs engaged in research on parallel processing, satellite graphics, audio I/O, numerical analysis, and applied mathematics. Funding for this research is provided by the Applied Mathematical Sciences program of the Basic Energy Sciences Division of DOE, the Los Alamos Supporting Research program of the Associate Director for Engineering Sciences, and C-Division recharge.

7.1 PARALLEL COMPUTING

In FY 1982, C-Division research in parallel computing will include development and testing of algorithms, study of languages, exploration of techniques with which to provide a CTSS front-end to a parallel processor, and assembly of a small parallel processor composed of microcomputers.

7.1.1 Algorithms

Our immediate objective is to develop and test algorithms for generic problem classes in the DOE and at Los Alamos. Our long-term objective is to assess

the potential of parallel processing to provide significant increases in speed for large-scale computations. In FY 1979, we selected three problem classes: particle-in-cell (PIC) calculations, Monte Carlo calculations, and diffusion calculations. We now have parallel processing algorithms for all three. In FY 1981, we proved that PIC can be parallel processed using computing equipment at the Naval Ocean Systems Center in San Diego. Because that equipment would not permit computation of a typical problem, we are now performing these experiments on the 4-processor UNIVAC 1100/84. We will complete these experiments in FY 1982 and perhaps repeat them on other equipment, for example, the Denelcor HEP computer and the LLNL S-1 computer. To date, our results are positive, exceeding our expectations.

Everyone believes that Monte Carlo calculations can be parallel processed; indeed they can. The question is what speedup will be obtained as a function of the number of processors used and of the communications media between them. Our objective is to provide quantitative answers to this question. We will do so in FY 1982 using UNIVAC equipment and in FY 1983 using the HEP and S-1.

Parallel processing of diffusion calculations is much different and much more difficult than parallel processing of PIC and Monte Carlo calculations. Thus we have delayed experiments in this area until preliminary results were available for PIC (if we cannot parallel process PIC efficiently, we surely cannot parallel process diffusion efficiently). Now that positive results are in hand for PIC, we will conduct experiments on diffusion in FY 1982. Substantive results in this area should not be expected until FY 1983 or later.

7.1.2 Languages

In support of research in parallel processing, we will investigate portable compiling techniques of sufficient flexibility to implement applicative languages on sequential machines. Eventually sequential languages on various parallel architectures will be implemented. Extensions to Fortran for explicit multiprocessing also will be implemented.

7.1.3 Parallel Processor Operating System

Los Alamos has a tremendous investment in the CTSS operating system and programs that run on it. The manufacturers of parallel processors will almost certainly not provide a CTSS-like system for their products. Rather, they are likely to provide a modest, batch-oriented operating system. Thus, our objective is to explore approaches providing Los Alamos with a CTSS-like interface to a parallel processor and to do so in a fashion that allows users convenient access to the parallel processing capabilities. Such an interface must be efficient in the use of hardware resources and portable to future generations of parallel processors. Potential solutions include porting CTSS; modifying NLTSS, the developmental operating system for the Livermore network; implementing a CTSS emulator; and implementing a CTSS front-end.

Each of these alternatives has some risk. For example, CTSS is not a parallel processor operating system, and it is unclear that it can be made into one. NLTSS is designed for use with networks of processors, and interprocessor communication with it may not achieve the requisite efficiency for parallel

processors. Emulation of CTSS shares the same risk as porting CTSS. It is because of these risks that we are studying the fourth approach.

Front-ending a parallel processor contains two major research issues:

(1) How is process-to-process communication best supported between the front-end and back-end in the system?
(2) How would users on the front-end access the capabilities of the parallel processor?

Our FY 1982 research will include

- modeling of alternate front end/back end configurations,
- recommendations for communication protocols,
- determination of minimum acceptable requirements for front-end/back-end communication hardware, and
- recommendations for changes to CTSS required to support projected interprocess communication requirements.

7.1.4 Assembly of a Parallel Processor

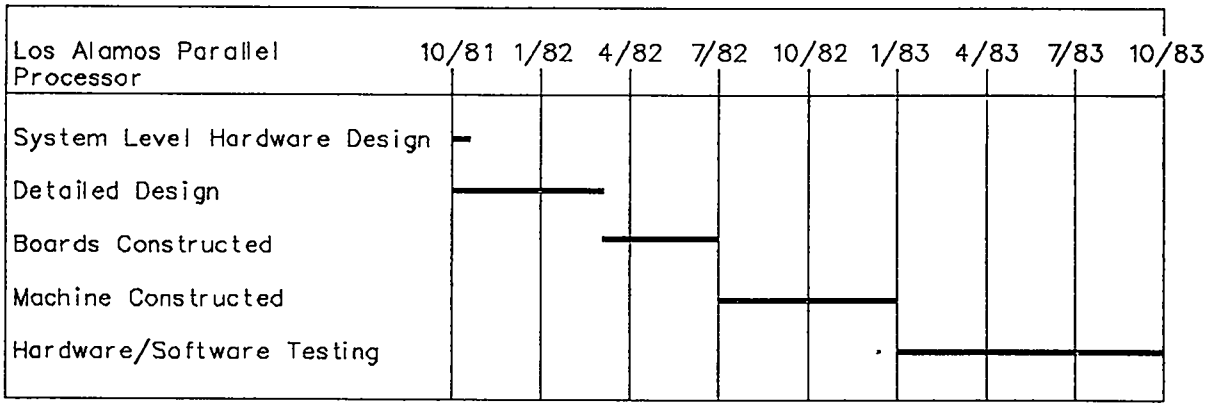
By 1990, computer manufacturers may be able to offer processor-rich systems, that is, parallel processor systems with 16 or more processors. Our current analysis indicates that it will be extremely difficult to efficiently utilize processor-rich systems and, of course, efficient utilization will be an important factor in the decision of whether to procure them. Analysis is always subject to error, and empirical results are needed for confirmation. Fortunately, VLSI technology makes possible construction of a parallel processor from low-cost components. Although slow, a processor-rich device constructed from this technology will be adequate to investigate the critical question of speedup as a function of the number of processors used.

