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PRODUCT SALES GUIDE

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INTRODUCTION

The announcement of the VAX-11/730 entry-level system and the VAX-11/782 attached processor system once again confirms DIGITAL's commitment to implementing the VAX architecture across a family of products. These new VAX family members, together with the established VAX-11/750 and VAX-11/780 systems, make the power of VAX systems available to an even wider range of users, applications, and budgets.

This edition of the VAX Product Sales Guide contains much of the information you'll need to know about VAX products and services in your selling efforts. For more detailed information on VAX products, refer to the *VAX Handbook Series* and the *VAX Technical Summary*. For specific configuring information concerning VAX products, refer to the *VAX Systems and Options Summary*.

THE VAX-11/730

The newest member of the VAX family, the VAX-11/730, uses state-of-the-art bit slice and Programmed Array Logic (PAL) technology. Like the other VAX family members, the VAX-11/730 implements the full VAX architecture and runs the VAX/VMS operating system and layered software. The VAX-11/730, however, makes VAX functionality available at a much lower price than ever before. The VAX-11/730 is ideally suited to be a powerful, remote DECnet node, allowing its users to access higher-performance members of the VAX family in the network.

THE VAX-11/782 ATTACHED PROCESSOR

The VAX-11/782 Attached Processor System is a performance-oriented extension of the VAX-11/780 that increases the system power by up to 1.8 times in compute-intensive applications. The VAX-11/782 is a tightly coupled asymmetric multiprocessing system. It consists of two VAX-11/780 CPUs, one copy of the operating system, and up to eight Mbytes of MA780 shared memory.

VAX/VMS V3.0 AND THE VAX INFORMATION ARCHITECTURE PRODUCTS

Hardware is only part of the VAX success story. DIGITAL has shown its continuing commitment to the VAX/VMS operating system by introducing Version 3.0 and the VAX Information Architecture products. VAX/VMS Version 3.0 was designed to significantly enhance the previous versions and to broaden the range of supported hardware. With the announcement of Version 3.0, your customers can be assured of compatibility with previous versions, continued high product quality and performance, as well as support for the new VAX-11/730 and VAX-11/782 systems.

DIGITAL'S VAX Information Architecture products were designed to provide your customers with a complete set of software capabilities for handling and managing data on their computer system. This new information management software includes a more powerful DATATRIEVE, a common data dictionary, and file, data, and database management capabilities.

SECTION 1
PRODUCT DESCRIPTION

VAX FAMILY ARCHITECTURE

The VAX family architecture is the basic foundation for the design of a family of compatible computer systems. All processors in the family share this common architecture.

The term architecture generally refers to the conceptual structure and functional behavior of a system as seen by an applications or systems programmer. This is distinct from the organization of the data flow and controls, the logical design, and the physical implementation. Thus, the VAX family architecture defines the consistent functional behavior seen by a programmer on all processors of the family.

The design of a specific member of the VAX family consists of two parts: the family architecture common to all members and the implementation-specific features of each processor.

The numerous advantages a common family architecture provides are obvious: a wide software base allowing multiple implementation of applications, migration, application mobility, and complete VAX family software compatibility through the common VAX/VMS operating system.

From the customer's point of view, VAX constitutes an investment in the future as well as the present. As the VAX family of processors grows, customers are guaranteed trouble-free compatibility and system upgrading. As customer application needs expand, so will their VAX systems, with minimal or no reprogramming required.

Following is a discussion of the architectural features common to all three VAX family processors, the VAX-11/730, the VAX-11/750, and the VAX-11/780. Note that the architectural features of the VAX-11/782 attached processor system are the same as those of the VAX-11/780 processor. For more detailed information, refer to the *VAX Technical Summary* or the *VAX Architecture Handbook*.

The Central Processor

A VAX central processor is a 32-bit computer providing full capabilities for 32-bit virtual addressing. The VAX CPU can directly address more than four gigabytes[1] of virtual memory. A user can directly address up to two gigabytes, providing plenty of room for future customer application expansion.

Virtual Memory Management

All VAX CPUs support state-of-the-art paged virtual memory management, permitting the user to write programs much larger than those which can actually be stored in physical memory. Paging is automatically handled by the operating system, but is controllable by the user who needs to optimize program performance.

Sixteen 32-bit General Purpose Registers

All VAX CPUs have sixteen 32-bit general purpose registers for use by both the operating system and the user.

Thirty-one Interrupt Priority Levels

All VAX CPUs provide 31 interrupt priority levels: 16 for the hardware and 15 for the software.

Compatibility Mode

In addition to its 32-bit native mode instruction set, all VAX CPUs are capable of concurrently executing a subset of the PDP-11 instruction set in compatibility mode.

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1 Gigabyte represents the number 10^9, or 1,000,000,000.

Process Structure/Exceptions & Interrupts
All VAX CPUs have well-defined and identical handling of interrupts and structure/scheduling of processes (programs). The process structure of the VAX architecture allows programmers to develop well-organized, cooperating program segments for interprocess communications.

Realtime and Time-of-Year Clocks
The VAX-11/780 and VAX-11/750 CPUs use two standard clocks: a programmable realtime clock and a time-of-year clock. The VAX-11/730 CPU has a programmable interval timer and a time-of-year clock. The programmable realtime clock and the programmable interval timer are used by the system diagnostics and by the VAX/VMS operating system for accounting and scheduling; the time-of-year clock, which ensures the correct time-of-day and date, is used by the operating system.

VAX Instruction Set
The VAX family architecture is also characterized by a rich and powerful set of 248 different instructions. This does not include the 56 G_ and H_ extended floating-point format instructions, which are standard on the VAX-11/730 and optional on the VAX-11/750, VAX-11/780, and VAX-11/782.

Designed for applications requiring the power and sophistication of a high-performance virtual memory system, the VAX instruction set offers great flexibility in the way operations and data can be specified. Many computation operations can be applied to more than one type of data, addressable by any of the thirteen addressing modes.

The VAX native-mode instruction set is the logical extension of the PDP-11 instruction set which shares the PDP-11's ease of programming characteristics. The similarity between the VAX and the PDP-11 enables straightforward manual conversion of existing PDP-11 assembly language programs to VAX. Most existing user mode PDP-11 programs, which do not need the extended features of VAX, can run unchanged in the PDP-11 compatibility mode provided on VAX processors.

Programmers who are already familiar with the PDP-11 instruction set will find not only the VAX instruction formats similar, but also the data formats and the use of addressing modes, general purpose registers, and stacks. Thus, conversion to VAX systems from PDP-11 systems requires only a minimal amount of programmer retraining. Programmers who are not familiar with the PDP-11 programming style will find that the consistency and power of the VAX instruction set allows them to produce efficient, executable code very quickly.

The VAX native-mode instruction set was specifically designed for easy, efficient implementation of high-level languages. Because the instruction set is so flexible, fewer instructions are required to perform any given function. The result is more compact, efficient, and faster executing programs, faster context switching, faster and more precise computation, and improved compiler-generated code.

VAX instructions and data are variable-length. They need not be aligned on longword boundaries in physical memory, but can begin at any byte address. Thus, instructions that do not require arguments use only one byte, while other instructions may take two, three, or up to 54 bytes depending on the number of operands and their addressing modes. The advantage of byte alignment is that instruction streams and data structures can be stored in much less physical memory.

Features of the VAX instruction set include:

- Complete arithmetic support (add, subtract, multiply, divide, compare, negate, etc.) for different data types: byte, word, longword, packed-decimal, F_floating, D_floating, G_floating and H_floating
- Thirteen different addressing modes for every operand of every instruction
- Optimized instructions for high-level languages and operating system functions, such as computed GO TO statements, loop control, queue manipulation, context switching, etc.
- Bit-field data type for general applications
- 8-, 16- and 32-bit integer arithmetic
- Character-string manipulation

Instructions can be grouped into related classes based on their function and use:

- Instructions to manipulate arithmetic and logical data types—including integer and floating-point instructions, packed-decimal instructions, character-string instructions, and bit-field instructions.
- Instructions to manipulate special kinds of data. These include queue manipulation instructions, that is, those that insert and remove queue entries, address manipulation instructions, and general register load and save instructions. These instructions are used extensively by the VAX/VMS operating system.
- Instructions to provide basic program flow control. These include branch, jump, and case instructions, subroutine call instructions, and procedure call instructions.
- Instructions to perform special operating-system functions quickly. These include process-control instructions, such as two special context-switching instructions which allow process context variables to be loaded and saved, using only one instruction for each operation, and the Find First instruction that, among other uses, allows the operating system to locate the highest-priority executable process. These instructions contribute to rapid and efficient rescheduling.
- Instructions provided specifically for high-level language constructs. The VAX architecture was specifically designed to implement frequently used, high-level language constructs as single VAX instructions. These instructions contribute to decreased program size and increased execution speed.

Each VAX processor offers 13 addressing modes that use the general registers to identify the operand location. By combining modes, the programmer can achieve even more addressing flexibility. The 13 addressing modes of the VAX instruction set are as follows: register, register-deferred, autoincrement, autoincrement-deferred, autodecrement byte, word, and longword, displacement-byte, word, and longword, displacement-deferred, indexed and literal. For more detailed information on the VAX instruction set, refer to the *VAX Architecture Handbook.*

What is not included in the VAX architecture?

