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An Overview of the Computer Aided Definition System for Design Definition at Sandia National Laboratories, Livermore FY91 Update

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AN OVERVIEW OF THE COMPUTER AIDED DEFINITION SYSTEM FOR DESIGN DEFINITION AT SANDIA NATIONAL LABORATORIES, LIVERMORE FY91 UPDATE

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Abstract

Sandia National Laboratories, Livermore is continuing the process of upgrading and enhancing its Computer Aided Definition System to incorporate new hardware capabilities and software functionality to meet our design definition mission. The original report, published in August 1988, detailed the current configuration and design concepts. Although many of the concepts are still valid, several new hardware capabilities are now available and significant software advances have been made since that report was published. This report describes the updated system configuration and revised concepts for the early 1990's.

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Purpose

Sandia Report number SAND88-8941 published in August 1988 (See Reference 1) describes the SNL, Livermore CADS as visualized after the conversion from the old CDS 4000 hardware platform to the CADDStation platform was complete. Since then, several new developments have occurred that, when implemented, will significantly enhance the system as originally conceived, e.g. SPARC technology from SUN Microsystems is now one of the widely accepted premier hardware platforms and is in the process of being integrated into the CADS configuration. This report documents the changes to the CADS currently being installed or proposed and the reasons for those changes.

Scope

This report is a complete document in itself describing the system configuration as it now exists with projections for future enhancements. It was written primarily from a systems management and systems administration point of view rather than from an end user perspective. It describes the underlying assumptions and concepts used to design the system implementation, the current hardware configuration, fundamental network operation, features intended to provide maximum system availability, and ease of system administration. It does not, generally, describe the capabilities available to the general user community. The actual hardware and major applications will be briefly touched upon; however, this report will not detail the capabilities of either hardware or software except as required to understand the total CADS configuration.

Note that the features described as implemented are in-house and in the process of being completed. The target completion date for all items is December 1, 1991.

General

Systems implementation, management and operations described in this document are performed by the Computer Aided Engineering (CAE) Division (8274). CADS users and workstations are located around the SNL, Livermore site with the primary computational facilities and on-line storage contained in the CADS Computer Center (CCC). The CCC is located in Building 912, Room 235. The majority of workstations are located in the 8270 design definition (drafting) area. Refer to Figures 1 and 2 for the CAD workstation locations at SNL, Livermore and the CCC layout respectively. The current classified and unclassified CADS configurations are depicted in Figures 3 and 4 respectively. Figure 5 lists the system printing and plotting devices and their interfaces. A detailed list of equipment and software descriptions can be found in Appendices A and B respectively. Appendix C and Reference 3 describes the repackaging of SUN 3 servers to meet space constraints.

In-house and contract design definition are the primary users of CADS in support of CAE design, analysis and documentation activities in the mechanical and electrical engineering arenas as well as CAM activities located in Livermore's NC machining area. The computer equipment consists primarily of SUN Microsystems or compatible components most of which were purchased through CV. The plotters are from Versatec. Several other types of peripherals of various manufacture are also used. All equipment is available to all users and operators via an ethernet network. It should be noted that the SNL, Livermore configuration is quite dynamic in that equipment can be easily relocated and the configuration changed to meet system or customer.

Separate Systems

It should be noted that there are two physically separate CAD systems: both "unclassified" and "classified" systems. The classified CADS is authorized to process classified information up to and including the level of Secret. The unclassified CADS supports contract design definition and some engineering activities that do not require a classified environment. The classified CADS supports all other users. The CAD capabilities of each system are virtually identical. The number of workstations and servers on both the classified and unclassified CADS is given in Appendix A.

Site Plan & CAD Workstation Locations

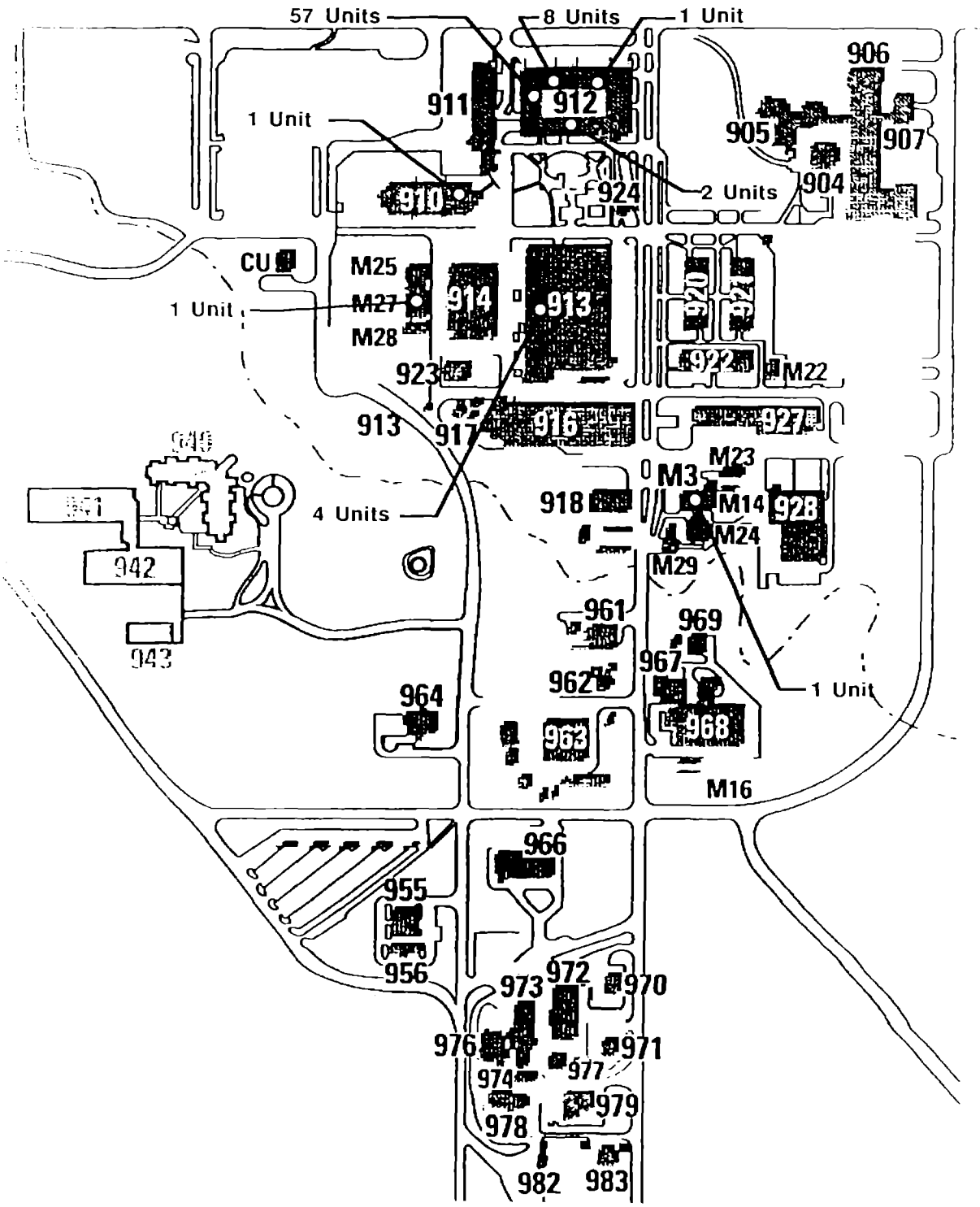
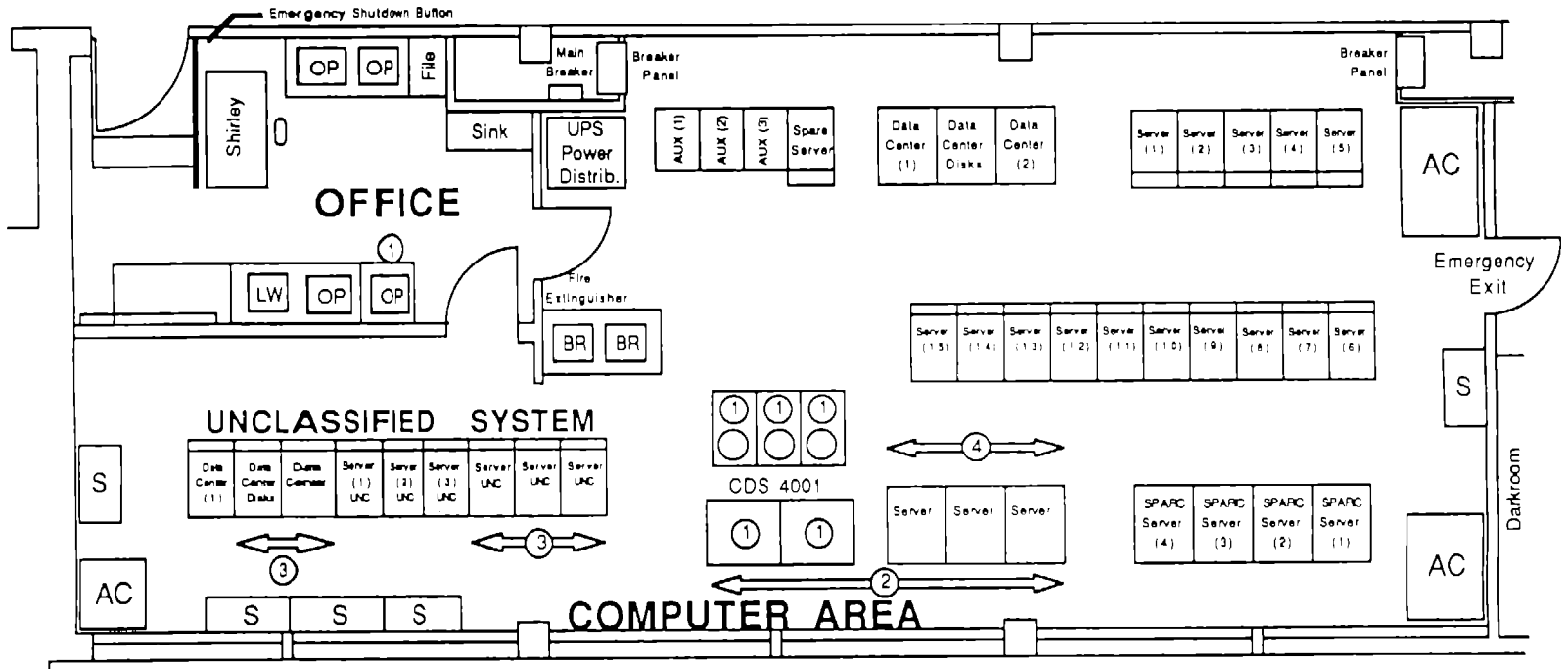


Figure 1 Site Plan & Workstation Locations

CADS COMPUTER CENTER

Sandia National Laboratories, Livermore

BLDG 912
ROOM 235



S - Storage
AC - Air Conditioning
OP - Operations Stations
BR - Bridge and Diag. Console

"Aux" Racks
1 Security
2 Auxilliary
3 Peripheral

(1) CDS 4001 To Be Removed Approx. 12/91
(2) SERVER Expansion
(3) Unclassified System Expansion (From Servers 11-15)
(4) Expected FY92 Purchase