We have begun design of a parallel processor and expect it to be running early in FY 1983. The design calls for a maximum of 16 processors, of which 8 to 10 will be included in FY 1982. The machine will be constructed of commercially available 16-bit microprocessors with 64-bit floating point capability. Both shared memory and network architectures will be provided. The only hardware we will build is a switch for processor-to-shared-memory access and a switch for processor-to-processor communication. A small local area network will be provided to allow communication to the ICN and local workstations. Code development, compilation, etc., will be done on the workstations, and the object code down-line loaded onto the parallel processor. This will allow us to have minimal software on the parallel processor. The workstation software will, for the most part, be commercially available. We will, therefore, satisfy our initial design constraints:

- network accessibility to CFS, PAGES, and terminals;
- virtually all hardware should be commercially available;
- floating point hardware;
- Fortran compilation; and
- nominal software development.

Given such a facility, we will repeat our algorithmic experiments on it to determine their performance on processor-rich systems.

Our plans for FY 1983 include expansion to the full complement of 16 processors, investigation of very high speed processor-to-processor links, and, of course, the implementation of the various algorithms described above.



Schedule 27. Assembly of parallel processor.

7.2 ANALYTICAL AND NUMERICAL TECHNIQUES

A primary focus of Laboratory activity is the development and analysis of mathematical models describing observed phenomena. Frequently, the development and the analysis are performed by separate groups whose interaction is limited.

Analysis of intricate models may be difficult because available computational and analytic techniques are unable to handle complete generality. Several simplifications or assumptions may be necessary to yield useful information.

To this end, C Division provides consulting and research in applied mathematics where applied mathematics includes many branches of computer science, mathematical physics, and mathematics. The project is funded to do basic research in three areas of numerical analysis: (1) dynamic mesh selection, (2) solution of large, sparse linear systems, and (3) numerical solution of integral equations of the first kind. Specific goals in FY 1982 for each of these areas are given below. In addition to these specific goals, we will continue to consult with other groups in the Laboratory employing the techniques developed in this project and identifying related problem areas.

Dynamic Mesh Selection

a. Complete development of the initial boundary-value code with particular emphasis on implicit mesh selection algorithms, parameter studies for multipoint boundary-value problems, and functional equations (such as

the equation of state for fluid dynamics) interspersed with differential equations.

b. Continue development of a two-space dimensional mesh selection algorithm based on equidistribution of a cost function. Implement a reasonable method in a prototype computer code.

c. Examine optimal knot placement algorithms in approximation theory, in particular, their relationship to collocation methods for solving ordinary differential equations.

d. Understand present methods of shock tracking for gamma law gas dynamics and begin looking at this problem for more general systems of conservation laws.

Large, Sparse Systems of Linear and Nonlinear Equations

a. Bring the software package FAPIN for solving elliptic boundary-value problems on general two-dimensional regions up to production status.

b. Develop algorithms suitable for the efficient solution of nonlinear systems of equations whose Jacobians are large and sparse.

c. Complete development of a multigrid algorithm for solving elliptic equations in spherical geometries.

d. Examine the efficiency of preconditioning strategies for solving linear systems derived from the underlying differential equations.

e. Begin to look at the extension of invariant imbedding algorithms to two-space dimensions.

Integral Equations of the First Kind

a. Examine collocation and Galerkin solution techniques for these equations, specifically the relationship between the solution basis (Legendre polynomials, splines, and trigonometric functions) and the ill-conditioning of the resulting linear system.

b. Implement an algorithm using promising bases that will incorporate knowledge of the data function and anticipated solution properties.

c. Examine the method of regularization with regard to whether averaging of the regularization parameter enhances overall performance.

d. Continue development of algorithms for specific classes of problems, namely, Fredholm equations with Cauchy singular kernels and Volterra equations with convolution kernels.

7.3 AUDIO I/O

As a consequence of progress in VLSI, word-recognition and voice-output systems are commercially available. Word-recognition systems have already proven effective in man-machine interactions with the following characteristics.