The term VAX architecture does not specify the widths, the bandwidths, the electrical specifications of the buses used to interconnect hardware subsystems, the size or even the presence of cache memory, the width and structure of the control store, the presence of specific maintenance registers, etc. For example, the SBI of the VAX-11/780 is not a part of the VAX architecture since the architecture only requires the processor to be able to access bytes in the physical address space. Implementation-dependent differences between VAX family processors do not affect the transportability of application code. However, they do affect total system performance.

Implementation Similarities

All VAX family processors share the basic foundation of the VAX family architecture. They also share some implementation-specific features which should not be confused with the architecture. The following list summarizes the true implementation-specific differences between the VAX family processors.

The Internal Memory Interconnect

VAX-11/730 — The VAX-11/730 memory system has 24 bits for physical address and allows 32-bit data transfers.

VAX-11/750 — The VAX-11/750 memory system has a maximum throughput rate of 5 Mbytes per second. The memory system has 24 bits for physical address and allows 32-bit data transfers.

VAX-11/780 — The VAX-11/780 memory system has a maximum throughput rate of 13.3 Mbytes per second with two memory controllers. The memory subsystem has 30 bits for physical addresses and allows 32-bit and 64-bit data transfers.

The Console Subsystem

Most of the traditional lights and switches found on other machines have been replaced by standard keyboard commands on the VAX console terminal. There are, however, a few lights and switches to indicate and handle overall system status and start-up procedures.

For customers with the appropriate, optional Field Service agreements, Remote Diagnosis/Remote Support is available.

VAX-11/730 — The VAX-11/730 microprocessor-driven console subsystem consists of redundant TU58 cartridge tape drives, a DECwriter hardcopy terminal and its serial line interface, and front panel.

VAX-11/750 — The VAX-11/750 console subsystem consists of an integral TU58 tape cartridge drive, a DECwriter hardcopy terminal and its serial line interface, and front panel.

VAX-11/780/ VAX-11/782 — The VAX-11/780 and the two VAX-11/782 console subsystems consist of an LSI-11 microprocessor with 16 Kbytes of RAM memory and eight Kbytes of ROM, a RX01 floppy disk drive and controller, a hardcopy DECwriter terminal and its serial line interface, an optional serial line interface for Remote Diagnosis (RD), and front panel.

The Main Memory Subsystem

VAX-11/730 — The VAX-11/730 ECC MOS memory is connected to the system via a single memory controller. Memory is organized in 39-bit words (32 bits for data and seven bits for ECC).

The minimum memory available with VAX-11/730 packaged systems is one Mbyte using 64 Kbit chips. Memory can be added in one-Mbyte increments for a system total of up to five Mbytes.

VAX-11/750

The VAX-11/750 ECC MOS memory is connected to the system via a single memory controller. Memory is organized in 39-bit words (32 bits for data and seven bits for ECC).

The minimum memory available with VAX-11/750 packaged systems is one Mbyte using 16 Kbit chips and three Mbytes using 64 Kbit chips. A system total of up to two Mbytes using 16 Kbit chips and eight Mbytes using 64 Kbit chips is supported.

VAX-11/780

The VAX-11/780 ECC MOS memory is connected to the system via a single memory controller. Memory is organized in 72-bit words (64 bits for data and eight for ECC).

The minimum memory available with VAX-11/780 packaged systems is one Mbyte using 16 Kbit chips. Memory may be added in 256-Kbyte increments for a total of four Mbytes per controller. Each VAX-11/780 can support up to two controllers for a system total of eight Mbytes of memory. An additional four Mbytes of memory can be configured using two MA780 multiport memory options (two Mbytes each).

VAX-11/782

The VAX-11/782 ECC MOS memory is connected to the two processors via the MA780 shared memory subsystem. Each MA780 shared memory subsystem can support up to two Mbytes of 16 Kbit chip ECC MOS memory. Up to four MA780 subsystems can be configured on a VAX-11/782 attached processor system for a total of eight Mbytes of shared memory. Local memory connected to each processor is used for diagnostic and system startup; it is not used by VAX/VMS.

User Control Store

VAX-11/730

The VAX-11/730 has no User Control Store.

VAX-11/750

The VAX-11/750 User Control Store option provides the user with 1 Kword of UCS. Each UCS word is 80 bits wide.

VAX-11/780

The VAX-11/780 User Control Store option provides the user with 2 Kwords of UCS. Each UCS word is 99 bits wide.

Cache

VAX-11/730

The VAX-11/730 has no memory cache.

VAX-11/750

The VAX-11/750 includes a four-Kbyte direct-mapped, writethrough memory cache with an effective 400 nanosecond memory access time.

VAX-11/780

The VAX-11/780 includes an eight-Kbyte two-way set associative, write through memory cache with an effective 280 nanosecond memory access time.

VAX-11/782

The VAX-11/782 includes two eight-Kbyte two-way set associative, write-through memory caches with an effective 280 nanosecond memory access time.

Input/Output Subsystem

DIGITAL's two generalpurpose standard I/O adapters, the UNIBUS and the MASSBUS, have been implemented in the VAX-11/750 and VAX-11/780 processors. The VAX-11/730 has a UNIBUS but no MASSBUS.

- The UNIBUS permits the interfacing of generalpurpose DIGITAL-supported and customer-developed peripherals. A UNIBUS adapter (UBA) provides the hardware pathways for data and control information to move between the UNIBUS and the system.
- The MASSBUS permits the interfacing of high-performance DIGITAL mass storage peripherals. MASSBUS adapters (MBAs) provide the hardware pathways for data and control information to move between a MASSBUS and the system, allowing high-speed data transfers. Parity is checked and generated for control and data transfers on the MASSBUS.

VAX-11/730

The VAX-11/730 includes one UNIBUS adapter for interfacing general purpose, DIGITAL-supported, and user-developed peripherals. The maximum aggregate throughput rate on the VAX-11/730 UNIBUS is 1.5 Mbytes per second.

VAX-11/750

The VAX-11/750 includes one UNIBUS adapter for interfacing general purpose, DIGITAL-supported, and user-developed peripherals as well as one additional UBA for a total of two. The maximum aggregate throughput rate on the VAX-11/750 UNIBUS is 1.5 Mbytes per second.

Each VAX-11/750 is capable of supporting a total of three MBAs. The peak throughput rate is two Mbytes per second per MBA, with the total throughput limited by the maximum memory bandwidth of five Mbytes per second. Systems with I/O rates approaching this bandwidth will need special configuration analysis.

VAX-11/780/ VAX-11/782

The VAX-11/780/VAX-11/782 includes one UNIBUS adapter for interfacing generalpurpose, DIGITAL-supported, and user-developed peripherals as well as three additional UBAs for a total of four. The maximum aggregate throughput rate on each VAX-11/780/VAX-11/782 UNIBUS is 1.35 Mbytes per second.

Each VAX-11/780/VAX-11/782 system is capable of supporting a total of four MBAs. The peak throughput rate is 1.3 Mbytes per second per MBA and up to two Mbytes per second with interleaved memory.

Please note that not all of the above items can operate simultaneously.

Refer to the *VAX Systems and Options Summary* for detailed configuring information.

VAX FAMILY SYSTEM DESCRIPTIONS

This section on VAX family system descriptions is divided into five categories: the VAX-11/730 Product Description, the VAX-11/750 Product Description, the VAX-11/780 Product Description, the VAX-11/782 Product Description, and the VAX/VMS Software System description. Please refer to the *VAX Family Technical Summary*, the *VAX Handbook Set*, and the User Documentation series for more detailed information.

THE VAX-11/730 PRODUCT DESCRIPTION

The VAX-11/730 computer system consists of the central processing unit, the console subsystem, the main memory subsystem, and the I/O subsystem.

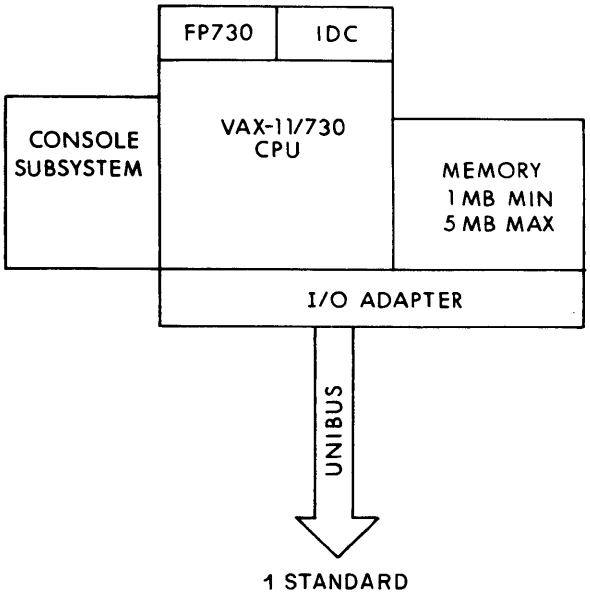

Figure 1-1 VAX-11/730 System Block Diagram

The VAX-11/730 Central Processing Unit

The VAX-11/730 central processor is a high-speed, microprogrammed 32-bit computer that is completely software-compatible with all other VAX family processors. It implements the full VAX architecture including four gigabyte virtual address space, memory management, interrupt structure and exception handling, as well as the complete and powerful VAX instruction set. This means that any program will run completely unmodified on all four of the VAX family systems.

