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RELEASE NOTICE

UNICOS 5.0

UNICOS® 5.0 Release Notice

UC-05.0-UAD-RN

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1. Introduction

This publication describes the features, capabilities, and documentation of the UNICOS 5.0 release.

In addition to new features included in the UNICOS 5.0 release, enhancements have been made to several existing features, including the tape subsystem, security, and accounting features. This UNICOS release requires TCP/IP, which is licensed separately from UNICOS.

With this UNICOS release, emphasis has also been placed on providing "COS functional equivalence." This does not mean that UNICOS will "look like COS," nor that it will "do things the way COS does." Implementations such as these would almost certainly compromise the benefits inherent to UNICOS. Rather, the UNICOS 5.0 release provides a means for sophisticated users of COS to perform their work under UNICOS with at least the same degree of flexibility and control that they have enjoyed with COS. It is Cray Research's belief that the UNICOS 5.0 release offers such users not only "COS functional equivalence," but also a wealth of new features and facilities that could not be provided with COS.

The UNICOS operating system is derived from the AT&T UNIX System V operating system. UNICOS is also based in part on the Fourth Berkeley Software Distribution (4.3BSD) under license from The Regents of the University of California. UNICOS provides most of the standard UNIX system calls and commands, as well as additional capabilities that enhance performance on Cray computer systems.

This release notice provides the following information about the content of the UNICOS 5.0 release:

- A product announcement
- A description of the release package, including hardware and communications supported

- Descriptions of software enhancements
- Support information, including a description of the documentation and training available supporting this release and COS-to-UNICOS migration information
- Licensing and ordering information, including order forms
- Compatibility issues between this release of UNICOS and the preceding UNICOS release that users should note
- An evaluation of the achievement of meeting the goals of this release, including results of the System V Verification Suite (SVVS) Base System tests

This release notice is a public document; it is included with the UNICOS 5.0 release package. The *UNICOS 5.0 Release Notice* is also available through the Cray Research, Inc. (CRI) Distribution Center in Mendota Heights, MN.

2. Product Announcement

Cray Research Announces Release 5.0 of the UNICOS Operating System

Release 5.0 of the Cray operating system UNICOS, which runs on any model Cray computer, provides users with functional equivalency for key major features of the Cray operating system COS. In addition to enhancing previous features of UNICOS and adding several new ones, UNICOS 5.0 makes great strides toward a common user interface for all Cray systems.

The UNICOS 5.0 release reflects the continuing commitment of Cray Research to providing its users with a stable, portable, and powerful software environment for both batch and interactive processing.

Hardware supported

UNICOS 5.0 supports all Cray computer systems (with the exception of CRAY-1 systems that do not have an I/O Subsystem [IOS] and that have less than 2 Mwords of memory). Almost all Cray peripheral storage units and communications hardware products are supported as well, as are the Cray Operator Workstation (OWS) and many third-party communications hardware products, including two new ones: LANlord, from Computer Network Technology, and the 1-Gbit/s UltraNet, from Ultra Network Technologies.

Enhancements

In addition to many improvements to the operating system, UNICOS 5.0 contains enhancements for the support of new hardware and for the support of new releases of compilers and assemblers. UNICOS 5.0 also incorporates several new or improved software tools, utilities, and libraries.

Significant enhancements to UNICOS include the following:

- Enhancements to many commands, system calls, and routines
- The user database (UDB), which streamlines the way system administrators access and update user information
- The new data migration feature, which performs general, system-administered file space management
- The UNICOS ~~share~~ scheduling facility, which allows explicit allocation of predetermined, administrator-specified shares of CPU resources on a per-user and per-group basis
- Enhancements to the `crayperf` facility, which allows system administrators to monitor in real time the performance of a Cray UNICOS system through graphical data displayed in a window
- Support for daisy chaining DS-40 Disk Subsystems, which enables doubled maximum storage capacity
- Full support of on-line tape subsystems
- Improved process and job accounting
- Optional multilevel security, providing better protection for sensitive information
- Improvements to the Network Queueing System (NQS)
- Support for the optional Remote Queueing System (RQS), a subset of NQS that runs on UNIX workstations
- User-level disk striping, for faster storage and retrieval of data

Not another one!

- Support for the Autotasking feature of the CFT77 Fortran compiling system on all multiprocessor Cray systems, including CRAY-2 systems
- A powerful new interactive debugger, CDBX, which permits debugging of applications written in any combination of Fortran, C, Pascal, or the Cray assembler CAL
- The initial release of a new source code management system, USM, which provides a powerful set of source maintenance features
- Updated TCP/IP code, based on 4.3BSD
- Support on all Cray systems for UNICOS Network File System (NFS), which allows transparent data access to UNICOS files by processes on remote systems
- The X Window System Version 11, Release 3, which allows output from a Cray system to be displayed on a bit-mapped graphic workstation

Languages supported

UNICOS 5.0 supports the following languages on all Cray computer systems: CFT77 3.0 (Autotasking on CRAY-2 systems requires CFT77 3.1), Cray C 4.1, Cray Standard C 1.0, Pascal 4.0, Cray Ada 1.0, Allegro Common Lisp 1.0, and CAL version 2 release 3.2. The UNICOS 5.0 version of CFT2 is supported on CRAY-2 computer systems. CFT 1.15 BF3 and CFT 1.16 are supported on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems.

Some of these language products are released independently and require separate licensing. Contact your Cray Research representative for more information.

Libraries, products, tools, and utilities

UNICOS 5.0 provides additional assistance for users through new or enhanced libraries, products, tools, and utilities. Expanded libraries include those for Fortran, C, and utilities, and for math, science, I/O, and multitasking routines. New features include enhanced tape and file processing routines, with implicit data conversion of files from IBM and DEC systems. The following commonly used products, tools, and utilities have been enhanced for UNICOS 5.0: UPDATE 5.0; SEGLDR 5.1; FTREF 5.0; and Cray Simulator (CSIM) 5.0. On-line diagnostics have been enhanced for all Cray systems. New diagnostic tests include those that provide additional information about CPUs, memory, networks, and disk or tape units.

Migration

Cray Research is continuing to simplify the process of converting from COS to UNICOS. The Guest Operating System (GOS) feature of COS allows users of multiprocessor CRAY Y-MP, CRAY X-MP EA, or CRAY X-MP systems to run COS and UNICOS concurrently, providing a valuable aid to migration. To help customers make a smooth transition to UNICOS, Cray Research provides a set of enhanced migration tools and a special migration team.

Training and publications

Cray Research offers a full range of training in UNICOS. Courses are available for first-time users, programmers and analysts, system administrators, and scientists and engineers. Special focus courses are also offered.

The UNICOS documentation set includes manuals specific to Cray computer systems, products, libraries, and utilities, and a UNICOS primer and a UNICOS overview for beginning system users. Most of the UNICOS manuals have been updated for release 5.0. Publications that document UNICOS libraries have been reorganized into a single set that pertains to all Cray systems. New publications include

UNICOS Overview for Data Center Managers, publication SG-2053; *UNICOS CDBX Symbolic Debugger Reference Manual*, publication SR-2091; and *UNICOS CDBX Debugger User's Guide*, publication SG-2094. Many manuals are provided on-line, including UNICOS reference information in preformatted files called man (manual) pages.

NOTE: Release 5.0 of UNICOS requires the UNICOS implementation of the TCP/IP protocol, which must be obtained under a separate license from Cray Research.

This product announcement can be ordered separately as PA 8905 from the Distribution Center in Mendota Heights.

The product specifications contained in this announcement and the availability of said products are subject to change without notice. For the latest information, contact the nearest Cray Research sales office.



3. Release Package Description

This section lists the contents of the release package. It also includes a list of Cray software products and language processors provided as part of this release and a summary of hardware and communications supported.

3.1 Release package contents

The release package for UNICOS 5.0 includes the following:

- A set of tapes containing UNICOS source code, essential binary code, and on-line documentation in the form of manual (`man`) pages
- Initial UNICOS installation source code
- For CRAY-2 systems, a set of diskettes (5 1/4 inch), including a customized Foreground Processor, system control console (SCC) code, and bootable kernel
- Cray Research, Inc. (CRI) publications supporting this release (see section 6, "Licensing and Ordering," for the complete list of manuals included in this release package)
- The *UNICOS 5.0 Release Notice*
- Supplemental information provided to Cray analysts for installing the release package

The Transmission Control Protocol/Internet Protocol (TCP/IP) source code is now a requirement for UNICOS. The absence of TCP/IP could seriously impair the functionality of the UNICOS 5.0 release. To receive the UNICOS 5.0 release, customers must be licensed for TCP/IP, which is licensed separately from UNICOS.

This UNICOS release includes a version of the CFT77 compiler used to generate products and libraries that use Fortran; both the binary and source code are included. A CFT77 license is required.

UNICOS Network File System (NFS) source code is included with this package. UNICOS NFS requires TCP/IP.

The encryption/decryption code has changed for this release. If you require the encryption software, it must be ordered as optional software.

A portion of the UNICOS data migration code, called the data migration catalog utilities version 1, is available to customers in binary form only. To receive the data migration catalog utilities with UNICOS 5.0, it must be ordered as optional software. There is no fee for this software and there is no separate license required.

There is a separate license required for the Remote Queueing System (RQS); also, there is a right-to-use charge. A separate RQS installation tape containing build procedures for SunOS RQS and Sun *man* pages for RQS will be released asynchronously. To order RQS see the *Remote Queueing System (RQS) Release Notice* when it becomes available.

On-line manuals are provided in the form of manual pages that use the *man* command to display the documentation; they are formatted and read-only. A source version of on-line *man* pages is available and can be ordered as optional software.

See section 6, "Licensing and Ordering," for all software licensing requirements.

For information on user documentation, COS-to-UNICOS migration, and training provided for this release, see section 5, "Support Information."

NOTE: Sites initially installing UNICOS 5.0 on CRAY-2 computer systems must contact Neill Haggard at the Mendota Heights office at (800) 284-2729 to verify your hardware configuration so the appropriate Foreground Processor binary code can be shipped with your UNICOS 5.0 release package. This is not required for sites upgrading to

UNICOS 5.0 on CRAY-2 computer systems; the proper makefiles, procedure files, and binary definition files are contained in the upgrade package, allowing sites that are upgrading to create their own Foreground Processor.

NOTE: UNICOS software is distributed on magnetic tape only. Sites performing initial installations on Cray computer systems with an IOS using an expander package must obtain the appropriate blank IOS expander channel disk packs to run UNICOS software. Sites with an IOS using an Operator Workstation (OWS) should refer to the *OWS Installation Bulletin* for information on requirements.

3.2 Software products and language processors

As part of this UNICOS release, the following Cray software products and language processors are provided:

- APLM 3.1, ADSTAPE 2.2, and BIND 2.2 (for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems)
- AUDPL 5.0
- Cray C 4.1 compiler used for generating products and libraries that use C
- CAL Assembler Version 2, release 3.2
- CDBX debugger
- CFT2 5.0 compiler (for CRAY-2 computer systems)
- CFT77 compiler used for generating products and libraries that use Fortran
- Cray Simulator (CSIM) 5.0
- DEBUG 5.0 debugger
- DRD and DDA 4.3 debuggers
- **fmp** (replaces PREMULT)

- Fortran, C, and Pascal library support
- FTREF 5.0
- MODECKS 5.0
- MTDUMP 5.0
- Network Queueing System (NQS)
- **nmodex** 5.0
- **nupdate** 5.0
- On-line diagnostics
- Pascal 4.0 compiler
- PLCOPY
- **premult** (calls **fmp**)
- Remote Queueing System (RQS), if licensed and ordered
- SEGLDR 5.1
- SEP communications package (for CRAY-2 computer systems)
- SORT
- TCP/IP
- UNICOS 5.0 commands and libraries
- UNICOS 5.0 data migration catalog utilities, if ordered
- UNICOS 5.0 on-line **man** pages
- UNICOS 5.0 operating system kernel
- UNICOS Network File System (NFS)
- UNICOS Source Manager 5.0 (**sm** command)
- UNICOS Station Call Processor (USCP) 5.0
- UPDATE 5.1



3.3 Cray hardware supported in this release

The UNICOS operating system executes on all Cray computer systems. However, CRAY X-MP and CRAY-1 computer systems require a minimum of 2 Mwords of memory and an I/O Subsystem (IOS).

3.3.1 CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems

The peripheral hardware currently supported under UNICOS for the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems is as follows:

- Back-door channel to the SSD solid-state storage device from the Auxiliary I/O Processor (XIOP) on the IOS (not available on Model A or some Model B I/O Subsystems)
- DD-29, DD-39, DD-49, and DD-40 (all configurations) disks accessed through the IOS using the Buffer I/O Processor (BIOP) or the Disk I/O Processor (DIOP)
- Expander channel peripherals (disk, printer, tape, and chronolog)
- Operator Workstation (OWS) (not supported with Model A or Model B I/O Subsystems)
- Front-end interface (FEI-1 and FEI-2) connection through the IOS using the Master I/O Processor (MIOP)
- Network interface (FEI-3) through the IOS using the Master I/O Processor (MIOP)
- High-speed External (HSX) Communications Channel through the IOS (Model C or Model D only), including stride processing (XIOP standard location for HSX)
- Magnetic tapes using a block multiplexer controller in the XIOP. For BMC-4 controller: IBM 3420-compatible tapes, IBM 3480-compatible tapes in 3420 emulation mode (with field upgrade to BMC-4). For BMC-5 controller: IBM 3420-compatible tapes, IBM 3480-compatible tapes in 3420 emulation mode or data-streaming mode (3.0 Mbyte/s channels). For STK4480 cartridge tapes: IBM

3480-compatible as for BMC-5 controller, plus with 4.5 Mbyte/s channel mode option.

- NSC HYPERchannel connection through the IOS (both A series and DX series of NSC HYPERchannel equipment) using the MIOP
- Support for Model D IOS
- SSD solid-state storage device connected to the CPU through a very high-speed channel, or via a high-speed channel on CRAY-1 S systems
- Support for dual I/O Subsystems on CRAY Y-MP series computer systems (Model C or Model D IOS only)
- Computer Network Technology Corporation (CNT) LANlord connections
- Ultra Network Technologies, Inc. UltraNet 1-Gbit/s Network (requires Model C or Model D IOS and an HSX on the XIOP)

UNICOS currently supports the following peripheral hardware for CRAY X-MP EA 14/se, CRAY X-MP EA 116/se, and CRAY X-MP 14/se computer systems:

- DD-39 disks using the BIOP
- Expander channel peripherals
- Operator Workstation (OWS)
- FEI connections to a front-end system (as for all CRAY X-MP computer systems) through the IOS using the MIOP
- FEI network interface (FEI-3)
- NSC HYPERchannel connection (both A series and DX series of NSC HYPERchannel equipment) using the MIOP
- CNT LANlord connections
- On-line tapes and HSX on the XIOP (as for all CRAY X-MP computer systems)
- Ultra Network Technologies, Inc. UltraNet 1-Gbit/s Network (requires Model C IOS and an HSX on the XIOP)

3.3.2 CRAY-2 computer systems

UNICOS currently supports the following hardware for CRAY-2 computer systems:

- DD-29, DD-49, and DD-40 disks
- Operator Workstation (OWS)
- Front-end interface (FEI-1 and FEI-2) connection through FEs
- Network interface (FEI-3) connection to the VME backplane
- Low-speed channels (LSPs)
- NSC HYPERchannel connections (both A series and DX series of NSC HYPERchannel equipment)
- IBM 3480 or 3420 tape subsystems (or compatible equipment) connected to a Cray Tape Channel (CTC) Model 1, 2, or 4
- High-speed External (HSX) Communications Channel support
- Computer Network Technology Corporation (CNT) LANlord connections
- Ultra Network Technologies, Inc. UltraNet 1-Gbit/s Network

3.4 Communications supported in this release

UNICOS supports the TCP/IP, UNICOS NFS, X Window System Version 11, release 3, SUPERLINK 2.2, and UNICOS USCP communications protocols. USCP supports Apollo, VM, VMS, MVS, NOS, NOS/VE, and NOS/BE stations. UNICOS TCP/IP is now based on extensions from 4.3BSD, and it provides file transfer and interactive access between Cray computer systems and other systems running TCP/IP.

4. Software Enhancements

This section of the *UNICOS 5.0 Release Notice* describes the new software features and enhancements provided in this release.

CAUTION: Source modifications to the UNICOS kernel can affect the level of support provided by Cray Research, Inc. Customers and Cray site analysts are cautioned about making changes to the UNICOS kernel. When on-site modifications are necessary, we encourage making such modifications at the library or user level rather than at the kernel level. The modular architecture of UNICOS allows most site-specific modifications to be made at the user level.

The I/O Subsystem (IOS) is Cray proprietary; local modifications are strongly discouraged and can severely affect both performance and the level of support provided by Cray Research, Inc.

4.1 Software enhancements to support new hardware

This subsection briefly describes the UNICOS 5.0 software enhancements that support new hardware. Where the IOS 5.0 release is required, it is noted.

4.1.1 DS-40 Disk Subsystem daisy-chaining

All Cray computer systems running UNICOS 5.0 now support multiple DS-40 units that have been daisy-chained together. Daisy-chaining describes the configuration where two DS-40 units are accessed through the same I/O channel and DC-40

controller. This allows for twice the maximum storage capacity per I/O channel; however, the data transfer rate remains that of one I/O channel because of the need to share the I/O channel.

For Cray systems configured with an IOS, see the *IOS 5.0 Release Notice* for additional information.

4.1.2 CNT LANlord connection

The CNT LANlord 6000 connection series provides an interface between Cray computer systems and the other hosts on the local area network (LAN). This connection allows for high-speed data transfer among mainframes and performs the functions of the OSI physical and data link layers. The Cray host interface connects to a low-speed (100-Mbit/s) channel on Cray computer systems.

The LANlord product is functionally compatible with the NSC A130 HYPERchannel host adapters. A CNT network was configured and tested by the Network Development Group in Mendota Heights from both a CRAY-2 and a CRAY X-MP system with connections to an IBM-compatible system running the VM operating system, a VAX system, and Sun Workstations. No software changes were made to any A130 HYPERchannel device drivers in any of the systems. Several functional tests and performance tests were executed running a variety of station connections and TCP/IP tests.

Based on initial tests by the Network Development Group, CNT performance is equivalent with NSC A130 connections. Note that NSC and CNT adapters cannot be intermixed on the same trunk.

In addition, the CNT 8023 connection provides an IP router capability that attaches directly to the Cray low-speed channel. This product provides two or four Ethernet connections and has a Cray interface that is compatible with the NSC A130 device support.

For Cray systems configured with an IOS, see the *IOS 5.0 Release Notice* for additional information.

4.1.3 NSC HYPERchannel connection

All Cray computer systems now support both the A series and the DX series of NSC HYPERchannel equipment. On CRAY-2 computer systems, the DF module is required to support the HYPERchannel N130 Adapter. No hardware changes are required on CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP computer systems; the DX adapter attaches to the low-speed channel on the Master I/O Processor (MIOP) of the IOS. A required new driver (available in the IOS 5.0 release) provides improved performance; see the *IOS 5.0 Release Notice* and the *Cray 12Mbyte Interconnect Protocol Driver Technical Note*, publication SN-0314, for additional information.

The NSC HYPERchannel DX product line (including the Cray N130 adapter and EN641 IP router) allows integration of different networks, including HYPERchannel-50, HYPERchannel-10, and Ethernet.

4.1.4 UltraNet support

Ultra Network Technologies markets a family of high-performance networking products that connect supercomputers, mini-supercomputers, and workstations in a network with a total bandwidth of 1 Gbit/s. The UltraNet system is planned to support a wide range of computers, including systems from Cray Research, Inc., Convex Computer Corporation, Alliant, Sun Microsystems, Inc., and Silicon Graphics.

The UltraNet system is a product of Ultra Network Technologies. Cray Research, Inc. is working closely with Ultra Network Technologies to ensure the UltraNet system can be installed properly on most Cray computer systems running either the UNICOS 4.0 or 5.0 release. The High-speed External (HSX) Communications Channel is the Cray interface to the UltraNet system. For Cray systems configured with an IOS, the *IOS 5.0 Release Notice* contains information about UltraNet system testing and connections through the HSX.

4.1.5 Operator Workstation

Cray computer systems running UNICOS 5.0 can also support the Operator Workstation (OWS). The OWS is a VME-based microcomputer running the UNIX operating system. The OWS replaces the IOS peripheral expander chassis on Cray systems that include an IOS and also replaces the system console on these Cray systems. (The IOS 5.0 release and IOS Model C or higher are required.)

Enhancements have been made to allow better performance and increased functionality. See the *OWS 1.0 Release Notice* for additional information.

4.1.6 Disk offloading support

This release supports disk offloading for all Cray computer systems. Physical devices can be marked "read only," inhibiting further file allocation. Files can now be removed from the device and saved in another designated area when the device is having hardware problems.

4.1.7 Disk striping for CRAY Y-MP and CRAY X-MP EA computer systems

The disk striping capability has been enhanced to also reside in the Cray mainframe, improving I/O performance and supporting dual I/O Subsystems. The possible striping factor has been increased to 15 for all disk types, using mainframe striping.

4.1.8 Model D I/O Subsystem support

The Model D IOS allows two high-speed channels to be configured per I/O Processor (increased from one channel on the Model C IOS).

One high-speed channel may be connected to the mainframe; the second may be connected to the SSD solid-state storage device for use as a back door. In the IOS 5.0 release, disks

and the HSX utilize the back door. The Model D IOS also allows configuration of a low-speed channel to each I/O Processor, and commands may be sent via either the MIOP or to the individual I/O Processor. This feature must be specifically enabled on the mainframe in UNICOS 5.0, and it requires the IOS 5.0 release.

4.1.9 Low-speed channel control for CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP computer systems with an IOS

This release provides the capability to turn selected communications channels either on or off on the MIOP from the Cray mainframe using the UNICOS `netconf` operator command. These channels must use the N-packet interface (NSC, FEI-3, or VAX-BI).

4.2 Enhancements to the operating system

This subsection describes operating system enhancements for the UNICOS 5.0 release.

4.2.1 Tape subsystem

The UNICOS tape subsystem runs on Cray computer systems configured with an IOS or on CRAY-2 systems configured with a Cray Tape Controller (CTC). This tape subsystem makes it possible to store extensive amounts of data while using the computational power of a Cray computer system for data analysis and large-scale problem solving.

The following enhancements have been made to the UNICOS tape subsystem for this release:

- Concatenated tape files provide the capability to read a group of tape files in a user-specified order as though they are one large tape file.

- Device failure recovery allows a tape volume to be moved to a new device upon discovery of a failed tape device.
- The multifile access without volume unload enhancement allows the access of multiple files on a single volume without a volume unload between file requests.
- Tape volumes terminated by a single tape mark can be read.
- Tape device accounting has been added.
- User end-of-volume (EOV) processing, which allows the user to gain control at EOV, has been added. **NOTE:** For CRAY-2 systems only, this enhancement was not fully completed for this release; any site wishing to use this enhancement should contact the UNICOS Software Development Group in Mendota Heights before attempting to use it.
- Automatic volume recognition (AVR) allows the operator and tape subsystem to recognize the presence of tape volumes mounted before the actual `tpmnt` request made by a user.
- For systems running AVR, a new feature disables the automatic unload of tapes at release time; this can be done by an operator with the new `-n` option of the `tpconfig` command or by the user with the new `-u` option of the `tpmnt` user command.
- The volume serial number (VSN) list in a file permits a list of VSNs to reside in a file and be retrieved with a `tpmnt` user command.
- Tape positioning using BACKSPACE, SETTP, GETTP (C and Fortran interfaces) SKIPBAD, rewind, and position by block (Fortran interface) were added for CRAY-2 systems and are now supported on all Cray computer systems.
- Foreign dataset conversion, which supports the implicit translation of file structures and type data conversion is now supported on all Cray computer systems. See subsection 4.4, "Enhancements to UNICOS libraries," for formats supported on specific Cray computer systems.

- Front-end tape services through USCP support catalog, librarian, security, and operator console functions have been added. The new **tpcatalog** user command catalogs, recatalogs, or deletes a file in a front-end catalog. **NOTE:** For CRAY-2 systems only, this enhancement was not fully completed for this release; any site wishing to use this enhancement should contact the UNICOS Software Development Group in Mendota Heights before attempting to use it.
- Tape channels, banks, control units, and paths can now be configured using the **tpconfig** administrator command.
- The **tpdev**, **tpset**, and **tpu** administrator commands have been added to this release: **tpdev** displays the current tape equipment configuration and status; **tpset** sets features for the tape subsystem; and **tpu** unloads tape devices for automatic volume recognition (AVR). Also, the **tapestart** administrator command has been added for CRAY-2 systems only; the **tapestart** command starts the tape and message daemons. For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, the **tpbm** command has been added; the **tpbm** command displays operator information about tape devices.

The following publications contain documentation relating to the UNICOS tape subsystem:

- *UNICOS Tape Subsystem User's Guide*, publication SG-2051
- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS User Commands Ready Reference*, publication SQ-2056
- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022

- *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079
- *UNICOS Macros and Opdefs Reference Manual for CRAY-2 Computer Systems*, publication SR-2082
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014

4.2.2 Accounting

The accounting feature has been enhanced to provide an interface that allows system daemons to report process and job accounting information.

The CRAY-2 version of the MEMINT memory integral has been modified in `cmd/acct/acctdef.h`, making MEMINT equivalent (the value is 2) on all Cray computer systems.

Three accounting options are available for a process's use of memory; these options are selectable in the `/usr/src/cmd/acct/acctdef.h` header file. The default memory integral selection for UNICOS 4.0 counted memory-in-use once for each processor. This provides the most reproducible numbers; however, when a process simultaneously uses more than one processor, the memory (which is shared) could be counted several times. The default memory integral for UNICOS 5.0 was changed to charge fairly for memory used by multitasked processes.

The `diskusg` administrator command supports the new disk accounting feature, which is provided on all Cray computer systems in this release. The new `-a` and `-A` options produce output of space used related to accounting ID numbers.

In addition, CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems now provide access to accounting by device, including disks (logical devices), tapes, SSD, and SDS.

The *UNICOS System Administrator's Guide* provides additional UNICOS accounting information, including logging and device accounting information. (See either the *UNICOS System Administrator's Guide for CRAY Y-MP*,

CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems, publication SG-2018, or the *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019.)

4.2.3 File system monitor

The file system monitor provides for management of “disk full” conditions and is supported on all Cray computer systems. It consists of a daemon that watches the volume of free space in all configured file systems, along with an operator interface, *fsmon*, that displays information on current disk capacity. The monitor provides a warning mechanism that is triggered at either of two optional threshold values. The warning mechanism works independently for each file system. When free space falls below a threshold, site-specified policing action can be initiated. A different policing action can be applied at each threshold. The file system monitor is capable of signaling other system components, such as NQS, to prohibit new work from entering the system.

The file system monitor feature is documented in the following publications:

- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022

4.2.4 UNICOS multi-level security

The security feature is now supported on all Cray computer systems. The UNICOS 5.0 release provides a multiuser environment in which information and resources can be shared easily. In many cases, proper administration of physical security and adherence to standard system security measures ensure adequate protection for both user data and

the system itself. However, at some sites and under certain circumstances, system integrity and the protection of sensitive information may require use of the UNICOS multi-level security feature. The security feature default is "off."

The secure UNICOS system facilitates concurrent processing of sensitive information at multiple security levels. To provide a secure framework for a Cray computer system running UNICOS, the system exercises control over the flow of information between a Cray computer system and link software (stations) and remote network hosts. That is, the secure UNICOS system provides protection for sensitive information and controls access to Cray systems from link software and networks, preserving security within UNICOS system boundaries. However, UNICOS does not provide security enhancements to connected link software and networks, nor does it guarantee a secure environment, which depends upon proper administration of physical security and proper application of system security features.

Design specifications for this feature were derived from the U. S. Department of Defense (DoD) evaluation criteria for trusted computer systems. These criteria describe the system software capabilities needed to satisfy government and private industry security requirements.

Security flags, levels, and compartments that are specific to an individual user are now stored in the user database (UDB); see subsection 4.2.5.

The UNICOS 5.0 release includes several new security features and enhancements:

- Security logging has been enhanced to allow path name reconstruction of a file in the audit trail of the file related to the log entries. All changed directory-relative path names are logged. The `reduce administrator` command can then reconstruct the path name by tracking the current full path name for each job or process ID. The ID is selected by the `reduce` option arguments.
- Disk file space can be automatically cleared by the UNICOS kernel whenever a file is removed. This feature is enabled by setting the `SECURE_SCRUB` parameter in `secparm.h`. The `spclr` user command can be used instead of this feature.

- Trusted daemons (NQS, USCP, tape, and security log) can be initiated either by `init` via `inittab` or from within the `/etc/rc` file executed on entry to the multiuser state. If the daemons are not properly initiated, or if they terminate prematurely, manual reinitiation is required by using the daemon startup entries in the user database.
- Future releases of UNICOS will use the `secstat` and `getusrv` system calls in place of the `getfcmp/getflvl` and `getucmp/getulvl` system calls, respectively. Because of this, the `getfcmp`, `getflvl`, `getucmp`, and `getulvl` system calls should not be used in UNICOS 5.0.

Changes for the use and control of compartments are as follows:

- A user can only add compartments to the active compartments.
- The compartments of a new directory must be equal to or dominate the compartments of the parent directory. A security administrator can override these restrictions by explicitly setting compartments on a file.
- The compartments of a file must be equal to the compartments of its directory. A security administrator can override these restrictions by explicitly setting compartments on a file.
- The archiving and restoring of sensitive files and files with access control lists (ACLs) can be achieved by the use of `cpio`, `tar`, `dump` or `restore` commands. For a normal user, a single `cpio` or `tar` dump can consist only of files labeled with the same security level and same set of compartments. The `dump/restore` administrator commands allow processing of an entire file system with files at multiple security levels and compartment settings.

Tape security has been enhanced by several new features, as follows:

- Tapes are marked secure by setting the ANSI accessibility byte or the IBM dataset security byte. The header label 1, trailer label, the file's security level, and compartments are written in the header label 2.
- Mandatory access controls have been added to control tape input/output operations.

- Label processing is mandatory.
- Permissions allow the reading or writing of unlabeled tapes or the bypass tape label processing. These permissions should be granted primarily to the security administrator.
- Tape security violations are recorded in the security log.

Network security has been enhanced by several new features, as follows:

- The `spnal` administrator command creates and maintains a network authorization list (NAL) that contains network node classification and access modes permitted from a UNICOS system. Each NAL contains information for a given node: Internet address (or station address), minimum and maximum security levels, authorized compartments, and UNICOS transmission privileges.
- All remote access requests through a TCP/IP network are validated against the mandatory access controls.
- The use of the SecurID card, manufactured by Security Dynamics, Inc., supports interactive logins to authenticate the user's identity and allows the user to authenticate a connection to a legitimate UNICOS system. Use of the SecurID feature is optional and requires special hardware, software, and user documentation from Security Dynamics, Inc.

If your site wishes to purchase the optional SecurID card used with network security, the necessary hardware, software, and user documentation can be obtained from:

Security Dynamics, Inc.
2067 Massachusetts Avenue
Cambridge, MA 02140
(617) 547-7820

UNICOS Station Call Processor (USCP) security has been enhanced by several new features, as follows:

- USCP runs as a trusted daemon.
- All batch violations (for example, bad or expired passwords) are logged by the security log daemon.

- A fetched file inherits the user's active security level and compartments.
- Station access and file transfers are controlled by privileges defined in the network authorization list (NAL).

The following new commands and utilities have been added to, renamed, or removed from the security feature for the UNICOS 5.0 release:

- The **spclr** user command removes and clears file space, and removes ACLs applied to files or directories; it replaces the **rmfacl** user command. The **-s** option removes the file and clears the file space on disk. The **-d** option removes a file and reclassifies the disk space according to DoD procedures. The **-a** option removes the ACL associated with the file or directory.
- The **sptfm** user command sets the trusted facility mask, which enables or disables the trusted facility compartments for file creation or access.
- The **acl** user command was renamed **spacl**; the function remains the same.
- The **rmfacl** user command is no longer a valid command (see **spclr**, listed previously).
- The **spcheck** administrator command performs security checks on logical filesystems (**-f** option) or on a user's home directory (**-u** option). For example, **spcheck** searches for programs with the set-user ID (SUID) or set-group ID (SGID) bits set, files with public read/write access modes, password changes, logins that have not been used for a long time, and logins with the same user ID.
- The **spfilek** administrator utility controls ownership, mode, and security attributes of files. It can use the following options: the **-c** option checks the owner, group owner, access modes, security levels, and compartments against a master list of files and then flags any discrepancies; the **-s** option sets the owner, group owner, and access modes for a list of files; and the **-m** option creates a master list (*/etc/permlist*) of files.
- The **spnal** administrator command creates and maintains an NAL for the specified host.

- The **spwcard** administrator command sets the wildcard security level on the appropriate system directories required for secure UNICOS to operate in multi-level mode. The directory names are defined within the **spwcard** program, and no parameters are required or allowed when executing the command.
- The **tsubcmd** administrator command, when executed in single-user mode, installs commands and utilities that require trusted subject privileges.
- The **udbcmd** administrator command, when executed by a valid security administrator, installs and properly labels the commands that need access to the protected version of the user database, **/etc/udb**.

The following user commands are supported by the UNICOS security feature:

setuemp	Raises your active compartments
setulvl	Raises your active security level
spacl	Manages access control list (ACL) files
spclr	Removes and clears file space and removes access control lists (ACLs) applied to files
spget	Gets security parameters
spset	Sets security parameters
sptfm	Enables or disables the trusted facility compartments for file creation or access

The following administrator commands are supported by UNICOS security feature:

cll	Lists or resets the login failure attempts field in /etc/udb
dump	Invokes an incremental file system dump
reduce	Extracts, formats, and outputs UNICOS security event files
restore	Performs an incremental file system restore
slogdemon	Security event logging daemon

spcheck	Performs a security audit on a UNICOS system; this command can also be used by users in a limited mode.
spfilck	Sets and checks file ownership, access, and security levels; this command can also be used by users in a limited mode.
spnal	Manages network authorization list (NAL)
spweard	Sets wildcard levels on system directories in a secure environment
tsubcmd	Installs commands that require trusted subject privilege to operate in a secure environment
udbcmd	Installs commands that require access to the protected version of the user database <code>/etc/udb</code> .

In addition to the administrator commands that specifically support the security feature, the following administrator commands also support the security feature: **fsck**, **labelit**, **mkfs**, **mount**, **nu**, and **udbgen**.

The following system calls support the mandatory and discretionary access controls established by the UNICOS security policy: **fseclstat**, **getfacl**, **getfcmp**, **getflvl**, **getsysl**, **getucmp**, **getulvl**, **getusrv**, **rmfacl**, **secstat**, **setfacl**, **setfcmp**, **setflvl**, **setsysl**, **settfm**, **setucmp**, **setulvl**, **setusrv**, and **slgentry**.

Due to the UNICOS security policy, the following system calls may function differently when the security feature is enabled: **chdir**, **chmod**, **chown**, **creat**, **link**, **mkdir**, **mknod**, **mount**, **open**, **rmdir**, **sysconf**, **umask**, **unlink**, and **utime**.

The following include and data files support the security feature: `/usr/include/sys/acl.h` (**acl(4F)**), `/usr/include/lastlog.h` (**lastlog(4F)**), `/usr/include/sys/slrec.h` (**slrec(4F)**), `/usr/include/sys/secparm.h`, `/dev/slog` (**slog(4D)**), and `/usr/adm/sl/slogfile`.

The following publications provide information about the security feature:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS Security Administration Reference Manual*, publication SR-2062
- *Cray C Library Reference Manual*, publication SR-0136
- *TCP/IP Network User's Guide*, publication SG-2009
- *TCP/IP Network Administrator's Guide*, publication SG-2021
- *Volume 5: UNICOS Network Library Reference Manual*, publication SR-2057
- *UNICOS Station Call Processor (USCP) Administrator's Guide*, publication SG-2072

4.2.5 User database (UDB)

A versatile facility called the user database (UDB) is provided to replace the `uentry` facility. Also, the traditional method for maintaining `/etc/passwd` and `/etc/group` has changed. The UDB is supported on all Cray computer systems running UNICOS 5.0. The UDB includes an entry for each user allowed to run jobs or log onto a UNICOS system. The UDB is derived from the `uentry` file implemented in previous UNICOS systems; this file, in turn, was based on the traditional `/etc/passwd` and `/etc/group` UNIX files. The UDB is implemented to access an individual

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user's information faster and to allow the safe change of information about a user from multiple sources. This enhancement includes the replacement of the library interface to the user information file.

All jobs and processes that enter the running system are assigned limit information obtained from the UDB. This action occurs for interactive as well as batch access.

A new administrator command, **udbgen**, creates the UDB. It also allows for information to be added to or changed in the UDB, and it can read **passwd** files. The new **addgroups** administrator command converts the **group** files to the UDB source. The new **udbsee** user command converts the database format to an ASCII file that may be used as input to **udbgen**. It also provides options to extract data for reports and other administrative uses. The new **udbpl** administrator command produces reports containing information from the kernel tables and the UDB. In addition, the **passwd** and **group** files are updated automatically when the UDB is updated. The new **udbcmd** administrator command installs commands required for accessing the UDB on a secure system.

The **nu** administrator command is now available on all Cray computer systems. This command provides administrators with a simple interface for creating new user accounts. The **nu** administrator command has also been modified to work with the new user database (UDB) feature. See the *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018, or the *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019, for a description of how to use this administrator command.

See section 7, "Compatibility/Differences," for additional information.

The UDB is documented in the following publications:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014

- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *Cray C Library Reference Manual*, publication SR-0136

4.2.6 Data migration

Data migration is a facility that allows sites to regulate file system capacity by removing user files to off-line media. The method of selecting migration candidates is determined by the site. The volume of free disk space to be maintained is also determined by the site. User access to off-line files is transparent unless automatic retrieval is disabled. Supported media for UNICOS 5.0 include both 3480 cartridges and 3420 reels. The support mechanism for management of media resident data is independent of the transport mechanism used to move data to and from the media.

Capabilities implemented for the UNICOS 5.0 release include the following:

- A set of administrator utilities (**dmfdgen**, **dmfree**, **dmhit**, and **dmmctl**) that scan file systems and generate lists of migration candidates, based on administrator-defined criteria; see subsection 4.2.25 for a complete list of data migration administrator commands.
- New user commands that support data migration: **dmget**, which recalls a previously migrated file; **dmlim**, which is a disk management utility; **dmmode**, which sets data migration recall mode; and **dmput**, which migrates an on-line file.
- A data migration daemon (**dmdaemon**) that performs basic file operations that move, provide status, or remove files from the data migration media

Change this to go thru'
stations

- A media-specific process that responds to data migration daemon requests by moving files to or from on-line tape and maintains a catalog of tapes and file names
- Two new system calls that support data migration: **dmmode**, which sets and gets data migration retrieval mode; and **dmofrq**, which processes off-line requests.

The data migration feature is dependent on the user database (UDB), on-line tapes, and file system monitoring features included in this release.