- The operator's hands and eyes are busy, for example, glovebox operator, assembly line inspector.
- The operator needs mobility, for example, warehouse inventory.
- The operating environment is too harsh, such as no convenient access to a terminal.
- The operator uses a limited vocabulary for data entry.
- The operator is remote.
- The operator is physically handicapped.

Voice-output systems have proven effective for warning messages, for example, automobiles, computer-aided instruction, commercial dial-up services (such as time and directory information), and automatic messages.

In the decade of the 1980s, we expect to see rapid progress in voice input and output systems. Voice input will be pushed by military applications, especially for "heads up" aircraft and tank displays. Voice output will encompass both phoneme synthesis and text-to-speech units with algorithms and processing power sufficient to produce well-intoned and inflected speech that is virtually indistinguishable from human speech. This technology will make possible significant productivity increases in such areas as data entry, data output, computerized instruction, etc.

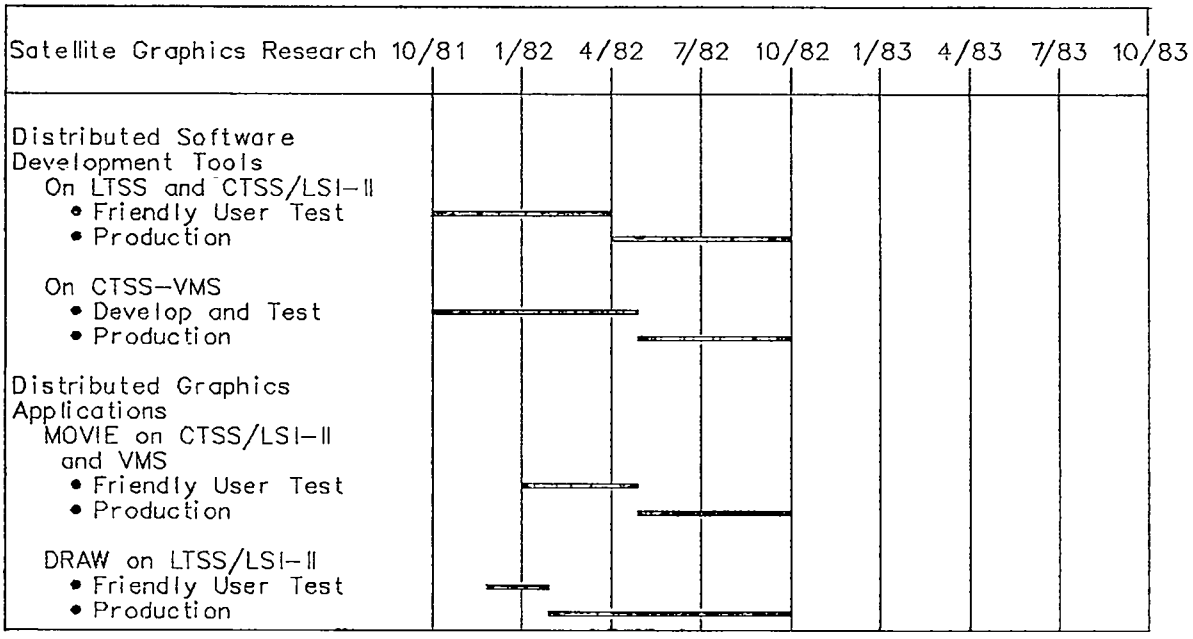
FOCUS and CBT-2s will become operational in FY 1982. Both projects are potential beneficiaries of audio I/O, and our research is targeted toward them. Using commercially available equipment, we will be investigating the implementation and utilization of audio I/O in such areas as satellite graphics, data collection, and computer command.

7.4 SATELLITE GRAPHICS

Satellite graphics is a form of distributed graphics processing. A satellite graphics computer system is a system of two or more computers, connected by a communications line of some type, programmed so that the graphics processing is done partly on the host computer, and partly on the (usually) smaller satellite computer. Satellite computers are normally located at or near graphics display devices. Such a system requires a different style of programming and requires a different set of services from the computer.

The main research issues are data access by remote computers, data compression to conserve intercomputer communications bandwidth, division of work among the computers, and good human-interactive techniques. Potential benefits of this research include increased user productivity, the potential to perform high-speed raster graphics over existing medium- and high-speed lines, the ability to do useful graphics over low-speed lines, and off-loading of Central

Computing Facility computers. In FY 1982 a great deal of this research will be directed toward use of intelligent terminals. Successful results will be applicable to AIDS and Distributed Processors as well. This project is funded by Laboratory Institutional Supporting Research.



Schedule 28. Satellite graphics research.

8 BUDGET

8.1 OPERATIONAL PLANS

Our FY-1982 operating budget shows an increase of $16.4M over FY 1981. This increase of 65.6% reverses the trend of the previous three years and results from sharply increasing the computing capacity in the CCF and acquiring the E-9 telecommunications function. ADP lease and maintenance costs will increase by $5.2M and there will be additional expenses of $6.8M because of the transfer of the communications function to C Division. We are beginning FY 1982 with approximately 23 FTEs more than we averaged during FY 1981 with a resulting increase in costs. Table XXVII shows our annual budget in dollars and percentages beginning with FY 1978.

