Cromemco

What you should know before you buy a UNIX system.

UNIX is becoming the standard for multi-user microcomputer operating systems. Its growth in the number of installations over recent years has been dramatic and is predicted to continue on that trend for some time.

At the same time, the high level of visibility of this operating system has caused confusion—multiple versions, different systems, enhancements, and UNIX-like sytems—making it difficult to sort out what you really need to meet your needs.

As a manufacturer of UNIX-based computers, we think it's appropriate to help eliminate some of that confusion. So, this brochure uses a straightforward *Question & Answer* approach to serve as an aid when considering the commitment to a UNIX computer.

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1 What is UNIX?

UNIX is a trademark of AT&T Bell Laboratories for a multi-user, multi-tasking operating system written by employees of Bell Laboratories, a research division of AT&T, the pioneer of the United States telephone system. Under license from AT&T and Unisoft, Inc., Cromemco has installed UNIX System V on its System 100 and System 300 computers. Unisoft, Inc., has assisted Cromemco in the installation of UNIX System V, plus certain enhancements developed by the University of California at Berkeley (see Question 4). Unisoft, Inc., refers to this software combination by its trademark, UniPlus + System V.

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2 Is UNIX being accepted and will it continue that way?

UNIX is definitely being accepted, not only by the market, but by system manufacturers and software developers. The number of UNIX installations increased more than 15 times in the two years between 1982 and 1984. And current projections indicate that the UNIX system market will approach $20 billion per year in this decade.

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3 What is the difference between UNIX System V and some of the other versions of UNIX?

The UNIX operating system was originated in 1969 and, therefore, has been through over 15 years of development. In that time, it has gone through 4 major "versions", each of which made improvements on the previous version.

The earliest widely used version was called Version 6, which was disseminated in the late 1960's. This was followed in 1979 by Version 7. UNIX System III followed the Version 7 introduction, and, most recently, UNIX System V was announced as the version that is officially supported by the originator as the standard.

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4 What is Berkeley UNIX 4.2?

Like all popular software, UNIX has a large, active group of users. The University of California at Berkeley, California, which has played an important role in the evolution of UNIX, is the home of one such group. They have developed certain utility modifications to UNIX, which are generally referred to as Berkeley UNIX 4.2.

We have added some of these utility programs from the University of California to our System V. However, since the only version of UNIX that is completely supported by AT&T is UNIX System V, these Berkeley enhancements were only added when they did not affect the standardization of UNIX System V. (Some of the Berkeley enhancements do affect the standardization; those are not included in the Cromemco systems).

Therefore, the user can be completely assured that Cromemco UNIX System V is equivalent to the standard, while including some additional enhancements that improve the operating system.

5 What version of UNIX does Cromemco use?

Cromemco uses the most recent version from AT&T, UNIX System V. As new releases become available from AT&T, users can be assured of always having the latest version of the UNIX software through Cromemco's customer Software Update Service.

6 What kind of software support and portability are available on Cromemco systems?

Cromemco systems use the standard 68000 family (non-proprietary), 10 MHz processor as the CPU. Therefore, the user has access to the very large base of software that has been and is being developed on this processor, assuring a high degree of software portability.

In addition, Cromemco systems offer multi-language support, including FORTRAN 77, C, PASCAL, COBOL, and BASIC, and a choice of two very popular database management systems, INFORMIX and UNIFY.

7 What are the standards associated with the Ethernet and is it supported under UNIX?

The Ethernet local area networking technique was developed by Xerox and includes a hardware standard pertaining to the cable and interfacing electronics to that cable. Cromemco supports Ethernet under UNIX System V with an optional-pair board module that is easily inserted into the system bus.

A cable from the board-pair module can be connected to another device called an Ethernet transceiver, which, typically, is physically attached to the Ethernet cable. The transceivers are available from multiple suppliers. Most transceivers provide DB-15 connectors for attaching the computer. The DB-15 is an Ethernet standard that Cromemco supports.

In addition to this hardware, Ethernet requires B-NET software to run under UNIX System V. B-NET is a University of California at Berkeley enhancement to the UNIX system that Cromemco has ported to UNIX System V.

The B-NET software is quite sophisticated and allows users to log in to other computers on the Ethernet, as well as to move jobs onto those computers and to execute them. Thus, a user may offload a job onto an idle computer. For example, a VAX 11/780 running Berkeley 4.2 UNIX with B-NET (not uncommon) could be sent jobs to execute via this Ethernet link (this is common in many engineering applications). The B-NET software, with other applications software, allows the user to consider all the files of all the computers on the network as if they were in his local computer.

The software communication protocol that makes this all work is called TCP/IP. This is a well-known standard protocol because it is used in ARPANET and Defense Data Network (DDN), which are 56K-baud telephone leased-line-based networks.