Most of the VAX-11/730 CPU logic is implemented in state-of-the-art Programmed Array Logic (PAL) technology. PALs are "programmed" by DIGITAL to do specific functions in the VAX-11/730, much as a ROM is programmed. Less expensive to develop and less flexible than the gate array, PAL technology saves up to 75 percent in parts over conventional Schottky TTL logic, reduces program development time and, consequently, reduces product cost. Among the benefits gained by the use of PAL technology are design flexibility, compactness, high speed, and programming ease and efficiency.

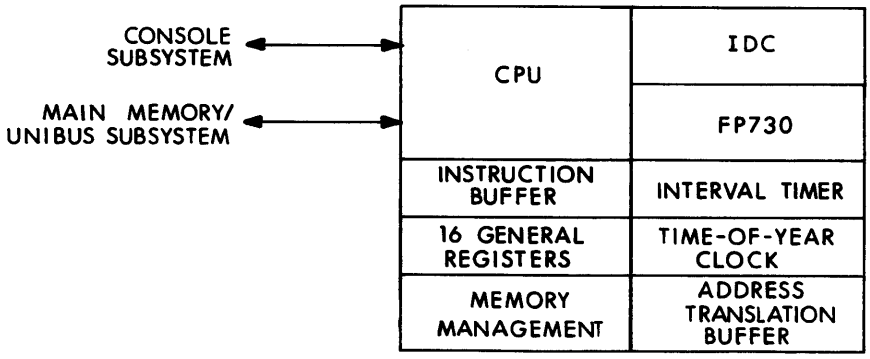

Figure 1-2 VAX-11/730 Central Processor

The Console Subsystem

The VAX-11/730 microprocessor-driven console subsystem consists of dual TU58 cartridge tape drives, a DECwriter hardcopy terminal and its serial line interface, and front panel.

The console subsystem serves as a VAX/VMS operating-system terminal, the system console, and a diagnostic console with optional remote support. As a VAX/VMS terminal, it is used by authorized system users for normal system operations. As the system console, it is used for operational control, e.g., bootstrapping, initialization, and software updates. As a diagnostic console with the remote support option, the console subsystem is used for both remote and local diagnosis and system maintenance activities.

The VAX-11/730 console subsystem uses dual integral TU58 (256-Kbyte each) cartridge tape drives. The TU58 provides an inexpensive, reliable device and medium for loading the microcode, bootstrapping the VAX/VMS operating system, loading diagnostics, distributing software updates, and conveniently storing data on cartridge.

Because the TU58 tape unit is standard on all VAX-11/730 systems, software updates are easily distributed by tape cartridge. Simple commands typed at the console terminal automatically update the system software with the new corrections distributed on the cartridge.

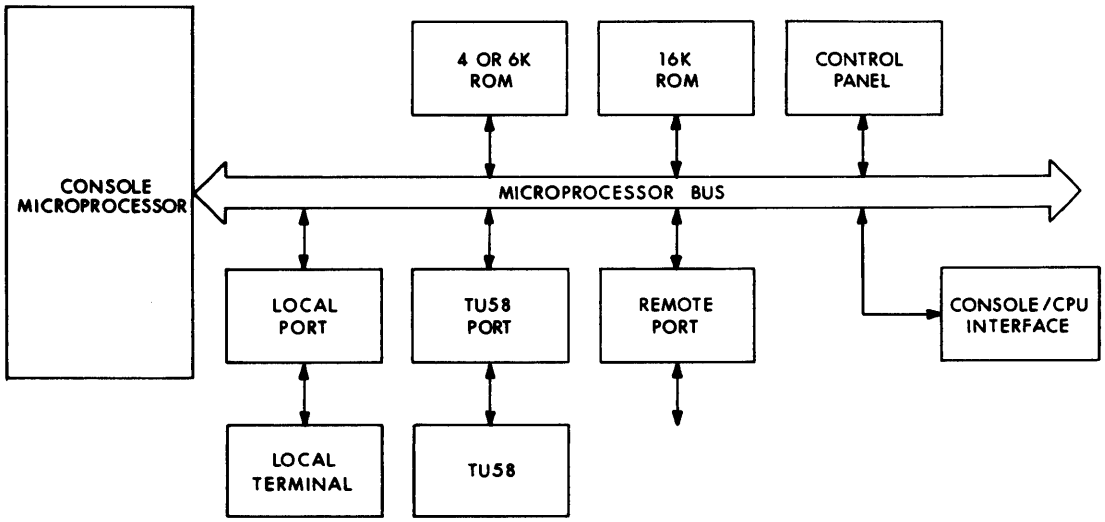

Figure 1-3 VAX-11/730 Console Subsystem

The Memory Subsystem

The main memory subsystem consists of between one and five Mbytes of ECC MOS memory, connected to the system via the memory controller. Memory can be added in increments of one-Mbyte up to a maximum of five Mbytes (using 64 Kbit chips). The benefits of ECC MOS memory include lower power requirements, greater packaging densities, greater performance,

higher reliability, lower selling price, and reduced maintenance costs when compared to less dense MOS or core memories.

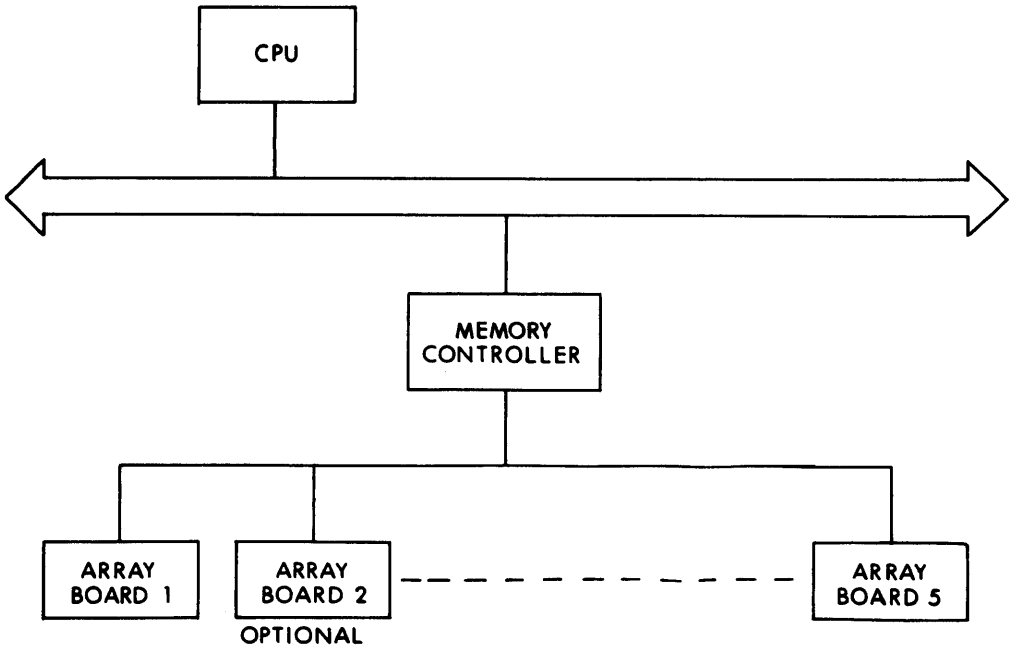

Figure 1-4 VAX-11/730 Memory Subsystem

The VAX-11/730 physical memory is organized in 32-bit longwords plus a seven-bit ECC (Error Correcting Code). ECC permits write operations to any combination of bytes within an aligned longword and enhances availability and reliability by correcting all single-bit errors and detecting all double-bit errors within the memory system. This provides a tenfold improvement in Mean Time Between Failure (MTBF) over non-ECC MOS memory.

The Input/Output Subsystem

The VAX-11/730's I/O subsystem consists of the UNIBUS, connected to the system by a special interface called an adapter. Each VAX-11/730 system has one integral UNIBUS adapter.

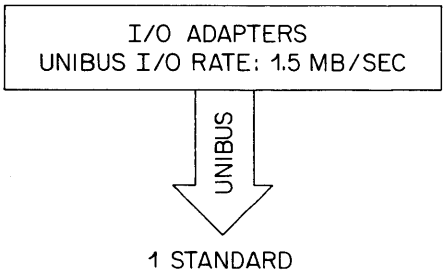

Figure 1-5 VAX-11/730 I/O Subsystem

The UNIBUS

Generalpurpose, DIGITAL-supported, and customer-developed devices are connected to the system via the VAX-11/730's integral UNIBUS. Since the memory subsystem deals in 24-bit addresses, 18-bit UNIBUS addresses must be translated into 24-bit addresses. This mapping function is performed by the UNIBUS adapter (UBA).

The UBA handles priority arbitration among devices on the UNIBUS. The UBA allows two types of data transfers: program interrupt and DMA (direct memory access). The maximum aggregate DMA throughput rate of the UNIBUS is 1.5 Mbyte per second.

Refer to the *Systems and Options Summary* for detailed configuration information and VAX family supported UNIBUS options and peripherals.

