UNIX™ on Microcomputers

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If you're investigating the purchase of a microcomputer system, you may have become aware of the confusion surrounding AT&T's Bell Laboratories' UNIX operating system and its place in the microcomputer market. This confusion can be contagious, since many of the questions raised in choosing operating systems are fundamental ones, involving the politics of information distribution, assessment of total system costs, and, even more generally, the most desirable course of evolution for information processing systems.

"I asked for an analytical engine . . . they sold me a digital watch with a calculator."

As the cost of computer hardware continues to fall, the use of operating systems or "user environments" more complex and resource-intensive than CP/M and MS-DOS becomes attractive. The Macintosh exemplifies technologies intended to use this power to make life easier for naive end-users; the UNIX model takes resource-abuse in a different direction, one aimed at providing sharing of programs, data, powerful computing resources, and communications capabilities among demanding users. In this environment, programmers and system designers are offered many alternatives in solving data processing problems; they can employ powerful tools for automating the "tiresome slicing and dicing" of raw data. This environment has evolved over the past 15 years to meet the needs of a diverse community of users; it provides both a stable, well-tested set of operating system functions (managing file systems, user accounts & security, etc.) and the flexibility required to develop an application with unusual requirements. In order to provide this environment, the UNIX system requires a fairly powerful engine; an adequate single-user system must have 512KB of RAM, the CPU power of a Macintosh or PC/AT, and a fast hard-disk of at least 10MB, all of which will add up to about $5000.

First, the good news.

UNIX stands out as an attractive software foundation for departmental-level data processing and communications because:

- There are inherent price, performance, and reliability advantages to multi-user systems over networked PCs. The hardware cost per user is substantially lower than that of the PC-only approach, and **all** users have access to the large memory and hard disk; where response time is critical, e.g., in text editing or real-time experimental applications, PCs can be used to do work locally, using serial lines and file transfer programs such as XMODEM or Kermit to exchange data with the UNIX host. (Much more sophisticated options are also available--for a price.) Networks must have intelligent disk-servers to be really useful; it costs only a little more to make the server run UNIX.

- Source code is portable across radically different machine architectures with acceptable performance, thanks to the use of the portable C programming language in writing the operating system internals, utilities, and most applications programs.[1] In as many words, advances in computing machinery will never make software you develop useless (though it might start showing its age!).

- The computer industry has responded enthusiastically to the system, and has made availabile hundreds of UNIX machines across the whole scale of CPU, disk, and communications capabilities. E.g., IBM offers an IX/370 UNIX which runs on its mainframes under VM; Cray offers UNIX on the Cray 2 supercomputer; DEC offers it, as do Sperry, Prime, NCR, Data General, Sun, Gould, Altos, etc., etc.).

- UNIX offers an environment in which programmers familiar with the system can develop applications programs quickly. These programs are often done using interpreted languages or super-

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[1]Hardware features, such as a CPU architecture (e.g., the Intel 80*86 series) with a small segmented address-space, *can* make the software developer's life difficult.

high-level language compilers packaged with UNIX, and may run "slowly" . . . this is often the optimal solution, when the alternative is developing a fast program slowly$. Hardware is cheap, talent isn't.

"We didn't tell you our machine requires a staff psychologist?"

The major *problems* with the UNIX system include:

• Confusing packaging. The dozens of licensed variants are all sold with slightly different subsets of the hundreds of "utility" programs developed for UNIX, and crucial omissions are made in some packages. There is a good argument for restricting the utilities included with the system: there are so many that on a small hard disk (10MB) the whole set requires most of your disk space! These variants also go under different names--ULTRIX-32, XELOS, XENIX, PC/IX, and UTS are but a few examples--due to the restrictions AT&T places on its licensees' use of the name UNIX, which is reserved for AT&T's implementations of the system.

• Delays in the acceptance of a standard set of OS calls to be supported by all UNIX variants, coupled with the proliferation of "somewhat compatible" versions of the system. XThis problem is looking less insurmountable, now that AT&T System V UNIX has been accepted, *de facto*, by IBM, Microsoft, and others who sell AT&T-licensed UNIX variants in the business market. This leaves Berkeley 4.2 UNIX as a major compatibility problem, although several minicomputer vendors offer machines which run SV and 4.2 **simultaneously**. The Berkeley version of UNIX is attractive for university and R&D systems; the source code for almost everything is available, making it something of a hacker's paradise. Few microcomputer UNIX systems offer 4.2 as an option.