For the UNICOS 5.0 release, the data migration facility is limited to the task of file migration to and from off-line media. Files must be either on-line or off-line. A file cannot have both attributes simultaneously. Consequently, when a file is retrieved from media, the media copy is discarded. In the event that the file is again a migration candidate, it must be written back to off-line media.

A portion of the data migration facility, called Data Migration Catalog Utilities, Version 1.0, is provided to customers in binary form only. Cray analysts generate the binary code for customers and retain the source code for Cray Research internal use only. There is no fee for this software and there is no separate license required; however, it must be ordered as optional software when ordering UNICOS 5.0. See section 6, "Licensing and Ordering," for additional information.

The data migration feature is documented in the following publications:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014

online tapes only - how
tricky to alter this??

- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012
- *Cray C Library Reference Manual*, publication SR-0136

4.2.7 Share scheduling facility

This release provides the UNICOS share scheduling facility, which is supported on all Cray computer systems running the UNICOS 5.0 release. The UNICOS share scheduling facility allows explicit allocation of predetermined, administrator-specified shares of CPU resources on a per-user and per-group basis. The share allocation is accomplished by analysis of historical data of usage that is accumulated by the UNICOS kernel. The analysis is performed by a daemon process that advises the kernel through priority adjustments. The facility is based on a package written by the University of Sydney called the Sydney Fair Share Scheduler. The UNICOS share scheduling facility relies on the user database (UDB) feature.

The following user commands have been added to support the UNICOS share scheduling facility: **shrates**, **shrinfor**, **shrstats**, and **shrusage**.

The following administrator commands have been added to support the UNICOS share scheduling facility: **shrlimit**, **shradmin**, **shrdaemon**, and **shrmon**.

The UNICOS share scheduling facility is documented in the following publications:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022

- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019

4.2.8 Network Queueing System

The Network Queueing System (NQS) is supported on all Cray computer systems. The following enhancements have been made to NQS for the UNICOS 5.0 release:

- **Memory management:** Based on the summation of memory limits specified by running requests, queued requests will be held in their queues until the summed limits drop below the queue limit, complex limit, and global limit.
- **Interface to user database:** The new user database (UDB) maintains user batch limit information. User limit information is assigned at time of acceptance from the UDB.
- **Multiple tape group support:** Control of tape devices in NQS has been enhanced. In particular, NQS allows the specification of more than one tape group.
- **qchkpnt command:** The new **qchkpnt** command allows users to take a checkpoint of their own requests, thus allowing a restart of the request by NQS.
- **qmgr commands:** The **qmgr** command **hold** now allows specified running requests to be put on hold, making those requests ineligible for processing. The **qmgr** command **release** removes the effect of **hold**.
- **Parallel checkpointing:** To improve the performance of **shutdown**, NQS requests checkpoints of more than one running request at a time, rather than checkpointing in the serial fashion previously used.
- **Synchronous shutdown:** During a shutdown of NQS, **qmgr** waits to exit until all processing, including checkpoints, is completed.

- **Daemon accounting:** The NQS accounting mechanism has been changed to utilize the new daemon accounting feature.
- **Directory restructuring:** To improve performance and maintainability, the structure of the directories used for maintaining the NQS database has been modified.
- **makefile redesign:** The source directory structure has been improved and the **makefile** is now specific for UNICOS.
- **SUPERLINK transport protocol support:** NQS networking has been enhanced to include the SUPERLINK transport protocol and support the slot concept.
- **qdel and qstat commands:** The **qdel** and **qstat** commands now support an option for **hostname** that allows these commands to be executed on remote hosts in a networked configuration.
- **qdev and qpr commands:** Since the device queue and request are not supported by Cray Research, Inc., these commands were removed because they are device specific.
- **nqsdaemon administrator command:** This command is now documented.

UNICOS NQS is documented in the following publications:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019

4.2.9 Remote Queueing System

To provide remote access to the UNICOS NQS queues, the UNICOS 5.0 release supports the Remote Queueing System (RQS) software for UNIX systems. This implementation of RQS provides for remote job submission, status, termination, and output retrieval from front-end systems and workstations that are based on UNIX.

RQS is a subset of NQS source and runs only on UNIX systems. The UNICOS NQS source is moved to the intended UNIX system, where RQS is built and installed. The UNICOS 5.0 release supports RQS on SUN-3 systems running either SunOS release 3.5 or 4.x. RQS is also supported on SUN-4 systems. All software problems reported (SPRs) that can be reproduced on RQS running on a SUN system to UNICOS NQS will be supported. If customers port RQS to other systems running UNIX, best efforts will be made to offer advice when possible; however, SPR support is based exclusively on SunOS experience. As other systems based on UNIX become available in Mendota Heights, including AT&T System V products, RQS will be also be installed and tested on these systems.

The following RQS user commands are supported with this release: `qdel`, `qstat`, and `qsub`. The following RQS administrator commands are supported with this release: `qmgr` and `qmapmgr`. Because batch capability is not supported under RQS, the `qmgr` commands pertaining to batch queues and complexes are not supported.

RQS will operate with UNICOS NQS through the use of pipe queues. Batch queues are not supported by RQS on the local UNIX system. UNICOS 5.0 NQS source code is required to install RQS.

NOTE: A separate license is required for RQS; also, there is a right-to-use charge. There will be a separate RQS installation tape that will contain build procedures for SunOS RQS and Sun man pages for RQS. This tape will be available from the Distribution Center in Mendota Heights after the UNICOS 5.0 release.

UNICOS RQS is documented in the *Remote Queueing System (RQS) Technical Note*, publication SN-2095. See the *Remote Queueing System (RQS) Release Notice* for additional information.

4.2.10 Temporary files

On all Cray computer systems, users may now designate a file as temporary and be sure that when the job or process leaves the system, the file space is released.

This feature is built around the **TMPDIR** environment variable. A unique temporary directory is created at the start of a job by **NQS** for batch jobs or **login** for interactive "jobs" and removed (by **NQS** or **init**, respectively) when the last process in the job terminates. Site administrators can configure a pool of file space to be used for this purpose. The **cleantmp** administrator command deletes temporary directories created by the **tmpdir** command.

Jobs can be run from within temporary directories. Saving permanent files would require copying them to the user's permanent directories (using the **HOME** environment variable). Users can create additional temporary directories with the **tmpdir** command. The **/etc/tmpdir.users** file controls access to the file systems available for use through the **tmpdir** command.

Temporary files are documented in the following publications:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022

4.2.11 User-level disk striping and preallocation

Striping is the ability to place disk files across a number of devices. Preallocation is setting aside disk space for a specific file without explicitly writing to it. Two commands provide the user interface: **assign** and **setf**. The **assign**

encourage use of this

command is Fortran-based, and the preallocation and striping is done only at OPEN time. The `setf` command preallocates the file at the time the command is executed. In this release, both the `assign` options `-r` and `-p` are supported for striping. The `-p` option is preferred, and the `-r` option will be dropped in a later release. The `-n` option is available to request the file size to be preallocated, for example:

```
-n <total file size>[:<allocation unit>]
```

All Cray computer systems running UNICOS 5.0 support the `-n <total file size>` part of this option. CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems also support the `[:<allocation unit>]` part of the option. On CRAY-2 systems, the preallocation will always be in allocation units equal to the track size of the device. If an allocation unit is requested, a warning message will be given but preallocation proceeds. Also, option `-c` is available to request contiguous preallocation. The `-p`, `-c`, and `-n` options are supported on both the `assign` and `setf` commands. With the exception of specifying the allocation unit, the user interface is the same on all Cray systems.

4.2.12 Berkeley time-of-day calls

The Berkeley 4.3 BSD `gettimeofday` and `settimeofday` system calls are now provided on all Cray computer systems running the UNICOS 5.0 release. These calls allow for the setting and retrieval of the time with microsecond accuracy. This interface does not replace the standard AT&T UNIX System V `gtime` and `stime` interface. See *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012, for additional information.

4.2.13 Restricted default path

Changes were made to `/etc/cshrc` and `/etc/profile` to remove `."` from the default path in these files. This modification has impact on users of all Cray computer systems running this release. Removing `."` from the default path means

users no longer can expect the system to find a command in their current working directory; that is, instead of typing `cmd` (assuming `cmd` is in their current working directory), they must type `./cmd` if `.` is not in their path.

CAUTION: Specifying the current directory in a user's `PATH` may cause software to execute that the user did not intend to execute. Devious users may take advantage of this situation and create "trojan horses" with the possibility of malicious intent.

If users are taking advantage of the current directory specification in their `PATH` and wish to continue doing so, they can insert `.` into their `PATH` environment variable within their local `.profile` (`sh`) or `.cshrc` (`csh`).

A site may wish to continue supporting `.` in the default path at the system level. In this case, `/etc/profile` and `/etc/cshrc` can be modified accordingly. You may also want to consider modifying `/usr/include/path.h`. This include file affects the functionality of `login`, `su`, `cron`, `init`, `NQS`, `rexecd`, and `rshd`.

For sites choosing to support `.` in the default path at the system level, it is suggested that it be added at the end of the list of directories to be searched.

4.2.14 Resource limits

The `limit` system call is supported on all Cray computer systems running the UNICOS 5.0 release, and it now provides the capability to record and enforce resource limits. Specifically, the following new limits are recognized and enforced:

- Up to eight tape device groups
- A job limit on new file space created
- For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, a job and process limit on Secondary Data Segments (SDS) space.

Users should not do this - have a script that runs around checking for instances of this.

Additionally, whenever processes initiate under UNICOS, either as batch or interactive, limit information is extracted from the UDB and assigned to the new process via the `limit` system call.

This feature is documented in the following publications:

- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018

4.2.15 Increasing memory size for Bourne shell (`sh`) scripts

Some large Bourne shell (`sh`) scripts exhaust all allocated `sh` memory (called `sh` stack space). Shell functions, expanded metacharacters, and other shell constructs use this `sh` stack space; which is allocated immediately upon invoking `sh`.

If users run out of `sh` stack space, they receive the message: `sh unable to provide enough stack space` or the message: `no space`. To increase the amount of available `sh` stack space, users can increase the value of `BREAKSIZE` in `sh/setbrk.c`. `BREAKSIZE` is the number of 64-bit words `sh` will use for its stack space.

CAUTION: Every `sh` being executed will be allocating `BREAKSIZE` number of words for stack space. Caution should be used when selecting a new value. For example, a `sh` could be built with `BREAKSIZE` set to 1024; which would be the default shell. A `bsh` could be built with `BREAKSIZE` set to 16000; which would be used by shell scripts requiring more stack space. The shell scripts that had run out of memory could now use `bsh`. Creating `bsh` is only an

example; sites must decide if they wish to create another shell with more memory or increase the memory in the default shell.

NOTE: In a future UNICOS release, Bourne shell scripts will have memory allocated dynamically.

4.2.16 /proc

The `/proc` file system is supported on all Cray computer systems and provides capabilities similar to those of `ptrace`, but with a better interface. A process, such as an interactive debugger, opens a path `/proc/nnnn` where `nnnn` is the pid of the desired process. The controlling process may then stop, start, and examine the controlled process. The `/proc` file system is not used by any debuggers in the UNICOS 5.0 release; it will be used in future UNICOS releases.

The `/proc` file system is documented in the *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019, and in the *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018.

4.2.17 crayperf

The `crayperf` facility, composed of the `crayperfd` daemon and the `crayperf` display program, allows the system administrator to monitor in real time the performance of a Cray system running UNICOS. It is an application for displaying graphical data about system performance and manages a set of displays showing data received from the `crayperfd` daemon. The displays are windows in the X Window System Version 11, Release 3.

Need a workstation

This feature is documented in the following publications:

- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS System Administrator's Guide for CRAY-2 Computer Systems*, publication SG-2019
- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018

4.2.18 File system performance improvements

For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, this release provides file system performance improvements, including improved I/O performance and improved bit map management strategies. There is no user impact.

4.2.19 Memory scheduling

Weighting factors were added to the algorithm used to calculate memory priority. These factors allow a site to determine the relative importance of job size, job priority, and time out of memory when ordering jobs that are eligible for core residence. This feature is supported on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems running this release.

Modifications were made to the `schedv` system call to implement this feature. Capabilities for memory, priority, share priority, nice value, time in memory, time swapped and thrash controls have been added.

This feature is documented in the following publications:

- *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012

4.2.20 IOS

on order!

Cray computer systems configured with an IOS require the IOS release 5.0 software in order to run the UNICOS 5.0 release.

4.2.21 Guest Operating System (GOS)

Using the **chmem** command, operators can now make manual changes to the field length of the Guest Operating System (GOS) while it is running. This feature allows the operator to return some of the GOS field length to COS users during periods of low GOS usage. This feature is supported on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems and requires the COS 1.17 release and the IOS 5.0 release.

The **chmem** command is documented in the *UNICOS Administrator Commands Reference Manual*, publication SR-2022, and GOS is described in the migration note *The Guest Operating System (GOS)*, publication SMN-7013.

4.2.22 Real-time

By default, the UNICOS 5.0 release running on CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP computer systems contains many features required for real-time applications. These features are as follows:

- Locking of a process in memory using the **plock** system call
- Easy addition of custom device drivers
- Preallocation of contiguous file storage using the **ialloc** system call
- Event-driven scheduling
- Fast context switch time

In addition to these features, the following have been added for this UNICOS release:

- A capability to establish a process as "real-time," providing the system with the ability to discriminate when scheduling CPU time
- A capability to dedicate one or more CPUs for exclusive use, avoiding the necessity of disconnecting another process when that CPU is needed
- An interval timer with a 1-millisecond granularity, providing a periodic signal at a specified interval
- A least-time-to-go scheduler above the normal scheduler to arbitrate between competing real-time processes

This feature is documented in *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012

4.2.23 SSD SDS administration and scheduling

Several new features have been added as part of the UNICOS 5.0 release that provide tools to observe and control the allocation of Secondary Data Segments (SDS). SDS is an optional configuration of the SSD solid-state storage device

and is supported on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems. The two other optional configurations of the SSD are logical device cache (*ldcache*) and conventional file system.

An observation tool named *sdss* is new with this release. This user-level utility produces various reports that illustrate current SDS utilization on a per-process basis. The information provided by *sdss* is limited to processes currently executing.

With the UNICOS 5.0 release, batch jobs (NQS requests) that utilize SDS are required to announce their total SDS needs through an NQS *qsub* option. Within NQS, the term for SDS is "quickfile" space. A job is constrained to the minimum of either the quickfile limit for the queue of origin or the SDS limit in the user database entry.

Another new capability allows the site administrator to specify the total volume of SDS space consumed by all NQS requests in execution. This capability is a limited form of control over SDS oversubscription. The reason that this is a limited capability is that interactive processes can also gain access to SDS if the user database is set appropriately. Interactive processes are not monitored by NQS. Therefore, total SDS allocation is not regulated in an exact way. Additionally, the size of SDS can be changed dynamically by the site administrator at any time. This can cause the ratio between resource size and the volume of SDS space admitted by NQS to vary.

Also new with the UNICOS 5.0 release is a capability for the NQS administrator or NQS operator to control which jobs reside on SDS. An operator can cause a job that is currently resident on SDS to be checkpointed and stopped in order to make room for a job waiting for SDS allocation. Two *qmgr* administrator commands are supplied for this purpose. They are called *hold* and *preempt*. The *hold* and *preempt* commands both cause SDS residence to be relinquished, but in slightly different ways. The *hold* command causes the job to be checkpointed and stopped and not made eligible for rescheduling until released. The *qmgr* administrator command, *release*, rescinds the effects of the *hold* command. The *preempt* command causes a job to be checkpointed and

stopped, but it remains eligible for scheduling. A new command, `restore`, causes a job that is preempted and waiting for SDS residence to be eligible immediately for device residence.

An automatic scheduling capability for SDS is provided with the UNICOS 5.0 release. The administrator package that performs this function is called `qfdaemon`, and it has the function of monitoring total batch job use of SDS and exchanging residence based on a round-robin, priority-driven algorithm. The minimum amount of time that a job is entitled to SDS residence can be determined by the site analyst. The SDS scheduling feature is specific to batch jobs only. SDS allocations for interactive processes are not affected by this service.

The transfer mechanism used to exchange SDS residence is the `chkpnt` and `restart` system calls. In a limited number of situations, an SDS residence change, either manual or automatic, may not be possible because the job cannot be checkpointed or restarted. Refer to the `chkpnt` and `restart` system calls for a description of the reasons why a residence exchange may not be possible.

4.2.24 New user commands

The following list describes new user commands for the UNICOS 5.0 release. It also lists user commands that were removed. UNICOS user commands are documented in the *UNICOS User Commands Reference Manual*, publication SR-2011.

The following new user commands have been added for the share scheduler:

<u>Command</u>	<u>Description</u>
<code>shrates</code>	Shows system share scheduling rates by scheduling group
<code>shrinfo</code>	Displays charges for share system usage calculations

<u>Command</u>	<u>Description</u>
shrstats	Shows histogram of share scheduler user priorities
shrusage	Shows bar graphs of usage rates for share scheduler user

The following new user commands have been added for autotasking:

<u>Command</u>	<u>Description</u>
fmp	Translates autotasking and microtasking directives
fpp	Analyzes Fortran code and inserts directives

The following new user commands have been added for data migration:

<u>Command</u>	<u>Description</u>
dmget	Recalls a previously migrated file
dmlim	Disk management utility
dmmode	Sets data migration recall mode; Bourne shell and C shell Built-in command.
dmput	Migrates on-line file

The following new user commands have been added for security:

<u>Command</u>	<u>Description</u>
spacl	Replaces acl
speir	Performs secure clear; replaces rmfac
sptfm	Sets trusted facility management mask; Bourne shell and C shell Built-in command.

Several products have been added or changed. These differences are reflected in the following commands:

<u>Command</u>	<u>Description</u>
cdbx	Provides source-level debugging
ld/sld	Link editor for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 (ld) and for CRAY-2 systems (sld)
nmodex	New mod generation utility

<u>Command</u>	<u>Description</u>
nupdate	New source code maintenance utility
perfdmp	Displays Perftrace data if program aborts
pg	AT&T UNIX System V, release 3
procrpt	Produces a report from raw procstat output
procstat	Gathers process statistics
profview	Reads prof raw format output and produces reports
sm	Invokes the UNICOS Source Manager (USM)
trlib	Transitional aid for duplicating global names with respect to underscore translation
udbsee	Writes ASCII source of a user database
yadb	No longer uses X Window System interface

The following are miscellaneous new commands:

<u>Command</u>	<u>Description</u>
asgcmd	Assigns characteristics to a file
chacid	Changes account ID of disk files
jstat	Displays job status information
lpq	Spool queue examination program
lpr	Off-line printer
lprm	Removes jobs from line printer spooling queue
nl	Filters line numbers
nslookup	Queries name servers interactively
ntalk	New talk ; enables one user to communicate with another
qchkpnt	Checkpoints an NQS request
resize	Resets TERMCAP with current size of a window; replaces the ttysize command
sdss	Reports status information about Secondary Data Segment (SDS) pool
tpcatalog	Catalogs, recatalogs, or deletes a file in a front-end catalog

The following new user commands support the Cray Ada compiler and are provided only to sites that order this compiler:

<u>Command</u>	<u>Description</u>
acmp	Compresses an Ada sublibrary
acp	Copies Ada library entities
ada	Invokes the Ada compiler

<u>Command</u>	<u>Description</u>
adbg	Invokes the Ada source-level debugger
ald	Ada linking and loading facility
als	Generates Ada library reports
amv	Moves Ada library entities
aopt	Invokes the Ada optimizer
apro	Invokes the Cray Ada profile report generator
arc	Creates Ada sublibraries
arec	Generates Ada recompilation reports
arel	Generates Ada relation reports
arm	Removes Ada library components
asd	Ada source dependency lister utility
asf	Ada source formatter utility
axr	Invokes the Ada cross-referencer

The following user commands have been made common for all Cray computer systems with this UNICOS release:

<u>Command</u>	<u>Description</u>
df	Reports the number of free disk blocks
setf	Initializes a file
setucmp	Sets user's active compartments
setulvl	Raises user's active security level
spget	Gets security parameters
spset	Sets security parameters

The following new user commands have been added for yellow pages (YP); note that YP support is deferred (see subsection 4.6.2, "UNICOS Network File System"):

<u>Command</u>	<u>Description</u>
domainname	Sets or displays name of current YP domain
ypcat	Prints values in a yellow pages database
ypmatch	Prints the value of one or more keys from a yellow pages map
yppasswd	Changes login password in yellow pages
ypwhich	Specifies which host is the yellow pages server or master

The following user commands have been removed from UNICOS:

<u>Command</u>	<u>Description</u>
alc	Renamed to spacl
dbx	Replaced by edbx
oar	Command removed from CRAY-2 systems; maintained archives and libraries.
occ	Command removed from CRAY-2 systems; invoked the nonvectorizing C compiler.
ocpp	Command removed from CRAY-2 systems; invoked the C language preprocessor
qdev	Displayed status of NQS devices
qpr	Submitted hardcopy print requests to NQS
rmfac1	Replaced by the spclr command
ttysize	Replaced by the resize command

4.2.25 New or changed administrator commands

This list describes new or changed administrator commands for the UNICOS 5.0 release. UNICOS administrator commands are documented in the *UNICOS Administrator Commands Reference Manual*, publication SR-2022.

Major new additions to the UNICOS 5.0 release are the data migration feature, the user database (UDB), the share scheduler, and file system monitoring. The accounting facilities also have been expanded greatly. A major new addition to CRAY-2 systems is the security feature. A major new addition to CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems is UNICOS NFS. The following list details changes to administrator commands for this release.

4.2.25.1 All computer systems

The following new administrator command has been added for all systems:

<u>Command</u>	<u>Description</u>
nicem	Alters priority of running processes

At 4.0 most sites have an equivalent local utility that makes the system call.

The following tape subsystem administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
tpdev	Displays current tape equipment configuration and status, up or down
tpset	Sets features for the tape subsystem
tpu	Unloads tape drives

The following file system monitoring administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
fsdaemon	File system monitor daemon
fsmon	Interfaces with the file system monitor administrator command, fsdaemon

The following share scheduler administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
shradmin	Changes/displays charges for share system usage calculations
shrdaemon	Cleans up defunct user limits structures
shrlimit	Sets another user's limits
shrmon	Monitors detailed system share scheduling information

The following USCP administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
usecpd	Starts USCP communication daemon
usecpfix	Removes slot files from the USCP SLOT directory

<u>Command</u>	<u>Description</u>
useplink	Displays USCP link status
usepops	USCP operator command
usepques	Displays USCP batch queue status
usepstat	Displays USCP system status
usepstrs	Displays USCP file transfer status

The following TCP/IP network commands have been added for all systems:

<u>Command</u>	<u>Description</u>
gettable	Gets NIC format host tables from a host
htable	Converts NIC standard format host tables
netperf	Displays real-time network activity with the X Window System

The following line printer commands have been added for all systems:

<u>Command</u>	<u>Description</u>
lpc	Controls the operation of the line printer
lpd	Line printer daemon
lptest	Generates line printer ripple pattern
pac	Collects and displays printer/plotter accounting information

The following user database (UDB) administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
addgroups	Converts group files to the user database source
udbcmd	Installs commands required for accessing the UDB on a secure system
udbgen	Generates or maintains the UDB
udbpl	Prints administrative information for designated users

The following data migration administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
dmdaemon	Starts the data migration daemon
dmdalter	Checks migrated file
dmdbase	Manipulates and interrogates the data migration database
dmdbval	Validates the volume and catalog databases
dmdebug	Manipulates the data migration daemon debug log
dmdelete	Generates a list of database entries to be deleted permanently
dmdidle	Idles data migration daemon
dmdjournal	Updates daemon database with journal entries
dmdproct	Generates the dmprocs file
dmdstat	Checks communications to the data migration daemon
dmdstop	Stops the data migration daemon

<u>Command</u>	<u>Description</u>
dmdtext	Manipulates text format of the data migration daemon database
dmfdgen	Generates or maintains the File System Description file
dmfree	Releases disk blocks of premigrated files
dmfsck	Validates the data migration system
dmhit	Generates "hitlist" of weighted files for a file system
dmmctl	Selects files for migration
dmtmerge	Merges sparse tapes
dmvdbgen	Generates and maintains the volume database

The following security administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
spcheck	Performs a security audit on a UNICOS system
spfilek	Sets and checks file ownership, access, and security levels
spnal	Manages network authorization list (NAL)
spwcard	Sets wildcard levels on system directories in a secure environment
tsubcmd	Installs commands that require trusted subject privilege to operate in a secure environment

The following accounting commands have been added for all systems:

<u>Command</u>	<u>Description</u>
ckdacct	Checks the size of the daemon accounting files
csaadde	Adds cacct records
csaboosts	Records system boot times for the accounting subsystem
csabuild	Generates a session record file
csacon	Condenses a session record file into a cacct file
csacrep	Reports on consolidated accounting data
csafef	Front-end formatting program
csajrep	Prints a job report from session record file
csaline	Processes a utmp file and outputs a list of connect sessions in ctmp.h format sorted by ending time
csanqs	Preprocesses the NQS accounting files
csaperiod	Runs periodic accounting
csarecy	Recycles unfinished sessions into next accounting run
csarun	Processes the daily accounting files and generates reports
csatape	Preprocesses the tape accounting files
getdpid	Returns daemon process ID and the signal number
setacid	Sets default accounting ID
turndacct	Turns daemon accounting on or off

The following UNICOS NFS administrator commands have been added for all systems:

<u>Command</u>	<u>Description</u>
makedbm	Creates a yellow pages dbm file
nfsaddhost	Adds host addresses to ID mapping domains
nfsaddmap	Defines a user ID and/or group ID map for use with UNICOS NFS
nfsclear	Removes user/group mapping tables, ID mapping domains
nfslist	Lists all kernel ID mapping domains
nfsmerge	Creates a user or group mapping between two machines
nfsrmhost	Removes host addresses to the ID mapping domains
nfsrmmap	Removes a previously defined user and/or group ID map
stdhosts	Converts and prints Internet addresses from hosts or networks files

The following yellow pages (YP) administrator commands have been added for all systems; note that YP support is deferred (see subsection 4.6.2, "UNICOS Network File System"):

<u>Command</u>	<u>Description</u>
makedbm	Creates a yellow pages dbm file
ypbind	Provides yellow pages server and binder processes

<u>Command</u>	<u>Description</u>
ypinit	Sets up a yellow pages database on a YP server
yppasswdd	Server for modifying YP password file
yppoll	Finds the YP map version at a YP server host
yppush	Forces the propagation of a changed yellow pages map
ypserv	Provides yellow pages server and binder processes
ypset	Points ypbind at a particular server
ypxfr	Transfers a yellow pages map from a YP server

The following administrator commands were removed from UNICOS:

<u>Command</u>	<u>Description</u>
merge	Created UNICOS NFS user and group maps (replaced by nfsmerge)
mkdomain	Utilized UNICOS NFS user and group maps
rmond	Provided remote access to memory map
sethost	Set host name from uname
ueset	Maintained the UNICOS specific user context database (replaced by udbgen)
usecpdebug	Turned debug flag on and off in USCP (replaced by uscpcd)
uscpcinit	Started USCP (replaced by uscpcd)

The following administrator commands have major changes:

<u>Command</u>	<u>Description</u>
acct	Accounting files previously in <code>/usr/adm</code> are now in <code>/usr/adm/acct/day</code>
acctdisk	Two new options, <code>-a</code> and <code>-A</code> , that accept output produced by <code>diskusg</code> with the same options
acctmerg	A new option, <code>-y</code> , that reports on transferred SDS blocks has been added for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems.
acctpre	A new file, <code>/usr/adm/acct/day/pacct</code> , is provided.
acctsh	New accounting scripts have been added; all accounting files previously in <code>/usr/adm/acct</code> are now in <code>/usr/adm/acct/day</code> ; new accounting files have been added.
chargefee	Now a command, with new functions and separated from the <code>acctsh</code> man page
cleantmp	Common for all computer systems; deletes job temporary directories.
cll	The options from 4.0 no longer exist; there are four new options: <code>-R</code> , <code>-r</code> , <code>-L</code> , and <code>-l</code> , that reset the login failed attempts field in the user database.
cpu	A new option, <code>-x</code> , and a new possible command line has been added for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems.
crayperf	Upgraded to run with the X Window System, Version 11, Release 3. This modification allows <code>crayperf</code> to function on the OWS.
crayperfd	This command has extensive changes.

<u>Command</u>	<u>Description</u>
disk	A new <i>cmd</i> command, <i>ronly</i> , has been added for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems. Although <i>disk</i> is still supported on CRAY-2 systems, it is recommended that the new <i>ioctl</i> command be used.
diskusg	Accepts new options, <i>-a</i> , <i>-A</i> , <i>-h</i> , and <i>-v</i> ; reports disk usage in two additional formats; displays a header; and specifies verbose mode.
dodisk	Accepts new options, <i>-a</i> , <i>-A</i> , and <i>-v</i> , that report disk accounting in two different formats and specify verbose mode.
dump	Common user interface for all Cray computer systems. The default is now round tapes, and the new <i>-c</i> option allows for the use of cartridge tapes. There are also new options, <i>-W</i> and <i>-w</i> (these are new functions only for CRAY-2 computer systems—the functionality previously existed for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems).
errdemon	New option, <i>-m</i> , that sets the amount of time between reading common memory errors (CRAY-2 computer systems)
ff	Now on all computer systems. The previously existing option, <i>-d</i> , is now documented.
fingerd	Reflects 4.3BSD
ftpd	Reflects 4.3BSD
fuser	For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, the <i>-k</i> option is restricted to super user
getty	No longer supported on CRAY-2 systems (replaced by <i>consoled</i>)

<u>Command</u>	<u>Description</u>
grpck	Although this command still exists, the new command udbgen guarantees synchronization of the user database and the /etc/group file.
hit	Now exists on all Cray systems
ifconfig	Accepts parameter, iftype , that sets the interface type
inetd	Includes a list of RFCs that contain information on inetd services
labelit	Common user interface for all Cray computer systems. The -f and -v options have been reinstated for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems.
mount	Common user interface for all Cray computer systems. Two new file system types are available: CI_4K and PROC . There is a new option, -b , for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems only.
netstart	Has an additional function, making a binary host file (with mkbinhost)
nu	Now on all systems; the command uses the user database (/etc/udb) instead of the /etc/passwd and /etc/group files. Information on installing nu on a secure system is included. Configuration variables have changed. The lock file /etc/ptmp no longer exists, and the password structure is now in the file /usr/include/udb.h .
oper	The snap command is common on all systems.
pwck	Although this command still exists, the new command udbgen guarantees synchronization of the user database and the /etc/passwd file.

<u>Command</u>	<u>Description</u>
qmapmgr	New element added, <i>service-name</i> , and new commands supporting this new element: add mid , add service , and delete service and an additional column in the database, SERVICES .
qmgr	<p>The following commands were added: set complex memory_limit, set queue memory_limit, set global memory_limit, set no_superlink_daemon, set superlink daemon, preempt, restore, set accounting_file, set no_quickfile_daemon, set quickfile daemon, set quickfile polling, and set quickfile residence.</p> <p>The <i>type</i> operand and description with possible values was added to set global tape_limit and set per_request tapefile_limit.</p> <p>The set complex tape_limit, set queue tape_limit were deleted.</p> <p>The minimum command string needed for the following commands was changed: purge, set network daemon, set no_access, and all the set queue commands.</p> <p>The set network daemon and set no_network_daemon refer to the TCP/IP daemon only.</p> <p>The hold command now works on waiting and running requests.</p>
reduce	Common user interface for all Cray computer systems. New options, -b , -n , -p , and -x , have been added, along with new identifiers, ej and chdir , and eight new functions. The default raw file is raw.reduce .
restore	Common user interface for all Cray computer systems. The default is now round tapes. The -c option is new on CRAY-2 systems and allows for the use of cartridge tapes.

<u>Command</u>	<u>Description</u>
rexecd	Reflects 4.3BSD
route	Reflects 4.3BSD; new argument for specifying maximum transmission units.
rshd	Reflects 4.3BSD
slogdemon	Any file prefaced by SL_ is now prefaced by SLG_ .
suspend	The -j option is no longer deferred on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems.
syslogd	No longer deferred on CRAY-2 systems
tpclr	Error numbers are now two-digit numbers.
tpconfig	Has been separated into two pages for the separate computer types. Error numbers are now two-digit numbers. The CRAY-2 version has a new option, -n . The CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 version has the following new options: -b , -c , -d , -u , -n , and -i .
tpfrls	No longer accepts as an operand a process group ID; instead it accepts a job ID. Error numbers are now two-digit numbers.
tpgstat	No longer prints status of process group ID; instead it prints job ID status. Error numbers are now two-digit numbers.
uscpcore	New options that allow you to specify what tables you wish to be displayed
uscptrace	New option, -r , that resets the trace file

4.2.25.2 CRAY-2 computer systems

The following administrator commands are new to CRAY-2 computer systems:

<u>Command</u>	<u>Description</u>
cil	Initializes or updates the UDB
consoled	Sets up an interactive connection for the system console (replaces getty)
fsicheck	Finds i-nodes with duplicate or out-of-range allocations
fspepy	Provides disk partition copy, remaps data areas and blocks
fsremap	Provides disk partition copy, remaps data areas and blocks
goall	Enables remaining CPUs for general use
ioctl	Sends an ioctl command to the device
slogdemon	Security event logging daemon
tapestart	Starts tape daemon and message daemon
vm	Virtual machine for CRAY-2 systems

The following administrator commands have major changes:

<u>Command</u>	<u>Description</u>
bb	The -c , -g , and -t options are now documented.
crash	New commands: procmgmt , resinfo , flock , buffer48 , jtab , slnodes , slipcs , slmipcs , slmounts
etc	New operand, assign , that assigns a number of buffers to an interface.

<u>Command</u>	<u>Description</u>
ift	Works with DD-49 and DD-40 disks
mkfs	New options, -l and -u , set the minimum and maximum security levels of a file system, respectively.
nfsdb	The ni command no longer needs a modifier and no longer accepts requests sdev and sino .
tpconfig	The CRAY-2 version has a new option, -n , that allows for the configuring of "sticky" (no-unload) devices.

4.2.25.3 CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems

The following administrator commands are new to CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems:

<u>Command</u>	<u>Description</u>
acct2csa	Shell procedure that converts multiple tacct files from UNICOS 4.0 to UNICOS 5.0 format; acct2csa is a subentry of the acctsh command.
chmem	Changes the system's notion of physical memory size
cosconv	Converts a UNICOS program into COS PDT format
csa4to5	Converts tacct files from UNICOS 4.0 to UNICOS 5.0 format; invoked by acct2csa .
ded	Runs a program in dedicated mode
devacct	Controls device accounting
fsoffload	Lists files and directories on a logical device
idmp	Performs SYSDUMP header initialization
mountd	NFS mount request server

<u>Command</u>	<u>Description</u>
netconf	Changes the state of N-packet "network" channels on the IOS
nfsd	NFS daemon
nfsstat	Displays NFS statistics
sem	Enables, disables, and displays semaphore timing information
ssd	Configures and displays SSD channels
swapper	Displays current system swapping activity
tpbmx	Displays operator information about tape devices

The following administrator command was removed from UNICOS:

<u>Command</u>	<u>Description</u>
vipw	Edits the password file

The following administrator commands have major changes:

<u>Command</u>	<u>Description</u>
bconfig	The -m option generates the setdev shell script.
bmap	There is a new block type, ACL block .
cpdmp	The -i option has been removed. New options, -n and -O , and a new operand, sysdump , have been added that allow cpdmp to accept multiple input files and to control the format of the output file.
crash	New commands: slipes , slmips .
fdmp	A new option, -i , has been added that allows fdmp to dump information from more than one IOS.
flaw	A new option, -e , has been added.

<u>Command</u>	<u>Description</u>
genecat	The format of the <code>/etc/fstab</code> file has changed.
hsxconfig	Can now configure a path in auto header mode
ldcache	A new option, <code>-a</code> , has been added.
mkfs	A new option, <code>-r</code> , that restores the super block has been added. Two new options, <code>-l</code> and <code>-u</code> , have been added for secure UNICOS systems.
rdump	No longer accepts keys; accepts options.
rrestore	No longer accepts keys; accepts options.
schedv	This command has been completely rewritten. There are new options and functions. The man page now includes how to calculate swap priorities.
suspend	The <code>-j</code> option is no longer deferred
surf	New option, <code>-e</code> , that inhibits data recovery in the blocks <code>surf</code> is attempting to flaw

4.2.26 New or changed system calls

This list describes new or changed system calls for the UNICOS 5.0 release. System calls are documented in *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012.

<u>System Call</u>	<u>Description</u>
access	Now supported on all systems, including those with the UNICOS security feature enabled; ENOENT error condition added.
chacid	New system call; changes disk file account ID.
chdir	Now supported on all systems, including those with the UNICOS security feature enabled

<u>System Call</u>	<u>Description</u>
chkpnt	Now may be used on processes with unlinked files; error conditions EFBIG, EXDEV, EFILESH and ENOTTY added.
chmem	(CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems only) New system call; retrieves or modifies system physical memory availability.
chmod	Synopsis line changed
creat	Now supported on all systems, including those with the UNICOS security feature enabled
devacct	(CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems only) New system call; controls device accounting.
dmmode	New system call; sets and gets data migration retrieval mode.
dmofrq	New system call; processes off-line requests.
exctl	(CRAY-2 systems only) New system call; exchanges control.
fsecstat	Now supported on all systems with the UNICOS security feature enabled; gets file security status (see <i>secstat</i>).
fstatfs	<i>fstyp</i> added to support SUPERLINK and NFS features now valid on all Cray computer systems (see <i>statfs</i>)
getfacl	Now supported on all systems with the UNICOS security feature enabled; gets access control list for file.
getfemp	Now supported on all systems with the UNICOS security feature enabled; gets compartments of named file.
getflvl	Now supported on all systems with the UNICOS security feature enabled; gets security level of named file.

<u>System Call</u>	<u>Description</u>
getjtab	New structure members added; synopsis line changed.
getsysl	Now supported on all systems with the UNICOS security feature enabled; gets minimum and maximum security levels for UNICOS. NOTE: This system call will not be supported in the UNICOS 6.0 release.
gettimeofday	New system call; gets date and time.
getucmp	Now supported on all systems with the UNICOS security feature enabled; gets user's active compartments.
getlvl	Now supported on all systems with the UNICOS security feature enabled; gets user's active security level.
getusrv	Now supported on all systems with the UNICOS security feature enabled; gets user's security validation information; new structure members added.
ialloc	New for CRAY-2 systems. Now supported on all Cray computer systems; supports preallocation; synopsis line changed; error conditions EBADF, EBIG, and ENOSPC added.
kill	Synopsis line changed
limit	Descriptions of the following added for the <i>resource</i> argument: L_TAPE <i>n</i> , L_PIOH, L_PBUF, L_FSBLK, L_CORE.
limits	New system call; returns or sets limits structure.
link	EMANV error condition added
listio	ENOSPC error condition added
mkdir	EACCES error condition added

<u>System Call</u>	<u>Description</u>
mknod	New file types 0110000 and 0120000 added for the <i>mode</i> argument; a description of the file handle for an off-line file added; new error conditions added.
mount	Synopsis line changed; new error conditions added.
open	Error conditions EINVAL, EOFFLIN, EOFLNDD, EDMOFF, and EOFLNRR added.
profil	Description of <i>offset</i> argument changed to include 1/10000 second for CRAY-2 systems, and changed to include "every interval specified by rate" for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems.
resch	Synopsis line changed
restart	Error condition ENOSPC added
rmfac	Now supported on all systems with the UNICOS security feature enabled; removes an access control list from a file.
schedv	(CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems only) New features support added.
secstat	Now supported on all systems with the UNICOS security feature enabled; gets file security status. Also, <i>long st_gen</i> member was added for CRAY-2 systems.
select	Now supported on all systems; examines synchronous I/O multiplexing; synopsis line changed.
setfac	Now supported on all systems with the UNICOS security feature enabled; sets access control list for file.