RAMP Features of the VAX-11/730

Extensive reliability, availability, and maintainability features were designed into the VAX-11/730. Many of these RAMP features are found in all VAX family members and are treated in detail in Section 2 of this Sales Guide, Reliability, Maintainability, and Availability, as well as in the *VAX Hardware Handbook*. RAMP features specific to the VAX-11/730 include a dual TU58 subsystem for microcode load backup, parity on soft control store RAMs, and microverify routines (bootstrapping self-diagnosis). The VAX-11/730 executes microverify routines automatically on a powerup sequence, when the VAX system is bootstrapped, or when the console front panel BOOT switch is pressed. These routines test the internal CPU data paths. Successful execution of the microverify routines indicates that the system should bootstrap predictably.

The new RAMP feature, Customer-Runnable Diagnostics (CRDs) via the TU58 and RL02 on the VAX-11/730, allows the system user to easily verify the proper operation of the hardware and to quickly isolate system failures to the subsystem or device level. Error information from the CRD session is then forwarded to the appropriate field service office, and a specialist with the proper spare parts and tools for the specific failure is dispatched to the customer's site. Thus, through the use of CRDs, most failures are corrected with a single service visit.

The VAX-11/730, like all other VAX family systems, can be diagnosed remotely. This capability is called Remote Support. The Remote Support option speeds repairs by enabling Field Service engineers to access additional technical resources from the customer's location.

Both Customer-Runnable Diagnostics and the Remote Support option are available to service contract customers.

OPTIONAL HARDWARE EQUIPMENT

Prewired and prepowered mounting space is available within the VAX-11/730 CPU chassis for mounting the following optional equipment: FP730 floating-point accelerator, DMF32 multifunction interface, and add-on memory. For detailed configuration information, refer to the *Systems and Options Summary*.

THE VAX-11/750 PRODUCT DESCRIPTION

The VAX-11/750 computer system consists of the central processing unit, the console subsystem, the main memory subsystem, and the I/O subsystem.

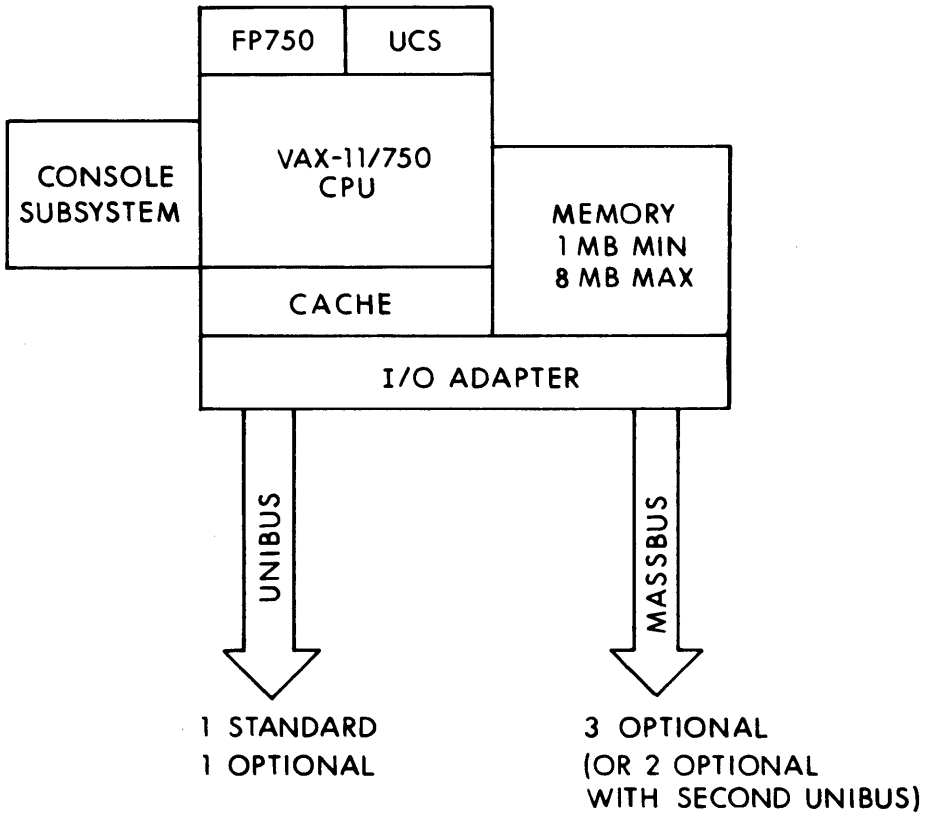

Figure 1-6 VAX-11/750 System Block Diagram

The VAX-11/750 Central Processing Unit

The VAX-11/750 central processor is a high-speed, microprogrammed 32-bit computer that is completely software-compatible with all other VAX family processors. It implements the full VAX architecture including four gigabyte virtual address space, memory management, interrupt structure and exception handling, as well as the complete and powerful VAX instruction set. The VAX-11/750 includes a four-Kbyte cache.

Most of the VAX-11/750 CPU logic is implemented in custom LSI (Large Scale Integrated) gate arrays designed by DIGITAL. Gate-array technology is a sophisticated process of manufacturing prefabricated chips with several hundred logic-circuit elements, called gates, which are

then interconnected in a custom pattern. For more detailed information on gate array-technology, refer to the appendix at the back of this Sales Guide, Logic Implementation on VAX Processors.

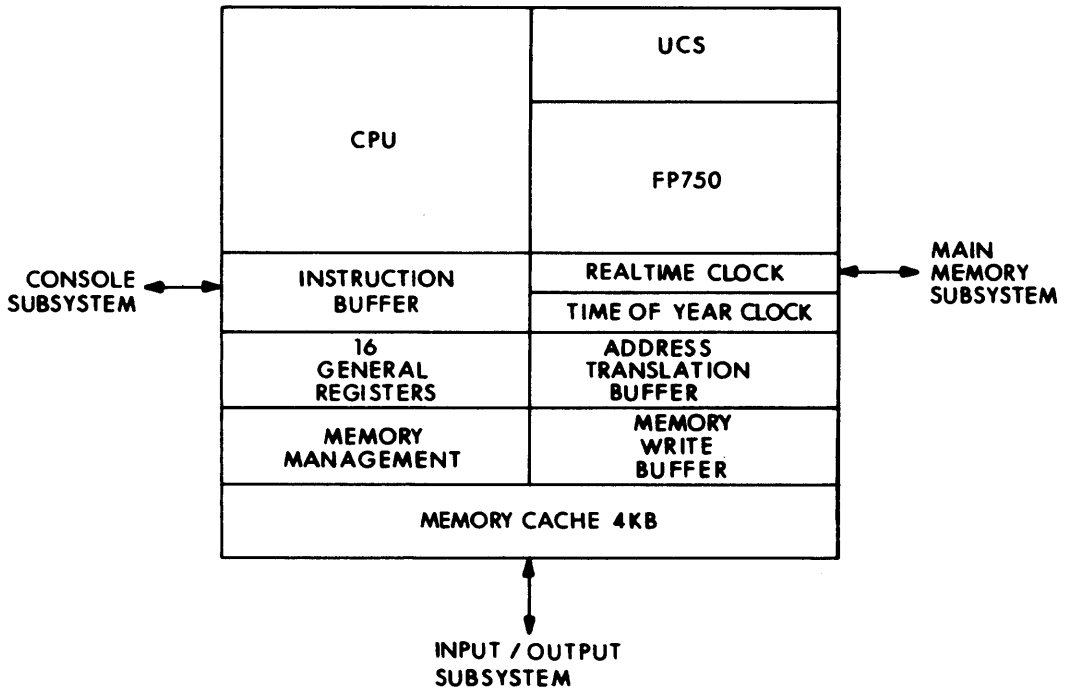

Figure 1-7 VAX-11/750 Central Processor

Caches

The VAX-11/750 CPU actually provides three cache systems: the memory cache, an address translation buffer, and an instruction buffer.

- **Memory Cache** The VAX-11/750 memory cache is the primary cache system for all data coming from memory, including addresses, address translations, and instructions. The memory cache is a four-Kbyte, direct-mapped, writethrough cache.

  Writethrough provides reliability because the contents of main memory are updated immediately after the processor performs a WRITE operation. Most writethrough cache systems tie up the processor while main memory is updated. However, this processor buffers its commands to avoid waiting while main memory is updated from the cache. Therefore, while providing the reliability of a writethrough cache, this system also provides much the same performance as a writeback cache.

  The memory cache also reduces the average time the processor waits to receive main memory data by reading eight bytes at a time from main memory and transferring four bytes to the CPU data paths, or instruction buffer. Since the remaining four bytes are already available, the memory cache also provides prefetching. The cache memory system increases integrity by carrying byte parity for both data and addresses for increased integrity. Cache locations are allocated when data is read from memory. When both of the possible locations for a particular datum are already filled, one of the previously cached data is randomly replaced.

The memory cache stores four Kbytes and is implemented as a direct-mapped, writethrough cache. This cache also watches I/O transfers and updates itself appropriately. Thus, no operating system intervention is needed to synchronize the cache with I/O operations; that is, the cache is totally transparent to all software.

- **Instruction Buffer** The instruction buffer consists of an 8-byte buffer that enables the CPU to fetch and decode the next instruction while the current instruction completes execution. The instruction buffer, in combination with the parallel data paths (which can concurrently perform integer arithmetic, shifting, and floating-point with the optional FPA installed operations), significantly enhances the VAX-11/750's performance.
- **Translation Buffer** The VAX-11/750 provides an address translation buffer that eliminates extra memory accesses the majority of the time during virtual-to-physical address translations. The address translation buffer contains 512 virtual-to-physical address translations which are likely to be used. There is parity checking on all entries.