SPARC Server

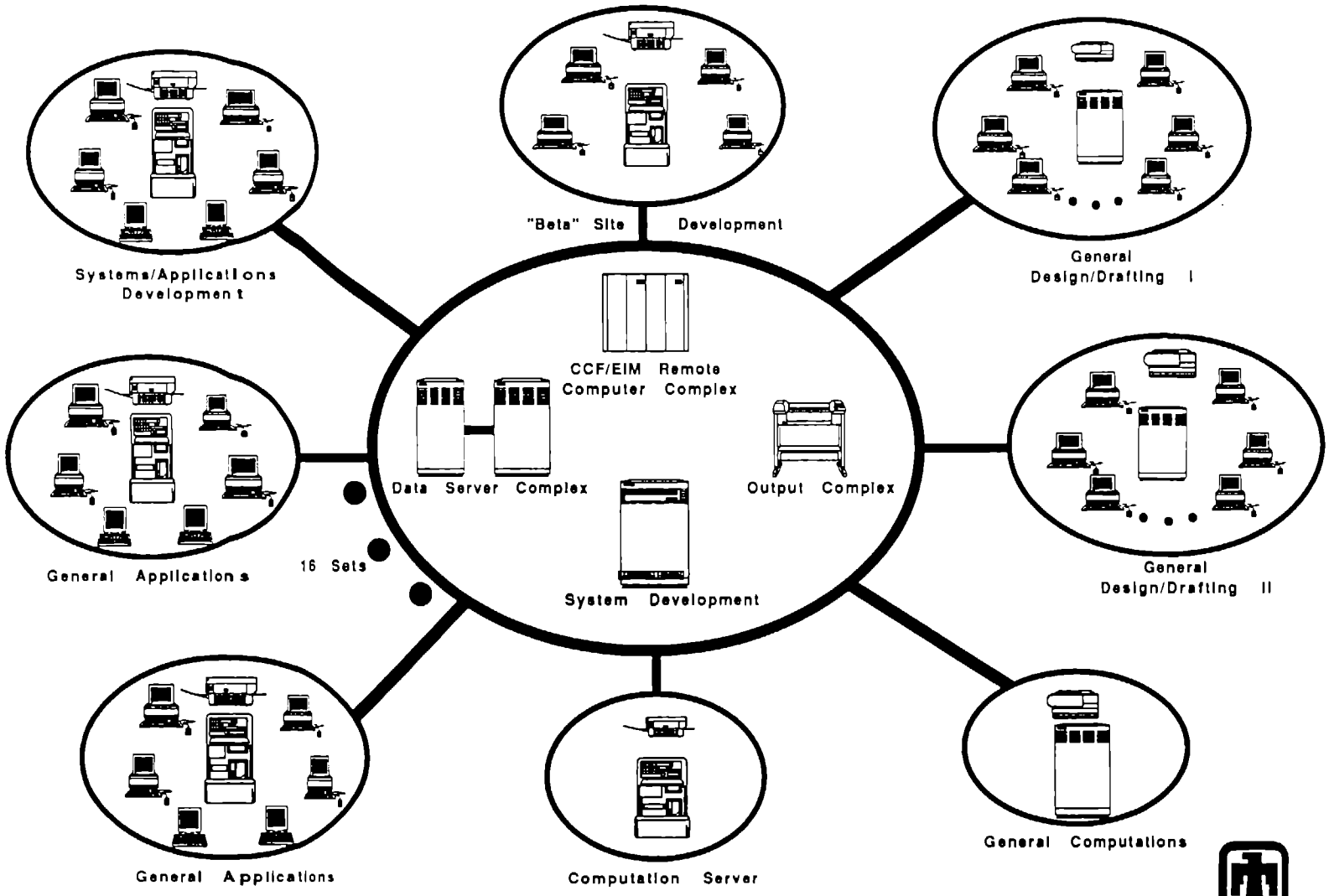
68000 Server

CADS COMPUTER ROOM
Date: April 19, 1991
File: RM235-Rev 10

Figure 2 CADS Computer Center (12)

Sandia, Livermore Functional CADS Configuration

CLASSIFIED NETWORK - FY '91

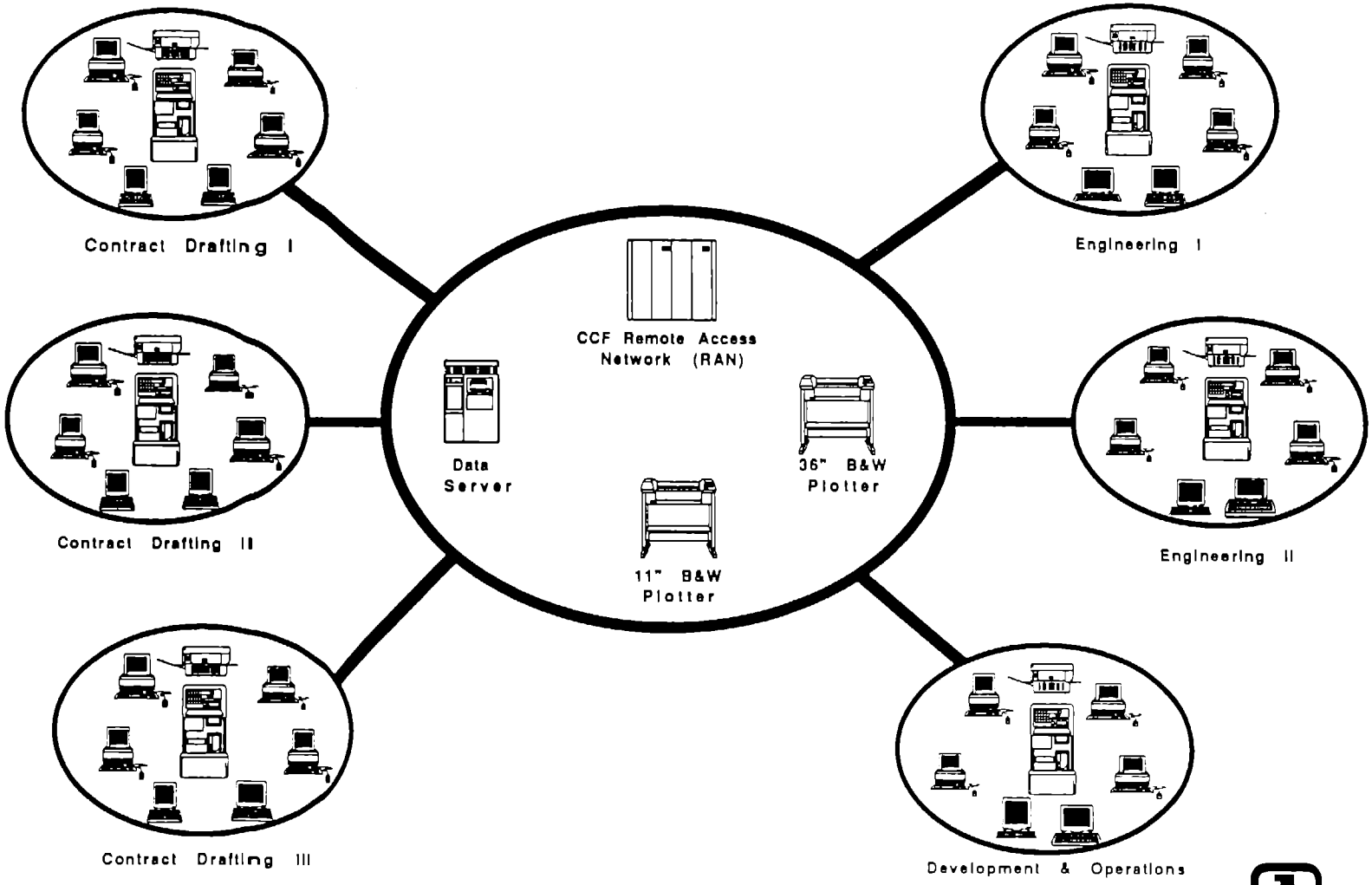


11/20/9

Figure 3 Classified Network - FY91 (13)

Sandia, Livermore Functional CADS Configuration

UNCLASSIFIED NETWORK - FY '91

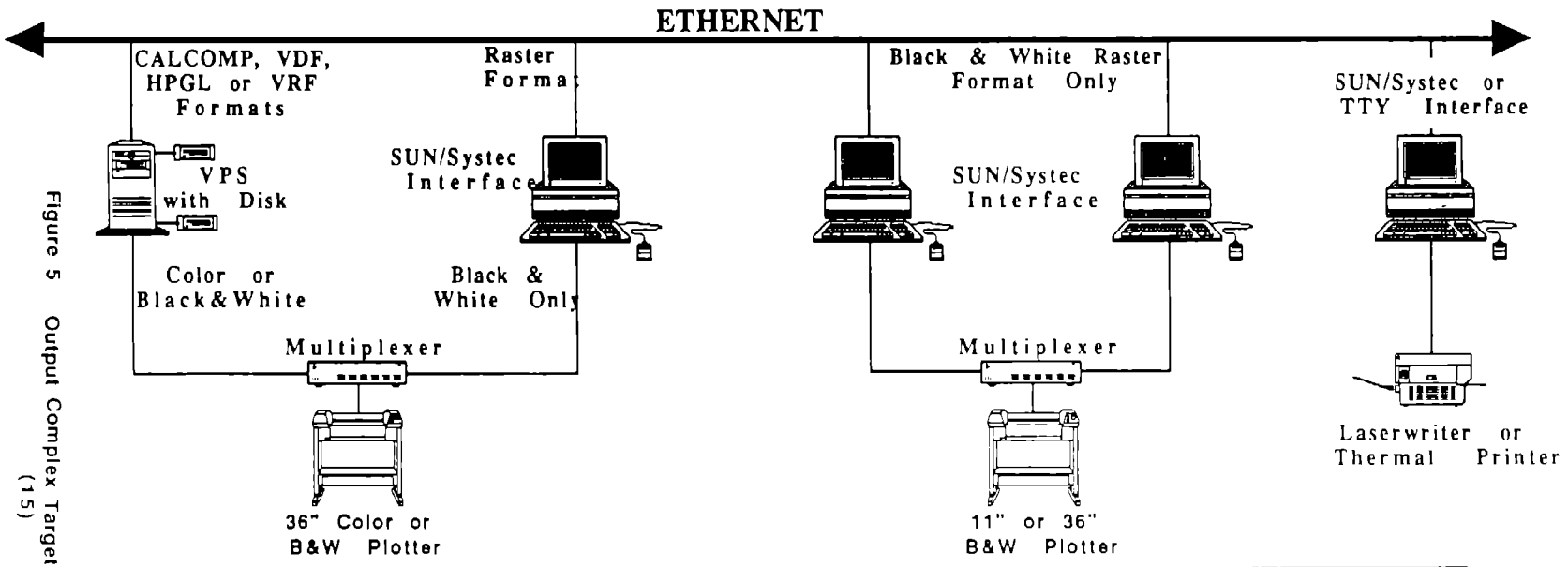


11/20/9

Figure 4 Unclassified Network - FY91 (14)

Sandia, Livermore CADS Functional Configuration

Output Complex Target Configuration - FY '91



DEVELOPMENT	DRAFTING SOUTH	DRAFTING NORTH	CCC
LASERWRITER (2)	*36" LASER PLOTTER* 11" B&W PLOTTER LASERWRITER	36" COLOR PLOTTER 11" B&W PLOTTER LASERWRITER	LASERWRITER

NC SHOP	CONTRACTING	DRAWING CONTROL	SPECIFICATIONS
36" B&W PLOTTER 36" PEN PLOTTER LASERWRITER	11" B&W PLOTTER LASERWRITER	*36" COLOR PLOTTER* THERMAL PLOTTER LASERWRITER	LASERWRITER

ITALICS - TO BE DONE

12/8/90

Figure 5 Output Complex Target Configuration - FY91 (15)

Although the two CAD systems are managed and operated essentially identically, they are physically and electrically unconnected. All data passed between systems requires the use of a magnetic tape. Data passed from the classified to the unclassified CADS are certified by the requestor to be unclassified. The classified CADS is the larger and more heavily used of the two. This report describes capabilities and functions in terms of this system. It should be remembered, however, that underlying principles and features apply equally to both CADS unless indicated otherwise.

The classified CADS processes the majority of SNL work especially weapons design information. It is connected to the CCF through a CADS gateway. This isolates our network from theirs allowing each to make changes independently of the other. See Appendix A for a detailed list of equipment.

