Prime Series 50 Family

MANAGEMENT SUMMARY

Prime Computer's first system, the Model 200, was aimed at users of the Honeywell 16 Series and introduced in September 1972. The Prime product line of business and scientifically oriented time-sharing systems has expanded considerably since then, and now includes four models with a wide range of capabilities.

The Prime Model 200 started with a body of highly sophisticated Honeywell Series 16-compatible system software originally developed by NASA and entered into the public domain, and then Prime built the hardware to optimize that software's performance. The basic philosophy underlying Prime's design was to achieve a higher level of overall system performance with the existing software than was available with Honeywell equipment.

In February 1973, the OEM Model 100 was introduced as a limited version of the 200 without memory parity and with a slower memory. The Prime 200 was intended as a direct replacement for the Honeywell 316 and 516, while the 100 represented a reduced-capability OEM version for inclusion in Honeywell-compatible systems.

The Prime 300, released in June 1973, represented a substantially enhanced version of the 200 with virtual memory capabilities which extended far beyond those of the Honeywell systems.

Along with the Model 300, Prime also released a time-sharing system that supported up to seven concurrent users and permitted each user to develop programs up to 128K bytes long. This system was shortly followed by a 15-user version, and in May 1975 by a newer version ➢

Prime Computer's product line currently consists of the Series 50 family, a four-member family of 32-bit systems introduced in January 1979. Fully upward-compatible with earlier Prime systems, the Series 50 systems range in price from $65,000 for an execute-only Model 450 to $130,000 for a basic Model 750 that can be expanded to include 8 million bytes of main memory and support up to 63 users.

CHARACTERISTICS

MANUFACTURER: Prime Computer, Inc., 40 Walnut Street, Wellesley Hills, Massachusetts 02181. Telephone (617) 237-6990.

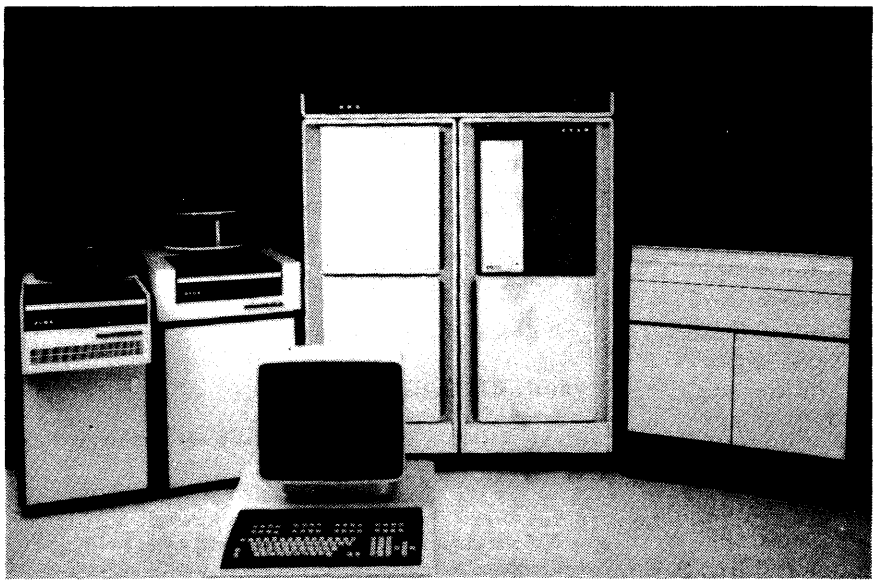
Founded in 1972, Prime markets systems primarily to end users in the time-sharing, communications, data acquisition, and business data processing fields; however, about 5 percent of its sales are currently made to OEM customers. Prime maintains sales and service offices in major U.S. cities. Distributors are also found in Australia, Austria, Canada, Ecuador, Greece, Italy, Japan, Korea, the Netherlands, New Zealand, Saudi Arabia, Singapore, and Switzerland. Subsidiaries are located in Denmark, the Federal Republic of Germany, France, Norway, Sweden, and the United Kingdom.

MODELS: Prime 450, 550, 650, and 750.

DATE ANNOUNCED: January 1979.

DATE AVAILABLE: 750—June 1979; others—February 1979.

NUMBER INSTALLED: 2600 of the earlier Prime systems were installed as of December 31, 1978. ➢



The Series 50 from Prime includes four systems with 32-bit architecture. The photo shows (left to right, rear) 80- and 300-megabyte disk subsystems, the Prime Series 50 CPU (as used in Models 550, 650, and 750) with a magnetic tape subsystem, and the 600-lpm line printer. A block-mode visual display unit is in the foreground. The Series 50 systems support up to 63 simultaneous users, up to 8 million bytes of main memory, and a 32-million-byte virtual address space for each user.

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Prime Series 50 Family

CHARACTERISTICS OF THE PRIME SERIES 50 MODELS

MODEL	450	550	650	750
Main storage:				
Type	ECC MOS	ECC MOS	ECC MOS	ECC MOS
Cycle time (microseconds per word)	1.0 (32 bits)	1.0 (32 bits)	1.0 (32 bits)	1.0 (64 bits)
Minimum capacity (bytes)	256K	256K	256K	512K
Maximum capacity (bytes)	1M	2M	4M	8M
Parity checking	Standard	Standard	Standard	Standard
Error correction	Standard	Standard	Standard	Standard
Storage protection	Standard	Standard	Standard	Standard
Maximum no. of terminals	31	63	63	63
High-level languages	BASIC, FORTRAN, COBOL, PL/1, RPG II	BASIC, FORTRAN, COBOL, PL/1, RPG II	BASIC, FORTRAN, COBOL, PL/1, RPG II	BASIC, FORTRAN, COBOL, PL/1, RPG II

capable of supporting up to 31 users, each with a 128K-byte virtual user area. The system permitted any mix of FORTRAN, BASIC, Macro Assembler, or Micro Assembler languages with full access to all peripheral devices, and was very successful.

The Prime time-sharing system's success has been due mainly to the company's design philosophy. The virtual memory on the Prime 300 system was based on demand paging from disk with 1024-byte pages. In order to maintain satisfactory system performance, Prime recommended main memory sizes based on 16K bytes per user. Consequently, each user always had 16 pages in memory, which reduced the number of paging operations required. Another significant factor in the time-sharing system's performance was the FORTRAN compiler. Prime optimized the object modules produced by the compiler and thereby reduced the size of compiled user programs. At the same time, however, certain functional aspects of FORTRAN sacrificed some memory space efficiency in order to enhance program execution times. For example, in-line code was substituted for subroutine calls in many standard library functions, and hardware indexing was used to make array address formation more efficient.

One feature that has contributed substantially to Prime's software flexibility is the availability of "unimplemented instruction traps," a technique that permits the full repertoire of Prime instructions (such as that of the Model 300) to be used on smaller models (such as the Model 100) with the unimplemented Model 300 instructions "trapped," or referred to software subroutines, for simulation. The advantage of this facility is that a user can develop a group of programs using the most potent set of Prime instructions without worrying about which system the software will ultimately run on. Systems houses can thus offer multiple stages of performance while incurring development costs only once. End users can upgrade performance with immediate results, simply by installing a larger processor.

The Prime 350, announced in February 1978, was designed to offer capabilities previously available only on the Prime 400 and 500 but in the Prime 300 price range. The

DATA FORMATS

BASIC UNIT: 32-bit word (4 bytes).

FIXED-POINT OPERANDS: 16 and 32 bits. Bit and 8-bit byte manipulation instructions are also provided.

FLOATING-POINT OPERANDS: Single-precision—8-bit exponent and 24-bit fraction; double-precision—16-bit exponent and 48-bit fraction.

INSTRUCTIONS: 16-, 32-, 48-, and 64- bit instructions; 16-, 32-, and 64-bit data formats.

In the Prime Series 50 "Virtual Mode," a 30-bit virtual address contains 2 bits for ring number (for security), 2 bits for descriptor table selection, 10 bits for segment number, and 16 bits for word displacement in the segment.

The instruction set for the Prime Series 50 contains three types of instructions: memory reference, register generics, and non-register generics.

Memory reference (MR) instructions can each specify any register as a target (source or destination, depending on the instruction), any base register, plus a 16-bit-word number displacement. The memory reference format can specify all combinations of single-level indexing and indirect addressing. The MR instructions can also specify register-to-register format and three classes of immediate. The MR class of instructions includes both full-word (32-bit) and half-word (16-bit) operand types.

Register generics (RG) instructions operate on the specified target register. This class includes branch, shift, and skip instructions which use the second 16 bits to specify a procedure-based displacement for the branch address.

Non-register generics instructions include all of the control and mode change instructions.

INTERNAL CODE: ASCII.

MAIN STORAGE

TYPE: Dynamic ECC MOS (metal oxide semiconductor) and bipolar cache memory.