The Console Subsystem

The VAX-11/750 console subsystem consists of an integral TU58 tape cartridge drive, a DECwriter hardcopy terminal and its serial line interface, and front panel.

The console subsystem serves as a VAX/VMS operating system terminal, the system console, and a diagnostic console with optional remote diagnosis. As a VAX/VMS terminal, it is used by authorized system users for normal system operations. As the system console, it is used for operational control, e.g., bootstrapping, initialization, software updates. As a diagnostic console with the remote diagnosis option, the console subsystem is used for both remote and local diagnosis and system maintenance activities.

The VAX-11/750 console subsystem uses one integral TU58 (256-Kbyte) cartridge tape drive. The TU58 provides an inexpensive, reliable device and medium for loading diagnostics, for distributing software updates, and conveniently storing data on cartridge. Note that the TU58 on VAX-11/750 systems is not used to bootstrap the microcode and the VAX/VMS operating system as on VAX-11/730 systems.

Because the TU58 tape unit is standard on all VAX-11/750 systems, software updates are easily distributed on tape cartridge. Simple commands typed at the console terminal automatically update the system software with the new corrections distributed on the cartridge.

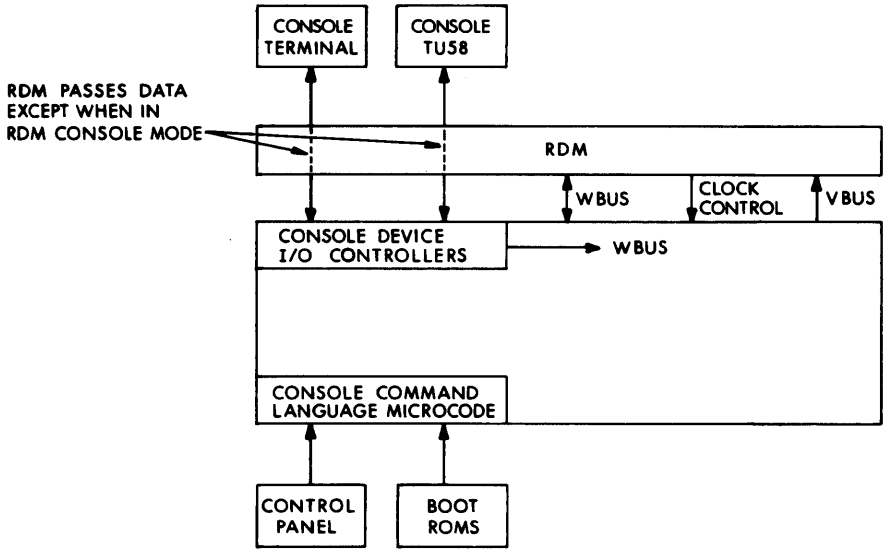

Figure 1-8 VAX-11/750 Console Subsystem

The Memory Subsystem

The main memory subsystem consists of between one and eight Mbytes of ECC MOS memory, connected to the system via the memory controller. Up to a maximum of two Mbytes of memory using 16 Kbit chips and eight Mbytes using 64 Kbit chips is supported. The benefits of ECC MOS memory include lower power requirements, greater packaging densities, greater performance, higher reliability, lower selling price, and reduced maintenance costs when compared to less dense MOS or core memories.

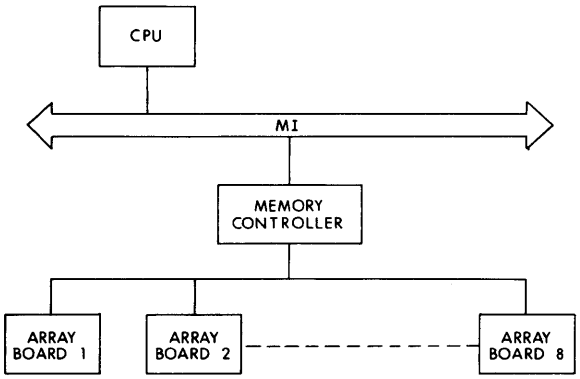

Figure 1-9 VAX-11/750 Memory Subsystem

The VAX-11/750 physical memory is organized in 32-bit longwords plus a seven-bit ECC (Error Correcting Code). ECC permits write operations to any combination of bytes within an aligned longword and enhances availability and reliability by correcting all single-bit errors and detecting all double-bit errors within the memory system. This provides a tenfold improvement in Mean Time Between Failure (MTBF) over non-ECC MOS memory.

In the case of a temporary power failure, the contents of MOS memory can be protected by an optional battery backup. Each battery backup option preserves the data integrity of two Mbytes of 16 Kbit chip memory or eight Mbytes of 64 Kbit chip memory for a maximum of ten minutes. In addition, a customer-supplied battery may be used in conjunction with the DIGITAL option to prolong backup time.

The Input/Output Subsystems

The VAX-11/750's I/O subsystem consists of the UNIBUS and the MASSBUS connected to the system through special buffered interfaces called adapters. Each VAX-11/750 system can support up to two UNIBUS adapters and up to three MASSBUS adapters. This allows customers a great degree of flexibility in balancing I/O across the system for improved performance.

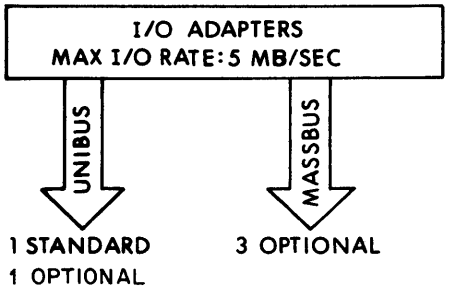

Figure 1-10 VAX-11/750 I/O Subsystem

The UNIBUS

Generalpurpose, DIGITAL-supported devices, and customer-developed devices are connected to the system via VAX-11/750's integral UNIBUS. Since the memory system deals in 24-bit addresses, 18-bit UNIBUS addresses must be translated to 24-bit addresses. This mapping function is performed by the UNIBUS adapter (UBA).

The VAX-11/750 UNIBUS has a number of different attributes, such as direct-vectored interrupts and higher bandwidth, which allow it, when performing some realtime applications, a higher throughput rate than the VAX-11/780 UNIBUS. For more specific details, refer to the UNIBUS chapter in the *VAX Hardware Handbook*.

The UBA handles priority arbitration among devices on the UNIBUS. The UBA allows three types of data transfers: program interrupt, buffered DMA (direct memory access), and unbuffered DMA. Concurrent program interrupt, unbuffered DMA, and buffered DMA data transfers are permitted. The maximum aggregate throughput rate of the UNIBUS, regardless of the type of data transfer, is 1.5 Mbytes per second.

On memory-to-UNIBUS transfers, the UBA anticipates UNIBUS requests by prefetching the next 32-bit longword from memory as the last 16-bit word is transferred. The result is increased performance.

To make the most efficient use of the VAX-11/750 memory bandwidth, the UBA provides three buffered DMA data paths for high-speed devices. Any number of unbuffered DMA transfers is handled by one direct DMA data path.

Refer to the *Systems and Options Summary* for detailed configuration information and VAX family supported UNIBUS options and peripherals.

The MASSBUS(es)

High-performance mass storage devices are connected to the VAX-11/750 system via MASSBUS adapter (MBA). These devices include the RM80, RM03, RM05, RP06, and RP07 (without the RP07-D option) disk drives and the TE16, TU77, and TU78 tape transports. The MBA is the interface between the MASSBUS and the memory system, and performs all control, arbitration, and buffering functions. Each VAX-11/750 can support a total of three MBAs.

Each MBA uses a 32-byte silo data buffer for input and output, permitting a two-Mbyte-per-second sustained transfer rate per MBA to and from physical memory. Data is assembled in 32-bit longwords to make efficient use of the VAX-11/750 memory bandwidth. The MBA attempts to keep the 32-byte MBA silo empty on input transfers from the MASSBUS to main memory and full on output transfers from main memory to the MASSBUS.

Refer to the *Systems and Options Summary* for detailed configuration information and VAX family supported MASSBUS options and peripherals.

RAMP Features of the VAX-11/750

Extensive reliability, availability, and maintainability features were designed into the VAX-11/750. Many of these RAMP features apply to all VAX family members and are treated in detail in Section 2 of this Sales Guide, Reliability, Maintainability, and Availability, as well as in the *VAX Hardware Handbook*. One RAMP feature specific to the VAX-11/750 is the microverify routines (bootstrapping self-diagnosis). The VAX-11/750 executes microverify routines automatically on a powerup sequence when the VAX system is bootstrapped or when the console front panel RESET switch is pressed. These routines test the internal CPU data paths, the 16 generalpurpose registers, most internal CPU registers, the instruction prefetch buffer, the parity logic of the cache, the translation buffer, and all of the cache memory. Successful execution of the microverify routines indicates that the system should bootstrap predictably.

OPTIONAL HARDWARE EQUIPMENT

Prewired and prepowered mounting space is available within the VAX-11/750 CPU chassis for mounting the following optional equipment: the FP750 floating-point accelerator, the DW750 UNIBUS adapter, add-on memory (both 16K and 64K bit chip), battery backup, and the KU750 user control store with G_ and H_ extended floating point microcode. For detailed configuration information, refer to the *Systems and Options Summary*.