• Administrative headaches, which are caused both by the "documentation" of some UNIX systems and by the fact that you cannot avoid *managing* your computer systems. In the PC world, users often avoid administrative tasks, with regrettable consequences; failure to maintain hard disk backups on floppies or tape is as common as it is foolhardy. The more modern versions of UNIX attempt to ameliorate this problem by providing simple interfaces to programs performing administrative chores, so that you don't need to understand the UNIX commands underneath the menu item or icon on the screen.

• Price becomes a barrier for some users; $5-8000 seems expensive for a system to be used for light word processing. Although most systems can be easily expanded to support more users for about $600/user with negligible performance loss, you may not really need more than one user, and even for those who do, the large "down payment" makes the investment look riskier. You *can* run UNIX on PC/XT clones, but slow hard disks (those with over 50-millisecond average access times) deliver sludgy performance under UNIX. CPU power on these machines is also generally short of requirements; under these performance constraints, the version of UNIX you run often has a great impact on performance.

Common Variants of UNIX		
Vendor	**Product**	**Applications**
Univ. of Calif. at Berkeley	4.2 Berkeley Standard Distribution	Research
AT&T Information Systems	AT&T UNIX System V Release 2	Business
Microsoft Corp.	XENIX (SIII-, soon SV-compatible)	Business
Venturcom	VENIX (ditto)	Real-time applications
Hewlett-Packard	HP-UX (ditto)	Real-time applications, HP standard
Interesting UNIX-based Products and Services		
Uniform Software Systems	The Connector	Runs MS-DOS programs under PC/IX, VENIX, and XENIX on 80*86-based PCs

| AT&T Information Systems | AT&T UNIX Toolchest | Browse, buy, and download AT&T UNIX software over the phone! (212-522-6900) |

"We're looking for a few good boxes. . . . "

With the introduction of the IBM PC/AT, the rush to market microcomputers designed to be capable of running UNIX effectively has begun. Many manufacturers have announced AT-compatible machines which will run XENIX (Compaq will offer a portable version!); some of these, e.g. Texas Instruments', comfortably support 4 users in their base configuration. NCR claims their AT-compatible machine supports up to 16 users (optimistic, perhaps, but they can probably support 8-10 simultaneous users if the system is well-engineered.) AT&T has announced the UNIX PC, which combines a powerful virtual memory UNIX SV engine with graphics and windowing software *a la* Macintosh; although primarily designed as a single-user machine, it can support 2-3 users.

Prices for these machines now start in the $5000 region, the price breakpoint for single-user machines, once the domain of the PC-XT.

RULE OF THUMB: If you will need to support multiple users who need to exchange information regularly, and your budget is over $5,000, you should definitely investigate UNIX-based systems. A UNIX-based 2-user system for text-processing with a laser printer could be acquired for $10,000 with Cornell discounts; you might want another $1,500 or so of 3rd party software for simpler word processing and spreadsheet modeling.

problems:
many systems weak on graphics support
text-editing and other real-time response can be poor

big wins:
user mail systems
powerful, interactive job programming language(s): bourne, csh, Korn shell
powerful programming languages not available on other
systems: awk, lex, yacc, m4, make,
Source Code Control System
(awk may just be the best report generation language ever written)
run printing and other jobs "in the background," allowing you to work on the task at hand
easy scheduling of batch jobs in off-hours
powerful tools for managing and manipulating text files
flexible, user-friendly network communications options
upward compatibility: if your machine lacks the power required for
your application, you can simply get a more capable machine.

| **Cost Assumptions for Small Systems** |

Basis for comparisons

The following configurations were used as examples in preparing the charts comparing the cost per user of different approaches to serving multiple users. Cost assumptions were made using discounted prices available through Cornell or 47th St. Photo; all systems are configured with no software besides the operating system; the complete UNIX system is included for UNIX systems, including programming environment and text processing, so these price estimates are actually slanted in

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This document was prepared on an Apple LaserWriter laser printer, using Adobe System's TranScript troff to PostScript translator and the UNIX text-processing utilities troff and tbl. Charts were prepared using Microsoft Chart on Apple's Macintosh.

favor of the little guys.

Networked PCs: PC system unit/keyboard w/monochrome display adapter ($1731), Monochrome monitor ($215), DOS ($51), and a network adapter with cable and software ($600) for a total of $2600 per station. A shared printer adds $500.