CYCLE TIME: 1 microsecond per 4 bytes (32 bits) in the 450, 550, and 650; 1 microsecond per 8 bytes (64 bits) in the 750.

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Prime Series 50 Family

PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION AND SPEED	MANUFACTURER
MAGNETIC TAPE UNITS		
4170	Industry-compatible, 45 ips, 7-track, 556/800 bpi	Pertec
4171	Industry-compatible, 45 ips, 9-track, 800 bpi	Pertec
4180	Industry-compatible, 45 ips, 9-track, 800/1600 bpi	Pertec
4190	Industry-compatible, 75 ips, 9-track, 800/1600 bpi, vacuum column	Pertec
PUNCHED CARD EQUIPMENT		
3160	Reader/punch; 80-column, 200/45-75 cpm	Decision Data
PRINTERS/PLOTTERS		
3135/3145	132-position, 64-character printer; 200 lpm	Data Printer
3136/3146	132-position, 64-character printer; 300 lpm	Data Printer
3137/3147	132-position, 64-character printer; 600 lpm	Data Printer
3166/3167	132-position, 64/96-character printer; 1000/750 lpm	Data Printer
3139/3149	132-position, 96-character printer; 125 lpm	Tally
3140/3150	132-position, 96-character printer; 200 lpm	Data Printer
3142/3157	132-position, 96-character printer; 430 lpm	Data Printer
3202	Printer/plotter, 11 inches by 500 feet, 100 points per inch, 96-character, 7 by 9 matrix, simultaneous print/plot, Gothic font	Versatec
3205	Printer/plotter, 11 inches by 500 feet, 200 points per inch, 96-character, 16 by 16 matrix, Courier font, simultaneous print/plot	Versatec
TERMINALS		
3101	Teletypewriter; ASR 33, 8-channel paper tape reader/punch; 10 cps	Teletype
3111	Keyboard/printer; 30 cps; 80-column width, optional punched paper tape and magnetic tape cassettes, 5 by 7 dot matrix	GE TermiNet
3113	Keyboard/printer; 30 cps; 132-column width, optional punched paper tape and magnetic tape cassettes, 5 by 7 dot matrix	GE TermiNet
3223/3225	Block-mode visual display unit with FORMS capability	Perkin-Elmer

350's hardware contained a 2K-byte, 80-nanosecond, bipolar cache memory and seventy-two 32-bit registers for microcode support, process exchange, direct memory access channels, and the normal tasks of indexing and accumulating. The Model 350 supported up to 31 users, each running programs of up to 768K bytes of virtual memory.

Other features of the Prime 350 were a maximum of 512K bytes of interleaved MOS main memory, up to 2 million bytes of virtual memory, parity checking throughout the processor and main memory, up to 1.2 billion bytes of on-line disk storage, hardware-implemented protection for system and software security, an embedded operating system in each user's virtual address space, and over 300 instructions. The 350 was 200 percent faster than a 300 running COBOL and 50 percent faster than a 300 running FORTRAN.

The Prime 400, announced in March 1976, utilized 2K bytes of bipolar cache memory, could address up to 8 million bytes of MOS main memory, supported up to 63 simultaneous users, offered error-correcting interleaved memory as an option, and allowed each user a virtual

CAPACITY: 256K to 1024K bytes on the 450; 256K to 2M bytes on the 550; 256K to 4M bytes on the 650; and 512K to 8M bytes on the 750.

CHECKING: Interleaved error-correcting memory is standard on all models.

STORAGE PROTECTION: Standard.

RESERVED STORAGE: The Prime Series 50 in virtual mode reserves segment 0 for I/O mapping and segment 4 for process exchange. Each segment consists of 128K bytes.

CONTROL STORAGE: The Series 50 can address up to 16K 64-bit words of control storage, although only approximately 5K words are currently used.

VIRTUAL MEMORY: All models have a standard VM capability that permits addressing of up to 32 million bytes of real memory. In "virtual mode," a page map is referenced to produce a 22-bit effective address (8M bytes of memory locations). A 64-entry segmentation translation look-aside buffer (STLB) holds the 64 most recently referenced memory pages. Since it is highly probable that subsequent memory references will require the same page map entry, the overhead time for many address translations is substantially reduced. Prime estimates that over 97 percent of address translations within one user program segment (time slice) can be accomplished using one of the 64 entries in the STLB. Hardware

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MASS STORAGE

DEVICE	DESCRIPTION	CAPACITY/DRIVE (BYTES)	MANUFACTURER
4205	Fixed-Head Disk, 8.7-millisecond average access, 509K byte/second transfer rate	512K	Digital Development
4207	Fixed-Head Disk, 8.7-millisecond average access, 509K byte/second transfer rate	1 million	Digital Development
4229	Cartridge Disk Drive, 47-millisecond average access, 312K byte/second transfer rate, one fixed and one removable cartridge (IBM 5440 style)	12 million	Pertec
4321*	Cartridge Module Disk Subsystem, 30-millisecond average access, 1.2 million byte/second transfer rate	32 million	Control Data
4331*	Cartridge Module Disk Subsystem, 30-millisecond average access, 1.2 million byte/second transfer rate	64 million	Control Data
4341*	Cartridge Module Disk Subsystem, 30-millisecond average access, 1.2 million byte/second transfer rate	96 million	Control Data
4351*	5-Surface Disk Pack Drive, 38-millisecond average access, 1.2 million-byte/second transfer rate	40 million	Control Data
4361*	5-Surface Disk Pack Drive, 38-millisecond average access, 1.2 million byte/second transfer rate	80 million	Control Data
4371*	19-Surface Disk Pack Drive, 38-millisecond average access, 1.2 million byte/second transfer rate	300 million	Control Data
4300	Dual Floppy Disk Drives, 373-millisecond average access	300K	Shugart
4304	Quad. Floppy Disk Drives, 373-millisecond average access	600K	Shugart

*Up to 3 additional drives per controller may be added; each drive must be designated as 2nd, 3rd, or 4th since the drives come with appropriate microcode to upgrade the controller.

address space of 512 million bytes. The Model 400 was an interactive system utilizing virtual memory management techniques with a combination of paging and segmentation. The system was based on demand paging from disk with 2048 bytes per page. The memory management system tracked the locations of all pages and handled the movement (swapping) of pages between disk and main memory. When required, pages of user programs were automatically transferred from disk to the least recently used area of main memory. To hold paging to a minimum, any number of users could share the same page of a common procedure once it was in main memory. For example, in a multi-user environment, all users could share one copy of the editor instead of each user having to page in his own copy.

The Prime 500, introduced in January 1977, supported up to 63 simultaneous users in a virtual memory environment; offered up to 2.4 billion bytes of disk storage, up to 8 million bytes of error-correcting MOS main memory, and 2K bytes of bipolar cache memory; and was supported by BASIC, COBOL, FORTRAN, and RPG II compilers, HASP and 2780 procedures, DBMS, and the FORMS utility language. The Prime 500 offered these advantages to both the business and scientific communities: fast floating-point hardware and 32-bit general-purpose register instructions were introduced to enhance calculation speeds, additional instructions were added to enhance the execution of COBOL, and software package discounts were available for COBOL/RPG II users.

In January 1979, Prime introduced its current product line, consisting of the 450, 550, 650, and 750. The new systems, collectively known as the Prime Series 50, can be summarized as follows:

memory protection, restricted execution mode, and page-turning (2,048-byte pages) or "swapping" are standard features used to implement VM. These features help produce a program hierarchy with a base or nucleus, supervisor or resident operating system, and user or application program levels. VM facilitates multi-user time-sharing, multi-tasking in real-time, and foreground/background processing with real-time, multi-user, or multi-tasking operations in the (protected) foreground.

Model 450 uses virtual memory management facilities to provide up to 31 users with individual address spaces in excess of the system's physical memory. These include both segmentation and paging and provide all users with the ability to use a program of up to 32 million bytes. By embedding operating system functions in each user's virtual memory, all operating system functions are immediately available as if they were an integral part of the user's program.

Models 550, 650, and 750 permit each of up to 63 simultaneous users to access a virtual space of 32 million bytes (245 128K-byte segments). Each page consists of 2,048 bytes.

CENTRAL PROCESSORS

The Prime processors are all microprogrammed and feature a memory bus, an I/O bus, and standard direct memory access channels (DMA). All models have a virtual memory capability and are microprogrammable through a user-accessible writable control storage (WCS).

Other standard features include direct memory channels, direct memory transfers (DMC/DMT), or direct memory queuing (DMQ); hardware multiply/divide and double-precision arithmetic; and automatic program load from teletypewriter, paper tape reader, disk, or magnetic tape. Double- and single-precision floating-point arithmetic is also standard.

REGISTERS: All Series 50 systems have 128 32-bit registers: 32 for system management, 32 for DMA channels, and two sets of 32 (which include the general-purpose registers) to be shared by the users.