VAX-11/780 PRODUCT DESCRIPTION

The VAX-11/780 computer system consists of the central processor, the console subsystem, the main memory subsystem, and the I/O subsystem. The VAX-11/780 CPU is a high-speed, microprogrammed 32-bit processor that is completely software-compatible with all other VAX family members. It implements the full VAX architecture including four gigabyte virtual address space, memory management, interrupt structure and exception handling, as well as the complete and powerful VAX instruction set. The VAX-11/780 includes an eight-byte cache and an LSI-11 console subsystem.

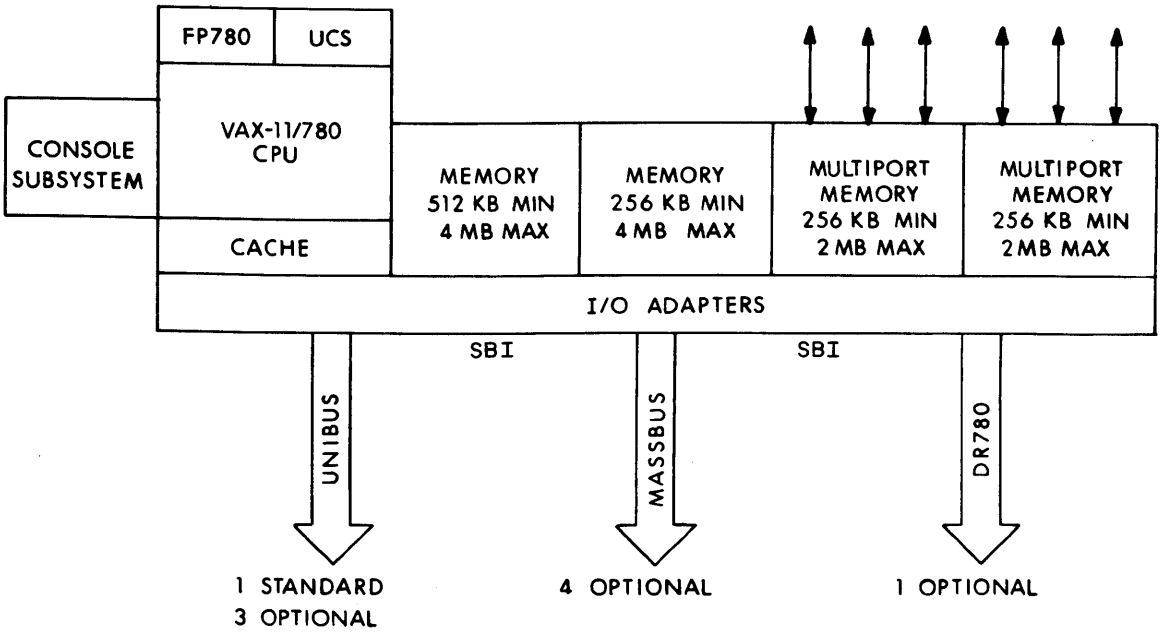

Figure 1-11 VAX-11/780 System Block Diagram

The I/O subsystem includes the Synchronous Backplane Interconnect (SBI)—an internal connection path that links the CPU with all three subsystems. The SBI uses only one clock, which increases reliability by allowing all transactions in the system to be synchronized.

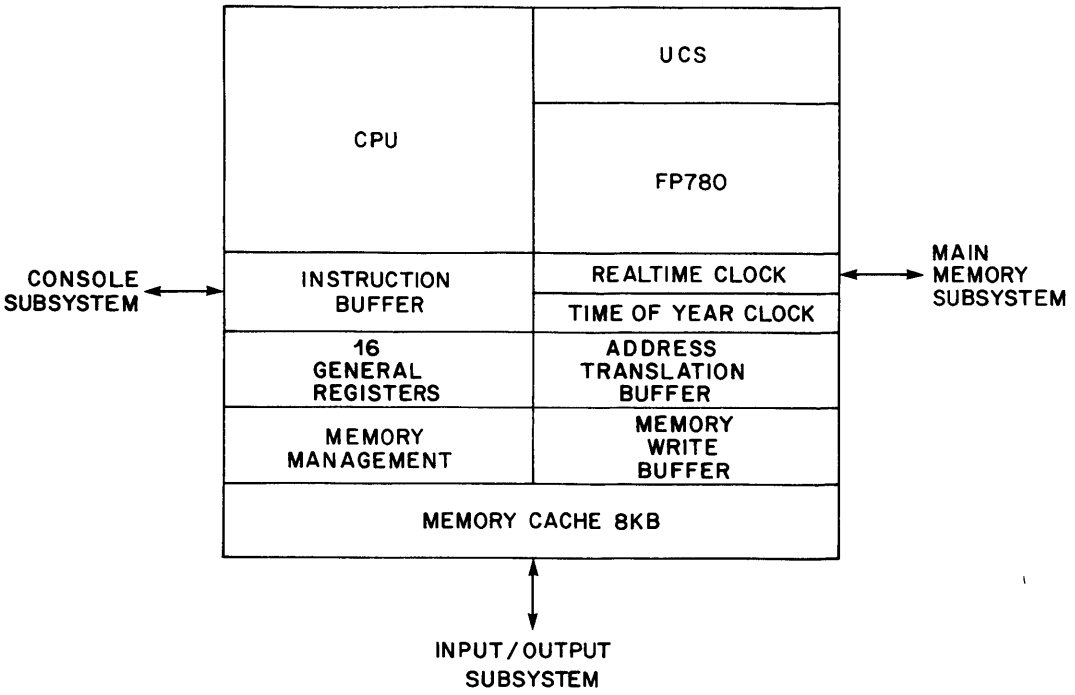

Figure 1-12 VAX-11/780 Central Processor

Caches

The VAX-11/780 CPU actually provides three cache systems: the memory cache, an address translation buffer, and an instruction buffer.

- **Memory Cache** The VAX-11/780 memory cache is the primary cache system for all data coming from memory, including addresses, address translations, and instructions. The memory cache is an eight-Kbyte, two-way set associative, writethrough cache.

  Writethrough provides reliability because the contents of main memory are updated immediately after the processor performs a WRITE operation. Most writethrough cache systems tie up the processor while main memory is updated. However, this processor buffers its commands to avoid waiting while main memory is updated from the cache. Therefore, while providing the reliability of a writethrough cache, this system also provides much the same performance as a writeback cache.

  The memory cache also reduces the average time the processor waits to receive main memory data by reading eight bytes at a time from main memory, and transferring four bytes to the CPU data paths, or instruction buffer. Since the remaining four bytes are already available, the memory cache also provides prefetching. The cache memory system increases integrity by carrying byte parity for both data and addresses. Cache locations are allocated when data is read from memory. When both of the possible locations for a particular datum are already filled, one of the previously cached data is randomly replaced.

- **Instruction Buffer** The instruction buffer consists of an 8-byte buffer that enables the CPU to fetch and decode the next instruction while the current instruction completes execution. The instruction buffer, in combination with the parallel data paths (which can concurrently perform integer arithmetic, shifting, and floating-point with the optional FPA installed operations), significantly enhances the VAX-11/780's performance.
- **Translation Buffer** The VAX-11/780 also provides an address translation buffer that eliminates extra memory accesses the majority of the time during virtual-to-physical address translations. The address translation buffer contains 128 virtual-to-physical address translations which are likely to be used. There is parity checking on all entries.

Standard Bipolar and Schottky TTL Logic

The VAX-11/780 CPU uses the proven bipolar and Schottky TTL logic technology, which combines fast switching speed with moderate power consumption. Emitter-coupled logic circuits, custom LSI circuits, and extensive use of pipelining design techniques have been used to optimize system performance and reliability.

Writable Diagnostic Control Store (WDCS)

Each VAX-11/780 processor has two Kwords (99 bits wide) of Writable Diagnostic Control Store (WDCS) for use by DIGITAL. WDCS is used by DIGITAL's diagnostics to verify system reliability as well as to implement part of the instruction set. In addition, the WDCS can be used to implement updates to the VAX-11/780's microcode. In this way, DIGITAL can keep customers up-to-date with corrections.

The Console Subsystem

The VAX-11/780 console subsystem consists of an LSI-11 microprocessor with 16 Kbytes of RAM memory and eight Kbytes of ROM, a RX01 floppy disk drive and controller, a hardcopy DECwriter terminal and its serial line interface, an optional serial line interface for Remote Diagnosis (RD), and front panel.