TABLE XXVII

TOTAL ANNUAL OPERATING BUDGET - FY 1977-FY 1982

FY	Cost ($K)	Increase ($K)	Increase (%)
1977 (actual)	12,942	-	-
1978 (actual)	16,782	3,840	29.7
1979 (actual)	20,176	3;394	20.2
1980 (actual)	23,210	3,034	15.0
1981 (actual)	24,955	1,745	7.5
1982 (forecast)	41,332	16,377	65.6

For purposes of analyzing our major cost categories, operating expenses are grouped as follows.

1. Personnel - Expenses for C-Division employees, such as salaries, fringe benefits, and overtime payments.

2. Burden - The charge made for supporting services provided by various service divisions in the Laboratory.

3. ADP - Costs for the lease and maintenance of major computers and peripherals.

4. Other Materials and Supporting Services (M&S) - Includes services provided by the Zia Company, E Division, and the Shops Division; travel expenses; materials; and other major procurements not involving ADP equipment.

5. Communication Charges - Costs for telephone services provided by Mountain Bell, FTS charges, and radio and data channel costs.

The costs in Table XXVIII are all charged to X3 program codes and are recovered by recharge to users of the computing and communications services.

TABLE XXVIII

OPERATING BUDGET BY COST CATEGORIES - FY 1978-FY 1982
(dollars in thousands)

Cost Category	FY 78	FY 79	FY 80	FY 81	FY 82
Personnel	6,163	6,607	6,913	8,075	10,792
Burden	3,287	3,562	3,967	4,883	6,938
ADP Lease & Maint.	5,524	6,208	9,069	7,335	12,555
Other M&S	1,808	3,799	3,261	4,662	5,012
Communications	-	-	-	-	6,035
	16,782	20,176	23,210	24,955	41,332

Table XXIX shows our operating budget by cost categories. As a percentage of our annual operating budget, direct personnel costs have decreased to about one-quarter of our budget. ADP equipment costs continue to be our most significant expense and, when combined with communication service charges, will take 45% of our budget.

TABLE XXIX

OPERATING BUDGET BY COST CATEGORIES - FY 1978-FY 1982
(percent)

Cost Category	FY 78	FY 79	FY 80	FY 81	FY 82
Personnel	36.7	32.7	29.8	32.3	26.1
Burden	19.6	17.7	17.1	19.6	16.8
ADP Lease & Maint.	32.9	30.8	39.1	29.4	30.4
Other M&S	10.8	18.8	14.0	18.7	12.1
Communications	-	-	-	-	14.6
	100.0	100.0	100.0	100.0	100.0

Personnel

The total number of FTEs (full-time equivalent employees) charged to the X3 program code increased by 7% during FY 1981. Groups C-6, C-8, and C-10 accounted for almost all of the increase while C-1 continued to show a gradual decline in the number of operators on board. The severe shortage of qualified computer professionals nationwide continues to make hiring of such people an expensive and time-consuming job. Forecasts continue to show that this demand for computer professionals will increase significantly during the 1980s. Therefore, we expect to spend much time and effort to maintain our staff and increase technical competence.

In FY 1982 the Computing Division staff charged to X3 programs will increase by 16 FTEs because of the transfer of the E-9 Telecommunications Group to C-4 and the addition of 5 FTEs formerly charged to Indirect operations. Table XXX compares FTE levels beginning with FY 1978.

TABLE XXX

AVERAGE FTE LEVELS - FY 1978-FY 1982

FTE	FY 78	FY 79	FY 80	FY 81	FY 82 (est.)
SM	100.6	97.0	87.3	93.5	118.6
GR	145.5	147.6	152.0	153.3	162.1
Total	246.1	244.6	239.3	246.8	280.7

8.2 RECHARGING FOR CCF SERVICES

Three primary considerations determine the form of the CCF charging algorithms. These are cost-recovery goals, and they are listed in order of priority.

- Total recovery of operating costs.
- Equitable distribution of charges to users based on actual usage.
- Self-support for each of the major service categories.

All Computing Division operational costs are assigned to one of seven major categories: (1) CTSS, (2) LTSS, (3) NOS, (4) ICN, (5) CFS, (6) PAGES, and (7) VMS. The operating costs for the various systems are not always proportional to the computer capacity or services delivered, so the three goals noted above cannot be fully achieved. The final charging algorithms reflect a reasonable compromise.

The charging algorithms are strongly influenced by one other factor, namely, the multiplicative application of shift differentials of 2/1/0.5 for services delivered during the prime shift, night production periods, and weekends or holidays, respectively. These shift differentials are applied to help distribute the number and types of problems submitted during the different periods so as to maximize overall system efficiency.

Table XXXI shows the percentage of total cost recovery from each of the service categories in FY 1981 and the estimated recovery for FY 1982.