The other Ethernet protocols are XNS (Xerox) and 3BNET (AT&T proprietary). The TCP/IP protocol is almost a universal standard in microcomputer applications at this time and is available on Cromemco systems as part of our B-NET software package.

8 Can I connect my IBM PC to a Cromemco UNIX system?

Yes. Cromemco offers an easy-to-use, economic method of attaching IBM PC's and IBM-compatible personal computers to UNIX system, through the PCworks software program, developed by Touchstone Software Corporation.

9 Can I communicate with other UNIX computers using standard modems?

The Cromemco UNIX system includes UUCP, which is a standard UNIX-to-UNIX telephone networking package. Error correction is provided for UNIX-to-UNIX file transfer. This UUCP transfer protocol is similar to the file-transfer protocol known (in the CP/M world) as the Ward Christiansen X-MODEM protocol. Both provide error-correcting file transmissions between similar operating systems on different hardware.

10 Does Cromemco support 3270 and X.25 communications protocols?

Yes. Cromemco offers an optional communications controller board, the BIART, which is an easy plug-in to the system. The BIART supports SNA, X.25, and other high-performance serial communications protocols.

11 What does the XMM Memory Manager do in the Cromemco UNIX system?

The XMM Memory Manager, included with all Cromemco UNIX computers, *makes the UNIX software run faster* than if the functions it performed were done in software. Systems competitive to the Cromemco system vary in how much of the memory management function is performed in software and how much is performed in hardware, but very few offer the hardware sophistication of Cromemco systems. This means a Cromemco UNIX computer will be very fast in memory management benchmarks, such as process-switching.

The Memory Manager permits each program that runs under UNIX to have the use of all installed user memory at whatever memory addresses the program requires (memory address translation). It also prevents each program from altering other programs or the operating sytem or from performing I/O operations without permission (memory protection).

The Cromemco Memory Manager is without a performance rival in the microcomputer marketplace. It offers a new state of the art for memory mapping speed.

Technically, the functions supported in hardware are as follows:
● Memory address translation
● Task isolation (memory protection)
● Sharing of RAM
● Elimination of external fragmentation in memory allocation.

Thus, the memory management hardware allows you to provide an efficient, easy way for many independent processes to coexist in memory, to allocate memory without wasting space, and to maximize system throughput by providing these functions (to the extent practical) in hardware.

In operation, the XMM divides the 16 megabyte address space into 4096 equal pages. Each piece (4096 bytes) is called a page. There are 16 bits of information associated with each page used by a process. Twelve bits contain the address of the page in physical memory, and four bits contain the attributes of the page. A "page table" containing the information associated with all 16 megabytes of a process' address space would require 8 kilobytes of RAM per process. Since most processes use much less than 16 megabytes of memory, the Memory Manager permits individual page tables for each 512K of memory used by a process. Consequently, most processes require only 768 bytes of main memory for their page tables.

Many competitive memory management systems require that each page table entry for each process be loaded into the memory management hardware by the operating system software. The XMM automatically DMA-transfers the page table entries into its 55- nanosecond translation buffer as needed by a process. Only the 32 entries for the process' 32 segments need be loaded into the XMM by the operating system. There are 15 sets of segment registers on the XMM so that the registers need not be reloaded when switching among processes.

Selecting another process' memory map during context switching is as fast and simple as changing the byte that contains the number of the currently active set of segment registers. This hardware-intensive approach results in significantly faster context switching with the XMM than with competitive products using software-intensive approaches.

One of the benefits of using Cromemco's Memory Manager under UNIX System V, besides the competitive speed advantages, is protection against destructive user programs. If a user attempts to access memory allocated to another user, control reverts to the operating system, and the user with the faulty program is issued an error message.

12 Is swapping the same as virtual memory?

Yes and no. Technically, swapping uses the disk memory as a low speed, but economical, substitute for RAM memory. This is what virtual memory does, too. But, what people are really looking for when they ask for a virtual-memory computer is the ability to run a *single program* that is larger than the RAM user space in the computer. If we take, for example, a computer with 300K bytes of user space, we may want to run a 900K byte program on it without program changes such as "chaining" or "overlays."

A virtual memory operating system on a computer with a memory manager capable of virtual operation allows the user to run a program up to a maximum size, commonly 8 megabytes, by using 8 megabytes of the disk memory system as a supplement to the available user RAM. The user RAM is generally much smaller than 8 megabytes (1 megabyte is typical).

Cromemco computers have 16 megabytes of RAM capability, twice that of many virtual-memory computers. Many other computers with 8-megabyte, virtual-memory capabilities offer limited physical memory (VAX 11/780 maximum physical memory is 6.5 megabytes; Apollo DN440 maximum physical memory is 3.5 megabytes). Such systems must have virtual memory because they lack large physical memory. These computers can cost much more than a Cromemco system, while running large programs slower than the Cromemco computer because of the speed of the physical memory.