PC/AT + networked PCs: This employs a base model PC/AT (5170068) which has been enhanced with additional resources to get the best price-performance as a fileserver for PCs. PC/AT system unit/keyboard (5170068, $2996), Monochrome adapter and display ($195, $215), 70 megabyte disk drive ($1495), 60 megabyte tape backup ($1300), a network adapter with cable and software ($600), and a printer ($500) for a total fileserver cost of $7300. Each additonal PC on the network costs $2600, apportioned as above.

PCATplus: This is a UNIX multiuser system employing an AT configured much like the previous system with additional memory and a serial port expansion card. PC/AT system unit/keyboard ($2996), Monochrome adapter and display ($195, $215), an additional megabyte of memory ($750), 70 megabyte disk drive ($1495), 60 megabyte tape backup ($1300), an "intelligent" 8-port serial card ($1000), complete XENIX (Core Utilities, $395, Text Processing $155, Software Development $450), and a printer, for a total core system cost of $9451. Each additional terminal costs $500 (conservatively--Qume has introduced an intelligent terminal at $400 list!)

PCATplus w/$1000 terminals: This configuration is the same as that of the ATplus. The only difference is that users are given microcomputers (base level Macintoshes or PC clones) rather than terminals. This is a good approach to dealing with the AT's limited terminal Input/Ouput capabilities; users can perform editing on their own computer with no effect on the host machine, using it for computer mail, to store their files, and work with large shared databases.

Enhanced PC/AT + XENIX: A low-cost XENIX system for 2 users. PC/AT System Unit/Keyboard, 512K and 20 megabyte hard disk (5170099, $4346), complete XENIX ($1000), a printer ($500), for a cost of $5846. The first terminal is $500; the cost growth path makes the assumption that resources are added when additional terminals are purchased, since performance in this configuration will degrade rapidly will the addition of new users.

Plain PCs
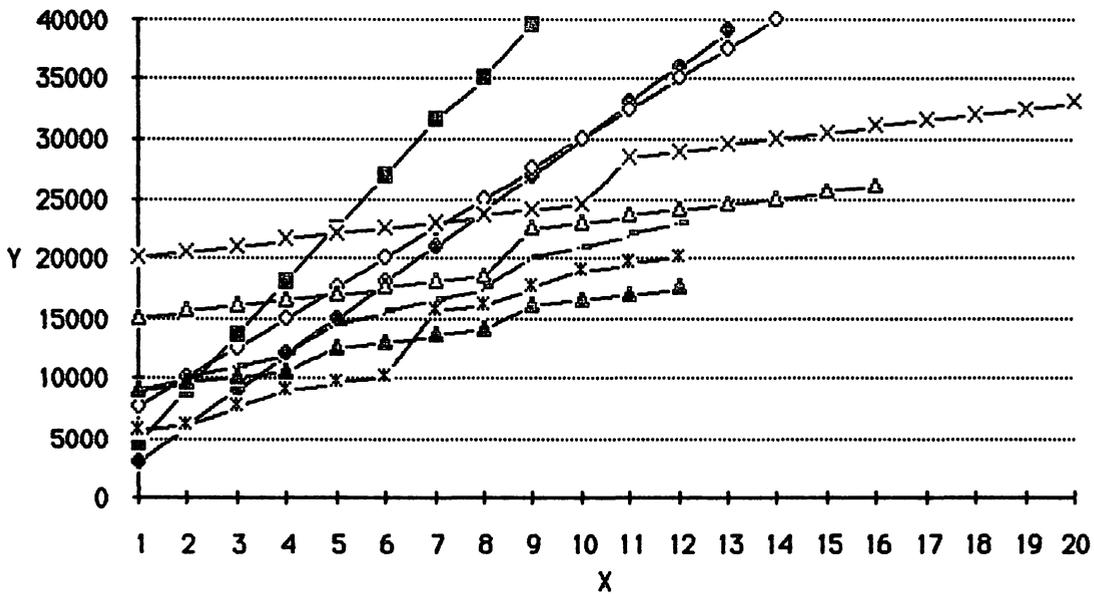
Legend:
- Plain PCs
- PC/AT (MSDOS network) + PCs
- PC-XT (MSDOS—1/user)
- Enhanced PC/AT (XENIX)
- PCATplus (XENIX)
- Tower-class (UNIX SV—68010)
- 68020 equivalent (SV UNIX)
- PC/AT Enhanced (Micnet)
- PCATplus w/$1000 terminals