TABLE XXXI

TOTAL COST RECOVERY BY SERVICE CATEGORY (%)

Service Category	Actual Cost Recovery FY 1981	Estimated Cost Recovery FY 1982
NOS	8.3	7.7
LTSS	20.7	17.3
CTSS	34.5	37.4
ICN	19.7	16.0
CFS	8.4	10.6
PAGES	8.4	9.8
VMS	0.0	1.3

Figure 7 shows the costs for CCF services since 1975. Table XXXII lists the FY-1981 and FY-1982 charges for services provided by the CCF. The charging algorithms and the factors used to derive these charges are described in the Appendix.

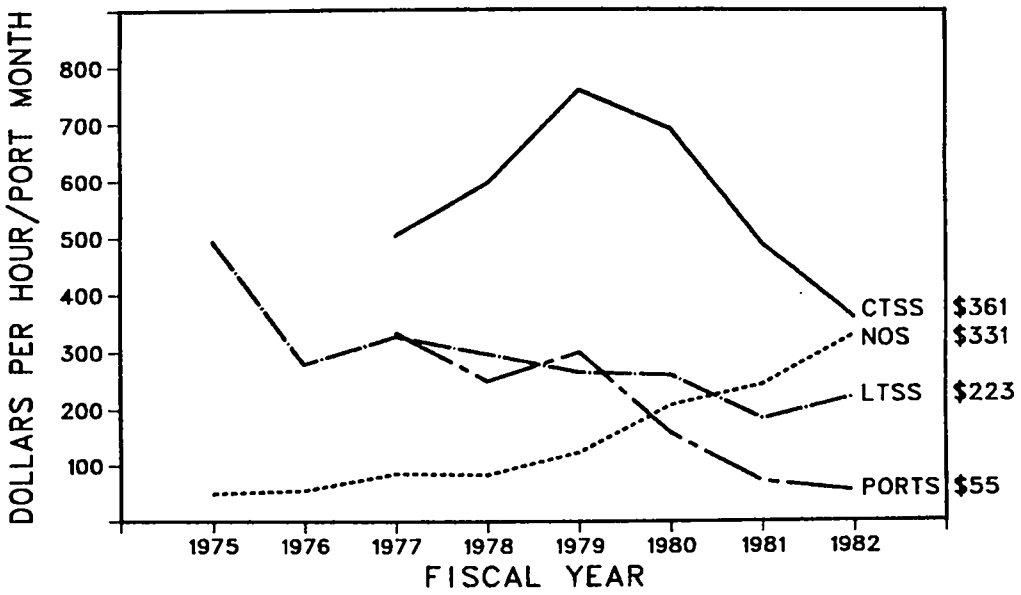


Fig. 7. Cost of computing at the Los Alamos National Laboratory.

CTSS and port rates continue to decline as we are able to provide more service more efficiently. The LTSS hourly rate has increased slightly from FY 1981 to FY 1982 because our fixed costs have increased by inflation and usage has decreased somewhat. NOS hourly rates continue to increase, primarily because of decreasing use.

TABLE XXXII

FY-1981 AND FY-1982 CCF CHARGES

CCF Services	FY-1981 CHARGE	FY-1982 CHARGE
Computing Services		
CTSS (recorded hour)	$ 489.00	$ 361.00*
LTSS (recorded hour)	185.00	223.00*
NOS (recorded hour)	245.00	331.00*
Tape Mount (each)	2.40	3.00*
ICN Services		
300-bit/s port/month	72.00	55.00
1200-bit/s port/month	none	82.50
9600-bit/s port/month	144.00	110.00
150-kbit/s port/month	216.00	165.00
CBT II port/month	none	330.00
200 UT port/month	590.00	440.00
CBT port/month	860.00	660.00
56-kbit/s XNET port/month	1,290.00	990.00
256-kbit/s XNET port/month	none	1,980.00
Connect Hour (300 bit/s)	2.00	1.60*
Connect Hour (1200 bit/s)	none	2.40*
Connect Hour (9600 bit/s)	4.00	3.20*
Connect Hour (150 kbit/s)	none	4.80*
Connect Hour (200 UT)	5.50	4.40*
Network Transmission (megaword)	2.96	2.20*
CFS Services		
Online Access (each)	.15	.20*
Offline Access (each)	2.40	3.00*
Online Storage (megaword month)	6.66	8.27
Offline Storage (megaword month)	.50	.75
PAGES Services		
Printed Output (pages)	.11	.14
Megabytes Processed	2.00	2.88
105-mm Fiche (each)	2.00	2.88
35-mm Film (frames)	.16	.16
16-mm Film (frames)	.08	.08
Plotter (sheets)	.25	.25
VMS Services		
Monthly Fee	none	200.00

*Charge is subject to shift weights.