Virtual memory was important when RAM was very expensive. Competition and microcomputer technology have combined to make RAM much less expensive and, therefore, a more cost-effective solution, in many cases.

Cromemco will offer virtual memory when it is available for the standard UNIX System V. Currently, only non-standard, user-group-modified versions of UNIX have virtual memory. The AT&T version of UNIX System V with virtual memory is scheduled to be available in 1985.

13 What is the minimum amount of RAM memory needed for a Cromemco UNIX system?

Cromemco recommends that a minimum of 512K bytes of RAM memory be used for all UNIX systems. In a 512K byte system, programs as large as 300K bytes may be executed. Of course, more memory is required to run programs larger than 300K bytes.

14 How much RAM memory does UNIX take for *multi-user* applications?

UNIX provides more than 300K bytes of user space in a 512K byte system. An excellent feature of UNIX is that all users of a multi-user system may concurrently use all of the 300K byte file. This is possible because UNIX maintains an area on the hard-disk memory called the "Swap Space." This area typically occupies 4 megabytes or more of space on the disk.

The size of the available Swap Space is important. For example, suppose on a system with 512K bytes of RAM, five users are concurrently running different programs, each approximately 300K bytes in size. This 300K bytes consists of approximately 270K bytes of program, plus 30K bytes of buffers allocated by the operating sytem to the user. On other operating systems, while the first user would be able to run programs without problems, the other users should receive "out of memory" error messages.

UNIX, however, loads programs from the normal hard-disk file system into RAM memory and then back to Swap Space if there is no RAM available when the user runs the programs. This allows all users to share the 300K bytes of RAM on a time-slice basis (although each program runs slower because of the sharing). When the programs are not running in RAM, they are temporarily moved to Swap Space, where they are stored while the other programs are running. Therefore, it is necessary that the Swap Space be big enough or the system will report errors.

Five users of 300K bytes (approximately 270K bytes of program, plus 30K bytes for buffers) require a Swap Space of more than 1200K bytes,

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since four of the users will be swapped out at any given time. While swapping does allow sharing, many users find the reduction in throughput during swapping a serious limitation. Therefore, for five productive 300K byte users, a better implementation would be to have 1500K bytes of user space, or approximately 1700K bytes (1.7 megabytes) of RAM, including the operating system. If the system is not often used by five 300K byte users simultaneously, less memory may be used (with a minimum of 512K bytes).

A key feature of Cromemco systems, in comparison to others, is the speed of the swapping process, because of the high performance of the cache memory STDC disk controller (see Question 19).

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15 Since memory seems to be so important, what are the capabilities of Cromemco sytems?

Cromemco systems come in a number of standard configurations with physical RAM memory from 512K bytes, minimum, to 16 megabytes using eight of Cromemco's 2 megabyte memory boards.

It is interesting to note that a 16-megabyte System 300 computer, with its large expansion capability (20 slots) can still accommodate up to 5 additional board modules for capability expansion.

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16 What is demand paging? How does it differ from Swap Space?

In any kind of swapping technique (both the user-space-limited swapping and the virtual-address-space swapping methods), the operating system decides how much to swap if swapping is to be done.

There are two common sizes of programs swapped from RAM to the disk by different operating systems: large pieces and small pieces. The swapping of large pieces occurs when entire user programs (or major portions of user programs) are swapped. The swapping of small pieces occurs when there is sufficient sophistication in the memory management hardware to allow little pieces of programs to be swapped, and there is software supporting that hardware. The small pieces of user programs swapped are called "pages," and when these pieces are swapped, it is called paging. Demand paging is simply a method by which paging is used.

Cromemco systems support demand paging in hardware with its Memory Management Unit. In Cromemco systems, these "small" pages are 4096 bytes each, and are swapped in response to operating system demand, to and from RAM and the disk. These pages are also used for other functions, such as determining the minimum-sized RAM that can be reassigned to a logical address.

Paging imposes no limitation on program address space. This is a great advantage over segmentation or bank-select schemes, which may limit the directly addressable space to 64K bytes. In Cromemco's UNIX systems, which use the 68000 family of 32-bit processors, there are 4096 pages of 4096 bytes each; the full 16-megabyte capability of the 68000 is supported. Thus, a programmer can ignore paging and presume a single 16-megabyte linear address space.

Demand paging is used by the operating system in two important ways: first, to copy pages to memory from disk, on an as-needed basis, to support the execution of the current task (virtual memory); and, second, to manage pages of RAM required by tasks other than the current task.