<u>System Call</u>	<u>Description</u>
setfemp	Now supported on all systems with the UNICOS security feature enabled; sets the file's compartments; EPERMIT and EINVAL error conditions added.
setflvl	Now supported on all systems with the UNICOS security feature enabled; sets directory or file security level.
setsysl	Now supported on all systems with the UNICOS security feature enabled; sets security levels for UNICOS. NOTE: This system call will not be supported in the UNICOS 6.0 release.
settimeofday	New system call; sets date and time.
settfm	New system call now supported on all systems with the UNICOS security feature enabled; sets and gets trusted facility mask.
setucmp	Now supported on all systems with the UNICOS security feature enabled; sets user's active compartments; EMANDV error condition added.
setulvl	Now supported on all systems with the UNICOS security feature enabled; sets user's active security level; EMANDV error condition added.
setusrv	Now supported on all systems with the UNICOS security feature enabled; sets user's validation information.
sigblock	Now supported on all systems; adds signals to mask of currently held signals.
signal	Synopsis line changed. Signals 33 through 64 are available for users; however, on CRAY-2 systems signals 33 and 34 are used by the Fortran library.
sigset	Synopsis line changed

<u>System Call</u>	<u>Description</u>
sigsetmask	Now supported on all systems; sets signal hold mask.
slgentry	Now supported on all systems with the UNICOS security feature enabled; makes security log entry.
statfs	<i>fstyp</i> added to support SUPERLINK and NFS features now valid on all Cray computer systems
sysconf	Several requests were modified.
sysfs	Now supported on all systems; gets file system type information.
target	New for CRAY-2 systems. Now supported on all Cray computer systems; retrieves or modifies machine characteristics.
_texit	New system call; terminates process.
_tfork	Return value changed. Upon successful completion, _tfork returns to each process its own <i>pid</i> ; if the _tfork fails, -1 is returned.
thread	(CRAY-2 systems only) Structure members changed
time	Synopsis line changed
uendsngl	Removed; ended single-threading of a multitasking group.
usngl	Removed; started single-threading of a multitasking group.
ustat	Synopsis line changed
write	ENOSPC error condition added
writea	ENOSPC error condition added

4.3 Enhancements to UNICOS compilers

This subsection indicates the availability of the UNICOS compilers that are supported by the UNICOS 5.0 release.

4.3.1 CFT77 compiler

The CFT77 3.0 compiling system, which is released independently, supports autotasking and includes the **fpp** Fortran dependence analyzer, the **fmp** Fortran multitasking translator, and related library modifications. CRAY-2 computer systems require the CFT77 3.1 release for autotasking support. See subsection 4.5, "Enhancements to Software Products," for information on **fpp** and **fmp**, and see the *CFT77 3.0 Release Notice* or the *CFT77 3.1 Release Notice* for information on the appropriate CFT77 release.

NOTE: The UNICOS 5.0 release includes a version of the CFT77 compiler used to generate products and libraries that use Fortran; both the binary and source code are included, and a CFT77 license is required.

4.3.2 CFT2 compiler

The UNICOS 5.0 version of the CRAY-2 Fortran (CFT2) compiler is packaged with the UNICOS 5.0 release and includes the following major additions:

- Full ANSI Fortran 77 implementation, including:
 - Character expressions involving concatenation
 - Character substrings (previously supported in EQUIVALENCE only)
 - Functions and statement functions of type CHARACTER
 - Character arguments to statement functions

- **TASK COMMON and CHARACTER entity support in the Cray extension NAMELIST**
- **Character loop optimizations and additional vectorization for enhanced performance**
- **Syntax checking for character constants used in I/O control lists as the format; this feature performs syntax checking at compile time rather than at run time.**
- **New and faster entry and exit sequences for recursive routines and for the Local Memory paging option**
- **Fortran 8x embedded comments; comments are allowed on Fortran source lines following an exclamation point.**
- **The -V command line option, which prints compiler statistics to stderr**

4.3.3 CFT compiler

For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, CFT 1.15 Bugfix 3, revision 1 is available from the Distribution Center in Mendota Heights, but it is not included with the UNICOS 5.0 release. Please refer to the *CFT 1.15 Bugfix 3, Revision 1 Release Letter* for further information. The UNICOS 5.0 release will also support the CFT 1.16 release, which will be released independently.

4.3.4 Cray C compiler

Cray C 4.1, which is released independently, is the default vectorizing C compiler for all Cray computer systems running the UNICOS 5.0 release. Cray C 4.1 is invoked through the `cc` command. The `occ` and `vec` commands are no longer supported on CRAY-2 computer systems.

The Cray C 4.1 compiler no longer translates underscore characters used in external names. For CRAY-2 computer systems, previous versions of the Cray C compiler translated the underscore character to @. For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, previous versions of the Cray C compiler translated the underscore character to \$.

Entry names in library routines have been changed. This modification was made to provide for UNIX compatibility, to improve compatibility with other languages, and to simplify debugging.

By default, the underscore characters within external names are left untranslated. However, using the `-h nounderline` code generation option on the command line translates underscore characters to @ for CRAY-2 computer systems and to \$ for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems.

Also, by default, messages are no longer issued for an invalid use of a structure. However, using the `-h strmesg` code generation option on the command line enables warning messages to be issued for invalid use of structures.

See section 7, "Compatibility/Differences," for additional information.

The Cray C 4.1 compiler is documented in the *Cray C 4.1 Release Letter*, which is included with the UNICOS 5.0 release package, and in the *Cray C Reference Manual*, revision C, publication SR-2024.

4.3.5 Pascal compiler

For all Cray computer systems, the UNICOS 5.0 release includes Pascal 4.0. The Pascal 4.0 compiler is documented in the *Pascal 4.0 Release Notice*, which is included with the UNICOS 5.0 release package, and in the *Pascal Reference Manual*, revision E, publication SR-0060. A Pascal license is required.

4.3.6 CAL version 2 assembler

The CAL version 2 assembler, release 3.2, supports all Cray computer systems running the UNICOS 5.0 release. The CAL version 2 assembler is documented in the *CAL Assembler Version 2 Reference Manual*, publication SR-2003.

4.3.7 Cray Standard C compiler

The UNICOS 5.0 release supports Cray Standard C 1.0. Cray Standard C 1.0 is released independently; see the *Cray Standard C 1.0 Release Notice* for additional information.

4.3.8 Cray Ada compiler

For CRAY X-MP systems with EMA (Extended Memory Addressing), CRAY X-MP/se, CRAY Y-MP (compatibility mode only), and CRAY-2 computer systems, the UNICOS 5.0 release supports Cray Ada 1.0.3. Cray Ada 1.0.3 is released independently; see the *Cray Ada 1.0.3 Release Notice* for additional information.

4.3.9 Cray Allegro Common Lisp compiler

The UNICOS 5.0 release will support Cray Allegro Common Lisp 1.0, which will be released independently. See the *Cray Allegro Common Lisp 1.0 Release Notice* for additional information.

4.4 Enhancements to UNICOS libraries

This subsection describes enhancements to the UNICOS libraries for the UNICOS 5.0 release.

4.4.1 Library enhancements for all Cray computer systems

The following enhancements have been made to libraries on all Cray systems.

4.4.1.1 Scientific library (*libsci*)

- Optimized CAL implementations of the unpacked Level 2 Basic Linear Algebra Subprograms (BLAS) and the Level 3 BLAS for both real and complex data types are now available on all Cray systems, except on CRAY-1 computer systems where only Fortran implementations are available. Fortran versions of the packed Level 2 BLAS are also available on all Cray systems.
- Extensions to the BLAS 3 matrix multiplication routines SGEMM and CGEMM based on a variation of Strassen's algorithm are also available as subroutines SGEMMS and CGEMMS. These routines allow matrix multiplication to be done up to 50% faster than the traditional way.

These routines are documented in *Volume 3: UNICOS Math and Scientific Library Reference Manual*, publication SR-2081.

4.4.1.2 Underscore character translation

To improve compatibility with other languages and to simplify debugging, the C compiler no longer translates underscore characters used in external names. Entry names in library routines have been changed appropriately. This change was made to improve compatibility with other languages and to simplify debugging. See subsection 4.3.4, "Enhancements to UNICOS Language Processors," for additional information.

Note that library names that contain @ characters (CRAY-2 computer systems) and \$ characters (CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems) that have been documented in the past as accessible to the user are still supported. These routines have dual entries, one as has been supported in previous releases and one with underscore character support.

For CRAY-2 systems, to help CAL programmers access C entry points with underscore characters, the u1 and u2 micros have been made available in ASDEF. These micros resolve to the underscore character after one pass and two passes of CAL editing, respectively. Documented entry point names that contain the underscore character have corresponding @ character entry points in the UNICOS 5.0 system.

4.4.1.3 Facilities to convert foreign data

In the UNICOS 5.0 release, there have been extensive enhancements to the available facilities to convert foreign data. Several explicit data conversion routines have been added to the set of available routines.

In addition, a powerful new facility has been added that allows the Fortran programmer to directly read and write data files in the format of other vendors' computer systems. This is generally referred to as implicit data conversion or foreign data conversion. This capability is built in to the Fortran I/O library and can be controlled by the `assign` command.

On all Cray computer systems, IBM record formats U, F, FB, V, VB, and VBS are supported on tape and disk. Optionally, data items in the records can be converted between Cray internal format and IBM numeric and character formats during I/O. No program changes are normally required to take advantage of this feature. In addition to IBM formats, CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems also support several other formats (see subsection 4.4.3.2).

4.4.1.4 *procstat utility*

Library support for the I/O statistics utility **procstat** has been added. For CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, support for the **procstat** utility is built in; for CRAY-2 computer systems, it must be requested by linking the program with the **procstat** library (**/lib/libstat.o**).

Support for the I/O statistics utility is documented in the *UNICOS Commands Reference Manual*, publication SR-2011, and in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040.

4.4.1.5 *Network libraries*

The TCP/IP library, **libnet**, has been replaced entirely with the TCP/IP 4.3BSD version. A new library called **libonet** has been added to contain the routines needed to maintain compatibility with UNICOS 4.0 and older versions of UNICOS. These libraries are documented in *Volume 5: UNICOS Network Library Reference Manual*, publication SR-2057.

The X Windows libraries have been replaced with the Release 3 versions, which include **xlib**, **Xtoolkit**, **widgets**, **libext**, **libxmu**, and **oldx**. These libraries are documented in the O'Reilly and Associates manuals (see subsection 4.6.3, "X Window System").

Also, a new library (**libyp**) has been added as an option to support Yellow Pages as a source for passwords beyond UDB for the support of NFS. This library is documented in the *UNICOS Yellow Pages (YP) Administrator's Guide*, publication SG-2063.

4.4.1.6 *Treatment of Fortran end-of-file (EOF)*

In previous UNICOS systems, Cray Research provided a deferred EOF capability in Fortran for unexpected EOFs. (An unexpected EOF is one that is encountered on a READ statement that does not have an END or IOSTAT specifier.) Instead of aborting the program as required by the Fortran 77 standard, a flag was set that could be interrogated with the EOF or IEOF function. A READ that immediately

followed (without a REWIND or BACKSPACE) would then cause an abort. That is, in order to give the user the opportunity to call the EOF function and evaluate its results, a program that had read an unexpected EOF did not terminate.

This policy had one serious drawback: If the user encountered an unexpected EOF and did not call the EOF function nor immediately do another READ, the iolist variables specified with the READ were undefined with no indication. This means that by providing the deferred EOF capability, a "trap" was created for Fortran users.

CRI is implementing a two-phase solution. In UNICOS 5.0, a warning message is issued to `stderr` whenever a Fortran READ encounters an unexpected EOF. The EOF and IEOF functions also issue a one-time warning message advising that they will be eliminated in a future release and that an END or IOSTAT specifier on the READ statement should be used.

In a future UNICOS release, the libraries will be changed to cause an unexpected EOF to terminate the program as specified in the Fortran 77 standard, and the EOF and IEOF functions will be eliminated.

Thus, in UNICOS 5.0 all existing Fortran programs continue to function as in the past, but with the added benefit that all Fortran programs are guaranteed an indication that an unexpected EOF has been read. Further, users of the EOF and IEOF functions will be directly advised to convert their programs to use the standard constructs for detecting EOFs.

Sensible

4.4.1.7 *User striping and preallocation support*

A common user interface to striping and preallocation now exists for all Cray systems running the UNICOS 5.0 release. See subsection 4.2.11, "User-level disk striping and preallocation," for additional information.

4.4.1.8 Library dependency for PREMULT

The UNICOS 5.0 libraries cannot be used with PREMULT 4.0. In the UNICOS 5.0 release, **fmp** has replaced PREMULT and cannot be used with UNICOS 4.0 libraries. If a site is running libraries other than the default UNICOS 5.0 libraries, it should retain PREMULT 4.0 to run with those libraries in addition to **fmp**. See subsection 4.5.5.2, "**fmp** and PREMULT," for additional information.

4.4.1.9 C library (*libc*)

The following enhancements have been made to the C library (*libc*) on all Cray computer systems:

- The **ffopen**, **ffread**, **ffwrite**, and **ffclose** routines have been added to support foreign dataset conversion.
- The **getpwent**, **id2nam**, **initgroups**, and **putpwent** routines have been modified to support multi-level security. A new routine, **secnames**, has also been added to support this feature.
- The **udblib** routines have been added to support the new user database (UDB) feature.
- The routine **getfsent** has been superseded by **getmntent** to support the UNICOS NFS feature.
- The routines **clrdpid**, **getdpid**, and **setdpid** have been added to support daemon accounting.
- The routines **libyp**, **librpc**, **librpcsvc**, and **libnet** are supported within *libc* if yellow pages (YP) is built on the system.

These routines are documented in the *Cray C Library Reference Manual*, publication SR-0136.

4.4.1.10 Fortran library I/O error message numbers

The IOSTAT= specifier in a standard Fortran I/O statement must contain one of the following values on return from a Fortran I/O statement:

- Negative value for end-of-file status
- Zero for successful status
- Positive value for error status

Programs that check for these types of values are more portable between Cray systems and more compatible between release levels of a system than programs that check the actual status values returned by a system. The status values may change over time and new status values may be added to provide more information about an error or end-of-file condition.

The error numbers and their corresponding messages are provided to assist the Fortran programmer in program debugging.

4.4.2 Library enhancements for CRAY-2 computer systems

The following enhancements have been made to libraries on CRAY-2 computer systems.

4.4.2.1 Autotasking

Library support (*libauto.a*) for the autotasking feature of the CFT77 compiler has been added for CRAY-2 computer systems. The CFT77 3.1 compiler is required, which is released separately. Autotasking is now supported on all Cray computer systems with multiple processors.

4.4.2.2 Multi-threading I/O improvements

In the UNICOS 5.0 release, the Fortran I/O library is multi-threaded. For the standard Fortran I/O methods, multiple tasks can be performing I/O in parallel when they use different units. For example, in a multitasking job, one

task can be reading from unit number 7 while another task writes to unit number 8. However, only one execution thread is permitted for each unit. If both tasks need to use the same unit, then one of them will wait. The best performance boost that can be achieved is in doing formatted I/O, which is highly CPU intensive. Codes that are modified to perform sequential formatted I/O on 4 units in parallel can expect speedups of up to 3.4 times during the I/O. For most other cases, no difference should be observed.

4.4.2.3 New \$REPEAT and \$UNTIL macros

The new \$REPEAT and \$UNTIL structured programming macros define a block of code that is repeated until a condition is satisfied. These macros are analogous to the versions running on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems. The \$REPEAT and \$UNTIL macros may be nested to any depth, although nesting more than three levels can decrease program clarity.

The new \$REPEAT and \$UNTIL structured programming macros are documented in the *UNICOS Macros and Opdefs Reference Manual for CRAY-2 Computer Systems*, publication SR-2082.

4.4.2.4 Targeting

The `target` command is new on CRAY-2 computer systems, enabling Cray compilers to generate better code on CRAY-2 systems. However, users cannot cross-compile a program on CRAY-2 systems and target it for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, or CRAY-1 computer systems or vice versa. Users can, however, use `target` as an on-line command to get machine characteristics on a CRAY-2 system.

4.4.2.5 Fortran library (libf)

The following enhancements have been made to the Fortran library (libf) :

- Support has been added to allow implicit translation of file structures and type data conversion for IBM formats. The **assign** command has been modified and the **asgcmd** command has been added.
- Support has been added for reading and writing of tape marks. This feature was added for COS equivalency.
- Bad data can now be skipped over through the use of the SKIPBAD routine. This feature was added for COS equivalency. See *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079, for more information.
- To improve performance and support parallel processing, several tasks can now perform I/O in parallel on different units; this is available for all synchronous types of standard Fortran I/O. See subsection 4.4.2.2, "Multi-threading I/O improvements."
- libf now supports NAMELIST I/O for TASK COMMON data and character data type.
- To provide COS compatibility, an asynchronous I/O interface has been added that uses the listio system call. This interface consists of the routines AQOPEN, AQCLOSE, AQREAD, AQREADC, AQWRITE, AQWRITEC, AQSTAT, and AQWAIT. These routines are documented in *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079.
- A library interface allows users to handle tape end-of-volume processing. This interface consists of the routines CHECKTP, CLOSEV, SETSP, and ENDSP. These routines are documented in *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079.
- The BUFFER IN/BUFFER OUT I/O method is now available on blocked files, allowing partial record and full record modes. This I/O form is now supported on all Cray computer systems.

- The @ character has been added to intrinsic library routine names that can be passed as arguments. This allows users to define their own routines with intrinsic names and not conflict with supported intrinsics.
- ISHELL (assign) calls from Fortran are now supported so that the file assignments can be made within a Fortran program to take effect during the ISHELL execution of the program.

4.4.2.6 C library (libc)

The following enhancements have been made to the C library (libc):

- To improve performance, the `memcmp()`, `strcmp()`, and `strncmp()` functions have been rewritten in CAL and have been vectorized. Speed ups range from 200 to 400 times for the `memcmp()` function and from 100 to 200 times for the `strcmp()` and `strncmp()` functions.
- `libc` and the common startup routine (`csu`) have been changed to support expandable common blocks. See the *Segment Loader (SEGLDR) and ld Reference Manual*, publication SR-0066, for additional information.
- The `syslog` routine has been added to support system log activity.

These routines are documented in the *Cray C Library Reference Manual*, publication SR-0136.

4.4.2.7 Utility library (libu)

The following enhancements have been made to the utility library (libu):

- The explicit VMS data conversion has been implemented with this release and is documented in *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079.

- IEEE explicit data conversion routines have been implemented for foreign dataset conversion. These routines are documented in *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079.

4.4.3 Library enhancements for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems

The following enhancements have been made to libraries on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems.

4.4.3.1 Multitasking library routines

To simplify user access to libraries, multitasking library routines are now part of the standard library set. All library codes run with a stack, and the default for assembly code is STACK. There is now only one version of libraries, and this version supports multitasking; static libraries are no longer necessary or supported. Users now load with the default libraries whether or not they are multitasking code.

4.4.3.2 I/O library (*libio*)

The following enhancements have been made to the I/O library (*libio*):

- For implicit data conversion, IBM formats U, F, FB, V, VB, and VBS are supported in addition to IBM numeric formats. Also, VMS formats for fixed length, variable length, and segmented records are supported for labelled tape, unlabelled tape, and disk. VMS numeric formats are also supported.
- In addition to the explicit routines available in UNICOS 4.0, routines have been added that allow conversion of CDC numeric formats and character sets. In UNICOS 5.0, IBM, VMS, and CDC explicit conversion is now supported.
- NAMELIST routines are available to CFT77 users; these routines provide support for character data. The CFT77 3.1 release is required.

- The POSITION parameter is now supported on the CFT77 OPEN statement. The CFT77 3.1 release is required.
- Users can now handle tape end-of-volume status. This feature was added for compatibility across Cray computer systems.
- The limits on the number of open COS blocked and BMX (tape) files have been removed. The limit on open COS files was previously 50, and on BMX files it was 40. The structures for these file types are now dynamically allocated, saving memory when not used. The total number of open UNITS is still 100 numbered UNITS and 20 named UNITS, respectively.

4.4.3.3 *libperf.a* library

Enhancements have been made to the Perftrace library, *libperf.a*, to support Perftrace changes; see subsection 4.5.5.5, "Perftrace," for a description of Perftrace changes.

4.4.3.4 *libprof.a* library

Enhancements have been made to the library, *libprof.a*, to support *prof* changes; see subsection 4.5.5.7, "*prof* and *profview*," for a description of *prof* changes.

4.4.3.5 *Targeting*

Enhancements have been made to libraries to support the *target* command and system call. Users of CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems can generate correct programs that are subsequently run on any of these systems. For example, a program may be prepared on a CRAY X-MP EA system running in 24-bit mode (X-mode) for execution on a CRAY Y-MP system running in 32-bit mode (Y-mode).

4.4.3.6 *Scientific library (libsci)*

The matrix-vector multiplication routines MXV, MXVA, SMXPY, and SXMPY and the matrix-matrix multiplication routines MXM and MXMA have been microtasked. Users calling these routines may get assigned multiple CPUs. To get only one processor, the environment variable NCPUS should be set to 1.

4.4.3.7 *libheap*

libheap is no longer supported. **libheap** was provided in previous UNICOS releases because of problems with the default heap manager in **libu**. These problems have been fixed and, as a result, support for **libheap** has been discontinued. If users require **libheap** for their site, the site should save the source from their UNICOS 4.0 release and submit an Software Problem Report (SPR) to explain why it is required.

4.5 Enhancements to software products

The following products have been added or enhanced to support the UNICOS 5.0 release.

4.5.1 APML 3.1, ADSTAPE 2.2, and BIND 2.2

APML is the assembly language used on the IOS, and ADSTAPE and BIND are the IOS software generation utilities for Cray computers systems using an IOS; they are documented in the *UNICOS Administrator Commands Reference Manual*, publication SR-2022, and in the *APML Assembler Reference Manual*, publication SM-0036. Also, see the *IOS 5.0 Release Notice*. Note that these products are the same versions as those released with the UNICOS 4.0 release.

4.5.2 Cray Simulator (CSIM) 5.0 enhancements

CSIM is supported on the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems. The following enhancements have been made to CSIM for the UNICOS 5.0 release:

- Support for symbol table structures generated by UNICOS products, which allows reference to symbols within CSIM directives
- Simulation of the VME (FEI-3) to provide support of the Operator Workstation **boot** and **start** commands
- Emulation of mainframe communication with individual I/O processors through low-speed channels (IOS Model D and IOS release 5.0 are required)

The following publications support the 5.0 release of CSIM:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *CSIM User's Guide for UNICOS*, publication SG-2059
- *CSIM Ready Reference for UNICOS*, publication SQ-2031

4.5.3 Debuggers

A new debugger, CDBX, is available with this UNICOS release. The **dbx** debugging utility is no longer supported, and this is the final release of DRD and DDA. In addition, the **adb** utility was made a common command.

4.5.3.1 *adb*

The **adb** utility is now a common command on all Cray computer systems running the UNICOS 5.0 release. The version of **adb** released for CRAY-2 computer systems in the UNICOS 4.0 release was ported to CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems, replacing the version previously released for those systems. In addition, a number of bugs were fixed.

4.5.3.2 CDBX

The new CDBX debugger is supported on all Cray computer systems. CDBX is a source-level, symbolic, interactive debugger. Based on the 4.3BSD dbx debugger, CDBX contains enhancements to improve its utility on Cray computer systems and with applications written in Fortran. The first release of the CDBX debugger is part of the UNICOS 5.0 release.

CDBX is a powerful debugger that permits interactive debugging of applications written in Fortran, C, Pascal, or CAL (and any combination), running on any Cray mainframe.

CDBX provides the following key features:

- Breakpoints can be placed at source lines, at statement labels, upon entrance to subroutines, or at absolute addresses; or when breakpoints can be conditional, depending on the values of variables. For example, **stop in subx if j > 33**.
- Traces are provided, with all the options of breakpoints. These traces display information and then automatically resume execution.
- Stepping is provided, by source line or by instruction. In addition, users can step into subroutines or step across subroutine calls to the next line or instruction in the current function.
- Variables or memory locations can be printed with their defined type or in a number of alternative formats. A user can also print expressions involving variables and constants (**print avalue/asize**).

NOTE: With this initial release of CDBX, users are not able to specify elements of structures (**today.day**) in expressions, and the dereferencing of pointers (***cp**) always results in an integer value. Users can specify elements of arrays and can print entire structures (seeing all elements). These limitations will be removed in a later release.

- Variables or memory locations can be modified.
- Simple macro capabilities and the ability to rename or abbreviate commands are provided to support aliases.

CDBX includes commands that provide on-line help, handle signals, and provide information about symbols. CDBX uses source files, if available, printing the current source line when program execution reaches a breakpoint or completes a "step." It has commands to list lines from the source file, search the source file for character strings, and invoke an editor to more carefully examine or change the source file. A CDBX user can use symbolic references to variables, subroutines, or labels, or can use absolute addresses, and also has access to all of the registers in the mainframe. CDBX also has commands that help debug corefiles created when multitasked applications fail; future releases will include additional support for debugging of multitasked applications.

CDBX is documented in the *UNICOS CDBX Symbolic Debugger Reference Manual*, publication SR-2091, the *UNICOS CDBX Debugger User's Guide*, publication SG-2094, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.3.3 dbx

The **dbx** debugger is no longer supported; it has been replaced by the new CDBX debugger.

4.5.3.4 DRD and DDA, Version 4.3

This is the final release of the Cray Dynamic Runtime Debugger (DRD) and Dynamic Dump Analyzer (DDA), which are being replaced by CDBX. Version 4.3 differs from version 4.2 only by a number of bugfixes. DRD and DDA will not be released with UNICOS 6.0.

The *UNICOS Symbolic Debugging Package Reference Manual*, publication SR-0112, revision C, remains available to support DRD and DDA 4.3 and 4.2.

4.5.3.5 *DEBUG 5.0*

Version 5.0 of *DEBUG* differs from version 4.2 only by a number of bugfixes.

The *UNICOS Symbolic Debugging Package Reference Manual*, publication SR-0112, revision C, remains available to support *DEBUG 5.0* and 4.2.

4.5.4 Graphical Multiprocessing Analysis Tool (GMAT)

The *GMAT* package consists of two commands, *stategraph* and *timeline*, which provide graphical displays of trace data from multitasked applications.

GMAT, available from the Distribution Center in Mendota Heights, can be run with trace files built on *UNICOS 5.0*. *GMAT* is not packaged and released with *UNICOS*, although it is intended to be released with future *UNICOS* systems. *GMAT* runs on Sun Workstations using the SunView window system.

4.5.5 Performance tools

The following performance tools have been enhanced or are new for this *UNICOS* release.

4.5.5.1 *fpp*

fpp is the Fortran dependence analyzer of the Autotasking system. *fpp* recognizes parallelization and vectorization opportunities and inserts autotasking and vectorizing directives for other parts of the autotasking compilation system to use.

fpp is packaged with the CFT77 release. **fpp** is documented in the *UNICOS User Commands Reference Manual*, publication SR-2011, and in the *Autotasking User's Guide*, publication SN-2088.

4.5.5.2 *fmp* and PREMULT

fmp is a Fortran translator. **fmp** recognizes microtasking and autotasking directives (for parallelism exploitation) and creates a source file that is readable by CFT77.

fmp replaces PREMULT for the UNICOS 5.0 release. Note, however, that the **premult** command line has not changed; that is, the user types in the command **premult**, as in earlier releases, and **premult** calls **fmp**. The only difference users will see is that microtasking directives are expanded into different code compared to what was generated by PREMULT 4.0. Note, however, that microtasked saved relocatable binaries that are run through PREMULT 4.0 will not execute under the UNICOS 5.0 system.

Since the PREMULT 4.0 and the UNICOS 5.0 libraries are NOT compatible, microtasked programs must be processed by **fmp/premult** before they can be executed under the UNICOS 5.0 system. On CRAY-2 systems, **libmicro** is the microtasking library and **libauto** is the autotasking library.

See subsection 4.3.1, "CFT77 compiler," for CFT77 release levels required for autotasking support. Note that **fmp** 3.0.1 is released with the UNICOS 5.0 release; **fmp** 3.1 will be released with the CFT77 3.1 release.

fmp is documented in the *UNICOS User Commands Reference Manual*, publication SR-2011, and in the *Autotasking User's Guide*, publication SN-2088.

The **premult** command is documented in the *UNICOS User Commands Reference Manual*, publication SR-2011, the *CRAY-2 Multitasking Programmer's Manual*, publication SN-2026, and the *CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP Multitasking Programmer's Manual*, publication SR-0222.

4.5.5.3 FTREF 5.0

FTREF 5.0 runs on all Cray computer systems running UNICOS 5.0. FTREF has been enhanced to allow sorting of variables in the global variable cross-reference listing. There are three distinct sort options available: alphabetical, common block, and address. FTREF also now displays unreferenced routines as part of the static calling tree report. In addition, users of CFT77 may now optionally prevent the display of unreferenced variables in the global variable cross-reference listing.

FTREF is documented in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.5.4 hpm

The **hpm** command has a new report format that provides better and more readable hardware performance information to the user. A new option generates the output statistics in a raw form for easier post-processing. A second new option shows megaflop values for both CPU time expended and wall-clock time used, which is useful for multitasked codes.

The **hpm** command is supported on CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP systems and is documented in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.5.5 Perftrace

The Perftrace tool on CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP systems has been enhanced to improve user control of its operating parameters. The tool has been enhanced to include an optional raw output format. Overhead time required by using Perftrace has been significantly lowered. A new option allows removal of frequently-called routines from the tracing process. Users now receive Perftrace output even if their codes do not terminate with a Fortran STOP statement. Users may now

use Perftace on specific, selected routines without enabling tracing for an entire code. A new program, `perfdmp`, has been added that post-processes the core dump file in case a program using Perftace aborts during execution.

Perftace is documented in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.5.6 *procrpt and procstat*

The `procrpt` command provides reports of statistics assembled from the use of the `procstat` tool by the user program. The report format provided by `procrpt` is more usable than the report format provided by using only `procstat`. The `procrpt` command is documented in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

`procstat` collects statistics of I/O and memory usage in user codes. I/O, memory, process status, and SDS activity are reported on a per file and a per process basis. The raw format output may be used by other, more complex analysis programs. The new `procrpt` utility is an example of such a post processor. A production program may access the statistics by being invoked through `procstat` (much like `time`). This tool presents information similar to that obtained from the `COS OPTION,STAT` command. All Cray computer systems support `procstat` in UNICOS 5.0; on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems, `procstat` is available by default on all programs. On CRAY-2 systems, `procstat` may be enabled by linking with the `procstat` library (`/lib/libstat.o`).

`procstat` is documented in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.5.7 *prof* and *profview*

The **prof** command now displays compiler-generated debugging symbols, such as statement labels and loop numbers, in its report output. Thus, users are better able to see time spent in a subroutine down to the statement level. A new feature has been added that allows "filtering out" listings of buckets below a specified hit count. This command has a new option that generates the output statistics in raw form for easier post-processing.

The profiling process itself has been enhanced on CRAY-2 systems to give better accuracy by faster sampling. On CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems, the default profiling has been altered to improve the granularity of sampled data by reducing the bucket size.

The **profview** command provides an interactive display of the output from the **prof** utility.

The **prof** and **profview** commands are documented in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.6 SEGLDR 5.1

SEGLDR 5.1 runs on all Cray computer systems running the UNICOS 5.0 release. SEGLDR 5.1 includes the following enhancements:

- SEGLDR supports two alternatives to the UNICOS **segldr** command. Prior to this release, **ld** on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems was a separate interface program that invoked **segldr**. Beginning with this release, **ld** and **segldr** are different invocations of the same loader. When invoked as **segldr**, the loader continues to execute as in previous releases. When invoked as **ld**, default settings for some directives are changed to provide traditional UNIX operations.

On CRAY-2 systems, the `sld` command (so named to avoid conflict with the current CRAY-2 `ld` program) provides traditional UNIX operations with SEGLDR. Both `/lib/lmset` and `/lib/csu` are supported in `/lib/libc.a`. Thus, they need not be supplied on the `sld` command line when invoked. Note, however, they should be specified on the `ld` command line.

- SEGLDR optionally supports libraries that depend on the order of modules in the libraries to select among duplicated entry points, which is similar to the traditional UNIX `ld` command. The new directive `DUPORDER=ON` enables this ordering option.
- SEGLDR now automatically computes the stack size dynamically during a link, unless the user employs a `STACK` directive or the `-S` option to explicitly set the stack size and increment.
- SEGLDR can now generate split-segment programs. Split-segment programs are separated into a code section and a data section, which SEGLDR allocates separately. On CRAY X-MP systems with EMA and on CRAY Y-MP systems, where all code must be loaded in the first 4 Mwords of memory, this feature permits data to be loaded above the 4-Mword limit, reserving the first 4 Mwords for code. This can permit loading of programs with large data areas in their root segments; such programs could not otherwise be loaded.
- Two options have been added to the UNICOS `segldr` command line that invokes SEGLDR. These options, `-H` and `-S`, permit users to set the initial and increment values for the stack, for the heap, or for both.
- Expandable common support has been added for CRAY-2 computer systems and is now supported on all Cray computer systems running UNICOS 5.0. This feature allows programs to increase the size of one common block at execution time.
- Symbol table generation for segmented programs is now supported; this is not yet supported by the debuggers.
- Support is provided on CRAY-2 computer systems for program segmentation.

- Messages about duplicated entry points that are not needed are now suppressed as are unnecessary messages about entry points in libraries.
- The **SEGLDR** environment variable accepts directives as well as the names of files containing directives.
- New directives simplify the task of selecting nonstandard default libraries.
- New segmentation routines use a faster form of I/O to swap segments.

SEGLDR 5.1 is documented in the *Segment Loader (SEGLDR) and ld Reference Manual*, publication SR-0066, and the *UNICOS User Commands Reference Manual*, publication SR-2011.

4.5.7 UNICOS source management

Released with UNICOS 5.0 are three new products: **nupdate**, an extended and faster version of UPDATE; **nmodex**, an equivalent of MODECKS; and USM (using the **sm** command), UNICOS Source Manager. For UNICOS 5.0, only a few Cray products are released using USM.; it will be more widely used for UNICOS 6.0. Future releases of USM will incorporate more equivalent SCCS capabilities. USM is documented in the *UNICOS User Commands Reference Manual*, publication SR-2011, on the **sm** man page.

4.5.8 UPDATE 5.0

With the UNICOS 5.0 release, the UPDATE sequence number generation has changed. Mods that have a single IDENT changing multiple DECKS may have different sequence numbers generated with the UPDATE released with UNICOS 5.0 versus the UPDATE released with UNICOS 4.0. If you have one IDENT per DECK changed, then the UNICOS 5.0 UPDATE will work identically to the UNICOS 4.0 UPDATE version.

The `-o os` option has been added to the `update` command line to force the UNICOS 5.0 UPDATE to use the old sequence number generation scheme. This option was added to provide compatibility with UNICOS 4.0 UPDATE and to allow sites with local mods time to add them to the PL with the UNICOS 5.0 UPDATE.

4.6 Enhancements to Communications

In the UNICOS 5.0 release, enhancements have been made to TCP/IP, NFS, USCP, and SUPERLINK ISO/OSI-based protocols. In addition, support for the X Window System, Version 11, Release 3 is supported. For information on the Network Queueing System (NQS) or the Remote Queueing System (RQS), see subsection 4.2, "Enhancements to the Operating System."

4.6.1 TCP/IP

The 5.0 release of TCP is based on the summer of 1988 TCP/IP release from Berkeley, often referred to as the 4.3BSD tahoe code. The TCP/IP code in previous versions of UNICOS operating system was based on 4.2BSD.

See section 6, "Licensing and Ordering," for required TCP/IP licensing information.

UNICOS TCP/IP is documented in the following publications:

- *TCP/IP Network User's Guide*, publication SG-2009
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014
- *TCP/IP Network Administrator's Guide*, publication SG-2021
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022

- *Volume 5: UNICOS Network Library Reference Manual*, publication SR-2057
- *TCP/IP Table Descriptions Internal Reference Manual*, publication SM-2068
- *TCP/IP Protocol Definitions Internal Reference Manual*, publication SM-2069

The following subsections describe enhancements to TCP/IP for the UNICOS 5.0 release.

4.6.1.1 Full subnet address support

This release has full subnet addressing support. A variable `subnetmask` is specified when using `/etc/ifconfig` to configure an interface. This implementation is compliant with RFC 950.

4.6.1.2 UNIX domain sockets

In the early releases of TCP/IP for UNICOS, UNIX domain sockets were supported on CRAY-2 computers, but not on CRAY X-MP computers. With the UNICOS 3.0 release, the two source trees were merged, and UNIX domain sockets were not supported on either machine. With the UNICOS 5.0 release, support has been added back in for UNIX domain sockets; they are included as a compile-time option, so a site does not need to build them in to the system.

4.6.1.3 Performance enhancements

Improvements include slow-start TCP/IP, congestion control, and round trip time (RTT) estimation. Slow-start TCP/IP is a mechanism whereby a TCP/IP connection starts sending data slowly when a connection is established, and keeps increasing the speed at which data is sent until packet responses begin to be lost. Once this condition occurs, then the packet transmission rate is slowed until packets are no longer lost. The slow-start method keeps TCP/IP from suddenly overwhelming a gateway machine if the TCP/IP windows are very large, which they usually are on a Cray computer.

Improved congestion control allows for better detection and handling if a gateway or underlying hardware is having trouble. If a packet is detected as being lost, the connection reverts to the slow-start code.

The RTT is now kept as two values, both a mean and a variance. Very large values are also believed, and any packet that has to be retransmitted is not included in the RTT estimation. With these changes, the kernel keeps better track of how well a particular connection is working and how long it is taking packets to traverse it to determine when a packet must be retransmitted because it was probably lost.

4.6.1.4 Cray enhancements

In addition to new code received from other sources, Cray has added several new features to the kernel code. The **checksum** routine has been vectorized for all machines, which can reduce the time required to calculate the checksum of a single packet by a factor of five.

The buffer management (**mbuf**) code has been modified to provide a cache for holding various sized, pre-allocated **mbufs**. The **mbufs** are underlying data buffers used in the networking code.

The restricted routing feature that was implemented in the UNICOS 4.0 release continues to be available in the UNICOS 5.0 release.

Error messages and other informational messages are passed to the **syslog** service, where information is recorded and edited for the entire system.

4.6.1.5 Application features

Upgrading to the 4.3BSD networking code has included replacing most of the user-level applications with the 4.3BSD versions of the same commands and libraries.