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Prime Series 50 Family

- *Model 450*—32-bit architecture; 1 million bytes of error checking and correcting (ECC) MOS memory; 2K bytes of cache memory; 32 users with 32 million bytes of virtual address space each; floating-point instructions; hardware-implemented system security; 32-bit interleaved memory access; eight general-purpose registers.

- *Model 550*—32-bit architecture; up to 2 million bytes of ECC MOS main memory; 2K bytes of 80-nanosecond-access cache memory; up to 63 users with 32 million bytes of virtual address space each; floating-point instructions; 32-bit interleaved memory access; eight 32-bit general-purpose registers and 128 32-bit registers for system management; hardware-implemented system security.

- *Model 650*—32-bit architecture; up to 4 million bytes of ECC MOS main memory; 2K bytes of 80-nanosecond-access cache memory; up to 63 users with 32 million bytes of virtual address space each; floating-point instructions; 32-bit interleaved memory access; eight 32-bit general-purpose registers and 128 32-bit registers for system management; hardware-implemented system security.

- *Model 750*—32-bit architecture; up to 8 million bytes of ECC MOS main memory; 16K bytes of 80-nanosecond-access cache memory; up to 63 users with 32 million bytes of virtual address space each; instruction prefetch and decoding; high-bandwidth burst-mode I/O; floating-point instructions; 64-bit interleaved memory access; 128 32-bit registers for system management; hardware-implemented system security.

All of the new systems support multi-ring memory protection, shared/re-entrant procedures, and multi-user, multi-language virtual memory which utilizes segmentation and paging. Of special importance to existing customers is the fact that their previously written software is completely compatible at the run-time level. Recompiling and reloading software is not necessary when upgrading an existing system, thus protecting a customer's investment in time and money. A major part of this compatibility is due to the PRIMOS operating system which is used on Prime's earlier models as well as on the new systems. A new CPU-identification instruction allows PRIMOS to be a uniform operating system, to self-configure, and to take advantage of new internal system features.

The 450 is offered in one standardized configuration in order to make the system available at an attractive price, although additional memory, peripherals, or communications controllers can easily be added. The standard 450 utilizes six of the 10 available board positions, allowing for the configuring of up to four additional options from the following possibilities: memory (up to three boards), magnetic tape subsystem, second Asynchronous Multi-line Controller (AMLC), Multi-line Data Line Controller (MDLC), PRIMENET Node Controller, unit record

ADDRESSING: Prime systems have six operating modes which govern the formation of effective memory addresses. The six modes—designated 16K sectored, 32K sectored, 32K relative, 64K relative, 64V virtual mode, and 32I immediate mode—are established through six ENTER MODE instructions. Within each operating mode, there are eight addressing modes.

In the sectored operating modes, bits 2 through 7 of the program counter are *concatenated* to the 9-bit displacement address in the instruction. In the relative modes, bits 2 through 16 of the program counter are *added* to the 9-bit displacement address.

In the 16K and 32K sectored modes, addressing can be direct (512 words), indexed, indirect, indexed-indirect (pre-indexed), or indirect-indexed (post-indexed).

In the 32K relative mode, addressing can be direct (512 words), indexed, indirect, indexed-indirect, indirect-indexed, program relative, program relative-indexed, program relative-indirect, or program relative-indirect-indexed (post-indexing). Also in the 32K relative mode, the 9-bit displacement value is limited to the range -240 through +255, instead of the normal -256 through +255. Displacement values below -240 invoke address modification and provide 16 additional addressing modes, including direct addressing of 32K words through a second address word.

In the 16K sectored, 32K sectored, and 32K relative modes, indirect addressing is multi-level.

The 64K relative mode functions identically to the 32K relative mode except for direct and indirect addressing. Direct addressing to 64K words is possible, but only one level of indirect addressing is permitted, since the indirect bit of an address word is used as part of the 16-bit address.

In the 64V virtual mode, the virtual address contains a segment number (one of 4,096), a page number (64 2K-byte pages per segment), and a word number (0 to 1,023). The virtual address is translated into a physical address by a series of segment tables and page maps stored in main memory. Translation is performed and addresses stored in a Segment Table Lookaside Buffer (STLB). When a process references a page that is not in main memory, a page fault occurs and the operating system replaces the least recently used page with the required page.

In the 32I immediate mode, any memory reference instruction can specify any register as a target (source or destination, depending on the instruction), or any base register plus a 16-bit word-number displacement. The memory reference format can specify all combinations of single-level indexing and indirect indexing. These options are specified by the "Tag" modifier field, which is also used to specify register-to-register; and the three classes of immediate instructions. This class of instructions includes both full-word and half-word (16-bit) operand types. The generic register instructions in this mode operate on the specified target register.

INSTRUCTION REPERTOIRE: All Series 50 systems have over 500 instructions.

INSTRUCTION TIMINGS: Timings for full-word, fixed-point operands, in microseconds:

Model	Load/ Store	Add/ Subtract	Multiply	Divide
450	0.56	0.56	4.20	4.76
550	0.56	0.56	4.20	4.76
650	0.56	0.56	4.20	4.70
750	0.32	0.24	1.38	4.56

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Prime Series 50 Family

subsystem, system option controller (SOC) for printer/plotter, diskette subsystem, and card reader/punch subsystem.

A Model 450 system that includes the CPU, 256K bytes of ECC MOS memory, virtual control panel, 16-line high-performance AMLC, new cabinet, execute-only PRIMOS operating system, and 32-megabyte cartridge module disk (CMD) subsystem sells for $65,000. Prime offers the 450 in minimum quantities of five systems.

The most powerful member of the new family, the 750, has many features which exploit its 32-bit architecture. Key new attributes which contribute to the 750's performance are a 16K-byte cache memory, an instruction prefetch unit, a high-bandwidth burst input/output mode, and fast floating-point hardware. The cache memory allows instructions from one or multiple programs to reside in an 80-nanosecond buffer which dramatically reduces memory access time and processor overhead. The instruction prefetch unit improves central processor performance by both prefetching and decoding up to four instructions from cache memory. Because it accesses cache memory independently of the central processor, it prefetches, decodes, and forms the effective address for up to four instructions in parallel with instruction execution. When the processor's execution unit is ready for the next sequential instruction, the instruction has already been prepared for execution.

The 750 utilizes a new burst I/O mode which increases throughput and reduces central processor overhead by providing an 8-million-byte-per-second transfer rate between the peripheral controllers and memory. This is accomplished by using the 64-bit interleaving capability of the memory. A new floating-point unit optimizes the 750's 32-bit architecture. With a 32-bit path between the unit and the central processor, the unit can accept data at an extremely high rate. Registers assigned to floating-point operations are integral to the unit itself, and it uses parallel logic to allow exponential and fractional calculations to be done simultaneously for increased speed. Separate parallel logic performs binary multiplication 4 bits at a time, division 3 bits at a time, and addition 48 bits at a time for high throughput. To support the processor's 32-bit architecture, the main memory, cache memory, and I/O bus are all capable of 32-bit parallel transfers.

In addition to software compatibility, Prime's new systems also offer hardware compatibility in that all of the Prime peripheral controllers are totally supported and capable of running in existing or new systems. Thus, there is no necessity to swap peripherals when upgrading to one of the new systems.

The virtual control panel (VCP), a standard feature on the four new systems, is a new system controller that offers the capabilities of system operation and diagnosis from a remote terminal. It also replaces the former System Option Controller (SOC) and all functions of the front control panel. The VCP allows any Prime Series

Timings for double-precision floating-point operands, in microseconds:

Model	Load/ Store	Add/ Subtract	Multiply	Divide
450	2.00	4.90	19.00	22.60
550	2.00	4.90	19.00	22.60
650	1.48	3.28	5.80	8.60
750	0.28	1.10	3.20	6.50

INTERRUPTS: 64-level vectored priority interrupts plus a party-line, interrogated interrupt are standard for all models.

PHYSICAL SPECIFICATIONS: All Prime CPU's and their associated memories and controllers are mounted on 16-by-18-inch PC boards in six, eight, or ten layers.

The 450 comes with a 10-board chassis, the 550 and 650 with a 24-board chassis, and the 750 with a 26-board chassis. Typical weight of an entire system is 700 to 2500 pounds.

Electrical requirements for all systems are 95 to 125 or 190 to 250 VAC; 47 to 63 Hz; 15 to 90 amperes. Heat dissipated by typical configurations of the three types of systems (10-, 24-, or 26-board) is about 6000 to 25,000 BTU's per hour.

Operating environment for all models is 15 to 32 degrees C. at 30 to 80 percent relative humidity (noncondensing).