The unclassified CADS supports contract design definition personnel and other users creating and manipulating only unclassified data. It is connected to the RAN through a second Ethernet port on the File Server. The unclassified CADS consists of 3 servers, 1 data center and 10 workstations all of the SUN 3 variety. Refer to Appendix A for a detailed list of equipment.

SNL, Livermore CADS Implementation Criteria

The following guidelines were used when designing the CADS environment at Livermore:

- The availability of the system to <u>each</u> end user must be maximized.
- The system must be as integrated as possible consistent within accepted policies and practices.
- All applications (e.g. electrical and mechanical) must be available from all workstations.
- All workstations will have the same "look and feel."

- Downtime must be minimized.
- During hardware failure, the system must be capable of easily moving users to similar equipment.
- Systems operations must be simple and able to be automated.
- Saving of data and libraries must be automated and fail-safe.
- Release and storage of completed data bases must be simple and fail-safe.
- "Standards" will be followed wherever possible.

Description of CAD Applications

CV, a Prime Computer Company, supplies all major applications used by CADS personnel. These applications include mechanical design definition (2D, 3D, physical property analysis, design, detailing, modeling, etc.), electrical design definition (schematic capture, PCB design and board layout, thermal and stress analysis, design rules verification, basic analysis and simulation, interfaces to mainframe analysis programs, etc.), 3D wire-frame, surfaces, solids and analysis capabilities (finite element, stress, thermal, kinematic, etc.) for engineering design and a manufacturing capability able to provide NC information for Livermore's machine tools. These programs comprise about 95% of the software used on CADS. Since the operating system is SUNOS (AT&T UNIX with Berkeley and SUN extensions), several other ancillary programs are used in support of the CAD effort, with some programs being written in-house. Although some specialized programming and equipment arrangement is required to support our classified environment and to generally "tune" the system, the amount of in-house programming effort is kept to a minimum. The general philosophy for the SNL, Livermore CADS is to use "standard, off-the-shelf" capabilities.Special vendor written code and in-house programming are need only where no other reasonable solution exists.

Virtually any application able to run on the SUN platform under SUNOS will run on the Livermore CADS. The primary applications, however, are mechanical and electrical CADS named CADDS™ and THEDA™ respectively that are registered trademarks of CV. These two applications account for

about 95% of the work performed on CADS. Specifically, the application areas are:

- Modeling - This function includes some conceptual design and analysis, but consists primarily of describing piece parts and assemblies as a preliminary to design definition. CADS is capable of performing interference analysis, physical property calculations, tolerance stack-up, thermal and stress analysis, and accounts for about 5% of the CADS workload.
- Mechanical design definition - Work done here includes some conceptual design and analysis, but consists primarily of creating piece parts and assemblies for the purposes of design definition including detailing and documentation. Design definition capabilities include three dimensional wire frame, surface and solids technologies. Mechanical design definition accounts for about 70% of the CADS workload.
- Printed Circuit Board design definition - The two major applications are schematics and PCB design definition. Schematics are drawn and checked, PCB's are designed and created, and manufacturing data is extracted and sent to the shop and other production agencies. PCB design definition accounts for about 20% of the system workload.
- Surface Mount Technology - Also known as Hybrid Microcircuits (HMC's) are properly part of the PCB application, but is mentioned separately here since not all PCB packages on the marketplace contain the tools needed to process HMC's.
- Manufacturing - About 5% of the system workload is used by in-house manufacturing that processes both mechanical and electrical parts.

Network Configuration

All CADS equipment communicates over a LAN operating under the IEEE 802.3 "Ethernet" communications protocol. Figure 3 shows a central network (or "backbone") connecting all the servers and data centers with

each other, with the network peripherals and with the CCF via a "gateway". Since user and library data is centralized, all user information from all servers eventually travels over the backbone. Informal analysis shows it to be very busy just before the end of the business day and just before lunch when all users tend to file their work. The next busiest time is just after working hours begin in the morning when users who have exited CADDS the previous night (not all do each day) start up again and acquire data bases.

The servers perform the same function for SUN 3 (Motorola 680x0 based) and SUN 4 (SPARC based) equipment. That is, they provide a disk farm to be used by clients in a diskless client environment. The network operates at ten megabits per second, but upgrades are available that can increase network speed or can increase throughput at the same network speed.

Features Supporting the CADS Design Criteria

The Livermore CADS was constructed to conform as closely as possible to the design criteria given previously. The features described below are intended to implement that criteria.

Standard Equipment & Software

SNL, Livermore uses standard hardware and software platforms insofar as possible. As a practice, we do not modify these platforms unless required to do so with sufficient justification. We believe this conforms to "good business practices" in that we need not know the internal structure of either the operating system or applications; nor must we maintain and upgrade such modifications between platforms and software revisions. Wherever possible, all enhancements are made to "add-on's" of separate programs. This detracts somewhat from a "fully integrated" system concept, but other advantages such as ease of code maintenance, not having to deal with large amounts of vendor source code, not having to know the internal structure of the vendor software, ease of progressing to new revisions, etc., outweigh this minor deviation. In most cases, the

separate nature of multiple programs is not visible to the end user since we attempt to provide seamless interfaces.

Unfortunately, there are always exceptions. As DOE requirements change or flaws are found in the operating system, some OS modifications are required to insure system and data security. In addition, SNL has unique requirements that are not always fully addressed by standard applications. Whenever possible, these add-on programs are generated in-house and are generally small applications or "scripts". If the feature cannot be addressed by an add-on or the program is larger than can be conveniently managed in-house, the appropriate applications software vendor is usually requested to provide and maintain the enhancement. In some cases where neither of these are feasible, such as with the need for a security feature that cannot be done outside SNL, the system or application modifications are done in-house regardless of complexity or size. For example, a separate program used by CADS operators to release drawings and store information on the Engineering Information Management System (EIMS) unique to Livermore's needs is being implemented (see Reference 2). In addition, several scripts were created to support the needs of the systems management and operations functions (i.e. data backup, library maintenance, etc.).

Common Configuration

Within the SUN architectures, CADS supports both SUN 3 and SUN 4 platforms. There are both servers and workstations in each platform with 3 styles of workstations currently supported in the SUN 3 platform. Each workstation and server is identically configured with other equipment of like function within a platform. In addition, all applications operate on all platforms and equipment. Workstations of the "diskless" variety were selected to keep hardware maintenance costs down and to satisfy security requirements. CADS supports two types of servers: 1) Data Centers that provide storage for all user files, the complete CADS library, special programs, etc. and 2) Servers (SUN 3 and SUN 4) that provide disk space and applications code for workstation usage.

There are a few "diskfull" clients attached to the unclassified CADS used for special purposes, e.g. as loaners to organizations wanting to have or learn CADS, but do not have a CADS ethernet connection. There are also a few diskfull workstations on the classified network used for special programs. The diskfull clients may be datafull or dataless depending on the requirements of the user.

CADS supports two Data Centers configured identically in hardware, software and information. These machines manage user data on large disk farms as their primary function. Each machine provides software data "mirroring." Currently, mirroring is a software function where each hour, data changed within the last two hours on each machine is copied to the other machine. In the near future, hardware data mirroring will be provided, e.g. all user data will be written simultaneously to separate disks shared by both Data Servers. Both implementations result in two copies of data being available to both Data Centers at all times providing both data and Data Center backup. The current software solution has provided the unexpected benefit of having a 2 hour on-line backup. This function will be retained when we move to hardware mirroring.

The Data Centers contain all the data, development source, complete library, etc.; that is, data that can change on a routine basis and must be available from all points on the network at any given time. Both Data Centers are normally in use; however, the configuration allows either to act for both in case of a malfunction by the other. SUNOS has an "automount" feature that allows access to a backup machine in an automated fashion.

All like Servers are also configured identically as to hardware, software and information. They act as disk and application farms for both diskfull and diskless clients, and, therefore, are configured to handle many smaller data transfers such as program accesses and virtual memory swapping. Each server supports the same applications, but contains no permanent data or user files. They contain only the operating system, application software, swap space for workstations and that part of the library that is "executable" (programs). Since these servers do not normally run programs or process data directly, they are also used as computation

servers, e.g. as resources for running long, background jobs not requiring operator intervention, especially overnight. Each server supports a number of workstations. As part of the "minimum downtime concept," both server platforms maintain an on-line "spare" that can be quickly configured to replace a downed server; in the interim, these spares are designated as "computation servers."

Workstations are typically of the diskless variety and, therefore, support no local data or applications. All operating system and applications are down-loaded from a server over the network. This scheme was chosen for security and systems management benefits. As a trade off, we expected to pay a performance penalty for performing "swapping" over the network (as opposed to using local disks). In fact, however, informal tests show this configuration to be almost as fast as diskfull clients up to the ethernet saturation point. Machines located in non-vault areas are disconnected at the vault end when not in use. Data in the memory of these units is lost after approximately 1 minute without power thereby satisfying security requirements.

Diskfull clients are used where special characteristics and/or security requirements are issues. Local disks are required to be of the removeable type even in vaulted areas. Disks are removed nightly and locked in approved repositories as required; otherwise the units are identical to diskless clients. Removeable disks are required since the location of Livermore CADS equipment is quite fluid and we do not guarantee these units will remain in a vaulted environment. As the cost of removeable disks is reduced and we develop better system management techniques, more workstations may be converted to the diskfull type. Our policy is to maintain the flexibility of relocating workstations outside of vault areas when appropriate.

Redundancy

There are several advantages to this method of configuring systems . First and foremost, it is much easier to administer. Periodic saves of data are performed from a single source, the Data Centers. This eliminates the need

to access each Server to collect changed data thereby easing the network load. The configuration also allows for redundancy of data on the Data Centers. In addition, data is not duplicated about the network.

Another benefit is that any user can operate from any seat in the network and perform whatever job is required. Because the servers and workstations are configured identically to "like" equipment, all workstations have "like" capabilities. This is a significant advantage since many of our users work from multiple locations with multiple applications (i.e. mechanical, electrical and/or machining). Additionally, all workstations have a similar "look and feel."

Software update and system management is also more efficient. One configuration is supported by all like equipment (at least within a platform) as opposed to unique configurations for servers and clients. This simplifies the process of rebuilding disks and machines after hardware failures, new revision installation, etc. It also allows us to maintain a single set of operating software and libraries that can be written to appropriate disks on all like servers; equipment update is easily performed over the network.

Since all like equipment is configured as identically as possible and all user data is centrally located, any piece of hardware can be physically substituted for any other similar piece with only minimum software reconfiguration. The system, therefore, provides its own backup and redundancy.

Spare Equipment and Client Space

Peripheral equipment, such as magnetic tape drives, streaming tapes, optical disks, CDROM, etc. are always provided with a spare capability if the device is considered critical to system operation. The spare unit is usually kept on-line and exercised to insure it remains in working condition and to help streamline operations. Special purpose equipment not considered critical to operations does not necessarily have a spare.

We do not consider "standby" workstations necessary since, considering the number of workstations installed, there are always some unused stations due to travel, illness, vacation, etc. "Hot standby" servers (both SUN 3 and SUN 4) are maintained so that users will not be "down" or suffer from a degraded condition due to a single malfunctioning server.

As an additional backup, we have configured each server (both platforms) to be able to handle additional clients in a degraded mode (2 on the SUN 3 platform and 6 on the SUN 4 platform). If one of the servers malfunctions, the spare can be reconfigured as a "clone" of the down system allowing users to be back on line within 15 minutes or so. This also allows the malfunctioning server to be repaired off-line. If a second server fails, the workstations on that server are reconnected to the remaining servers using a local patching arrangement. The servers are then reconfigured in software to provide for the additional clients allowing all affected users to operate in a degraded mode. This process can continue until about one-third of the servers are down at once (all slots filled or extremely poor performance is seen) - an unlikely probability. SUNOS 4.0 and above makes adding and deleting clients on an individual server easy.