In previous releases of the UNICOS operating system, the TCP/IP code had some incompatibilities with standard Berkeley TCP/IP socket interfaces. These differences have been addressed in the UNICOS 5.0 release. The **struct**

`sockaddr_in`, `struct hostent`, and library routines `inet_makeaddr()`, `inet_lnaof()`, `inet_netof()`, and `inet_ntoa()` have been changed to be source-code compatible with the latest BSD distribution. At the same time, compatibility has been maintained with previous versions of UNICOS TCP/IP by providing an option to compile and link programs using the 4.0 and previous UNICOS socket structures and library routines. See section 7, "Compatibility/Differences," for additional information.

4.6.1.6 *inetd*

The use of `inetd` is included, which is a program that listens for all port connections in place of each of the inbound daemons, such as `telnetd`, `rshd`, and `ftpd`. Once a connect is made for a port, then the appropriate daemon is called with the new port connection. The use of `inetd` reduces daemon memory consumption and swapping overhead. However, `/usr/lib/sendmail`, `ntalkd`, and `lpd` require their own processes.

4.6.1.7 *Berkeley Internet Name Domain (BIND) Server, version 4.8*

The UNICOS 5.0 release includes the Berkeley Internet Name Domain (BIND) Server, version 4.8. BIND is an implementation of the DARPA Internet name server, and it is used to replace the static `/etc/hosts` file. By default, the UNICOS 5.0 release will continue to use the `/etc/hosts` file; however, the libraries and applications are built to easily use either the resolver or the name server to resolve name-to-IP-address translations. The use of the name server or `/etc/hosts` for resolving Internet addresses is easily switched on line by using an environment variable.

4.6.1.8 *lpr/lpq, remote line printer*

The Berkeley line printer package is also provided in the UNICOS 5.0 release. This package allows printouts to be sent directly from a Cray computer to other machines that have line printers and run the Berkeley line printer protocols. Included are all the standard applications; `lpr` (to

spool jobs to be printed), */etc/lpd* (to print or transfer jobs to other systems), *lpq* (to print out the job queue), *lprm* (to remove jobs from the print queue), and */etc/lpc* (to control the daemons and queues).

4.6.1.9 *ntalk*

The UNICOS 5.0 release supports the *ntalk* protocol on all Cray computer systems. *ntalk*, released with 4.3BSD, is a modified version of the *talk* protocol that was released with 4.2BSD. *ntalk* allows two people to communicate with each other through the Cray computer, using a window-type interface. It also works across the network, so you can use *ntalk* to communicate with people on other machines.

4.6.1.10 *sendmail.MX*

The most recent Berkeley version of *sendmail* is supplied; this version recognizes the domain name server and MX (Mail eXchanger) records. It also includes all of the latest corrections to prevent unauthorized access and use of UNICOS through the mail system.

4.6.1.11 *rlogind and dumb telnetd*

The *rlogin* protocol is supported for inbound connections to CRAY-2 computer systems; a terminal driver was added to the */etc/rlogind* daemon to handle character processing. This same character processing is in the */etc/telnetd* daemon, so that dumb versions of *telnet* can work with CRAY-2 systems.

4.6.1.12 *New versions of old applications*

Several of the existing applications are being replaced by their 4.3BSD equivalents. These include *ftp*, *telnet*, *rlogin*, *tftp*, *rsh*, *rcp*, *rexecd*, and *finger*. These work the same as before with some improvements; however, the *rcp* program syntax changed slightly. Previously, the syntax for

specifying a file was `[machine[.user]:]pathname`, now it is `[[user@]machine:]pathname`. This change is necessary because, with the domain name system, a period is now a valid character in a machine's fully qualified domain name.

Other changes include line mode support by Cray telnet. Line mode was only supported with `telnetd` in previous UNICOS releases. Also, `tftpd` now authenticates external file accesses through the use of a list of validated path names with both read and write permissions specified. Without the authentication list, external `tftp` access is denied. In addition, `ftp` now provides support for macros, new 4.3BSD commands, and Internet security fixes for better access controls to UNICOS and its file system.

`netstat` has been upgraded to match the 4.3BSD features. One new feature allows the `-I` option to provide usage statistics for each individual network interface. The old `-I` option is now the `-S` option.

4.6.1.13 Mandatory access controls for network security

Mandatory access controls have been added in this release. These controls ensure that all remote access requests through TCP/IP are validated against the security policy set in the UNICOS kernel (see subsection 4.2.4).

4.6.1.14 netperf

The new `netperf` administrator utility has been added; it uses the X Window System to display real-time network activity statistics in a graphical form.

4.6.1.15 Standards conformance

The UNICOS 5.0 TCP/IP implementation is consistent with the authoritative standards for the Internet protocols and has made full use of the reference implementations as well as other available information. The Internet RFC standards are taken as precedent when a conflict occurs.

The DoD Defense Communication Agency (DCA) has been directed to provide conformance testing for the Internet standards. Cray Research is working with the DCA on conformance tests, which are evolving. As the conformance testing effort evolves and the results and policies become understood, information will be provided. The UNICOS 5.0 TCP/IP implementation is consistent with the following:

<u>Protocol</u>	<u>Internet RFC</u>	<u>MIL-STD</u>	<u>Description</u>
IP	791&950	1777	Internet Protocol
TCP	793	1788	Transmission Control Protocol
UDP	768	-	User Datagram Protocol
ICMP	792	-	Internet Control Message Protocol
SMTP	821	1781	Simple Mail Transfer Protocol
Mail	822	-	Mail message format
Domain Mail	974	-	Mail routing with the domain system
FTP	959	1780	File Transfer Protocol
TELNET	854	1782	Interactive Terminal Protocol
TELNET Options	855, 856, 857, 858, 860	-	Telnet options
TELNET Options	1091	-	Telnet terminal type option
TFTP	783	-	Trivial File Transfer Protocol
FINGER	742	-	NAME/FINGER Protocol
DOMAIN Names	1034 & 1035	-	Domain name service
Domain Mail	974	-	Mail routing and the domain system
Domain System	973	-	Domain system changes
Time	868	-	Time protocol
Daytime	867	-	Daytime protocol

<u>Protocol</u>	<u>Internet RFC</u>	<u>MIL-STD</u>	<u>Description</u>
Character Generator	864	-	Character generator protocol
Discard	863	-	Discard protocol
Echo	862	-	Echo protocol
Assigned Numbers	1010	-	Number code registration for fields in packets
HYPERchannel	1044	-	IP over NSC HYPERchannel
SUN RPC	1057	-	Remote Procedure Call
SUN XDR	1014	-	eXternal Data Representation Protocol
SUN NFS	1094	-	Network File System, version 2 protocol

In addition, other standards and documents related to UNICOS TCP/IP are supported by products used with a Cray computer system. For instance, there are several Ethernet-related standards that are not supported on Cray computer systems but are supported by an Ethernet gateway. The subjects are:

<u>Subject</u>	<u>RFC/Standard</u>	<u>Description</u>
Official Protocols	RFC 1083	IAB declaration of official protocol standards
Gateway Requirements	RFC 1009	Requirements for Internet gateways
IP-E	RFC 894	IP datagrams over Ethernet
IP-X25	RFC 877	IP datagrams over public networks
IP-IEEE	RFC 1042	IP datagrams over IEEE 802 networks
ARP	RFC 826	Ethernet Address Resolution protocol for 48-bit addresses

<u>Subject</u>	<u>RFC/Standard</u>	<u>Description</u>
RARP	RFC 903	Reverse ARP
MIL-STDS Problems	RFC 963	The problems with MIL-STD-1777 IP
MIL-STDS Problems	RFC 964	The problems with MIL-STD-1788 TCP
EGP	RFC 904	Exterior Gateway Protocol
RIP	RFC 1058	Routing Information Protocol
IEEE 802.3	IEEE	Ethernet standard
Ethernet	FIPS 107	Ethernet 802.3 standard
FDDI	ANSI X3T9	Fiber Distributed Data Interface
HSC	ANSI X3T9.3	Intelligent peripheral interface and High Speed Channel

4.6.2 UNICOS Network File System (NFS)

UNICOS NFS requires TCP/IP and is now supported on all Cray computer systems. UNICOS NFS is based on an AT&T UNIX System V port of NFS version 3.2.

UNICOS NFS allows a number of remote file systems to be mounted as local file systems on the Cray computer system with transparent data access provided to UNICOS processes. This means that users can use the standard UNICOS commands to access and manipulate files in a remote host's file system, just as they would perform these operations on files in the local file system hierarchy. At the same time, UNICOS file systems can be mounted as file systems on remote systems. The result is transparent data access to UNICOS files by processes on remote systems. The means for communicating across diverse network environments is provided by Sun Microsystems' remote procedure call (RPC) facility. RPC uses the External Data Representation (XDR) data definition language for communication in a machine-independent manner. Access to local or remote files is subject to the system permission checks. Also, there may be a relative increase in file access time during the use of the UNICOS NFS feature. This is typically offset by the

convenience of not having to copy files between systems. Note that "secure RPC" is not supported, which requires yellow pages (YP) and a single YP domain for an entire network. Also, "secure RPC" is a new NFS feature of Sun Microsystems, Inc. that is currently supported on SunOS only.

UNICOS NFS offers the following major advantages:

- **Easy extensibility:** UNICOS NFS is a network service that offers a set of protocols for data exchange. It is separate from the UNICOS operating system, so it allows integration of new protocols without disturbing the existing software environment.
- **Transparent information access:** Information on the network is transparent. Users do not need to know the network address to get directly to the files they want. Except for performance, there is no apparent difference between reading or writing a file contained on a private disk and reading or writing a file on a disk in the next building.
- **Easy network administration:** With UNICOS NFS, a set of network files is no more difficult to administer than a set of local files on a timesharing system. Some special UNICOS NFS utilities have been provided for network administration, but most of the existing file access utilities can be used.
- **Reliability:** UNICOS NFS uses a stateless protocol; that is, the server does not keep a record of requests it receives. This stateless protocol allows client workstations to continue to operate even when the server crashes and reboots or the network fails. When a server crashes or the network fails, the client simply resends UNICOS NFS requests until it receives a response. The client does not detect the crash or the recovery, nor does it lose any data. When a client fails, no recovery is necessary for either the client or the server.

The following NFS enhancements are provided with the UNICOS 5.0 release.

4.6.2.1 UNICOS NFS ID mapping

Both client and server ID mapping are now provided for all Cray computer systems. This facility allows UNICOS NFS to be used in diverse administrative environments. Traditional NFS environments use Sun Microsystems, Inc. yellow pages (YP) distributed look-up service to allow a particular binary value to uniquely identify one specific user or group. However, Cray computer systems are often shared by many groups, making the creation of a single administrative space for user and group a disadvantage. To meet the needs of these environments, Cray Research, Inc. developed UNICOS NFS user mapping, which is supported in this release.

4.6.2.2 UNICOS NFS security

The basic security mechanisms in UNICOS NFS allow administrators to: restrict the hosts allowed to mount Cray file systems; control both the remote systems from which they will import file systems and permissions used on the UNICOS directories on which mounting will be done; and use standard UNICOS file permission checking. Another level of security can be implemented through UNICOS NFS user mapping.

When UNICOS is built with multi-level security, the following rules apply to NFS. By default, exporting of UNICOS file systems is not allowed and remote file systems can be mounted as read only. However, the site may choose to alter these default settings by using the following two flags in `/sys/secparm.h`:

- `NFS_SECURE_EXPORT_OK`, which allows a site to export UNICOS local files if the file system has a security level and a compartment of 0; and
- `NFS_REMOTE_RW_OK`, which allows a user to access a remote file system with both read and write permission as long as the UNICOS user process is at security level 0 and has no compartments.

4.6.2.3 Yellow pages (YP)

UNICOS 5.0 NFS includes the source code for Sun Microsystems, Inc. yellow pages (YP) distributed data lookup service. SUN NFS YP directory service is used for user passwords and for common user ID and group ID administration. Optionally, the Cray system can be used as the YP server, or it can be configured to run only as a client to the YP server located on another host in the network. YP server support includes all of the database utility programs. The Cray system does not allow the use of YP for any other UNICOS database services, such as */etc/hosts* or the domain name server. YP may be used separately or in combination with UID mapping.

NOTE: Support for YP has been deferred so that proper and complete testing of this feature can be accomplished. Until then, the source code is provided for those customers who need this feature. However, a site should contact International Software Technical Support (ISTS) for the most recent information on this feature before the site attempts to use it.

4.6.2.4 UNICOS NFS confidence test suite

This suite is provided to ensure proper installation of UNICOS NFS; the tests are used by system analysts and administrators. Three groups of tests are provided: basic, special, and performance. All confidence tests are self-checking; error messages are provided. See the *UNICOS NFS Administrator's Manual*, publication SR-2064, for additional information.

The remote procedure call (RPC) facility is documented in the *Remote Procedure Call (RPC) Reference Manual*, publication SR-2089.

UNICOS NFS is documented in the following publications:

- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS NFS Administrator's Manual*, publication SR-2064

- *Yellow Pages Reference Manual*, publication SR-2063
- *UNICOS NFS Internal Reference Manual*, publication SM-2065

4.6.3 X Window System

The X Window System is a product of the Massachusetts Institute of Technology (MIT). The X Window System has been upgraded to MIT Version 11, Release 3 for the UNICOS 5.0 release.

The X Window System allows a "client" application running in the Cray to interact with a user at a bit-mapped graphic workstation (Sun, Apollo, DEC, etc.). The user workstation runs a "server" program that displays output (text and graphics) from clients and passes user events (key clicks, mouse movement and button presses) back to the client. The client program does not need to be concerned with the type of workstation hardware or operating system. Only client support is provided on the Cray computer system.

The programming interface for the X Window System is contained in the `xlib` library, which provides host-independent and network-transparent access to the X server that runs on the user's workstation. The `man` pages documenting the X Window System are also included. The `xlib` Version 11, Release 3 from MIT includes support for `Xt` toolkit and Athena Widgets and fixes to Releases 1 and 2. The `xlib` Version 11, Release 3 functions with the UNICOS 5.0 release. Version 10 is no longer supported.

NOTE: The X Window System release documentation from MIT is available directly from MIT. Also, the *XLIB Programming Manual* (2-volume set) and the *X Window System User's Guide* are available from O'Reilly & Associates, Inc. publishers; the *Introduction to the X Window System* is available from Prentice Hall, Inc.; and the *X Window System C Library and Protocol Reference* is available from Digital Press.

4.6.4 USCP 5.0

The UNICOS Station Call Processor (USCP) protocol provides Cray link (station) software connections on Cray computer systems running the UNICOS operating system.

USCP 5.0 communicates with the following release levels (and higher) of Cray station software:

- Apollo Station 2.03
- CDC NOS Station 1.18
- CDC NOS/BE Station 1.16
- CDC NOS/VE Station 1.1 and 2.0
- DEC VAX/VMS Station 4.01
- IBM/MVS Station 3.01
- IBM/VM Station 5.00

In many cases, specific station mods are required for optimization in a USCP 5.0 environment. You are directed to contact International Software Technical Support (ISTS) in Mendota Heights for the latest support information before ordering USCP 5.0 or appropriate station software. As with previous releases, USCP 5.0 can co-exist under GOS with the COS Station Call Processor (SCP).

A major factor for upgrading to station-supported levels is that USCP 5.0 does not support job submission in the CB (character blocked) data format. USCP 5.0 requires full UD (UNIX data) support by the front-end station.

USCP 5.0 communicates over the following hardware:

- Cray Research front-end interface (FEI-1; FEI-2 (DSI))
- NSC HYPERchannel (DX and A Series)
- Cray Research network interface (FEI-3)
- VAX Supercomputer Gateway
- CNT LANlord

Under GOS, COS and UNICOS share access through the IOS to front-end station software.

The *UNICOS Station Call Processor (USCP) Administrator's Guide*, publication SG-2072, provides information for those who install, maintain, and debug USCP. USCP is also documented in the *Front-end Protocol Internal Reference Manual*, publication SM-0042, and the *UNICOS Administrator Commands Reference Manual*, publication SR-2022.

4.6.4.1 USCP operator interface

The USCP operator interface allows an operator to configure front-end stations on or off dynamically; to kill or drop USCP jobs, file transfers, or USCP interactive sessions; to reset the logfile; and to display USCP status information (such as, stations logged on, current system batch status, current queue status, and file transfer status). The following commands provide these functions: **useplink**, **usepops**, **usepques**, **usepstat**, and **usepstrs**.

4.6.4.2 File transfer accounting

USCP generates accounting records for dataset transfers.

4.6.4.3 Tape daemon front-end servicing

USCP has been enhanced to allow front-end servicing for tape requests. This feature was added for COS equivalency.

4.6.4.4 Group ID support

The group ID concept provides for "clustering" of front-ends into logical groups, allowing certain dataset transfers to alternate SID's. This enhancement is based on the two-character station ID; the first character identifies the group, and the second character distinguishes a station as a group member. This enhancement allows file transfer to use any available member of the group as the recipient of

the transfer output. With this facility, some load balancing is possible. If the second character is an underscore, the feature will be invoked. This feature was added for COS equivalency.

4.6.4.5 Improved USCP and NQS interface

USCP now issues `qsub` commands with the `-re` and `-ro` options. This causes the job output to be created in the USCP spool directory and removes the penalty paid to move spool job output between the two subsystems. This feature was added to improve performance.

4.6.4.6 Display of system environment data

During logon, USCP advises the station of operating system and release level, and the hardware identification through the return of the `start` segment.

4.6.4.7 UNICOS file and information display status

UNICOS file status and information display status capabilities are provided in this release. This feature requires station support to be invoked.

4.6.4.8 SAVE/RECEIVE facility

A SAVE/RECEIVE facility for acquired files has been implemented. This feature requires station support to be invoked.

4.6.4.9 Interactive message limit

USCP has been modified to allow multiple messages to stations that support and request a message limit during an interactive logon sequence. This feature requires station support to be invoked.

4.6.4.10 USCP security enhancements

New USCP security features have been implemented for the UNICOS 5.0 release; see subsection 4.2.4 for additional information.

4.6.5 UltraNet software support

UNICOS 5.0 contains a provision for the installation of UltraNet software. UltraNet software includes a set of include files in a new directory `/usr/include/ultra`, new library archives in `/usr/lib`, and utility programs and scripts in `/etc`. A set of modules named `unet.c` constitute a character-special driver in the UNICOS kernel. Also in the kernel, a module named `if_un.c` links UNICOS TCP/IP and related protocols, including NFS, to the UltraNet. The UNICOS 5.0 release includes only provisions for the installation of UltraNet software, not the software itself. All UltraNet software, including the UNICOS kernel-resident modules, is supplied by Ultra Network Technologies, Inc. Contact the ISTS support analyst for information regarding installing the UltraNet software interface.

NOTE: UltraNet support requires that TCP/IP be installed with the UNICOS 5.0 release because it uses the TCP/IP libraries and utilities, such as `rep` and `ftp`.

4.6.6 SUPERLINK 2.2

The UNICOS 5.0 release running on all Cray systems contains the necessary kernel and command hooks to support SUPERLINK 2.2. SUPERLINK 2.2 is released asynchronously. See the *SUPERLINK 2.2 Release Notice* for additional information.

4.7 Enhancements to on-line diagnostics

On-line diagnostics provide system hardware testing while UNICOS is operating. The diagnostic system consists of the following components: confidence tests, maintenance tests, deadstart diagnostics (require an IOS), network tests, down-device tests, and utilities.

For a complete description of the on-line diagnostic system, refer to the *CRAY-2 Computer System UNICOS On-line Diagnostic Maintenance Manual*, publication SMM-2028, or *CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems UNICOS On-line Diagnostic Maintenance Manual*, publication SMM-1012, and the *On-line Diagnostic Network Communications Program (OLNET) Maintenance Manual*, publication SMM-1016. **NOTE: The information in these publications is proprietary to Cray Research, Inc.**

4.7.1 CRAY-2 on-line diagnostic enhancements

Specific new features for CRAY-2 computer systems are as follows:

- **oldmon** (down CPU monitor) allows the down CPU tests to execute in a down CPU from an operational CPU running under UNICOS.
- **ollm** is the on-line diagnostic for Local Memory testing.
- **olnet** is the on-line diagnostic network test for NSC and VME external connections.
- **donut** (disk on-line maintenance utility) provides field personnel with the following disk maintenance functions for the DS-40 Disk Subsystem:
 - Surface analysis and disk formatting
 - Flaw table maintenance
 - ID verification

4.7.2 CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 on-line diagnostic enhancements

Specific new features for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems are as follows:

- **donut** (disk on-line maintenance utility) provides field personnel with the following disk maintenance functions:
 - Writing and reading of disk controller buffers (buffer echo)
 - Surface analysis and disk formatting
 - Reading and writing of device and system flaw tables
 - Reading and writing of device ID
 - Reading of controller/device status registers
- **offmon** (off-line confidence monitor) provides a transparent user interface that allows some of the confidence tests to be executed either in an off-line environment or in a down CPU under the down CPU monitor, **oldmon**.
- **olefpt** (on-line comprehensive floating-point test) generates floating-point instructions and data to detect data-sensitive failures in floating-point functional units.
- **olem** (Central Memory test) exercises Central Memory addresses and data paths and tests the portion of memory that is available to a single user job.
- **oldmon** (down CPU monitor) allows the down CPU tests to execute in a down CPU from an operational CPU running under UNICOS. (This is not available on CRAY-1 computer systems.)
- **olibuf** (on-line instructions buffer test) generates instruction buffers to detect data-sensitive failures, and it generates test buffers to detect branching failures.
- **olnet** is the on-line diagnostic network test for NSC and VME external connections; it supports IBM/VM and SunOS.
- **olsbt** is the on-line comprehensive inter-CPU control and communication instruction set test. The **olsbt** diagnostic tests the shared B registers, shared T registers, and semaphores.

- **unitap** (on-line magnetic tape test) provides field personnel with the following testing functions:
 - Testing of a user-specified control path (block multiplexer channel, controller, and device)
 - Byte counter tests
 - Buffer tests
 - Bus test
 - Ladder test
 - Stress test
 - Position command tests

4.8 Convergence of user interface

With this release of UNICOS, considerable progress was made toward the convergence of the user interface and functionality of libraries and commands between CRAY-2 systems and the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems. These changes have been mentioned throughout this section of the *UNICOS 5.0 Release Notice*; however, significant changes are highlighted in this subsection.

4.8.1 Documentation of UNICOS libraries

The publications that document UNICOS libraries have been reorganized; libraries that were previously documented separately for CRAY-2 and for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems are now combined into a single set. See section 5, "Support Information," for a description of the publications.

4.8.2 Common commands

A significant number of user commands (224) now have common source and a common user interface.

4.8.3 File format of BUFFER IN/BUFFER OUT files

CRAY-2 systems now support BUFFER IN/BUFFER OUT on COS blocked files. The default file format is the pure data format for compatibility with existing CRAY-2 systems. By using the `assign` command and selecting the `-s blocked` option, a Fortran unit can be designated to be a blocked file. The I/O performed on the file is synchronous, but the record-based behavior that is supported is compatible with COS and with CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems.

4.8.4 Consistency of unformatted character data

With this release of UNICOS, CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems have changed so the mixing of character data and word-based data (such as REALs and INTEGERS) are handled consistently with CRAY-2 systems. Character data is concatenated with neighboring character data. Word-based data always starts on a word boundary. Gaps between character data and word data are padded with blanks.

4.8.5 Common interface for user striping and preallocation

With the exception of specifying the allocation unit on preallocation, which is not supported on CRAY-2 systems, the user interface for requesting user striping and preallocation is identical on all Cray systems running the UNICOS 5.0 release. See subsection 4.2.11 for additional information on preallocation.

4.8.6 Asynchronous queued I/O

The asynchronous queued I/O package is now supported on CRAY-2 systems. The user interface is identical to the COS interface and to the existing UNICOS interface on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems.

4.8.7 POSITION= parameter

The POSITION= parameter of the Fortran OPEN statement is now supported on all Cray systems.

4.8.8 Common procstat tool

The **procstat** performance analysis tool is available on CRAY-2 systems. Performance considerations require that this implementation utilize a special **/lib/libstat** library. This library must be loaded with the user program. Except for this implementation difference, the user interface is the same on all Cray systems running the UNICOS 5.0 release.

4.8.9 Expandable common block

Dynamic expansion of one common block is now supported on CRAY-2 systems and is available on all Cray systems running the UNICOS 5.0 release. The user interface is identical on all systems.

4.8.10 Ordered search in SEGLDR

The ordered search scheme in the style of the traditional UNIX **ld** command is now available on SEGLDR.

4.8.11 File assignment from Fortran

ISHELL (**assign**) invocations from Fortran will now take effect immediately on CRAY-2 computer systems, providing the same functionality and user interface on all Cray computer systems.

5. Support Information

This section describes the technical documentation and training available to support this release.

5.1 Documentation

Most of the UNICOS manuals have been updated for the UNICOS 5.0 release. The UNICOS 5.0 Publications Order Form is included in section 6, "Licensing and Ordering," and provides a complete list of UNICOS 5.0 documentation with revision levels indicated. Each updated publication contains a feature summary at the beginning of the publication, which is designed to be a quick reference for changes documented in the publication.

The *User Publications Catalog*, publication CP-0099, contains descriptions of all CRI manuals. In addition, Cray personnel can access a Publications menu system on the Pyramid computer system ("crayamid") in Mendota Heights to determine the manuals and manual revision levels that support a particular software release.

All 8 1/2-x-11-in. CRI publications are 7-hole punched (3 for U.S. standards and 4 for European standards) for insertion into binders. Sites may supply their own binders or order CRI 3-ring, silver logo binders.

The publications that document UNICOS libraries have been reorganized; libraries that were previously documented separately for CRAY-2 and CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems are now combined into a single set.

The following publications documenting libraries are available with this release:

- *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079, describes the Cray Fortran library routines available to users of all Cray computer systems.
- *Cray C Library Reference Manual*, publication SR-0136, describes the routines in the Cray C library available to users of all Cray computer systems and now includes all 3C and 3S routines previously documented in the *CRAY-2 UNICOS Libraries, Macros and Opdefs Reference Manual*, publication SR-2013. (*Volume 2: UNICOS C Library Reference Manual* will replace publication SR-0136 in a future UNICOS release.)
- *Volume 3: UNICOS Math and Scientific Library Reference Manual*, publication SR-2081, describes math and scientific libraries available to users of all Cray computer systems.
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012, describes all UNICOS system calls and the error returns for these calls.
- *Volume 5: UNICOS Network Library Reference Manual*, publication SR-2057, describes network library routines used by the Transmission Control Protocol/Internal Protocol (TCP/IP) product when used with UNICOS.
- *Volume 6: UNICOS Internal Library Reference Manual*, publication SM-2083, describes internal library routines often used by system analysts and developers. This manual replaces the *System Library Reference Manual*, publication SM-0114.
- *UNICOS Macros and Opdefs Reference Manual for CRAY-2 Computer Systems*, publication SR-2082, describes UNICOS macros, opdefs, and calling sequences.

In addition, the following publications are new with this release:

- *UNICOS Overview for Data Center Managers*, publication SG-2053
- *UNICOS CDBX Symbolic Debugger Reference Manual*, publication SR-2091

- *UNICOS CDBX Debugger User's Guide*, publication SG-2094
- *UNICOS Shell and Variable Ready Reference*, publication SQ-2060

5.1.1 On-line documentation

Some of the reference information for UNICOS is also available on-line in preformatted files called man pages. These man pages can be accessed by using the **man** command.

The following documentation is included on-line:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014
- *Cray C Library Reference Manual*, publication SR-0136
- *UNICOS Macros and Opdefs Reference Manual for CRAY-2 Computer Systems*, publication SR-2082
- *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079
- *Volume 3: UNICOS Math and Scientific Library Reference Manual*, publication SR-2081
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012
- *Volume 5: UNICOS Network Library Reference Manual*, publication SR-2057

- *Volume 6: UNICOS Internal Library Reference Manual, SM-2083*; only routines for CRAY-2 computer systems are available on-line with this release; routines for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems are planned to be available on-line with a later release.

The **troff** source for these on-line UNICOS manuals can be obtained if you wish to make local modifications to the man pages using your front-end UNIX system. For further information, contact the Software Publications Department via:

- Publications Hotline at (612) 681-5729
- Send UNIX mail to **sun!tundra!hall!publications** or to **uunet!cray!publications** or to **publications@cray.com**
- Write to: Cray Research, Inc.
Technical Publications Department
1345 Northland Drive
Mendota Heights, MN 55120
- Send FAX to (612) 681-5602

The UNICOS 5.0 release offers both the permuted index and the functional index in on-line form. These indexes are accessed with the **man** command options **-k** and **-i**, respectively. The **-i** option is new with the UNICOS 5.0 release; it searches the functional index for entries containing the specified search strings and returns the corresponding commands and routines.

On-line documentation in the category called **info** has been enhanced and is provided with the release package. The man pages in this category are available only in an on-line version and provide information that is either not available in, or not suitable for, the UNICOS manuals. These informational pages are displayed by keying either

man filename

or

man info filename

The manual **info** pages provide information such as the following:

- General topics (for example, **memory** explains memory allocation)
- Introductory information about a particular product or subsystem (for example, **tapes** describes the tape subsystem)
- User information on subjects also covered in the primer or other manuals (for example, **perftrace**)

5.1.2 UNICOS migration documentation

Migration information is available from the Distribution Center in Mendota Heights. This information assists sites in the transition from COS to UNICOS. Region and country offices, DAMs, AICs, trainers, and sales personnel have order forms for ordering individual migration documents. Also see section 5.3, "Migration from COS," for additional information.

5.1.3 General UNIX documentation

Several useful publications not available through Cray Research, Inc. describe the UNIX operating system. *Understanding UNIX: A Conceptual Guide*, by Groff and Weinberg, is a good overview for management or the casual user. *The UNIX Programming Environment*, by Kernighan and Pike, provides a more in-depth study appropriate for programmers using UNIX systems. The following bibliography lists these and other useful books on UNIX systems and the C Language:

- Bach, Maurice T. *The Design of the UNIX Operating System*. Prentice-Hall, 1986.
- Birns, Brown, and Muster. *UNIX for People*. Prentice-Hall, 1985.

- Comer, D. *InterNetworking with TCP/IP Principles, Protocols, and Architecture*. Prentice Hall, 1988.
- Comer, D. *Operating System Design: The XINU Approach*. Prentice Hall.
- Groff and Weinberg. *Understanding UNIX: A Conceptual Guide*. Que Corp.
- Harbison and Steele. *C: A Reference manual*. Prentice-Hall, 1984.
- Kernighan, Brian W. and Dennis M. Ritchie. *The C Programming Language*. Prentice-Hall.
- Kernighan, Brain W. and Rob Pike. *The UNIX Programming Environment*. Prentice-Hall, 1984.
- Leffler, Samuel J., Marshall Kirk McKusick, Michael J. Karels, and John S. Quarterman. *The Design and Implementation of the 4.3BSD UNIX Operating System*. Addison-Wesley Publishing Company, 1989.
- McGilton, H. and Rachel Morgan. *Introducing The UNIX System*. McGraw Hill, 1983.
- Plum, T. *C Programming Guidelines*. Plum-Hall.
- Plum, T. *Learning to Program in C*. Plum-Hall.
- Sobell, Mark G. *A Practical Guide to UNIX System V*. Benjamin Cummings, 1985.
- Wood, Patrick H., and Stephan G. Kochan. *UNIX System Security*. Hayden Book Company, 1985.
- "UNIX System." *AT&T Bell Laboratories Technical Journal* (October 1984).
- "UNIX Time-Sharing System." *Bell System Technical Journal*, vol. 57, no. 6, part 2 (July/August 1978).

5.2 Training

Cray Research provides a full range of training to support UNICOS. Software Training offers startup courses for first-time users of UNICOS, as well as detailed courses for experienced customers or Cray analysts. Courses are targeted for scientists, engineers, applications programmers, systems programmers, systems administrators, and systems analysts. Cray Research also offers special focus offerings on languages, optimization, and other aspects of UNICOS. This training support is described in the *Software Training Catalog*, which can be ordered from regional training coordinators or from the Distribution Center in Mendota Heights. Order TR-EMPCAT for the employee version and TR-CUSTCAT for the customer version of the catalog.

The *Software Training Catalog* lists regional office locations, describes the training philosophy, and provides curriculum charts for employees and customers. It also contains a current course schedule and a complete description and outline for each course. This catalog can help you determine the courses that best match your background and need for information on UNICOS.

All of the courses described in the training catalog are available at the Mendota Heights training facility. This facility is equipped with terminals, front-end batch systems, interactive access, network access to all types of Cray mainframes, and a host of other amenities to provide a complete, hands-on learning environment. The regional training locations can also provide comparable learning environments. Cray Research also offers on-site training if customers prefer. Please see your regional training coordinator for more details.

Because many customers of Cray Research are considering migrating from COS to UNICOS, courses are provided specifically for those needs. See subsection 5.3.5, "Migration Training," for more information.

5.3 Migration from COS

A number of steps are being taken to simplify the conversion process from the COS environment to that of UNICOS. These steps promote an orderly and convenient migration from COS to UNICOS.

5.3.1 GOS

COS provides a feature referred to as the Guest Operating System (GOS), which allows UNICOS to run concurrently with COS. To run UNICOS 5.0 as a guest system requires COS 1.17 or later, using the 5.0 IOS release.

The decision to run GOS as a step in migrating to UNICOS must be based on a number of different factors such as the amount of spare CPU, memory, disk space, and SSD space available at a site. Additionally, the types of jobs run on a system, and the flexibility of that workload influence whether or not GOS is a viable choice.

5.3.2 Compatibility issues between COS and UNICOS

Because of the degree of commonality of compilers on both systems, most compiler source files will require no conversion. The use of library routines should be checked during migration because not all routines in the COS libraries have been implemented in UNICOS. The \$DMYLIB migration tool identifies an application's use of COS routines that are not supported under UNICOS.

There are several important differences between Fortran I/O on COS and Fortran I/O on UNICOS.

The **plcopy** UNICOS command translates COS UPDATE PLs into UNICOS PLs. A PL must be disposed with **DF=TR** before **plcopy** is run on the disposed file. The **plcopy** command is documented in the *UNICOS User Commands Reference Manual*, publication SR-2011.

See the *Migration Tools Release Notice* for specific migration compatibility issues.

5.3.3 Special migration team

Certain field analysts, representing every region and country, have been designated as part of a special migration team. This team also has members from Mendota Heights representing the various Software Division, Publications, and Training functions. These individuals have current information and training on migration planning and execution. They collect information about site migration to produce software tools and documentation and develop training courses. The focal point for receiving and releasing information on migration from COS to UNICOS is Joe Wittl in Software Technical Support, Mendota Heights.

5.3.4 Access to UNICOS systems

Cray analysts can access UNICOS systems available at Mendota Heights by using dial-up lines; call the Computer Center help desk at (612) 681-3302 in Mendota Heights to arrange access to these systems.

5.3.5 Migration training

One of the keys to a smooth migration is planning well in advance of the event. The migration planning course (MIGRP) will help customers plan for and achieve an orderly migration to the UNICOS system. Cray Research also offers training on migration tools (MIGR) and techniques for moving large application codes to UNICOS (APPCON). All migration-related courses are described in the *Software Training Catalog*. Contact your regional training coordinator for more information.

6. Licensing and Ordering

This section provides required licensing information for the UNICOS 5.0 release. This section also includes forms for ordering the UNICOS 5.0 release and additional publications.

6.1 Licensing information

UNICOS source code is licensed under a software contract by Cray Research, Inc. to its customers. Cray Research, Inc. does not offer a binary sublicensing option. To receive a UNICOS source code license, customers must first obtain a UNIX source code license from AT&T for each machine that will run UNICOS. Customers contract directly with AT&T for this license and pay the associated fees to AT&T.

6.1.1 AT&T license requirements

The UNICOS 5.0 release requires an AT&T UNIX license at the System V, Release 3.0 level. The UNIX licenses currently offered by AT&T cover all UNIX System V versions through Release 3.0 (or Release 3.2 if desired). Customers specify the release level they want. Cray customers who do not already have an AT&T UNIX license but are obtaining one at this time will automatically become licensed at the appropriate release level for UNICOS 5.0. Cray customers with existing licenses at lower AT&T UNIX release levels must upgrade their AT&T licenses to UNIX System V, Release 3.0 to receive the UNICOS 5.0 release. For customers currently running UNICOS 4.0, no changes to licensing are necessary.

The AT&T standard source license limits the copying of UNIX documentation. Cray Research, Inc. has negotiated an exemption to these limits for its customers who use UNICOS documentation to support internal business on their Cray systems. Customers desiring additional documentation reproduction rights must contact AT&T.

6.1.2 UNICOS Set license

The UNICOS Set license is a new licensing option in which the key software elements are included in a single licensed item, allowing customers to sign a single license for a defined set of software.

This simplifies the administration of software licenses for customers and for Cray Research, Inc. and enables Cray Research, Inc. to respond more quickly to requests for additional software.

The major components of the UNICOS Set license include UNICOS, CFT, the Cray C compiler, the Cray Standard C compiler, the I/O Subsystem software, NFS, Cray Pascal compiler, and binary rights for CFT77, data migration software, and the Operator Workstation.

A customer who has licensed the UNICOS Set does not need to individually license CFT77, Cray C, Cray Standard C, or Pascal.

Note that Link (station) software, TCP/IP, and the new compiling environments (Cray Ada and Cray Allegro Common Lisp) continue to be licensed separately. Please see your contract administrator for details.

Sites running previous UNICOS releases do not automatically convert to this new licensing option; sites wanting this option must modify Schedule A of their software contracts to license the UNICOS Set.

6.1.3 Cray C compiler license

The AT&T UNIX license and the Cray UNICOS or UNICOS Set license include a Cray C compiler license. For customers without a UNICOS or UNICOS Set license, the Cray C compiler is licensed separately under a Cray software contract. See the *Cray C 4.1 Release Letter* for more information.

6.1.4 Cray Standard C compiler license

The Cray UNICOS Set license includes a Cray Standard C compiler license. For customers without a UNICOS Set license, the Cray Standard C compiler is licensed separately under a Cray software contract. See the *Cray Standard C 1.0 Release Notice* for more information.

6.1.5 CFT77 compiler license

This UNICOS release includes a version of the CFT77 compiler used to generate products and libraries that use Fortran; both the binary and source code are included. A CFT77 license is required.

The Cray UNICOS Set license includes a Cray CFT77 compiler license. For customers without a UNICOS Set license, the CFT77 compiler is licensed separately under the Cray software contract. CFT77 is licensed only in binary form. Cray analysts generate the binary code for customers and retain the source code for Cray Research's internal use only. There is no fee for this software. See the *CFT77 3.0 Release Notice* for more information.

6.1.6 Pascal license

The Cray UNICOS Set license includes a Cray Pascal compiler license. For customers without a UNICOS Set license, the Pascal compiler is licensed separately under a Cray software contract. There is no fee for the Cray Pascal compiler. See the *Pascal 4.0 Release Notice* for more information.

6.1.7 TCP/IP license

TCP/IP is an integrated networking protocol developed by the U. S. Department of Defense. The UNICOS implementation of the TCP/IP protocol runs only on Cray computer systems. UNICOS TCP/IP is required for the UNICOS 5.0 release and must be specified separately under the Cray software contract. There is a licensing fee (paid up license or monthly fee) and a monthly service fee for TCP/IP.