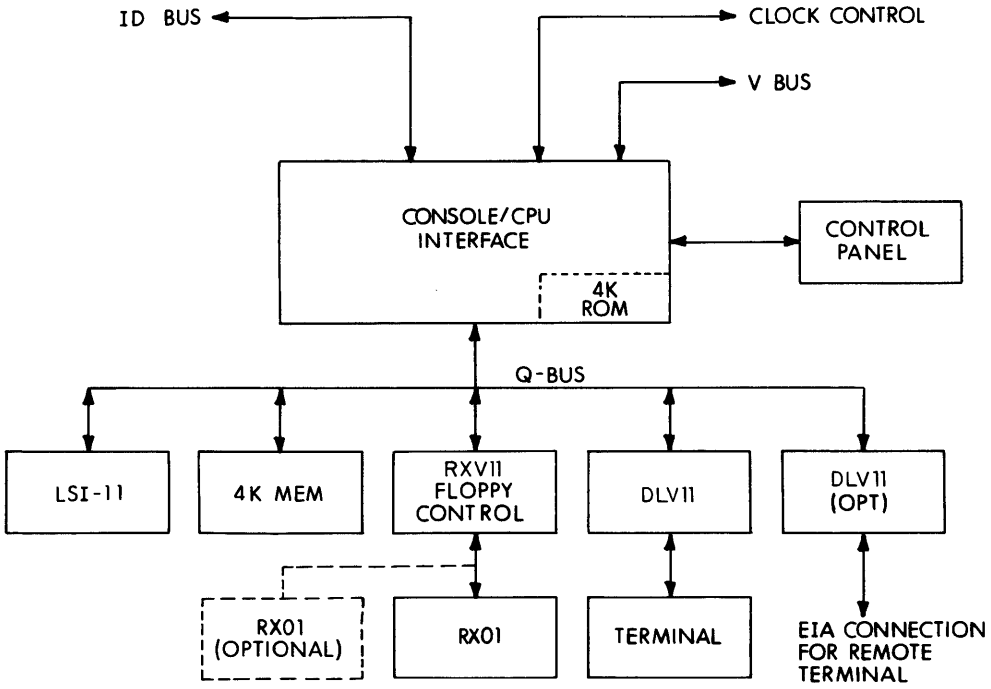

Figure 1-13 VAX-11/780 Console Subsystem

The console subsystem serves as a VAX/VMS operating system terminal, the system console, and as a diagnostic console. As a VAX/VMS terminal, it is used by authorized system users for normal system operations. As the system console, it is used for operational control, e.g., loading, bootstrapping, initialization, and software updates. Because the floppy drive is standard on all VAX-11/780 systems, software updates are distributed via floppy disk. Simple commands typed at the console terminal automatically update the system software with the new corrections.

As a diagnostic console with the remote diagnosis option, the console subsystem is used for both remote and local diagnosis and system maintenance activities. The LSI-11 console terminal performs a selftest on powerup. If it is inoperative, another terminal can be substituted. However, if the microcomputer and the floppy disk are inoperative, the reliability of the system is seriously impaired. The Field Service policy is to replace these units if they are not functioning.

A watchdog timer in the LSI-11 console terminal detects hung machine conditions (such as a hang in the microcode or a halt condition). Indicator lights on the front panel show whether the VAX-11/780 CPU is running or in a halt state. If the auto/restart switch on the processor console is set, automatic crash/restart recovery actions are initiated after either a hang condition or a halt.

The Memory Subsystem

The main memory subsystem consists of between two and eight Mbytes of ECC MOS memory, connected to the system via the memory controller. Memory can be added in increments of 256 Kbytes up to a maximum of four Mbytes per controller. Each VAX-11/780 system supports up to two memory controllers, for a total of eight Mbytes of physical memory. The benefits of ECC MOS memory include lower power requirements, greater packaging densities, greater performance, higher reliability, lower selling price, and reduced maintenance costs when compared to less dense MOS or core memories.

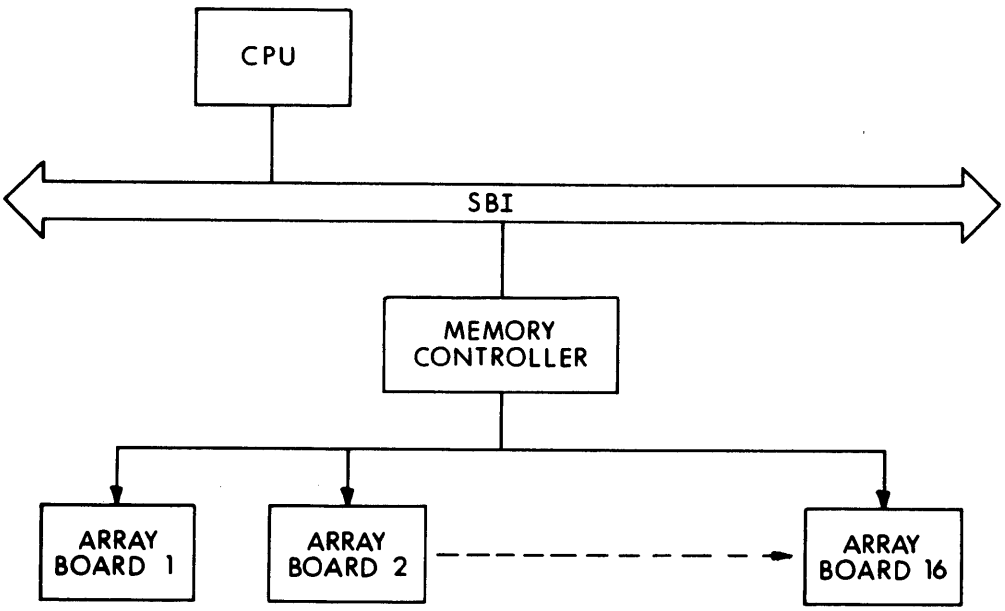

Figure 1-14 VAX-11/780 Memory Subsystem

The VAX-11/780 physical memory is organized in 64-bit quadwords plus an eight-bit ECC (Error Correcting Code). ECC permits write operations to any combination of bytes within an aligned quadword and enhances availability and reliability by correcting all single-bit errors and detecting all double-bit errors within the memory system. This provides a tenfold improvement in Mean Time Between Failure (MTBF) over non-ECC MOS memory.

Two memory controllers with equal amounts of memory on each can be interleaved. Interleaving is enabled/disabled at the console terminal by the system manager during powerup. As a general rule of thumb, interleaving memory on VAX-11/780 systems should be used when the system aggregate throughput requirement exceeds five Mbytes per second and when it is necessary to achieve 2.2-Mbyte-per-second peak transfer rates on the MASSBUS for the high-speed RP07 disk drive with the RP07-D option. Note that most applications will not require interleaving, because of the VAX-11/780's efficient memory-buffering system and because the RM80, RM03, RP06, RM05, and RP07 (without the RP07-D option) disk drives operate at speeds less than 2.2 Mbytes per second.

In the case of a temporary power failure, the contents of MOS memory can be protected using optional battery backup. Each battery backup option preserves the data integrity of four Mbytes of memory for a maximum of ten minutes. Two battery backup units are necessary to preserve eight Mbytes of memory for the same amount of time. In addition, a customer-supplied battery backup can be used with the DIGITAL option to prolong backup time.

The Input/Output Subsystem

The VAX-11/780's I/O subsystem consists of UNIBUS and MASSBUS devices as well as customer-designed devices which are connected to the SBI through special buffered interfaces called adapters. Each VAX-11/780 system can support up to four UNIBUS adapters and four MASSBUS adapters and one DR780. This allows customers a great degree of flexibility in balancing I/O across the system for improved performance.

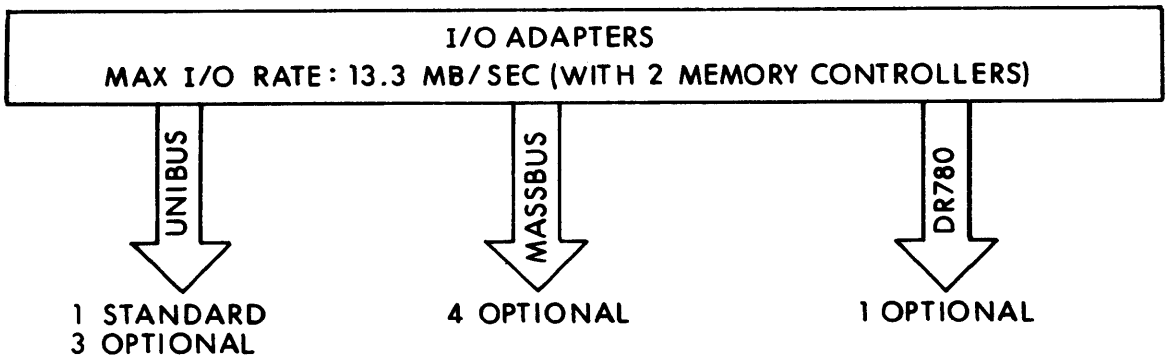

Figure 1-15 VAX-11/780 I/O Subsystem

The Synchronous Backplane Interconnect

The SBI is the primary control and data transfer path in the VAX-11/780 system. It has a physical address space of one gigabyte (30 bits wide) that permits it to address all physical locations of the subsystem.

