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Computing Division
Two-Year Operational Plan
FY 1981—1982

LOS ALAMOS NATIONAL LABORATORY
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University of California

LOS ALAMOS SCIENTIFIC LABORATORY
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Computing Division
Two-Year Operational Plan
FY 1981—1982

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LOS ALAMOS NATL. LAB. LIBS.
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This plan is the work of many people in C Division. We wish to thank our Group and Division Leaders who worked so closely with C Division Office to develop the plan, and the C Division people who provided input to the plan. Special thanks are due Marjorie Blackwell, Computer Documentation Group, who entered all the original text and cheerfully entered all the revisions as well; and to Virginia Romero and Betty Hewett, Computer Documentation Group, and Velma Payne, Computer Graphics Group, who prepared the computer-generated figures.

EXECUTIVE SUMMARY

This plan provides users of the Los Alamos Central Computing Facility (CCF) and the Integrated Computer Network (ICN) with C Division's software and hardware plans for the next two years. In FY 1980 we completed a large number of projects, including the following.

- Adopted a change-control mechanism to better control ICN changes and provide a more stable computing environment.
- Defined levels of support for our software and began defining ICN standard utilities and libraries.
- Installed the second Cray-1 and moved a second CDC 7600 to the Open partition.
- Implemented CTSS on both Cray-1s and provided the Los Alamos standard libraries, utilities, and documentation.
- Placed distributed processors on line and provided a standard set of software.
- Implemented the Print and Graphics Express Station (PAGES). PAGES now automatically controls all three FR80s and the two Versatec plotters as an integrated part of the Network.
- Improved considerably the performance of the LTSS and CFS systems with more reliable software, hardware, and network connections.
- Defined and began the implementation of a new set of network protocols that will allow us to evolve to a truly distributed computing network.
- Increased considerably the number of ICN ports, and began using the new protected wireline.
- Began placing our documentation in the CFS so users can access it online from any system.
- Automated our accounting systems.
- Converted C-1 to a 12-hour work shift that saved some operating costs.
- Survived the lightning season with a minimum of problems through the use of the new Uninterruptible Power Supply.
- Maintained and continued the development of all of our other projects.

In FY 1981 we will continue with all of our existing projects and undertake some new activities. As you read this plan, you will see the following general principles applied to our projects:

1. better planning,
2. use of software engineering techniques,
3. stabilization of the user interface,
4. standardization of software and hardware components, and
5. automation of functions when possible.

Among the new projects that appear in this plan are:

- Making the CCF easier to use for casual users.
- Designing and beginning the implementation of a high-speed video graphics system and a better production facility.
- Investigating multiprocessing, distributed computer graphics, better numerical techniques, and audio I/O as part of our research efforts.
- Bringing the data communication center on line to better detect and correct data communication problems between the CCF and user terminals or distributed processors.
- Upgrading a Cray-1 to two million words of memory in February 1981.
- Obtaining our third Cray-1 in September 1981.
- Bringing up two high-speed printers on PAGES.
- Relocating the COM area upstairs in the CCF for better operational service.
- Providing consulting in numerical techniques to assist users in better formulation of algorithms and programs.

The bottom line of this plan is that we are assembling a very powerful computing network with a wide variety of computing hardware, software, and services. Users will be able to choose among several alternatives to select the type of computing that best suits their needs.

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ABSTRACT

This report is a comprehensive planning guide for the Computing Division of the Los Alamos National Laboratory for fiscal years 1981 and 1982. Subjects discussed include critical issues, programmatic requirements, hardware plans, software projects, direct user services, research projects, and projections of future developments.

0 INTRODUCTION

0.1 PURPOSE AND SCOPE

The purpose of this document is to provide the users of the Central Computing Facility (CCF), Laboratory management, C-Division personnel, and other interested people with CCF planning information for the next two fiscal years (FY 1981 and 1982). Although some information is given for FY 1983 through FY 1987 in Sections 8-10, the scope of this plan is largely constrained by both the limited programmatic guidance available from the program offices of the Department of Energy (DOE) and the rapidly changing opportunities in computer technology.

Studies in the forecasting of computer technology show that the probability of a specific-year forecast being accurate drops below 0.5 beyond about three years. Nevertheless, we feel it is valuable to document the best information we have and to state the assumptions on which our plans are based. We trust that the reader will keep in mind that the accuracy of technical planning decays rapidly with time beyond the planning date.

This report is organized into ten sections. This section reviews the C Division organization, some of our user interactions, and how we would like to plan our activities. Section 1 discusses some of the critical issues facing us, and Section 2 briefly describes the Laboratory's programmatic requirements. Section 3 presents our general hardware plans. Section 4 presents our on-going software projects, and Section 5 presents new projects that the Computer User's Priority Task Force recommended that we undertake if funding and personnel are available. Section 6 lists the direct user services that we provide and Section 7 describes our new research program. Section 8 lists hardware acquisition schedules and Section 9 reviews some aspects of C Division's budget. Section 10 contains some projections concerning how we expect computing to evolve at the Laboratory.

0.2 C-DIVISION MISSION

The C-Division mission is to provide the general-purpose computing resources necessary for successful completion of Laboratory programs for the Department of Energy. In fulfilling that mission, we have two related goals:

- to help maximize the productivity of the CCF users, and
- to help maximize the productivity of the CCF resources.

The order stated for these two goals of C Division reflects the C-Division view of our priorities: <u>computer users are more important than computers</u>.

The most valuable resources available to the Laboratory for its defense and energy programs are the scientists and engineers who work on these programs. Regardless of its sophistication and cost, no computer or experimental device has yet had a thought that led to the design of safer, more efficient, or more

cost-effective weapons or energy systems. These inanimate resources are important tools that provide information to humans, but they do not have ideas--only human beings contribute in this way. It is important to keep this perspective in mind when setting performance objectives for computer systems. Loading a computer resource to levels approaching saturation causes long service delays that violate the first priority. That is, trying to get too much work out of a computer in order to maximize its productivity causes such long service delays that it destroys the productivity of computer users. Thus, a modest amount of idle time on computer systems is an essential ingredient of the services needed to maximize the productivity of scientists and engineers.

To satisfy the requirements of our 3200 computer users, we have designed and built one of the largest (and we believe the best) computing facilities in the world. We expect to continue to expand our software support efforts across the ICN 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, and anticipate many developments that will make computing easier for all Laboratory employees to use. Among the developments will be very powerful computer-based terminals, distributed computing, electronic mail, and interactive management information systems.

Generally, all of our activities in support of our mission 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. Users will have a broad menu of computing services from which they can choose how best to compute for their situation. In carrying out these activities, C Division must very carefully make sure that we meet today's user's needs while preparing for tomorrow's. We believe that we are on the proper track and will continue to improve and evolve all of our services.

0.3 C-DIVISION ORGANIZATION AND PROJECTS

A block diagram of the C-Division organization is shown in Fig. 1. The Division is staffed with about 275 people, organized into seven groups plus the Division Office. All of our projects span group boundaries, however projects are listed below in the group that has major responsibility.

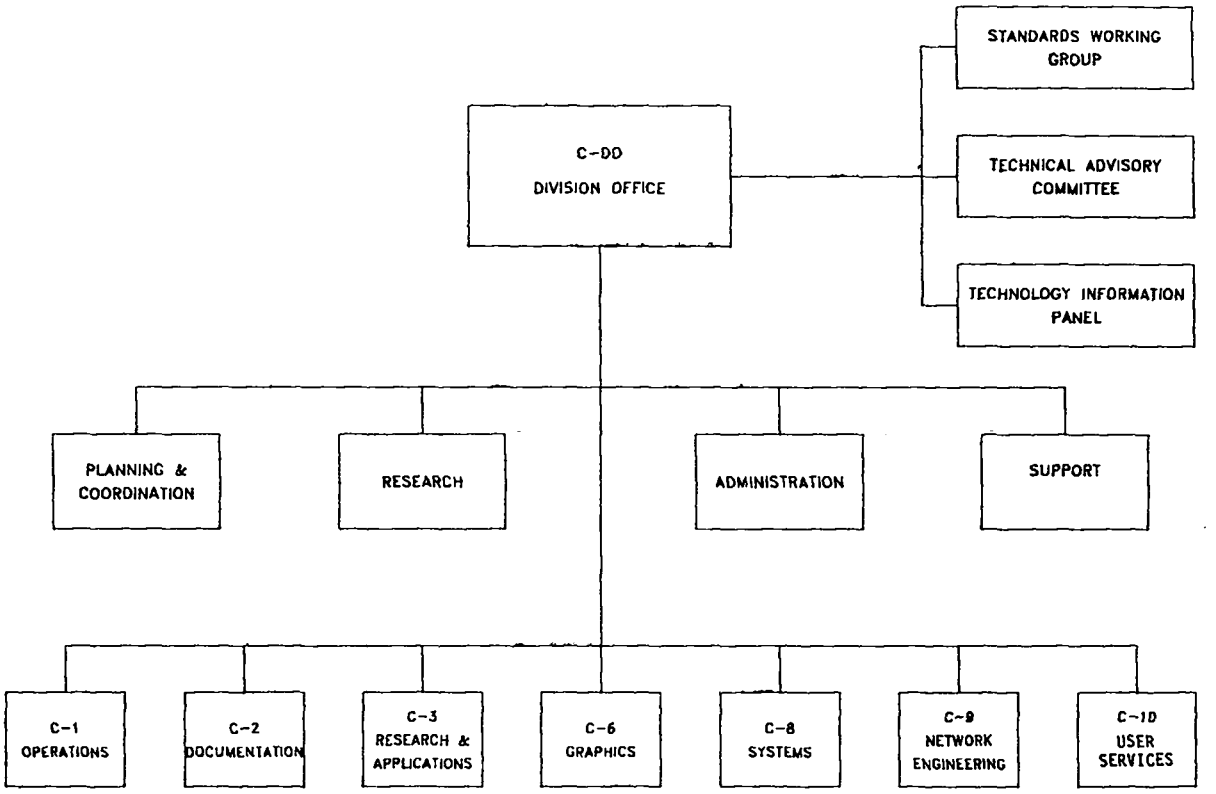

Fig. 1. C-Division organization.

0.3.1 Group C-1: Computer Operations

Functions.

C-1 is the largest group in C Division, with about 90 employees. This group operates the worker computers and graphics systems of the 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.

Projects.

- Continued operation of all CCF resources.

0.3.2 Group C-2: Computer Documentation

Functions.

C-2 generates and maintains documentation for C-Division hardware and software. The staff edits and produces the C-Division News and the ICN Change Bulletin. They also edit and word process special documents, including the Los Alamos Site Input to the DOE ADP Long-Range Plan, planning guides, procurement implementation plans, and the C-Division Two-Year Operational Plan. The group provides keypunch and slide-generation services for C Division and, on a Form-B basis, other Los Alamos organizations.

Projects

- Continued production of the C Division NEWS and ICN Change Bulletin.
- CTSS documentation
- New graphics documentation
- New network documentation
- PIM updates as necessary
- ADP Long-Range Plan
- C-Division Two-Year Operational Plan
- Continued editing, word processing, graphics, and keypunch operations
- On-line information-retrieval project.

0.3.3 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 data-base and project-management systems. The Group performs research in advanced computer architectures, numerical algorithms, and applied mathematics.

Projects.

- Continuation of the program library.
- Continuation of the standard math library for all systems.
- Benchmarking of Laboratory and external high-performance computers.
- Custom programming for the Laboratory.
- Research in high performance computing, numerical analysis, multiprocessing, and applied mathematics.

0.3.4 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 now developing an on-line ICN output station, the Print and Graphics Express Station (PAGES) and is beginning to develop a new high-speed Advanced Interactive Display System (AIDS). C-6 also performs research in satellite graphics, addressing such issues as distribution of labor and data compression.

Projects.

- PAGES
- 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 (AIDS)

0.3.5 Group C-8: Computer Systems

Functions.

Group C-8 provides operating system maintenance and development support for major CCF computers, including the CTSS operating system for the Cray-1 computers, the LTSS operating system for the CDC 7600s, the NOS operating system for the CDC 6000-series computers, and the OS-VS1 operating system and production program for the IBM-based Common File System (CFS). C-8 also performs the CCF accounting activities and is initiating a new project to automate the control of production computing.

Projects

- CTSS: maintenance; implementation of the standard charging algorithm; implementation of a simplified intermachine protocol to standardize and facilitate machine-to-machine communication (SIMP, JOB, PTP); and upgrading to a two-million word Cray-1.
- LTSS: maintenance; implementation of SIMP; and implementation of a high-speed parallel interface (HSPI) to handle high-speed data transfers between ICN computers.
- NOS: maintenance.
- UNIX: maintenance.
- VMS: maintenance; implementation of system modifications to Distributed Processor software for security reasons.
- CFS: maintenance; implementation of SIMP and new user functions.
- MODEL system development language: continued maintenance and enhancement for joint work with LLNL.

- Planning and design of future operating systems.
- Completion of the automatic accounting functions.
- Modeling of the ICN, CTSS, and user jobs.
- Development of the Automated Production Controller.

0.3.6 Group C-9: Computer Network Engineering

Functions.

Group C-9 designs and builds prototypes of all the specialized interfaces necessary to allow high-speed data transmission within the ICN. C-9 acquires/builds new communications concentrators as needed and helps customers coordinate their computer communications requirements. The group also writes and maintains the software necessary to operate switch, concentrator, status, and security machines. The group maintains all the ICN switches, concentrators, and terminal communication lines. C-9 is currently developing a major extension to the ICN, the Extended Network Access System (XNET).

Projects

- Continued support of ICN hardware.
- Design and development of High Speed Parallel Interface (HSPI) connections for Cray-1, CDC 7600, and CDC 6000-series computers.
- Continued development of memory expansion in network switches to support higher data rates.
- Continuation of software and hardware support for XNET.
- Addition of new file-transport machines and remote-worker connections.
- Continued development of the Data Communications Center and design of new Laboratory data communications facilities.
- Continued support of Laboratory data communications facilities.
- Development of new computer based terminal support.

0.3.7 Group C-10: Computer User Services

Functions.

Group C-10 provides direct user services in consulting, utilities, and languages. C-10 is responsible for quality assurance, coordinating change control, and for chairing the Standards Working Group (SWG). The group performs research in programming languages, addressing such issues as portability and multiprocessing.

Projects

- Continued consulting services, with the addition of Distributed Processors.
- 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 support of FTN and CFT, implementation of FTN5 for NOS and LTSS, and acquisition of ANSI standard FORTRAN 77 compilers and their run-time libraries for all systems.
- Continued development and support of the standard utilities.
- Development of the casual user project.
- Development of a comprehensive user education program.
- Research in programming languages.

0.3.8 C-Division Office

Functions.

In addition to the normal functions of Division administration, C-DO manages the C-Division Property Office, ADP and word-processing procurement and review, and CCF allocations.

Projects.

- Management of C Division.
- ADP procurement and review.
- Word-processing procurement and review.
- CCF allocations.
- Property management

0.4 ROLE OF ADVISORY COMMITTEES

There are several computing advisory committees that have important roles in the formulation of C-Division plans and the setting of priorities for C-Division projects.

- The Computer Users Priorities Task Force (CUP) is an ad hoc committee chartered by the Associate Director for Engineering Sciences (ADES) to assess the relative importance of proposed and existing C-Division projects for the upcoming fiscal year. Its output is a list of these projects in priority order. Constraints on C-Division funding, manpower, and time may make it impossible to support all projects proposed by users and C Division, and this list is used to select the projects to be supported in the budget year.

  The CUP "Report of the Task Force on Computer Users' Priorities" is included in this plan as Appendix A. The report includes two categories of recommendations: (1) the "core" projects, considered by CUP to be essential to the operation of the CCF, and (2) "priority" projects, considered by CUP to be important to the users, but not as essential as the core projects to the CCF during FY 1981. The core projects are included in Section 4.0 and the priority projects are discussed under New Development Projects in Section 5.

- The Interactive Computing Task Force (ICTF) played a major role this past year in advising the Director on which operating system was most

appropriate for the Cray-1 computers, and in advising C Division on user priorities for implementing CTSS. This task force has now completed its mission and has been disbanded.

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

- The Technical Advisory Committee (TAC) 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 will play an advisory role roughly similar to that performed by the ICTF.

- The Technology Information Panel (TIP) is composed of non-Laboratory computing experts who meet at least annually to review C-Division plans 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.

There are also several Laboratory divisions that have internal computing advisory committees, including the X Division Computer Liaison Committee and the 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.

0.5 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, and C-Division employees work with the following: X3H1 (Operating Systems), 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 users groups for IBM (SHARE), CDC (VIM), Digital Equipment (DECUS), and Cray Research (CUG).

- 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; the Laboratory is a regular exporter of graphics software through this Forum.

- Professional Societies. There is extensive participation by C-Division employees in professional societies, including the American Mathematical Society (AMS), Association for Computing Machinery (ACM), the Institute of Electrical and Electronics Engineers (IEEE), the Society for Industrial and Applied Mathematics (SIAM), the Society for Technical Communication (STC), and the International Word Processing Association (IWP).

- 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 also 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. It has recently been agreed to expand this committee to include the Lawrence Livermore National Laboratory Computing Center, the Magnetic Fusion Energy Computing Center, and Sandia National Laboratory Livermore computing center.

0.6 CONCEPTUAL MODEL FOR CCF PLANNING

Figure 2 illustrates the conceptual planning model on which this two-year plan is based. As noted in the discussion of the C-Division mission, the primary objective of the CCF is to provide computing services to the scientists and engineers who work on the Laboratory's defense and energy programs. There are, however, three levels of CCF users: (1) the end users, who use the resources of the CCF in their programmatic or administrative tasks; (2) the applications developers, who use the CCF resources to develop new applications for use by end users; and (3) the system programmers and engineers in C Division, who provide the systems tools needed by the other two levels of users.

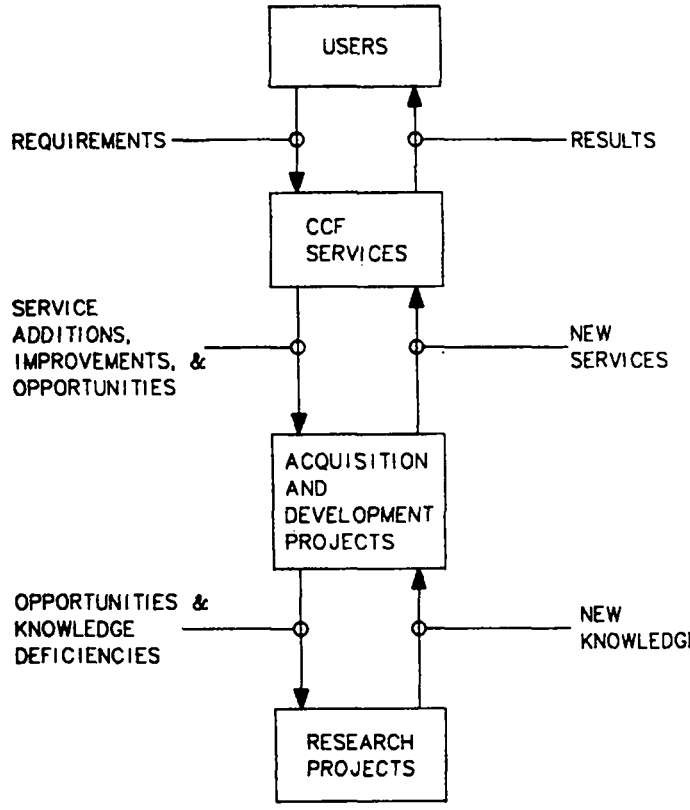

Fig. 2. A conceptual model for CCF planning.

Regardless of the excellence of any computing center, there are always opportunities for quantitative and qualitative improvements in the computing resources. Computing requirements are continually changing; existing services are never perfect. Hence there is always a backlog of improvements that need to be made to meet present and future needs. These opportunities for improvements are the motivation for the acquisition and development of new computing resources, which are necessary in order to provide new and improved computing services. 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.

Computing is a rapidly changing field driven by a considerable investment in research. Computing research seeks either improved techniques or new techniques where none currently exist. Similarly, the objective of C-Division research is to improve our computing facility by either exploring opportunities resulting from new ideas and products, or by developing technology to do things that we currently do not know how to do, i.e., knowledge deficiencies.

When research produces new or improved technology, the result is development projects, which in turn provide users with the new or improved services. Thus, both research and development in C Division are driven by our users'

current or projected needs.

In summary, C-Division planning is driven by three feedback loops:

(1) the loop between the users and the existing services, in which user requirements are responded to with the results requested;

(2) the loop between the existing services and the C-Division acquisition/development projects, in which existing services are improved; and

(3) the loop between the acquisition/development projects and the research projects, in which opportunities and inadequate knowledge are addressed, providing new knowledge needed to begin acquisition/development projects.

Specific information on each of these categories is given in the plan that follows.

1 CRITICAL ISSUES

In this section we discuss several issues that users have repeatedly brought to our attention, thereby indicating an unusually high level of interest, and certain problems that pose unusual difficulties in carrying out our plans.

1.1 CCF STABILITY AND EVOLUTION

C Division faces a continuing paradox in providing computing services:

The CCF should be stable, but it must provide state-of-the-art facilities.

Given that the CCF must change to meet the increasing and changing nature of the user requirements, C Division observes the following order of preference in making changes:

(1) Make changes in a manner that is transparent to the users.

An example of this kind of change is the work done by the Computer Systems group in optimizing the queueing algorithms for LTSS disks. I/O blockage was reduced from a minimum of about 20% to about 10%, with the only effect on user codes being that of increased throughput.

(2) Make changes in a manner that is upward compatible with existing services.

An example of this kind of change is the upgrade of the existing one-million word Cray-1 to the two-million word Cray-1.