Development Server

The development server and some of its clients are unique in that they do not follow the basic rules for common configurations. We consider this acceptable since it is the CADS "test" and "program development" system. It is not used in production, and is typically unique since some software or hardware product is usually being tested. The base machine, however, is of the common configuration, but there are additional disks and a tape drive to help offload the production network. Note that neither CADS operations nor system management for the production network are performed from this server and, therefore, if this server or its clients malfunction, there is no loss to production. In addition, many elements of this system are available for emergency use as replacements in the production system.

One of the primary uses of this system is to test the next revision of software before it is put in production. The newest version of applications and the operating system are built on this system and then operated there to test data security, new features and attempt to discover bugs. When the test group is satisfied, the new system is simply copied to appropriate servers on the network.

Repacking of SUN 3 Client Servers

The original SUN 3 servers purchased from CV were configured as a deskside system with a large add-on unit to house a maximum of 2 disks. a 1/2 inch magnetic tape and a 19 inch bit-mapped monitor as a system device. The physical space requirements were deemed too large and cumbersome for our use; consequently, the server and peripherals were repackaged into a standard 19 inch electronic rack configuration. Since the monitors were only system console devices, they were replaced with inexpensive VT320 terminals. Appendix C outlines the repackaged unit and the equipment required. Reference 3 details the repackaging of hardware and the reasons this was done.

Peripherals

CADS supports a large array of peripherals; especially printers and plotters. These peripherals are described in Appendix A. CADS also supports a number of devices used to aid in systems and operations management.

Printers & Plotters

Figure 5 shows the CADS "output complex." It consists of several printers and plotters distributed about the SNL, Livermore site according to needs. The classified CADS currently supports 3 large (36" wide) color electrostatic plotters manufactured by Versatec, Inc. These plotters are interfaced to the CADS using both a Versatec Processing System (VPS-890)

and a simple raster interface as shown in Figure 5. These plotters perform the majority of plots including all finished release plots. They can plot in both color or black & white; two are located in design definition and one in drawing control. SNL, Livermore no longer saves mylar or paper prints after drawing release. When a drawing is released, a copy of the plot file is saved in the CCF; that file is recalled by drawing control and plotted directly on their plotter when a mylar, vellum or paper print is required. Hardcopy archive requirements are met with microfilm.

There are two small (11" wide) black & white electrostatic plotters located in the design definition area. These units make small plots and can print text on roll or fanfold stock as required. There are a number of laser printers (Apple Laser Writer II NT or equivalent) scattered about the CADS network to support screen dumps and general printing requirements. The second interface to the plotters (SYSTEC in Figure 5) is a backup in case the primary interface fails and plots to that unit cannot be delayed.

The unclassified CADS supports one large and two small black & white plotters; the large and one small plotter are located in the contract design definition area and the other small plotter is in the NC area. Two laser printers are also supported and located in the same two areas.

Other Output Devices

As shown on Figure 5, a thermal color printer/plotter is also supported. This unit outputs on either "A" or "B" size paper or acetate and can be used to make vu-graphs directly in multiple colors. A Tektronix 4836D, primarily used by the CAE Division MacIntosh network, will soon be shared with CADS. This is a wax transfer process device also capable of producing either standard or legal size plots on paper or acetate (vu-graphs).

A COM device is on-line to the CADS. This Wicks & Wilson unit is capable of making aperture cards from the final CADS plot file that is augmented by some administrative information. Although not currently in use, the

unit can also scan existing aperture cards and provide a "raster" image of the microfilm and a text file of administrative information.

The NC shop interfaces a Gerber photoplotter and 36" Hewlett Packard pen plotter to their workstations. This Gerber is down-loaded with data files and runs independently rather than as an on-line peripheral. The shop also outputs to a device called a "mini-file" that uses standard 3.5 floppy diskettes as media. Similar units are interfaced to their NC machines to facilitate receipt of machining information.

CADS Computer Center Peripherals

A high speed printer purchased from QMS supports our engineering specifications activity. Specifications,using Interleaf on SUN workstations, generates a great deal of paper requiring a printer of the QMS variety providing up to 20 pages per minute of output.

Exabyte™ 8 mm video tape cartridges and Sony erasable 5-1/4" optical disks, both supplied through Delta Microsystems, are used to assist in systems and operations management. The CADS library is stored on video tape and a copy is sent off-site for storage each month as a disaster backup. The tapes hold about 2 Gigabytes of data each that is sufficient for daily and most weekly backups, but is too small for monthly and some weekly backups. We are considering an upgrade that will quadruple both capacity and speed allowing operations to perform daily, weekly, monthly, system and library backups overnight in unattended mode. However, optical disks are also being considered for this purpose.

Our optical disks are currently of low density (650 Megabytes), but are also relatively inexpensive. We are experimenting with this technology as we believe it will be heavily used in the near future for everything from archival of CADS drawings to augmenting magnetic disks as on-line and near on-line data storage.

CADS also has a number of CDROM devices used primarily to load software from SUN and CV. Both companies now distribute their software and

firmware on CDROM. Although we have not found a current need for such, these are standard units and used in industry to distribute large volumes of information quickly and relatively cheaply, e.g. standard library components. We are considering the use of this media to store and distribute drawings in native CAD and/or raster formats.

CCF/EIMS/CFS

Release and storage of drawing and other data base information is performed on the SNL, Livermore EIMS and the CFS. CADS has an Ethernet connection with the CCF as shown in Figure 3. The CCF is used to perform conversion operations necessary to transmit CADS information to other NWC agencies and to perform some analytical functions. It is also part of the vehicle needed to actually transmit and receive electronic CADS data from other sites. The CFS is electronically connected to the CCF so that information can be obtained and stored there through this connection.

The EIMS is used to effect release of drawings and CADS data bases so they may be tracked and accounted for according to DOE requirements. Currently, CADS information is stored on the EIMS; however, this function will soon be augmented by the CFS. Only the latest releases will be kept on the EIMS or possibly in the CCC for quick reference. The EIMS also provides a number of informational reports about programs, parts and drawings that incorporate CADS generated information. For a complete description of the CADS oriented function of the EIMS, CCF and CFS, refer to Reference 2 listed in this document.

Future Capabilities

Both CAD hardware and software technologies are changing very quickly. SNL, Livermore is continually evaluating new or improved hardware and software available in the marketplace and intends to maintain the most modern and capable system possible consistent with customer needs, good business practices, vendor and platform reliability, and funding. We will

continue to support a design definition capability with a high degree of utility; however, the customer base is expected to expand in the CAM environment and begin to be used in the engineering environment. To support these new and expanded environments together with an increase in the number of users, a number of advanced capabilities must be considered. The following areas outlined below are currently being explored.

As matter of course, we will continue to keep close touch with advancements at CV and incorporate appropriate capabilities as they become available including migration to more advanced computing platforms. Of particular interest is the ability to read and write information from other CADS through standard translators. Therefore, the CALS initiative will become a large part of our operational requirement.

Our current network is based on Ethernet as defined in IEEE 802.3. There are several upgrades that improve the speed of Ethernet while maintaining its format, most notably FDDI that operates at speeds up to 100 megabits per second. This technology is of present interest since some of our in-building and all of our inter-building communications are accomplished over fiber optic cables. Currently, FDDI does not have a complete, singly accepted description as does Ethernet and is still expensive. We will watch this emerging standard and will probably incorporate it - at least in the CADS backbone - when it becomes accepted and cost effective.

There are network enhancements that claim to increase throughput on existing Ethernets by performing packet and address generation, resolution, receival and acknowledgement in hardware. Such items are less effective in the SUN 4 environment than they are on the Motorola platform. We do not consider them to be cost effective at this time, but will continue to follow the progress for possible use on the Data Centers.

The current CADS uses SMD technology disk drives on the Data Centers and software to simulate mirrored storage of user and system data. These will soon be upgraded to the more reliable and much faster IPI technology.

SNL, Livermore will be testing a communications switch capable of directly connecting pathways at up to 100 megabits per second over fiber optics. At this rate, Ethernet, even at FDDI rates, can have direct connections from the buss to the workstation. Such a switch would greatly increase communications security and allow CADS to use the laboratories fiber optic system rather than install or extend our own fibers to new locations.

To operate after normal working hours outside vault-type areas requires CADS workstations to be attached through a special transceiver line protected by a physical key and lock. Other workstations located outside of vault-type areas are routinely disconnected at the end of each work day and reconnected just prior to the beginning of the next work day. Two companies are known to have a product that will allow communications access only during programmed hours unless special codes and passwords are specified. The capability is available for RS232 type interfaces, but not for Ethernet. Since the methodology employed is acceptable to DOE and is considered more secure than the current protection method, SNL, Livermore has requested these companies modify the existing capability to operate on Ethernet. This has not yet been accomplished, but we are following their progress.

There are several software tools available from various companies used to assist the systems, operations and network management of large installations. Our network is now large enough to benefit from such tools and we are currently evaluating existing products.

The new SPARC technology is clearly superior to our Motorola products from almost every standpoint especially the cost of maintenance. We intend to convert our existing Motorola CAD platform to SPARC at the earliest opportunity, funding permitting. CV has a workstation trade-up program and we expect the cost differential to be completely recovered within 2 years. If possible, the Motorola stations will be saved and provided to the laboratory as standard SUN workstations. An informal study is currently in progress to determine the actual break even point.

CV currently maintains all the CADS equipment except the plotters and a few minor peripherals. Moving to the SUN 4 platform will give us a completely generic hardware platform free from any application hardware dependencies. We are exploring alternatives to a "full-service" maintenance service such as competitive services, self maintenance and on-call maintenance from either a single source or from the hardware manufacturers. Since software is still a proprietary product, its maintenance will continue with CV.

Raster images saved on WORM style optical disks are thought to be an excellent candidate for replacing the current drawing archival system. Optical technologies are growing at almost an exponential rate and many innovations are expected in the near future. DOE has not approved optical disks as an archival medium, but this appears to be a possibility. In any case, CALS compliant raster images seem to hold the best promise for saving, transmitting and electronically receiving drawing data bases among dissimilar systems (and possibly among similar systems at different revision levels). CADS has a pilot program planned to implement raster technology directly on CADS, interfacing to optical media and incorporating an interface to the SNL, Albuquerque raster system.

Although we currently operate in a diskless environment, we believe a diskfull system may increase both speed and productivity. The primary reasons for not converting are the cost of: 1) maintaining a good security environment and 2) properly managing the system with all the extra media. The cost of long term, reliable removeable disks is approaching a level where there may be little difference in the cost of a diskfull and diskless environment. The removeable media also addresses our security concerns. The system management and administration costs of the extra equipment is still prohibitive, but some techniques appear promising and will be pursued.

"Conference planners" are available for CADS at this time although they are quite expensive. These units allow multiple locations to see and modify a given plot file simultaneously. This could be a very useful tool for design-engineering-manufacturing interfaces. Additionally, workstations could be

placed at SNL, Albuquerque, AS-KCD, etc. where design changes, ECO's, etc. could be viewed by all concerned parties. A software-only solution to this problem already developed by Sandia, Albuquerque would reduce costs significantly. Again, this is a technology to watch.

Security is always a concern especially for the classified CADS. Electronic drawing sign-off is of interest. Along these lines, both signature recognition equipment and other positive identification devices, such as fingerprint comparison, are being evaluated and may be incorporated into CADS if appropriate.

Several devices are available to increase productivity. Among these are remote command recognition, a mouse that operates in three dimensions and stereoscopic viewing devices. At first analysis, these items sound like so much fluff, but I believe they have real application value. The current method of selecting CADS commands is to pick items from menus, a function keyboard, and/or to type in commands directly from an alpha-numeric keyboard; more than occasionally, data is input directly from the keyboard. A remote command recognition capability could greatly enhance data entry by shortening the required input time and by eliminating erroneous menu picks. It would also free the operator from having to sit directly at a console.