6.1.8 RQS license

The Remote Queueing System (RQS) for UNIX systems is supported by the UNICOS 5.0 release. A separate license is required; also, there is a right-to-use charge. An RQS installation tape containing build procedures for SunOS RQS and Sun man pages for RQS will be available separately from the UNICOS 5.0 release. See subsection 4.2.9, "Remote Queueing System," and the *Remote Queueing System (RQS) Release Notice* for more information.

6.1.9 UNICOS-to-COS Link software

The UNICOS-to-COS Link software is a migration tool. It is optional software covered by the terms and conditions set forth in the UNICOS license agreement. There is no fee for the UNICOS-to-COS Link software. When sites receive this software, the customers must sign and return the acknowledgment form that is shipped with the software.

This is being sent
right now!

6.1.10 Cray Ada license

The Cray Ada release is licensed separately, in binary form only, under the Cray software contract. There is a licensing fee (paid up license or monthly fee) and a monthly service fee. See the appropriate Cray Ada release notice or release letter for more information.

6.1.11 Cray Allegro Common Lisp license

Cray Allegro Common Lisp release 1.0 is licensed separately, in binary form only, under the Cray software contract. There is a licensing fee (paid up license or monthly fee) and a monthly service fee. Cray Allegro Common Lisp 1.0 will be available only for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems running the UNICOS 5.0 release. See the *Cray Allegro Common Lisp 1.0 Release Notice* for more information.

6.1.12 Export license

For international shipments only, an export license from the U. S. Department of State is required for the encryption software. When ordering the UNICOS 5.0 release package to be shipped outside the U. S., order the encryption software listed as optional software on the order form.

U. S. Department of State export licenses for UNICOS are obtained from Morris Stockburger at the following address:

Morris Stockburger Telephone: (800) 284-2729
1200 Northstar East (612) 333-5889
Cray Research, Inc.
608 Second Avenue South
Minneapolis, MN 55402 Telex: 290-789

NOTE: This export license is required in addition to the Department of Commerce export license necessary for Cray hardware.

6.1.13 Further licensing information

For further information on licensing or export clearances, see the contracts administrator for your region or contact Sarah White at the following address:

Sarah White Telephone: (800) 284-2729
Cray Research, Inc. (612) 681-2901
1408 Northland Drive FAX: (612) 681-2999
Mendota Heights, MN 55120

6.2 UNICOS 5.0 software order form

The UNICOS 5.0 release is distributed by order only to sites that have signed a Cray software license agreement or to Cray personnel at regional offices who have signed the software control acknowledgment. The most current revision of the UNICOS 5.0 release is supplied.

To order the UNICOS 5.0 release, use the following software order form or call the Distribution Center in Mendota Heights.

Please note that full sets of documentation may be ordered with each release package. If you wish to order specific UNICOS 5.0 release publications, use the publications order form that follows the software order form. Note that some publications are dependent upon machine type.

If you have questions or if the site has not signed all appropriate Cray software license agreements, contact your regional contract administrator or Lois Olson, Software Licensing Coordinator, at (612) 681-2910.

UNICOS 5.0 release software order form

To order the UNICOS 5.0 release package, complete the entire order form and send it to:

Cray Research, Inc.
2360 Pilot Knob Road
Mendota Heights, MN 55120
U.S.A.
Attention: Distribution Center - Order Desk

You can also call the Order Desk at (800) 284-2729, extension 5907; (612) 681-5907; or FAX: (612) 681-5920.

The basic release package will automatically include the latest revision level (mods tape and documentation) that has been released.

NOTE: One completed form **MUST** be submitted for **EACH** licensed machine requesting the UNICOS 5.0 release. Use this form **ONLY** for the machine designated by the serial number below. Please ensure that the required licensing is in place before ordering the UNICOS 5.0 release; a TCP/IP license is required to order the UNICOS 5.0 release. See subsection 6.1 of this *UNICOS 5.0 Release Notice* for licensing information. If you have any questions, or if licensing is not in place, please contact your regional Contract Administrator or Lois Olson, Software Licensing Coordinator, in Mendota Heights at (612) 681-2910.

6.2.1 Site information

AIC name: _____

Date: _____ Site: _____

Region: _____ Telephone number: _____

Mainframe Serial Number: _____

IOS-0 Serial Number: _____

IOS-1 Serial Number: _____

Ship to: _____

6.2.2 Mainframe type

- CRAY-1, old expander (will not be available at the time of the general release)
- CRAY X-MP, non-ema, old expander
- CRAY X-MP, non-ema, new expander
- CRAY X-MP, ema, new expander
- CRAY X-MP, ema, OWS
- CRAY X-MP EA, new expander
- CRAY X-MP EA, OWS
- CRAY Y-MP, new expander
- CRAY Y-MP, OWS
- CRAY-2

6.2.3 Basic release package

- Initial Installation**
Sites performing initial installations with an IOS using a peripheral expander are responsible for obtaining the appropriate expander pack(s) required. Sites with an IOS using an Operator's Workstation (OWS) should refer to the OWS Installation Bulletin for requirements.
- Upgrade Installation**

6.2.4 Media type

- 3480 Cartridges (CRAY-1, CRAY X-MP, & CRAY Y-MP: upgrade only; CRAY-2: initial or upgrade)
- 6250 bpi round tapes
- 800 bpi round tapes (CRAY-1 & CRAY X-MP, old expander only)

6.2.5 Asynchronously-released products NOT included with the UNICOS 5.0 release

The following UNICOS-related, asynchronously-released products are NOT included with the base release and need to be ordered below, if you do not already have the minimum level indicated:

- Cray C (4.1 or later)
- CFT (1.15, BF 3, Rev 1 or later)
- CFT77 (3.0.1 or later) includes the autotasking software
- IOS (5.0 or later) CRAY-1, CRAY X-MP, CRAY Y-MP series only
- OWS; Operator Work Station (1.0 or later)

NOTE: Generation compilers, gcc and gcft77, included with the base release are intended for operating system generation only. The end-user versions of these releases must be ordered above.

PASCAL, TCP/IP, and NFS (requires TCP/IP) are included with the base release.

6.2.6 Optional software

NOTE: Optional software may not be available in the media requested for the operating system. Contact the Distribution Center.

- Crypt (optional encryption software; export license required for non-domestic sites)
- Data Migration Catalog Utilities, Version 1.0 (required for data migration facility)
- Cray Standard C 1.0 (optional; special licensing required)
- UNICOS-to-COS Link Software (optional; CRAY-1, CRAY X-MP, CRAY Y-MP series only; requires acknowledgment form that will be included with product shipment to be signed and returned)

This is already ordered

6.2.7 Documentation sets

Two sets of documentation are normally included with the release package for the AIC's use. If you do not want the two sets, so indicate below. Order **ADDITIONAL** documentation below for the customer's use per the terms of their contract:

- Do not include two sets of documentation
- Complete set of manuals for Initial Installation
- Complete set of manuals for Upgrade Installation
- Additional copies of the *UNICOS 5.0 Release Notice*
- 1-inch Binders (BIND SL L 1)
- 1.5-inch Binders (BIND SL L 1.5)
- 2-inch Binders (BIND SL L 2)
- 3-inch Binders (BIND SL L 3)

6.3 UNICOS 5.0 release publications order form

NOTE: Two sets of documentation are sent with each release package. Please use the following publications order form to order any additional publications; note that some publications are dependent upon machine type.

CRI 3-ring binders are available and can be ordered using the following publications order form. All 8½-x-11-in. CRI publications are 7-hole punched (3 for U.S. standards and 4 for European standards) for the convenience of sites wishing to supply their own binders. If you are outside of the U.S., call your subsidiary office for prices of binders. Otherwise, call the Cray Distribution Center in Mendota Heights.

Name: _____

Date: _____

Site: _____

Region: _____

Ship to: _____

Send the completed order form to:

Cray Research, Inc.
2360 Pilot Knob Road
Mendota Heights, MN 55120
U.S.A.
Attention: Distribution Center – Order Desk

You can also reach the Distribution Center at:

(800) 284-2729, extension 5907, (612) 681-5907,
or FAX: (612) 681-5920.

6.3.1 Additional publications

The release package contains two of each of the following manuals. For additional copies, indicate the number of additional manuals on the appropriate blank.

6.3.1.1 General UNICOS manuals

Pub. Only	Pub. with Binder	Pub. Number	Title
_____	_____	SR-2011 5.0*	<i>UNICOS User Commands Reference Manual (BIND SL L 3)</i>
_____	NA	SQ-2056 5.0	<i>UNICOS User Commands Ready Reference</i>
_____	_____	SG-2051 5.0	<i>UNICOS Tape Subsystem User's Guide (BIND SL L 1)</i>
_____	_____	SR-0222 F	<i>CRAY Y-MP, CRAY X-MP EA, and CRAY X-MP Multitasking Programmer's Manual (BIND SL L 1.5)</i>
_____	_____	SN-2026 C	<i>CRAY-2 Multitasking Programmer's Manual (BIND SL L 1)</i>
_____	_____	SR-2049 5.0	<i>UNICOS Index for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems (BIND SL L 1.5)</i>
_____	_____	SR-2048 5.0	<i>UNICOS Index for CRAY-2 Computer Systems (BIND SL L 1.5)</i>
_____	_____	SR-2040 B	<i>UNICOS Performance Utilities Reference Manual (BIND SL L 1)</i>
_____	_____	SR-2014 5.0*	<i>UNICOS File Formats and Special Files Reference Manual (BIND SL L 1)</i>
_____	_____	SR-2015 5.0	<i>UNICOS Kernel Error Message Manual (BIND SL L 1)</i>
_____	NA	SQ-2060	<i>UNICOS Shell and Variable Ready Reference</i>

* Please order publication SR-2096, *UNICOS 5.0 Release Addendum to Software Publications*, when ordering this publication.

Pub. Only	Pub. with Binder	Pub. Number	Title
___	___	SG-2053	<i>UNICOS Overview for Data Center Managers</i> (BIND SL L 1)
___	___	SG-2009 D	<i>TCP/IP Network User's Guide</i> (BIND SL L 1)
___	___	SN-2086	<i>CRAY-2 Computer System User Environment</i> (BIND SL L 1)
___	___	SR-2089	<i>Remote Procedure Call (RPC) Reference Manual</i> (BIND SL L 1)
___	NA	SR-2096	<i>UNICOS 5.0 Release Addendum to Software Publications</i> ; provides revised pages to UNICOS 5.0 publications noted on this order form with an * included in the publication number. (BIND SL L 1)

NOTE: The following general UNICOS publications have not been revised for the UNICOS 5.0 release; these publications are included as part of the release package only for new UNICOS customers:

Pub. Only	Pub. with Binder	Pub. Number	Title
___	___	SG-2010 C	<i>UNICOS Primer</i> (BIND SL L 1)
___	___	SG-2050	<i>UNICOS Text Editors Primer</i>
___	___	SG-2052 A	<i>UNICOS Overview for Users</i> (BIND SL L 1)
___	NA	SQ-2054	<i>UNICOS vi Reference Card</i>
___	NA	SQ-2055 A	<i>UNICOS ed Reference Card</i>
___	___	SG-2017 B	<i>UNICOS Source Code Control System (SCCS) User's Guide</i>
___	___	SG-2016 C	<i>UNICOS Support Tools Guide</i> (BIND SL L 1)
___	___	SN-2067	<i>Defining and Compiling terminfo Definitions for the UNICOS Operating System</i> (BIND SL L 1)

6.3.1.2 Administrator manuals

Pub. Only	Pub. with Binder	Pub. Number	Title
—	—	SG-2018 C	<i>UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems</i> (BIND SL L 1.5)
—	—	SG-2019 C	<i>UNICOS System Administrator's Guide for CRAY-2 Computer Systems</i> (BIND SL L 1.5)
—	—	SR-2022 5.0*	<i>UNICOS Administrator Commands Reference Manual</i> (BIND SL L 1.5)
—	—	SR-2062 A*	<i>UNICOS Security Administration Reference Manual</i> (BIND SL L 1)
—	—	SG-2021 C*	<i>TCP/IP Network Administrator's Guide</i> (BIND SL L 1)
—	—	SG-2063	<i>UNICOS Yellow Pages (YP) Administrator's Guide</i> (BIND SL L 1)
—	—	SR-2064 A	<i>UNICOS NFS Administrator's Manual</i> (BIND SL L 1)
—	—	SG-2072 A	<i>UNICOS Station Call Processor (USCP) Administrator's Guide</i> (BIND SL L 1)
—	—	SG-2005 D*	<i>I/O Subsystem (IOS) Operator's Guide for UNICOS</i> (BIND SL L 1)

6.3.1.3 Products and language processors

Pub. Only	Pub. with Binder	Pub. Number	Title
—	—	SR-2007 D	<i>CRAY-2 Fortran (CFT2) Reference Manual</i> (BIND SL L 1)
—	NA	SQ-2008 C	<i>CRAY-2 Fortran (CFT2) Reference Card</i>
—	—	SR-0066 F	<i>Segment Loader (SEGLDR) and ld Reference Manual</i> (BIND SL L 1)
—	—	SG-2059 A*	<i>CSIM User's Guide for UNICOS</i> (BIND SL L 1)

* Please order publication SR-2096, *UNICOS 5.0 Release Addendum to Software Publications*, when ordering this publication.

Pub. Only	Pub. with Binder	Pub. Number	Title
—	NA	SQ-2031 A	<i>CSIM Ready Reference for UNICOS</i>
—	—	SR-2091 5.0	<i>UNICOS CDBX Symbolic Debugger Reference Manual (BIND SL L 1)</i>
—	—	SG-2094 5.0	<i>UNICOS CDBX Debugger User's Guide (BIND SL L 1)</i>

NOTE: The following UNICOS products publications have not been revised for the UNICOS 5.0 release; these publications are included as part of the release package only for new UNICOS customers:

Pub. Only	Pub. with Binder	Pub. Number	Title
—	—	SR-0112 C	<i>UNICOS Symbolic Debugging Package Reference Manual (BIND SL L 1)</i>
—	NA	SQ-0303 A	<i>SEGLDR Reference Card</i>
—	—	SR-0013 I	<i>UPDATE Reference Manual (BIND SL L 1)</i>
—	NA	SQ-0302 A	<i>UPDATE Directives Reference Card</i>
—	—	SR-0074 B	<i>SORT Reference Manual (BIND SL L 1)</i>
—	—	SR-0085 B	<i>Symbolic Machine Instructions Reference Manual (does not support CRAY-2 computer systems) (BIND SL L 1)</i>
—	NA	SQ-0083 C	<i>CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 CAL Assembler Version 2 Ready Reference</i>
—	—	SR-2003 C	<i>CAL Assembler Version 2 Reference Manual (BIND SL L 1.5)</i>
—	NA	SQ-2002 C	<i>CRAY-2 CAL Assembler Version 2 Ready Reference</i>

6.3.1.4 Libraries, macros, and opdefs

Pub. Only	Pub. with Binder	Pub. Number	Title
_____	_____	SR-0136 5.0*	<i>Cray C Library Reference Manual</i> (BIND SL L 1.5)
_____	_____	SR-2082	<i>UNICOS Macros and Opdefs Reference Manual for CRAY-2 Computer Systems</i> (BIND SL L 1)
_____	_____	SR-2079 5.0*	<i>Volume 1: UNICOS Fortran Library Reference Manual</i> (BIND SL L 1.5)
_____	_____	SR-2081 5.0*	<i>Volume 3: UNICOS Math and Scientific Library Reference Manual</i> (BIND SL L 1)
_____	_____	SR-2012 5.0*	<i>Volume 4: UNICOS System Calls Reference Manual</i> (BIND SL L 1)
_____	_____	SR-2057 5.0	<i>Volume 5: UNICOS Network Library Reference Manual</i> (BIND SL L 1)
_____	_____	SR-0012 D	<i>Macros and Opdefs Reference Manual</i> (does not support CRAY-2 computer systems); <u>this publication has not been revised for the UNICOS 5.0 release</u> ; it is included as part of the release package only for new UNICOS customers. (BIND SL L 1)

6.3.1.5 Internal design and maintenance documents

With Binder	Without Binder	Pub. No.	Title
_____	_____	SM-2065	<i>UNICOS NFS Internal Reference Manual</i> (BIND SL L 1)
_____	_____	SM-2083 5.0*	<i>Volume 6: UNICOS Internal Library Reference Manual</i> (BIND SL L 1.5)
_____	_____	SM-0042 H	<i>Front-end Protocol Internal Reference Manual</i> (BIND SL L 1)
_____	_____	SM-2068 A	<i>TCP/IP Table Descriptions Internal Reference Manual</i> ; available July 1989 (BIND SL L 1)
_____	_____	SM-2069 A*	<i>TCP/IP Protocol Definitions Internal Reference Manual</i> (BIND SL L 1)

* Please order publication SR-2096, *UNICOS 5.0 Release Addendum to Software Publications*, when ordering this publication.

Pub. Only	Pub. with Binder	Pub. Number	Title
_____	_____	SM-0225 C	<i>Debug Tables Internal Reference Manual (BIND SL L 1)</i>
_____	_____	SD-0119	<i>AUDPL Internal Reference Manual; <u>this publication has not been revised for the UNICOS 5.0 release</u>; it is included as part of the release package only for new UNICOS customers. (BIND SL L 1)</i>
_____	_____	SD-0123 B	<i>Symbolic Debugging Package Internal Reference Manual; <u>this publication has not been revised for the UNICOS 5.0 release</u>; it is included as part of the release package only for new UNICOS customers. (BIND SL L 1)</i>
_____	_____	TR-UKIT	<i>UNICOS Kernel Internal Tables Reference Manual (BIND SL L 1)</i>

6.3.1.6 Cray Proprietary internals and on-line diagnostics

NOTE: The following publications are proprietary to Cray Research, Inc. Dissemination of this documentation to non-CRI personnel requires approval of the appropriate vice president and that the recipient sign a nondisclosure agreement. Export of technical information in this category may require an export license.

Pub. Only	Pub. with Binder	Pub. Number	Title
_____	_____	SMM-1012 C	<i>CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems UNICOS On-line Diagnostic Maintenance Manual (BIND SL L 1.5)</i>
_____	NA	SQ-1018	<i>CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems UNICOS On-line Diagnostic Ready Reference</i>
_____	_____	SMM-1016 A	<i>On-line Diagnostic Network Communications Program (OLNET) Maintenance Manual (BIND SL L 1)</i>

Pub. Only	Pub. with Binder	Pub. Number	Title
—	—	SMM-2028 C	<i>CRAY-2 Computer System UNICOS On-line Diagnostic Maintenance Manual (BIND SL L 1)</i>
—	NA	SQ-1019	<i>CRAY-2 Computer System UNICOS On-line Diagnostic Ready Reference</i>
—	—	SP-2020 A	<i>CRAY-2 Foreground Processor Reference Manual (BIND SL L 1)</i>
—	—	SP-2023 5.0	<i>UNICOS Internal Reference Manual for CRAY-2 Computer Systems (BIND SL L 1)</i>
—	—	SP-2041 5.0	<i>UNICOS Internal Reference Manual for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems (BIND SL L 1)</i>
—	—	SN-2099 5.0	<i>UNICOS Tuning Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems; available May 30, 1989 (BIND SL L 1)</i>

6.3.1.7 Supplemental notes, papers, or manuals

Qty.	Pub. No.	Title
—	S1-0113	<i>LINPACK User's Guide.</i> Dongarra, Bunch, Moler, and Stewart. Society for Industrial and Applied Mathematics
—	S2-0113	Lecture Notes in Computer Science, 6, Matrix Eigensystem Routines-EISPACK Guide by Smith, Boyle, Dongarra, Garbow, Ikebe, Klema, Moler
—	S3-0113	Lecture Notes in Computer Science, 51, Matrix Eigensystem Routines-EISPACK Guide Extension by Boyle, Dongarra, Garbow, Moler
—	S1-2014	<i>SENDMAIL - An Internetwork Mail Router</i> by Eric Allman of Britton-Lee, Inc; this is also included in the UNIX 4.3BSD System Maintenance Manual from the University of California at Berkeley.

Qty.	Pub. No.	Title
_____	S2-2014	<i>SENDMAIL - Installation and Operation Guide</i> by Eric Allman of BrittoLee, Inc; this is also included in the UNIX 4.3BSD System Maintenance Manual from the University of California at Berkeley.

6.3.1.8 Other release documentation

The release package contains one of each of the following publications. For additional copies, indicate the number of additional publications on the appropriate blank.

Pub. Only	Pub. with Binder	Pub. Number	Title
_____	_____	UC-05.0-UAD-RN	<i>UNICOS 5.0 Release Notice</i> (BIND SL L 1)

Note: The following documents are Cray private documents and can be distributed to non-CRI personnel only with the approval of the appropriate Cray manager.

Pub. Only	Pub. with Binder	Pub. Number	Title
NA	_____	UC-05.0-UAD-RNS	<i>UNICOS 5.0 Release Notice Supplement; this is the binder and tabs for the following UNICOS 5.0 installation, performance, outstanding problems, and UNICOS interface differences information.</i> (BIND SL L 1.5)
_____	_____	UC-05.0-U2D-UIB	<i>UNICOS 5.0 Release Upgrade System Installation Bulletin for the CRAY-2 Computer System</i>
_____	_____	UC-05.0-U2D-IIB	<i>UNICOS 5.0 Release Initial System Installation Bulletin for the CRAY-2 Computer System</i>

Pub. Only	Pub. with Binder	Pub. Number	Title
_____	_____	UC-05.0-UMD-UIB	<i>UNICOS 5.0 Release Upgrade System Installation Bulletin for the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems Using the Peripheral Expander</i>
_____	_____	UC-05.0-UMD-IIB	<i>UNICOS 5.0 Release Initial System Installation Bulletin for the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems Using the Peripheral Expander</i>
_____	_____	UC-05.0-UMD-IIB1	<i>UNICOS 5.0 Release Initial System Installation Bulletin for the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems Using the Operator Workstation (OWS)</i>
_____	_____	UC-05.0-UMD-UIB1	<i>UNICOS 5.0 Release Upgrade System Installation Bulletin for the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems Using the Operator Workstation (OWS)</i>
_____	_____	UC-05.0-UAD-PER	<i>UNICOS 5.0 Release Performance Report</i>
_____	_____	UC-05.0-UAD-PROB	<i>UNICOS 5.0 Release Problems List</i>
_____	_____	UC-05.0-UAD-DIF	<i>UNICOS 5.0 Release Interface Differences Report</i>

6.3.1.9 To order troff source code of on-line documentation

The troff source code can be obtained for the following on-line UNICOS manuals if you wish to make local modification to manual (`man`) pages using your front-end UNIX system:

- *UNICOS User Commands Reference Manual*, publication SR-2011
- *UNICOS Administrator Commands Reference Manual*, publication SR-2022
- *UNICOS File Formats and Special Files Reference Manual*, publication SR-2014
- *Cray C Library Reference Manual*, publication SR-0136
- *UNICOS Macros and Opdefs Reference Manual for CRAY-2 Computer Systems*, publication SR-2082
- *Volume 1: UNICOS Fortran Library Reference Manual*, publication SR-2079
- *Volume 3: UNICOS Math and Scientific Library Reference Manual*, publication SR-2081
- *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012
- *Volume 5: Network Library Reference Manual*, publication SR-2057
- *Volume 6: UNICOS Internal Library Reference Manual*, SM-2083; only routines for CRAY-2 computer systems are available on-line with this release; routines for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems are planned to be available on-line with a later release.

For further information, contact the Publications Hotline at (612) 681-5729, send UNIX mail to `sun!tundra!hall!publications`, `uunet!cray!publications`, or `publications@cray.com`, or write:

Cray Research, Inc.
Technical Publications Department
1345 Northland Drive
Mendota Heights, MN 55120

6.3.2 Additional binders

To order quantities of CRI 3-ring, silver logo binders, indicate the quantity of each size binder on the appropriate blank.

Qty.	Description
_____	1-in. Silver Logo Binder (BIND SL L 1)
_____	1.5-in. Silver Logo Binder (BIND SL L 1.5)
_____	2-in. Silver Logo Binder (BIND SL L 2)
_____	3-in. Silver Logo Binder (BIND SL L 3)

7. Compatibility/Differences

This section describes user issues involved in moving from previous UNICOS releases to the UNICOS 5.0 release.

7.1 All Cray computer systems

The following compatibility issues apply to users of all Cray computer systems running UNICOS 5.0.

7.1.1 TCP/IP compatibility issues

TCP/IP library routines: TCP/IP library routines have incompatibilities between 4.2BSD and 4.3BSD. TCP/IP provided with UNICOS 5.0 supports both UNICOS 4.0 and UNICOS 5.0 socket structures, making it upward compatible. Between 4.2BSD and 4.3BSD, the arguments and return values of the `getsockopt` and `setsockopt` TCP/IP library routines changed. The UNICOS 3.0 and 4.0 releases supported both interfaces. In UNICOS 5.0, backwards compatibility has been dropped, only the 4.3BSD argument and return values are supported. Any program that has not yet been modified to use the 4.3BSD argument and return values must be modified and recompiled to run correctly on a UNICOS 5.0 system.

Berkeley TCP/IP compatibility issues: In previous UNICOS releases, the TCP/IP code had several incompatibilities with standard Berkeley TCP/IP code.

These differences have been addressed in the UNICOS 5.0 release and are described below:

- The Berkeley commands have been placed in a new directory called `/usr/ucb`. As a result, `remsh` has been changed to the Berkeley form `rsh` and is located in `/usr/ucb`; however, the restricted shell is still available and is still called `rsh` in `/bin`. Manipulation of the path variable allows the user to gain access to one or the other.
- Several new `ftp` commands are included in UNICOS 5.0, and the `ftp` macro support is also included.
- The mechanism for port number allocation for UNICOS 5.0 outbound r-series commands has been changed from 4.3BSD because of noticeable performance problems. The standard 4.3BSD mechanism defines the maximum port number to be `IPPORT_RESERVED - 1` or 1023 and a search for an open port is done backwards from 1023. The maximum port number in UNICOS 5.0 is computed as follows:

```
max. port = IPPORT_RESERVED - 1 - (getpid()
%(IPPORT_RESERVED)/4))
```

The value of `IPPORT_RESERVED` is 1024 and `getpid` is the process ID.

This formula randomizes the maximum port number from 766 to 1023. The minimum port number used is 512. The port number allocation algorithm searches for an available port, decrementing from the maximum to the minimum port number. Therefore, using a random maximum port number can speed up the port allocation process.

- The `rcp` syntax has been changed to match the 4.3BSD version, which is now `[[user@]machine:]pathname` instead of `[machine[:user]:]pathname`.
- Definition of `struct sockaddr_in`: In previous releases, this structure contained a 32-bit bit field, called `sin_addr`. In the 5.0 release, `sin_addr` is now defined as `struct in_addr`, as in Berkeley code.

- **Definition of struct in_addr:** In previous releases, this structure contained a 32-bit bit field, called `saddr`. It now contains a 32-bit bit field called `s_addr`, as in Berkeley code.
- **Definition of struct hostent:** This change affects the `gethost*()` routines. In previous releases, the `h_addr` field pointed to a "long" that contained the 32-bit internet address. In the 5.0 release, the `h_addr` field has been replaced by `h_addr_list`, with `h_addr` being defined as `h_addr_list[0]` for backwards compatibility. These are all now pointers to `struct in_addr`, as in Berkeley code. The consequence of this change is that in the 64-bit word that contains the 32-bit address, the 32-bit address is now in the upper 4 bytes, whereas in previous releases it was in the bottom 4 bytes.
- **Library routine inet_makeaddr():** In previous releases, this function returned a "long." This function now returns a `struct in_addr`, as in Berkeley code. The consequence of this change is that it is now returning a structure instead of a "long," and in the 64-bit word that is returned, the 32-bit address is now in the upper 4 bytes, whereas in previous releases it was in the bottom 4 bytes.
- **Library routines inet_lnaof(), inet_netof(), and inet_ntoa():** In previous releases, these functions took a "long" as an argument. With this release, these functions take a `struct in_addr` as an argument as in Berkeley code. The consequence of this change is that the routine input argument is now a 32-bit address located in the upper 4 bytes of a 64-bit word instead of the lower 4 bytes of the word.
- Executables that were compiled under a UNICOS 4.0 system should continue to run under a UNICOS 5.0 system.
- The UNICOS 5.0 release also provides the ability to compile existing code without having to make these modifications, though existing code should be modified as soon as possible. **NOTE:** 4.2BSD TCP/IP source compatibility will be removed in the UNICOS 6.0 release.

- The binary layout of the **struct sockaddr_in** and **struct in_addr** structures is identical to previous releases. In the header file `<netinet/in.h>`, which defines these structures, if **OLDTCP** is defined, then the old format of these structures will be used.
- For the **gethost*()**, **inet_makeaddr()**, **inet_lnaof()**, **inet_netof()**, and **inet_ntoa()** routines, we have provided a backwards compatibility library `-lonet`, to allow existing code to compile and link properly.

For example, assume you have existing code, `foo.c`, for the UNICOS 4.0 release that you wish to compile under 5.0. Previously, you would have compiled it with:

```
cc foo.c -o foo -lnet
```

Under UNICOS 5.0, you can compile it with:

```
cc -DOLDTCP foo.c -o foo -lonet -lnet
```

Note that you still must include `-lnet`. The `-lonet` library only contains a minimal number of routines to provide the backwards capability.

7.1.2 NFS differences

The following NFS differences should be considered when upgrading from UNICOS 4.0 to UNICOS 5.0:

- The **mount** command has been changed to support UNICOS NFS on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems; also, new options have been added.
- The ability to remove individual ID mapping domain entries or individual ID maps has been added. A range of Internet addresses may be specified in the definition of an ID mapping domain entry. An ID mapping domain entry can specify use of different ID maps for client and server mapping. Also, the commands used to administer NFS ID mapping have changed. The **merge** command has been

enhanced and renamed to **nfsmerge**. The **mkdomain** command has been replaced by several commands that provide additional functionality.

- The function **xdr_vector** has been included in the RPC libraries; this function was not included in earlier versions of **rpc/xdr**.

7.1.3 X Window System support

X Version 10 is no longer supported in the UNICOS 5.0 release. X Version 11, Release 3 replaces X Version 10 and functions with the UNICOS 5.0 release.

7.1.4 Network libraries

As described in subsection 7.1.15, earlier versions of the Cray C compiler, external references to functions and data structures from within a program with the underscore character in the names were replaced with the \$ character on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems and with @ characters on CRAY-2 systems wherever the underscore appeared. The Cray C 4.1 compiler no longer alters names with underscore characters. Consequently, the **libnet** and **librpc** libraries have been altered to include three different names for routines using an underscore in their names so that the libraries can be used by programs compiled by older versions of the compiler on any Cray system. For example, the routine **inet_lnaof** can be referenced externally by three different names: **inet_lnaof**, **net\$lnaof** (for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems), and **net@lnaof** (for CRAY-2 systems). These alternate external names will be removed in the UNICOS 6.0 release.

NOTE: The X Windows libraries have not been altered to include \$ or @ versions of external names. Programs using the X Windows libraries must be compiled with the Cray C 4.1 compiler so that the library names including an underscore can be properly referenced.

7.1.5 limit system call

For all Cray computer systems, the `L_TAPE` resource argument to the `limit` system call has changed. In previous releases it indicated the maximum number of tape devices permitted for the job. In this release, the argument now indicates the maximum number of tape devices allowed for tape group; it is synonymous with the `L_TAPE0` resource argument. The `L_TAPE` resource argument will be removed in a future UNICOS release.

7.1.6 CAL code

CAL code that depends on translation done by the 4.1 Cray C compiler must be changed to match the translation changes that were made to the 4.1 C compiler.

7.1.7 prof performance tool

The `prof` command now displays routine addresses by module start location. The previous version of `prof` displayed these addresses by entry point (which is not always the same as the start of the routine). The field for the relative bucket address will now contain absolute bucket addresses instead. Note that this command will show routine names with special symbols appended to them, if users compile their code with debugging symbols enabled. The appearance of these symbols will be quite different from previous versions of `prof`. Users wishing to see all symbolic locations within their programs must change their compiler options to include debugging symbols. These options are described in the *UNICOS Performance Utilities Reference Manual*, publication SR-2040.

Some report output formats have changed for this command. User post-processing programs that expect the older format must be altered. However, the `prof` command has been enhanced to provide a raw output format, which should be simpler to post-process.

7.1.8 ftref performance tool

The **ftref** program now displays several new error messages. A new listing section is now present for unreferenced routines. The method of searching for a default ROOT program has changed, so some static calling trees will appear differently from those generated by UNICOS 4.0. Long variable names generated from CFT77 will appear differently in the global variable cross-reference report. All of these listing changes will affect any user programs that read the output of **ftref**.

7.1.9 sh and csh script files

This release has reinstated support for the **#!** character sequence. Support is at the kernel level like the traditional Berkeley UNIX implementation. When a pathname is found that has proper execute permissions, the shell forks a new process and passes it, along with its arguments, to the kernel. If the file is a text file, and the first line begins with **#!**, the next word is taken to be the pathname of a shell (or command) to interpret that script. Subsequent words, usually only one if any, on the first line are used as a single option to that shell.

7.1.10 fmp and PREMULT

fmp, the autotasking translator, replaces **PREMULT** for the UNICOS 5.0 release. Note, however, that the **premult** command line has not changed; that is, the user types in the command **premult**, as in earlier releases, and **premult** calls **fmp**. The only difference users will see is that microtasking directives are expanded into different code compared to what was generated by **PREMULT** 4.0. Note, however, that microtasked saved relocatable binaries that are run through **PREMULT** 4.0 will not execute under the UNICOS 5.0 system.

Since the PREMULT 4.0 and the UNICOS 5.0 libraries are NOT compatible, microtasked programs must be processed by **fmp/premult** before they can be executed under the UNICOS 5.0 system. On CRAY-2 systems, **libmicro** is the microtasking library and **libauto** is the autotasking library.

7.1.11 Using UDB with uentry

UNICOS sites running with **uentry** must relink any code using **getpwx** or **getgrx** C library routines since the map files used with **uentry** are not present in UNICOS 5.0. In UNICOS systems not using **uentry**, the old **getpwx** and **getgrx** routines will work.

/etc/passwd and **/etc/group** files in UNICOS 5.0 are compatible with the same files in earlier systems, with the exception that the encrypted password is not available (its position is occupied by the character "*" as a placeholder).

7.1.12 NQS

The following NQS differences should be considered when upgrading from UNICOS 4.0 to UNICOS 5.0:

- NQS requests using tapes must be changed to conform to the new options.
- NQS accounting no longer exists and new **qmgr** commands exist for daemon accounting.
- The specification of a service under **qmapmgr** is required when networking is attempted.
- UNICOS NQS 4.0 and UNICOS NQS 5.0 are incompatible with respect to the database and directories in **/usr/spool**.

7.1.13 UNICOS 5.0 release disk space requirements

The disk space required to store a complete UNICOS 5.0 system is approximately 1.3 Gbytes (317,382 blocks) for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 mainframes and 1.2 Gbytes (292,968 blocks) for CRAY-2 mainframes. A complete system implies SCM files, UPDATE files, source files, and the binary files for all parts of the operating system, commands, products, libraries, utilities, generation compilers, and networking components. The disk space requirements may be reduced if all capabilities provided by the UNICOS 5.0 release are not installed or if all SCM/UPDATE and source files are not maintained on-line simultaneously. See Appendix A for more information.

It has been observed that the disk size of an absolute Fortran application compiled on the UNICOS 5.0 system and associated libraries will occupy upwards of 80,000 bytes more disk space than the same application processed under the UNICOS 4.0 system with associated libraries. This disk space increase is attributable to the changes produced by the UNICOS 5.0 libraries. Review the description in Appendix A concerning the UNICOS 5.0 libraries for details. Sites should review the size of user partitions as a result of this increase in disk space.

7.1.14 UNICOS 5.0 release memory usage

Memory usage has increased with the introduction of the UNICOS 5.0 release due to increased functionality. Enhancements contributing to the increased memory usage are in the areas of security, scheduling, system log, accounting, checkpoint/restart, and tapes. Additional features are in the areas of the share scheduler, limits, diagnostics driver, CPU control, multi-threading, and multiple low-speed channels. For example, on a 2 million word system, a basic UNICOS 5.0 system without TCP/IP or security is 33K words larger than a similarly configured UNICOS 4.0 system. With TCP/IP and security configured, the UNICOS 5.0 kernel is 38K words larger than the UNICOS 4.0 kernel. As expected, the user space remaining for user applications is dependent on a site's configuration and installed options. See Appendix A for additional information.

All details needed to calculate accurate memory and disk space requirements are not included in Appendix A for this release. With the information provided, the site should be able to make a determination of the memory and disk conflicts that may arise with the installation of the UNICOS 5.0 system. The data and formulas presented in Appendix A will continue to be developed to provide additional accuracy in future UNICOS releases.

7.1.15 SEGLDR support for the `segldr`, `ld`, and `sld` commands

SEGLDR supports two alternatives to the UNICOS `segldr` command. Prior to this release, `ld` on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems was a separate interface program that invoked `segldr`. Beginning with this release, `ld` and `segldr` are different invocations of the same loader. When invoked as `segldr`, the loader continues to execute as in previous releases. When invoked as `ld`, the loader does not recognize the SEGLDR environment variable, and default settings for some directives have changed to provide more traditional UNIX operations.

On CRAY-2 systems, the `sld` command (so named to avoid conflict with the current CRAY-2 `ld` program) provides traditional UNIX operations with SEGLDR. Both `/lib/lmset` and `/lib/csu` are supported in `/lib/libc.a`. Thus, they need not be supplied on the `sld` command line when invoked. Note, however, they should be specified on the `ld` command line.

7.1.16 UPDATE

With the UNICOS 5.0 release, the UPDATE sequence number generation has changed. Mods that have a single IDENT changing multiple DECKS may have different sequence numbers generated with the UPDATE released with UNICOS 5.0 versus the UPDATE released with UNICOS 4.0. If you have one IDENT per DECK changed, then the UNICOS 5.0 UPDATE will work identically to the UNICOS 4.0 UPDATE version.

The `-o os` option has been added to the `update` command line to force the UNICOS 5.0 UPDATE to use the old sequence number generation scheme. This option was added to provide compatibility with UNICOS 4.0 UPDATE and to allow sites with local mods time to add them to the PL with the UNICOS 5.0 UPDATE.

7.1.17 Dependency between Cray C 4.1 compiler and UNICOS libraries

A site must build the UNICOS 5.0 system with the generation C compiler, which is a version of the Cray C 4.1 compiler. This version no longer translates the underscore (`_`) character to a `$` character (CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 systems) or to an `@` character (CRAY-2 systems) in external names by default.

Duplicate definitions of the `_` and `$` or `@` routines are supplied in the libraries so both definitions exist in the libraries. This allows users to compile their code with either the Cray C 4.0 compiler, which translates the `_` character, or with the Cray C 4.1 compiler, which does not translate.

The `trlib` user command is provided with the UNICOS 5.0 release; this command is a transition aid for duplicating global names with respect to underscore translation. The `trlib` command will not be supported after the UNICOS 5.0 release.