INPUT/OUTPUT CONTROL

I/O CHANNELS: The Prime CPU's can transfer data from up to 64 devices at the following speeds:

Model	I/O rate (bytes per second)
450	2.5 million
550	2.5 million
650	2.5 million
750	8.0 million

A microprogrammed DMA system is standard on all Prime models to handle high-speed I/O data transfer. In addition to the standard DMA mode, Direct Memory Channel (DMC) and Direct Memory Transfer (DMT) modes are available, and a DMQ I/O mode is standard. The DMQ I/O mode allows the multi-line controllers to queue messages without the need for extensive software overhead, thus reducing PRIMOS overhead in dealing with user terminal I/O.

The DMA mode provides 32 DMA channels with 32 pairs of channel control words. Each channel can handle up to 8K bytes per block transfer, and multiple channels can be chained to handle larger blocks and scatter/gather transfers. The DMC mode is similar to DMA except that the control word pairs are located in the first 4K of main memory, allowing up to 2048 DMC channels to be specified, with each capable of handling blocks of up to 128K bytes. The DMT provides the highest data transfer rates by utilizing device controllers that automatically handle all channel control functions without using external control words. The data transfer capabilities are summarized below.

Mode	Maximum Data Rate (bytes/second) Input	Output
DMA (450, 550, 650)	2.5 million	2.27 million
(750)	8.0 million	7.5 million
DMC (all)	961,538	724,638
DMT (all)	2.27 million	2.50 million
DMQ (all)	200,000	200,000

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50 system to be accessed by an authorized local or remote terminal for the purposes of system operation (booting, loading, running, etc.) or local or remote diagnosis (field engineering test programs, etc.). The VCP provides an asynchronous interface for the system console as well as two RS-232C serial printer interfaces. Physically, the VCP consists of a microprocessor-based I/O controller which is mounted in the main chassis and an operation/status panel which is mounted on the top bezel of the processor cabinet.

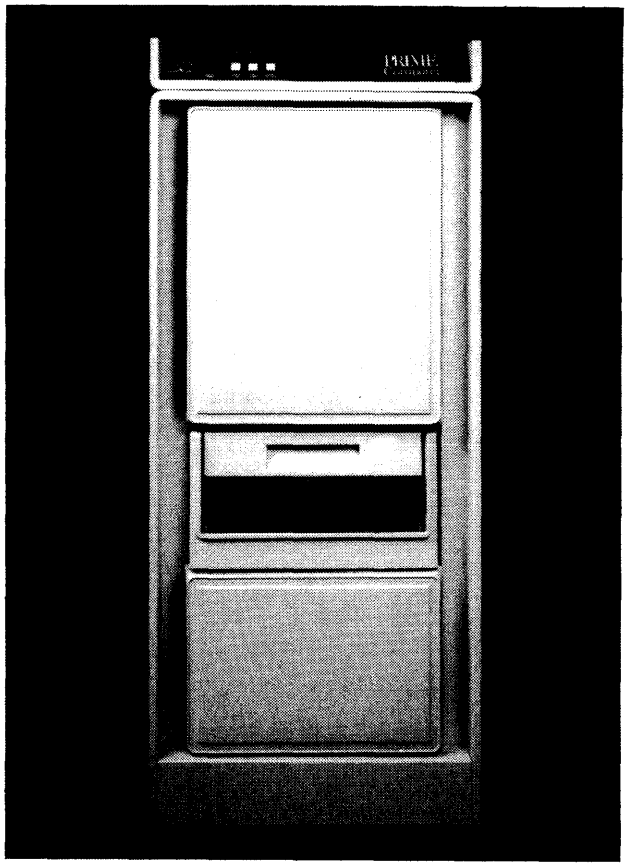
Since the VCP replaces the present control panel, it offers a "control panel" mode of operation. Utilizing the VCP, it is now possible, with a local console or authorized remote terminal, to perform all the former manual control panel functions using easily understood operator commands. The microprocessor in the VCP has permitted the implementation of a simple command language.

The VCP operation/status panel consists of these five switches and four indicator lights:

- The Power On/Off switch turns the power on or off and activates the POWER ON indicator.
- A two-position keylock locks or unlocks the remaining three switches.
- The Master Clear switch initializes the system and activates the STOP light.
- The Remote Enable switch permits remote access to the system via the VCP and turns on the REMOTE indicator.
- The Control Enable switch allows a remote terminal to take control of the system. If this switch has been pushed, the REMOTE ACTIVE light blinks, indicating that the local terminal has been placed in monitor mode.

The Control Enable switch controls the extent to which a remote user may manipulate the system. A local operator may give a remote operator full privileges just as if the remote operator were at the system's local console, or he may give the remote operator monitor privileges only. With monitor privileges, the remote terminal displays everything that is typed on the local systems terminal. In addition, anything typed on the remote terminal will be displayed on the local console; however, it will not be allowed to affect the machine or VCP state. If the local operator presses the Control Enable button, giving the remote user unlimited control, the blinking REMOTE ACTIVE light will draw attention to this. The remote access/privileges button is easily accessed on the front of the processor cabinet so that the systems administrator/operator can enable or disable remote access at any time.

The PRIMOS operating system lets all Prime systems perform multi-terminal, batch, and multi-task operations.



This photo of the Prime 450 CPU shows the five switches and four lighted indicators of the VCP (Virtual Control Panel) at the upper left of the cabinet. The VCP, a standard feature on all Series 50 models, allows the system to be accessed by an authorized local or remote terminal for purposes of system operation or local or remote diagnosis.

SIMULTANEOUS OPERATIONS: Data transfers of all four types (DMA, DMC, DMQ, and DMT) share access to memory with the processor.

CONFIGURATION RULES

Model 450 comes with a 10-board chassis. Models 550 and 650 use a 24-board chassis, and Model 750 has a 26-board chassis.

Each memory module occupies one board. Peripheral and communications controllers all require one board.

According to the "Prime peripheral subsystem philosophy," controllers will support only Prime peripherals. This is accomplished through a programmable controller which requires microcode upgrades to access additional peripherals. Each peripheral is supplied with the appropriate microcode, and peripherals cannot be interchanged.

MASS STORAGE

4205 AND 4207 FIXED-HEAD DISKS: Provide storage for 512K bytes (4205) or 1 million bytes (4207). Average access time is 8.7 milliseconds. Data transfer rate is 509K bytes per second. The 4002 or 4003 controllers provide connection for one 4205 or 4207 disk unit and up to four moving-head disk units. Either controller occupies one board. The fixed-head disk units are manufactured by Digital Development Corporation.

4229 CARTRIDGE DISK: Provides 12 million bytes of storage on one fixed and one removable IBM 5440-type,

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Because PRIMOS is embedded in each user's virtual memory space, it ensures fast program access to operating system resources. It supports re-entrant procedures, permitting a single copy of a software module, such as the text editor or FORTRAN compiler, to be shared by many users. PRIMOS further supports ANSI'74 COBOL, ANSI '77 FORTRAN, BASIC, BASIC/VM, RPG II, PL/1, Prime Macro Assembler, the source-level debugger, and the various levels of query facilities provided by PRIME/POWER; DBMS, Prime's CODASYL-compatible data base management system; MIDAS, the Multiple Index Data Access System; FORMS, the Forms Management System; and a wide variety of application packages available from the Prime Users Library Service (PULSE), from other users, and from third-party vendors.

USER REACTION

Datapro contacted seven users with a total of eight Prime systems installed. One installation had two 400's, while the other six had one computer each, including two 300's and four 400's. The systems had been installed for periods ranging from 10 months to 2 years and averaging 19 months. Two of the systems were being rented, and the remaining five had been purchased.

Memory included in the systems ranged from 192K bytes to 768K bytes, averaging about 480K bytes per system. Disk storage capacity ranged from 40 megabytes to 460 megabytes and averaged 210 megabytes. All the users had at least one magnetic tape unit, with two having two units.

Four users reported business data processing and data base management as their principal applications. Other applications included scientific/engineering and data communications (two users each) and education (one user). All seven reported that applications programming had been done by in-house personnel, while two had also used contract programming houses and one had used proprietary software packages. Programming languages in use included FORTRAN, COBOL, and BASIC.

Only two remote batch terminals were reported by the seven users, but a total of 144 interactive terminals were connected to the 8 systems, ranging from 3 to 48 terminals per computer.

The user responses from the survey are tabulated below, and the weighted averages of a previous Datapro user survey are also shown for purposes of comparison.

	Excellent	Good	Fair	Poor	1979 WA*	1977 WA*
Ease of operation	7	0	0	0	4.0	3.6
Reliability of mainframe	6	1	0	0	3.9	3.4
Reliability of peripherals	5	2	0	0	3.7	2.6
Maintenance service:						
Responsiveness	4	3	0	0	3.6	3.4
Effectiveness	4	2	1	0	3.4	3.2
Technical support	2	4	1	0	3.1	3.2
Manufacturer's software:						
Operating system	6	1	0	0	3.9	3.6
Compilers and assemblers	5	2	0	0	3.7	3.2
Applications programs	3	2	0	0	3.6	—
Ease of programming	5	2	0	0	3.7	3.4
Ease of conversion	2	3	0	0	3.4	3.3
Overall satisfaction	5	2	0	0	3.7	3.4

*Weighted Average on a scale of 4.0 for Excellent.

top-loading disk cartridges. Data is recorded in 8 sectors of 896 bytes each per track. There are 406 tracks per surface. Average head positioning time is 35 milliseconds, and average rotational delay is 12.5 milliseconds. Data transfer rate is 312K bytes per second. Up to four drives can be connected to a 4002 or 4003 controller along with one fixed-head drive. The drives are Pertec 3000 series units.