(3) Minimize the incompatibilities with existing services when providing new services.

An example of this kind of change is the manner in which CTSS is being implemented. CTSS will be implemented so it is largely compatible with LTSS, and certain of the superior characteristics of CTSS will be retrofitted to LTSS.

(4) Make incompatible changes when no other alternative exists, but only when an acceptable level of new capability is thereby achieved.

An example of this kind of change is the replacement of the Hydra/Photostore system with the Common File System (CFS). For new supercomputers, it is a standing C Division policy that incompatible supercomputers will be acquired only when they provide an increase in performance of at least a factor of 3-5 over installed computers.

The Consulting Office has been assigned the responsibility for coordinating software and hardware changes in CCF systems, to assure that when a change is made, all other C-Division groups whose responsibilities might be affected are alerted, quality assurance tasks are completed, and the users are provided with as much notice as is feasible.

1.2 SUPPORT OF LTSS/CTSS

It is planned that LTSS and CTSS will be supported in the long term, and that the characteristics of these two systems will converge. We expect these systems to evolve, but they will not be replaced by another supercomputer operating system in the foreseeable future.

1.3 SUPPORT OF NOS

NOS will be supported for at least the next two years. The long-term support of NOS depends in large measure on three factors:

(1) How rapidly AADP moves to other systems.

(2) The extent to which Distributed Processors take over the "software-rich" services for NOS scientific users. If Distributed Processors become software rich and users move their NOS work to these new systems, usage and therefore the funding support for NOS would decrease.

(3) The difficulty of integrating new versions of NOS into the ICN.

1.4 DISTRIBUTED PROCESSORS

Distributed Processors (DPs) are just beginning to be connected to the ICN through the Extended Network Access System (XNET). C Division is supporting DPs by conducting the procurement action, through XNET, through the development of DP software (see Sections 4.1.6 and 4.4.4), and by providing consulting services. Distributed Processors are expected to offload some of the work that has traditionally been done in the CCF, especially interactive work and small-scale computing. This new form of computing service is not expected to replace the CCF services but to augment them.

1.5 CLASS VI/VII COMPUTERS

The Cray-1 is rated as a "Class VI" computer, with an execution bandwidth of about 40-million instructions per second. (The CDC 7600 has a nominal execution bandwidth of 10-million instructions per second.) A computer faster than the Cray-1 by about a factor of 3-5 would be rated as a Class VII computer, and it is this scale of computer that will eventually augment or supersede the Cray-1. C Division has included "Class VI/VII" computers in the Laboratory input to the DOE ADP Long-Range Plan for Fiscal Years 1981, 1983, and 1985 in anticipation that an advanced computer will be required for these years. However, C Division's best estimate at this time is that no Class VII computer will be developed until FY 1985, and a 4-million-word Cray-1 will be acquired to fill the FY 1981 and 83 Class VI/VII capacity requirement.

Regardless of the vendor of the Class VII system, the Laboratory CTSS/LTSS user interface must be provided on the Class VII computers. By implementing, adapting, or obtaining a compatible system from a vendor for the Class VII, we hope to minimize conversion problems to the Class VII.

1.6 HARDWARE ACQUISITION

A perennial critical issue has been the body of special regulations and prescribed procedures, mandated by DOE Orders, which apply to the acquisition of computer hardware in contrast to other types of equipment. These rules, which reflect the extraordinary levels of attention paid to Government computing activities by Congress and the Office of Management and Budget, have been the cause of protracted procurement cycles for new CCF resources.

Until about two years ago, the Laboratory's authority in acquiring ADP equipment was limited to items costing less than $25,000. Because the threshold is now $100,000, the number of acquisition proposals that require submission to DOE for approval, with a consequent lengthening of the procurement cycle, has been considerably reduced.

At the same time, and with respect to those higher value items that still require DOE concurrence, C Division and the Materials Management Department have been working more closely with the ADP management staff in the Albuquerque Operations Office and the procurement staff in the Los Alamos Area Office--discussing computer plans and strategies and identifying in advance issues that might require resolution prior to granting of approval. This has brought about improved turnaround following formal submission of proposals.

The same approach, with discussions that also included DOE's Headquarters staff, resulted in a relatively short approval cycle for the recent proposal to upgrade the memory capacity of one of our Cray-1 computers to two million words.

1.7 RELEASING COMPUTERS

At this time, C Division does not plan to release any of the worker computers of the ICN. The release of worker computers typically occurs as the result of funding constraints, limitations within the physical plant, or the appearance of more cost-effective technological opportunities for meeting user needs. However, all worker computers are currently fully occupied during prime shift, serving the interactive needs of the users. The view is obsolete that idle time during the non-prime production shifts means excess capacity is installed and a computer should be released, and certainly does not apply to a fully interactive computing environment such as the Laboratory CCF. Some idle time is <u>essential</u> if interactive response time is to be held small enough to avoid delaying the work of the users.

2 PROGRAMMATIC REQUIREMENTS

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.

While major emphasis is on weapons design calculations, considerable effort is also directed towards weapon test calculations and investigations into experimental diagnostics. Both require large-scale computer simulations.

Weapons computing exerts considerable leverage in maintaining an effective yet economical nuclear weapons program. If a Comprehensive Test Ban Treaty is ever negotiated, it will force increased reliance on computational tools. This in turn will require the Laboratory to commit even more of its resources to computational physics and associated facilities.

The second largest user of computing resources, though small compared to the Weapon's 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 underway 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.

Resolution of physics questions regarding complex target interaction requires a very close working relationship between experimentalists and target designers, and depends upon computer simulation codes that strain the capacity of existing computers. Effective computations demand the resources of a local, on-site, high-capability, high-capacity, and secure computing center.

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 while SIMMER models hypothetical core disruption accidents for the liquid-metal fast breeder reactor.

The development and application of these codes relies on both the capabilities and the large size of the CCF. The large size is very important in responding to crash efforts, such as the analyses necessitated by the Three Mile Island accident. It was possible, for short periods, to divert a significant fraction of the CCF capacity to those analyses without severely impacting current programmatic work.

The combined effect of these three programs on the Laboratory's total projected computer capacity is great, as shown in Fig. 3. It should be noted, however, that out-year estimates of need resources are just that, estimates. Funding restrictions obviously could cause downswings just as unusual nuclear test results, for instance, could cause new commitments. Thus, while estimated computer resources for most nonweapons activities are now projected as being static or dropping very slowly with time, factors beyond the Laboratory's control can change this picture.

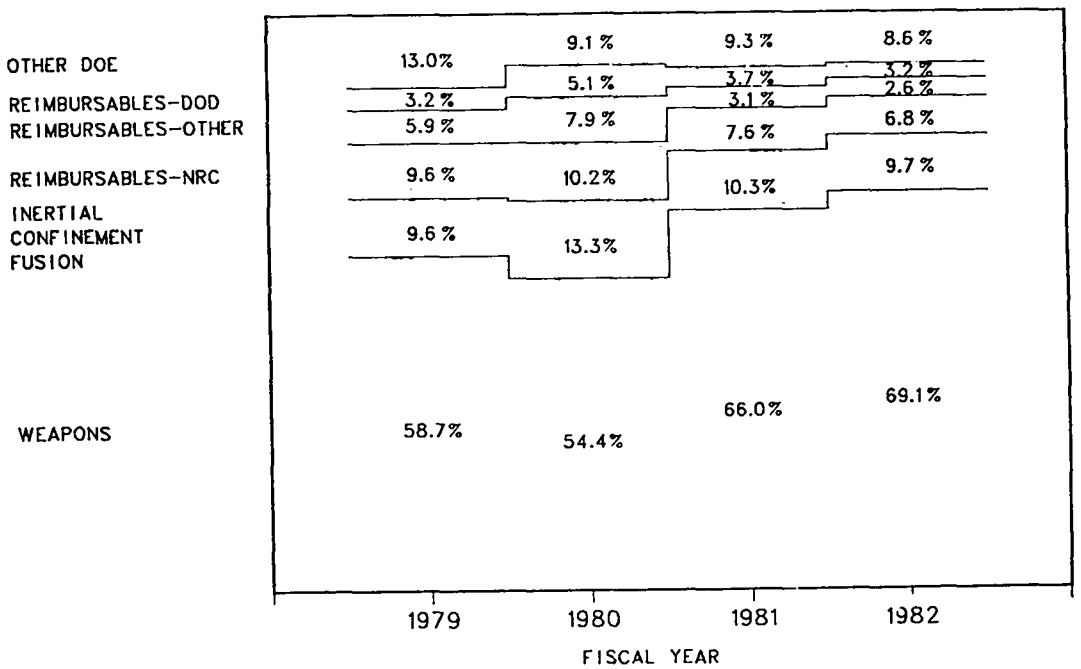

Fig. 3. Trend in usage of CCF resources by program.

Figure 4 shows CCF usage by Division in FY 1980.

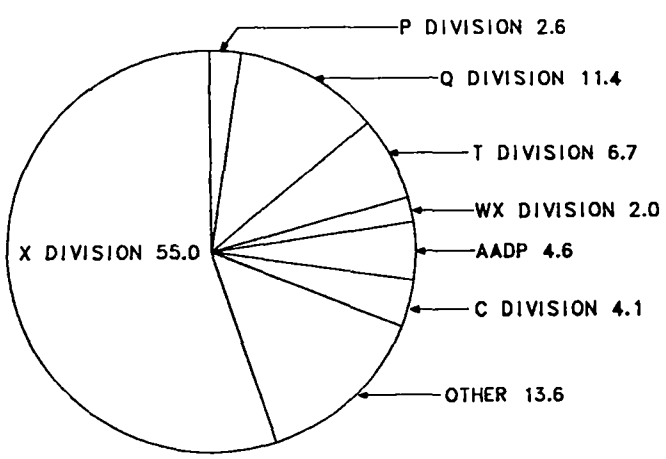

Fig. 4. Percent of CCF usage by Division.

3 INTEGRATED COMPUTER NETWORK HARDWARE, PHYSICAL PLANT UPGRADES, AND SECURITY

The Integrated Computer Network (ICN) 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 (CFS), the Print and Graphics Express Station (PAGES) and the Extended Network Access System (XNET). From the user's point of view, the ICN consists of terminals, the worker computers, CFS, PAGES, and XNET. From C-Division's point of view the network also includes many communications resources, such as concentrator computers, message switches, file-transport switches, the network status machine (NSM), and the network security controller (NSC).

Figure 5 shows the major units that make up the ICN. In the following discussion, the capitalized term "Network" will refer only to the communications portion of the ICN.

3.1 TERMINALS

During FY 1981 we will define new sets of standard ICN terminals to meet changing user requirements and to take advantage of newer technologies. Existing standard terminals are

- KBT - Keyboard Terminal. The Texas Instruments hardcopy terminal family, currently operable at 300 bit/s, and including portable models for dial-up use and units with tape cassettes for data storage.

- KCT - Keyboard CRT Terminal. The Research Incorporated Teleray alphanumeric video terminal. The capabilities of the alphanumeric video terminal now being defined (see below) will include the functions of this KCT as a subset.

- KGT - Keyboard Graphics Terminal. The Tektronix 401X family of monochromatic graphics terminals and associated hardcopy devices.

- 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 - Computer-Based Terminal. A Digital Equipment Corporation PDP-11 configuration with a wide range of capabilities including job entry to CCF worker computers.

In FY 1981, the following new terminals will be defined.

- Higher speed KBTs. Texas Instruments has extended the standard KBT to include 1200-bit/s hardcopy terminals. Procurement of these terminals may begin soon, but 1200-bit/s ports will not be available until April 1, 1981.

- KGT-2. A very lengthy procurement is just being completed that will define a standard family of color graphics terminals. Procurement of these terminals may begin in December 1980.

- KCT-2. We are defining a new family of alphanumeric video terminals that will run at 9600 bit/s. This procurement should be complete during March 1981.

- CBT-2. A new family of computer based terminals will be defined by September 1981. These terminals will have local intelligence, and a variety of communication utilities and graphics software will be provided.

3.2 TERMINAL NETWORK

User terminals are connected to the Network through "ports." During FY 1981 we plan to increase the number of ports substantially by adding KCCs and swapping 300-bit/s ports for 1200-bit/s ports as needed. C-Division's plans for port availability on the Network are summarized in Table I below.

TABLE I

PORT AVAILABILITY PLANS FOR THE ICN

TYPE	10/1/80 total	11/1/80 increment	1/3/81 increment	5/1/81 increment	10/1/81 total
300 bit/s	908	+75	+75	+75	1133
1200 bit/s	0				up to 225
9600 bit/s	196	+45	+30	+30	301
150K bit/s	1		+11		12
200 UT	20				20
CBT-1	30				30
CBT-2	0				+20
XNET A Ports	5	+1	+4	+5	16
XNET B Port	1		+1	+1	3

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 75 300-bit/s terminals and 30 9600-bit/s terminals. During FY 1981, C Division will be able to convert up to 225 300-bit/s ports to 1200-bit/s ports to support higher-speed KBTs.

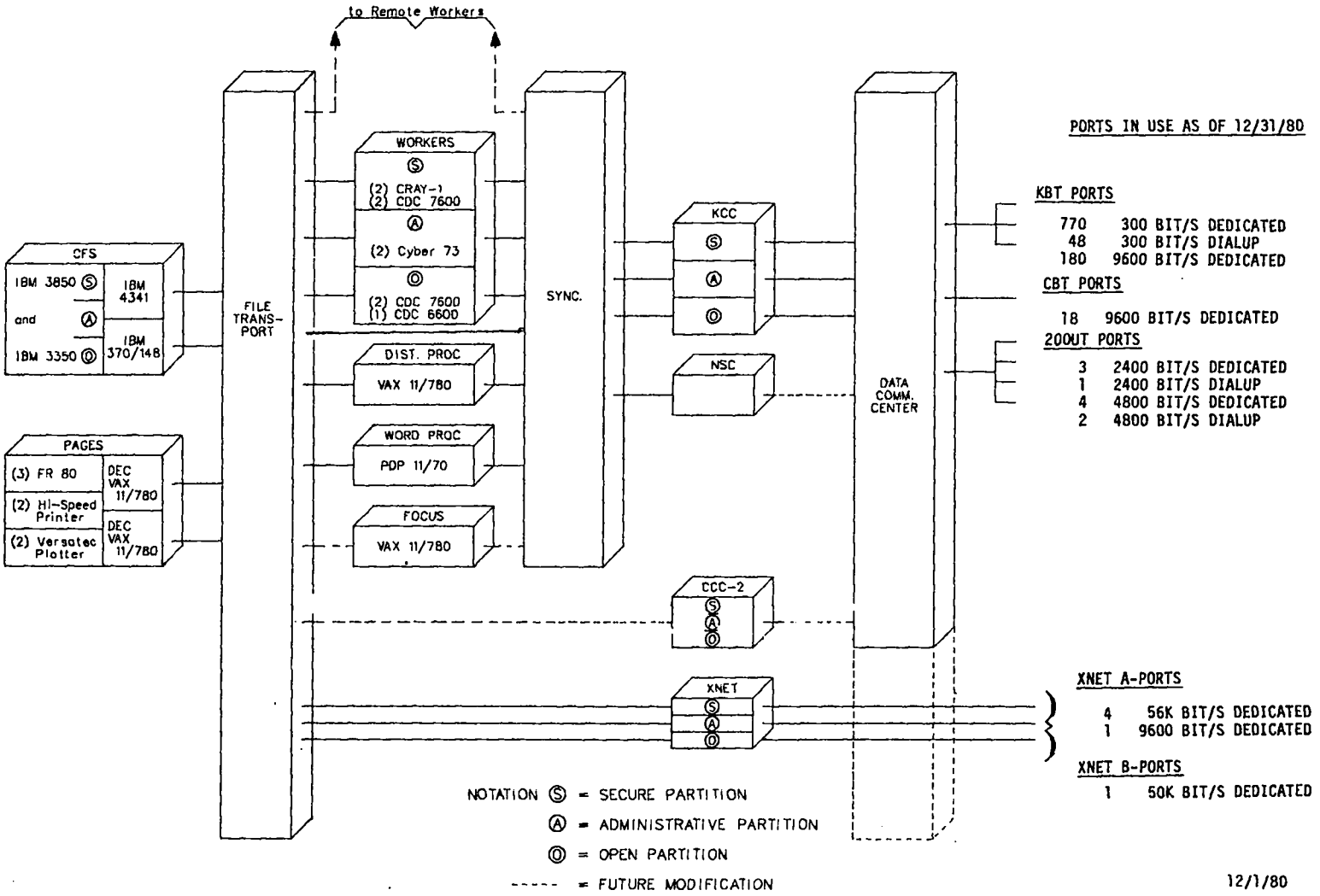

Fig. 5. Integrated Computer Network.

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

- CBT Communications Concentrator-2 (CCC-2). The CCC-2 is a follow-on subsystem that will be developed to support CBTs and CBT-2s. For further information, see Section 5.3.

- Keyboard Graphics Concentrators (KGCs). The KGCs are designed to serve a small number of high-speed Tektronix terminals. To better support the Laboratory users, C Division designed an interface card, the High-Speed Tektronix Interface (HSTI), for the Tektronix 4014. Each HSTI is interfaced to the KGC through another C Division-designed hardware interface, the Asynchronous Line Interface (ALI). Each ALI can serve four ports. The ports require three wire-pairs and operate at speeds up to 300K bit/s. The HSTI line length is limited to a distance of 2000 feet from the concentrator computer.

  The KGC is limited to 24 HSTI ports, and at present the memory buffers in the KGC are limited to 990 bytes. KGC service will soon be extended to X Division. A development terminal is installed and operating within the CCF near KGC 50.

Also included in the terminal portion of the Network are the Synchronizers (SYNCs), which switch messages between the concentrators and the worker computers; the Network Security Controller (NSC), which checks the security authorization of requested services; and the Network Status Machine (NSM), which monitors and displays the status of the Network nodes.

3.3 WORKER COMPUTERS

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

TABLE II

WORKER COMPUTERS AT LOS ALAMOS

Quantity	Type	Relative Power	Memory Size (M words)	Operating System	Fortran Compiler
2	CRI Cray-1	4	1	CTSS	CFT
4	CDC 7600	1	0.56	LTSS	FTN (LTSS)
1	CDC 6600	0.2	0.63	NOS	FTN
1	CDC Cyber 73	0.1	0.63	NOS	FTN
1	CDC Cyber 73	0.1	0.32	NOS	FTN

The memory capacity of one of the Cray-1 computers will be upgraded to two-million words in the first quarter of 1981. We are also currently seeking approval to sole-source two more Cray-1 computers. We are seeking this approval jointly with LLNL, and they are also seeking approval for two more Cray-1s. Our plans call for the installation of our third Cray-1 in September 1981 and our fourth early in FY 1983. However, these plans have yet to be approved by DOE Headquarters. Plans for the acquisition of worker computers in FY 1981 through FY 1986 are shown in Table XIV in Section 8. The major peripherals attached to the worker computers are shown in Table III, below.

TABLE III

WORKER COMPUTER PERIPHERALS

Machine	Disks	Total Disk Capacity (M words)	Tapes	Printers
CRI Cray-1 (V)	17 DD 19 Disks with 4 DCU-2 Controllers	592 (64 bit)	None	None
CRI Cray-1 (W)	17 DD 19 Disks with 4 DCU-2 Controllers	592 (64 bit)	None	None
CDC 7600 (U)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	2 CDC 580
CDC 7600 (T)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	2 CDC 580
CDC 7600 (S)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	2 CDC 580
CDC 7600 (R)	3 Dual-Density 819 3 7639 Controllers	240 (60 bit)	5 IBM 3420 1 IBM 3803 controller	2 CDC 580
*CDC Cyber 73 (L)	5 844 Disks 2 7154 Controllers		2 CDC 669 2 CDC 667	2 CDC 580
*CDC Cyber 73 (N)	17 844 Disks 3 7154 Controllers 3 7154 Controllers	198 (60 bit)	2 CDC 677 6 CDC 679	2 CDC 580
CDC 6600 (M)	6 844 Disks 11 844 Dual-Density Disks 6 7154 Controllers	231 (60 bit)	3 CDC 677 5 CDC 679	2 CDC 580

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

3.4 FILE TRANSPORT NETWORK

The File Transport network handles the large data-block transfers in the local network environment. These data blocks go between the worker computers and the Common File System, PAGES, and the XNET switches. In addition, the worker-to-worker traffic is increasing.

The data in the File Transport Network is characterized by several small control messages followed by large (25K-byte) data blocks. To support this traffic we use the File Transports (FTs) containing a 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 April 1981 we will add a fourth File Transport that will provide an additional 13 ports in the File Transport network to support more worker computers and services. To connect workers to the File Transport network, we are developing a standard communication interface called a High-Speed Parallel Interface (HSPI) capable of operation at speeds up to 40M bit/s. We have already developed and are currently running HSPIs for connections to IBM 370/148 and 4341, VAX 11/780, PDP-11 family, FR 80s, and SEL 32/55. In FY 1981 we will develop and implement two new HSPIs for Cray-1 computers and CDC 7600s. The HSPIs will provide users with faster response time and more reliable operations.

An additional service is planned to support high-speed (greater than 2M bit/s) connections to remote sites. This facility shown at the top of Fig. 5 is designed to provide a limited number of very broadband computer-to-computer communication channels interfaced to the ICN. The design provides the following:

- five broadband, full-duplex channels,
- full ICN protocol over the channel,
- standardized computer channel interface hardware,
- hardware error detection and correction (Hamming code), and
- CCF monitoring of channel errors.

Our plans for the development of the File Transport network are shown in Fig. 6.