Devices used to visualize and work with data directly in a three dimensions are new, but appear promising. Special headsets allow users to visualize data directly in three dimensions from standard monitors or from large overhead monitors by large groups. Holographic displays are beginning to enter the marketplace. Couple this with eye tracking devices able to identify objects by looking at them, selection devices that operate in three dimensions and gloves that track according to finger position, extremely sophisticated input/output equipment will soon be generally available.

As always, there are a great number of enhancement products available to increase processing speed, memory, disk access, network management and

enhancement, etc. Devices of this nature are individually evaluated and incorporated into the system if cost and performance gains warrant.

A new or enhanced EIMS is being seriously considered to help in the release, storage and management of drawings and associated data. This is a very large, complex problem and any system must be fully compatible, and hopefully integrated with CADS. Several systems capable of performing these functions are currently available from the private sector.

A "Tiered" or Hierarchical" storage complex will be needed in the near future to contain required on-line or "near" on-line data. A possible system is depicted in Figure 6. Such a system will most likely have at least some magnetic storage, a large R/W optical storage unit and an even larger WORM storage unit. It may also contain a backup for the magnetic storage. The purpose of the unit would be to store and manage data with the actual location being invisible to the end user. Data would be migrated through the storage mediums according to usage and data type, and recalled to on-line status as needed. The optical media could be removed and the system would know to request reinsertion of the media if required. There are at least two good systems on the market today capable of handling this need; however, neither provide for a redundant CPU and network interface. Since this node would provide such a great deal of data, we feel redundancy is required.

A local CDROM writing capability would be useful. CDROM may become an archival medium and would be a useful tool today to archive raster based drawings and possibly for passing large amounts of information, including drawings, between NWC and outside agencies. In addition, a CDROM "jukebox" arrangement is being considered. There are several libraries of information available on CDROM and installing such a capability allows us to keep and access these libraries on-line to the CADS.

A "Dual Ported" disk arrangement is being considered to allow the classified and unclassified to exchange data without the need of a magnetic tape. A possible schematic is shown in Figure 7. Two disks, configured identically, would be interfaced through a switch box capable of switching

the two disks between systems. The switch would be manually operated and only one of the disks would be attached to each system at any given time. There are still some potential electrical and security hurdles to be addressed.

Mirroring (shadowing) of user data will be implemented in the near future. This will require the proper operating system level support and dual ported disks. Having this feature will provide full and current user data at all times even if an entire user data disk fails. Figure 8 shows a possible configuration.

Sandia, Livermore CADS Functional Configuration

Hierarchical Data Storage - FY '93

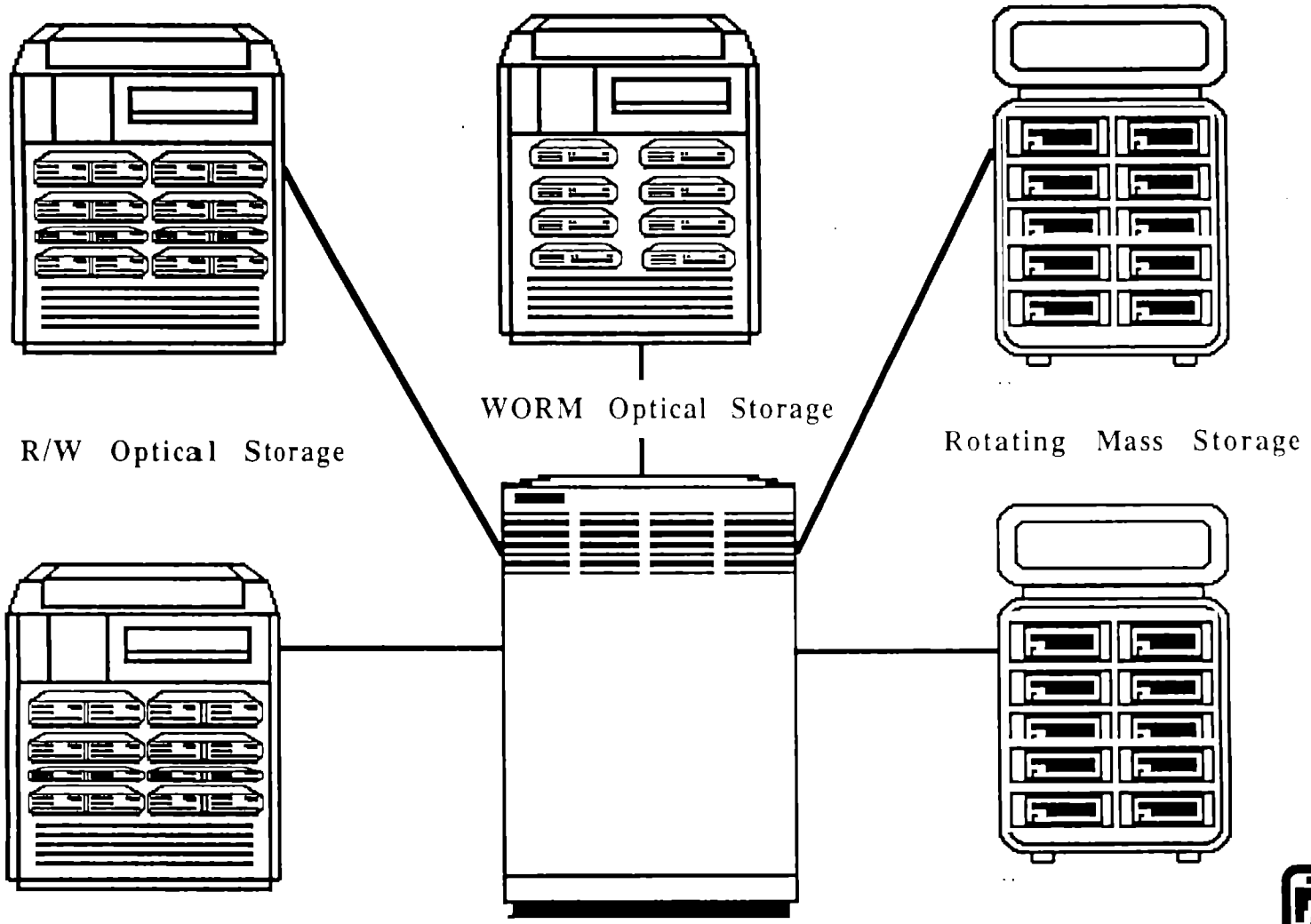


Figure 6 Hierarchical Data Storage - FY93 (35)

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Sandia, Livermore CADS Functional Configuration

"Split" Disk System - FY '93

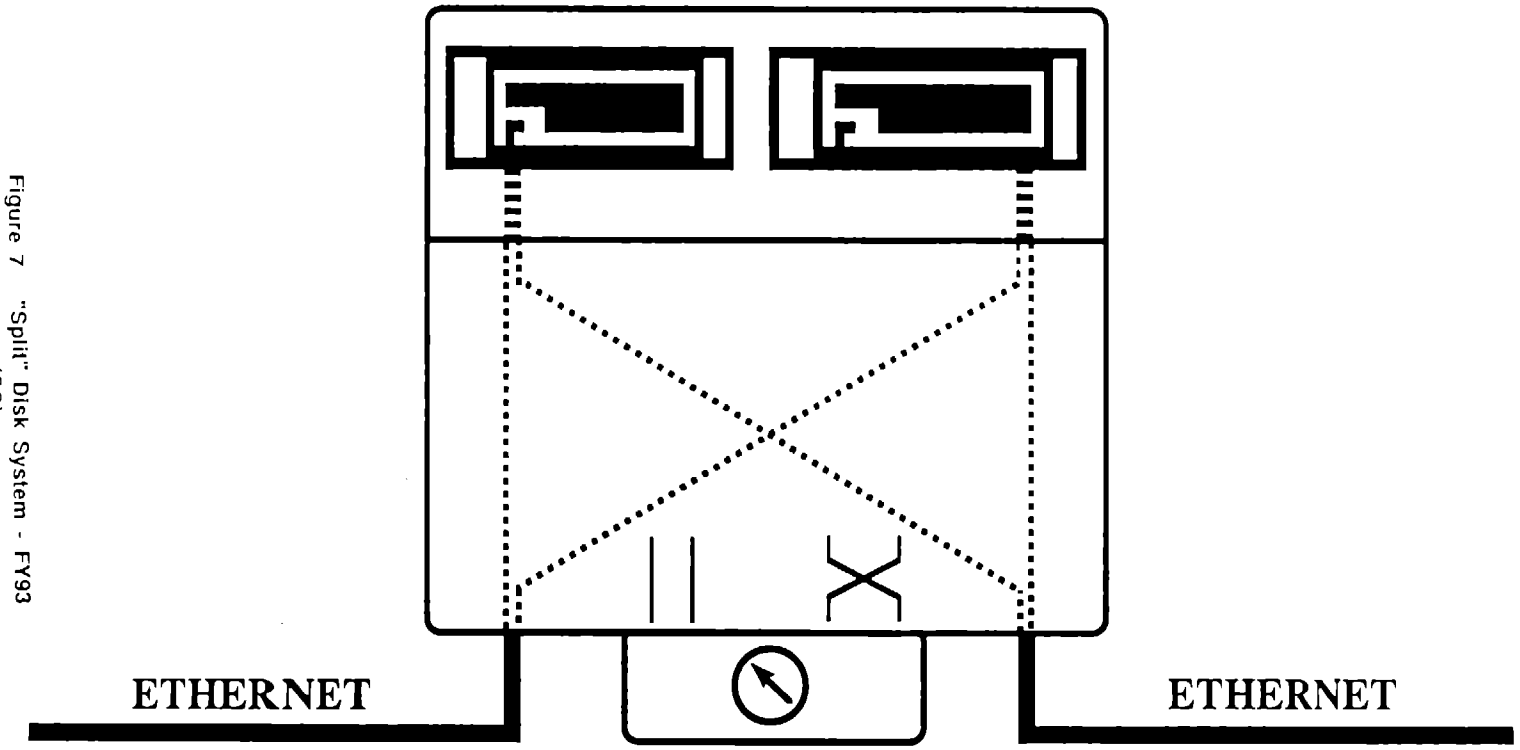

Figure 7 "Split" Disk System - FY93
(36)

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Sandia, Livermore Functional CADS Configuration