4351 AND 4361 DISK PACK DRIVES: Provide 40 million (4351) or 80 million (4631) bytes of storage on a CDC 9877-type 5-platter disk pack. Average access time is 38 milliseconds, and the data transfer rate is 1.2 million bytes per second. There are 2,080 bytes per sector, 9 sectors per track, and 823 (4361) or 406 (4351) tracks per surface. Each pack contains five disks: three inner recording disks, and top and bottom protective disks. User files are recorded on five surfaces of the three inner disks, while the sixth surface is reserved for prerecorded servo information used by the disk unit's head positioning system. Up to four 4361's or two 4351's can be connected to a single disk controller. The units are manufactured by Control Data.

4371 DISK PACK DRIVE: Provides 300 million bytes of storage on a CDC 9883-type 12-platter disk pack. Average access time is 38 milliseconds, and the data transfer rate is 1.2 million bytes per second. There are 2,080 bytes per sector, 9 sectors per track, 823 tracks per surface, and 19 of the possible 24 surfaces are used to record data. One top and one bottom disk are used for protection, and the 20th surface is used to record servo information used by the disk unit's head positioning system. Up to four drives can be connected to a single disk controller. The drive is manufactured by Control Data.

4321, 4331, AND 4341 CARTRIDGE MODULE DISK SUBSYSTEMS: Provide 32 million (4321), 64 million (4331), or 96 million (4341) bytes of storage. Each disk drive features one removable, front-insertable, top-loading cartridge of 16 million bytes, with the balance in fixed-disk storage. Up to four disk drives in any mix can be on one controller, providing subsystem capacities from 32 million to 384 million bytes. Average access time is 30 milliseconds, and the data transfer rate is 1.2 million bytes per second. There are 2,080 bytes per sector; 9 sectors per track; and 1,646 (4321), 3,292 (4331), or 4,938 (4341) tracks per drive.

Head positioning is performed using a voice-coil linear actuator which derives its positioning information from a dedicated servo disk surface. An error-correcting code utilized by the controller provides detection and correction of up to 11 consecutive bits to ensure that data is read accurately. For additional drive integrity, the internal operation of the device is under control of a microprocessor which continually checks the internal status of the device and records up to 15 different error conditions in its memory as they occur. The cartridge module disk has a storage-module-compatible interface, allowing storage module and cartridge module devices to be intermixed on the same controller. The units are manufactured by Control Data.

4300 FLOPPY DISK: Includes dual floppy disk drives and a controller. The controller can support up to eight drives on one board. The drive automatically unloads the heads 600 milliseconds after each transaction to minimize disk surface wear. Storage capacity is 300K bytes per drive. Average rotational delay is 83.3 milliseconds, and average seek time over 28 tracks is 290 milliseconds. An IBM 3740-compatible recording module is optional. The floppy disk drives are manufactured by Shugart.

4304 FLOPPY DISK: Includes four floppy disk drives and a controller. The unit is identical to the Model 4300 in all other respects.

INPUT/OUTPUT UNITS

See Peripherals/Terminals table.

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The user ratings gathered in this year's survey are higher in every category except technical support, which reflects a slight drop. Reliability of peripherals, reliability of mainframe, and compilers and assemblers are the categories showing the largest increases.

These users were unanimous in their praise for the flexibility of their Prime systems as well as the virtual memory architecture. Other aspects mentioned favorably included CPU power, cost, speed, the Primos operating system, FORTRAN, DBMS, ease of use, system security, and disk management. On the negative side, one user cited a "lack of system controls" as a weakness, another was not happy with "certain features of COBOL," and a third cited Prime's documentation as "poor."

Prime has rapidly become a strong competitor in the "supermini" market, with over 2600 systems installed by year-end 1978. The new line of 32-bit systems, with all of their advanced features, should make the company an even more formidable adversary in the future.□

DATA ACQUISITION AND CONTROL SYSTEMS (DACS): Four models are available for use in sensor-based control environments. Model 6000 is a general-purpose A/D conversion system with differential multiplexer control for up to 64 channels (16 channels are included), and is used to support programmed I/O or DMA/DMC operation. Models 6020 and 6040 are digital input and output systems that provide 64 input or output lines, respectively. Model 6060 is a digital-to-analog conversion subsystem that provides two, four, or six 10-bit analog output channels at 10 volts and 10 ma.

COMMUNICATIONS CONTROL

5100 ASYNCHRONOUS MULTI-LINE CONTROLLERS (AMLC): The high performance AMLC hardware interface can control 8 or 16 asynchronous full-duplex lines via a Direct Memory Queue (DMQ) mode of operation. DMQ allows the AMLC to queue messages to reduce the number of interrupts serviced by the CPU. Two models are available for 103/113/212 type data sets (5152 and 5154) with an EIA interface, plus one for direct-connect 20-milliamp current loop devices (5174). The 5175 supports 8 EIA RS-232C/CCITT V.24 lines and 8 20-milliamp current loop lines. Program-selectable line speeds can be 110 to 9600 bps.

5600 MULTI-LINE DATA LINK CONTROLLER (MDLC): Provides for high-speed synchronous interface for 2 or 4 lines. By using microcode to format communications messages and to test data for special characters and sequences, the MDLC increases system throughput. Direct Memory Access (DMA) and full character buffering are additional features that provide high-speed operation and lower overhead. MDLC features Cyclic Redundancy Checking and parity checking for error correction and detection, plus a line-looping feature for hardware troubleshooting. Supports EIA RS-232C/CCITT V.24 electrical interface standards at speeds up to 56,000 bps, in half- or full-duplex mode for 201, 203, 208, 209, DDS modems. Multiple protocols are supported: IBM Bisync for HASP and 2780; High-Level Data Link Control (HDLC) for X.25 packet-switched networks; Control Data 200UT: and Univac 1004.

5400 MULTIPLE AUTO-CALL INTERFACE: MACI allows the Prime system to control up to eight Bell 801 automatic call units (ACU) or compatible. Automatic call units, under program control, can initiate a call to any telephone number in the Direct Distance Dial Network. Either dial pulse calls or touch-tone dialed calls can be made. Once the call is completed, data transmission is then handled by one of Prime's synchronous (5600) or asynchronous (5100) line controllers. MACI has a loop-back feature to help isolate line and ACU problems.

7041 PRIMENET NODE CONTROLLER: PNC is the communications medium for locally connected networks with up to 750 feet (230 meters) between any two Prime systems. PNC's for each system are connected to each other with coaxial cable to form a high-speed ring network at speeds up to 8 million bits per second. Link protocol, implemented in this hardware, ensures data integrity via a CRC scheme. Failsafe operations are provided through distributed control architecture. PNC is designed to assure continuity of operation in the event one or more systems fail. Hardware failures, including loss of power, and software failures in one system do not affect network operations between active systems. Individual systems can be removed from the network or restored to on-line status without disturbing the operation of other systems.

SOFTWARE

OPERATING SYSTEMS: There are currently two operating systems available for use with Prime computers.

The *Real-Time Operating System (RTOS)* is a modular multiprogramming system that coordinates the allocation of system resources to application programs executed in a real-time environment. RTOS is available in either a memory-resident or swapped main memory/disk version and provides interrupt handling, multiprogram and multitask scheduling, and I/O control functions. Systems with memory management and disk storage can also support foreground/background operations, in which RTOS operates in a protected foreground area and the background area can function as a disk operating system providing facilities for program development or off-line processing.

Components of RTOS include a real-time executive, a set of I/O peripheral drivers, a real-time I/O library, keyboard-controlled utilities, and a user-configured system information module that defines all tasks, specifies which resources are to be allocated, and assigns job priorities.

PRIMOS optimizes the Prime systems' high-speed computational ability and large memory capacity by integrating interactive, queued-job and real-time supervisory services into a single "embedded" operating system. The Prime systems feature paged and segmented virtual memory with an address space of 32 million bytes, an interleaving main memory system of up to 8 million bytes with a 16K-byte bipolar cache memory, and a disk capacity that can exceed 2.4 billion bytes. PRIMOS can support up to 63 simultaneous users.

PRIMOS includes assembly-language support for the 32-bit general-register architecture. Under PRIMOS, decimal arithmetic, character manipulation, and character editing instructions are directly executed with a combination of hardware and firmware.