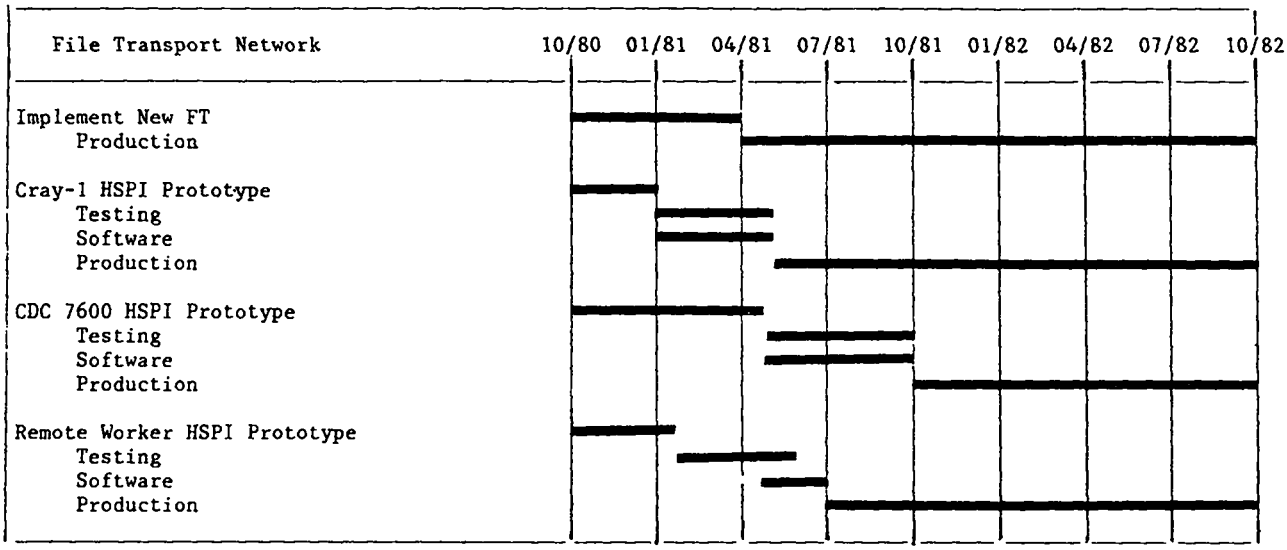

Fig. 6. File Transport network Schedule.

3.5 COMMON FILE SYSTEM (CFS)

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 1.5 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 an hierarchical storage system. Active files are stored on disk, less active and large files are stored on the 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. We have been running the CFS in a production mode for about 1-1/2 years; Fig. 7 shows the growth of CFS storage since its inception.

No major CFS hardware will be added in FY 1981. In FY 1982 we plan to upgrade the CFS controllers and storage media to increase throughput and storage capacity. Our plans for CFS software projects are given in Section 4.1.7.

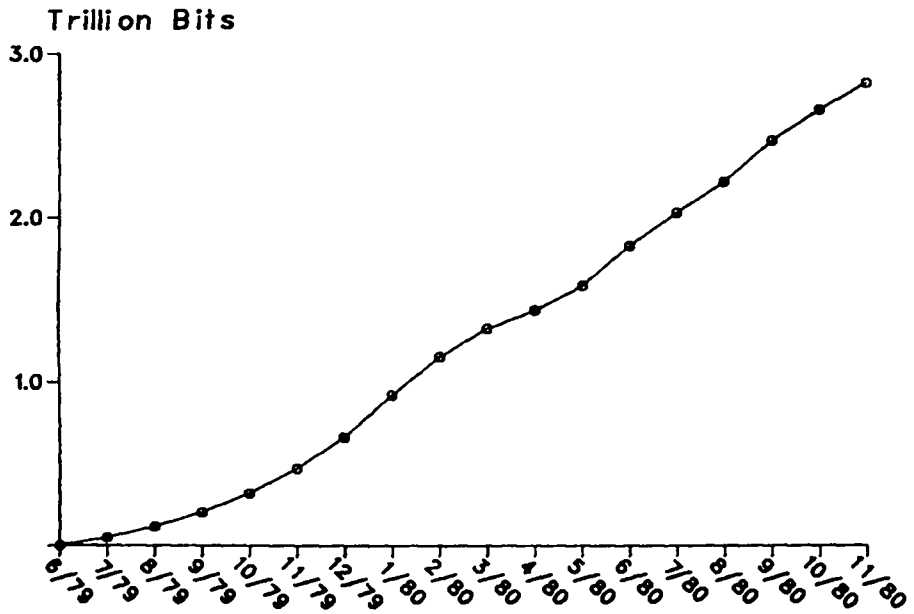

Fig. 7. Common File System storage growth.

3.6 PRINT AND GRAPHICS EXPRESS STATION (PAGES)

The Print and Graphics Express Station (PAGES) provides online ouput generation through the ICN. PAGES was devised to handle an ever increasing quantity of output in the CCF (see Fig. 8) and to provide better quality output more rapidly. The controller for this system is a DEC VAX-11/780, which is used to connect graphics devices to the ICN. PAGES went into full production for all graphics microfilm and electrostatic plotters on March 4, 1980, and added alphanumeric microfiche capability on June 2, 1980. A new color generation scheme using additive colors has also been evaluated and adopted. An improved operator interface will be available by September 1981.

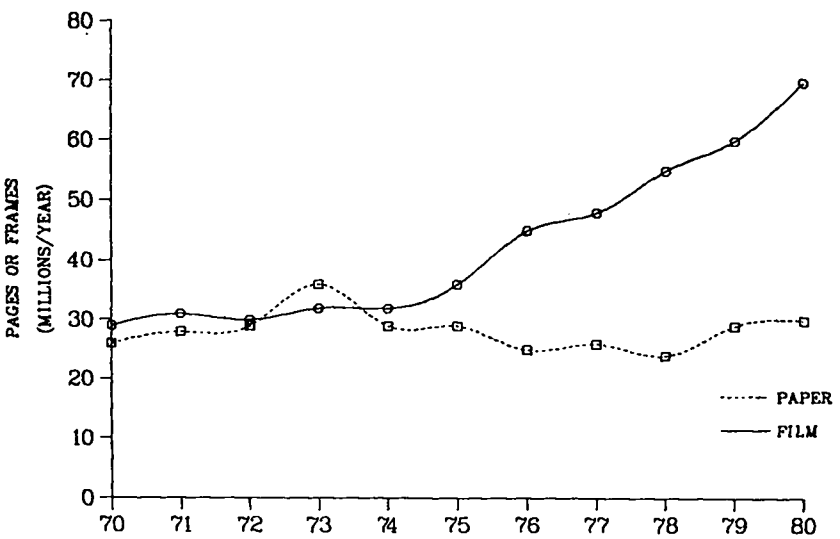

Fig. 8. Computer output generated at Los Alamos.

FY 1981 is expected to be the last year of major PAGES development work, however FY 1981 will be very busy. We will implement a second PAGES controller to remove the single controller point of failure. To improve our operational efficiency and improve job turnaround time, we will move all of our COM operations upstairs onto the main level of the CCF. We are also completing a procurement that will allow us to obtain two high-speed printers that will be attached to PAGES. These printers are each capable of printing up to two pages of high-quality text each second. As these printers are phased in, we expect to be able to reduce the number of older impact printers in the CCF.

We will also be replacing two obsolete film processors and an alphanumeric microfiche recorder during FY 1981. The new film processors should help us ensure better film quality and consistency. The alphanumeric fiche recorder will be placed on-line on PAGES and will complete the effort to put all COM operations on-line.

We currently run two Versatec plotters on PAGES and will be improving their service. The 500,000-vector limit for Versatec plots will be removed in February 1981, and we expect the banding problems to be eliminated by September 1981.

Our plans for this new PAGES hardware are shown in Fig. 9. PAGES software projects are described in Section 4.1.8.

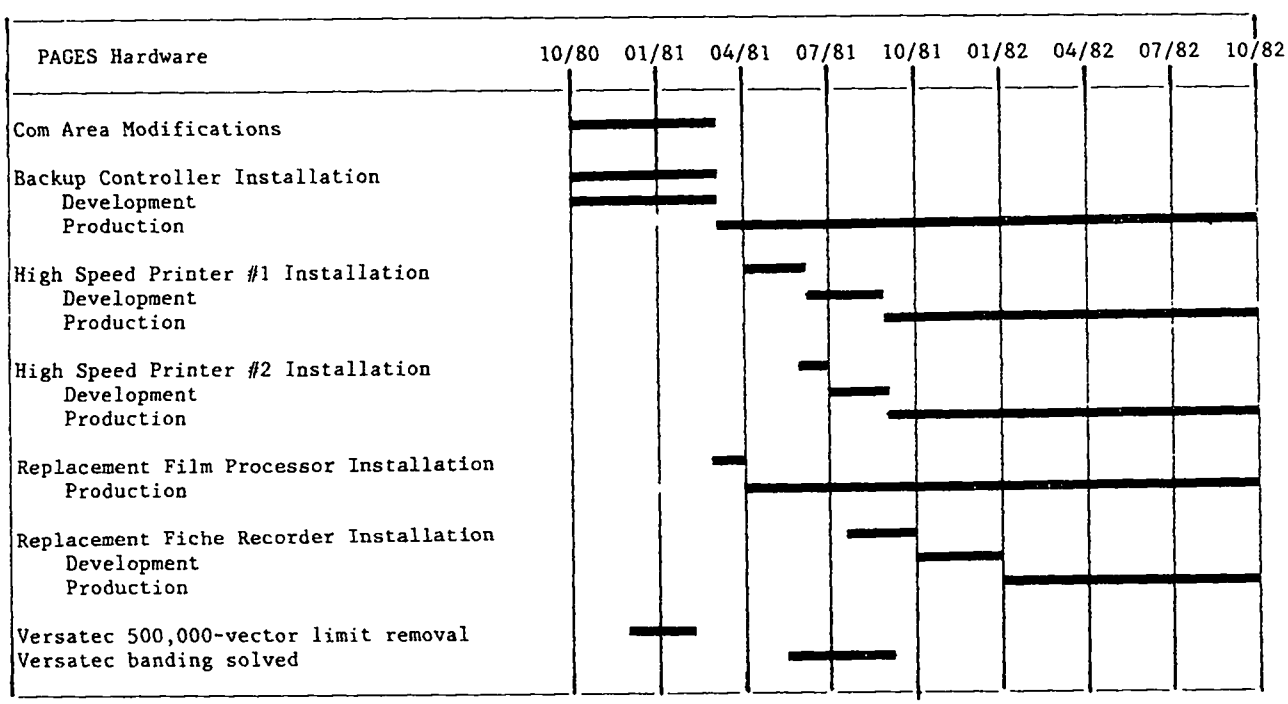

Fig. 9. PAGES hardware schedule.

3.7 EXTENDED NETWORK ACCESS SYSTEM (XNET)

XNET provides access to the ICN services for remote computers installed throughout the Laboratory through the use of A-Ports. XNET may also provide B-Ports to allow ICN terminals to access remote Distributed Processors.

A-Port installations have begun, with five VAX-11/780 Distributed Processors (DPs) in use as of 1 October 1980. Additional installations of DPs connected to A-Ports are planned, with some 16 DPs expected to be in use in FY 1981. A-Ports provide a general file shipping capability between a distributed processor and the CCF.

An XNET B-Port will make possible interactive access to remote computers through the ICN terminal network; that is, selected remote computers will be available to authorized users from any ICN terminal in the proper security partition of the ICN. Hardware and software associated with these ports must meet DOE requirements for privacy and security.

Our schedule for XNET is given in Fig. 10.

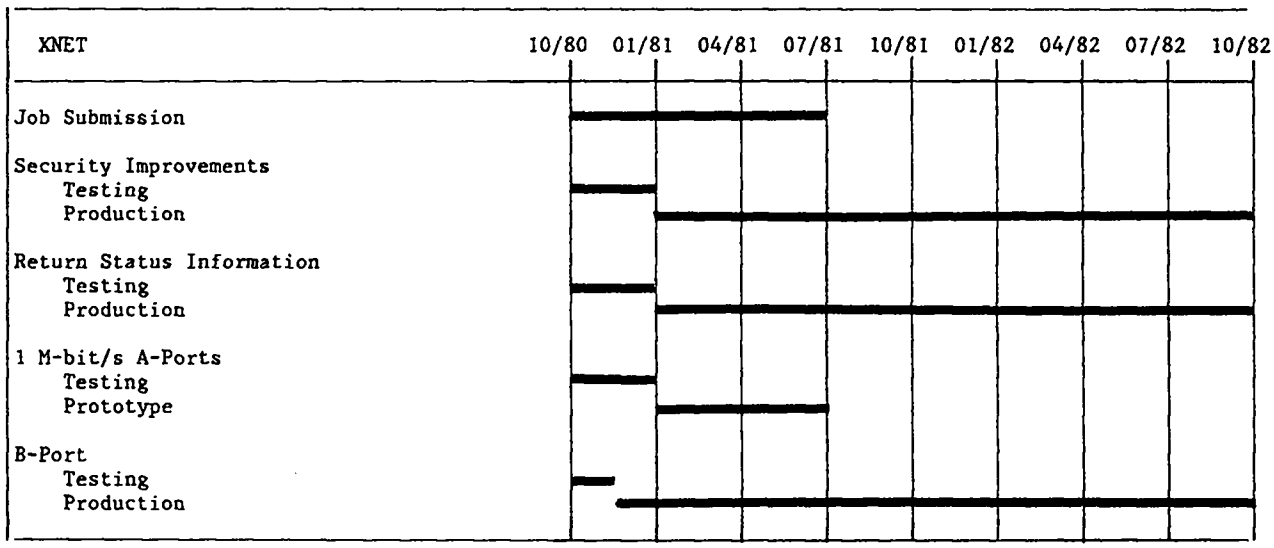

Fig. 10. XNET schedule.

3.8 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 Engineering Department, and the extreme rarity with which users experience problems due to the physical plant is silent testimony to the excellence of ENG's work. Changes to the physical plant are continually being made for the installation of new equipment and the improvement of computer operations. Some of the major upgrades of the physical plant planned for the future include the following.

- Upgrade of the second Cray-1 (W) to two million words of memory. New modules will be installed, disks will be relocated, and additional power supplies provided.

- Relocation of the tape library. The tape library formerly occupied all of Rm. 260, but it has now been moved to a smaller area in Rm. 280. This move has been made possible by the reduction in use of half-inch magnetic tape 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 been cut in half from its maximum of about 50,000.

- Relocation of the COM/PAGES systems. The COM/PAGES systems have been in Rm. 180 in the basement of the CCF. The increased usage of COM output and the planned addition of high-speed printers to PAGES make it advisable to move these systems to the area vacated by the tape library in Rm. 260 to provide a more efficient distribution of user output.

- Installation of Class VI computers. C-Division's plans for the installation of additional Class VI computers will require some modification of the CCF floor plans, power supplies, and environmental controls to accommodate them, but no new floor space is planned.

3.9 SECURITY

Several kinds of sensitive data are processed in the ICN by several kinds of users. To implement protective measures appropriate to the different data sensitivities and to control access by users with differing security authorizations, three logical networks are being implemented. These networks, called ICN partitions, are the Open partition where unclassified scientific work is done; the Administrative partition, which is used for processing sensitive unclassified data; and the Secure partition where classified work may be done. See Fig. 11 for the logical configuration of the Network for data protection.

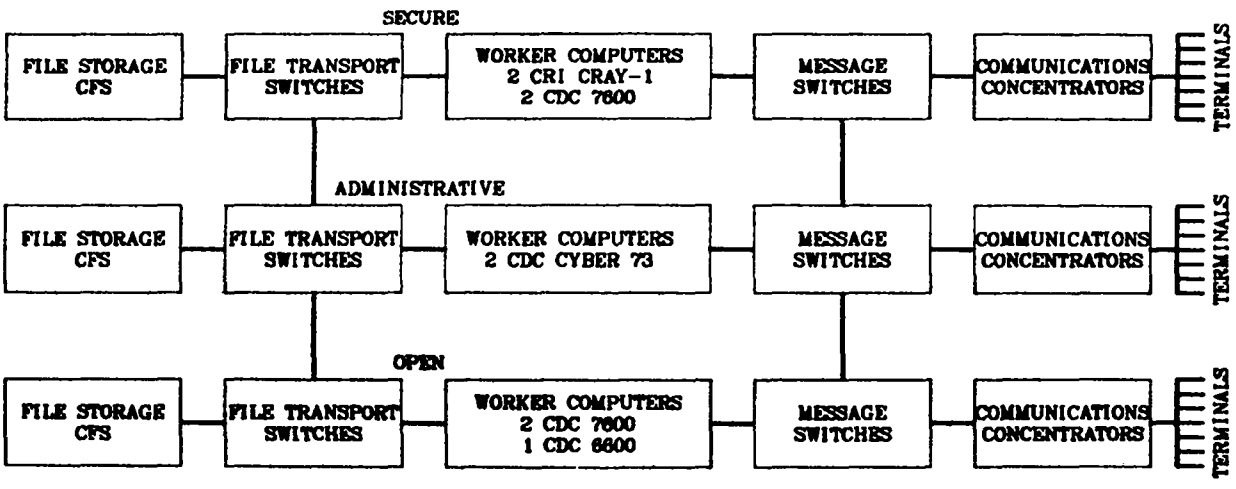

Fig. 11. Network logical configuration for data protection.

For various reasons, the ICN cannot be structured as three completely separate networks. Financial and operational considerations preclude duplicating unique resources such as the Common File System, PAGES, and the Network Security Controller. Additionally, the nature of Los Alamos computing makes it very beneficial for cleared and uncleared people to work together on some projects. Because working together usually means computing together, it is frequently desirable to transfer data in both directions between the partitions.

For the reasons cited above, several controlled connections have been implemented between the partitions. These connections allow the users of a Secure worker computer to access any file in the storage system to which they otherwise have legitimate access. But, they do not permit a Secure worker to create or write into files that can be accessed from the Administrative or Open partitions, and they do not permit a user in one of these partitions to access files created from the Secure partition. Greater detail on the ICN partitioning can be found in the "ICN Partitioning Guide," LASL-79-46, dated May 1979.

Group OS-4, Computer and Telecommunications Security, authorizes user validations on ICN worker computers. They provide all authorized users with passwords that are changed yearly and they process special validations, such as requests for classified passwords. OS-4 ensures that CCF operations comply with DOE regulations, consults throughout the Laboratory on system development and protection, conducts computer and communications security R&D, and generally works to make security effective without interfering with computing productivity.

No major security changes are planned for the ICN in FY 1981. The TA-3 protected wireline (PWL) has been completed and we are beginning to use it. All necessary data communications should be converted to the PWL during FY 1981.

4 CONTINUING SOFTWARE PROJECTS

C Division provides a variety of software across several machines. 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 plan 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 will standardize and stabilize the user interface.

3. Software engineering techniques will be used to make our software easy to use, more portable, and easy to maintain.

4.1 SYSTEMS

4.1.1 Protocols

A protocol is a set of rules for accomplishing some action. In the CCF 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.

As we build for the distributed processing network and a more distributed operating system, we will need a standard set of protocols in the CCF. We are defining and implementing those protocols today. A review of the standard higher level protocols that we are defining and using is:

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.

JOB - an intermachine job submission protocol that will allow one computer to start a job on another computer.

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.

We are implementing some of these protocols on each system, and their implementation schedule is given in each operating system section.

4.1.2 CTSS

CTSS is the system that runs on both Cray-1 computers and will run on the third Cray-1 to be installed in September 1981. We plan to concentrate our resources on CTSS to improve its compatibility with LTSS, usability, reliability, and maintainability. We plan to add new network protocols to improve intermachine communication, improve production facilities, and minimize the user-visible differences between the systems where feasible. When Machine W is upgraded to two-million words, we will also provide compatibility with existing system calls. The format of the CTSS accounting file will also be made compatible with that of Los Alamos LTSS.

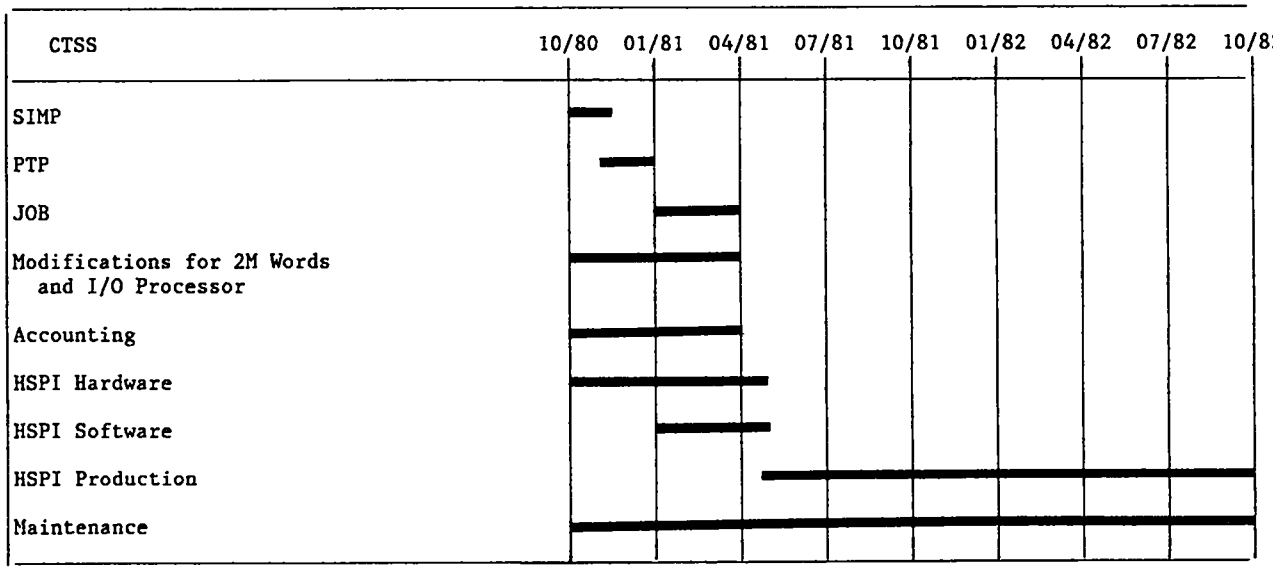

Fig. 12. CTSS schedule.