APPENDIX

CHARGING ALGORITHMS AND FACTORS FOR CCF RECHARGE RATES

There are many CCF services for which charges are made and these services are measured in a variety of ways. To simplify matters, each quantity of service is converted to an equivalent number of Service Units (SU) and SUs are then billed at a fixed rate. An SU is defined to be one weeknight hour of LTSS use. Each quantity of service delivered is converted directly to SUs using the following algorithm:

$$SUs = S \times SUF \times Service \quad .$$

S, the appropriate shift weight factor, is currently set to 2.0 for prime shift usage, 1.0 for weeknight usage, and 0.5 for weekend usage. Some services are shift weighted as noted in Table A-I. SUF is a service unit factor that is given in Table A-I for each type of service or allocation. Service is a quantity of a particular CCF service in generic units.

Recharge rates are then completely defined by establishing the charge for an SU and generating a set of SUFs that can be used to convert services to SUs. The charge for an SU is the ratio of costs to be recovered by LTSS to the number of LTSS hours delivered. For FY 1982, the SU charge is $223.

TABLE A-I

FY-1982 SERVICE UNIT FACTORS FOR CCF SERVICES

CCF Services	$	SUF
Computing Services		
CTSS (recorded hour)[a]	$ 361.00	1.618834
LTSS (recorded hour)[a]	223.00	1.000000
NOS (recorded hour)[a]	331.00	1.484305
Tape Mount (each)[a]	3.00	0.013453
ICN Services		
300-bit/s port/month	55.00	0.246637
1200-bit/s port/month	82.50	0.369955
9600-bit/s port/month	110.00	0.493274
150-kbit/s port/month	165.00	0.739910
CBT II port/month	330.00	1.479821
200 UT port/month	440.00	1.973094
CBT port/month	660.00	2.959641
56-kbits/ XNET port/month	990.00	4.439462
256-kbits/ XNET port/month	1,980.00	8.878924
Connect Hour (300 bit/s)[a]	1.60	0.007175
Connect Hour (1200 bit/s)[a]	2.40	0.010762
Connect Hour (9600 bit/s)[a]	3.20	0.014350
Connect Hour (150 kbit/s)[a]	4.80	0.021525
Connect Hour (200 UT)	4.40	0.019731
Network Transmission (megaword)	2.20	0.009865
CFS Services		
Online Access (each)[a]	.20	0.000897
Offline Access (each)[a]	3.00	0.013453
Online Storage (megaword month)	8.27	0.037085
Offline Storage (megaword month)	.75	0.003363
PAGES Services		
Printed Output (pages)[b]	.14	0.000628
Megabytes Processed	2.88	0.012915
105-mm Fiche (each)	2.88	0.012915
35-mm Film (frames)	.16	0.000717
16-mm Film (frames)	.08	0.000359
Plotter (sheets)	.25	0.000112
VMS Services		
Monthly Fee	200.00	0.896861

[a]All items noted are subject to shift weights.

[b]Pages printed on both sides.

NOTE: Recorded Hour = 0.8 x CP hours + 0.2 x channel hours + memory megaword hours.

GLOSSARY OF TERMS AND ACRONYMS

ACC	The Department of Energy Advanced Computing Committee.
ACM	Association for Computing Machinery.
Ada	Department of Defense standard programming language.
Administrative Computer	A worker computer devoted primarily to processing sensitive unclassified data or data subject to a privacy act. Today, some unclassified scientific computing is done on these computers, and all users are Q-cleared.
Administrative Partition	That portion of the Integrated Computing Network that is available to administratively authorized personnel either from terminals inside a security area or from a terminal outside a security area that is connected through a locked box. Classified computing is not permitted in the Administrative partition.
AED	Advanced Electronics Design. Manufacturers of the AED-512 color graphics terminal.
AESOP	The Department of Energy Association for Energy, Systems, Operations, and Programming.
AFT	A File Transport protocol that is used to transmit files in the ICN.
AIDS	Advanced Interactive Display System.
AIMS	Automated Information Management System.
A-Port	A port that provides a remote computer of the Extended Network Access System with the capability to ship files to and from the Integrated Computer Network.
ANSI	American National Standards Institute.
ASA	Andrew Sipos Associates project management system, software package used by Group C-3 for project management scheduling.

ASCII	American Standard Code for Information Interchange. The standard 7-bit 128-character set recommended for use in telecommunications.
CAD/CAM	Computer Aided Design/Computer Aided Manufacturing.
CAI	Computer-aided instruction.
CBT-1	Computer-Based Terminal. A remote job entry terminal consisting of a computer that supports peripheral devices. Currently, CBTs are Digital Equipment Corporation PDP-11 computers supporting a line printer, card reader, and terminals. They are used to ship files to and receive files from an LTSS worker computer.
CBT-2	A new family of computer-based terminals that will provide more local capabilities and increased interaction with ICN computers.
CCC	CBT Communications Concentrator. A DEC PDP-11 computer used as a concentrator for CBTs.
CCF	Central Computing Facility. The physical location of the main Los Alamos computing center.
CDC	Control Data Corporation. The manufacturer of the CDC 6600, CDC 7600, CDC Cyber 73, CDC Cyber 173, CDC Cyber 76, and CDC Cyber 176 computers. Also the vendor of the Network Operating System (NOS) used on the CDC 6600 and CDC Cyber 73 computers in the Central Computing Facility.
CDSS	Computing Division Support Section.
CFS	Common File System. The Los Alamos centralized filing system. It consists of IBM computers (a 370/148 and a 4341) and an IBM 3850 mass storage system.
CFT	Cray Fortran compiler provided by Cray Research, Inc.
CGS	Common Graphics System. A basic system of computer graphics primitives that is available for all graphics devices and operating environments in the Central Computing Facility.
CGS Intermediate File	A device-independent file structure for graphics files. The Print and Graphics Express Station requires that graphics files be in this format.