PRIMOS's virtual memory management system (a combination of paging and segmentation) makes it possible to run multiple processes, each within a private 256-million-byte virtual space, plus an additional 256-million-byte space that is automatically shared with all other processes. PRIMOS can support as many as 63 interactive time-sharing users at local or remote terminals, and can automatically take advantage of additional increments of main memory which can be added to minimize the paging demands of an expanded virtual memory.

Because a common operating system architecture is used throughout the Prime processor family, user programs and data files created on one Prime computer can be used on any other larger or smaller Prime computer without modi-

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fication. This compatibility holds true both at the source level and at the memory-image level.

System integrity is constantly monitored by features such as memory parity, main memory error-correcting codes, and microprogrammed routines that test the central processor's logic and help determine the cause of failures. Parity is maintained and checked on all the live registers in the processor and data in cache, as well as all external busses. The systems also have a diagnostic status word (a 96-bit field) that is set by the processor whenever it detects an error, resulting in a machine check signal to the software, which can read the diagnostic status word to determine the origin of the signal and take appropriate action.

PRIMOS allows the system operator to lock out pages of main memory should errors be detected and reported within the pages. The operating systems also include file access integrity features such as forward and backward pointers and built-in utilities to regenerate record availability tables. Certain security measures, such as the protection of the operating system from users and other processes, are automatic and unalterable by any user or program. Other measures, such as the permission scheme necessary to access files, can be tailored by the user to match the needs of each installation.

Some other features of the PRIMOS operating system include: time scheduling to a maximum of two-second duration per time-shared process, memory management, page sharing by users, disk space allocation, I/O handling (including spooling), and data communications.

Another feature of PRIMOS is the availability of "phantom users." A phantom user is a process that, once initiated from a terminal, requires no further user interaction or terminal output until it is completed; then the user can continue to initiate other phantom user processes from the same terminal, use the terminal interactively, or log it off the system. The operating system treats phantom and interactive users in the same way except that interactive users are given a higher priority for time slices. In some cases phantom users are used to accomplish printer spooling, card reader spooling, and IBM 2780 input/output.

A system-builder version of PRIMOS is offered to support execute-mode operation of Model 450 systems running application software supplied and supported by system builders. The system-builder version of PRIMOS does not support program development. This version of PRIMOS includes standard PRIMOS shared libraries, file utilities, device handlers, spoolers, the editor, and all user and operator commands not directly related to program development. No programming language support is available, and loaders and debuggers are also unsupported. Since system-builder PRIMOS is an adaptation of standard PRIMOS, full compatibility with all other Prime systems is assured; any program developed on a Prime system can be executed on a system-builder system.

For users wishing to do development on a 450 system-builder system, a special version of PRIMOS is available with runs on the system-builder machine and which does support full program development. This development version of PRIMOS is a separate product and is separately priced.

LANGUAGES: Prime offers five high-level language processors, FORTRAN, BASIC, COBOL, PL/1, and RPG II; and one assembler, the Macro Assembler.

FORTRAN is based on ANSI X3.9-1966 FORTRAN and includes several extensions to the basic package. It is a one-pass compiler that is compatible with all Prime operating systems. In addition, a stand-alone version is available. Output from the compiler is in blocked binary format and must be loaded through a linking loader.

Prime has enhanced the FORTRAN compiler for more efficient operation. The improvements include in-line code generation of floating-point instructions, hardware indexing during array processing, and use of in-line code for special functions instead of the normally performed subroutine calls.

Other functional enhancements include user-designated protection from interrupts for functions and subroutines, additional format field-types for edited data, error returns in both READ and WRITE statements, an END return in READ statements, and a special array LIST that allows referencing absolute memory addresses.

FORTRAN 77 is based on and fully compliant with the revised 1978 specifications for ANSI X3.9-1978 FORTRAN and includes significant extensions to the standard language. Prime FORTRAN 77 exploits the high-level instruction set and the 32-bit architecture of the Series 50. Compatibility features with ANSI '66 FORTRAN include Hollerith data, unconditional DO-loops, and extended range, while mainframe extensions include NAMELIST, double-precision COMPLEX, ENCODE and DECODE, and IBM-style direct-access I/O. FORTRAN 77 generates shareable, reentrant code for improved memory utilization in a multiprogramming environment and is compatible with FORTRAN and other Prime software at the object level. In general, libraries and object modules translated by the FORTRAN compiler can be loaded with those translated by the FORTRAN 77 compiler. FORTRAN 77 supports the following optional software: MIDAS, FORMS, DBMS, and the Source Level Debugger.

BASIC is an extended subset of Dartmouth BASIC and is available in three versions: BASIC, LBASIC, and DBASIC. BASIC does not include matrix (MAT) functions or PRINT USING functions and is intended for users with small-memory systems who wish the simplest form of the BASIC language. LBASIC is a full BASIC interpreter that includes the MAT and PRINT USING functions. DBASIC adds the double-precision floating-point capabilities of the Prime CPU to the LBASIC interpreter.

The BASIC interpreter offers three operating modes: conversational, batch, and immediate. In the conversational mode, users input, edit, and execute programs. In batch mode, existing programs written in BASIC are executed. In immediate mode, each BASIC statement is executed as it is input from a user terminal.

Enhancements to the BASIC interpreter include the ability to call subroutines written in FORTRAN or assembler language; the use of arithmetic, string, or relational operators to form expressions; special I/O statements to aid file handling in both batch and conversational modes; and formatted print descriptors that permit specification of control strings which, in turn, describe both print formats and file outputs.

COBOL is an implementation of the 1974 ANSI standard. All phases of the COBOL compilation can be handled through any one of the interactive terminals. Source-language statements can be entered and modified, compilations can be initiated, and programs can be executed, listed, and saved on a disk. An interactive text editor for all languages simplifies debugging, since the editor can search for and correct all repetitions of identified errors and return the program to disk storage. The editor also allows the programmer to display output files on a CRT terminal and selectively print only those portions of the file that are desired. A "Run-off" function available with the text editor allows printed output to be generated in a manuscript format.

PL/1 Subset G is an optimizing compiler for a subset of ANSI PL/1, X3.53-1976. The subset does not require the

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resources needed to support full PL/1, offers greater simplicity, exploits the virtual memory and 32-bit architecture of the Series 50, supports programs of up to 32 megabytes, and is object-compatible with other Prime languages. An upgrade option will be available for the user who wishes to upgrade to full PL/1. General release of PL/1 Subset G is scheduled to commence in December 1979, while full PL/1 will be made available in 1980.

RPG II is said to be highly compatible with IBM System/3 Model 10 RPG II. The coding is done on standard coding sheets. RPG II programs can communicate with COBOL, FORTRAN, and Macro Assembler programs by using the external linkage feature. Card input files can be submitted from a disk file, from the input spooler, or from a terminal. Card and printable output files can be directed to the output spooler, a terminal, or an intermediate disk file. RPG II uses standard MIDAS data management software for manipulating its indexed or direct-access files, and can take advantage of FORMS.

The *Macro Assembler* is a two-pass assembler that produces relocatable code in blocked format that must be loaded through a linking loader. Features of Prime's Macro Assembler include multiple statements per line or multiple-line statements; symbols up to 32 characters in length; generation and calling of application-oriented macro routines; over 60 pseudo-operations to provide flexible variable definitions and storage allocation, program linking, addressing mode control, and conditional assembly; and use of arithmetic, logical, or shift operators in address expressions.

UTILITIES: Prime offers an assortment of utility programs through the PRIMOS operating system.

DATA BASE MANAGEMENT SYSTEM (DBMS) is an advanced implementation of the recommendations and specifications of the Data Base Task Group report of the Conference on Data System Languages (CODASYL). DBMS consists of five major functional modules: 1) a Data Definition Language translator for describing the data base, 2) ANSI 1974 COBOL and FORTRAN Data Definition Language translators for describing host-language-dependent data base subsets, 3) pre-processors for translating Data Manipulation Language into the COBOL or FORTRAN host language constructs, 4) a re-entrant Data Manipulation Language Command Processor, and 5) an on-line interactive Data Base Administrative Command Processor for defining and administering the DBMS environment.

DBMS provides capabilities for describing, creating, manipulating, and maintaining structured data bases in a diverse range of applications. Data structures can be singular, ordered, tree, hierarchical, network, or cyclical, in any combination.

DBMS offers concurrent access by multiple readers and/or updaters, a program test mode that allows program testing against the live data base without interference between the test and production users, privacy locks, password validations, a comprehensive set of recovery facilities, and a total data base capacity that is limited only by the maximum disk storage available.

The *Multiple Index Data Access System (MIDAS)* is a keyed file access system whose files may be independent or supported under DBMS. MIDAS permits users to access fixed or variable-length records with locks specified at the data record level to avoid concurrent usage conflicts. A single program can sequentially and randomly access a MIDAS file and do complete or partial field searches based on one of the up to 20 keys. To describe, create, and maintain large structured data files, MIDAS and its users interact via a series of questions and answers.