NOTE: If users wish to load with UNICOS 4.0 libraries, UNICOS 5.0 libraries, or third-party libraries generated with the Cray C 3.1 compiler, they should use the `-h nounderline` option of the `cc` command.

7.1.18 New warning message for reading EOF

A new warning message appears when a user encounters an ENDFILE record on a READ statement without an `END=` or an IOSTAT parameter. A warning message also appears when the EOF/IEOF function is called (see subsection 4.4.1, "Library enhancements for all Cray computer systems").

7.1.19 Fortran library I/O error message numbers

The IOSTAT= specifier in a standard Fortran I/O statement must contain one of the following values on return from a Fortran I/O statement:

- Negative value for end-of-file status
- Zero for successful status
- Positive value for error status

Programs that check for these types of values are more portable between Cray systems and more compatible between release levels of a system than programs that check the actual status values returned by a system. The status values may change over time and new status values may be added to provide more information about an error or end-of-file condition.

The error numbers and their corresponding messages are provided to assist the Fortran programmer in program debugging.

7.2 CRAY-2 computer systems

The following compatibility issues apply to users of CRAY-2 computer systems running UNICOS 5.0.

7.2.1 Profiling sample rate change

The profiling sample rate has been changed from 100/second to 10000/second. This change will have an impact on anyone interpreting the results from the `profil` system call with their own software. The `prof` command has been changed to correct for this new feature.

7.2.2 Profiling output data file name

The profiling output data file name has been changed from **prof.out** to **prof.data**. User programs that process this file name must be changed. The **prof** command has been changed to reflect this new file name.

7.3 CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems

The following compatibility issues apply to users of CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems running UNICOS 5.0.

7.3.1 Security feature

The following aspects of the security feature have changed:

- The **acl** command is now the **spacl** command.
- For write operations, the compartment rules (part of the baseline security policy) have changed from the UNICOS 4.0 release. In the UNICOS 4.0 release, the subject's compartments needed to match the object's or be a superset of the object's compartments. In the UNICOS 5.0 release, a subject may write to an object only if the subject's active compartments are equal to the compartments assigned to the object.
- The new **-a** option of the **spclr** command removes an access control list, making the **rmfac** command of the 4.0 release obsolete.

7.3.2 Fortran OPEN statement

The behavior of the Fortran OPEN statement has been changed on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems. For files opened STATUS=SCRATCH, the default file name now used is the same as other Fortran files. For example, if UNIT 32 is opened, the name **fort.32** is used. The FILE= clause on the OPEN statement is also honored now for SCRATCH files (it used to be ignored). This change allows the assign command to work properly with SCRATCH files. This change may have an adverse impact on Fortran codes that open Fortran SCRATCH units and expect the local **fort.nn** files to remain untouched.

7.3.3 On-line tapes

Fortran programs using on-line tapes must be relinked. The size of the **bmX** structure has changed (several fields were added) and can overwrite user's programs by up to a word if the Fortran programs are not relinked.

C programs directly accessing the **bmX** structures must be recompiled.

7.3.4 listio changes

UNICOS 3.0 release absolute binaries that used **listio** system calls ran under UNICOS 4.0 but will not run under UNICOS 5.0. These binaries must be recompiled under UNICOS 5.0. The old **listio** has been phased out; only the version supplied with UNICOS 5.0 is supported.

7.3.5 Default direct access structure

In previous UNICOS releases the default Fortran file structure for DIRECT ACCESS files was BIN. The BIN structure uses the word-addressable package to transfer data between the users variables and the external medium. For

users who did unformatted direct access I/O of character variables, there have been problems if the character variables were not a multiple of 8 bytes, or if the location of the character variable was not aligned on a word boundary. These problems and several others have been fixed in the UNICOS 5.0 release by changing the default file structure from BIN to SBIN.

This change has two visible effects for users. The first is that the performance characteristics of direct access I/O will change. Wall-clock time for I/O on files with small records will run faster, while larger records will run slower. Wall-clock times can vary considerably from UNICOS 4.0 and will differ depending on system configuration and system load. CPU times are similar to UNICOS 4.0 times. The problems seen in UNICOS 4.0 with significantly slow performance on small records have been eliminated.

The second effect is that if files written with DIRECT ACCESS contain unformatted records with character variables, and the length of any of the character variables is not a multiple of 8 bytes, then the data will be stored differently using the UNICOS 5.0 libraries as compared to the UNICOS 4.0 libraries. This means that files of this type created on a UNICOS 4.0 system cannot be used on a UNICOS 5.0 system. If performance problems are encountered with the UNICOS 5.0 libraries, then the BIN structure can still be requested for any given file using the

assign command. If files that were generated with the UNICOS 4.0 libraries as described above are found to be necessary on a UNICOS 5.0 system, CRI recommends that the data be regenerated with UNICOS 5.0 libraries. Another method would be to generate the data with the UNICOS 4.0 libraries using the SBIN file structure. If the data cannot be regenerated, and this is a major problem, please contact Software Development in Mendota Heights for assistance.

CRI does not recommend the BIN structure for use with files containing unformatted records with character data that is not a multiple of 8 bytes or with record lengths that are not multiples of 8 bytes.

7.3.6 CFT 1.14 Bugfix 8

Because of changes made to the libraries relating to STACK/STATIC (targeting), CFT 1.14 Bugfix 8 cannot be used as a migration aid from COS to UNICOS 5.0. CRI recommends using CFT 1.15 Bugfix 3, revision 1 or CFT 1.16 when available.

7.3.7 Fortran tape I/O

In the UNICOS 5.0 release, the concept of end-of-file (EOF) and end-of-data (EOD) is fully supported with COS blocked files and tape datasets. However, for compatibility with the UNICOS 4.0 release tape subsystem, the CALL READ and CALL READP library routines have been modified to return an EOF status when reading from magnetic tape, regardless of whether the actual status returned from the tape is EOF or EOD. This change allows programs that expect the EOF condition to always precede the EOD to continue to work.

To receive the more accurate EOF and EOD status return codes from the CALL READ and CALL READP library routines, the user should specify the `-s` option on the `assign` command to be `bmx50` or `tape50`. To apply this to any

larger scope, such as an entire job, the environment variable `ENABLE_BMX_50` can be set, which will force the accurate EOF and EOD statuses to be returned.

This change does not affect intrinsic Fortran READ and WRITE statements.

7.3.8 Accounting

UNICOS 4.0 `tacct` files must be converted to UNICOS 5.0 format by using the `acct2esa` administrator command.

7.3.9 hpm

The report output format of the **hpm** command has been changed. User post-processing programs that expect the older format must be altered. However, the **hpm** command has been enhanced to provide a raw output format that should be simpler to post-process.

7.3.10 Default bucket size for profiling

The default bucket size for profiling has been changed from 64 words to 4 words on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 computer systems. This change increases the memory requirements during profiling of user codes. Users experiencing memory problems when running profiling should increase the bucket size, which is done by changing the environment variable **PROF_WPB**. For example, if your executable code is on the file **a.out**, you would use the following command:

```
env PROF_WPB=16 a.out
```

This example decreases the profiling memory requirement by a factor of 4 from the default.

7.3.11 Perftrace

The Perftrace facility has been internally rewritten for the UNICOS 5.0 release. (See section 3, Software Enhancements, for information on new features.) Users will see several impacts:

- Perftrace execution itself is now included in the counter values and timings reported. Perftrace will attempt to subtract estimated times and counter values for its own execution from the totals per routine. However, this method causes the counter values to be inexact. Tests have shown that the counters are correct to 3 decimal digits. In addition, several performance counters vary

from one program execution to another. However, the estimated times used by Perfttrace are fixed. Thus, some counter differences will appear between different runs of the same program.

- Performance statistics generated by the new Perfttrace will not be the same as those generated by the old version that was provided in previous UNICOS releases. These different values should not be a cause for alarm, since the two software tools are using different methods of data accumulation. Relative performance times (percentages) should not significantly change between system versions.
- The appearance of the Perfttrace report output has been changed. User programs that post-process this output will have to be altered. However, a new feature of Perfttrace for the UNICOS 5.0 release is a raw output format, which will make post-processing easier.

7.3.12 libheap

libheap is no longer supported. **libheap** was provided in previous UNICOS releases because of problems with the default heap manager in **libu**. These problems have been fixed and, as a result, support for **libheap** has been discontinued. If users require **libheap** for their site, the site should save the source from their UNICOS 4.0 release and report through an SPR (Software Problem Report) why it is required.

7.3.13 Change in C default libraries

With the UNICOS 5.0 release, the **libu** and **libm** libraries must also be included with **libe** if users are loading libraries. The **cc** command, however, loads all three of these libraries by default when the link phase occurs. This does not preclude users from specifying **-lm** or **-lu** on the **cc** command line, and therefore does not cause problems with existing makefiles or scripts.

7.3.14 schedv system call

The `schedv` system call has changed to support several additional options. Memory, priority, share priority, nice value, time in memory, time swapped and thrash controls have been added. Because of the large range of variables now available to control memory scheduling in UNICOS, please refer to *Volume 4: UNICOS System Calls Reference Manual*, publication SR-2012, and to the *UNICOS System Administrator's Guide for CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY-1 Computer Systems*, publication SG-2018, for more information about how these options can alter the behavior of UNICOS.



8. Evaluation

This section describes the activities and results of testing performed by Software Quality Assurance (SQA) for the UNICOS 5.0 release for CRAY-2 and CRAY X-MP computer systems. Unless explicitly stated otherwise, the information contained within this document refers to UNICOS 5.0 on both CRAY-2 and CRAY X-MP, CRAY X-MP EA and CRAY Y-MP computer systems.

There will be a mods tape released with this system that addresses many of the documented problems. Refer to the UNICOS 5.0 System Installation Bulletin for a list of mods included on the tape and for testing information concerning these mods.

The C, CFT2, CFT77 and Pascal compilers are released separately from UNICOS. Because the versions of these compilers are likely to change during the life of this report, all testing information on them is excluded. This information is available from the Distribution Center in Mendota Heights, and it can be found in each respective compiler's latest release testing report.

Future references to *UNICOS 5.0 for CRAY-2 computer systems* will be shortened to *CRAY-2 UNICOS*, and references to *UNICOS 5.0 for CRAY X-MP computer systems* will be shortened to *CRAY X-MP UNICOS*.

8.1 UNICOS Operating System

This subsection describes the testing effort performed for the following UNICOS 5.0 operating system components: system calls, library routines and commands.

8.1.1 Testing Comprehensiveness

During the UNICOS 5.0 release cycle, four different test suites were run. These were the UNIX Regression Test Suite (URTS), the Perennial UNIX Test Suite, AT&T's System V Verification Suite (SVVS) for AT&T System V.3, and the Cray UNICOS Test Suite (CUTS). URTS tests the Bourne shell commands described in section (1) of the *UNIX System User's Manual* and section (1M) of the *UNIX System Administrator's Manual* and library functions described in section (3) of the *UNIX System User's Manual*. The Perennial test suite tests UNIX commands, system calls, and library functions. SVVS tests all system calls and library functions listed in the System V Interface Definition Base and Base Addendum sections for AT&T System V.3.

CUTS places emphasis on the testing of commands, system calls, and C library functions that are not covered by the other test suites or that are functions specific to UNICOS. In addition, a set of tests within CUTS tests each command for existence and for critical and negative functionality. CUTS also contains tests for the C shell and Bourne shell command programming languages. The test suites contain tests for almost every command for at least existence, option availability, and the correct handling of invalid options. Also tested are all system calls and C library functions (except for those listed in the following table), some math library functions, and the C shell and Bourne shell programming languages.

Untested System Calls and Standard C Library Routines						
CRAY-2 UNICOS						
System Calls			Standard C Library Routines			
acct	boot	chacid	FLOWMARK	MEMDTRAC	MEMETRAC	MEMLIMIT
dmofrq	exctl	exece	MEMSTATS	MEMTROFF	MEMTRON	RTSTATUS
fstats	getptab	gettimeofday	STACKSZ	STKSTAT	@nicv	@nocv
jacct	killm	limits	_extend	_free	_howbig	_inplace
logins	mtimes	resch	_malloc	_memcheck	_memdtrac	_memetrac
resume	select	setgroups	_memlimit	_memstats	_memtroff	_memtron
setsemf	setsysl	settimeofday	_realloc	acid2nam	acidnamfree	cfree
setucmp	setulvl	setusrv	cntocm	cmtolm	cuserid	endpwent
slgentry	stats	suspend	ermo	fgtrent	fgtrent	getgmam
sysconf	target	tfork	getlogin	getoptlst	getpass	getpwnam
thread	waitjob		getpwsent	getpwuid	getutid	getutline
			gid2nam	gidnamfree	initgroups	l64a
			lntocm	lntolm	memstats	nam2uid
			memwcpy	nam2acid	nam2gid	nam2uid
			nlist	putpwent	putpwsysent	regcmp
			regex	regexp	seekdir	setpwent
			shutdsav	sigoff	sigon	stdio
			sys_errlist	sys_nerr	telldir	tracebk
			uid2nam	uidnamfree	varargs	
CRAY X-MP UNICOS						
System Calls			Standard C Library Routines			
acct	chacid	chmem	_cptoofd	_fdlen	_fdtoep	acid2nam
devacct	dmofrq	exece	acidnamfree	closelog	cuserid	endfsent
fpathconf	fstats	gettimeofday	endgrent	endpwent	ermo	fgtrent
jobacct	killm	limits	getfsent	getfsfile	getfspec	getfstype
mtimes	newdmofrq	nicem	getgmam	getlogin	getmntent	getoptlst
pathconf	resch	resume	getpass	getpwnam	getpwsysent	getpwuid
schedv	select	setgroups	gettimeofday	getutid	getutline	getwd
setsysl	settimeofday	setucmp	gid2nam	gidnamfree	index	initgroups
setulvl	setusrv	slgentry	l64a	lstat	lto13	monitor
stats	suspend	sysconf	nam2acid	nam2gid	nam2uid	openlog
tabread	target	tfork	putpwent	putpwsysent	re_comp	re_exec
utimes	waitjob		regcmp	regex	regexp	rename
			rindex	scandir	seekdir	setfsent
			setlogmask	setpwent	sigoff	sigon
			sys_errlist	sys_nerr	syslog	telldir
			uid2nam	uidnamfree	utimes	varargs

The complete test base was run every two weeks on both a CRAY-2 computer system and a CRAY X-MP computer system. In addition, much work was involved in testing for AT&T System V.3 conformance (see the SVID Compliance section for more information).

8.1.2 Results Summary

In the following tables, these qualifications should be noted:

- Several test cases may log a failing status for the system under test due to the same problem. Hence, there is not a one-to-one correspondence between tests that fail and SPRs.
- There are two levels of granularity in the statistics. The term *test programs* refers to the number of test source programs provided by the test suites acquired from outside sources. Each test program may contain several actual tests. The term *test cases* refers to the number of actual tests contained in the test programs.

The UNICOS Quality Assurance group has written tests so that test results may be obtained at the test case level. Because this granularity could not be achieved with the external test suites, the statistics for each of them are displayed separately.

<i>CRAY-2 UNICOS 5.0 Testing</i>						
	Results from Outside Test Suites			Results from Tests Written by UQA		
Area Under Test	Total Test Programs	Passed	Failed	Total Test Cases	Passed	Failed
Commands	222	220	2	7226	6950	276
C/Bourne Shell	71	71	0	1319	1314	5
System Calls	193	192	1	702	685	17
Libraries	216	215	1	267	255	12
Environment	8	8	0	0	0	0
NQS	0	0	0	1548	1376	172
TOTALS	710	706	4	11062	10580	482

<i>CRAY X-MP UNICOS 5.0 Testing</i>						
	Results from Outside Test Suites			Results from Tests Written by UQA		
Area Under Test	Total Test Programs	Passed	Failed	Total Test Cases	Passed	Failed
Commands	224	222	2	7209	6928	281
C/Bourne Shell	71	71	0	1068	1059	9
System Calls	193	192	1	675	651	24
Libraries	214	214	0	31	31	0
Environment	8	8	0	0	0	0
NQS	0	0	0	1631	1409	222
TOTALS	710	707	3	10614	10078	536

8.1.3 Evaluation

It is the opinion of the UNICOS Quality Assurance group that UNICOS 5.0 running on both the CRAY-2 and CRAY X-MP computer systems is very stable. Testing of these systems has gone well, and many problems have been resolved. UNICOS 5.0 has had more testing than any previous UNICOS release. There have been more Alpha and Beta tests, more workload tests, and more version tests. These have all helped stabilize UNICOS 5.0

However, a problem which has negatively impacted some of our testing should be mentioned.

It has been observed that a Bourne shell program has an unknown stack size limit for shell function sizes, function arguments, and function numbers, all of which are stored on the stack. Also, it has been observed that Bourne shell command substitution output is stored on the stack. Something as simple as "echo 'find . -print'" can overflow the stack for this process.

Stack overflow shell messages do not always result in the termination of the process under all circumstances.

8.1.4 SVID Compliance

The 5.0 release for both CRAY-2 UNICOS and CRAY X-MP UNICOS is SVID Base System compliant.¹ 100% of the Base System tests passed or have been granted a waiver due to performance considerations or because the SVVS test was in error.

8.1.5 Security

UNICOS 5.0 contains the second release of the security feature with CRAY X-MP UNICOS and the first release with CRAY-2 UNICOS. The following is an evaluation of the security feature but does not include an evaluation of security in relation to tapes or network software. These areas should be covered in their respective evaluations.

8.1.5.1 Testing Comprehensiveness

A large portion of the security feature remains to be tested. Below is an attempt to summarize exactly what testing was performed for UNICOS 5.0.

¹This is based on CRAY X-MP UNICOS running with the Cray C 4.1.6 compiler release.

The test suites partially cover security existence, option availability, and option testing of the `cpio(1)`, `reduce(1M)`, `spacl(1)`, `spget(1)`, and `spset(1)` commands, as well as most security system calls.

No feature testing was done, although some interactive testing was done for security logging, the `cll(1M)`, `setucmp(1)`, `setulvl(1)`, `spcheck(1M)`, `spclr(1)`, `spfilck(1M)`, and `sptfm(1)` security commands as well as the security changes in `chmod(1)`, `chown(1)`, `cp(1)`, `exp(1)`, `fsck(1M)`, `labelit(1M)`, `ln(1)`, `login(1)`, `mail(1)`, `mkdir(1)`, `mkfs(1M)`, `mv(1)`, `mount(1M)`, and `pr(1)`.

Testing began at the end of the release to test NQS with security. See the NQS Evaluation section for details.

8.1.5.2 Problems

There is a problem with sending and receiving mail at various levels and compartments. For example, if user A at level 1 sends mail to user B and then user C tries to send mail to user B at level 2, the mail cannot be sent. It is returned as not forwardable. This is due to the way mail is designed using only one mail file. This problem will be addressed with UNICOS 6.0.

8.1.5.3 Evaluation

Since much security testing still needs to be done and much upfront planning and understanding of this feature is needed, any site wishing to use the security feature should contact their support personnel for help and guidance.

8.1.6 Cray System Accounting

The Cray System Accounting (CSA) feature is introduced in UNICOS 5.0. CSA provides process and connection accounting similar to that of the standard UNIX accounting. In addition, CSA accounts for resource usage such as NQS, Tapes and USCP. All of the accounting information is collected into one file. This file is used for reporting the daily accounting information. Information from this file is summarized into total records (per user) and placed in a different file to be included in the Periodic Accounting reports. Testing of the CSA feature was concentrated in two areas: data integrity and accuracy of reports.

The integrity of the accounting data was tested from its origination in the files written by the daemons and the kernel, to the daily accounting file and its organization and the periodic total files. This included testing of the `csabuild(1M)`, `csaboosts(1M)`, `csaline(1M)`, `csatape(1M)`, `csanqs(1M)`, `csarecy(1M)`, `csacon(1M)`, and `csaadddc(1M)` commands. Administrators should be aware of the following problem:

- The accounting records written by the Tape Daemon in some cases

are in error on CRAY-2 systems. If tape accounting data is used on CRAY-2 systems, the daily accounting run (csarun(1M)) will error. Tape accounting should not be enabled on CRAY-2 systems.

All daily and periodic reports were run with various option combinations. This included the csarun(1M), csaperiod(1M), csajrep(1M), ja(1) and csacrep(1M) commands. The reports generated were checked for proper values.

8.1.7 Network Queueing System

The Network Queueing System (NQS) is the batch subsystem of UNICOS. NQS allows users to submit, monitor, and control jobs (known to NQS as batch requests) in UNICOS.

8.1.7.1 Testing Comprehensiveness

NQS has several new features that have been introduced into the UNICOS 5.0 systems. These features include memory resource control, multiple tape group support, parallel checkpointing, synchronous shutdown, directory restructuring, makefile redesign, new daemon accounting, SUPERLIN transport, resource control interface to the UDB, the qchkpnt user command and a new option to qstat and qdel.

Most of the testing effort was in the areas of memory resource control, multiple tape group support, resource control interface to the UDB, and the qchkpnt user command.

8.1.7.2 Evaluation

The memory resource control allows the administrator to limit the amount of memory used by NQS as a whole, by each queue and by each complex. Per process and per request memory values are used as acceptance criteria by batch queues. There are unlimited and unspecified memory limits. The unspecified limit means no limit was set therefore the limit is unlimited. There are no known outstanding problems with the new memory resource control.

The multiple tape group support feature has also been added to UNICOS 5.0. There are now eight tape group types. The group type names are not descriptive. Each type is defined by NQS to match to a specific tape daemon port. The multiple tape group support feature has added seven global and seven queue per_request tape limits. Unlike memory and CPU limits, a user can not use tapes through NQS unless he/she has specified what type and how many tapes will be used. The qsub option to specify tapes is now a three character option. The first two characters are the same as UNICOS 4.0 (-IU). The third character defines the tape type. There are a couple of outstanding problems with the new tape group support.

When a queue per request tape limit is set to unspecified, any request submitted to that queue that does not ask for tape will get an unlimited tape limit. However, if the request asks for so many tapes of a particular type, the request tape limit will be set to that value.

The `qmgr` command "`set per_request tape type = unlimited queue-name`" sets the `per_request` tape limit to unspecified instead of unlimited.

There was no direct testing of parallel checkpointing, synchronous shutdown, directory restructuring, or makefile redesign features. The changes have not taken away any functionality from NQS. There has been an increase in performance of NQS shutdown due to the new parallel checkpointing feature.

The new NQS daemon accounting seems to be working. Accounting records will only be stored if both accounting is on and NQS accounting is enabled. Accounting testing has evaluated the use of accounting commands on NQS account records.

NQS uses the UDB for additional resource validation. Previously, NQS used queue resource limits as default limits for a request. Now, NQS will look at a user's UDB entry and assign resource limits based on what is more restrictive between the UDB entry and queue limits. When a request is submitted to NQS that explicitly asks for a resource and the amount asked for is more than what is defined in the UDB, NQS will not submit the request as expected, but the error message returned from `qsub` can be misleading. The error message will tell you which limit was in violation but it will say it was the queue limit instead of the UDB limit.

There are several new `qmapmgr` commands. These commands were added to allow for the alternative transport superlink. There were basic tests done on these commands. They all seem to be working fine.

Testing of the `qchkpnt` user command shows it works rather well. It is still limited to the `chkpnt/restart` restrictions. It will provide the user with the ability to `chkpnt` his/her request at a known checkpointable state.

The `qstat` and the `qdel` commands have added new remote execution. This means you should be able to delete or look at a request running on another machine. The `-h` option was added to these commands for specifying a remote machine as a default. The new remote feature has added a couple of small problems to `qstat`.

The `qstat` command will print out an error message followed by the header string when trying to monitor a nonexistent request or a queue that does not contain any requests. `qstat` also prints two header strings in some cases. Another problem the remote feature has added to `qstat` output is that it prints the machine name after each queue. This tends to clutter the output.

NQS running on a secure system has changed since UNICOS 4.0. On

UNICOS 4.0, a request was allowed to activate compartments and change levels. The ability to do that is a security violation. On UNICOS 5.0, a request will not be able to activate compartments or change levels. There are two other problems with NQS and security:

- The `qsub` command will not submit requests to NQS when a user's minimum security level is greater than zero or if the user does not have the `readdwn` permit and is executing at a security level greater than zero.
- The `qstat` command returns a NQS FATAL error when executed by a user whose minimum security level is greater than zero or when a user does not have `readdwn` permit and is executing at a security level greater than zero.

8.1.8 Data Migration

The data migration feature was designed to ensure the availability of file system space by migrating selected files to an alternate storage medium after exceeding a site specified free space threshold.

The data migration feature consists of the following components:

- User interface
- Data migration daemon
- Automated space management
- Media-specific processes (on-line tape)

8.1.8.1 Testing Comprehensiveness

Testing was concentrated in the user interface, system administrator commands, and the on-line tape MSP.

Four new user commands were added for this feature: `dmput`, `dmget`, `dmlim`, and `dmmode`. Testing for these commands consisted of critical and negative testing along with functionality testing. The critical and negative tests checked the existence of the command as well as the availability of the documented options for the command. The functionality tests verified that the user could migrate files, recall migrated files, and mark files to be exempt from migration.

Eighteen new system administrator commands were added for this feature: `dmdaemon`, `dmdalter`, `dmdbase`, `dmdbval`, `dmdebug`, `dmdelete`, `dmdidle`, `dmdjournal`, `dmdproct`, `dmdstat`, `dmdstop`, `dmfdgen`, `dmfree`, `dmfsck`, `dmhit`, `dmmctl`, `dmtmerge`, and `dmvdbgen`. All of the above commands were tested for basic functionality.

Testing of the on-line tape MSP consisted of ensuring that files could

be migrated to tape and retrieved from tape with no loss in data integrity. The ability to combine a number of "short" and/or sparsely populated tape volumes onto fully populated volumes was also tested.

It is the opinion of the UNICOS Quality Assurance group that the data migration feature in UNICOS 5.0 is acceptable. The feature is reliable under normal conditions with the following exceptions:

- Data migration currently does not work with files at different security levels and/or which have security compartments assigned to them. The data migration feature is denied access to secure files and directories.
- Data migration can cause checkpointed processes to fail on restart. If a file which is used by a process is migrated off-line while the process is in a checkpointed state, then the restart of the process will fail since it no longer can access that file.
- On the CRAY X-MP UNICOS system a problem exists with the migration of files which have been preallocated using the `setf(1)` command. The data migration feature looks at the `stat` block of the file to get the file size, but this only returns the number of bytes that have been written to the file, not the number of bytes allocated to the file. Therefore, if you allocate 10,000 contiguous blocks for a file then write 5000 blocks of data to it and the file is then migrated and brought back on-line, the 5000 data blocks will be restored but the additional 5000 blocks allocated to it will not be.
- A similar problem exists on the CRAY-2 UNICOS system. On the CRAY-2, files are track allocated meaning that any file requiring less than one track of disk space will still have the entire track allocated to it. This can cause the data migration feature to free more space than necessary since it looks at the file size in the `stat` block which does not accurately represent the amount of space the file is actually taking up on the filesystem.
- The data blocks from files that are removed while in a pre-migrated state remain in the pre-migration directory. These disk blocks should be released when the pre-migrated file is removed. The `dmfsck` command will always cross check the daemon database will all filesystems. The `-d` option which should allow the user to specify an FSDEF file containing a list of filesystems to check does not work.

8.1.9 Fair Share

The testing of the fair share scheduler within UNICOS 5.0 has verified the basic components of this feature as well as identified a few important problem areas. The basic purpose of the fair share scheduler is that it allocates machine resources differently than previous UNICOS process schedulers. The fair share scheduler is designed to take into ac-

count user's past resource consumption histories when scheduling a current process for execution. The ultimate effect of considering resource consumption histories is that process response times will be slowed where past histories of resource consumption are high.

8.1.9.1 Fair Share Problem Areas

The problem areas determined will be addressed in the appropriate fair share scheduler testing section if the scope of the problem is isolated to just that area. Most of these problems are of this nature. However, one problem area is relative to all fair share scheduler testing areas and will be discussed here.

The major problem with the fair share scheduler is that its costing mechanism for process resource consumption is not consistent from process invocation to process invocation. The same process executed numerous times might be charged double costs for resource consumption or might not be charged anything at all. This discrepancy in process resource consumption costs is a result of the cost sampling technique employed and is influenced by the duration of process execution times. Short duration processes have been observed to have as much as a thirty-four percent deviation in resource consumption costs. Longer duration processes have been observed to have as much as a four percent costing deviation. However, this effect on the scheduler's ability to consider past resource consumption histories has not caused testing results to be too misleading.

8.1.9.2 Fair Share Scheduler Testing Areas

Tested areas of the fair share scheduler are listed below and are discussed in greater detail in the appropriate section:

- Simple Fair Share
- Resource Consumption or Usage Decay
- Nicely valued process considerations under Fair Share
- Resource Consumption Costs
- Effect of Multiple Processes under Fair Share
- Maroon Avoidance
- Effect of Multiple Processors under Fair Share
- Edge Effect Avoidance
- Effect of Root Spawned System Processes under Fair Share
- Hierarchical or Resource Group Fair Share
- Effect of Orphan Processes under Fair Share

The testing of these areas has been performed under the suggested UNICOS 5.0 release scheduler parameter settings which operate on a timer that ticks 60 times per second. The fair share scheduler UNICOS 5.0 release parameter settings are as follows.

- The 1/60-second tick is used for process evaluation.
- Every 60 ticks, process priorities are decayed.
- Every 240 ticks, user resource consumption or usage is decayed.

8.1.9.3 *Simple Fair Share*

The basic premise behind the fair share simple share feature component is that users with differing share assignments would be expected to have different work levels. A user with twice the amount of assigned shares would be expected to be able to perform twice the amount of work. The design of simple fair share tests utilize computer execution times as the basis for process work level determinations. The testing scenario for simple fair share involves the establishment of user accounts with everything identical except differing share assignments. A CPU-bound process is then invoked by each user and is allowed to run for a specific testing period. All process invocations and terminations are done in a manner that insures concurrency. However, this concurrency is not exact because of the testing approach of simulating user logins instead of physically activating them.

The simple share testing results are indeterminate in nature. Those test cases involving a few simulated user logins do not exhibit execution time ratios comparable to assigned share ratios. For those test cases involving a large number of simulated user logins, the comparison of execution time ratios and assigned share ratios exhibit a tendency to be true. However, exact matching has not been shown.

Of possible related influence is the costing problem described above. The short duration test cases certainly were influenced by costing deviations. The longer duration test cases exhibited more of a comparison in ratios and would be consistent with the costing deviation mentioned earlier.

8.1.9.4 *Resource Consumption or Usage Decay*

The effects of resource consumption or usage decays has not been tested by the creation of self-contained, self-checking automated tests due to the costing problems indicated earlier. However, scenario tests and individual observations would indicate no problems are present within this area. Formal test development will continue in UNICOS 6.0 when absolute process costing is implemented within the fair share scheduler.

8.1.9.5 *Nicely valued process consideration under Fair Share*

The effects of scheduling a process with a nice value has been tested with the following results. Nice values in the range from zero to nineteen were tested and compared to the following expected result criteria. Processes scheduled with nice values are expected to exhibit a reduction of CPU execution times and a reduction of resource consumption costs. When nicely scheduled processes compete, the higher valued nice process is expected to exhibit a lower CPU execution time and resource consumption cost. This nice value relationship is successfully tested for the nice value range zero to fifteen. Problems result when testing nice values sixteen to nineteen. These nice values result in process priorities which fall into a fixed process priority range under the fair share scheduler. Fixed process priority values are assigned within the range 980 to 998. These fixed process priority values require an almost idle CPU environment before process execution starts. Automated tests of all nice values result in broken test cases for nice values fifteen to nineteen. Monitor routines checking for process activations timed out after ten minutes. This could infer that nice values in the range of fifteen to nineteen demonstrated a further slowing of CPU execution times when in competition with lower valued nice jobs. However, formal testing of these nice values were unable to generate pass or fail test case results.

8.1.9.6 *Resource Consumption Costs*

The costing problems indicated earlier have been observed from testing within this area. The development of self-contained, self-checking, automated tests will be undertaken once absolute costing is implemented in UNICOS 6.0.

8.1.9.7 *Effect of multiple processes under Fair Share*

The effects of multiple processes on a user's machine entitlement has exhibited the following test results. A user with multiple processes will see a significant reduction in their CPU execution times when in competition with users with single processes. This verifies that a user's share of machine resources is reduced as more and more processes are started.

8.1.9.8 *Maroon Avoidance*

The effects of high resource consumptions or usage on consumers is successfully tested with the following results. High resource consumption amount values of 1e4, 1e5, and 1e6 were tested against multiple users having no usage. These high usage amounts exhibited that no blockage of further access to machine resources occurred within the first few cycles of the fair share scheduler. This exhibition is consistent when these high usage amounts are in competition with one, six, twelve, or eighteen zero usage users. It is important to note that higher usage test amounts beyond 1e6 have exhibited blockage within the first few cycles of the fair share scheduler. However, this did not result in the user be-

coming marooned. These usage amounts simply required more fair share cycles before further CPU access could be seen. This blockage occurred in test situations where more than six zero usage users became active.

One important consideration of these results is usage decay. It is very impractical for any fair share user to accumulate a resource consumption amount anywhere above the $1e6$ value. As usage is increased when incurring machine resource consumption costs, it is decreased when the user is inactive. These usage testing amounts do not reflect any user inactivity which would normally prevent any usage amount from reaching such a level.

8.1.9.9 *Effect of multiple processors under Fair Share*

The effects of multiple processors on user processes has exhibited the following test results. As more CPU processors are available, user processes have demonstrated that higher CPU execution times are achieved.

8.1.9.10 *Edge Effect Avoidance*

The effects of new user account creations or zero usage users on high machine resource consumers is successfully tested with the following results. New machine resource consumer accounts do not receive 100 percent of machine resources when activating their logins. Nor are high machine resource consumers denied machine resources when zero machine resource consumers become active. These results have been exhibited during a 4 second cycle period of the fair share scheduler. High usage amounts of $1e6$, $1e8$, and $1e10$ have not blocked a user from CPU access when in competition with a zero usage user for one cycle of the scheduler.

8.1.9.11 *Effect of root spawned system processes under Fair Share*

The favoritism of root spawned system processes by the fair share scheduler has exhibited the following test results. Any and all processes started from the device system console under the root login have demonstrated a ninety-five percent CPU execution time domination when in competition with non-system processes during cycle of the fair share scheduler.

8.1.9.12 *Hierarchical or Resource Group Fair Share*

The organization of user accounts under resource group accounts transforms the fair share scheduler from a simple share scheduler to a hierarchical scheduler. User work level entitlements based on share assignments are no longer applicable. What the fair share scheduler does in this instance is to convert user assigned shares into comparable values. These comparable values are entitled machine shares. User machine share values are the measure by which work load levels can be compared when determining proper machine resource entitlements.

Current fair share scheduler machine share conversions presents a problem for testing purposes. The machine share value computed for an active user login is a dynamic value; one that is initially set to represent a user's machine entitlement, but also one that is changed as resource consumptions near machine entitlements. Automated tests have exhibited a matching of fair share computed machine share values to hand calculated machine share values for various resource group structures up to and including the maximum nesting level of resource group accounts. However, this matching is not reproducible from test invocation to invocation because of the cycle state of the scheduler at test process invocation. Access of in-core machine values may be the machine share initially computed or an adjusted amount which keeps user resource consumptions in line with machine entitlements. Therefore, there is no formal basis for consistently reproducing test results which validate this feature component. However, testing observations will support the operable condition of this aspect.

There are two problems dealing with this component of the fair share scheduler. The establishment of resource group user accounts with no corresponding resource group account has demonstrated a significant reduction of machine shares for all user accounts and resource accounts at the first level of hierarchical fair share. The fair share scheduler defaults such an account to one level down from the root account and has exhibited as much as a twenty-five percent reduction of machine resources from correctly defined resource group structures.

The second problem addresses a resource group structure which exceeds the maximum level of nested resource group structures. User accounts defined beyond the maximum level can be activated, but the in-core structure in which this activation is attached is a shifting and totally random assignment. In other words, login mary can run under login jeff. The shifting aspect of this problem relates to the migration of login attachments back up the levels of resource group structures until it attaches to a login structure one level down from root. It is noted that this random attachment does not coincide with currently active user accounts. However, resource consumption histories are posted under the attached account.

8.1.9.13 Effect of orphan processes under Fair Share

User processes which create processes inheritable by the init process are successfully tested with the following results. Any and all init-inherited processes are still attached to the fair share user in-core structure entitled kern_lnode. All init-inherited process resource consumption costs are charged to the user's kern_lnode. User kern_lnode usage accumulations are appropriate. No loss of user process information and fair share control is exhibited during the processing of init-inherited processes.

8.1.9.14 Testing Summary

The testing of the fair share scheduler has exhibited the operability of most of the scheduler's components. The problems which have been en-

countered are identified and a formal test incident report filed. Final test development for those areas listed will be undertaken when absolute costing is implemented in UNICOS 6.0. Also, the effects of inconsistent costing will be rechecked again on simple share and dynamic machine share tests once absolute costing is in place.

From an overall viewpoint, the fair share scheduler presents a mechanism for fairly distributing machine resources across group and user accounts. High resource consumption histories do in fact, slow down process response times. High resource consumption decays do in fact, allow a user to reclaim faster process response times. Machine resource allocations demonstrate work level entitlements under hierarchical fair share. All of this has been exhibited under the suggested UNICOS 5.0 release parameter settings. However, limited resources have prevented verifying each of the fair share components under different parameter settings and the results indicated here pertain only to values assigned to these parameters.

8.2 AUDPL

Audpl is a library auditing utility for use with program libraries created with the UPDATE package. This product consists of machine-common code.

8.2.1 Testing Comprehensiveness

No new enhancements have been added to audpl since the UNICOS 3.0 release. There were 33 tests run on audpl. All of the listing options and a majority of the command line options to audpl were tested. The tests did not cover the PULLMOD and COMMENT directives, or the -y, -w, and -b options.

8.2.2 Evaluation

Audpl performed well against the available tests and is considered a stable product. Audpl passed all 33 tests, thus no new TIRs or SPRs were opened for this release. There are no open TIRs or SPRs against audpl.

8.3 Debuggers

The symbolic debuggers available with UNICOS 5.0 are `debug 5.0`, `SYMDUMP 5.0`, `DDA (Dynamic Dump Analyzer) 4.3`, `DRD (Dynamic Runtime Debugger) 4.3`, and `cdbx 5.0`. `Cdbx 5.0` is a new product, and will replace `DDA` and `DRD` in UNICOS 6.0. `Cdbx` is an interactive, symbolic source-level debugger based on `dbx`, which is part of the Berkeley Software Distribution version of UNIX. `Debug` allows the post-mortem examination of a program memory dump (core file). `SYMDUMP` interprets the memory of the running program, rather than a memory dump file. `DDA` allows the interactive examination of the contents of a core file. `DRD` dynamically monitors and modifies program execution.

8.3.1 Testing Comprehensiveness

For this release, the only changes to `DRD`, `DDA`, and `SYMDUMP` were bug fixes. `Debug` added multi-tasking. `Cdbx` is a completely new product. No new tests were added for any of the debuggers except `cdbx`. There were 68 new tests written to test `cdbx`.