This second capability is important in order to maximize system performance and can result in a significant performance difference. If a large (several megabyte) task is running and is succeeded in the next time slice by a small (few kilobyte) task, the small task may swap code from the hard disk into a few pages of RAM occupied by the much larger task. When execution of the large task resumes, it is desirable that the few pages of RAM disrupted by the swapping are all that must be restored. The XMM Memory Manager on Cromemco systems currently supports this benefit of demand paging systems, as well as the virtual memory extensions that are anticipated for future releases of UNIX System V.

17 How much hard disk memory is used by the operating system and utilities on Cromemco's System 100 and System 300 UNIX-based computers?

UNIX and its utilities require 20 megabytes if you include the optional Programmer's and Documenter's Software Tools packages and 4.5 megabytes of disk Swap Space.

UNIX uses more memory than some other systems because of the reserved Swap Space, the large size of the on-line manual, the elaborate time-accounting management software, and many optional software utilities that are not necessary for the basic operation of the system.

It is possible to operate with as little as 8 megabytes if the on-line manual is removed and the optional packages are not included.

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18 How much hard disk storage can I use with a Cromemco system?

Cromemco systems come standard with 50 megabytes of hard disk storage. In addition, Cromemco offers an optional interface for SMD hard disks, which supports up to 1200 megabytes of hard-disk storage.

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19 Why is Cromemco's hard disk controller so important to UNIX?

Cromemco's hard disk controller represents a new performance level in state-of-the-art 5¼-inch Winchester disk speeds. Its four-track cache memory architecture provides superior performance in comparison to other 5¼-inch Winchester hard-disk drive systems. It is very fast.

UNIX uses the hard disk for many functions. While less sophisticated operating systems can be run with floppy disk alone, this simply is not practical with UNIX because of the incredibly slow execution speeds that would result.

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20 How does the speed of Cromemco systems compare to others?

Cromemco sytems are designed to provide high speed performance. Over the years, computer users have used many methods to evaluate computers, one of the more popular being benchmarks.

Benchmarks test the capabilities of a given system by exercising the hardware and software so that competitive comparisons can be made. One of the most popular benchmarks is the Sieve of Erasthosthenes. Its popularity stems from the fact that it tests hardware speed, operating system efficiency, and compiler efficiency.

The results of benchmarking a Cromemco System 300 computer with 1 megabyte of RAM memory and the UNIX System V operating system are shown in the following table:

Manufacturer/System	Execution Time (seconds)
Cromemco (10 MHz UNIX)	3.0
Plexus (P35)	3.3
NCR (Tower)	4.0
Pixel (80)	4.3
Hewlett-Packard (9000/220)	4.3
Cromemco (8 MHz CROMIX)	4.3
Altos (586)	4.4
Intel (286/380)	4.6
IBM (XT)	5.2
Callan (Unistar 200)	5.4
Codata (3300/84)	5.4
Onyx (C8002M)	5.9
Corvus (Uniplex)	7.2
Fortune (XP 30)	7.6
Wicat (155)	7.6
Dual (80)	7.7
Apple (Lisa with Xenix)	8.1
Apple (Lisa with Uniplus+)	8.2
DEC (Professional 350)	10.5
IBM (XT with Sritek Xenix)	11.5
IBM (XT with Venix)	11.8

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21 What can I do on a Cromemco system for high-speed computation applications?

Users that have a requirement for very high speed computation can add Cromemco's MAXIMIZER (tm) 12 MIPS microcodable co-processor to their system. The MAXIMIZER is a program accelerator for high-performance number-crunching and floating-point operations.

22 How long has Cromemco been building high-performance micro-computers?

Cromemco has designed and manufactured high-performance microcomputers longer than any other company. Established in 1975, the company has gained a 10-year reputation for high quality and state-of-the-art design.

Today, Cromemco's products are used in a wide variety of applications ranging from individual professional applications to worldwide networks, such as those used by the U.S. Air Force, a long time Cromemco customer. Throughout the years, Cromemco has made significant contributions to the state-of-the-art of computer circuit design, system design, and system packaging.

23 What conclusions can be drawn from all of this?

First of all, we hope it helps in sorting through the information available about UNIX systems and that you see the need to evaluate various UNIX-based systems before you make a commitment. You need to know more about the operating system than simply that it is UNIX.

At Cromemco, we are proud of the fact that we build computer systems which use the UNIX System V operating system and offer performance that is unequalled in the industry. This performance is attained through the use of cache memory, expandable RAM memory up to 16 megabytes for multi-user and large program operations, advanced memory management in hardware, and exceptional expansion capabilities.

24 How can I learn more about Cromemco's UNIX System V computers?

We have established a worldwide network of Official Cromemco UNIX System V System Centers that can demonstrate the high capability of Cromemco systems. They can also answer additional questions you might have and offer system design assistance for your particular application.

See our listing for the center nearest you. Or, call Cromemco directly.

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