Data Server Complex - FY '91

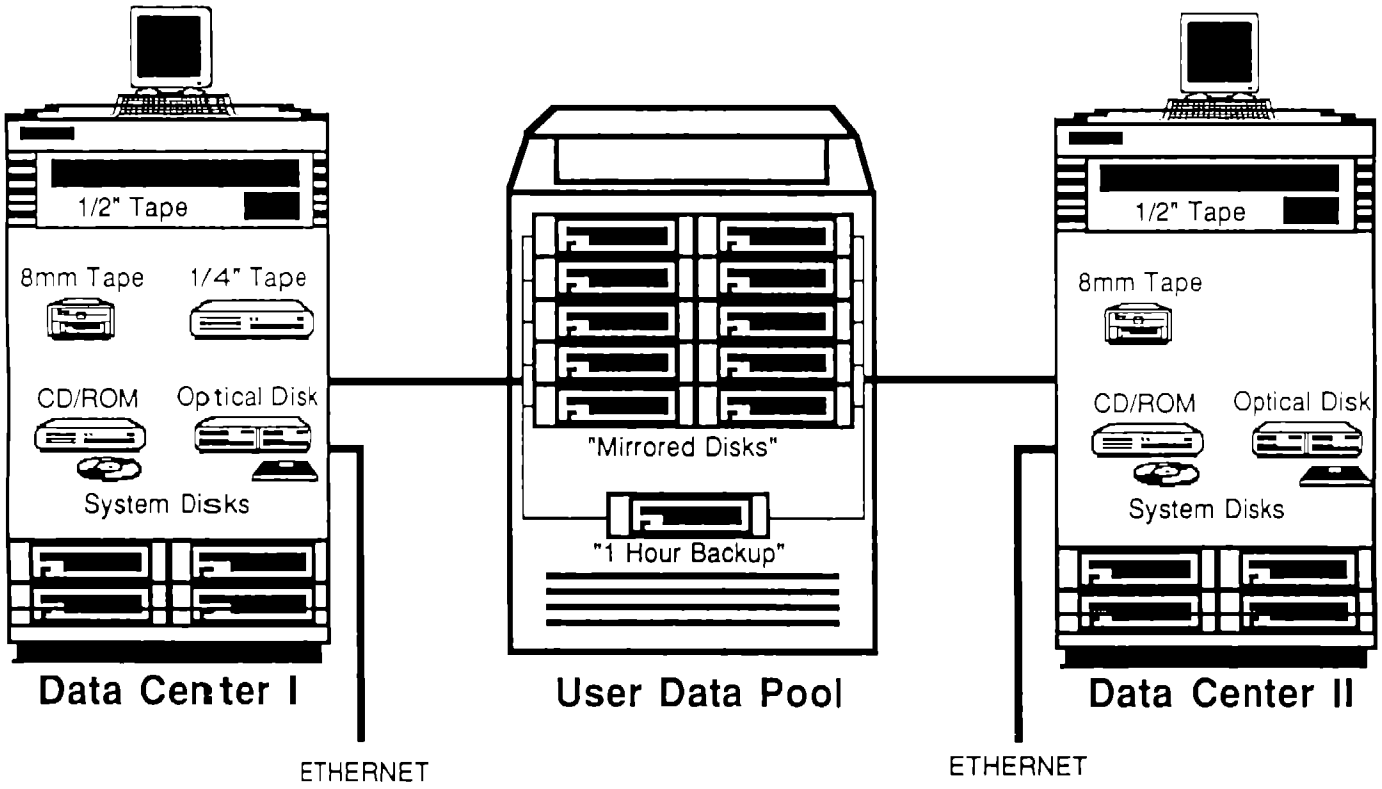

Figure 8 Data Server Complex - FY91 (37)

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1. "An Overview of the Computer Aided Design System for Drafting at Sandia National Laboratories Livermore," SAND88-8941, August 1988, B. E. Koopmann

2. "Data Definition, Storage and Communications within the Sandia National Laboratories, Livermore CADS Environment," SAND89-8246, August 1989, D. B. Hall, B. E. Koopmann

3. "CADDStation Repackaging and Implementation of Non-Computervision Hardware on the Sandia Livermore Computer Aided Definition System," Proceedings of the 10th Annual Computervision User Conference, April 1989, B. E. Koopmann

Appendix A
CADS Hardware Components

As stated in the body of this report, like hardware components are configured as closely as possible to each other to help both with system management and equipment redundancy. Other than the Ethernet network itself, the CADS network consists primarily of Data Centers, Servers, Clients and peripherals. Data Centers serve as data repositories; Servers serve as disk and application resources for clients; Clients can be of the diskless, diskfull or stand-alone varieties; and peripherals are of two major types - computer and input/output (I/O).

The CADS hardware platform consists exclusively of SUN Microsystems based equipment and other fully compatible items. Much of the hardware and all the applications software is supplied by CV. The systems consists of a mix of workstation models with the same end user "look and feel." The specific models are SUN 3/60, 3/140, 3/160, 3/260, SPARCstation 1+, SPARCstation 2 and 4/490 hardware (CV models 33C, 32CV, 32C, 34S, 42S, 52P and 45S respectively). We also use SUN3/110 workstations as "bridges" between networks. With the exception of "processing speed," the workstation type available to the end user is immaterial as all provide the same functionality.

The only differences among server configurations are the hardware platform (and therefore the processing speed) and specific peripherals (different disks and tapes supported). The specific configurations for each server is presented in Appendix A. Some servers are based on the "old" SUN 3 (Motorola 680x0) processor, ranging from 2 to 4 MIPS processing speed for the equipment at SNL, Livermore. This was the only platform available at the writing of the previous report. "New" servers are based on the SUN 4 SPARC technology and range from 16 to 22 MIPS processing speed for equipment purchased by Livermore.

It should be noted that pure MIPS processing speed cannot be easily compared between platforms; however, the SUN 4 equipment is

significantly faster and less expensive than the SUN 3 platform. The important feature is that the functionality and capabilities of each platform are identical from the user viewpoint. Therefore, the user will experience the same "look and feel" regardless of the workstation type or the supporting server - a primary goal for the Livermore CADS.

Classified Network

Data Centers (2 each)

The Data Centers provide central disk and file management resources to store and manage all changeable production data within the system. They are also the UNIX NIS servers - a special capability within SUNOS that provides a central master file for many system oriented files. Each machine is configured identically to provide full backup for each other in case of failure except for the 1/4" tape drive that is not considered critical. These are not CADS machines (i.e. not licensed to run the CV CADDS software), but can run all other software. Generally, operations and system management are performed through these machines. Although clients are allowed, none are usually configured. Specifically, the Data Centers consist of the following:

Base Machine (2 each)

1 ea. SUN Model 4/490 (CV Model 45S)
1 ea. 32 Megabytes Central Memory
2 ea. 1.2 Gigabyte IPI Disk Drives
1 ea IPI Disk Controller
1 ea. 1600/6250 BPI Tape Drive
1 ea. CDROM Player
1 ea. 1/4" Cartridge Tape Drive (on 1 base machine only)
1 ea. 8 mm Cartridge Tape Drive
1 ea. Optical Read/Write Disk
1 ea. SUN Bit-mapped System Terminal

Special Peripherals (per Base Machine)

5 ea. Dual Ported 1 Gigabyte SMD Disk Drives
2 ea. SMD Disk Controller

Servers (19 each)

Servers are of either the SUN 4 (SPARC) or SUN3 (Motorola) technologies (see figures A1 and A2, respectively). Only the SUN 3 platform was available at the writing of the last report; however, we are now installing, and intend to upgrade to, the SPARC technology. It is considerably faster, contains no CV hardware dependencies, less expensive to maintain and considered more reliable.

Servers provide a disk resource for diskless clients, i.e. OS, applications and disk space is provided to each diskless client over the Ethernet. Specifically, these servers consist of the following:

Base SUN 3 Server (16 each - including 1 spare)

1 ea. SUN Model 3/260 (CV Model 34S)
1 ea. 32 Megabytes Central Memory
1 ea. 515 Megabyte Disk Drives
2 ea. 736 Megabyte Disk Drives
1 ea SMD Disk Controller
1 ea VT320 Alphanumeric System Terminal
1 ea. Second Ethernet Interface

Other Peripherals

Generally, None

Beta Server (1 each)

1 ea. Base SUN 3 Server
1 ea. 800/1600 BPI Tape Drive and Controller
2 ea. Additional 736 Megabyte SMD Disk Drives
Lot Additional Test Hardware as Required

Base SUN 4 Server (4 each)

1 ea. SUN 4/490 (CV 45S)
1 ea. 32 Megabytes Central Memory
2 ea. 1.2 Gigabyte IPI Disk Drives
1 ea IPI Disk Controller
1 ea. VT320 Alphanumeric System Terminal
1 ea. Second Ethernet Interface

Development Server (1 each)

1 ea. Base SUN 3 Server
1 ea. 800/1600 BPI Tape Drive and Controller
2 ea. Additional 1.2 Gigabyte IPI Disk Drives
Lot Additional Test Hardware as Required

Clients (97 each)

Clients are of either the SUN3 (Motorola) or SUN 4 (SPARC) technologies. Only the SUN 3 platform was available at the writing of the last report; however, we are now installing, and intend to upgrade to, the SPARC technology. Clients may be diskless (required servers to provide disk space, applications and operating system), dataless (local disks for operating system and swap space, otherwise operating as diskless), or stand-alone (a diskfull system that can operate independently of servers,

but may also use network resources for data storage, applications, libraries, etc.). In general, diskless is favored considering both price, system management efficiency and security implications. A few dataless and stand-alone clients are being considered for some special situations; the disks are removeable and must be removed from the system each night and locked in an approved vault or safe. Two stand-alones are provided as "loaners" when required for a test or training effort, or located in areas where the CADS network does not yet operate. Specifically, these clients consist of the following:

Base SUN 3 Diskless Client (74 each)

1 ea. SUN Models 3/140, 3/160 or 3/60 (CV Models 32CV, 32C or 33C)
1 ea. 16 Megabytes Central Memory

Base SUN 4 Diskless Client (27 each)

1 ea. SUN SPARCstation 1+ (CV Model 42C)
1 ea. 16 Megabytes Central Memory

Other Peripherals

1 ea. 760 Megabyte Disk Drive (for Datafull Machines)
1 ea. Additional 760 Megabyte Disk Drive (for Stand-Alone Machines)
1 ea. Optional Laserwriter (Printer) or Plotter

I/O Peripherals

The term "I/O Peripherals" refers to the printers, plotters and other equipment on the CADS network that produces hard-copy output. The output may be paper, vellum or mylar, or may be 8 mm video tape cartridges, film and magnetic tape/diskettes. The large and small

electrostatic plotters are connected to the CADS Backbone; other peripherals are connected to local clients. These connections are used since large data files are generally transferred to the plotters; data for other peripherals is either quite small in size or is generated directly by the client involved.

Network Based Peripherals

2 ea. 36" Color Versatec Electrostatic Plotter Interfaced via VPS 890's
2 ea. 11" Black & White Versatec Electrostatic Plotter Interfaced to SUN 3 Data Centers

Client Connected Peripherals

1 ea. Thermal Plotter ("A" and "B" size paper and vu-graphs)
1 ea. Screen Based Camera (Polaroid, vu-graphs and 35mm film)
1 ea. Thermal Plotter ("A" and "B" size paper and vu-graphs
----- Laserwriters ("A" size paper output) (Quantity as required)
1 ea. COM (create and/or scan aperture cards)

Unclassified Network

Data Center (1 each)

The Unclassified Data Center provides the same functions as the Classified Data Center; however, mirroring of data is not provided. Currently, the entire network consists of SUN 3 technology, but this is not a requirement. Specifically, the Data Centers consist of the following:

Base SUN 3 Data Center (1 each)

1 ea. SUN Model 3/260 (CV Model 34S)
1 ea. 32 Megabytes Central Memory

1 ea. 515 Megabyte Disk Drives
2 ea. 736 Megabyte Disk Drives
1 ea SMD Disk Controller
1 ea. VT320 Alphanumeric System Terminal

Special Peripherals (each Data Center)

2 ea. 736 Megabyte Disk Drive
1 ea. SMD Disk Controller

Servers (1 each), Clients (4 each) and I/O Peripherals

Servers and clients on the unclassified network are identical to the SUN 3 servers and clients on the classified network.