4.1.3 LTSS

LTSS runs on the four CDC 7600 computers. We will continue to maintain the system and eliminate LTSS system bugs. The new protocols will be implemented and a new HSPI connection completed.

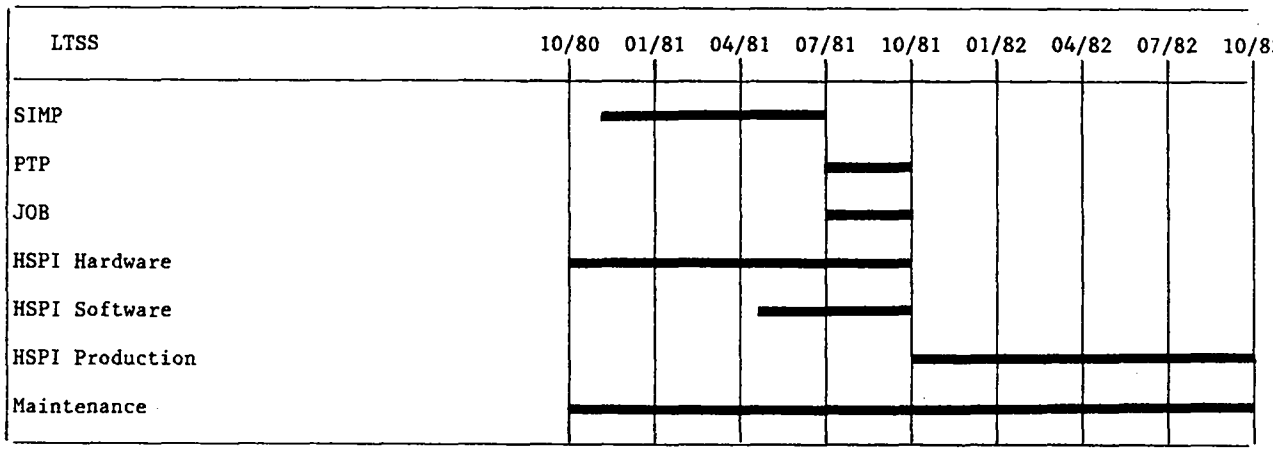

Fig. 13. LTSS schedule.

4.1.4 NOS

The plans for NOS include providing the latest developments of the vendor, Control Data Corporation. We also plan to maintain our existing networking capabilities and attempt to isolate our modifications to the operating system in order to minimize the conflicts between our changes and those of the vendor.

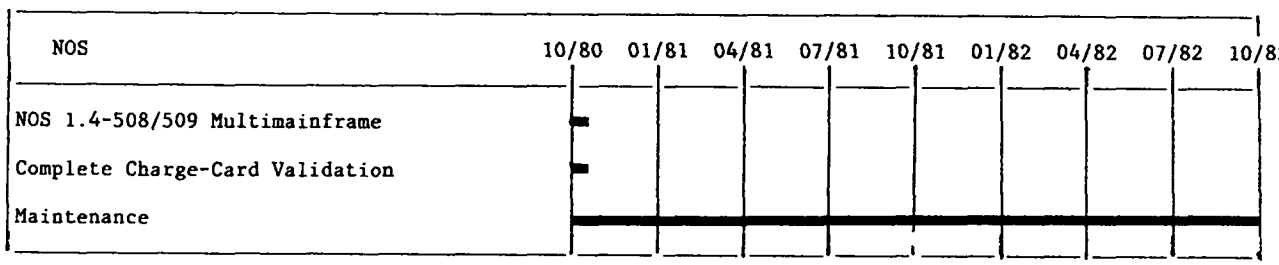

Fig. 14. NOS schedule.

4.1.5 UNIX

UNIX is an operating system marketed by Western Electric for Digital Equipment Corporation PDP-11 and VAX-11 machines. UNIX is currently used for word processing in C Division and for some advanced development activities. We plan to continue to support UNIX for these activities.

4.1.6 VMS

VMS is the operating system supported by Digital Equipment Corporation for their VAX family machines. Our support philosophy for VMS will be similar to

that for NOS. We plan to provide the latest offering of the vendor with a minimum of local changes. We plan to integrate the VMS system into the ICN and provide network access to CFS, PAGES, and worker systems.

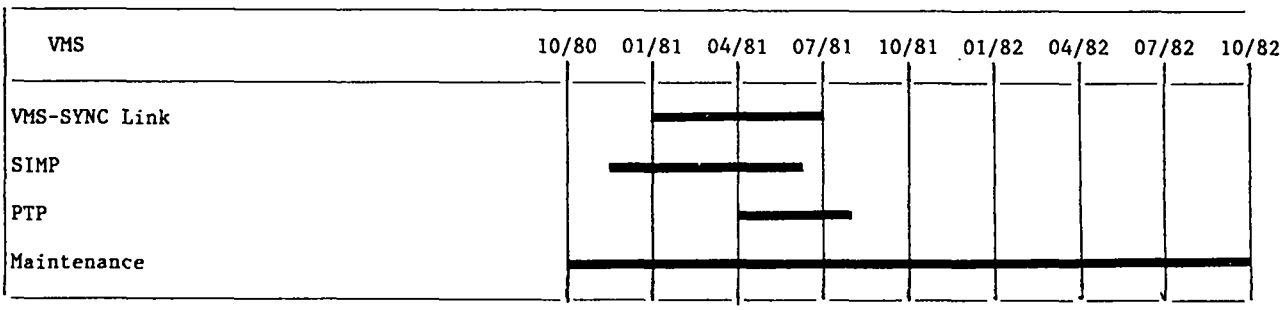

Fig. 15. VMS schedule.

4.1.7 CFS

The Common File System is the ICN's central hierarchical file storage system based on IBM 370/148, 4341, and 3850 Mass Storage System. The bulk of the systems work on CFS is dedicated to improving reliability, performance, and uptime. The software projects planned for CFS are given below and their schedule is given in Fig. 16.

- SIMP. SIMP will be implemented so that the CFS will be able to communicate with computers that use SIMP as well as those that do not.

- ABORT function. This new function will allow users to abort an in-progress function.

- COPY function. This new command will allow users to copy a file within CFS to a different directory tree.

- 99 files-per-node limitation. The 99 files-per-node limitation will be removed.

- Moving Files Across Security Partitions. Several users want to move files across security partition boundaries. Because the current manual procedure is slow and cumbersome, the CFS MODIFY command will be used to accomplish this.

- Maintenance and Support. We maintain the IBM VS1 software, the MSS micro code, and our locally developed software. Our support activities are management of mass store space, operations support, and librarian work.

- CFS Software and Enhancements. We are planning to add new functions, such as LINK node and UNLINK node, and new features, such as release a file in "n" days and change the owner of a directory tree. We will continue to improve CFS performance, the file transport mechanism, and file migration.

- MVS Feasibility Study. We anticipate that IBM will phase out the VS1

operating system we are currently using and replace it with MVS.

- Video Disk Feasibility Study. Video disk is a new mass storage technology that might be available in the mid 80's. We want to start tracking vendor progress and user experience to determine future CFS applicability.

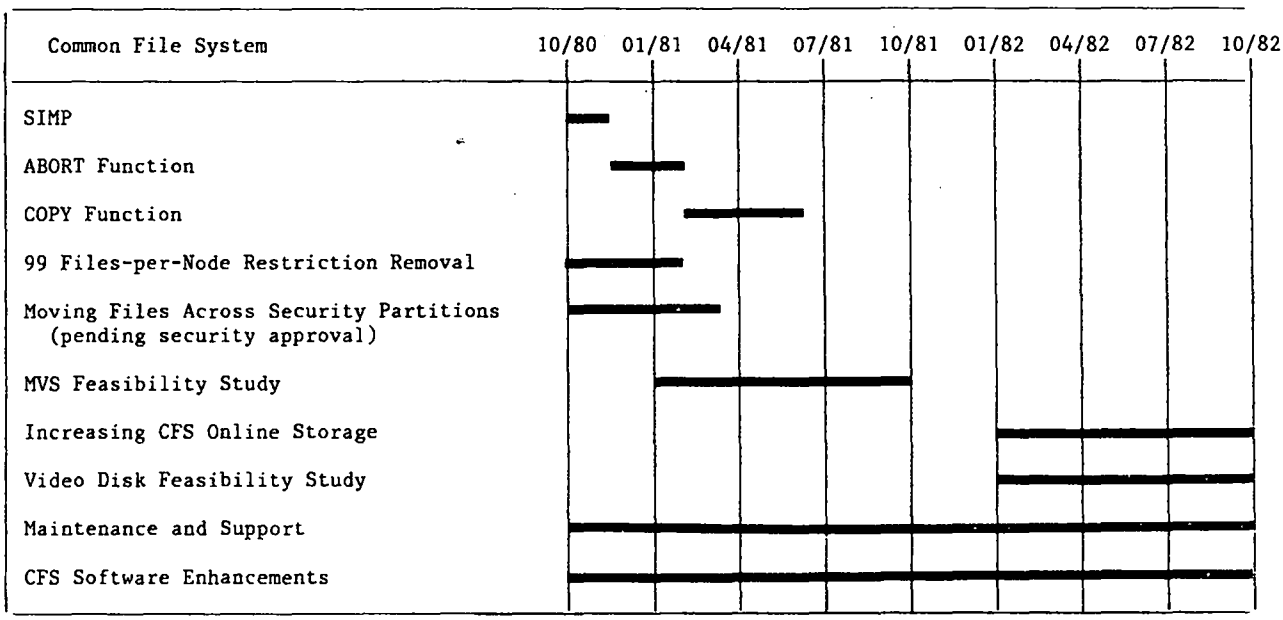

Fig. 16. Common File System schedule.

4.1.8 PAGES

PAGES is becoming the central CCF station for printed and graphical output. In addition to the hardware additions listed in Section 3.6, we plan to improve the operator interface to PAGES and maintain and enhance the operation of the system. Figure 17 reviews the schedule for PAGES.

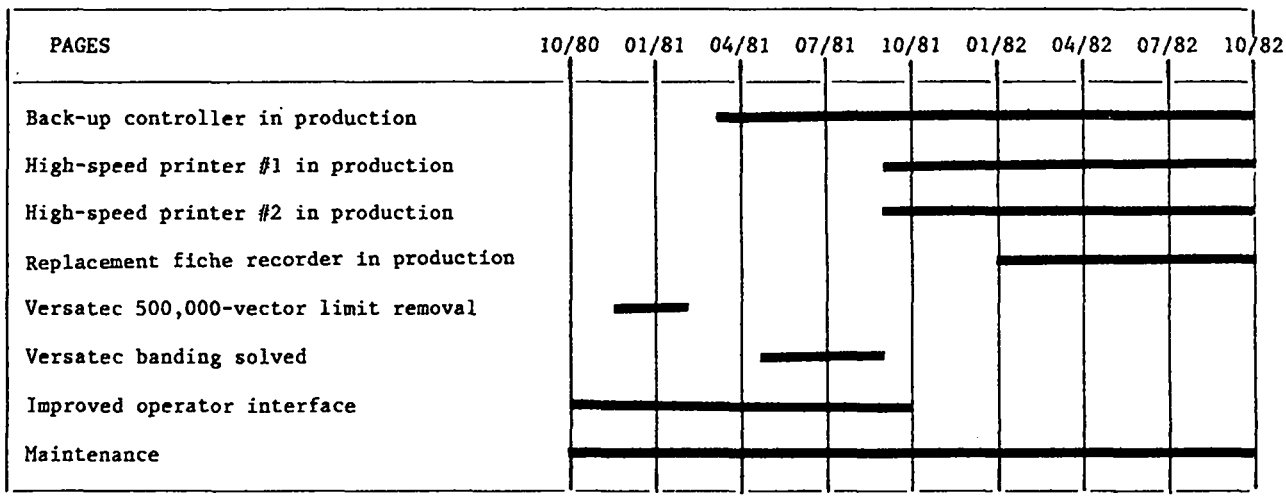

Fig. 17. Review of PAGES schedule.

4.2 LANGUAGES

Fortran is and will continue to be the most heavily used Laboratory computer language. C Division will remain active in the ANSI and DOE Fortran standardization efforts and will also maintain an interest in new languages, so that as new hardware and programming techniques become available, we will be ready to apply these techniques when beneficial.

4.2.1 Fortran

The 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. Recognizing that the standard compilers may not provide all the features required by Los Alamos codes, we will support certain enriched compilers on the supercomputers. We may also make experimental compilers available to users.

CIVIC is a dialect of Fortran available on CTSS. We do not support that compiler but will make it available for compatibility with LLNL.

Fig. 18 shows the lifetime of our Fortran compilers. The organization maintaining each compiler is shown in parentheses.

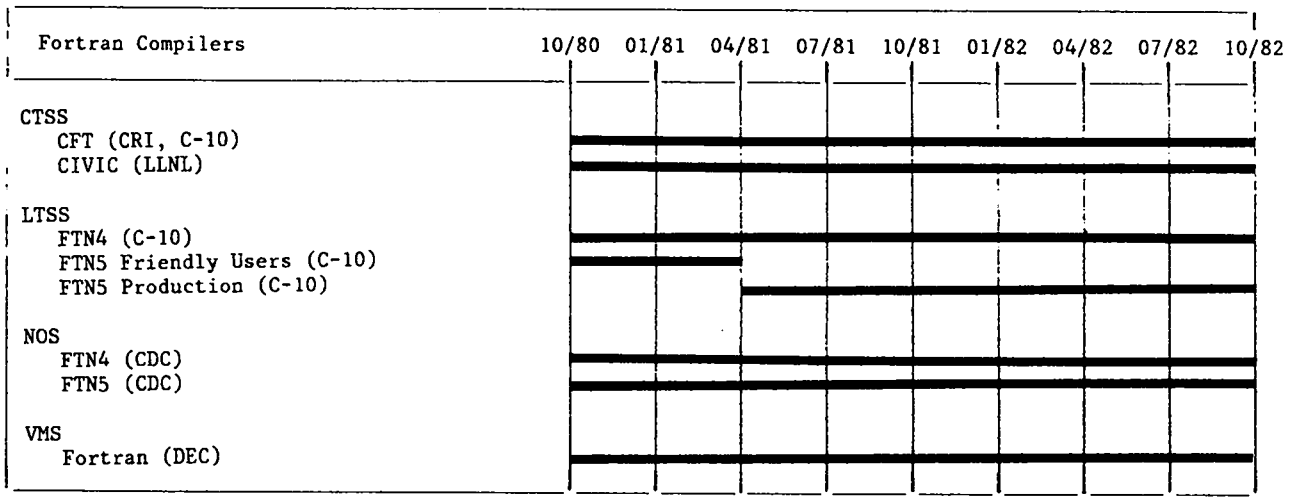

Fig. 18. Fortran compilers.

4.2.2 Assemblers

C Division does not directly support any assemblers except on LTSS. The use of assembly language is discouraged by C Division because of the portability and programmer productivity issues. However, it is recognized that certain routines are best coded in assembly language, and the assemblers listed in Fig. 19 are available.

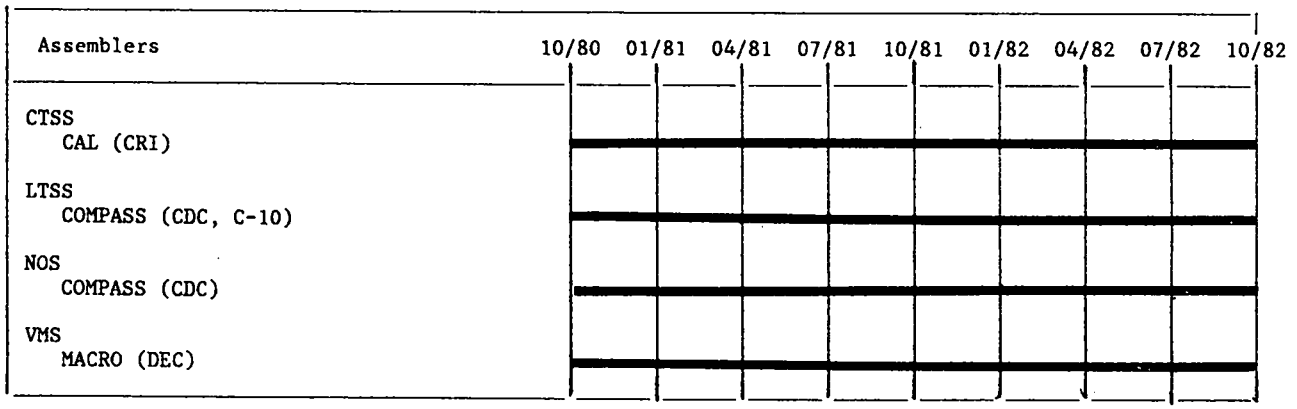

Fig. 19. Available assemblers.

4.2.3 Other Languages

Certain other languages are provided by vendors and others and are available for your use. C Division does not actively support any of these compilers or interpreters. The languages include those shown by system in Table IV.

TABLE IV

AVAILABLE LANGUAGES NOT DIRECTLY SUPPORTED BY C DIVISION

CTSS	LTSS	NOS	UNIX	VMS
BCON	ALTRAN	APL	APL*	BASIC
MODEL	BCON	BASIC	AS	BLISS
PASCAL	CPU76	COBOL	BC	COBOL
RATFOR	MODEL	GASP IV	C	MACSYMA*
	PASCAL	GPSS	DC	PASCAL
	RATFOR	MIMIC	Fortran*	
		PASCAL	LISP*	
		PL/I	ML	
		SIMSCRIPT	ML/I	
		SIMULA	MODEL*	
		SNOBOL4	PASCAL	
		SYMPL	RATFOR	
		S2K	SNOBOL3	

*Available January 1981.

4.2.4 State-of-the-Art Languages

C Division will maintain an awareness of state-of-the-art languages and will seek a modern language for use in C Division efforts in multiprocessing, portability, and structured programming. As such a facility becomes available, others may use the compiler at their own risk, but there is no guarantee that the compiler will be stable or supported.

4.3 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.

4.3.1 System Libraries

We currently provide a number of system libraries as shown in Fig. 20. Some of these libraries have different user interfaces, and our goal is a common system library available in all C-Division supported operating environments. During the next three years we will develop this library to supplement FORTRAN 77. Among the functions that this library may support are:

- Character and bit manipulation
- Data type and character set conversion
- Ability to get system parameters
- Error and interrupt handling
- File handling and I/O
- Task handling and interprocess communication
- Search and sort

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.

We plan to first evaluate the existing libraries and analyze their time and space requirements. We will also investigate what FORTRAN 77 can offer in the way of library functions contained as part of the language. In addition, we will survey users to find what routines they use, the frequency of use, and the routines they like and dislike. Our schedule for the common system library is given in Fig. 21.

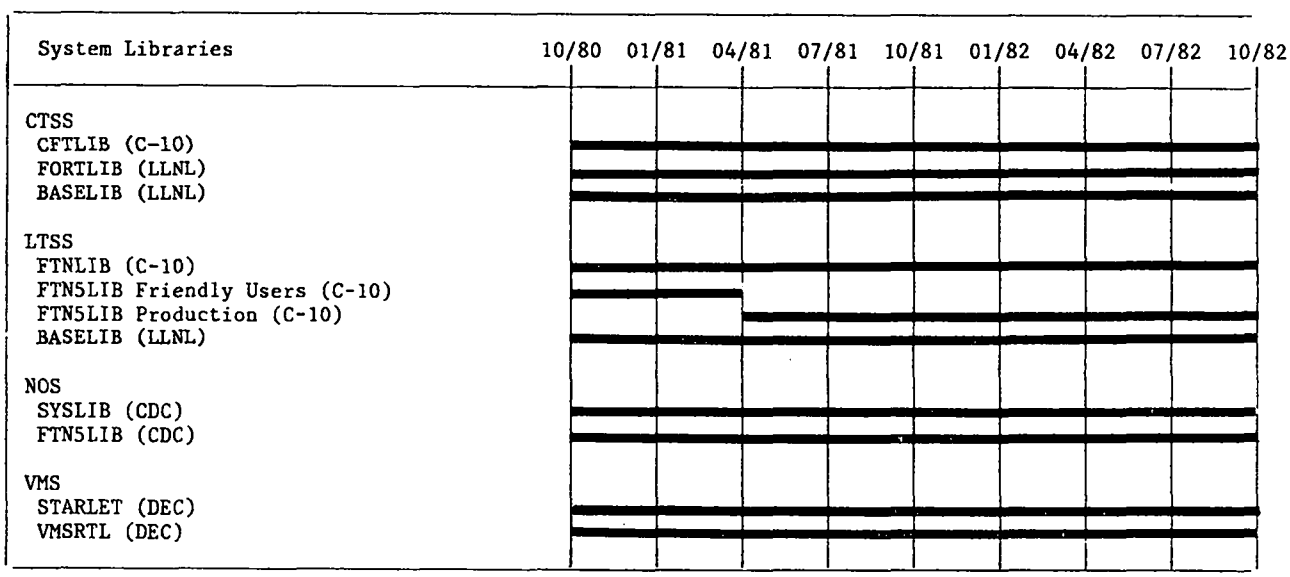

Fig. 20. System libraries schedule.