The *FORMS Management System* works in conjunction with all of Prime's compilers to enhance the capabilities of the DBMS software when transactions are entered and are immediately recorded in an integrated data base. The programmer uses the FORMS description language to design forms for the entry and display of data transactions, and to control how data fields are to be displayed or received from one or more device types. Thus, the input and output of files can be controlled at run time. References to the form and its variable fields are made through standard COBOL I/O statements. The data is entered by on-line terminal operators, and current information is instantly displayed or printed as needed.

The *Source Level Debugger* is a language-independent debugging tool that enables users of Prime's programming languages (including FORTRAN, FORTRAN 77, PL/1 Subset G, and PL/1) to control interactively and monitor the execution of object programs for the purpose of testing and debugging. The Source Level Debugger enables programmers to interact with an executing object program in terms relating directly to the source program and requires no specialized knowledge of assembly language, load maps, or the execution-time environment.

Commands are provided which enable a user to dynamically set and clear breakpoints on source statements, examine and modify variables, step through a program, trace statement execution, restart or proceed from a breakpoint, display source statements, intercept subroutine calls and returns, and display subroutine activation history. The Source Level Debugger adapts automatically to the syntactic conventions of the host language for the purposes of evaluating expressions and establishing references to objects such as variables and statement labels or paragraph names in the source language program.

The Source Level Debugger will operate with the following host languages, subject to the availability of debugger support in the corresponding language processor: FORTRAN, FORTRAN 77, PL/1 Subset G, and PL/1.

PRIME/POWER is a user-oriented software system based on an English-language command system designed to permit on-line data management by data processing and non-data processing personnel without requiring extensive training or programming expertise. PRIME/POWER's data query and reporting language supports standard data files which are accessible by COBOL, FORTRAN, RPG II, PL/1, and BASIC/VM programs. These include Index Sequential (MIDAS), ASCII Sequential, binary, and direct-access files. PRIME/POWER provides a comprehensive set of facilities including a report generator, forms writer, data directory, query language, data entry system, and password and user-access security features.

PRIME/POWER+ is an extended version of PRIME/POWER with additional features such as formatted data entry, multi-file report writer and query language, system accounting and auditing functions, plus text and table processing. Like PRIME/POWER, PRIME/POWER+ works with sequential, direct, and MIDAS files.

PRIMENET, Prime's networking program, provides complete local and remote network communication services for Prime systems. In geographically dispersed network configurations, PRIMENET allows Prime computers to communicate with other Prime systems, with computers from other vendors that support X.25, and with terminals attached to an X.25 packet switch network or terminals connected to other Prime systems. In local networks, PRIMENET allows physically adjacent Prime systems to be connected via a high bandwidth, multi-point loop arrangement using the PRIMENET Node Controller.

PRIMENET supports three distinct media: X.25 Packet Switch Networks, as presently implemented by Telenet

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(U.S.A.) and Datapac (Canada), point-to-point synchronous networks, and high-speed, multi-point loop networks.

PRIMENET's Inter-Program Communication Facility communications, program-to-terminal communications, and program-to-file communications. The choice of functional elements is normally determined by the volume of network traffic and the user's application program design.

PRIMNET's Inter-Program Communication Facility (IPCF) allows full-duplex communication between programs residing on one or more computers at one or more locations. It gives users the flexibility to share programs with other systems or to divide the execution load among multiple processors.

This facility is useful when a complex distributed system is designed to operate in a network environment. It allows the application designer to partition programs and data in an optimum way for specific applications. An application program can collect data from local terminals and, based upon data content, direct data base inquiries to one of several other systems in the network. This frees the terminal user from any need to understand how the data base is physically allocated among the systems in the network.

APPLICATION PROGRAMS: A wide variety of application programs is available from the Prime Users' Library Service (PULSE), from other users, and from third-party vendors.

PRICING

POLICY: Prime computers are offered for outright purchase or on three- to five-year full-payout leases. OEM discounts are available for qualified volume orders on a negotiated basis.

Prime software is unbundled except for PRIMOS. The software is licensed, and specific software prices are included in the price list in this report. An alternative method of software pricing is offered whereby the user pays an installation fee and a monthly use fee which includes maintenance. Four man-weeks of training are provided at no charge with each system purchased. Other separately priced training is available.

Prime offers a user plan that allows a system to be upgraded. Trade-in values of the replaced equipment are guaranteed if the upgrade installation occurs within two years of the original installation. (The Model 450 main cabinet must be exchanged when upgrading to a 550, 650, or 750.)

SUPPORT: Prime's field engineering provides three types of maintenance:

- Full Service, which includes pre-installation, installation, preventive maintenance, engineering change orders, remedial maintenance, and spare parts inventories;
- Factory Repairs, which includes warranty repairs and unit repairs; and
- Time and Materials, which includes service and parts based on current availability.

WARRANTIES: OEM sales—30 days, parts only; all other sales—90 days, parts and labor.

EQUIPMENT: The following packaged central systems include all controllers, adapters, and cabling in the quoted purchase prices.

ENTRY-LEVEL SYSTEM: Consists of Prime 550 CPU with 256K bytes of memory, virtual control panel, high-performance AMLC, cabinet, PRIMOS, and console (TermiNet-30). Purchase price is $70,000.

MEDIUM SYSTEM: Consists of Prime 650 CPU with 256K bytes of memory, virtual control panel, high-performance AMLC, cabinet, PRIMOS, and TermiNet-30. Purchase price is $95,000.

LARGE SYSTEM: Consists of Prime 750 CPU with 512K bytes of memory, virtual control panel, high-performance AMLC, cabinet, PRIMOS, and TermiNet-30. Purchase price is $130,000. ■

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
SYSTEMS			
450-QMB	450 CPU, 256K ECC MOS memory, virtual control panel, high-performance 16-line AMLC, 10-board chassis, 32M-byte cartridge disk subsystem, execute-only PRIMOS, cabinet	$ 65,000	$500
550-QMB	550 CPU, 256K ECC MOS memory, virtual control panel, high-performance 16-line AMLC, 24-board chassis, PRIMOS, TermiNet-30 console, cabinet	70,000	488
650-QMB	650 CPU, 256K ECC MOS memory, virtual control panel, high-performance 16-line AMLC, 24-board chassis, PRIMOS, TermiNet-30 console, cabinet	95,000	595
750-HMB	750 CPU, 512K ECC MOS memory, virtual control panel, high-performance 16-line AMLC, 26-board chassis, PRIMOS, TermiNet-30 console, cabinet	130,000	785
MEMORY			
MMI-QMB	256K interleavable ECC MOS memory; takes one board position	15,000	90
MMI-HMB	512K interleavable ECC MOS memory; takes two board positions	25,000	180
MMI-1MB	1024K interleavable ECC MOS memory; takes four board positions	40,000	360
MMW-HMB	512K interleavable ECC MOS memory; takes two board positions, for 750 only	25,000	180
MMW-1MB	1024K interleavable ECC MOS memory; takes four board positions, for 750 only	40,000	360
MASS STORAGE			
4002	Disk Controller for one fixed-head disk drive and up to four moving-head drives, in any combination; 1 board	3,500	25
4205	Fixed-Head Disk; 512K bytes	14,500	135