The tests are basic functionality tests that check command-line option processing and most of the implemented directives. In addition, `cdbx` functionality was tested interactively, using both the `CFT77` and `C` compilers. `SYMDUMP` was not tested for this release.

8.3.2 Evaluation

`debug`, `DDA`, `DRD`, and `cdbx` performed well against the tests available for them, and `cdbx` performed well in intensive interactive testing. No new TIRs or SPRs were written against `DRD`. Only one TIR was written against `DDA`, and it was a minor one that will not be fixed, as the problem does not occur with `cdbx`. No new TIRs or SPRs were written against `debug`. Six SPRs were written against `cdbx`. All six represent problems that will not interfere with efficient usage of `cdbx`. All six problems will be fixed in `cdbx 5.1`.

8.4 FLOWTRACE, FLODUMP, and FLOW

For CRAY-2 UNICOS, `flow` and `flodump` display FLOWTRACE information for programs that execute with the FLOWTRACE compiler options or directives. With CRAY X-MP UNICOS, `flodump` is used to display the FLOWTRACE information.

8.4.1 Testing Comprehensiveness

FLOWTRACE, flodump, and flow were exercised with CFT, CFT77, Pascal, and C programs. The FLOWTRACE compiler directives (FLOW, NOFLOW, BT+, and BT-) and FLOWMARK were also tested.

8.4.2 Results Summary

No new problems were encountered, and all existing internal TIRs have been resolved for this release. FLOWTRACE, flodump, and flow performed well and are considered to be reliable and stable products.

8.5 FTREF

The ftref command generates a listing containing several forms of information about a Fortran program. The ftref command reports on common block variables, entry point names, calling routines, and called routines for each subroutine. For multitasked programs, ftref summarizes the use of multitasking subroutines and reports whether a common block variable or a subroutine is locked when it is referenced or redefined.

8.5.1 Testing Comprehensiveness

All documented features of ftref were tested except for the sort option, -s, and the elimination of the unreferenced variables option, -u. All other features of ftref were verified with all three Fortran compilers, CFT, CFT77, and CFT2.

8.5.2 Results Summary

No new problems were encountered, and all existing internal TIRs have been resolved for this release. Ftref functioned extremely well in all areas.

8.6 CAL Version 2, Release 3.2

CAL Version 2 is a powerful symbolic assembler which generates object code to be loaded and executed on CRAY-1, CRAY X-MP, CRAY Y-MP, and CRAY-2 computer systems.

8.6.1 Testing Comprehensiveness

There are 181 test cases which verify the assembler's ability to generate CRAY-2 opcodes and 1,399 test cases which verify the assembler's ability to generate CRAY X-MP and CRAY Y-MP opcodes. These test cases exercise all of the assembler's symbolic machine instructions and many of its pseudo instructions.

CAL Version 2, Release 3.2 Test Results				
Machine	Test Cases	PASS	FAIL	% PASSED
CRAY-2	181	181	0	100
CRAY X-MP	547	547	0	100
CRAY Y-MP	852	852	0	100

8.7 Evaluation

This release of CAL Version 2 has proven to be an extremely reliable product. The assembler handles all symbolic machine instructions correctly and its pseudo instructions function properly.

8.8 LDOVL

The `ldovl` command creates overlaid programs for CRAY X-MP and CRAY Y-MP computer systems from object module and directive input. The overlay directives are identical to those of `LDR` under the COS operating system. The eight tests exercise the `ldovl` command-line and error messages.

LDOVL Test Results				
Machine	Test Cases	PASS	FAIL	% PASSED
CRAY Y-MP	8	8	0	100

8.8.1 Evaluation

The `ldovl` command performed well during testing. All outstanding TIRs from past releases were closed with this release.

8.9 Segldr 5.1

The `segldr` command is an automatic loader for overlaid and non-overlaid code produced by language processors such as CAL Version 2, CFT, CFT2, CFT77, Pascal, and C.

8.9.1 Testing Comprehensiveness

The 82 test cases exercise `segldr`'s command-line, directives, and error messages for both segmented and non-segmented applications.

Segldr Test Results				
Machine	Test Cases	PASS	FAIL	% PASSED
CRAY Y-MP	81	81	0	100
CRAY-2	81	80	1	98

8.9.2 Evaluation

`Segldr 5.1` performed well during testing. One minor problem was discovered for segmented applications on CRAY-2 computer systems.

8.10 libf (CRAY-2 UNICOS Only)

The `libf.a` library consists of run-time I/O routines and miscellaneous utility routines. The run-time I/O routines are called by code generated by the Cray Fortran compilers CFT2 and CFT77. The utility routines are directly available to Fortran programmers. The following section refers only to CRAY-2 UNICOS.

8.10.1 Testing Comprehensiveness

Multithreaded I/O - A total of thirteen comprehensive tests were written. The basic flow of the tests was to have the main program spawn off four tasks which would execute the same subroutine, performing I/O to four separate units. Unformatted-sequential, unformatted-direct, formatted-sequential, formatted-direct, namelist, list-directed, bufferin/bufferout and internal I/O were all tested in this manner. The `ja` command was used to gather timing information.

Asynchronous Queued I/O - The `aqio` routines were extensively tested. The `aqopen` routine was tested using a character literal, a unit number (unaliased), and a unit number aliased with an `assign` statement. Various queue sizes, non-contiguous requests, positive/negative memory strides and positive/negative disk strides were also tested.

FCVS Tests - Of the 110 tests, 42 validate formatted I/O. The A, X, I, F, E, D, L, and P edit descriptors were all tested with files connected for direct and sequential access. Apostrophe, quotation mark, and slash editing were also exercised. The remaining 69 tests were developed from SPR test cases.

Approximately 75 other new tests were archived, about half were taken from SPR test cases and the rest were developed to cover areas that had little or no test coverage.

Performance - Twelve new I/O performance tests were added, covering 18 standard Fortran I/O statements and six extended Fortran I/O statements (`BUFFER IN`, `BUFFER OUT`, `CALL PUTWA`, `CALL GETWA`, `CALL READMS`, `CALL WRITMS`). Only one configuration was covered by each test. These tests consisted of writing a file several times and then reading it back in an equal number of times. The tests were run with one user in multiuser mode under UNICOS 4.0 and UNICOS 5.0. Elapsed times and CPU times were then compared for each test.

Performance tests for multithreaded I/O were also added. Multithreaded I/O libraries allow the CRAY-2 to perform I/O on several different devices concurrently. These tests compared the elapsed time to complete identical I/O operations on four files with one and four CPUs.

8.10.2 Evaluation

Multithreaded I/O - The Multithreaded version of `libf.a` (5.0) showed a performance improvement of 1.4 to 6.1 times over its single-threaded (4.0) counterpart, and a 1.6 to 3.4 times performance improvement between the 5.0 `libf.a` using 1 CPU and the 5.0 `libf.a` using 4 CPUs. One problem currently remains open.

Asynchronous Queued I/O - A total of eight tests were written, each of which tests several `aqio` routines, verifies data integrity and checks for

the correct status return. Correct results for approximately twelve different end cases are verified within each test. There are no outstanding problems at this time.

There is one outstanding problem from the FCVS test suite with list-directed I/O.

Performance improved markedly for Fortran formatted-sequential I/O, unformatted-direct I/O and unformatted-sequential I/O, word-addressable I/O, internal read/write, and encode/decode. All three TIRs were closed on performance in these areas.

Performance of the CRAY-2 I/O libraries diminished for formatted direct-access Fortran I/O. An SPR on this is open and will be addressed in UNICOS 6.0.

8.11 libio (CRAY X-MP/CRAY Y-MP UNICOS Only)

The libio.a library consists of run-time I/O routines. These routines are called by code generated by the Cray Fortran compilers CFT or CFT77.

8.11.1 Testing Comprehensiveness

Of the 150 tests, 42 validate formatted I/O. The A, X, I, F, E, D, L and P edit descriptors were all tested with sequential and direct access files. Apostrophe, quotation mark and slash editing were also exercised. Approximately 25 of the new tests exercise assign options. The u, bin and sbin file types were tested with different types of I/O, and the SDS option was also exercised. The remaining tests were developed from SPR test cases.

Performance - Twelve new I/O performance tests were added, covering 18 standard Fortran I/O statements and six extended Fortran I/O statements (BUFFER IN, BUFFER OUT, CALL PUTWA, CALL GETWA, CALL READMS, CALL WRITMS). Only one configuration (DD49 with ldcache) was covered by each test. These tests consisted of writing a file to disk several times and then reading it an equal number of times. The tests were run with one user in multiuser mode under UNICOS 4.0 and UNICOS 5.0. Elapsed times and CPU times were then compared for each test. Standard Fortran I/O is not multithreaded on the CRAY X-MP and CRAY Y-MP computer systems.

8.11.2 Evaluation

The libio library performed well against the formatted I/O tests and no regressions were discovered from the SPR tests. Several problems found with the assign command options were fixed in the 5.0 release.

Performance of the CRAY X-MP and CRAY Y-MP UNICOS libraries did not change significantly for eight of the twelve performance tests. Performance degraded 44%-64% (0.36-0.56 times) for Fortran unformatted direct access I/O [WRITE (lunit, REC=nrec) list] due to a change in the default file structure to "sbin" in UNICOS 5.0 to provide character I/O integrity. This is almost the worst case, since these tests minimize the value of caching which "sbin" provides and "bin" does not. The developer reports improved performance with "sbin" in at least one user environment.

Performance testing was done with both assign -s bin and assign -s sbin. Performance improved with assign -s bin, although use of -s sbin is recommended and should be tried.

Performance improved markedly for Fortran unformatted sequential I/O (1.4 times), formatted direct access I/O (1.2-1.4 times), and CALL WRITMS/READMS (1.2 times). No SPRs were opened against libio performance.

Performance seen with any application will vary depending on many factors. These results should be viewed as indicative of where change may occur and the magnitude of change.

8.12 MATH LIBRARY

The math library, libm, contains routines for trigonometric, logarithmic and exponential functions, as well as routines that obtain random numbers and perform data type conversions.

8.12.1 Testing Comprehensiveness

Test coverage for the majority of the math functions is moderate. Coverage for the Boolean arithmetic routines is extensive.

8.12.2 Evaluation

Based on the current level of test coverage, the math functions are generally considered stable and reliable.

8.13 SCIENTIFIC LIBRARY

The scientific library, `libsci`, contains routines for performing computations involving linear algebra, Fast Fourier Transforms, searching, and sorting.

8.13.1 Testing Comprehensiveness

An extensive test set was added for testing the level 2 and 3 BLAS routines (Basic Linear Algebra Subprograms). Coverage for the remainder of the scientific library is moderate.

8.13.2 Evaluation

The level 2 and 3 BLAS routines performed flawlessly on the CRAY X-MP and CRAY Y-MP computer systems. The optimized CAL implementations of these routines provide significant speedups over their Fortran counterparts. For further performance information, consult the paper by Vu, Liu, Sheikh and Yang of the CRI Mathematical Software Group.

On CRAY-2 computer systems, the level 2 and 3 BLAS routines performed moderately well with some exceptions. The following level 2 and level 3 routines did not correctly detect illegal values for some of their parameters:

SGEMV, SSYMV, SSBMV, STRMV, STBMV, STRSV, SGER, SSYR, SSYR2, CGEMV, CHEMV, CHBMV, CTBMV, SGEMM, SSSYMM, STRMM, STRSM, SSYRK, SSYR2K.

The following level 2 routines reported the wrong parameter number when they were passed an invalid argument:

SSBMV, STBMV, CTBMV.

The following level 2 routines aborted when they were called:

SSPMV, STRSV, CHPMV.

The test program also reported a large error ratio for results produced by the level 2 routine `STBSV`. This may indicate inaccuracy in the results produced by this routine.

The remainder of the scientific library is generally stable and reliable based on the current level of test coverage.

8.14 IMPLICIT FOREIGN DATASET CONVERSION

Implicit Foreign Dataset Conversion (FDC) is a new feature in UNICOS 5.0. Built into the I/O libraries, FDC allows the Fortran programmer to read and write foreign datasets using the standard Fortran I/O statements. The dataset format (COS, IBM fixed, IBM variable, etc.) is specified at run time through the use of the UNICOS `assign` or `asgcmd` commands.

8.14.1 Testing Comprehensiveness

User Interface QA tested the effectiveness of FDC disk I/O. See the Tape Subsystem section of this report for information on FDC's performance with tape I/O.

There are three options on the `assign` and `asgcmd` commands (-F, -N and -C) which are relevant to FDC and numerous record classes, types and subtypes. Most of the record types accept a record size and block size specification. The -F option can also be layered (one record type being "wrapped" within another for any number of layers). Since the number of possible test cases is enormous, a test generator was written to generate and execute test cases. All of the generated tests write a dataset in a specific format and then attempt to read it back, checking for problems with the data. A small number of manual tests were also written to check for specific problems. In these tests, the datasets were dumped and inspected for format errors.

On CRAY X-MP computer systems, COS, IBM (all record types), VMS (all record types and subtypes) and NULL record classes were tested using both formatted and unformatted I/O. A large number of layering tests were also run (up to three levels deep).

On CRAY-2 computer systems only unformatted IBM I/O was tested since this is all that's being released in UNICOS 5.0.

The FDC `libc` functions `ffopen`, `ffread`, `ffwrite` and `ffclose` were not tested.

8.14.2 Results Summary

Unformatted FDC I/O always fails when using the `assign` command without specifying a numeric or character conversion (SPR #32075). This problem can be circumvented either by specifying a numeric or character conversion or by using `asgcmd` instead of `assign`.

76 tests failed because the test format requires a containing layer; this is not a problem with FDC but the documentation does not mention the layering requirement. All correct layering tests passed, but `assign` and `asgcmd` did not always detect incorrect layered combinations (SPR #32073). Two manual tests of the -N option also failed (SPR

#32074). On the CRAY-2 computer system using unit 6, even when it is explicitly opened within a Fortran program, will not work with `assign` and `asgcmd`: the conversion doesn't happen (SPR 32076).

8.14.3 Evaluation

FDC formatted I/O is very reliable. Unformatted I/O works well provided a numeric or character conversion is specified on the `assign` command (or if `asgcmd` is used). There is a set of mods (F11535X, F11535Y and F11535Z) available to fix unformatted I/O (*not included in UNICOS 5.0*), but they have not yet been tested. The error messages resulting from this problem (usually "floating point exception") are likely to be misunderstood by users.

`Assign` and `asgcmd` do not reliably detect errors in their command line arguments, especially invalid multiple layer combinations and numeric or character conversion options. This can be very frustrating since Fortran programs usually abort with a strange error message in these cases. The documentation for these commands is incomplete: it does not say that class NULL must be accompanied by a numeric conversion specification nor does it say that some record types (IBM.U, for example) cannot be used by themselves but must have an enclosing layer.

Following is a summary of cautions and known problems with FDC:

- Unformatted I/O fails when using `assign` without specifying a numeric or character conversion.
- The `assign` command does not always detect invalid values for the options, and invalid layered combinations are usually not detected.
- Some record classes or types (e.g., IBM.U, NULL) must be "wrapped" in a higher level layer; this is not explained in the `assign` man page. `Assign` doesn't detect the error so the user gets a mysterious abort.
- The CRAY-2 UNICOS 5.0 `assign` man page lists COS, IBM, VMS and NULL as valid record classes when it should say that only IBM unformatted I/O is supported.
- CDC record class is accepted for the -F option of the CRAY X-MP `assign` command but is not supported in this release.
- On CRAY-2 computer systems, using `assign` has no effect on the format of the dataset when unit 6 is used.
- The `cs` alias for `asg` given in the `asgcmd` man page is incorrect; it should read:

```
alias asg 'eval `usr/bin/asgcmd \!*`'
```

- On the CRAY X-MP computer system, `assign` can be used with a file name argument (using `"fort.nn"` is not necessary); on the CRAY-2 computer system `"fort.nn"` must be used.

8.15 UPDATE 5.1

UPDATE is a line-oriented text editor for maintaining source code and other types of text data. UPDATE creates and modifies program libraries and produces output that can be used as input to other programs, particularly compilers and assemblers.

8.15.1 Testing Comprehensiveness

UPDATE 5.1 has had no changes, except bug fixes, since UNICOS 4.0. No new tests were developed for this release. The test coverage for UPDATE is very good.

8.15.2 Evaluation

Of the tests run, none discovered any new problems. One test failed due to a problem that will not be fixed in UPDATE. It is fixed in the new product NUPDATE. There are no other existing TIRs or SPRs. UPDATE is an established product whose stability is well-known.

8.16 MULTITASKING SOFTWARE

There are three components of the multitasking software developed by Cray Research: macrotasking, microtasking and Autotasking. Autotasking is released with CFT77 asynchronously, and all testing information on Autotasking will be included in the CFT77 Release Notice.

Macrotasking is parallel processing at the Fortran-subroutine or Pascal-procedure level. Using calls to macrotasking library routines, the programmer must explicitly code subroutines or procedures so they can be run in parallel.

Microtasking permits multiple processors to work on a Fortran program at the DO-loop level, and is accomplished by using PREMULT. PREMULT interprets a small number of compiler directives and rewrites the program to contain microtasking library calls. The resulting program then determines the viability of dispatching individual loops to separate processors at run time. Starting with this release of

UNICOS, a new implementation of PREMULT is being used. This implementation is a subset of the the Autotasking mid-processor, fmp.

Microtasking on the CAL level is also available on the CRAY X-MP by using the CAL Version 2 microtasking macros.

Software for debugging multitasked programs is also included with the multitasking system software. The MTDUMP tool examines an unformatted dump of the multitasking history trace buffer and displays multitasking actions in several useful formats.

8.16.1 Testing Comprehensiveness

For macrotasking, test coverage is good for the following functions:

LOCKON, LOCKOFF, LOCKASGN, LOCKREL, EVPOST, EVWAIT, EVASGN, EVREL, EVCLEAR, BARASGN, BARSYNC, BARREL, TSKSTART, TSKWAIT, TSKVALUE, and the Cray-2 specific functions: EVPOSCLR, ICRTADD, ICRTMUL, ISELFADD, ISELMUL, ISELSCH, XCRITADD, XCRITMUL, XSELFADD, and XSELMUL.

Test coverage is also good for the Cray Fortran language extension **TASK COMMON.**

The multitasking tuning function, **TSKTUNE**, and the multitasking status functions **TSKTEST, LOCKTEST, and EVTEST** were not tested.

Test coverage of Fortran microtasking deals primarily with the microtasking preprocessor, PREMULT. PREMULT's functionality and error detection capabilities are well covered by the available tests. Explicit testing has not been performed on the actual microtasking functionality, performance, and mixed micro- and macrotasking.

Test coverage of the CAL microtasking macros is good.

The parameters on the MTDUMP command line were tested for basic functionality only. All MTDUMP output was manually verified.

Product	Total Tests	% PASS	% FAIL
PREMULT	101	100	0
CAL Microtasking	105	100	0
Macrotask- ing Libraries	209	100	0

8.16.2 Evaluation

The macrotasking library routines performed well during final version testing and the software is considered to be stable and reliable.

The new implementation of PREMULT initially resulted in a few problems, but all problems have been fixed and the product is considered to be stable and reliable.

This implementation of PREMULT removes some limitations that affected the previous PREMULT: outer and inner DO-loops no longer require separate CONTINUE statements and the limit of ALSO PROCESS statements has been removed.

Not all mods required to run microtasking made it into the final version of UNICOS 5.0, the mods tape containing mod f13257c must be applied to multipl before doing any microtasking.

Although testing of MTDUMP was limited, it appears to be a stable product. All parameters of the MTDUMP command line work as expected and MTDUMP should be of considerable benefit when debugging multitasked programs.

8.17 ON-LINE DIAGNOSTICS

The UNICOS 5.0 CRAY-1, CRAY X-MP, CRAY X-MP EA and CRAY Y-MP on-line diagnostic release consists of three UPDATE PLs, CRAY1PL, XMPPL, and DIAGPL. CRAY1PL and XMPPL contain maintenance diagnostics and the monitor olmon. DIAGPL contains the makefile, utilities, confidence level diagnostics and monitor, down CPU monitor, and subsystem diagnostics. Items tested include: 29 maintenance level diagnostics run under olmon, 33 down CPU diagnostics run under oldmon, 7 confidence level diagnostics run under olmon, 5 confidence level diagnostics run under offmon, 4 subsystem diagnostics, and 2 utilities.

The UNICOS 5.0 CRAY-2 on-line diagnostic release consists of two UPDATE PLs, CRAY2PL and DIAGPL. CRAY2PL contains maintenance diagnostics and the monitor olmon. DIAGPL contains the makefile, utilities, confidence level diagnostics and monitor, down CPU monitor, and subsystem diagnostics. Items to be tested include: 17 maintenance level diagnostics run under olmon, 22 down CPU diagnostics run under oldmon, 7 confidence level diagnostics run under olmon, 5 confidence level diagnostics run under offmon, 2 subsystem diagnostics, and 2 utilities.

8.17.1 Testing Comprehensiveness

The following definitions are used to describe the testing performed:

- **Go/nogo:** The test consists of running the diagnostic to completion without error.
- **Feature:** The test consists of running the diagnostic and verifying by some means other than mutation that it executed correctly.
- **Mutant analysis:** The test consists of changing the diagnostic code to verify that the diagnostic works correctly.

On-line diagnostics were tested as follows:

- **Maintenance level tests:** go/nogo testing was performed on the maintenance level tests under the control of olmon and oldmon.
- **Confidence level tests:** go/nogo and feature testing was performed on the confidence level tests under the control of offmon and olcmon. Mutant analysis was performed under the control of oldmon.
- **oldmon:** Feature testing was performed on the down CPU monitor. All features of the monitor were thoroughly tested on the CRAY-2, CRAY X-MP, CRAY X-MP EA, and CRAY Y-MP.
- **olnet:** Feature testing was performed on the NSC and VME portion of the diagnostic. The active/passive and loopback portions of the NSC test were run between a CRAY-2 (UNICOS), CRAY X-MP (UNICOS), CRAY X-MP EA (UNICOS), CRAY Y-MP (UNICOS), Sun Workstation (UNIX), and Amdahl (VM). The VME portion of the test was run between a CRAY X-MP EA and Motorola workstation.
- **donut:** Feature testing was performed for the CRAY-2 and CRAY X-MP, CRAY X-MP EA and CRAY Y-MP versions of donut with DD-40 and DD-49 disk drives.
- **cleario/dsdiag:** go/nogo testing was performed on the IOS diagnostics. The diagnostics were run on a model B,C,and D IOS from tape and disk. They were also run from an OWS for the model C and D IOS.
- **olhpa:** Feature testing was performed on the olhpa diagnostic for the CRAY X-MP, CRAY X-MP EA, CRAY Y-MP and CRAY-2 versions of the diagnostic. Error reporting for multiple IOS machines was tested.
- **runsequence:** Feature testing was performed on the runsequence script for the CRAY X-MP, CRAY X-MP EA, CRAY Y-MP and CRAY-2 systems.

The following remain untested:

- **olnet:** The FEI portion of the diagnostic remains untested, as does the cable loopback of the VME and NSC portion of the diagnostic. No testing was performed under COS.
- **donut for CRAY X-MP, CRAY X-MP EA and CRAY Y-MP:** No testing was performed on DD-10, DD-19, DD-29, or DD-39 disk drives.
- **donut for CRAY-2:** No testing was performed on DD-29 disk drives.
- **unitap:** No testing was performed on this diagnostic.
- **CRAY-1:** No testing was performed on a CRAY-1.
- **cleario/dsdiag:** The IOS diagnostics weren't tested on a model A IOS.

8.17.2 Result Summary

The following summarizes testing results for the UNICOS 5.0 on-line diagnostic release.

8.17.2.1 CRAY-2 Maintenance Tests

The 17 maintenance level diagnostics were run go/nogo under the control of olmon and oldmon on a CRAY-2. No errors were encountered.

CRAY-2 MAINTENANCE TESTS		
diag	olmon	oldmon
bfpt	•	•
bmvt	•	•
csft	•	•
cvit	•	•
eamt	•	•
east	•	•
efpt	•	•
elmt	•	•
esat	•	•
esht	•	•
esmt	•	•
esvt	•	•
evat	•	•
evbt	•	•
evlt	•	•
evmt	•	•
evrt	•	•

8.17.2.2 CRAY X-MP, CRAY X-MP EA and CRAY Y-MP Maintenance tests

The 28 maintenance level diagnostics were run go/nogo under the control of olmon and oldmon, on a CRAY X-MP, CRAY X-MP EA, and CRAY Y-MP. No errors were encountered during testing.

CRAY X-MP/X-MP EA/Y-MP MAINTENANCE TESTS						
	olmon			oldmon		
diag	X-MP	X-EA	Y-MP	X-MP	X-EA	Y-MP
aht	NA	NA
arb	NA	NA
arm	NA	NA
brb	NA	NA
cmp	NA	NA
cmx	.	.	NA	.	NA	NA
gth	NA	NA
ibz	NA	NA
mit	NA	NA
sfa	NA	NA
sfn	NA	NA
sfr	NA	NA
sis	NA	NA
sr3	NA	NA
sra	NA	NA
srb	NA	NA
srl	NA	NA
sts	NA	NA
stan	NA	NA
svc	NA	NA
trb	NA	NA
vpp	NA	NA
vra	NA	NA
vrl	NA	NA
vm	NA	NA
vtr	NA	NA
vts	NA	NA
vrx	NA	NA

8.17.3 CRAY-2 Confidence Tests

The confidence level tests were run go/nogo under the control of

olcmon on a CRAY-2. Mutant analysis was performed on them under the control of oldmon. They were run go/nogo under the control of offmon using BART from the system control console. No errors were encountered during testing.

CRAY-2 CONFIDENCE TESTS			
diag	olcmon	offmon	oldmon
cfdt	.	NA	NA
cfpt	.	.	.
crit	.	.	.
csvc	.	.	.
ibuf	.	.	.
ollm	.	.	.

8.17.4 CRAY X-MP, CRAY X-MP EA and CRAY Y-MP Confidence Tests

The confidence level tests were run go/nogo under the control of olcmon on a CRAY X-MP, CRAY X-MP EA, and CRAY Y-MP. Mutant analysis was performed on them under the control of oldmon on a CRAY X-MP, CRAY X-MP EA, and CRAY Y-MP. They were run go/nogo under the control of offmon using CMOS on a CRAY X-MP. No errors were encountered during testing.

CRAY X-MP/X-MP EA/Y-MP CONFIDENCE TESTS									
diag	olcmon			offmon			oldmon		
	X	EA	Y	X	EA	Y	X	EA	Y
cfdt	.	.	.	NA	NA	NA	NA	NA	NA
cfpt
cm
crit
csvc
ibuf
sbt	.	.	.	NA	NA	NA	NA	NA	NA

8.17.5 Olnet

Feature testing was performed on *olnet*. The *olnet* diagnostic detects faults in NSC, VME, and FEI communication links. The NSC portion of the diagnostic can be run on a Sun or Motorola workstation, a CRAY-2, CRAY X-MP, CRAY X-MP EA and CRAY Y-MP or an IBM under the UNIX, COS, UNICOS, or VM operating system.

The NSC diagnostic consists of:

- 1) Display of local and remote adapter statistics packages
- 2) Remote and local adapter loopback
- 3) Cable loopback
- 4) Active/passive mode message transfer and verification

The VME portion of the diagnostic detects faults in the communication link between a CRAY X-MP, CRAY X-MP EA, or CRAY Y-MP and a Sun or Motorola workstation with a VME interface.

The VME diagnostic consists of:

- 1) Cable loopback
- 2) Active/passive mode message transfer and verification

Five TIRs were opened against *olnet*, all were closed prior to final test.

8.17.6 Oldmon

Oldmon allows individual CPUs to be downed and diagnostics to be run in them while the system remains up and running. Feature testing was performed on *oldmon* for the Cray X-MP, CRAY X-MP EA, CRAY Y-MP and CRAY-2. No errors were encountered during testing.

Tests were run against *oldmon* as follows:

- 1) **Append/dump:** append or dump the following information to a file: *dib*, registers, or memory in instruction, parcel or word format. Append or dump the current screen to a file.
- 2) **CPU:** select a CPU for information display.
- 3) **Enter:** enter a value at a selected memory location; flag a bad value.
- 4) **Fill:** fill memory locations with data; fill a range of locations with a value, or fill with a list of values starting at the specified address.
- 5) **Go:** start diagnostic execution in the specified CPU.
- 6) **Halt:** stop diagnostic execution in the specified CPU and put it in a wait state.

- 7) Load: load a diagnostic into a CPU's buffer.
- 8) Options: set terminal type and display refresh time.
- 9) Up/down: bring all but one CPU down, then bring them up one at a time.
- 10) View: display exchange package, dib, register, and memory in word, parcel, text, or instruction format.
- 11) Write: write central memory in binary format to a file.
- 12) Execute: execute oldmon commands stored in a text file.
- 13) Conflict: run multiple copies of oldmon, see if system catches error when trying to down an already downed CPU.
- 14) Status: CPU status.
- 15) Redraw: redraw display.
- 16) Quit: exit monitor.

OLDMON				
Test	CRAY-2	X-MP	X-MP EA	Y-MP
append/dump
cpu
enter
fill
go
halt
load
options
up/down
view
write
execute
conflict
status
redraw
quit

8.17.7 CLEARIO and DSDIAG

Go/nogo testing was performed on the IOS diagnostics, cleario and dsdiag. The diagnostics are available for the model A, B, C and D IOS, and can be run from expander disk, tape or OWS.

Three TIRs were opened against dsdiag, all were fixed prior to final test.

The testing of cleario and dsdiag consisted of the following:

- 1) Tape: Create a bootable tape and see if the diagnostics load and run using tape.boot.
- 2) Disk: Load the diagnostics onto the expander disk, and see if they run under the control of disk.boot.
- 3) OWS: Transfer the diagnostics to the OWS and run them using the iosboot utility.

CLEARIO / DSDIAG				
Test	Model A	Model B	Model C	Model D
Tape		.	.	.
Disk		.	.	.
OWS			.	.

8.17.8 Donut

The donut utility is an on-line disk maintenance and diagnostic program. It can be used to perform disk surface analysis and to manipulate flaw tables.

There were eight TIRs opened against donut for the CRAY-2. Seven of the TIRs have been closed. No CRITICAL or MAJOR TIRs remain open.

The following tests were run on donut:

- 1) Disk info: display and verify the disk information for the selected disk.
- 2) Read/write buffer : write data to the controller buffer, then read back.
- 3) Error utility: manipulate donuts' found flaw table:

Add entry from error log to found flaw table.
Delete error records from error log.
Save error record to file.
Save error log (all error records) to file
Delete error log entries.

4) Surface tests: surface tests will be run on scratch sectors.

Write/read/compare: write a selected bit pattern to a sector,
read and compare.
Read exercise - check to make sure sectors can be read.
Read absolute - absolute reads of a physical sector.

5) Factory, user, system found flaw: read, verify, add and delete
flaws to tables. Verify the addition and deletion of flaws by read-
ing modified flaw tables using the absolute read function, and also
by exiting donut and re-entering it then reading the flaw table.

Donut (CRAY X-MP/X-MP EA/Y-MP)						
Test	dd10	dd19	dd29	dd39	dd40	dd49
disk info					.	.
rd/write buffer					.	.
error utility					.	.
surface tests					NA	.
factory flaw					.	.
user flaw					.	.
system flaw					.	.
found flaw					.	.
seek exercise	NA	NA	NA	NA	NA	NA
error correction					.	.
auto execution					.	.
formatting					.	.
set parameters					.	.

Donut (CRAY-2)			
Test	dd29	dd40	dd49
disk info		.	.
rd/write buffer	NA	NA	NA
error utility		.	.
surface tests		.	.
factory flaw		NA	.
user flaw		.	.
system flaw		.	.
found flaw		.	.
seek exercise		.	.
error correction		.	.
auto execution	NA	NA	NA
formatting		.	.
set parameters		.	.

8.17.9 Olhpa

THE olhpa utility generates formatted system error information from an error log file, /usr/dimin/errfile. Command line options are passed to it which control the format of the error report. The following options were tested by comparing the output of the error report to the content of an errorlog file.

OLHPA Utility	
Option	Description
-l	Display the long version of the error report
-q	Display only summary information of the report
-g [d]n	Displays a bar graph, if n specified, intervals of n hours are used, if preceded by d then intervals are days
-d	Display a report of all disk errors
-t	Display a report of all tape errors
-D argument	Display disk or error information. Argument can have the form P[,+,]dfield[,field] which adds the field(s) to the default display, or S,field=value[,field=value] which displays only the fields which meet the associated value specifications, or H for help info
-s	Start time of report
-e end	Set the end time of the report, end can be in format hh:mm,MM/DD/YY hh:mm MM/DD/YY
errfiles	One or more files created by the error daemon

8.17.10 Runsequence

The runsequence script allows automatic sequencing of tests. A crontab file is created which in turn invokes runsequence at specified times. Runsequence in turn kicks off the tests as specified in a sequence file, and logs run information and sends mail when errors occur. When testing runsequence, a crontab file and some sequence files were created to run diagnostics.

Features were tested by setting variables in the runsequence script.

Runsequence Utility	
Variable	Description
DIAGBIN	Location of the executable diagnostics
DIAGLOG	Location of the diagnostics log files
RUNLOG	Program log
NICE	Sets the priority
SAVECORE	Determines if core file will be overwritten
MAILLIST	List of users to get mail on errors

8.17.11 Evaluation

CRAY-2, CRAY X-MP and CRAY Y-MP Maintenance Level Diagnostics: The maintenance level diagnostics, along with the monitor `olmon` are stable products. They all tested with no regressions from previous releases.

CRAY-2 Confidence Level Diagnostics: The diagnostics, along with the monitors `olcmon` and `offmon` are stable products. They tested with no regressions from previous releases. The newly released diagnostic `ollm` passed `go/nogo` tests as well as mutant analysis.

CRAY X-MP, CRAY X-MP EA and CRAY Y-MP Confidence Level Diagnostics: The previously released CPU diagnostics, along with the monitors `olcmon` and `offmon` are stable products. They tested with no regressions from previous releases. The newly released diagnostics `olibuf`, `ollsbt`, and `olcm` all passed `go/nogo` tests, `olibuf` and `olcm` also passed mutant analysis.

CLEARIO and DSDIAG IOS diagnostics: This diagnostic set is stable. The new features to allow these diagnostics to be run from the OWS tested fine. There was a regression running from tape. There was also a regression when building from the IOS configuration file, involving the interpretation of mainframe memory size. Both of these problems were fixed prior to final test.

oldmon: The newly released monitor `oldmon` is stable. No TIRs were opened against it.

CRAY-2 donut: The newly released disk maintenance and diagnostic program has been thoroughly tested on the DD-40 and DD-49 disk drives. Testing on the DD-40 resulted in eight TIRs being written. Seven of these TIRs have been closed and no critical or major TIRs remain

open. Testing on the DD-49 resulted in finding major problems in 5 of the 9 main menu functions and minor problems in 3 of the remaining functions. It is recommended not to use CRAY-2 donut on the DD-49 disk drives.

CRAY X-MP/Y-MP donut: This newly released diagnostic is stable for DD-40 and DD-49 disk drives.

olnet: The NSC and VME portions of this newly released diagnostic are stable. Five minor TIRs were opened against it, all were fixed before final test.

runsequence: The enhanced version of runsequence is stable, no problems were found with it.

olhpa: The error report generator is stable, no errors were encountered when testing it.

unitap: This diagnostic is untested.

8.18 NETWORKING SOFTWARE

The following section discusses the testing activities and results for TCP/IP, NFS, USCP, the X Window System, and linking (station) software.

8.18.1 TCP/IP

The Transmission Control Protocol (TCP) provides reliable, flow-controlled, two-way byte streams between pairs of programs running on hosts in an Internet Protocol (IP) Internetwork.

8.18.1.1 *Testing Comprehensiveness*

Documentation updates and improvement involved significant contributions from the TCP/IP tester. Work began on TCP/IP certification through the DCEC TCP/IP validation suite. This project continues, but has been delayed because the proper equipment has not always been available in Mendota Heights and there is no official certification lab.

8.18.1.2 *Evaluation*

Even though no formal testing occurred, much of the TCP/IP software is used daily and heavily in Mendota Heights. Problems that were encountered have been fixed by development.

8.18.2 NFS

The UNICOS Network File System (UNICOS NFS) is an implementation of the Network File System (NFS) for Cray computer systems running UNICOS. NFS was originally designed and developed to reduce the need for local disk storage in distributed environments.

8.18.2.1 Testing Comprehensiveness

This is the first release of UNICOS that supports NFS on CRAY X-MP and CRAY Y-MP systems. (NFS was available on CRAY-2 systems in UNICOS 4.0.) A major portion of the NFS testing effort involved ensuring proper functionality on those systems. The NFS test suite, originally from Sun Microsystems, and the SVVS tests pertaining to file access were used to evaluate NFS on Cray computer systems. The UNICOS 5.0 distribution contains a documented and repackaged version of the NFS test suite so that customers can use it as an installation confidence suite. Testing has been performed between Cray architectures, and between Cray systems, Sun and DEC VAX Workstations and file servers.

Baseline NFS performance values have been gathered. The intent is to compare relative performance of each release with that of the previous release.

ID Mapping commands have been reworked for this release. Informal testing has been performed to evaluate these commands. Currently there is no suite to test them.

Tests have been developed to evaluate several of the basic XDR transport routines. Most RPC and XDR routines have not been explicitly tested, although many are exercised daily through NFS and other applications.

8.18.2.2 Evaluation

NFS testing indicates a solid Cray implementation. ID mapping commands represent a significant improvement over the UNICOS 4.0 (CRAY-2 only) commands. The *UNICOS Administrator's Manual* provides the system administrator with a detailed description of ID mapping guidelines and procedures.

Administrators should be aware of the following:

- A suite of installation confidence tests is packaged with the release and documented in section 4 of the *UNICOS Administrator's Manual*.
- Mapping of GIDs and UIDs (ID Mapping) requires administrator planning. Changes in the computing environment (e.g. host machines, users, groups) must be reflected in the mappings. In addition, paired UIDs and GIDs must be correct to ensure proper user access.

- NFS requires an increase in the size of the TCP/IP pool of mbufs. Refer to Section 4 of the *UNICOS Administrator's Guide* for guidelines on choosing the number of mbufs.

8.18.3 USCP

USCP (The UNICOS Station Call Processor) is a process that allows communication with front-end stations. USCP is implemented as a UNICOS daemon and communicates with one or more stations through the implemented hardware interfaces.

8.18.3.1 Testing Comprehensiveness

The USCP test suite is early in its development, so it is not complete. The current test suite makes use of two tools, a command generator and a station simulator, to test as many possible scenarios as possible. Nine of the eleven new USCP features have been tested thoroughly, with tape daemon front-end servicing and the enhanced interactive message limit features being the exception. Tape daemon front-end servicing has been tested and used by our MVS station tester. Testing has taken place in secure and non-secure environments, in GOS mode, and in native UNICOS.

8.18.3.2 Evaluation

With this version of USCP, administrators should be aware that the *CB* and *BB* formats are no longer supported for job submissions. The new *uscrops(1M)* command will come in very handy for USCP operator tasks. To this point, all tests in the test suite have passed, and new tests are continuing to be developed.