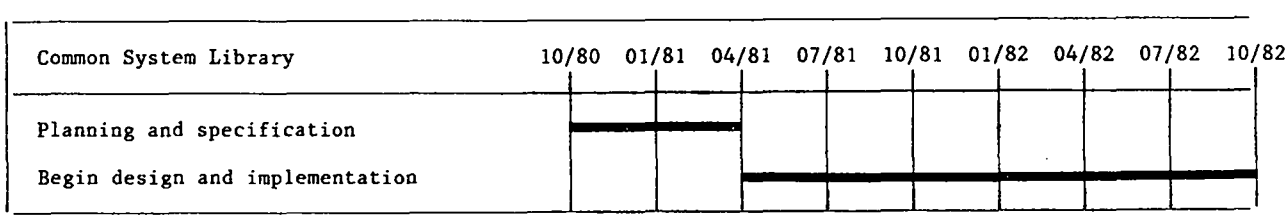

Fig. 21. Common system library schedule.

4.3.2 Common Mathematical Library

In producing a common mathematical 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.
- 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.

During FY 1981, 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 Air Force Weapons Laboratory at Kirtland, Lawrence Livermore National Laboratory, Magnetic Fusion Energy Computing Center, National Bureau of Standards, Sandia National Laboratory Albuquerque, and Sandia National Laboratory 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. First, an inventory must be made of precise math library holdings. Second, these must be correlated, where desirable, with the SLATEC collection. Third, new libraries (CFTMATH, FTNMATH, VAXMATH) must be built to reflect the common source. Fourth, documentation must be produced that reflects this organization. This will include the machine-readable documentation available with the SLATEC collection.

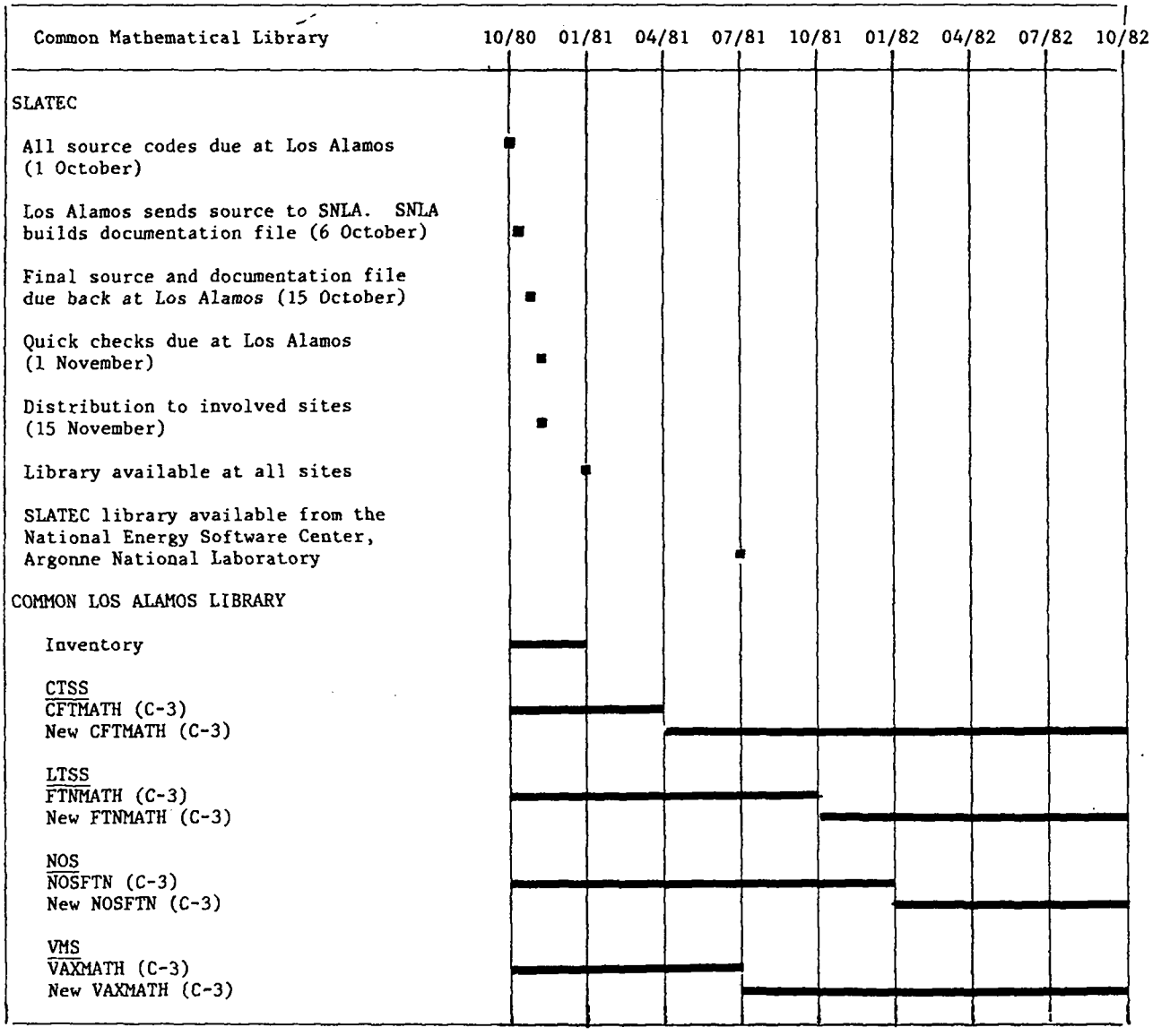

Fig. 22. Common mathematical library schedule.

4.3.3 Graphics Libraries

Graphics libraries provide a common user interface across all supported operating systems for all supported graphics devices. These libraries include the Common Graphics System (CGS), the SC-4020 emulator routines, and the vendor-supplied DISSPLA routines. They will be supported on CTSS, LTSS, NOS, and VMS and operate the following graphics devices: Tektronix 401X terminals, FR-80 microfilm recorders, Versatec electrostatic plotters, and Zeta plotters. The NCAR graphics library will also be supported, but not on all operating environments. A new production library will be defined and supported on all systems where CGS resides. This library will consist of high-level graphics routines that are needed at Los Alamos.

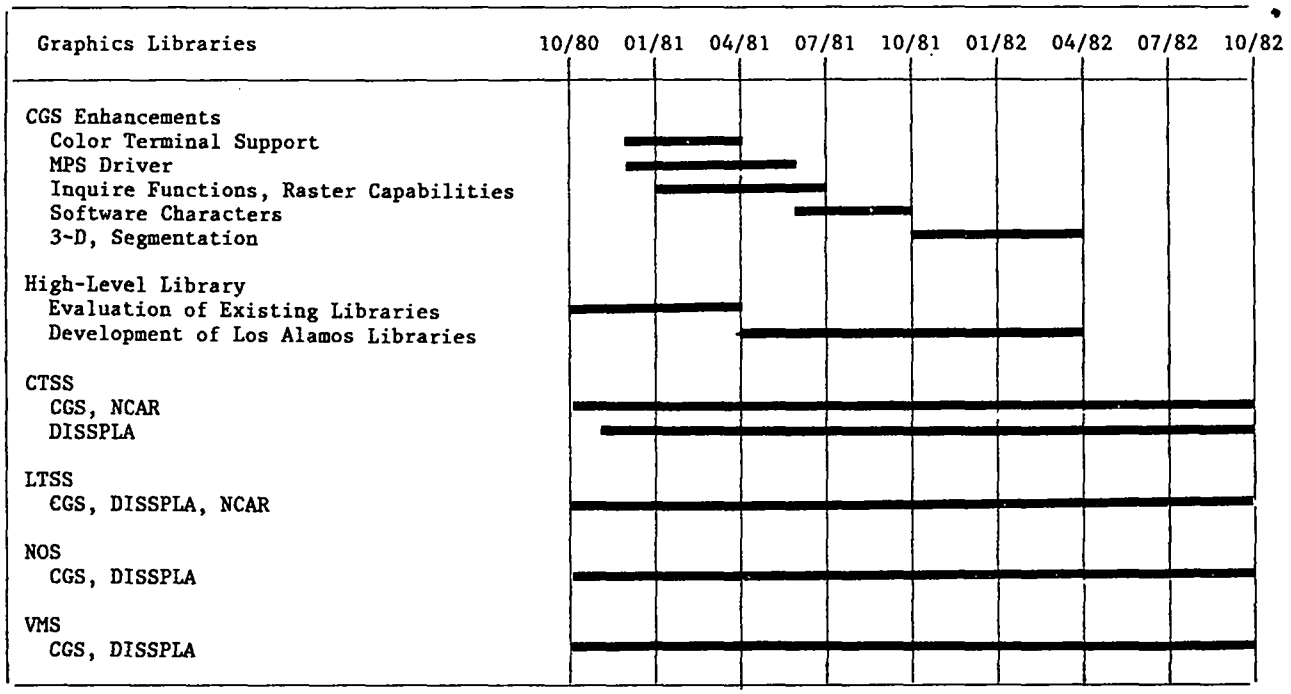

Fig. 23. Graphics libraries schedule.

4.4 UTILITIES

We plan to define a standard set of utilities that are common to all systems that we support. We are defining a standard utility syntax and assembling software tools that will allow us to write more portable utilities. In our work on utilities we are striving for as much compatibility and cooperation with LLNL as possible. We have adopted four levels of support for our user interface software shown in Table V.

TABLE V

SUPPORT LEVELS FOR UTILITIES

Level	Explanation
Level 1 (full support)	C Division will either develop the utility in-house or bring it in from other places (such as LLNL or MFE). If brought in from outside, we will make all changes necessary to make the utility run correctly on our systems. We will document the utility 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 utility in its current state, provide consulting, and, if possible, fix bugs. We will make only such changes as are absolutely necessary to make the utility run on our systems. We will modify existing documentation where needed. In those cases where the utility 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.

Our plans for the utilities for the various systems follow.

4.4.1 CTSS

We gave highest priority to our work on CTSS utilities during FY 1980, and that will continue in FY 1981. Table VI shows the supported utilities for CTSS and our plans for obtaining all sources, documentation, and quality assurance. Additionally, we will be converting network file shipping utilities so that they use the standard file format. As the intermachine job submission and process-to-process communication protocols are implemented, we will plan user level utilities to facilitate their use.

TABLE VI

CTSS UTILITIES STATUS

Utility	Level	On Floor	Sources	Documented	QA
ALLOUT	1	Yes	Yes	Yes	Yes
AR	4	Yes	Yes	Yes	No
BUILD	1	Yes	Yes	Yes	Yes
CHECK	3	Yes	No	No	No
COMPARE	1	Yes	No	Yes	No
CONVERT	1	Yes	Yes	Yes	Yes
COPY	1	Yes	Yes	Yes	Yes
COSMOS	1	Yes	Yes	Yes	No
CSUM	3	Yes	No	No	No
DDT	1	Yes	Yes	No	No
DESTROY	1	Yes	Yes	Yes	Yes
DISKEDIT	3	Yes	Yes	No	No
DJ	3	Yes	Yes	No	No
ED	4	Yes	Yes	Yes	No
EDIT	2	Yes	Yes	Yes	Yes
ERGO	4	Yes	Yes	No	No
EXE	2	Yes	Yes	Yes	Yes
FILES	1	Yes	Yes	Yes	Yes
GIVE	1	Yes	Yes	Yes	Yes
HISTORN	3	Yes	Yes	Yes	No
INCL	4	Yes	Yes	Yes	No
INDEX	1	Yes	Yes	No	No
INFO	1	Yes	Yes	Yes	No
LDR	1	Yes	Yes	Yes	No
LFICHE	1	12/31/80	No	No	No
LIB	1	Yes	Yes	Yes	Yes
LPRT	1	7/1/81	No	No	No
MAGIC	1	Yes	Yes	Yes	No
MASS	1	Yes	Yes	Yes	Yes
MOVE	1	Yes	Yes	Yes	Yes
NROFF	4	Yes	Yes	Yes	No
NTEXT	1	12/31/80	No	No	No
QED	3	Yes	Yes	Yes	No
QUO	1	Yes	Yes	Yes	Yes
RAT4	4	Yes	Yes	Yes	No
SNOOPY	1	4/1/81	4/1/81	Yes	No
SPRINT	1	12/31/80	No	No	No
STEXT	1	12/31/80	No	No	No
SWITCH	1	Yes	Yes	Yes	Yes
TALLY	1	Yes	Yes	Yes	Yes
TIDY	1	Yes	Yes	Yes	No
TRANS	1	Yes	Yes	Yes	Yes
TRIXGL	1	Yes	Yes	Yes	No
WHO	1	Yes	Yes	Yes	Yes
WHT	2	Yes	Yes	Yes	Yes
X0001	1	2/1/81	2/1/81	No	No

The X0001 utility is a prototype utility to gather and report usage statistic:

4.4.2 LTSS

We are beginning to define the standard utilities for LTSS. Table VII shows our progress and short-term plans. During FY 1981 we plan to complete the definition of the LTSS utilities, obtain the sources and perform our quality assurance cycle on this software.

Additionally, we will be converting network file shipping utilities so that they use the standard file format. As the intermachine job submission and process-to-process communication protocols are implemented, we will plan user level utilities to facilitate their use.

TABLE VII

LTSS UTILITIES STATUS

Utility	Level	On Floor	Sources	Documented	QA
ALLOUT	1	Yes	Yes	Yes	Yes
AR	4	Yes	Yes	Yes	No
COMPARE	1	Yes	No	Yes	No
CONVERT	1	Yes	Yes	Yes	Yes
COPY	1	Yes	Yes	Yes	Yes
COSMO	1	Yes	Yes	Yes	No
DDT	1	Yes	Yes	No	No
DESTROY	1	Yes	Yes	Yes	Yes
ED	4	Yes	Yes	Yes	No
EDIT	2	Yes	Yes	Yes	Yes
FILES	1	Yes	Yes	Yes	Yes
FILES99	1	Yes	Yes	Yes	No
GIVE	1	Yes	Yes	Yes	Yes
HISTORN	3	Yes	Yes	Yes	No
INCL	4	Yes	Yes	Yes	No
INDEX	1	Yes	Yes	No	No
INFO	1	Yes	Yes	Yes	No
LFICHE	1	12/31/80	No	No	No
LIB	1	Yes	Yes	Yes	Yes
LIX	1	Yes	Yes	Yes	Yes
LOD	1	Yes	Yes	Yes	No
LPRT	1	7/1/81	No	No	No
MAGIC	1	Yes	Yes	Yes	No
MASS	1	Yes	Yes	Yes	Yes
MOVE	1	Yes	Yes	Yes	Yes
NROFF	4	Yes	Yes	Yes	No
NTEXT	1	12/31/80	No	No	No
QED	3	Yes	Yes	Yes	No
RAT4	4	Yes	Yes	Yes	No
SNOOPY	1	4/1/81	4/1/81	Yes	No
SPRINT	1	12/31/80	No	No	No
STATUS	1	Yes	Yes	Yes	Yes
STEXT	1	12/31/80	No	No	No
SWITCH	1	Yes	Yes	Yes	Yes
TALLY	1	Yes	Yes	Yes	Yes
TIDY	1	Yes	Yes	Yes	No
TRANS	1	Yes	Yes	Yes	Yes
TRIX	3	Yes	No	No	No
TRIXAC	3	Yes	No	No	No
TRIXGL	1	Yes	Yes	Yes	No
WHO	1	Yes	Yes	Yes	Yes
WHT	2	Yes	Yes	Yes	Yes
X0001	1	2/1/81	2/1/81	No	No

The X0001 utility is a prototype utility to gather and report usage statistics.

4.4.3 NOS

We are just beginning to define standard NOS utilities. The utilities defined thus far are shown in Table VIII.

TABLE VIII

NOS UTILITIES STATUS

Utility	Level	On Floor	Sources	Documented	QA
HISTORN	3	Yes	Yes	Yes	No
LFICHE	1	No	No	No	No
LPRT	1	No	No	No	No
MAGIC	1	Yes	Yes	Yes	No
MASS	1	Yes	Yes	Yes	Yes
NTEXT	1	No	No	No	No
SPRINT	1	No	No	No	No
STEXT	1	No	No	No	No

4.4.4 VMS

We are just beginning to define standard VMS utilities. The utilities defined thus far are shown in Table IX.

TABLE IX

VMS UTILITIES STATUS

Utility	Level	On Floor	Sources	Documented	QA
AR	4	Yes	Yes	Yes	No
ED	4	Yes	Yes	Yes	No
HISTORN	3	Yes	Yes	Yes	No
INCL	4	Yes	Yes	Yes	No
LFICHE	1	No	No	No	No
LPRT	1	No	No	No	No
MACRO	3	Yes	No	No	No
MAGIC	1	Yes	Yes	Yes	No
MASS	1	Yes	Yes	Yes	Yes
NROFF	4	Yes	Yes	Yes	No
NTEXT	1	No	No	No	No
RT4	4	Yes	Yes	Yes	No
SPRINT	1	No	No	No	No
STEXT	1	No	No	No	No

4.5 GRAPHICS UTILITIES

In addition to the utilities listed in the previous section, we support a standard set of graphics utilities. We are developing these utilities using software engineering techniques and are providing common utilities across systems. Our work in graphics utilities includes the following.

4.5.1 CTSS

CTSS is our newest system and we are providing the standard utilities for use with CGS and PAGES. We have also implemented the Graphical Analysis System (GAS) for use with weapons programs. Table X gives the status of the CTSS graphics utilities.

TABLE X

CTSS GRAPHICS UTILITIES STATUS

Utility	Level	Production	Documentation	QA
GAS	1	Yes	Yes	Yes
PESP	1	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes
PSCAN	1	Yes	Yes	Yes
PTEKT	1	Yes	Yes	Yes
PVERS	1	7/81	7/81	7/81
PZETA	1	1/81	Yes	Yes

4.5.2 LTSS

The LTSS graphics utilities are our standard set for use with the libraries and PAGES. In addition, we support a number of higher level graphics utilities for generation of visual aids as well as specific applications. Table XI gives the status of the LTSS graphics utilities.

TABLE XI

LTSS GRAPHICS UTILITIES STATUS

Utility	Level	Production	Documentation	QA
DRAW	1	Yes	Yes	Yes
FRME	1	Yes	4/81	3/81
GAS	1	Yes	Yes	Yes
GRAPE	2	Yes	Yes	Yes
MAPPER	1	Yes	Yes	Yes
PESP	1	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes
PLYDRAW	4	Yes	Yes	Yes
PSCAN	1	Yes	Yes	Yes
PTEKT	1	Yes	Yes	Yes
PVERS	1	4/81	4/81	3/81
PZETA	1	Yes	Yes	Yes
QUADRAW	4	Yes	Yes	Yes
SLIDES	1	Yes	Yes	Yes

4.5.3 NOS

The standard graphics utilities, libraries, and the high level packages MAPPER, SLIDES, and DRAW are supported on NOS. Table XII give the status of the NOS graphics utilities.

TABLE XII

NOS GRAPHICS UTILITIES STATUS

Utility	Level	Production	Documentation	QA
DRAW	1	Yes	Yes	Yes
MAPPER	4	Yes	Yes	-
PESP	1	Yes	Yes	Yes
PFILM	1	Yes	Yes	Yes
PSCAN	1	10/81	Yes	Yes
PTEKT	1	Yes	Yes	Yes
PVERS	1	7/81	7/81	6/81
PZETA	1	1/81	Yes	Yes
SLIDES	1	Yes	Yes	Yes

4.5.4 VMS

Some of the standard utilities are available on VMS and others will soon be available as shown in Table XIII.

TABLE XIII

VMS GRAPHICS UTILITIES STATUS

Utility	Level	Production	Documentation	QA
PESP	1	12/80	Yes	Yes
PFILM	1	12/80	Yes	Yes
PSCAN	1	1/81	Yes	Yes
PTEKT	1	Yes	Yes	Yes
PVERS	1	7/81	7/81	6/81

4.6 OTHER PROJECTS

We also have some 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.

4.6.1 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 currently 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.

Currently 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.

4.6.2 Benchmarking

We have a continuing benchmarking effort to test both Laboratory computers and new computers of potential interest to the Laboratory. During FY 1981 we plan to benchmark three supercomputers, test existing systems and I/O performance of Laboratory computers, and begin the development of an interactive benchmark. Our general plans for the benchmark effort are shown in Fig. 24.

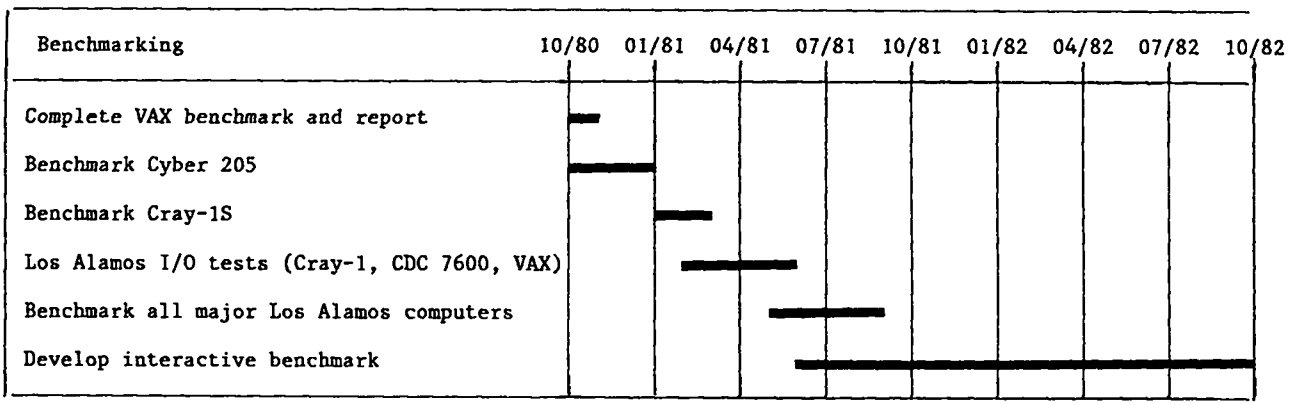

Fig. 24. Benchmarking schedule.