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
MASS STORAGE (Continued)			
4207	Fixed-Head Disk; 1 million bytes	17,500	165
4229	Cartridge Disk Drive; 12 million bytes; includes cartridge	15,000	125
4351	Disk Pack Drive; 40 million bytes, includes controller	23,500	200
4352	2nd Disk Pack Drive; 40 million bytes, controller upgrade	14,500	140
4361	Disk Pack Drive; 80 million bytes, includes controller	27,000	200
4362	2nd Disk Pack Drive; 80 million bytes, controller upgrade	18,000	165
4363	3rd Disk Pack Drive; 80 million bytes, controller upgrade	18,000	165
4364	4th Disk Pack Drive; 80 million bytes, controller upgrade	18,000	165
4371	Disk Pack Drive; 300 million bytes, includes controller	42,000	300
4372	2nd Disk Pack Drive; 300 million bytes, controller upgrade	33,000	260
4373	3rd Disk Pack Drive; 300 million bytes, controller upgrade	33,000	260
4374	4th Disk Pack Drive; 300 million bytes, controller upgrade	33,000	260
4300	Dual Floppy Disk Drive; 300K bytes, includes controller	5,200	52
4304	Four Floppy Disk Drives; 600K bytes, includes controller	9,000	90
4302	Expansion from 2 to 4 diskette drives	4,000	—
4234	6-million-byte disk cartridge	300	—
4245	40-million-byte disk pack	1,000	—
4246	80-million-byte disk pack	1,000	—
4247	300-million-byte disk pack	2,500	—
4166	Diskette, IBM format	25	—
4167	Diskette, Prime format	25	—
4321	Cartridge module disk (CMD) subsystem, 32M bytes, controller, cable, 16M-byte disk cartridge	17,500	180
4322	Second 32M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	13,000	145
4323	Third 32M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	13,000	145
4324	Fourth 32M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	13,000	145
4325	Disk cartridge, 16M bytes	325	—
4331	CMD subsystem, 64M bytes, controller, cable, 16M-byte disk cartridge	23,000	190
4332	Second 64M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	18,500	155
4333	Third 64M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	18,500	155
4334	Fourth 64M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	18,500	155
4341	CMD subsystem, 96M bytes, controller, cable, 16M-byte disk cartridge	28,500	200
4342	Second 96M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	24,000	165
4343	Third 96M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	24,000	165
4344	Fourth 96M-byte CMD expansion drive, controller upgrade, cable, 16M-byte disk cartridge	24,000	165
MAGNETIC TAPE EQUIPMENT (STANDARD)			
4170	Magnetic Tape Drive; 7-track, 45 ips, 556/800 bpi; includes controller, cabinet, and cables	12,000	102
4171	Magnetic Tape Drive; 9-track, 45 ips, 800 bpi; includes controller, cabinet, and cables	12,000	102
4045	7-track Tape Drive, Add-on; requires drive option	7,200	77
4046	9-track Tape Drive, Add-on; requires drive option	7,200	77
4172	2nd Tape Drive Option; includes microcode (7- or 9-track)	2,000	—
4173	3rd Tape Drive Option; includes microcode (7- or 9-track)	2,000	—
4174	4th Tape Drive Option; includes microcode (7- or 9-track)	2,000	—
MAGNETIC TAPE EQUIPMENT (HIGH PERFORMANCE)			
4180	Magnetic Tape Drive; 9-track, 45 ips, 800/1600 bpi; includes controller, cabinet, and cables	17,000	155
4190	Magnetic Tape Drive; 9-track, 75 ips, 800/1600 bpi; includes controller, cabinet, and cables	19,500	155
4056	45 ips, 800/1600 bpi Tape Drive, Add-on; requires drive option	9,000	100
4058	45 ips, 556/800 bpi Tape Drive, Add-on; requires drive option	7,200	77
4059	45 ips, 800 bpi Tape Drive, Add-on; requires drive option	7,200	77
4165/4168	75 ips, 800/1600 bpi Tape Drive, Add-on; requires drive option	11,500	100
4182/4192	2nd Tape Drive Option; includes microcode	2,500	—
4183/4193	3rd Tape Drive Option; includes microcode	2,500	—
4184/4194	4th Tape Drive Option; includes microcode	2,500	—
LINE PRINTERS			
As first device on a unit record subsystem:			
3135	132-position, 64-character, 200 lpm; includes controller	10,000	90
3136	132-position, 64-character, 300 lpm; includes controller	14,500	110
3137	132-position, 64-character, 600 lpm; includes controller	18,500	150
3139	132-position, 96-character, 165 lpm; includes controller	11,000	95
3140	132-position, 96-character, 200 lpm; includes controller	15,500	120
3142	132-position, 96-character, 430 lpm; includes controller	19,500	160
3166	132-position, 64-character, 1000 lpm; includes controller	30,000	150
3167	132-position, 96-character, 750 lpm; includes controller	31,000	140

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Prime Series 50 Family

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
LINE PRINTERS (Continued)			
As 2nd or 3rd device utilizing first controller:			
3145	132-position, 64-character, 200 lpm	8,000	65
3146	132-position, 64-character, 300 lpm	12,500	85
3147	132-position, 64-character, 600 lpm	16,500	125
3149	132-position, 96-character, 165 lpm	9,000	70
3150	132-position, 96-character, 200 lpm	13,500	95
3157	132-position, 96-character, 430 lpm	17,500	135
3168	132-position, 64-character, 1000 lpm	28,000	125
3172	132-position, 96-character, 750 lpm	29,000	115
PRINTER/PLOTTERS (ELECTROSTATIC)			
3202	11 inches wide, 100 dots per inch, 96-char., simultaneous print/plot, Gothic font	12,500	115
3205	11 inches wide, 200 dots per inch, 96-character set, simultaneous print/plot, Courier font	15,000	130
SERIAL INTERFACE PRINTERS			
3133	132-position, 64-character interface, 140 lpm	7,400	70
3134	132-position, 96-character interface, 125 lpm	7,700	75
CARD READER/PUNCH SUBSYSTEM			
3160	80-column Reader/Punch, 200/45-75 cpm; with controller and cable	22,000	220
TERMINALS			
3101	ASR 33 Teletypewriter; 10 cps	1,500	30
3111	TermiNet 30; 30 cps, 80-column width	2,400	25
3113	TermiNet 30; 30 cps, 132-column width	2,600	28
3221	Teletypewriter-compatible visual display unit (no FORMS capability)	1,250	20
3222	Teletypewriter-compatible visual display unit with 12-key numeric pad (no FORMS capability)	1,325	23
3223	Block-mode visual display unit (includes FORMS capability)	1,700	23
3225	Block-mode visual display unit with 16-function key and line drawing (includes FORMS capability)	1,850	25
I/O CONTROL			
7000	General-purpose I/O interface; contains all logic for programmed I/O, DMA operations, and vectored priority interrupt, and has mounting sockets for user-designed control logic; can support up to four user-designated controllers; 1 board	1,200	12
7010	General-purpose I/O interface; similar to 7000 above but contains more sockets for larger controllers; 1 board	1,500	15
7030	Interprocessor controller for any two Prime computers; 1 board per CPU	Must be quoted	
7031	Interprocessor controller for an additional Prime computer	Must be quoted	
COMMUNICATIONS CONTROL			
5104	Asynchronous multi-line controller (AMLC), high-performance, 16 lines, full data set, RS-232C or CCITT V.24 interface	6,000	35
5152	AMLC, high-performance, 8 lines, limited data set, RS-232C or CCITT V.24 interface	3,500	18
5154	AMLC, high-performance, 16 lines, limited data set, RS-232C or CCITT V.24 interface	4,000	21
5174	AMLC, high-performance, 16 lines, 20-milliamp interface	4,000	21
5175	AMLC, high-performance, 8 lines for 20-milliamp interface; 8 lines for limited data set with RS-232C or CCITT V.24 interface	4,000	21
5602	Multi-line data link controller (MDLC), two lines, RS-232C or CCITT V.24 interface	3,500	26
5604	Additional two-line expansion for 5602	500	6
5622	MDLC, two lines, digital data service interface	3,500	26
5624	Additional two-line expansion for 5622	500	6
5646	IBM Bisync and HDLC/X.25 protocol option for 5602 or 5622	1,500	6
5650	IBM Bisync and UT 200/1004/7020 protocol option for 5602 or 5622	1,500	6
5651	HDLC/X.25 and UT 200/1004/7020 protocol option for 5602 or 5622	1,500	6
7041	PRIMENET Node Controller (PNC)	4,000	25
5402	Multiple autocall interface (MACI) for four Bell 801 or equivalent, uses programmed I/O	2,000	16
5403	MACI for six Bell 801 or equivalent; uses programmed I/O	3,000	21
5404	MACI for eight Bell 801 or equivalent; uses programmed I/O	4,000	28

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Prime Series 50 Family

SOFTWARE PRICES

		Paid-Up License Fee	Monthly Maint.
8540-P	COBOL	$ 5,000	$ 45
8020-P	2780 Remote Terminal Package	1,500	14
8060-P	UT200 Remote Terminal Package	1,500	14
8500-P	PRIMOS Operating System for 550, 650, and 750	5,000	45
8501-P	PRIMOS Operating System for 450, execute only	2,500	23
8502-P	PRIMOS Operating System for 450, development	20,000	180
8530-P	PL/1 Subset G	5,000	45
8532-P	PL/1	12,000	108
8534-P	PL/1 upgrade	7,000	108
8510-P	FORTRAN 77	4,500	41
8515-P	FORTRAN	Included in PRIMOS	
8538-P	Source Level Debugger	1,500	14
8560-P	PRIME/POWER	7,500	75
8562-P	PRIME/POWER+	12,500	125
8120-P	HASP II Remote Terminal Package	2,000	18
8550-P	Data Base Management System (DBMS)	20,000	180
8546-P	RPG II	5,000	45
8548-P	FORMS Management System	5,000	45
8320-P	SPSS (Statistical Package—commercial)	5,000	167
8180-P	RJE/1004	1,500	14
8190-P	RJE/7020	1,500	14
8410-P	DPTX/Data Stream Compatibility	5,000	45
8420-P	DPTX/Terminal Support	6,000	54
8430-P*	DPTX/Transparent Connect	12,000	108
8440-P	PRIMENET	5,000	45
8450-P	X.25 Packet Network Interface	7,000	63

*Transparent Connect includes Data Stream Compatibility and Terminal Support software.

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