Clearance Document	A document sometimes required by the Department of Energy in addition to the Implementation Plan in computer acquisitions. Approval of the Clearance Document must be obtained before procurement can proceed.
Closed Line	A dedicated data channel, usually leased from the telephone company, with administrative controls at the line end where the terminal is connected.
Closed Terminal	A terminal used to access ICN worker computers for unclassified computing. Users of closed terminals must be Q-cleared. Administrative access control is required for terminals outside secure areas.
Controlled KBT	A keyboard terminal used to access worker computers for unclassified computing through controlled lines. Controlled KBTs will replace closed KBTs.
Controlled Line (Administrative)	A data channel that does not leave an administratively controlled area or is encrypted when outside the area (using the Data Encryption Standard) approved by the National Bureau of Standards). All controlled lines within administratively controlled areas will be installed as emanation-shielded "house cable," owned by the Laboratory and installed by cleared contractor personnel. Used for unclassified computing in the Secure partition.
Controlled Line (Secure)	A data channel that does not leave a security area or is encrypted when outside a security area (using the Data Encryption Standard approved by the National Bureau of Standards). All controlled lines within security areas will be installed as emanation-shielded "house cable," owned by the Laboratory and installed by cleared contractor personnel.
CPM	Critical Path Method. A project management tool for organizing activities into a logical sequence that will result in the shortest duration for the whole program with the most efficient use of resources. Used in ASA software package.
CRI	Cray Research, Incorporated. The manufacturer of the Class VI Cray-1 computer used in the Central Computing Facility and the vendor of Cray Fortran (CFT).
CTSS	Cray Time Sharing System. The timesharing system used on the Cray-1 at Los Alamos.

CUP	Computer Users' Priorities Task Force.
DEC	Digital Equipment Corporation. The manufacturer of the DEC PDP-11 and VAX-11 families of minicomputers embedded in the Integrated Computing Network to perform dedicated switching, control, and monitor functions. DEC PDP-11s are also used as computer-based terminals.
DECnet	Digital Equipment Corporation's standard intermachine protocol that C Division uses between XNET and the Distributed Processors.
Dedicated	A term used to indicate that a computing resource is reserved for a specific purpose.
DES	Data Encryption Standard. An encryption standard that is approved by the National Bureau of Standards for government telecommunications and data storage.
Distributed Processor	Midicomputers of the DEC VAX class used for XNET remote computing.
DP	Distributed Processor.
DRS	Data Retrieval System. Database management software for Distributed Processors.
FOCUS	Facility for Operations Control and Utilization Statistics.
FT	File transport. A computer that controls file traffic between specific worker machines in the Integrated Computer Network.
FTN	Fortran Extended compiler.
HSPI	High-Speed Parallel Interface. A type of interface that handles high-speed data transfer between computers in the Integrated Computing Network.
IBM	International Business Machines Corporation. The manufacturer of the IBM 370/148 and IBM 3850 mass storage system used in the Common File System.
ICN	Integrated Computing Network. The Laboratory's main computer network consisting of worker computers, file storage, network services, local and remote terminals, and data communication interfaces.
Implementation Plan	A document that is prepared to request Department of Energy approval for the acquisition of automatic data processing equipment valued at more than

	$100,000 and word processing equipment valued at more than $25,000. It describes our requirements, our plans for meeting those requirements, and the acquisition method that we plan to use. It must be approved before quotations can be solicited.
IMSL	International Mathematical and Statistics Library.
ISSCO	Integrated Software Systems Corporation, vendors of DISSPLA.
KBT	Keyboard Based Terminal. A low-speed keyboard terminal with a printer.
KCC	Keyboard Communications Concentrator. A DEC PDP-11 computer used as a concentrator for low- and medium-speed terminals.
KCT	Keyboard CRT Terminal. A low-speed keyboard terminal with a viewing screen for alphanumeric characters.
KGC	Keyboard Graphics Concentrator. A DEC PDP-11 computer used as a concentrator for high-speed graphics terminals.
KGT	Keyboard Graphics Terminal. A medium-speed graphics terminal.
KG-13	A particular model of encryption equipment that is approved by the National Security Agency for transmission of classified data at up to 100 kbit/s.
KG-34	A particular model of encryption equipment that is approved by the National Security Agency for transmission of classified data at up to 1.6 Mbit/s.
KTT	Keyboard Typewriter Terminal. A low-speed keyboard terminal that provides good-quality printed output.
Low-Speed Terminal	A terminal that operates at a speed of 300 bit/s or less.
LTSS	Livermore Time Sharing System. The timesharing system that is used on the CDC 7600 computers at the Laboratory.
LUG	VAX Local Users Group at Los Alamos.
Medium-Speed Terminal	A graphics terminal that operates at a speed of 300 bit/s input and 9600 bit/s output.