4.6.3 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 refinement of a CTSS model, (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 the following:

- prepare a validated model of CTSS and the Cray-1 hardware;
- develop Laboratory workload characteristics; and
- investigate alternate CTSS software and Cray-1 features.

Machine-Independent Description of CCF Job Load

This project will seek means to report data such as:

- number of batch vs interactive jobs;
- ratio of CPU- to I/O-bound jobs;

- origin (KCC ports vs CBT vs 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.

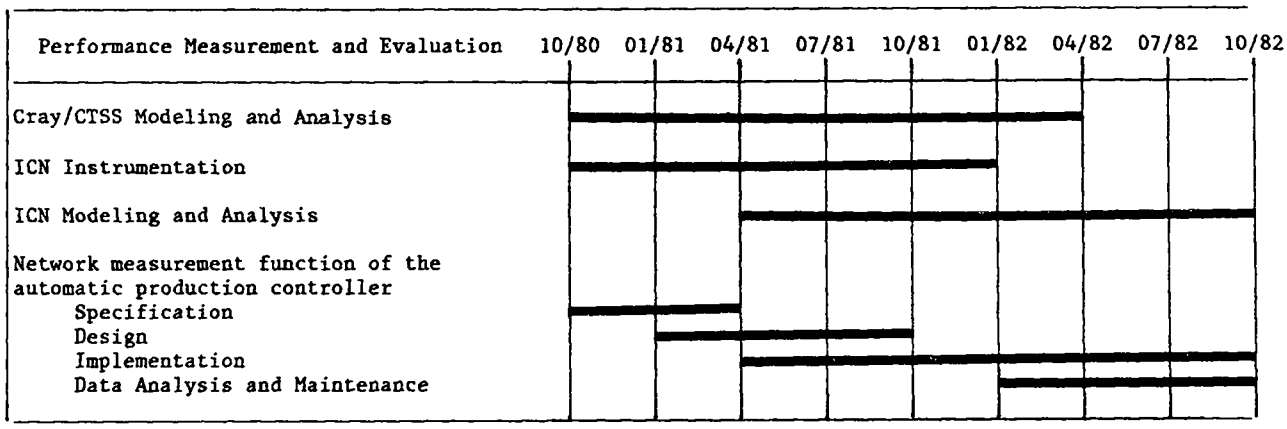

Fig. 25. Performance measurement and evaluation schedule.

4.6.4 Automated Information Management

To improve our internal information handling and management, we will continue to apply computerized solutions to the management of our information. In the past we have performed our document preparation on a standalone PDP-11; during FY 1981 we plan to move that work into the network to facilitate placing the information on-line.

4.6.5 Automated Accounting

In the past, the accounting for CCF usage for charging purposes was done manually by nine people. C Division has now automated the process and reduced the staff to one person.

October 1, 1980, marked the culmination of eight months' work as the AUTOLOG utilization tracking system went into production in the CCF. All CCF service categories (CTSS, LTSS, NOS, CFS, PAGES, and ICN) are now periodically logging utilization data in the AUTOLOG data base on CFS. The data base consists of a set of job invoices for each machine in a uniform format based on the Laboratory Standard Text File Definition.

Monthly wage summaries and an AO Charges File are generated by a modified version of the previously used summary program. For on-line data retrieval, a very versatile and powerful tool called AUTOSUM has been designed. A proof-of-concept implementation of AUTOSUM is available to friendly users.

Work remaining to be done includes improving the self-initiation features for several of the systems, stabilizing the operation, doing a full implementation of AUTOSUM, and replacing the monthly summary tools.

5 NEW DEVELOPMENT PROJECTS

Development projects listed in this section were recommended by the Computer Users' Priority Task Force. We are planning to implement these projects in FY 1981 subject to funding limitations.

5.1 ADVANCED INTERACTIVE DISPLAY SYSTEM (AIDS)

A need exists at the Laboratory to provide high-speed interactive display of both graphical and textual data at workstations convenient to CCF users. Workstations are most beneficial if they are located near the users, preferably in their offices. This project will provide relatively inexpensive hardware, moderately high-quality graphics, and high-speed display of graphic and alphanumeric information. The AIDS project will combine work in the areas of satellite graphics, network software, distributed computing, high-speed communication links, computer based terminals, high-speed Tektronix terminals, and the Evans and Sutherland Multi Picture System. The project will be divided into the following four phases to provide this capability:

Phase 0 - Experimental Base and Technology Review

An experimental base system will be developed to investigate communication strategies and monitor characteristics. User requirements for video monitors will be determined by displaying demonstration programs simultaneously on several monitors. Additionally the Evans and Sutherland Multi Picture System will serve as an AIDS experimental base for studies of system throughput and communication software.

A technological review of communication equipment and local network installations will be made.

Phase I - Feasibility and Functional Specifications

This phase will consist of a series of iterations on feasibility and functional specifications. The results of this phase will consist of documents describing the functional capabilities of the proposed versions of the system, spinoff and interim products, proposed technical solutions and alternatives, and a final recommendation.

Phase II - Detailed Design

This phase will consist of the design of the system(s). The cost and calendar will be dependent on the results of Phase I.

Phase III - Implementation

This phase will consist of implementing the system. Its cost and calendar will be a function of the decisions reached in the earlier phases.

All phases of this work will be accomplished with considerable help from X Division.

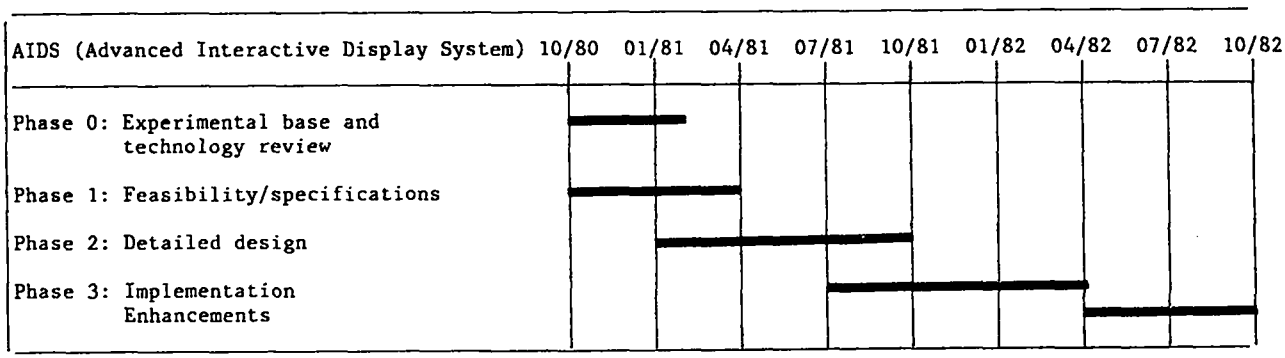

Fig. 26. AIDS (Advanced Interactive Display System).

5.2 FACILITY FOR OPERATIONS CONTROL AND UTILIZATION STATISTICS (FOCUS)

A midicomputer will perform the functions of a general automated production control system, an operator status and control system, and a performance measurement system.

This project will coordinate and control the production systems of the large Laboratory computers. Automatic load leveling between these computers will also be accomplished.

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 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 FOCUS project was initiated in October of this year by C-8. A subset of its capabilities will be implemented this fiscal year as the first phase.

PHASE I - Project Definition, Detailed Design, and Implementation

The initial effort during this phase will be to define the project by selecting the capabilities to be implemented and to produce definitions, schedules, and staffing plans for the selected features.

Detailed design is anticipated to require six to nine months, although the actual schedule will depend on the project definition.

Implementation can begin as soon as detailed designs of specific features are complete, thus providing some overlap. The final schedule will depend upon the decisions reached at this point.

Initial Phase I capabilities will include a multiple-machine production control system for the Cray machines, and a system to record workload characterization and status information for major ICN nodes. Additional capabilities will be implemented in Phase II.

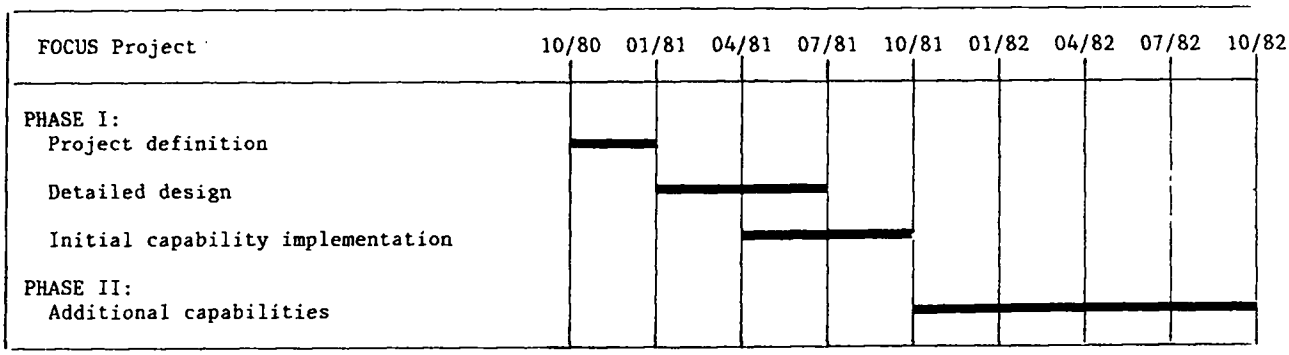

Fig. 27. FOCUS project schedule.

5.3 COMPUTER BASED TERMINALS

The way that we currently run CBTs is not optimal within the ICN and our operating systems. We will implement software and hardware projects that will allow us to eliminate our problems with current CBTs (now referred to as CBT-1s) and, at the same time, allow CBTs to run as they do today from the user's viewpoint.

A second part of this project will be to define a new family of computer based terminals called CBT-2s. Among the features that such terminals might support are:

- Local editing of text files with page editor.
- Standalone operation. User programmable in Fortran, and possibly other languages.
- High local interaction rates.

- ICN access for large amounts of data storage, execution of large programs, access to central facilities such as film recorders.

- Capability of establishing a logical connection and communicating with a CCF worker task.

- Intelligent graphics operations.

To support existing and new CBTs, we will develop a new generation of CBT Communication Concentrators called a CCC-2. The CCC-2 will be implemented on a VAX 11/780 computer connected to the file transport network (see Fig. 6). We will use C-Division standard protocols to communicate between the ICN and the CCC-2, and we plan to be able to use the X.25 protocol to communicate between the CCC-2 and the CBT-2s. The schedule for CBT-2 implementation is shown in Fig. 28.

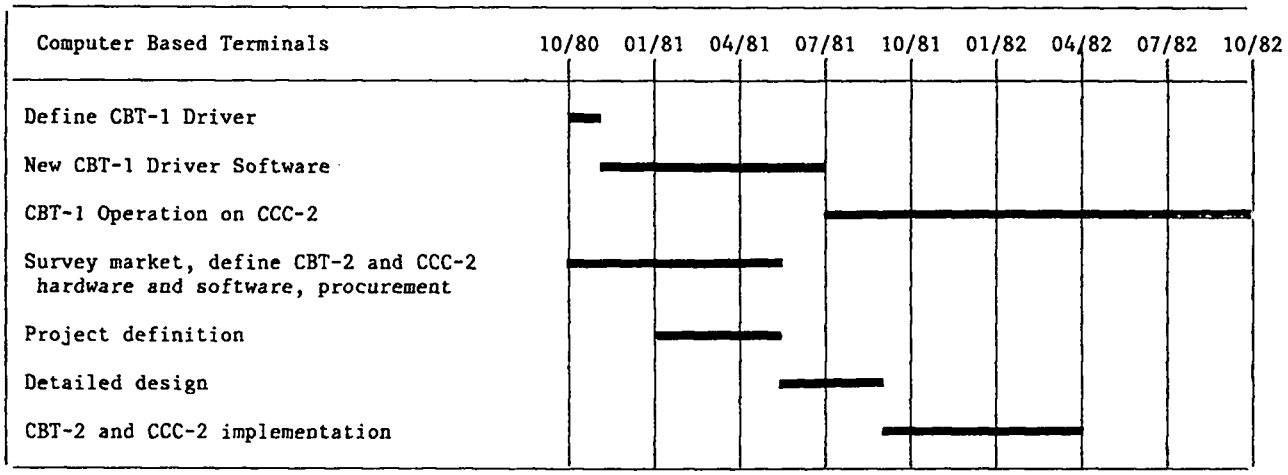

Fig. 28. CBT schedule.

5.4 DATA COMMUNICATIONS CENTER

The Data Communications Center is a computer-based diagnostic system for testing data communication channels to the CCF. It has provision to select any one of over 1000 channels, and to perform diagnostic tests on it. It can test asynchronous or synchronous channels with data rates over one million bits per second. It 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 the ports, modems, and transmission lines. The computer selects the channel through a diagnostic bus switch circuit, configures it for a particular test, and performs the diagnostic tests using IEEE-488-based test equipment.

Automating the tests provides several benefits over present methods of trouble shooting channel problems. It is a means of doing consistent, rapid testing, that can pinpoint and restore a faulty channel quickly. In addition,

automatic testing of all channels on a regular schedule while they are not in service will restore failing channels before they are completely out of service.

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 Center will contain a data base system that will greatly aid in these record-keeping chores and will also allow statistical reports on the data communications channels to be easily generated.

The Data Communications Center provides C Division with a much needed tool that will aid in maintaining and managing a very complex and large data communications system. The Center and its automated features should reduce growth in personnel required to maintain the data communications facilities.

The Data Communications Center will provide the user with more up time, thus more computing time, than presently available. It will provide quicker and more reliable location of trouble whether it is in the terminal, in the data communications equipment, or in the transmission lines. Checkout of new installations and moves are also speeded up with the system.

In FY 1981 the following activities are planned for the Center:

a. Installation of the first 16 channels of prototype hardware. This equipment will be installed on 16 C-Division ports to perform operational checkout of the Data Communications Center.

b. Install the data base management software in the control computer. Develop the schema and data element structures for the management system.

c. Complete and test the production software that will control all of the online instrumentation in the center.

d. Fabricate, test, and install the communications switch hardware to provide online service for 240 ICN ports.

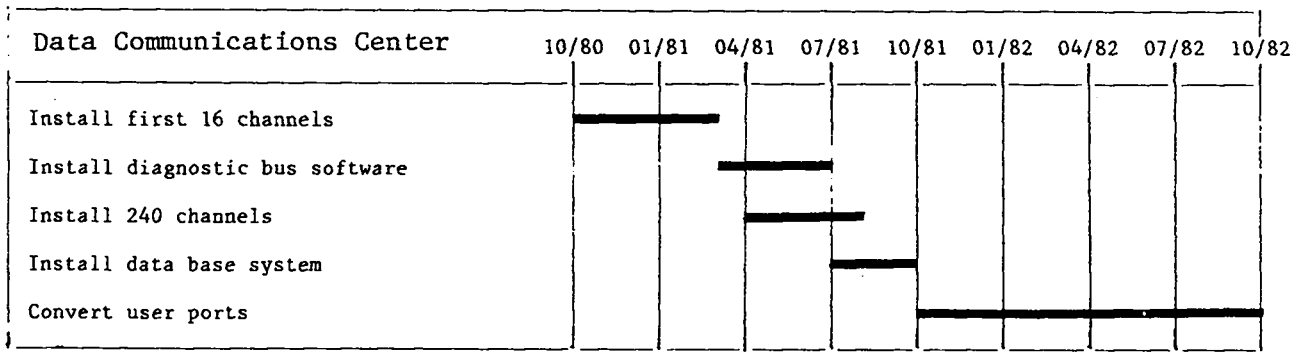

Fig. 29. Data Communications Center schedule.

5.5 ONLINE INFORMATION RETRIEVAL

During FY 1980 we began the online information retrieval project by making some documentation files available on the Common File System. The first set of documentation available was the CTSS utility write-ups. We plan to design new documents so they can be easily and uniformly placed on line as they are completed. Existing documents will be made available as they are updated.

An enhanced information retrieval system for system documentation would provide users with easy access to information related to the use of the ICN computers. As a minimum, the system should provide the ability to view or print individual documents or parts of documents. Preferably, it should be able to construct a data base from a set of documents (for example, all CTSS utility write-ups) and to perform a full text search of that data base.

A commercial data-base management system on an ICN VAX could provide the necessary features. The system should be one that is generalized so that it can be used to manage any textual data bases. Dependence upon the VAX data base management software requires that users signed on to other worker computers have access to the VAX software via process-to-process (PTP) communication.

The project can be divided into the following phases. This schedule attempts to coordinate conversion of documentation for the data base with routine updating of the documentation. This will allow us to move to the system in a reasonable time period without requiring additional personnel.

Phase 0 - Documentation Files on CFS

CTSS write-ups are placed on line in CFS; other documentation is also made available as time permits. C-2 word processing moves into the ICN.

Phase 1 - Retrieval System Running on a VAX

CTSS write-ups and the FTNLIB-CFTLIB manual as well as other information are available in a data-base management system running on a VAX in the ICN. Users sign on to the VAX directly to access the system. Documentation files continue to be available in CFS.

Phase 2 - VAX Accessed from Other Worker Computers

During this phase, work on SIMP and PTP is completed, so that communications between the VAX and other worker computers is possible. A utility providing user access to the VAX information retrieval system from CTSS, LTSS, and NOS is written. Documentation for major systems and libraries is moved to the VAX retrieval system as the documents are revised. Documentation continues to be available in CFS.

Phase 3 - All Major Documentation Included in System

After the documentation for all major systems (CTSS, LTSS, VMS, and NOS) and all major libraries are available, remaining documentation is made available as time permits. Documentation continues to be available in CFS.

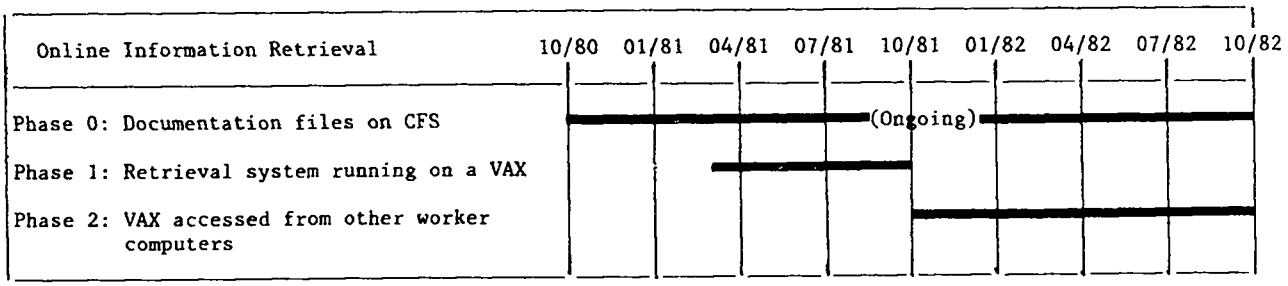

Fig. 30. Online information retrieval schedule.

5.6 CASUAL USER PROJECT

The Casual User Project is aimed at making the CCF easier to use for the occasional user. We have a new employee for the User Interface Group and will ask her to serve as the Casual User Project coordinator. Since this person is new to the Laboratory, she will be facing many of the new user challenges and can indicate problem areas. Additionally, we will attempt to make the CCF easier to use in many of our existing projects. Specifically, we will work on the following projects.

User Survey

We have hired a consultant to survey the Laboratory user community to provide a base of information. From the survey we should be able to point to the weakest areas of the user interface.

New Employee Orientation

We will participate in new employee orientations and provide tours of the CCF. During the orientation we will discuss:

(1) the types of computers and other hardware available;

(2) the major operating systems, compilers, libraries, and utilities available;

(3) the function of the Program Library;

(4) the function of the Consulting Office;

(5) simple examples of how to use the computers.

Improved HELP Package

We will be providing a new HELP package (called ERGO) that will provide an English language description of some LTSS and CTSS errors. This initial package will be complete by December 1980. Beyond that date we will

investigate having utilities and libraries optionally invoke these error descriptions.

Improved Sign-On Line

We will investigate an improvement to the network sign-on line with OS Division. In particular, we will look into prompting the users with the sign-on line format if they are unsuccessful in signing on the first time.

Casual User Documentation

We have started a series of primers to provide very simple guides to the more complex systems and software.

Online Documentation

Online documentation will be provided in the online documentation project.

Computer Aided Instruction (CAI)

We will investigate the possibilities of existing CAI systems. In particular we will evaluate the CDC PLATO system.

Classes

We will provide two types of computer classes: introductory classes for casual users and advanced classes. We will not teach classes that are offered by vendors (for example, VAX/VMS classes, NOS, etc.). We are planning to offer classes on subjects such as:

(1) Common File System,

(2) Common Graphics System,

(3) text editors,

(4) compilers, loaders, and libraries,

(5) interactive debuggers,

(6) assembly-language programming,

(7) vectorization techniques, and

(8) Job Control Languages (JCLs).

Software Improvement

We will make new software easier to use by providing standard syntax across new products. We are also striving to make software products on CTSS compatible with corresponding products on LTSS and, where possible, on Distributed Processors (VAXes). We continuously monitor user reactions to our

software efforts, and in consultation with groups such as CUP, TAC, and SWG, evolve towards a more user-pleasing set of software.