8.18.4 The X Window System

X Windows is a network transparent window system developed at MIT which runs on a wide range of computing and graphics machines.

8.18.4.1 Testing Comprehensiveness

We are currently working with the X Window Testing Consortium to develop a test suite for Xlib. At this point we have breadth tests for all 300+ functions in Xlib. We also have full tests for about 40% - 60% of the functions. In addition to Xlib testing we have performed a great deal of client testing. Following is a list of clients that have been informally tested:

atobm	bitmap	bmtoa	ico	maze	muncher
plaid	puzzle	wm	xbiff	xcalc	xclipboard
xclock	xcutsel	xdpr	xdpyinfo	xedit	xev
xeyes	fd	xkill	xload	xlogo	xlsfonts
xterm					

The following items have not been tested:

The X Toolkit, the Athena widget set or any widget set, any client not listed above.

8.18.4.2 Evaluation

The test suite for Xlib is relatively young. There are still a number of bugs in it. In addition, the results are often inconclusive. Because it isn't clear where a problem is located (either in the test suite or Xlib), no TIRs have been opened against Xlib. This does not indicate that Xlib is bug free, only that it is difficult to determine where errors are located.

The problems with the clients listed above are identical to those with any other X11R3 implementation. In general, the problems that we have found do not appear to be Cray-specific bugs, but rather implementation independent.

A particularly annoying bug is that xedit does not display tabs.

8.18.5 Linking Software

The following chart shows the levels of linking (station) software that have been successfully tested with UNICOS 5.0.

Linking Software	
UNICOS System	Product Levels Tested
UNICOS For CRAY X-MP Computer Systems	VAX/VMS 4.01/4.01BF1 IBM/MVS 3.01 IBM/VM 5.00 APOLLO 2.03 CLS/UX 1.01/1.02
UNICOS For CRAY-2 Computer Systems	VAX/VMS 4.01/4.01BF1 IBM/MVS 3.01 IBM/VM 5.00 CDC/NVE 1.1/2.0 CDC/NBE 1.16 CDC/NOS 1.18 CLS/UX 1.01/1.02

In addition, the following stations testing was performed on both CRAY X-MP/Y-MP and CRAY-2 computer systems.

- 1) Configuration Testing
- 2) Regression Testing
- 3) USCP Testing
- 4) NQS Testing
- 5) Interface HYPERchannel (NSC)
- 6) Front-end Interface (FEI)
- 7) VAX Super-Computer Gateway (VSG)

8.19 UNICOS 5.0 TAPE SUBSYSTEM

This section describes the testing performed on the Tape Subsystem for the UNICOS 5.0 release and includes a summary of the results obtained from that testing.

8.19.1 Testing Comprehensiveness

The following kinds of testing were performed on the Tape Subsystem for UNICOS 5.0:

- Feature testing
- Regression testing
- Stress testing

- Field testing
- Performance testing

The philosophy behind the testing performed by the Tape Testing Group is to test in a manner similar to the way tape users use the Tape Subsystem. Therefore, although the Tape Subsystem consists of three separate elements: the commands (such as `rsv`, `tpmnt`, and `rls`); the tape daemon; and the tape driver, testing was performed at the user level only. No attempt has been made to test any of the elements of the Tape Subsystem in isolation from the others.

8.19.1.1 Feature Testing

New feature tests were written for the following features and were run against various levels of the development system during UNICOS 5.0 code development:

- Front-end servicing - A total of 35 test cases were written to test front-end servicing. These test cases verify that the catalog has been correctly updated for various tape storage classes (single-file, single-volume; multi-file, single-volume; single-file, multi-volume; and multi-file, multi-volume).
- Special end-of-volume (EOV) processing - A total of 20 test cases were written to test EOV processing. The EOV processing test cases attempt to simulate end case conditions that users could encounter when EOV processing is enabled.
- Foreign dataset conversion features - A total of 9800 test cases were written to test the foreign dataset conversion feature. These test cases test various combinations of options that can be specified with the `-F` parameter on the `assign` command, boundary conditions for data types, various alphanumeric patterns, and all of the supported data types that can be specified using Fortran.
- Concatenated tape files - A total of 3 cases have been written for testing concatenated tape files. These cases use concatenated files in conjunction with front-end servicing and special EOV processing.
- Tape device accounting - This feature has been manually inspected for basic functionality, and several tools have been developed by the Tape Testing Group that use the data generated by tape device accounting.
- Tape security - This feature has been manually inspected, but has not received enough testing to verify that the feature performs as expected in all situations.
- Automatic Volume Recognition - AVR has been thoroughly tested through exposure testing at Mendota Heights. The Data Center at Mendota Heights has been running both the development and re-

lease systems with AVR enabled for many months. In addition, a total of 14 tests were written to verify that various features of the AVR system function as designed.

- Enhancements to `tpconfig` (ability to up/down channels and controllers) command - A total of 48 tests were written to verify that channels, controllers, and devices could be enabled or disabled as desired.
- Single tape mark label processing - A total of 10 tests were written to test label processing for the single tape mark. In addition, tests were written that verify that the tape mark is recognized as expected when encountered.
- No unload of devices from `tpmnt` and `tpconfig` commands - This feature was tested through exposure testing by the Tape Testing Group. In addition, a total of 9 tests were written to test the no unload feature with single-file, single-volume; multi-file, single-volume; single-file, multi-volume; and multi-file, multi-volume.
- VSN from file list - A total of 54 tests were written to test this feature.
- Internal/external VSN list - A total of 18 tests were written to test this feature.
- `tpu` command - A total of 24 tests were written to test this feature.

8.19.1.2 Regression Testing

In addition to the testing needed for the new features of UNICOS 5.0, the complete Regression Test Suite for Tapes (feature tests written for the UNICOS 3.0 and 4.0 releases) was run. The purpose of this testing was to detect and prevent regressions and incompatibilities from entering the Tape Subsystem. A total of 936 individual test cases were run against CRAY X-MP and CRAY-2 systems for regression testing. All regressions have been corrected at the time this report was written, with the exception of tape positioning on the CRAY-2.

8.19.1.3 Field Testing

The Tape Testing Group coordinated the activities of two testing projects that involved analysts from the field. One project involved analysts from a customer site, the other involved analysts from the Mid-States region.

The analysts performed testing at Mendota Heights to verify that no regressions were introduced into the system with new features for UNICOS 5.0. The analysts were pleased with the stability and performance of the UNICOS 5.0 Tape Subsystem.

The analysts from the Mid-States Region were concerned with testing tape features of interest and importance to customers in their region. The following features were tested by analysts from the Mid-States Region at Mendota Heights during three separate testing visits:

- Foreign dataset conversion
- EOVS processing
- Front-end servicing

As a result of the visits made by the analysts from the Mid-States region, a number of problems have been identified and fixed.

8.19.1.4 Batch Testing

Some attempt has been made to test (or at least check the basic functionality of) the Tape Subsystem in UNICOS 5.0 through NQS, since a large portion of the customers using tapes prefer batch operations. While this testing is by no means rigorous or complete, it is sufficient to provide a level of confidence that there are no incompatibilities between tapes and NQS. That is, while there are problems in various areas of the Tape Subsystem, and in NQS, there are no new problems caused by processing tapes under NQS.

As a part of regression testing, a set of tests developed at a customer site for data recovery were submitted through NQS. These tests were reliably submitted to the system and functioned as expected once in the system.

8.19.1.5 Performance Testing

This section describes the performance testing performed for the UNICOS 5.0 release. The measurements were taken on a dedicated CRAY X-MP EA/464 Computer System with an internal clock speed of 8.5 nanoseconds. The system was configured with one prototype Model D IOS that contained the multiple low-speed channel feature.

The tape performance testing was performed using StorageTek Model 4670 reel-to-reel and StorageTek Model 4480 cartridge tape devices. All measurements were taken using a Fortran program that synchronously writes and reads approximately 8 million words using BUFFER OUT and BUFFER IN statements. The block size, measured in bytes, was varied from 8K to 131K as shown in the following tables. The XIOP had 1700 octal Kwords reserved in Buffer Memory for this IOP and 17 decimal 512-word data buffers.

The multiple low-speed channel feature did not have any performance impact on the tape tests. This is due to the small percentage of system overhead time compared to the time required for the actual data transfer.

The results of the test conducted on reel-to-reel tape are shown in Ta-

Table 1. The percentages in parentheses are a ratio based on the maximum transfer rate of 1.25 MBytes per second.

Table 1. Testing Results -- Reel-to-Reel Tape				
Block Length (Bytes)	Read Rate (MByte/sec)	Write Rate (MByte/sec)	Read Time (seconds)	Write Time (seconds)
8192	0.84 (67.2%)	0.85 (68.0%)	80.16	79.40
16384	1.02 (81.6%)	1.01 (80.8%)	65.76	66.61
24576	1.09 (87.2%)	1.08 (86.4%)	61.70	62.21
32768	1.12 (89.6%)	1.12 (89.6%)	59.73	60.07
40960	1.15 (92.0%)	1.14 (91.2%)	58.46	58.96
49152	1.16 (92.8%)	1.16 (92.8%)	57.64	58.00
57344	1.18 (94.4%)	1.17 (93.6%)	57.09	57.35
65536	1.18 (94.4%)	1.18 (94.4%)	56.70	56.82
73728	0.87 (69.6%)	0.87 (69.6%)	77.55	77.43
81920	0.87 (69.6%)	0.87 (69.6%)	77.19	76.97
90112	0.87 (69.6%)	0.88 (70.4%)	76.90	76.53
98304	0.88 (70.4%)	0.88 (70.4%)	76.60	76.22
106496	0.88 (70.4%)	0.88 (70.4%)	76.47	76.19
114688	0.88 (70.4%)	0.88 (70.4%)	76.45	76.01
122880	0.88 (70.4%)	0.89 (71.2%)	76.16	75.58
131072	0.88 (70.4%)	0.89 (71.2%)	76.06	75.59

The results of the test conducted on the cartridge tape are shown in Table 2. The percentages in parentheses are a ratio based on the maximum transfer rate of 3.0 MBytes per second.

Table 2. Testing Results -- Cartridge Tape				
Block Length (Bytes)	Read Rate (MByte/sec)	Write Rate (MByte/sec)	Read Time (seconds)	Write Time (seconds)
8192	2.11 (70.3%)	2.09 (69.8%)	31.82	32.04
16384	2.46 (82.0%)	2.47 (82.3%)	27.27	27.18
24576	2.61 (87.1%)	2.63 (87.6%)	25.68	25.54
32768	2.70 (90.0%)	2.71 (90.4%)	24.84	24.76
40960	2.76 (91.9%)	2.74 (91.2%)	24.34	24.53
49152	2.79 (93.0%)	2.78 (92.5%)	24.04	24.18
57344	2.82 (93.9%)	2.80 (93.4%)	23.81	23.94
65536	2.84 (94.5%)	2.83 (94.2%)	23.67	23.73
73728	1.73 (57.7%)	1.73 (57.8%)	38.79	38.69
81920	1.74 (58.0%)	1.74 (58.1%)	38.53	38.47
90112	1.75 (58.2%)	1.75 (58.4%)	38.38	38.29
98304	1.75 (58.4%)	1.76 (58.6%)	38.27	38.15
106496	1.76 (58.5%)	1.76 (58.8%)	38.21	38.06
114688	1.76 (58.6%)	1.77 (58.9%)	38.13	37.95
122880	1.76 (58.6%)	1.77 (59.2%)	38.18	37.80
131072	1.77 (58.8%)	1.78 (59.3%)	38.01	37.73

The tape performance test was executed using two data streams in order to calculate the cumulative transfer rate of multiple streams. The measurements were taken on a dedicated CRAY X-MP EA/232 Computer System running the UNICOS 5.0 operating system. Two StorageTek Model 4480 cartridge tape devices with two StorageTek control units were configured on a 4.5 MByte per second channel. The system had one Model C IOS (no multiple low-speed channel capability).

The results of the test conducted with two streams are shown in Table 3. The percentages in parentheses are a ratio based on the maximum channel transfer rate of 4.5 MBytes per second.

Table 3. Testing Results -- Cartridge Tape -- Two Streams				
Block Length (Bytes)	Read Rate (MByte/sec)	Write Rate (MByte/sec)	Read Time (seconds)	Write Time (seconds)
8192	2.75 (45.9%)	2.73 (45.5%)	48.78	49.15
16384	3.42 (56.9%)	3.41 (56.9%)	39.30	39.33
24576	3.73 (62.2%)	3.74 (62.3%)	35.94	35.91
32768	3.90 (65.0%)	3.91 (65.2%)	34.42	34.31
40960	4.00 (66.7%)	3.99 (66.5%)	33.52	33.64
49152	4.10 (68.3%)	4.04 (67.4%)	32.76	33.20
57344	4.11 (68.5%)	4.08 (68.1%)	32.66	32.86
65536	4.18 (69.6%)	4.02 (67.1%)	32.14	33.35

8.19.2 Results Summary

The following sections summarize the results of the testing performed for the Tape Subsystem on the CRAY X-MP and CRAY-2 versions of UNICOS 5.0.

The tests in Table 4 were run on a CRAY X-MP/464 running UNICOS 5.0 and an IOS Model D during final test. Ninety-seven percent of the tests logged a status of PASS and three percent of the tests logged a status of FAIL.

The tests in Table 5 were run on a CRAY-2 Computer System with four processors and 256 Mwords of static memory, running UNICOS 5.0 during final test. Eighty-nine percent of the tests logged a status of PASS and eleven percent of the tests logged a status of FAIL.

Table 4. Regression Testing Results - CRAY X-MP			
Feature	Tests Run	PASS	FAIL
Append file	18	18	0
cpio (large blocks)	9	9	0
cat (large blocks)	15	15	0
c I/O (large blocks)	15	15	0
tar (large blocks)	15	15	0
cp (large blocks)	15	15	0
c I/O (multifile bypass)	8	7	1
c I/O (multifile)	18	18	0
c I/O (multi volume)	9	9	0
cpio (small blocks)	12	12	0
c I/O (small blocks)	15	15	0
tar (small blocks)	15	15	0
cp (small blocks)	15	15	0
cpio (single volume)	12	12	0
c I/O (single volume)	14	14	0
tar (single volume)	15	15	0
dd (single volume)	18	18	0
FORTRAN BUFFER IN/OUT	8	8	0
FORTRAN data conversion (short int)	9	9	0
FORTRAN data conversion (long int)	9	9	0
FORTRAN data conversion (logical * 1)	9	9	0
FORTRAN data conversion (logical *4)	9	9	0
FORTRAN data conversion (character)	9	9	0
FORTRAN data conversion (dbl real)	9	9	0
FORTRAN data conversion (single real)	9	9	0
FORTRAN GETTP	2	2	0
FORTRAN character I/O	3	3	0
FORTRAN integer I/O (32 bit)	3	3	0
FORTRAN integer I/O (64 bit)	3	3	0
FORTRAN end of file	3	3	0
FORTRAN double precision I/O	3	3	0
FORTRAN single precision I/O	3	3	0
FORTRAN READP/WRITEP	3	3	0
FORTRAN I/O multi volume	6	6	0
FORTRAN I/O single volume	9	9	0
read/write tape marks	6	6	0
Absolute tape positioning	6	3	3
Backspace tape positioning	5	0	5
Relative tape positioning	5	3	2
FORTRAN library I/O	9	9	0
C library I/O	3	3	0
Total Tests Run	381	370	11

Table 5. Regression Testing Results - CRAY-2			
Feature	Tests Run	PASS	FAIL
Append to tape	18	16	2
cpio (large blocks)	15	15	0
cat (large blocks)	15	15	0
c I/O (large blocks)	12	12	0
tar (large blocks)	12	12	0
cp (large blocks)	14	14	0
cpio (small blocks)	8	8	0
cat (small blocks)	17	15	2
c I/O (small blocks)	15	15	0
tar (small blocks)	15	15	0
cp (small blocks)	15	15	0
cpio (single volume)	12	12	0
cat (single volume)	12	12	0
c I/O (single volume)	13	13	0
tar (single volume)	13	13	0
dd (single volume)	18	18	0
FORTRAN BUFFER IN/OUT	12	12	0
FORTRAN data conversion (short int)	7	7	0
FORTRAN data conversion (long int)	7	7	0
FORTRAN data conversion (logical*1)	7	7	0
FORTRAN data conversion (logical*4)	7	7	0
FORTRAN data conversion (character)	7	7	0
FORTRAN data conversion (dbl real)	7	7	0
FORTRAN data conversion (single real)	7	7	0
FORTRAN GETTP	2	0	2
FORTRAN character I/O	2	2	0
FORTRAN integers (32 bit)	2	2	0
FORTRAN integers (64 bit)	2	2	0
FORTRAN end of file	2	2	0
FORTRAN double-precision I/O	2	2	0
FORTRAN single-precision I/O	2	2	0
FORTRAN READP/WRITEP	11	11	0
FORTRAN error recovery	5	0	0
read/write tape marks	6	0	6
absolute tape positioning	6	0	6
backspace tape posit.	5	0	5
relative tape positioning	5	0	5
library I/O routines	9	0	9
Total Tests Run	341	304	37

8.19.3 Evaluation

The following sections summarize the evaluation of the Tape Subsystem of UNICOS release 5.0. These evaluations represent the opinions of the UNICOS tape testing team based on several months of exposure to the developing release.

8.19.3.1 *Tape Subsystem, UNICOS 5.0 for CRAY X-MP Computer Systems*

Front-end servicing appears stable and correct on the CRAY X-MP system. Late in the testing phase, a problem was identified in using multi-file, multi-volume files. When appending a file to multi-volume set, the last volume of the set must be specified in the mount request, instead of the first.

Tape security works within the limits of the testing performed by the Tape Testing Group, but further testing must be performed for this feature before the Tape Testing Group is confident about end conditions.

The Tape Testing Group expects that many sites will not want to enable tape security because of the additional restrictions that it places on users and operations. Currently, users are restricted to writing/reading tapes at their current security level. Sites that make extensive use of unlabeled tapes would probably want to avoid the extra restrictions required by security for unlabeled tapes.

Tape device accounting works within the limits of the testing performed by the Tape Testing Group. Records are being written to the accounting file and manual inspection has detected no errors in the data. In addition, the Tape Testing Group has written several utilities take advantage of the data collection files to measure the load on the Tape Subsystem and the average time for tapes to be mounted.

Users should be aware that unlike COS, individual accounting information is not appended to user output files at the completion of the users tape job. The tape device accounting feature is intended for use by the system administrator.

Foreign Data Conversion was thoroughly tested throughout the development cycle and proved to be stable and to function as advertised. However, at the very end of the release cycle, a problem was encountered in foreign data conversion with the writing of unformatted data. The SPR number and a description of a workaround may be found in the first paragraph of Section 8.14.2 of the evaluation section.

Special EOVS processing; A problem was identified late in the development cycle. If a user enables special EOVS processing and writes off the end of the reel, the Tape Subsystem enters an endless loop trying to complete the write of the block out to the tape. Users should exercise care when enabling special EOVS processing to avoid running off the end of the reel.

Concatenated tape files, where tested in conjunction with front-end ser-

ving and special EOVS processing. No problems were encountered, but not all possible combinations of labels and block sizes were tested. The user is warned in the documentation that record sizes must be consistent throughout the volume set.

VSN list from file; No known problems outstanding.

Single tape mark processing; No known problems outstanding.

Enhancements to `tpconfig`; No known problems outstanding.

Automatic Volume Recognition has been extensively tested and there are no known outstanding problems.

Documentation indicates that tape users can specify tape blocks of up to 4-MBytes. Problems have been encountered with these super block sizes, however, and users are cautioned not to specify blocks larger than 1-MByte for tape blocks. This restriction also applies to special EOVS processing.

No unload of devices through `tpmnt` and `tpconfig` has been extensively tested and there are no known outstanding problems.

`CALL READ`; This FORTRAN library routine was modified for the UNICOS 5.0 release to return a new status (3 = End-of-data). This additional status was intended to provide a better interface between the hardware and users that require more sophisticated status information. Unfortunately, this change can cause incompatibilities with applications written for UNICOS 4.0 libraries.

At the urging of field analysts, the libraries have been released with an installation *switch*, that allows the local system administrator to set the default libraries to UNICOS 4.0 or UNICOS 5.0. A special option has also been added to the `assign` command that allows the user to specify the UNICOS 4.0 version of the libraries.

8.19.3.2 Tape Subsystem, UNICOS 5.0 for CRAY-2 Computer Systems

Front-end servicing is not supported for the CRAY-2 version of UNICOS 5.0. Full support for front-end servicing for the CRAY-2 will be provided with UNICOS 5.1. Testing indicates that problems exist with updates for the LABEL, DEN, DTRTCH, and CJOB fields in the TMC entry.

Tape Security was not rigorously tested on the CRAY-2 version of UNICOS 5.0.

Tape device accounting - Minimal testing was done of this feature for the CRAY-2 version of UNICOS 5.0. There are no known outstanding problems.

Foreign Data Conversion is not supported for the CRAY-2 version of UNICOS 5.0. Full support for foreign data conversion for the CRAY-

2 will be provided with UNICOS 5.1.

Special EOY Processing is not supported for the CRAY-2 version of UNICOS 5.0. Full support for special EOY processing for the CRAY-2 will be provided with UNICOS 5.1.

Concatenated tape files were tested in conjunction with the front-end servicing testing that was performed on the CRAY-2. There are no known problems outstanding, but there is also very little test data on this feature.

VSN list from file; No known outstanding problems.

Single tape mark processing; No known outstanding problems.

Enhancements to tpconfig; No known outstanding problems.

Automatic Volume Recognition; No known outstanding problems.

No unload of devices through tpmnt and tpconfig; No known outstanding problems.

FORTTRAN BUFFER IN/OUT is not supported by the CRAY-2 version of UNICOS 5.0.

FORTTRAN READP/WRITEP is not supported by the CRAY-2 version of UNICOS 5.0.

Tape positioning; None of the tape positioning tests written for UNICOS 4.0 logged passing statuses on the CRAY-2 under UNICOS 5.0.

The data and formulas presented in this appendix will provide a rough approximation of what sites can expect for disk and memory requirements when installing the 5.0 UNICOS release. THIS INFORMATION WILL PROVIDE ONLY AN ESTIMATION, THE DATA PRESENTED WILL NOT PROVIDE MEASURES OF WHAT YOUR SITE WILL EXPERIENCE. With future releases of UNICOS, the data and formulas presented here will continue to be modified to provide more accurate information.

DISK SPACE REQUIREMENTS

Information on the amount of disk space required to store the SCM/UPDATE PL files, source files, and binaries is presented below. Disk space can be saved if the SCM and Update PL files are NOT simultaneously maintained with the source files used by the generation procedures. Sites should create a user partition in the range of 1.3 gigabytes on CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY 1 mainframes and 1.2 gigabytes on CRAY-2 mainframes if all options available with 5.0 UNICOS are to be installed. The size information below is in 512 word blocks as calculated by the respective mainframe du UNICOS command.

All footnotes are at the end of this Appendix.

	<u>Non CRAY-2</u>		<u>CRAY-2</u>	
	Number Files	Block Size	Number Files	Block Size
<u>Standard Source & Binaries</u>				
usr/src/cmd	6173	49969	2835	37566
usr/src/diag	7	5160	87	8993
usr/src/include	271	477	277	436
usr/src/lib	2875	11761	1604	4718
usr/src/man	1843	3887	1607	3405
usr/src/tcp	1387	9219	1386	10553
usr/src/uts	1993	14075	377	3712
usr/src/prod				
usr/src/prod/PL	26	23076	22	15216
usr/src/prod/adstape	7	129		
usr/src/prod/apml	21	428		
usr/src/prod/as	8	3221	10	3603
usr/src/prod/audpl	99	353	103	355
usr/src/prod/bind	10	253		
usr/src/prod/cc	86	2543	86	3576
usr/src/prod/cf77	34	139	34	171
usr/src/prod/cft	19	1683		
usr/src/prod/cft77	21	6975		
usr/src/prod/cft2			30	3541
usr/src/prod/db	147	2585	146	3529
usr/src/prod/flodump	7	222		
usr/src/prod/fmp	145	1091	74	1008
usr/src/prod/fpp	2674	5902	2486	5106
usr/src/prod/ftref	51	376	70	453
usr/src/prod/gcc	92	5317	92	6320

usr/src/prod/gcft77	68	18615	68	20699
usr/src/prod/ldovl	151	517		
usr/src/prod/modecks	65	258	69	340
usr/src/prod/mtdump	37	240	39	252
usr/src/prod/nmodex	121	435	123	501
usr/src/prod/nupdate	333	1161	337	1262
usr/src/prod/odb	66	1731	65	2439
usr/src/prod/pascal	28	2887	28	3199
usr/src/prod/perfdmp	7	201		
usr/src/prod/plcopy	7	127	7	155
usr/src/prod/segldr	14	2689	14	2696
usr/src/prod/update	231	793	235	743
usr/src/prod/usm	244	642	244	676

Optional Source & Binaries

/usr/src/net/X11	2488	10004	1827	16220
/usr/src/net/nfs	455	1620	481	2536
/usr/src/net/nqs	690	4690	337	4876
/usr/src/net/rpc	531	1749	250	2463
/usr/src/net/sl	581	3187	567	2513
/usr/src/net/ultra			91	300
/usr/src/net/uscp	189	872	122	2196
Ada 1.0.3 (binary only) ^A	179	8329	179	10781
Allegro CL 1.0 (binary only)	17	3043	Not Supported	

TOTAL (all files) 24,498 212,631 16,413 187,108

CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, CRAY-1 MEMORY REQUIREMENTS

The following information can be used to determine the amount of memory reserved by the kernel and those daemons that are recommended to be locked in memory for performance reasons. Memory used by the system does not increase linearly as the memory size of the mainframe increases. All measurements have been rounded to the nearest 1,000 64-bit words.

$$\text{kernel size (words)} = \text{KERNEL} + (\text{MEM}/20) + \text{SEC} + \text{NFS} + \text{SL} + \text{TCP}$$

- where KERNEL^B = 440,000 words
- MEM = mainframe memory size in words
(MEM/20 = system buffer size)
- SEC = 24,000 words if security is configured on
- NFS = 80,000 words if NFS is configured on
- SL^C = 41,000 words if SUPERLINK is configured on
- TCP^D = 140,000 words if TCP/IP is configured on

For performance reasons, the following daemons are recommended to be "locked" in memory to prevent swapping. The memory required by these daemons is given below.

<u>Feature</u>	<u>Daemon Name</u>	<u>Memory Required</u>	<u>Comments</u>
NQS	nqsdaemon ^E	107,000 words	
USCP	uscpd ^F	220,000 words	(default

SUPERLINK sltsd^G 126,000 words install.h)

CRAY-2 MEMORY REQUIREMENTS

The following information can be used to determine the amount of memory reserved by the kernel and those daemons that are recommended to be locked in memory for performance reasons. Memory used by the system does not increase linearly as the memory size of the mainframe increases. All measurements have been rounded to the nearest 1,000 64-bit words.

$$\text{kernel size (words)} = \text{CODE} + \text{DATA} + \text{SL} + \text{MBUF} + \text{NFS} + \text{TCP} + \text{BUF}$$

- where CODE = 105,000 words for KERNEL code
- DATA = 459,000 words for KERNEL data and bss space
Value is heavily dependant on system table sizes as influenced by NPROC, NINODE, NFILE, and NUSERS parameter settings. 459,000 represents the values of the released system
- SL^H = 39,000 words for SUPERLINK (always included)
- MBUF^I = 192,000 words for NFS and TCP/IP
- NFS^I = 71,000 words if NFS is configured on
- TCP^I = 61,000 words if TCP/IP is configured on
- BUF^J = 9,228,000 words

For performance reasons, the following daemons are recommended to be "locked" in memory to prevent swapping. The memory required by these daemons is given below.

<u>Feature</u>	<u>Daemon Name</u>	<u>Memory Required</u>	<u>Comments</u>
NQS	nqsdaemon ^E	107,000 words	
USCP	uscpd ^K	204,000 words	(default install.h)
SUPERLINK	sltsd ^G	126,000 words	

LIBRARIES

Three different measures were performed to determine the effects of the 5.0 UNICOS libraries on user applications. For the first measure, a NULL Fortran, C, and Ada program were compiled, linked, and loaded. The sizes of these binaries produced on 4.0 UNICOS with associated libraries were then compared with the binaries produced using 5.0 UNICOS and associated libraries. For the second measure, the comparisons were repeated for an application (GRADSCF). For the third measure, a customer benchmark was used in the comparison. All measurements are reported in 64-bit words.

Measure 1: Null Program Compilation

<u>Language</u>	<u>4.0.11</u>	<u>5.0.7</u>	<u>Difference</u>
Ada 1.0.3 on CRAY-2	33,733	34,888	+1,155
C 4.1 on CRAY X-MP	16,708	20,013	+3,305
CFT77 on CRAY X-MP	38,350	54,561	+16,211
Standard C 1.0	17,950	20,287	+2,337
Portable C 4.0.2	17,756	20,020	+2,264

For the C null tests above, 4.0 numbers were taken on a CRAY X-MP and 5.0 numbers were taken on a CRAY Y-MP.

Measure 2: GRADSCF Compilation

GRADSCF (CFT compiled)	448,778	471,042	+22,264
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Measure 3: Customer Benchmark Compilation

For this customer benchmark, the size of thirty one (31) binary Fortran programs were compared between 4.0 UNICOS and 5.0 UNICOS. The CFT77 1.3 compiler was used for measurements on the CRAY X-MP and the CFT77 2.0.24 compiler was used on the CRAY-2. Program sizes were those reported by SEGLDR.

For the Fortran programs on a CRAY X-MP, program sizes of the absolute binaries increased from +13,872 to +16,349 words. On the 4.0.7 UNICOS system, the binary programs ranged in size from 48,386 to 3,499,693 words. In analyzing the size of the binary for each program versus the size increase for each program, there was no correlation of original size to the size of increase observed under 5.0 UNICOS.

For the Fortran programs on a CRAY-2, program sizes of the absolute binaries either decreased from -1,000 to -2,625 words or increased from +9,000 to +12,267 words. On a 4.0.9 UNICOS system, the binary programs ranged in size from 76,819 to 3,530,172 words. As was the case on the CRAY X-MP, there was no correlation of original binary size to the size of decrease or increase observed under 5.0 UNICOS.

Following is a point by point explanation of why the library increases occurred and why they were necessary. When appropriate, an explanation of what the user or system administrator can do to reduce the memory size increase is present. Items are presented in order of memory size impact (most significant first).

1. Foreign Data Conversion (FDC) causes an increase of +10,792 words for Fortran programs. The FDC feature allows the user to select, at run time, record translation and data conversion. The conversion or translation is done at I/O time and allows users to use and create data that is compatible with foreign computer systems. For the 5.0 UNICOS release, IBM and VAX/VMS data and record formats are supported.

These routines are loaded only by programs that do FORTRAN I/O.

For sites that anticipate little or no use of this feature, much of the memory cost can be eliminated at library and command build time. There exist "switches" in the include file `/usr/include/foreign.h` that control the generation of this feature. For instance, if the "switch" named "ENABLE_VMS_DAT" is set to "NO" then the VMS data conversion routines will not be loaded by user programs. If that type of data conversion is then requested, the `assign` and `asgcmd` commands will issue a warning. Approximately 5,000 words can be saved by disabling the data conversion capabilities, ("ENABLE_xxx_DAT"). Approximately 3,000 words can be saved by disabling the record translation ("ENABLE_xxx_LYR").

2. Error messages cause an increase of +1,518 words for Fortran programs. The number and quality of error messages has been greatly increased in 5.0 UNICOS. This data and code is currently all resident in the executable image. Work is being done for 6.0 to change this.
3. Malloc causes an increase of +720 words for all programs. For the 5.0 release, the `mallopt` (3) and `mallinfo` (3) routines were added to the `malloc` (3) suite of routines. This was done for SVID conformance.
4. Procstat causes an increase of +580 to +982 words depending on usage. Procstat was added for the 5.0 UNICOS release to allow users to gather process statistics on a per process and per file basis. The `procstat` library support is built into the default libraries on the CRAY Y-MP, CRAY X-MP EA, CRAY X-MP, and CRAY 1 mainframes.

A switch exists to disable `procstat` at system build time.

5. Multi-tasking support causes an increase of +596 words for all programs. In previous releases, multiple versions of the libraries were maintained. One set of libraries was maintained for multi-tasking use, and another for other programs. This imposed a burden on the user to ensure that his multi-tasked program was loaded with the proper library. It also imposed a burden on development and site administrators in maintaining two versions.

It was decided to combine the libraries into one version that would support both single and multi-tasked applications. The approach was to use a SEGLDR feature called 'soft externals' to load only those modules from the libraries that are actually used. Hence, only the multi-tasked applications would actually load all of the multi-tasking support routines. Some cost is, however, imposed upon all users to make this possible because some of the more basic support routines must be loaded regardless of whether multi-tasking is being used.

6. Namelist I/O causes an increase of +4,182 words for those programs using namelist I/O. Namelist I/O was enhanced in the 5.0 UNICOS release for 32-bit addressing and to support character I/O.

COMMANDS/UTILITIES

The information for this section was collected on a CRAY X-MP mainframe. Data is from 4.0.8 UNICOS and 3.1 C versus 5.0.7 UNICOS and 4.1 C. All measurements have been rounded to the nearest 1,000 64-bit words.

86 of 94 routines in /bin increased in size less than 9,200 words. The 8 remaining routines increased in size as follows:

dda	86,000	ld	84,000	debug	73,000
drd	64,000	newacct	16,000	acctcom	16,000
hostid	12,000				

For dda, drd, and debug, the increase is a function of some new interaction between PASCAL and SEGLDR 5.0. Together, the two products are over estimating the amount of heap space needed to run the program compiled and loaded. Specifying "STACK=512" in the SEGLDR directive file during build time for these routines will cause the amount of memory to actually decrease from 4.0 UNICOS to 5.0 UNICOS as follows:

dda	-1,000	debug	-2,000	ddr	-1,000
-----	--------	-------	--------	-----	--------

This problem also exists for cdbx and any other command or utility compiled with PASCAL when no "STACK" directive is supplied to SEGLDR during build time (CFT77 and SCC provide this directive and don't have the problem). The make file for debug and cdbx will be changed for the 5.1 UNICOS release. A mod to 5.0 UNICOS will also be prepared to address this problem for debug and cdbx; no action will be taken for dda and drd since these commands will be dropped with the 6.0 release.

62 of 71 routines in /etc increased in size less than 10,000 words. The 9 remaining routines increased in size as follows:

rpcinfo	26,000	mount	20,000	rrestore	18,000
crash	15,000	telnetd	14,000	rlogind	12,000
ifconfig	12,000	route	12,000	ping	11,000

79 of 84 routines in /usr/bin increased in size less than 9,000 words. The 5 remaining routines increased in size as follows:

sim	28,000	yacc	17,000	awk	12,000
mailq	11,000	newalias	11,000		

Of special interest is that the following 2 routines (Note: edit, ex, vedit, vi, and view are the same file) in /usr/bin decreased in size as follows:

yadb	15,000	edit	16,000	ex	16,000
vedit	16,000	vi	16,000	view	16,000

Footnotes to Appendix A

- A. Ada is released in binary form only and binaries are installed in /usr/bin and /usr/lib.
- B. This number represents the requirements for KERNEL code, data, and bss space. The code space required will be separated from the data and bss space in future versions of this appendix.
- C. SUPERLINK may use system buffers as other kernel components do. In general, SUPERLINK uses no kernel buffers on the CRAY-2 and minimal buffers on the CRAY X-MP EA and CRAY Y-MP systems. Additionally, SUPERLINK limits its use of system buffers to two (2) times the number of SLIPC devices configured or half of the kernel buffers whichever is less. There are 100 SLIPC devices configured in the released system.
- D. TCP/IP is required if the installation has an Operator Workstation (OWS) instead of expander channel peripherals. While TCP/IP is required as a standard option with the 5.0 UNICOS release (and must be licensed), we realize that some sites may choose to not install TCP/IP in order to reclaim memory used by TCP/IP. In future UNICOS releases, TCP/IP may be required to run UNICOS. The CRAY X-MP EA number presented includes Mbuf table space which is shared with NFS if it is installed.
- E. The numbers presented were from a CRAY Y-MP and are for NQS configured as networked with qf daemon. If qf is not configured, the size (in words) of nqsdaemon is reduced to 106,000 and qfdaemon does not exist. If NQS is included in the system but configured as not networked, the sizes reduce to 96,000 for nqsdaemon, 20,000 for logdaemon, 24,000 for pipe client, and 38,000 for net client. There is a copy of nqsdaemon in the system running as a shepherd process for each running job. Multiple pipe and net clients may be in the system but only for a short period of time.
- F. Non CRAY-2 USCP memory size is dependant on the site configuration and can be computed by the following formula:

$$\begin{aligned}
 &(\text{MAXSID} * 76) &+& (\text{MAXDTR} * 67) &+& (\text{MAXNET} * 18) &+ \\
 &(\text{MAXDEV} * 13) &+& (\text{MAXMSG} * 61) &+& (\text{MAXJOB} * 20) &+ \\
 &(\text{MAXQUE} * 6) &+& (\text{MAXPIP} * \text{BNFPIP}) &+& (\text{MAXIAU} * 41) &+ \\
 &(\text{MAXPTY} * \text{BUFPTY} / 8) &+& (\text{MAXGTY} * \text{BUFGTY} / 8) &+& (\text{SECTOR} / 8) &+
 \end{aligned}$$

$(7 * FNSIZE / 8) + (MAXSID * BUFPPI / 8) + 60,000$ words +
80,000 words of code

All symbols are found in `/usr/src/net/uscp/include/ins`.

A reduced configuration could require 170,000 words compared to 220,000 words as reported.

- G. The size given is for a reasonable configuration reaching transfer rates near the 1 megabyte/second range for 32K block sizes. For smaller systems, `sltsd` has been configured as low as 107,008 words with a corresponding decrease in thruput rates to .1 megabytes/second for 4K block sizes.
- H. With the 5.0 UNICOS release, SUPERLINK on the CRAY-2 is always configured into the kernel. The size given represents code, data, and bss space. An installation option to select/not select SUPERLINK will be provided with the 6.0 UNICOS release.
- I. Mbufs on the CRAY-2 for TCP/IP and NFS are statically allocated in TCP/IP bss space. The numbers provided reflect the released system settings of 1500 Mbufs. Sites not installing NFS can reduce the number of Mbufs to 750.

The TCP/IP number presented (61,000 words) represents the size of text, data, bss, and rnode table space.

- J. Buffer headers are allocated for sector, track and physical (raw) I/O at start-up time. Buffers for the sector and track buffer pools are also allocated at this time. The NBUF parameter in `sys/param.h` controls the number of 512 word sector buffers. The NBUF42 and NBUF48 parameters determine the number of DD-49 and DD-40 buffers allocated. DD-49 buffers are 21,526 words each and DD-40 buffers are 24,598 words. Physical buffer headers have no associated data buffer. This configuration had 1000 sector buffers, 400 DD-49 track buffers and 2000 physical buffers.
- K. See footnote 4 above for the memory formula. A reduced CRAY-2 configuration could require 150,000 words compared to 204,000 words as reported.

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