Sandia, Livermore Functional CADS Configuration

SPARCserver Configuration - FY '91

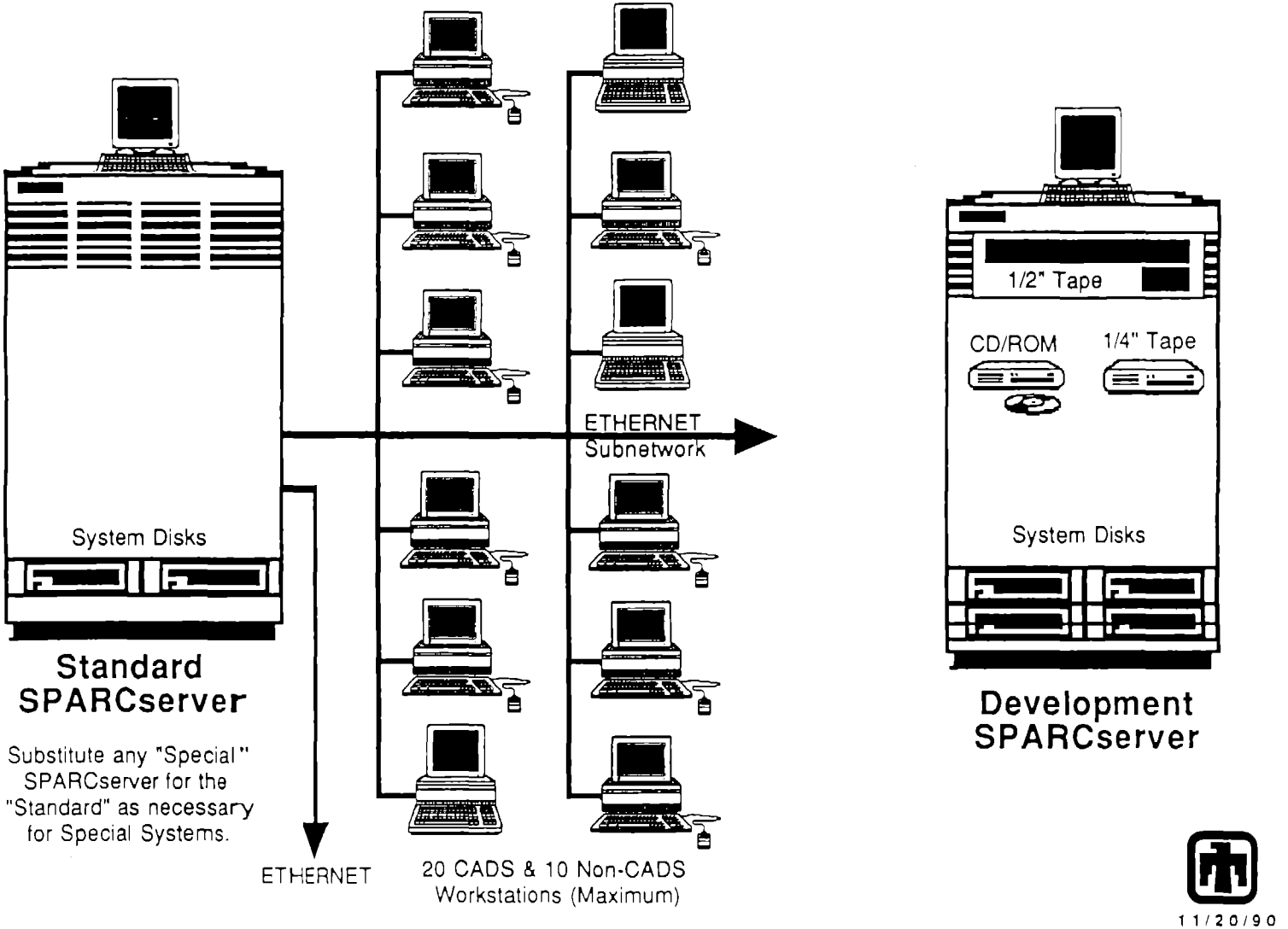

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Figure 9 SPARCserver Configuration - FY91

Sandia, Livermore Functional CADS Configuration

MC68000 Server Configuration - FY '91

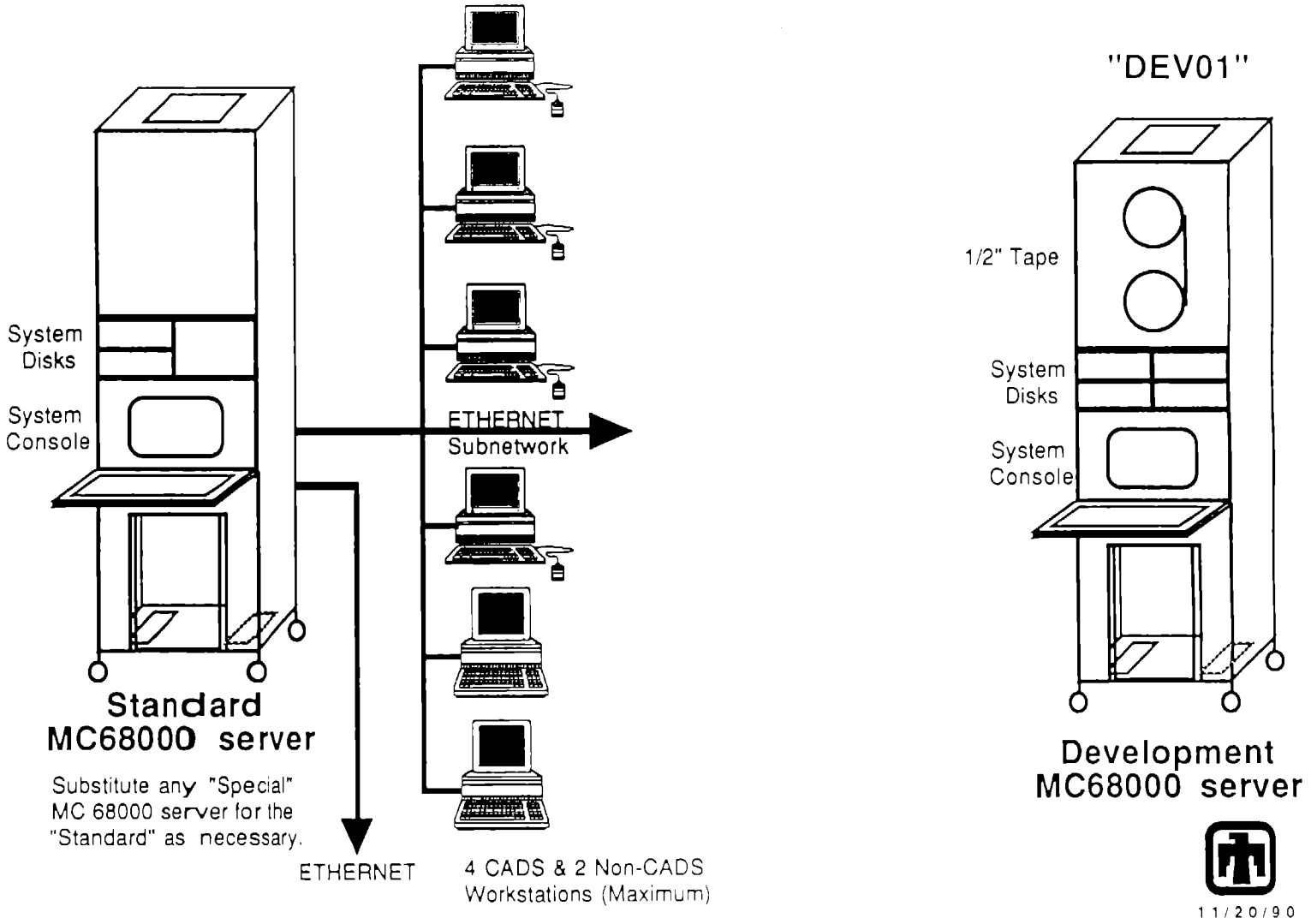

Figure 10 MC68000 Server Configuration - FY91 (47)

Appendix B

CADS Software Components

There are three major software packages on the CADS, the SUNOS operating system, CADDS™ mechanical design definition package and THEDA™ electrical design package. To ease the workload of system/operations management and the user population, several add-on software packages have been purchased and added to the system; these are generally limited to word processors, spreadsheets, etc. In addition, several in-house applications have been written to enhance the unique requirements of SNL, Livermore. At this writing, one security modification has been made to the OS, and none have been made to CADDS, THEDA or external add-on packages.

SUNOS™ Operating System

This is the standard UNIX based operating system obtained from SUN Microsystems through CV. It is based on the original AT&T UNIX system as improved over the years and includes the University of Berkeley and SUN Microsystems enhancements. It also contains some UNIX System V enhancements since AT&T UNIX and SUNOS are expected to converge this year at System V. CADDS and THEDA run under SUNOS exclusively at this time.

UNIX is usually considered a class "D" security system according to the DOD "Orange Book." A version of SUNOS known as MLS is now being tested for certification by NCSC at a "B1" level. Several of the "B1" security features will be available as "add-on's" to the current SUNOS giving it an uncertified level of "C2" as required by DOE. We are involved in the definition of needs with SUN and will use these capabilities as the only modifications to either the CADS OS or applications code. This practice is consistent with the requirement that we do not enhance our capabilities by modifying vendor source unless absolutely necessary.

CADDS™, THEDA™ and CV-NC™ Applications Software

The primary mechanical application software package used on CADS is the Computer Aided Design and Drafting System (CADDS) provided by CV. This is a state-of-the-art mechanical design definition system incorporating both two and three dimensional entities including surfaces and solids modeling. It also includes finite element modeling (meshing and analysis) software and interfaces to external packages, plant engineering enhancements including piping and mapping applications and analysis software and interfaces to external analysis packages. The primary electrical (PCB) application software package provided by CV is THEDA. The primary manufacturing application software package used on CADS is the Computervision Numerical Control (CVNC) provided by CV.

Third Party Applications

SUNOS simulates a "DOS" environment within the operating system allowing us to use most software packages available to IBM (or compatible) personal computers. The primary package used at Livermore is MSWORD, a word processing package. This package is compatible with that used by Organization 8000 as its internal standard.

FoxBase™ is an inexpensive data base manager for the system. It is similar in functionality to DBASE III+, but operates under DOS on IBM PC equipment, SUN workstations under UNIX and on MacIntoshs. Several applications are in use including an inventory control program to manage CADS equipment, equipment down time recording and management.

The "Island Graphics" Write/Paint/Draw packages are used for office automation capabilities directly from UNIX. The packages are similar to the equivalent MacIntosh based MacWrite/MacPaint/MacDraw software. Converters are available with these packages to interface with the "Mac" packages and MSWORD among others. The "SCO 20/20" package is available for spreadsheet type applications; WINGS is also being considered. At least one project management package will be made

available. All but the last two packages are currently in-house and will be installed as soon as possible.

While other CAD applications are not considered viable with CADS, we do support the storage and operation of AutoCAD; consequently, we will maintain licenses and converters to bi-directionally translate CADDS and AutoCAD. Such conversions are made on a "best effort" basis only and 100% conversion is not guaranteed. We expect to improve the AutoCAD-CV interface.

Several other programs are currently in-house and will be installed as soon as practical. These are "OGP," a program to detect and correct the owner, group and protection on files and catalogs; "AutoLogout," automatically "logs-out" an interactive program after 15 minutes of inactivity; and "Compare Part," compares two CADDS data bases and/or drawings and creates a third file of differences. The standard SUN "OPENLOOK" and Visix "LOOKING GLASS" user interfaces will be available upon installation of CADDS Revision 6.

Interleaf publishing software is available for use in the Text & Graphics functions involved with writing and publishing specifications. This is a de-facto standard among the NWC agencies for exchanging and preserving such data. Since it is on the system, it is also available to other users if needed.

FXIGES and "Preview" software have been added to facilitate transfer of information to NWC production agencies. We currently perform DOEDEF translations on the CCF VAXs, but expect that function to move to CADS in the near future.

Appendix C

Repackaging of SUN 3 Servers

When comparing the available floor space in the CCC with the standard floor space required by 20 SUN 3 servers, disks and system consoles, it was evident that there was a serious space problem if we continued using the standard CV packaging. To fit all the equipment desired into the available floor space, we elected to repackage the CV equipment incorporating as much of the non-CV peripherals as possible. Since CV did not then provide a rack mount configuration, we designed our own. CV agreed to this process providing they reviewed the new packaging and were on hand for the first installation. A complete description of the units, hardware purchased and reasons for the repackaging is found in Reference 3.

The servers (equipment to be repackaged) reside in the CCC, a computer environment where power, air conditioning and primary fire control are provided from beneath a raised floor. The cabinets chosen was a standard 19" electronic rack with cutouts in the bottom of the rack to allow underfloor air to flow from cutouts in the raised flooring and an exhaust fan on top to insure adequate air flow as shown in Figure C1. The unit has side panels, a rear door and standard filler panels on the unused areas of the front. A list of equipment used in each server is shown in Table C1.