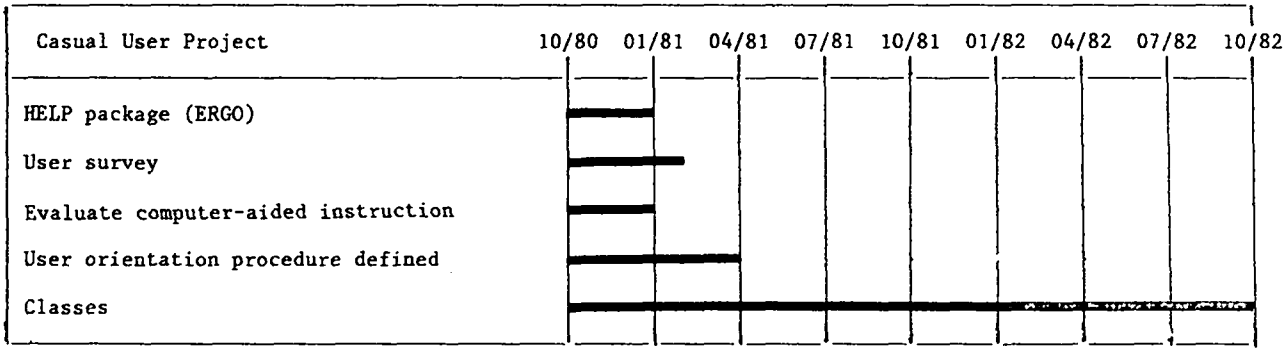

Fig. 31. Casual user project schedule.

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 CCF users on all supported major computers, operating systems, and libraries. 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 the system and associated utilities prior to their being installed.

Finally, the consultants will, from time to time, conduct 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 will begin a consulting and research service designed to increase the effectiveness of these models. This will take the form of 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 user documentation effort will continue for CTSS, LTSS, CFS, and NOS, and new documentation will be prepared for graphics and XNET. A major effort will be undertaken to produce up-to-date LTSS documentation and to update NOS information so users have current information easily available to them for all important CCF resources.

6.4 PROGRAM LIBRARY

The C Division Program Library staff maintains source code, listings, abstracts, and write-up for several libraries consisting of hundreds of

subprograms. The staff also stocks and distributes all CCF documentation. Automatic shelving will be installed by the end of 1980, and this should compress our storage and increase our efficiency. Users should find this new facility much easier to use.

6.5 CUSTOM PROGRAMMING

C-3 provides programming services for other groups throughout the Laboratory. The work is performed by a pool of programmers and data analysts whose abilities must extend over all CCF 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, data-base 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 Support Section 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 NSA requirements for security protection.

6.7 COMPUTER COMMUNICATIONS SUPPORT

The Computer Communications Office (CCO) was established to provide a single point of contact for customers desiring to acquire and install Distributed Computing equipment. This office gathers all information about the project and provides the requestor a written proposal that details all the requirements. A cost analysis is included in the proposal with detailed estimates of each requirement.

Once a project proposal is accepted by the requestor, a project plan is developed. The project plan is coordinated with the requestor 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

Group C-2 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.

6.9 PROJECT MANAGEMENT AND DATA BASE SYSTEMS

Group C-3 maintains project management information and support systems for on-going Laboratory R&D construction projects including standard 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.

C-3 also provides and maintains data-base management software on the NOS machines (System 2000) and for the Distributed Processors (Data Retrieval System, DRS). Consulting and short-term programming help is provided on an as-needed basis.

6.10 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 300 computer systems and 100 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 Automatic Data Processing (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 a large body of federal 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 (7-6171) as soon as needs are identified.

7 RESEARCH

Throughout the era of electronic computation, the Laboratory has used state-of-the-art computers. We have done so because our scientists and engineers have found numerical simulation to be cost effective; have continually increased the sophistication of their numerical simulation models, thereby increasing execution time; and have required computational results on a daily basis, i.e., overnight. Thus we have procured and will continue to procure computers with the highest level of performance.

In using state-of-the-art computers, we have made important advances in computing technology. During the 1950s, the Laboratory played a leading role in design and development of computer hardware and software. Beginning in the early 1960s, we pioneered hardware and software for computer-generated film--first black and white, then color. In 1976 the Laboratory acquired the first Cray-1 computer. Our evaluation of that machine demonstrated a need for memory error correction, a feature subsequently added to all production versions by the manufacturer. Since that time we have provided software tools and expertise that have enabled Los Alamos scientists to develop major production codes that perform an order of magnitude faster on the Cray-1 than on the CDC 7600. Currently, C Division is performing research in the following areas.

7.1 ALGORITHM ANALYSIS FOR HIGH-PERFORMANCE SYSTEMS

Under funding from the Applied Mathematical Sciences Program of Basic Energy Sciences (DOE), and in collaboration with Lawrence Livermore Laboratory, C Division is conducting research in algorithm analysis for high-performance systems. Our technical approach is to study specific DOE large-scale computations for implementation on various classes of high-performance computers. In the next few years we will emphasize multiprocessors and their applications to such things as Monte Carlo calculations, particle-in-cell calculations, hydrodynamic calculations, and diffusion calculations.

7.2 LANGUAGES

Concurrent with our work on algorithms for multiprocessors, we will investigate language features to support multiprocessing, for example, sharing same-name data, locking of data, task spawning/joining, etc. We will also study the ease of implementing certain algorithms in several high-level languages and perform research in generation of efficient code from portable compilers.

7.3 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 with little interaction.

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 in order 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. This project is funded by the Laboratory Institutional Supporting Research Program and C-Division recharge.

7.4 MULTIPROCESSORS

We are developing algorithms for implementing particle-in-cell calculations, Monte Carlo calculations, and hydro calculations on multiprocessors. We need experience implementing these algorithms on hardware to (1) expose "elephant bugs", i.e., bugs too big to see, and (2) obtain quantitative performance data.

Thus we need access to multiprocessing hardware. Under recharge funding, we will initiate a study in FY 1981 to determine the feasibility of establishing a multiprocessing capability at the Laboratory. The following boundary conditions will be imposed on this facility:

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

Given such a facility, our technical approach will be to take prototypical large-scale numerical simulations and study their implementation on this facility. A prime candidate is the LLNL SIMPLE benchmark. This benchmark incorporates the salient features of large-scale hydrodynamic and diffusion calculations of weapon simulation codes.

The primary research issues are:

1. Providing algorithms that accommodate partitioning of computational work across the processors while maintaining good overall utilization and without excessive implementation complexity;

2. Providing language constructs for controlling several processors collaborating on a common task;

3. Providing language features for sharing same-name data, data locking, etc.;

4. Compilation of 2 and 3; and

5. Providing overall performance as a function of implementation, algorithm, and system configuration.

7.5 DYNAMIC MESH SELECTION

In calculating solutions with large gradients, success often depends on choosing a mesh commensurate with regions of rapid change. This requires a priori knowledge of the solution. Under the Laboratory Institutional Supporting Research program, C Division personnel are investigating the use of implicit coordinate transformations to dynamically generate meshes without special knowledge of the solution.

7.6 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.

Graphics programs are fairly complex, involving well-understood applications. 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. Although a great deal of this research is directed toward intelligent terminal use, successful results will be applicable to PAGES and Distributed Processors as well. This project is funded by Laboratory Institutional Supporting Research.

7.7 AUDIO I/O

Audio input/output technology has matured to a point where it is now used in special situations within the computing industry. C Division is investigating its implementation and utilization in such areas as graphics, data collection, and computer command.

7.8 POSTDOCTORAL APPOINTMENTS

Postdoctoral appointments are considered in all areas of computer science especially those related to large-scale scientific computation, such as networking, graphics including distributed graphics and display of data in a volume, distributed data base management, audio I/O, languages, extensible user interface, simulation and modeling, numerical analysis, applied mathematics, operating systems, diagnostics, code generation for vector and parallel processors, and algorithms for vector and parallel processors. Appointments are open to recent recipients of the doctoral degree and are for one year, renewable for a second year.

8 EQUIPMENT

8.1 FY 1980

The FY 1980 equipment items for the CCF have been ordered and most have been installed.

Items with purchase prices in excess of $100K include:

(1) a high-speed printer for connection to PAGES,
(2) the first C-Division Distributed Processor,
(3) a backup controller for the CFS,
(4) a midicomputer for CCF and ICN development activities,
(5) a second PAGES controller for redundancy and increased workload.
(6) a third XNET switch to complete the set for a 3-partition ICN,
(7) a fourth file transport, and
(8) a disk controller for symmetry of the four LTSS machines.

Items in the $30K to $100K price category include:

(1) a set of peripherals to "flesh out" the XNET switches,
(2) memory expansion modules to increase XNET switch throughput,
(3) a complement of multiplexers for the ICN, and
(4) a controller memory-expansion module for the CFS.

8.2 FY 1981

Included in the Laboratory's Weapons Program budget submission for FY 1981 were:

(1) purchase of our first Cray-1 computer,
(2) continued lease of the second Cray-1, and
(3) start of the lease of a 4M-word Class VI/VII system.*

C Division also identified, for Weapons Program funding, the following priority items costing more than $100K.

(1) a second high-speed printer for PAGES,
(2) a CCF production control machine, and
(3) a second Distributed Processor for support activities.

*The term "Class VI/VII system" was used in budget submissions to reflect the indeterminate date of availability of the first Class VII computers. Since such machines are not now expected to be introduced until FY 1985, Laboratory requirements for additional computing capacity in the meantime will presumably be satisfied through acquisition of more Class VI Cray-1 systems.

A list was submitted of technically obsolete and operationally inadequate CCF equipment for replacement in FY 1981 under the Weapons equipment restoration program, including:

(1) an alphanumeric microfiche recorder,
(2) a variety of modems for ICN communications lines,
(3) two film processors, and
(4) replacement disk drives for worker computers.

CCF candidates for General Indirect and Recharge Equipment funding in FY 1981 included, in approximate priority ranking but omitting items under $30K:

(1) equipment to provide more XNET ports,
(2) a prototype CBT-2,
(3) a concentrator for CBT-2s,
(4) memory expansion modules for the three SYNCs,
(5) equipment to provide more KCC ports,
(6) more disk capacity for PAGES,
(7) equipment for the Data Communications Technical Center,
(8) disk drives for the XNET switches, and
(9) miscellaneous components for various ICN switch machines.

8.3 FY 1982

Included in the Laboratory's Weapon Program budget submission for FY 1982 are

(1) purchase of our second Cray-1 computer,
(2) continued lease of the 4M-word Class VI/VII system identified in the FY 1981 submission,
(3) a CFS upgrade for increased throughput and storage capacity, and
(4) an electronic swapping system.

8.4 FY 1983 THROUGH FY 1987

The Laboratory is currently preparing its submissions for the FY 1983 DOE budget and ADP Long-Range Plan. Table XIV reflects current major computer lease and purchase activities and C Division's plans through FY 1987.

TABLE XIV

MAJOR ADP LEASES AND PURCHASES

		FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87
FOR CCF								
CRAY-1 (1st)	*Lease*	*210*						
	PURCHASE	2600						
CRAY-1 (2nd)	*Lease*	*3000*	*2900*					
	PURCHASE		8300					
CRAY-1 (3rd)	*Lease*	*340*	*4100*	*1050*				
	PURCHASE			12700				
MASS STORAGE UPGRADE (1st)	*Lease*		*110*	*40*				
	PURCHASE		480	290				
ELECTRONIC SWAPPING SYSTEM	*Lease*		*40*	*40*				
	PURCHASE			410				
CRAY-1 (4th)	*Lease*			*2050*	*4100*	*1050*		
	PURCHASE					12000		
ADMINISTRATIVE COMPUTER	*Lease*			*185*	*370*	*95*		
	PURCHASE					710		
MASS STORAGE UPGRADE (2nd)	*Lease*							
	PURCHASE				1100			
CLASS VII COMPUTER (1st)	*Lease*					*2300*	*4500*	*1100*
	PURCHASE							13500
CLASS VII COMPUTER (2nd)	*Lease*							*2300*
	PURCHASE							
MASS STORAGE UPGRADE (3rd)	*Lease*							
	PURCHASE							1500

9 BUDGET

9.1 OPERATING PLANS

Our FY 1981 operating budget shows an increase of $1999K over FY 1980. This increase of 8.6% is smaller than increases in the previous three years and continues the downward trend that has occurred during the last four years. Table XV shows the annual change in dollars and percentages beginning with FY 1978.

TABLE XV

TOTAL ANNUAL OPERATING BUDGET - FY 1977-FY 1981

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 (forecast)	25,209	1,999	8.6

An analysis of principal cost categories indicates that changes in ADP lease and maintenance costs have had a major impact on our operating budget. For purposes of this analysis, major categories are:

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

2. Indirect - 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.

TABLE XVI

OPERATING BUDGET BY COST CATEGORIES - FY 1977-FY 1981
(dollars in thousands)

Cost Category	FY 77	FY 78	FY 79	FY 80	FY 81
Personnel	5,134	6,163	6,607	6,913	8,523
Indirect	2,796	3,287	3,562	3,967	5,094
ADP Lease & Maint.	3,145	5,524	6,208	9,069	7,542
Other M&S	1,867	1,808	3,799	3,261	4,050
	12,942	16,782	20,176	23,210	25,209

These costs are all charged to X3 program codes and are recovered by recharge to CCF users.

TABLE XVII

OPERATING BUDGET BY COST CATEGORIES - FY 1977-FY 1981
(percent)

Cost Category	FY 77	FY 78	FY 79	FY 80	FY 81
Personnel	39.7	36.7	32.7	29.8	33.8
Indirect	21.6	19.6	17.7	17.1	20.2
ADP Lease & Maint.	24.3	32.9	30.8	39.1	29.9
Other M&S	14.4	10.8	18.8	14.0	16.1
	100.0	100.0	100.0	100.0	100.0

As a percentage of our annual operating budget, personnel costs have decreased to about one-third of our budget. ADP equipment costs have shown marked year-to-year fluctuations.

Personnel

The total number of FTEs (full-time equivalent employees) charged to the X3 program code has shown a small drop since FY 1978. The severe shortage of qualified computer professionals nationwide has made hiring of such people a difficult and time-consuming job. There is every indication that this demand for computer professionals will increase significantly during the 1980s. Therefore, we must prepare to spend much time and effort if we expect to maintain our staff and increase technical competence.

Table XVIII shows the FTE levels beginning with FY 1977.

TABLE XVIII

AVERAGE FTE LEVELS - FY 1977-FY 1981

FTE	FY 77	FY 78	FY 79	FY 80	(est.) FY 81
SM	86.8	100.6	97.0	87.3	100.3
GR	144.0	145.5	147.6	152.0	153.5
Total	230.8	246.1	244.6	239.3	253.8

9.2 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.

A study showed that all operational costs could be assigned to one of six major categories: (1) CTSS, (2) LTSS, (3) NOS, (4) ICN, (5) CFS, and (6) PAGES. 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 selected by the Director's Office.

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 XIX shows the percentage of total cost recovery expected from each of the six service categories in FY 1981.

TABLE XIX

TOTAL COST RECOVERY BY SERVICE CATEGORY (%)
FY 1981

Service Category	Estimated % Recovery
NOS	11.8
LTSS	24.5
CTSS	28.0
ICN	16.5
CFS	6.3
PAGES	12.9

Figure 32 shows the general decline of costs for CCF services. Table XX lists the FY 1981 charges for services provided by the CCF. The charging algorithms and the factors used to derive these charges are described in Appendix B.

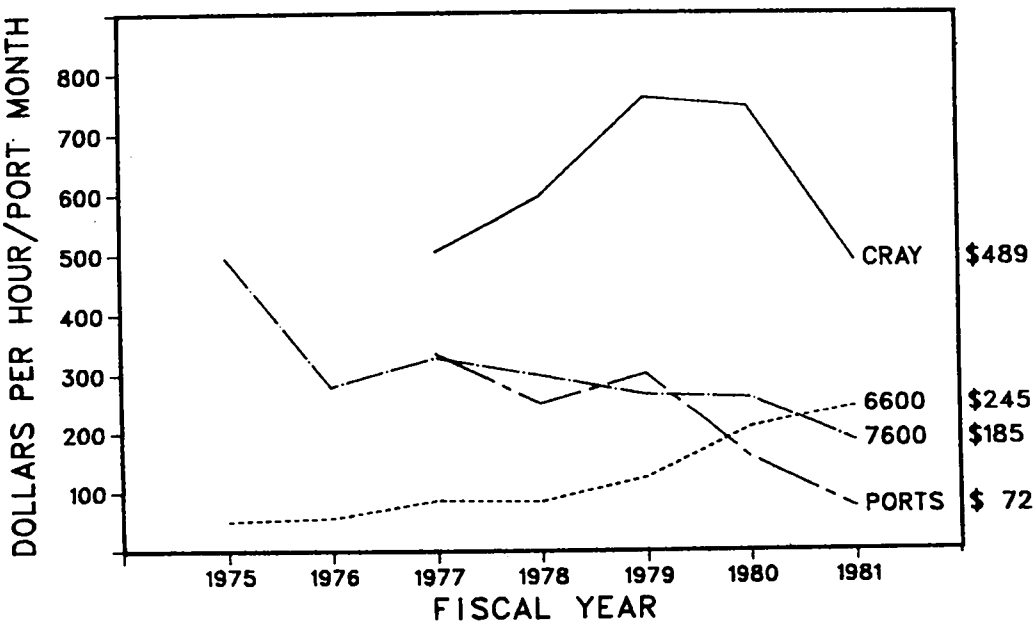

Fig. 32. Cost of computing at the Los Alamos National Laboratory.

TABLE XX

FY 1981 CCF CHARGES

CCF Service	FY 1981 CHARGE
Computing Services	
NOS (recorded hour)	$ 245.00
LTSS (recorded hour)	185.00
CTSS (recorded hour)	489.00
Tape mount (each)	2.40
PAGES output (megabyte)	2.00
Printed output (1,000 lines)	.83
Fiche (each)	2.00
35-mm film (frame)	.16
16-mm film (frame)	.08
Printer/Plotter (sheet)	.25
ICN Services	
300-bit/s port/month	72.00*
9600-bit/s port/month	144.00*
150K-bit/s port/month	216.00*
200 UT port/month	590.00
CBT port/month	860.00
XNET A-Port/month	1,290.00
Connect hour (300 bit/s)	2.00
Connect hour (9600 bit/s)	4.00
Connect hour (150K bit/s)	6.00
Connect hour (200 UT)	5.50
Network transmission (megaword)	2.96
CFS Services	
CFS on-line storage (megaword month)	6.66
CFS off-line storage (megaword month)	.50
CFS on-line access (each)	.15
CFS off-line access (each)	2.40

*Base charge only - approximately 1/3 of total charge.

NOTE: The charges listed above are for weeknight service.

10 THE FUTURE

10.1 GENERAL PLANS

DRIVING FORCES

The main driving forces for C-Division's plans include:

- Programmatic assumptions. C-Division's plans are based on certain assumptions about the programmatic work of the Laboratory and the computing requirements this work will impose on C Division.

- Commitments. Users are committed to their existing application codes, to the Fortran language, and to algorithms optimized for specific architectures; C Division is committed to existing software systems, to an existing network, and to the personnel skills that support these systems.

- Advances in technology. Because Laboratory scientists and engineers work at the frontiers of science and technology, their computing requirements often exceed the installed CCF capacity and capability, so new computing resources must be acquired to meet the Laboratory's needs.

- Research. In the long term, our plans must consider factors extending beyond current and near-term technology, because products that are now in the research stage will become available and offer new opportunities to meet users' needs and reduce costs.

ASSUMPTIONS

DOE National Security Programs and DOD work will continue to supply about half of the Laboratory's funding and will continue to require, and dominate the use of, supercomputers. The number of computer users will continue to grow because virtually all Laboratory programs will require more computing and because the ICN will support Laboratory-wide information management facilities. Our projection is that by 1990 there will be 5,000-6,000 ICN users. The new users will want more computing services that are easier to use, and the current set of users will want facilities that evolve from (be upward compatible with) those in use today.

Computing technology advances will produce supercomputers by 1990 that are about 10 times as fast as today's Cray-1, with 16M words of very fast memory plus additional back-up storage. In terms of constant dollars, these machines will probably cost about the same as today's supercomputers.

By 1990 intelligent terminals will probably be more powerful than today's VAX 11/780 Distributed Processors and will contain audio equipment. High-resolution color computer graphics displays (up to 5,000 scan lines) will be available using CRT or newer technologies. Such intelligent terminals may contain up to 1M words of local memory and may have several peripherals attached, including the ability to view video movies. The price of these intelligent terminals will vary from a few hundred dollars to about $30,000

(in 1980 dollars), with performance varying in proportion to cost. The performance per dollar will increase, and the cost of a given performance level will decrease.

Computers with capabilities between that of intelligent terminals and supercomputers will continue to develop and will have improved price/performance characteristics. All new computers will certainly have much improved reliability, and even the supercomputers will, it is hoped, be as reliable as today's super minicomputers.

Optical storage technologies will become available during the 1980s, providing low-cost archival storage for both large- and small-scale computers.

Supercomputer architecture will continue to evolve toward more parallelism, with vector uniprocessors dominating the first half of the decade of the 1980s and vector multiprocessors dominating the last half of the decade.

Special-purpose computers will become more economically feasible, and data-base computers will be an early development in the 1980s.

COMPUTING IN THE 1980s

The using community generally desires a very stable computing environment, but the most recent hardware is required to support the Laboratory programs. New hardware (for example, a multiprocessor computer) may require new software methods and new approaches to solving existing problems. At the same time, computing must be provided to the Laboratory in a cost-effective manner, which requires very careful planning and management.

Given these somewhat diverse (and sometimes contradictory) requirements, how will computing develop in the 1980s? Stability and evolution (rather than revolution) will be key words. In 1973 the Laboratory began a transition period from batch-oriented operating systems to time-sharing systems. In 1980 that transition was completed with the implementation of the Cray Time-Sharing System. C Division has also been working on defining and providing a standard set of languages, libraries, and utilities. Time-sharing systems are now available on all CCF worker computers and a common set of languages, libraries, and some utilities operate on all machines. The user interface that is now available with CTSS and LTSS will be supported for the foreseeable future. We plan to support that user interface on the next generation of computers (probably available in 1985), thus providing for the graceful evolution of Laboratory computing.