MPS	Evans and Sutherland Multi Picture System. A high-speed graphics device.
MVS	Multiple Virtual System. An IBM operating system for medium and large computers.
NAG	Numerical Algorithm Group.
NOS	Network Operating System. The CDC time-sharing system used on the CDC Cyber 73 and CDC 6600 computers at the Laboratory.
NSA	National Security Agency.
NSC	Network Security Controller. A DEC PDP-11 computer that verifies a user's identity before allowing the user to access the Integrated Computing Network.
NSM	Network Status Machine. A DEC PDP-11 computer that monitors and displays the status of components of the Integrated Computing Network.
Open Computer	A worker computer available to anyone who has a legitimate need to compute at the Laboratory. Open computers can be used only for unclassified work. Users may be cleared or uncleared.
Open Environment	That portion of the Integrated Computer Network that is available to anyone who has a legitimate need to compute at the Laboratory. Only unclassified computing is permitted in the Open environment; users may be cleared or uncleared.
Open Terminal	A terminal used to access only Open computers. Currently, Open terminals are connected to the Open Computers through Open KCCs.
Operating Environment	A specific computer, operating system, compiler, and supporting libraries.
OS/VS1	Operating System/Virtual System 1. An IBM operating system used on CFS.
PAGES	Print and Graphics Express Station. The node in the Integrated Computing Network that is used to produce microfilm, microfiche, electrostatic printer/plotter output, and high-speed printer output.
PTP	A process-to-process protocol that will allow a process (task) on a computer to communicate with a process on another computer.

PWL	Protected Wireline. A wireline approved by the Department of Energy for transmission of classified data inside a security area.
QA	Quality Assurance.
RSX-11	A family of operating systems for the DEC PDP-11 computer family.
RTLI	Remote Terminal Line Interface. An interface that is used between switching machines in the Integrated Computing Network. It is also used to connect Computer-Based Terminals to the CBT Communications Concentrator.
Secure Computer	A worker computer on which classified data may be processed.
Secure Environment	That portion of the Integrated Computing Network that is available for classified computing from a Secure terminal.
Secure Terminal	A terminal used to access Secure computers for classified computing. A Secure terminal may also be used to access all worker computers for unclassified computing. Users of Secure terminals must have authorization from their division leader to do classified computing.
Secure Line	A data channel approved for communication with a Secure computer. Protected wireline or NSA-approved encryption must be used for classified access, and controlled lines (Secure) can be used for unclassified access. Secure lines are the only way to access Secure computers. All secure lines are installed as emanation-shielded "house cable," owned by the Laboratory and installed by cleared contractor personnel.
SEL	System Engineering Laboratory. The manufacturer of the (SEL) 32/55 machines used in the CFS file transport system.
SIMP	Simple Intermachine Protocol that is used to create a communication path between computers.
SLATEC	Sandia, Los Alamos, Air Force Weapons Lab Technical Exchange Committee.
Software Tools	A set of programming tools developed from concepts presented in the book Software Tools by Brian Kernighan and P. J. Plauger.

SWG	Standards Working Group.
SYNC	Synchronous Communications Concentrator. A DEC PDP-11 computer that switches message traffic and synchronizes transmission rates in the Integrated Computing Network.
TAC	Technical Advisory Committee.
TAPS	Terminal Access Paths.
Terminal Passthrough	An XNET capability that will enable a terminal that is physically attached to a remote computer to be used for interaction with the CCF worker computers.
TIP	Technology Information Panel.
TNPC	Terminal Network Planning Committee.
UNIX	An operating system developed by Bell Laboratories and used on some DEC PDP-11 computers in the Central Computing Facility.
Unprotected Line	A data channel that is suitable for Open computing only.
VAX	Virtual Address Extension. An upward extension of the DEC PDP-11 family of minicomputers.
VLSI	Very large scale integration.
VMS	Virtual Memory System. The standard operating system for the DEC VAX machines.
Wireline	A data channel.
Worker Computer	Any computer in the Integrated Computing Network that executes user programs.
WP	Word processing.
XNET	Extended Network Access System. Provides Integrated Computer Network access for remote computer sites.
XCC	Extended Communications Concentrator for CBTs.
X.25	An international standard protocol, something like DECNET, that C Division will use for CBT-2s and possibly external networks.

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051-075	7.00	A04	201-225	13.00	A10	351-375	19.00	A16	501-525	25.00	A22
076-100	8.00	A05	226-250	14.00	A11	376-400	20.00	A17	526-550	26.00	A23
101-125	9.00	A06	251-275	15.00	A12	401-425	21.00	A18	551-575	27.00	A24
126-150	10.00	A07	276-300	16.00	A13	426-450	22.00	A19	576-600	28.00	A25
									601-up	†	A99

†Add $1.00 for each additional 25-page increment or portion thereof from 601 pages up.