Repackaged Client CADDServers consist of the following:

1 each Computervision CADDServer, Model 34S includes:
- CPU (Motorola 680x0) - SUN 3/260 equivalent
- 32 Megabytes Central Memory
- Second Ethernet Controller
- Graphics Processing Unit or Graphics Accelerator Board

1 each 451 Disk Controller
1 each CDC 515 Megabyte Disk Drive
2 each CDC 736 Megabyte Disk Drive
1 each DEC VT320 Terminal

1 each 77" high Electronic Cabinet
1 each Magnetic Tape Drive & Controller (beta server)
1 lot Additional Disk Storage (beta server)
Each cabinet has rear door and sides, rollers, anti-tip bars, cutouts in bottom and top, fan, front shelf, internal shelf for monitor, various size front panels, bottom panel with cutout for CADDServer, power strip (inside rear) with a master power switch on the front of the server panel.

The skins and wheels of the CV 34S server were removed and the unit was bolted to the base of the rack. Air flow is provided on both sides of the unit. The cabinets are mounted on wheels since they are required to move forward and back because CV requires access to the sides of their servers as well as the front and rear. Each server is fitted with a its own disk controller and 32 megabytes of memory.

Standard internal and external shelves are mounted above the server unit to accommodate a DEC VT320 terminal serving as a system console. This type of console is adequate since its primary uses are to field system error messages and for loading software. The server disks, consisting of two CDC 736 megabyte disks and one CDC 515 megabyte disk, are mounted above the system console. Servers to be used for development or in support of beta site activities are equipped with additional disk storage (external to cabinet) and a magnetic tape drive mounted above the disks.

SUN 3 CADDServer Configuration

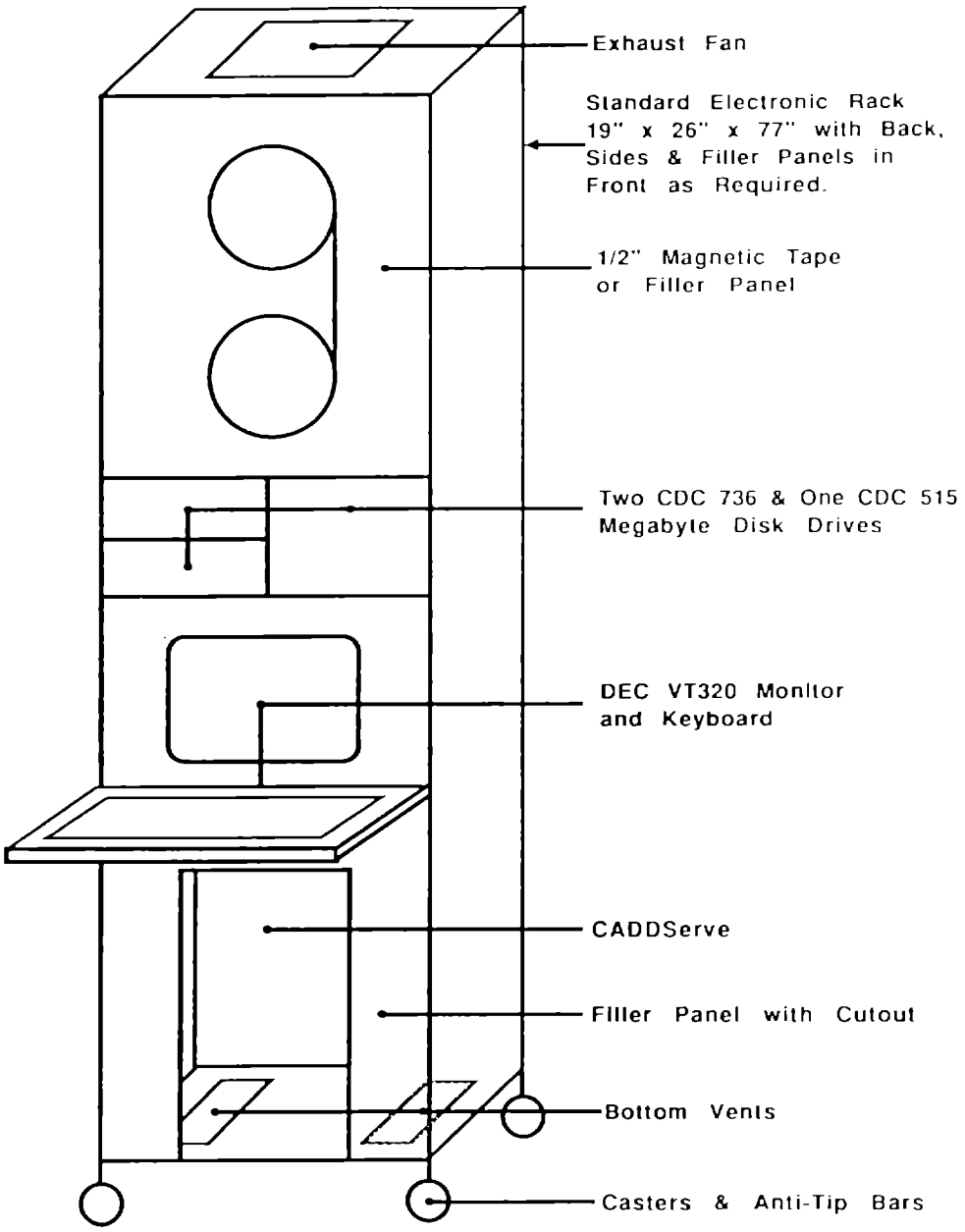

Figure 11 SUN 3 CADDServer Configuration

GLOSSARY

Note to readers of report SAND88-8941 - The terms "file server," "client server," and "diskless client" have been replaced by the terms "data center," "server," and "client" respectively in this report.

AEC - Architectural, Engineering and Construction.
AT&T - Registered Trademark, American Telephone & Telegraph
CADDS - Registered Trademark, Computer Aided Design and Definition System owned by Computervision Corporation.
CADDStation - A SUN Microsystems workstation licensed to perform CADDS™ work.
CADS - Computer Aided Definition System. The system used at SNL, Livermore.
CAE - Computer Aided Engineering.
CALS - Computer Aided Logistics System. A DOD information processing standard.
CAM - Computer Aided Manufacturing.
CCC - CADS Computer Center at SNL, Livermore.
CCF - Central Computer Facility. Primary computer center at SNL, Livermore
CDIF - CADS Definition Information Form.
CDROM - Compact Disk Read Only Memory.
CDS - Registered Trademark, Computervision Distributed System. Usually followed by a number indicating the type of system.
CFS - Central File System. A terabit class storage system residing in the CCF.
CISC - Complex Instruction Set Computer.
Client - A workstation that relies, at least in some part, on a server for data or services. It is usually "diskfull" or "diskless."
COM - Computer Output Microfilm.
CPU - Central Processing Unit.
CV - Registered Trademark, Computervision Corporation. The primary supplier of CAD equipment at SNL, Livermore.
Data Center - A server on the CADS network that provides data storage and management services for users and systems/operations personnel. This was called a "file server" in the previous report.
Dataless - A Diskfull workstation that contains no user data. It contains the operating system, swap space and, optionally, application programs.
Datafull - A Diskfull workstation that contains user data in addition to the operating system, swap space, applications, etc.
DELNI - Registered Trademark of Digital Equipment Corporation. A product of Digitial Equipment Corporation that provides up to 8 ethernet connections via an "Ethernet Multiplexor." The product can stand alone as a mini network or be connected to a standard ethernet cable as part of a larger network.
DESNQ - Registered Trademark of Digital Equipment Corporation. A data encryption and decryption device for Ethernet style networks.
Diskfull - A SUN Microsystems workstation or CADDStation that has its own "local" disk storage in addition to being able to use storage on other servers or workstations.
Diskless - A SUN Microsystems workstation or CADDStation that has no "local" disk storage. It strictly uses storage on other servers or workstations.
DOD - Department of Defense
DOE - Department of Energy - a department of the U.S. Government
DOEDEF - A subset of IGES entities supported by NWC agencies.

Down - A term indicating that some equipment is malfunctioning to the point where it is totally unusable.
EDM - Engineering Data Management.
EIMS - Engineering Information Management System. An IBM based system at SNL, Livermore used to manage drawing control and non-graphical information about drawings.
Ethernet - A network communications protocol as defined by the IEEE standard. It is used by the CADS network to communicate among appropriate equipment. operating at 10 megabits per second using the TCP/IP protocol
FDDI - Fiber Data Distribution Interface. A fiber optic upgrade that allows Ethernet communication at 100 Megabits per Second.
Giga - A prefix indicating "one billion".
Helios - Registered Trademark, Helios, Inc., a division of PIICEON Inc.
IBM - Registered Trademark, International Business Machines
IEEE - Institute of Electrical and Electronics Engineers.
IGES - Interactive Graphics Exchange Specification
I/O - Input and/or Output
Instaview - Registered Trademark of Computervision Corporation. An older style workstation that operates on the CV CDS 4000 equipment.
LAN - Local Area Network
Mega - A prefix indicating "one million"
MicroCADDS - Registered Trademark, Personal Computer based CADDS from Computervision Corporation.
MIPS - Million Instructions per Second.
MLS - Multi-Level System. A "B1" rated secure operating system from SUN Microsystems.
ML - Material List
MS-DOS - Registered Trademark, MicroSoft Inc., Disk Operating System.
Motorola 680x0 - A CPU manufactured by Motorola, Inc. The basic CPU chip for the SUN 3 platform. The specific version currently used in CADS is the 68020, but previous equipment used the 68000 and 68010 versions. A 68030 and 68040 are also available in the marketplace.
NC - Numerical Control(led).
NCSC - National Computer Security Center
NFS - Registered Trademark, Network File System from SUN Microsystems.
NIS - Network Information System. A SUNOS methodology (formerly called "Yellow Pages") whereby files can be centrally located and appear to be local for usage.
NWC - Nuclear Weapons Complex
NWCNET - Nuclear Weapons Complex NETwork
Orange Book - An NCSC Document defining computer security levels appropriate to government systems and the requirements for each
OS - Operating System
PCB - Printed Circuit Board(s)
PE - Plant Engineering
Prime/CV - See CV.
RAN - Random Access Network. The unclassified network at SNL, Livermore.
RISC - Reduced Instruction Set Computer.
RPM - Registered Trademark, Raster Processing Machine from Versatec Inc.
R/W - Read/Write.
Scripts - Programs written to use OS commands.
Server - A machine that provides disk space and computational services to other machines.
SMD - Storage Module Device. A type of disk storage and interfacing techniques.
SNL - Sandia National Laboratories

SNL,A - Sandia National Laboratories, Albuquerque
SNL,L - Sandia National Laboratories, Livermore
SPARC - Scalable Processor ARChitecture. The basic CPU for the SUN 4 platform.
Stand-Alone - A "datafull workstation" having sufficient peripherals and resources to operate independent of any server. If it is connected to the network to use additional data and services, it is called a "datafull" workstation.
SUN - Registered Trademark, SUN Microsystems Inc.
SUN 3 - SUN Microsystems hardware architecture based on the Motorola 680x0 technology. See Motorola 680x0.
SUN 4 - SUN Microsystems hardware architecture based on the SPARC technology.
SUNIPC - Registered Trademark, SUN Integrated Personal Computer.
SUNOS - Operating system supplied by SUN Microsystems based on AT&T UNIX modified by SUN and using University of Berkeley enhancements.
Terra - A prefix indicating "one trillion".
THEDA - Registered Trademark of CV. Their electrical CAD product.
UNIX - Registered Trademark of AT&T. A multiuser, networked operating system.
UPS - Uninterruptable Power Supply. Includes power conditioning.
VAX - Registered Trademark of Digital Equipment Corporation.
Versatec - Registered Trademark, Versatec Inc.
WBCN - Wide Band Communications Network.
Workstation - One of a number of intelligent terminals containing at least a CPU, memory and the ability to connect to other workstations, systems and terminals.
WORM - Write Once/Read Many. An optical disk technology.
WR - War Reserve

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