The distributed computer network that is being implemented will continue. The Laboratory has completed a procurement action that will allow 25 VAX 11/780s to be installed. Five of those machines, plus a VAX at Battelle Northwest Laboratory in Richland, Washington, are currently running. The C-Division standard libraries and some utilities will also be provided for these distributed processors so users will not have to learn a new set of software. This distributed computer network will evolve during 1981-82 to become a true distributed computing network in which not only files and jobs may be shipped between computers, but a process on any computer may communicate with a process on another computer. This process-to-process communication will allow

programs to run on more than one computer (which means that the program could be larger than any one computer) and more sharing of computer resources.

The distributed computing network being developed by C Division is moving computing power closer to the user. The next major step in that direction will be taken in 1981 with the advent of more advanced computer-based terminals (CBTs). These new terminals will contain a microcomputer, probably a disk, display devices (graphic and alphanumeric), and perhaps other peripherals (high-quality printers). C Division will define a family of these computer-based terminals that will provide for both graphic and alphanumeric output, local software (editor, utilities, and perhaps libraries), high-speed ICN communication facilities, and will be upgradable to new hardware advances. The ability to upgrade will become very important since it is currently projected that by 1983-85 a computer on a chip will be available with capabilities similar to a VAX 11/780. If the Laboratory family of intelligent terminals and the distributed computing network evolve as we envision, it is conceivable that by the mid-1980s a user could have a VAX class computer in his/her terminal and it could perform in the distributed computing network.

In addition to the distributed computing network, the Laboratory will also be evolving toward distributed electronic offices. There are currently many different standalone word-processing systems in use in the Laboratory. We will be investigating techniques and technologies that would allow these systems to access the network when necessary.

To provide stability and to help control the costs of computing at the Laboratory, C Division will be moving even more toward standardization and software engineering. After the rapid growth of computing in the 1970s, the Division is "cleaning up" some of the interim hardware and software. We are now assembling standard hardware components and connections that will allow for the evolution of the network. Similarly, a set of standard supported software is being defined and implemented using "software engineering" techniques. Software engineering involves carefully designing software before implementation, and then following a set of procedures during implementation to ensure that the software works properly, is modular, and is as portable as possible. Software engineering has allowed complex systems such as the Common File System and the Common Graphics System to be easily maintained and extended. The goal behind our hardware and software standardization and engineering efforts is to minimize long-term maintenance and enable us to make new hardware operational very rapidly.

Additionally, functions that can be profitably automated will free personnel for other projects. Examples of this sort of effort include the automation of CCF accounting and a data communication control system to allow on-line data communication diagnostics.

10.2 HARDWARE TRENDS

The cornerstone of Laboratory computing has always been state-of-the-art supercomputers, and that will continue to be true. C Division is currently seeking to fill out its stable of Class VI (Cray-1) supercomputers, and those machines should support Laboratory applications throughout the 1980s. About

1984-1985, it is expected that a Class VII machine will be available that will run about 3-5 times as fast as a Cray-1. Our current expectation is that the first such machines will be multiprocessors, that is, each computer will have several processors capable of operating in parallel.

In about 1990, computers using some newer technology might appear. These machines might be based on Josephson Junction technology, would be cooled by liquid helium, and run about 10 times as fast as a Cray-1.

At the other end of the spectrum, great advances will be made in the small computer world, and C Division will be supporting those systems as it helps move computing to the users. Intelligent terminals will become increasingly more intelligent, and a VAX-class computer on a chip may be a reality by 1983-85. Intelligent terminals that talk (or at least use some jargon) are also a possibility this decade. Audio input is a much larger problem and solutions are coming more slowly than for audio output.

The increased local computing power will require faster and better communication facilities. The first step along that path has been taken with the recently completed protected wireline project in which a new wireplant was installed in some of the major user areas. The Laboratory has also begun using the new wide-band coaxial communication facility for distributed processor communications. New buildings at the Laboratory will also contain conduit to allow them to be wired for computing. When fiber optic communication becomes cost effective, C Division plans to install fiber optic cables in existing conduits.

10.3 SUMMARY

Computing at the Laboratory is reaching a stable base in both hardware and software. Future computing at the Laboratory will be characterized by upward-compatible software, thus providing evolutionary computing systems. The development of the distributed processing network will continue with more computers, computer-based terminals, and better communications.

The long-range goal of C Division is to provide the computing resources and services necessary to support Laboratory programs. We intend to provide a wide variety of computing alternatives so Laboratory users can select computing to match their needs.

APPENDIX A

REPORT OF THE TASK FORCE ON COMPUTER USERS' PRIORITIES

Preamble

The Task Force on Computer Users' Priorities held both public and private meetings during the months of March, April, and May 1980. In these meetings the Task Force

1) reviewed in great detail the work plan for FY81 proposed by C Division,
2) heard an extensive series of presentations of proposed C-Division projects presented by the X-Division Computer Liaison Committee,
3) invited public comment from any interested user in the Laboratory, and
4) discussed all of these proposals both within the committee and with representatives of C and X Division.

Members of the Task Force made an effort to contact every Division and Department of the Laboratory to invite user comment on these proposals and to invite additional proposals. A preliminary version of this report was made available to all Divisions and Departments and user comment was invited and integrated into this paper.

Although this Task Force was formed by and reports to the Associate Director for Engineering Sciences, we expect the report to be widely distributed. Therefore we want to clarify, for the benefit of other readers, the role of the Task Force, and the assumptions under which it operated.

This Task Force advises the ADES on the subject of users' priorities. Therefore, what follows is not a work plan for C Division but reports our best judgement as to what the community of CCF users wants and needs, in the coming fiscal year, in priority order. We understand that these recommendations will be only a part of the considerations (among the others is available money) that result in a final work plan.

The CUP is not a general user forum and it will not oversee the implementation of those recommendations that are accepted. [We have, however, informed the Technical Advisory Committee (TAC) of the user comments that we received.]

In formulating our recommendations we have assumed that C Division will continue its efforts to maintain, where possible, a common user interface across all systems, to change that interface only when necessary (and slowly), and to consult with the user community on all projects that affect the user interface. We recommend that the projects discussed below be further defined and implemented in consultation with appropriate user representations, either through the TAC or through specially constituted advisory groups.

Core Projects

The projects that are listed in this section are, in the judgment of this Task Force, essential to the operation of the CCF. For this reason we have chosen not to assign a priority ranking to any of these projects, and we strongly urge that all of these projects be included in the C Division work plan for FY81.

- Continue operation of all CCF resources. (C-1)
- Continue production of PIM updates as necessary, the monthly CCF News, software documentation, and the ADP Long Range Plan. (C-2)

- New PIM graphics documentation. (C-2)
- New PIM network documentation. (C-2)
- Editing, word processing, graphics, and keypunch operations as necessary to the support of CCF projects. (C-2)
- On-line documentation. (C-2, C-10) This is a basic project in which all CCF documentation is placed on the Common File System in its most current form, available to any user through one of the CCF text editors.
- Continue support of the program library and of the standard math library. (C-3)
- Benchmarking and performance measurement of present and future computers and systems. (C-3, C-8)
- Project management consulting to the Laboratory. (C-3)
- Distributed Processor software work, including math library, graphics library and post-processors, required system modifications for security and for network interfacing, and standard utilities for file conversion, file shipping, job submission, etc. (C-3, C-6, C-8, C-10)

  This work is essential in FY 81 for the utility of LASL's large and rapidly growing inventory of DPs.
- Continuation of the PAGES project, including the following activities:

  implementation of a back-up controller, implementation of high-speed printer(s), on-line microfiche, improvement of the operator interface, and connections for Distributed Processors. (C-6)
- Support the graphics libraries on all systems. (C-6)
- Maintain the graphics post-processors for all devices. (C-6)

- Develop higher level graphics utilities and libraries for such functions as contouring, charting, etc. (C-6)
- Maintain and improve existing operating systems: CTSS, LTSS, NOS, UNIX. (C-8)
- Bring CFS performance up to the design standard, maintain CFS, and add parallel control processors to increase throughput. (C-8)
- Implement SIMP (Standard Intermachine Protocols) in all systems. (C-8)
- Plan and design future systems both for Class VI/VII machines and for Distributed Processors. (C-8)
- Continue operation of the accounting system, improve it, and complete the automation of the accounting functions. (C-8)
- Continue work on modeling of user jobs, of the network, and CTSS. (C-8)
- Continue maintenance and enhancement of the MODEL compiler and joint work with LLL. (C-8)

  This or similar work is necessary in planning and developing the next generation of operating systems.
- Continue support of ICN hardware. (C-9)
- Design of HSPI (High-Speed Parallel Interface) connections for CRAY-1, CDC 7600, and CDC 6600 and for remote worker connections. (C-9)
- Continue hardware and software development to support high data rates. (C-8, C-9)
- Continue software support and expansion to XNET Phase II and XNET B-ports. (C-9)

- Add new file transport machines and remote worker connections. (C-9)
- Continue support of Laboratory data communications facilities. (C-9)
- Continue consulting services, including consulting on C-Division DP software. (C-10)
- Maintain FTNLIB/CFTLIB. (C-10)
- Continued support of FTN, CFT, and implementation of FTN5 for NOS and LTSS. (C-10)
- Continued development and support of the standard utilities on LTSS and CTSS. (C-10)
- Feasibility study, planning, and initiation of HSRD project (see priority project 1.)

PRIORITY PROJECTS

In this section we list substantial projects which, while important to the users, do not belong to the category of activities essential to the utility of the CCF in FY 81.

We emphasize that there are no unimportant projects on this list. All are important to the future excellence of the CCF and, if funds are available, all should be undertaken in FY 81. The projects are listed in order of their importance to the user community, as estimated by the Task Force.

1. High-speed Remote Display Project (HSRD).

This is by far the highest priority project. In fact, it is so important that we regard it as essential that a beginning be made even if no priority projects can be funded. For this reason, initiation of the HSRD project is included as a core item.

The Task Force is convinced that the capability described below is critically needed for weapons design. The personnel involved in weapons design work are certain that the payoff in increased efficiency and effectiveness will be large. (At present they operate at a distinct disadvantage.) Moreover, there is a large potential payoff for the other segments of the Laboratory that rely increasingly on sophisticated graphics output.

This project is very complex because it must take into account existing systems and projects and because its implementation depends on a number of other complex issues.

C Division is already at work on a high-speed Tektronix project which will significantly improve the present graphics capabilities of Tektronix terminals. This project should definitely continue and possibly even be expanded. The Task Force is convinced, however, that a more sophisticated system with the functional capabilities of the Livermore TMDS (Television Monitor Display System) is badly needed. Such a system should have, at the very least, the following capabilities.

(a) Relatively inexpensive hardware (display terminal and wire-line) so that the system can be widely available in many staff member offices.

(b) Moderately high quality graphics display.

(c) High-speed display of file data, so that the user can display the contents of graphics files during execution in such a way as to create the illusion of motion or rapidly page through an alpha-numeric file.

It is not sensible to recreate the Livermore TMDS system at LASL because it depends upon obsolete technology. The Task Force recommends that C Division establish a project to develop an HSRD system at Los

Alamos based upon the most modern technology. A special Task Force with representation from C Division, X Division, and other divisions should be created to specify the detailed functional capabilities and provide advice on implementation.

This project must address, at the very least, not only the questions of functional capability for the system but also its relation to the HPGS (High Performance Graphics System) project, the high-speed Tektronix project, Distributed Processor graphics, network interfaces, and high-speed data links. The project should also include the required graphics research in the areas of distributed graphics, data compression, three-dimensional modeling, and human factors.

Some interim system, consistent with the final version, should be made available at the earliest possible date.

The proposed HSRD project specifically does not include HPGS, an issue which is addressed below.

2. Automated Production Controller.

The Task Force recommends that C Division develop an automated production control system removing the work of running the production system from the worker computers and operators, and providing automatic load leveling between the worker computers.

3. Casual User Project.

Usage of the CCF, by any measure, is dominated by a relatively small number of individuals, probably only a few hundred. These users can all be classed as expert. The majority of users, however, can be classed as inexpert or casual users. Therefore, any system characteristics that make access to the CCF difficult for the inexpert user have a very major effect on the scientific productivity of the Laboratory,

its employees, and consultants. LTSS/CTSS is a particularly powerful interactive system for expert users but can be described as hostile to the nonexpert. The Task Force strongly recommends that C Division begin a project to remedy this situation. The project should include CCF orientation and computer assisted instruction for new employees and consultants but should not be limited to these features. Access to the system for the naive user must be improved from the sign-on line, through readily accessible on-line documentation, imaginative "help" packages and prompts, and by making available versions or options of the most important utilities that are easily learned and easily used by nonexperts. The Task Force recommends that a separate committee with C Division and user representation be constituted to oversee this project.

4. Remote Input/Output Stations.

The existing collection of CBTs is felt by C Division to be incompatible with the existing network. For some users, the CBT functions will be taken over by Distributed Processors. Many remote users, however, will not have ready access to a DP and will have a need for a remote printer, a remote plotter, and remote input (card reader, tape, etc.). The Task Force recommends that C Division develop and implement a low cost network node that can drive standard output devices of the type mentioned above and that can accept input according to some standard protocol. Compatibility with existing CBT hardware is highly desirable. CBTs must not be removed until these Remote I/O Stations are readily available.

5. Other Kinds of Terminals.

C Division should actively investigate and test other kinds of terminals including color graphics terminals, intelligent terminals, inexpensive CRT terminals, etc., and make them available as CCF supported devices as appropriate in light of user needs and available CCF and network resources.

6. Continued Development of the Data Communications Technical Center and Design of New Laboratory Data Communications Facilities.

Present ICN data communications involve a large number of channels and a variety of communication equipment and new communication facilities are being implemented. They include the wide-band coaxial trunk line system, the protected wireline facility, additional high-speed multiplexed channels, and the XNET system. The Data Communications Center will provide automatic testing of the communication equipment and lines. Automation provides a means of doing consistent, rapid testing to achieve quick restoration of faulty channels. In addition, prediction of failures can be addressed by automatically testing all channels on a regular schedule while they are not in service. Work will also continue to upgrade data communications facilities to exploit modern technological advances.

7. Research.

The Task Force supports additional research efforts (beyond those included in the base plan) in the areas of graphics, performance measurement and modeling, and other areas directly related to the CCF functions. Other areas of research such as numerical analysis, fluid dynamics, etc., while no doubt appropriate for C Division, should seek support from ISR, WSR, Basic Energy Sciences, etc.

8. On-line Documentation.

The Task Force supports an enhanced on-line documentation project (beyond that included in the base plan). With the guidance of a special committee of C Division personnel and representatives of the user community, the most desirable functions of a sophisticated on-line documentation system should be defined (consistent with the system implemented under the base plan) and a modest project to implement these functions should be initiated.

Other Remarks

1. High Performance Graphics System (HPGS). The HPGS system proposed by X Division would, in the judgment of this Task Force, be of uncertain utility to the majority of CCF users. In light of this judgment, and the limited CCF resources available, the Task Force recommends that further development of the HPGS system be restricted to that work which X Division is willing to fund from its own resources. C Division must, however, provide, in a timely fashion, a high speed interface to the network.

2. Office Automation Project. C Division has proposed a very ambitious project under which the entire Laboratory would be connected through the CCF network for word processing, electronic mail, filing systems, and a number of other functions. The initial part of the project would entail surveys and analyses of the Laboratory's existing office and internal mail structures and procedures followed by the design of a modern high technology system that would meet not only the current needs but also anticipate advances that would make office administration more efficient in the future.

The Task Force believes that this may be a very important proposal with a large potential pay-off for the entire Laboratory. We do not believe that is appropriate to support this project with CCF funds. We recommend that this project be presented to the Laboratory management as an important candidate for possible funding under Laboratory Indirect.

Acknowledgments

The Task Force is grateful for the cooperation of the C-Division management, the X-Division Computer Liaison Committee, and the representatives of other Divisions in the Laboratory. These individuals have given generously of their time, knowledge, and advice, and without their assistance the Task Force could have not done its job.

APPENDIX B

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:

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

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 not shift weighted as noted in Table B-I. SUF is a service unit factor that is given in Table B-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 1981, the SU charge is $185.

TABLE B-I

SERVICE UNIT FACTORS FOR CCF SERVICES

CCF SERVICE	NOS	LTSS	CTSS	ICN	CFS	PAGES
CP time	1.322	1.00	2.645	.	.	.
Channel time	1.322	1.00	2.645	.	.	.
Memory megaword hours	1.322	1.00	2.645	.	.	.
Network transmission	0.016	0.016	0.016	.	0.016	.
Tape mount	0.013	0.013	.	.	.	.
Printed lines (1000)	.	.	.	.	.	*0.0045
Connect time (300 bit/s)	.	.	.	0.0108	.	.
Connect time (9600 bit/s)	.	.	.	0.0216	.	.
Connect time (150K bit/s)	.	.	.	0.0324	.	.
Connect time (200 UT)	.	.	.	0.0297	.	.
300-bit/s ports	.	.	.	*0.39	.	.
9600-bit/s ports	.	.	.	*0.78	.	.
150K-bit/s ports	.	.	.	*1.17	.	.
200 UT ports	.	.	.	*3.19	.	.
CBT ports	.	.	.	*4.65	.	.
XNET A-Ports	.	.	.	*6.97	.	.
CFS on-line storage	.	.	.	.	*0.036	.
CFS off-line storage	.	.	.	.	*0.0027	.
CFS on-line access	.	.	.	.	*0.00081	.
CFS off-line access	.	.	.	.	*0.013	.
COM megabytes	.	.	.	.	.	*0.0108
150-mm fiche	.	.	.	.	.	*0.0108
35-mm film frame	.	.	.	.	.	*0.00086
16-mm film frame	.	.	.	.	.	*0.00043
Printer/Plotter sheet	.	.	.	.	.	*0.00135

*These services are not subject to the shift weight factor.

Note: SUFs for 300-, 9600-, and 150,000-bit/s ports are for base charge only.

APPENDIX C

GLOSSARY OF ICN TERMS AND ACRONYMS

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 Computer 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.
AFT	A File Transport protocol that is used to transmit files in the ICN.
A-Port	A port that provides a remote computer of the Extended Network Access System (XNET) with the capability to ship files to and from the Integrated Computer Network.
ASCII	American Standard Code for Information Interchange. The standard 7-bit 128-character set recommended for use in telecommunications.
B-Port	A port in the network that makes a B-Site computer available to users of ICN terminals.
CBT-1	Computer Based Terminal. A remote job entry terminal consisting of a computer that supports peripheral devices. Currently, CBTs are Digital Equipment Corporation (DEC) 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.
CFS	Common File System. A centralized filing system. It consists of IBM computers (a 370/148 and a 4341) and an IBM 3850 mass storage system.
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 (PAGES) 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 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.
Closed Line	A dedicated data channel, usually leased from the telephone company, with administrative controls at the line end where the terminal is connected.
Common File System (CFS)	A centralized filing system. It consists of two IBM computers (a 370/148 and a 4341) and an IBM 3850 mass storage system.
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 (DES) 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.
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 (DES) 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.
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 time-sharing system used on the Cray-1 at Los Alamos.
DEC	Digital Equipment Corporation. The manufacturer of the DEC PDP-11 and VAX-11 families of minicomputers embedded in the Integrated Computer 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.
FT	File Transport. A computer that controls file traffic between specific worker machines in the Integrated Computer Network.
High-Speed Terminal	A graphics terminal that operates at a speed of up to 300K bit/s.
HPGS	High Performance Graphics System. An interactive graphics system designed for use with hydrodynamics codes in weapons designs. The hardware includes a

	DEC PDP-11/70 computer and an Evans and Sutherland Picture System 2 connected to a Cray-1 computer.
HSPI	High-Speed Parallel Interface. A type of interface that handles high-speed data transfer between computers in the Integrated Computer 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 Computer 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.
JOB	An intermachine job submission protocol that will allow one computer to start a job on another computer.
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 100K bit/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 1.6M bit/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 time-sharing system that is used on the CDC 7600 computers at the Laboratory.
Medium-Speed Terminal	A graphics terminal that operates at a speed of 300 bit/s input and 9600 bit/s output.
MTM	Protocol for machine-to-machine file transmission. Being developed by C Division.
MVS	Multiple Virtual System. An IBM operating system for medium and large computers.
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 Computer Network.
NSM	Network Status Machine. A DEC PDP-11 computer that monitors and displays the status of components of the Integrated Computer 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.
OS/VS1	Operating System/Virtual System 1. An IBM operating system used on CFS.
PAGES	Print and Graphics Express Station. A node in the Integrated Computer 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.
RCI	Remote Computer Interface. A special XNET interface for B-Port terminals that provides multiplexing and demultiplexing of ICN terminals.
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 Computer 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 Computer 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. Beginning with Phase 2 of the Integrated Computer Network partitioning, Secure lines will be the only way to access Secure computers.
SEL	System Engineering Laboratory. The manufacturer of the SEL 32/55 machines used in the CFS file transport system.
SIMP	Intermachine protocol that is used to create a communication path between computers.

SYNC	Synchronous Communications Concentrator. A DEC PDP-11 computer that switches message traffic and synchronizes transmission rates in the Integrated Computer Network.
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.
VMS	Virtual Memory System. The standard operating system for the DEC VAX machines.
Wireline	A data channel.
Worker Computer	Any computer in the Integrated Computer Network that executes user programs.
XNET	Extended Network Access System. Provides Integrated Computer Network access for remote computer sites. See A-Port and B-Port.
X.25	An international standard protocol, something like DECNET, that C Division will use for CBT-2s and possibly external network.

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