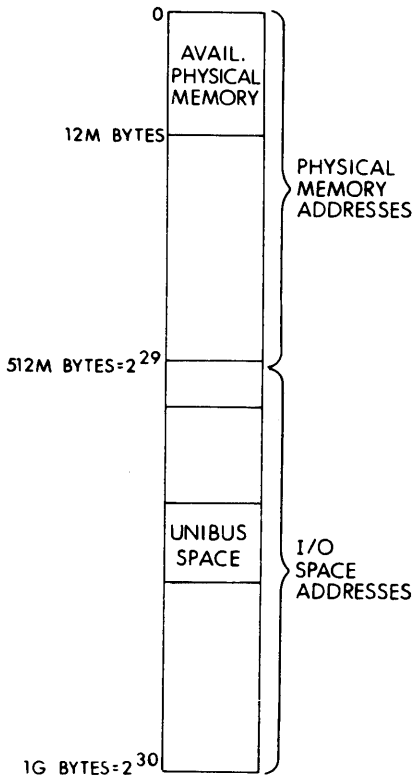

Figure 1-16 SBI Physical Address Space

Of the 512 Mbytes of memory that can be addressed, up to 12 Mbytes of physical memory (eight Mbytes of local memory plus four Mbytes of shared memory) can be connected to a VAX-11/780 system. This is a packaging constraint, rather than an architectural or implementation restriction. I/O registers and memory can be addressed by instructions.

The SBI is capable of an aggregate throughput rate of 13.3 Mbytes. Every transaction on the SBI, that is, data transfers, address transfers, or command transfers, is parity-checked and confirmed by the receiver. In addition, substantial protocol checking occurs on every cycle where the SBI checks the integrity of the data it receives and transmits. Data transferred from MASSBUS devices includes parity, while data from UNIBUS devices does not.

A 16-level silo monitors SBI activity and retains a history of the 16 most recent cycles. If an error or predetermined special condition occurs, the silo is latched, that is, the silo contents are frozen, enabling the user to examine the contents of the silo to determine the cause of the problem.

The UNIBUS(es)

Generalpurpose, DIGITAL-supported, and customer-developed devices are connected to the system via the VAX-11/780's UNIBUS. Since the SBI deals in 30-bit addresses, 18-bit UNIBUS addresses must be translated to 30-bit SBI addresses. This mapping function is performed by the UNIBUS adapter (UBA).

The UBA handles priority arbitration among devices on the UNIBUS. The UBA allows three types of data transfers: program interrupt, buffered DMA (direct memory access), and unbuffered DMA. Concurrent program interrupt, unbuffered DMA, and buffered DMA data transfers are permitted. The maximum aggregate throughput rate of the UNIBUS, regardless of the type of data transfer, is 1.35 Mbytes per second.

On memory-to-UNIBUS transfers, the UBA anticipates UNIBUS requests by prefetching the next 64-bit quadword from memory as the last 16-bit word is transferred. The result is increased performance.

To make the most efficient use of the SBI, the UBA provides buffered DMA data paths for up to 15 high-speed devices. Any number of unbuffered DMA transfers are handled by one direct DMA data path.

Refer to the *Systems and Options Summary* for detailed configuration information and VAX family supported UNIBUS options and peripherals.

The MASSBUS(es)

High-performance mass storage devices are connected to the VAX-11/780 system via MASSBUS adapter (MBA). These devices include the RM80, RM03, RM05, RP06, and RP07 (without the RP07-D option) disk drives and the TE16, TU77, and TU78 tape transports. The MBA is the interface between the MASSBUS and the SBI, and performs all control, arbitration, and buffering functions.

Each MBA uses a 32-byte silo data buffer that permits a 1.3-Mbyte-per-second transfer rate per MBA to and from physical memory on a single memory controller system. The maximum transfer rate with two memory controllers interleaved is 2.2 Mbytes per second. On memory-to-MASSBUS transfers, as on memory-to-UNIBUS transfers, the MBA anticipates MASSBUS requests by prefetching the next 64-bit quadword.

Refer to the *Systems and Options Summary* for detailed configuration information and VAX family supported MASSBUS options and peripherals.

RAMP Features of the VAX-11/780

Extensive reliability, availability, and maintainability features were designed into the VAX-11/780. Many of these RAMP features apply to all VAX family members and are treated in detail in Section 2 of this Sales Guide, Reliability, Maintainability, and Availability, as well as the *VAX Hardware Handbook*.

RAMP features specific to the VAX-11/780 include UNIBUS adapter recovery. When the UBA detects certain error conditions on the UNIBUS, it reports these conditions in the error log. If the conditions persist, the UNIBUS is reinitialized and all I/O operations currently in progress on that UNIBUS are restarted. Another RAMP feature of the VAX-11/780 is that the VAX-11/780 UNIBUS adapter or any VAX-11/780 UNIBUS peripheral cabinet can be separately powered on/off during normal system operation. This allows online replacement of devices which have been diagnosed as faulty on the UNIBUS. All operations in progress on other devices are restarted automatically when the UNIBUS is powered on. The VAX-11/780 SBI has a 16-level silo which monitors the VAX-11/780's central bus activity and contains a history of the 16 most recent cycles of bus activity. The SBI also includes parity. If an error or predetermined special condition occurs, the silo is latched, that is, the silo contents are frozen, and can be examined to help determine the cause of the problem. The VAX-11/780 uses clock margining to vary the central bus clock rate via console commands. This can aid the Field Service engineer in diagnosing intermittent hardware problems.

OPTIONAL HARDWARE EQUIPMENT

Prewired and prepowered mounting space is available within the VAX-11/780 CPU chassis for mounting the following optional equipment: the FP780 floating-point accelerator, the DW780 UNIBUS adapter, add-on memory, battery backup, the KU780 user control store, and the KE780 G_ and H_ extended floating-point. For detailed configuration information, refer to the *Systems and Options Summary.*

VAX-11/782 PRODUCT DESCRIPTION

The VAX-11/782 Attached Processor System is a performance-oriented extension that increases the system power of a VAX-11/780 system by up to 1.8 times in compute-intensive applications. The VAX-11/782 is a tightly coupled, asymmetric multiprocessing system. It consists of two VAX-11/780 CPUs (the primary and the attached processors), one copy of the operating system, and up to eight Mbytes of shared multiport memory.

The primary processor can be fully configured and does all the I/O and scheduling in addition to computational work. The attached processor is only used as a resource for computational work. The MA780 shared memory is accessible by both processors. In addition, both the primary and attached processors on a VAX-11/782 are configured with local memory for running diagnostics. All peripherals are connected to the primary processor ONLY; they are not supported by the attached processor.

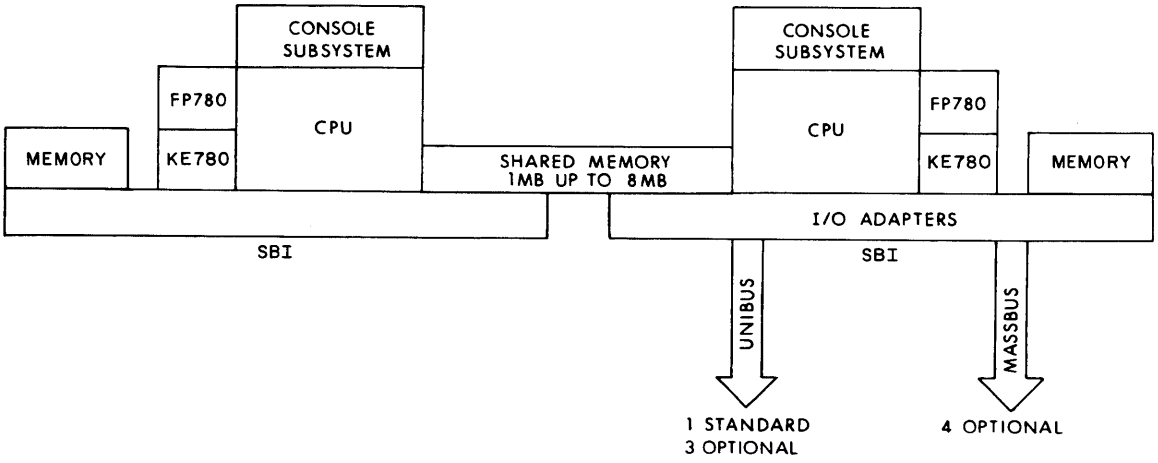

Figure 1-17 VAX-11/782 System Block Diagram

The MA780 handles all cache updates to ensure that neither cache has "stale data". To optimize the VAX-11/782 system performance, a cache invalidation map is included. This device remembers whether a CPU has read a particular location in the MA780 shared memory, so that, when this location is changed (written into), only that CPU receives a cache invalidate request. Naturally, if both CPUs have accessed the location, both will be notified. This minimizes the number of cache invalidate requests sent to each processor and reduces the effective

memory access traffic on the SBI. In addition, the MA780 hardware provides the capability for either processor to interrupt the other. The cache invalidation map and the hardware interrupt are the keys to making the multiprocessing system both possible and effective. It is used extensively in the VAX/VMS multiprocessing code, in both directions.

Minimizing the changes to VAX/VMS, by avoiding complex and pervasive changes to the kernel mode code, has preserved the the inherent reliability of VAX/VMS.

The console floppy disks for the primary and attached processors allow the processors to automatically restart after power failures and automatically reboot after fatal bugchecks and machinechecks.

The VAX-11/782 attached processor system has several hardware rules which must be observed. First, both processors must be the same model, VAX-11/780s. They must also both be at the same ECO level, and run the same version of the microcode. Second, if a CPU option such as the floating point accelerator or the G_ and H_ extended floating point is configured on one processor, then it must also be present on the other processor. Third, since all the MA780 memory is used for main memory, it cannot be used as a system interconnect as in the VAX-11/780. Operationally, there is little difference between and the VAX-11/780 and the VAX-11/782. Indeed, from a user's perspective, there is only one difference—the performance enhancement.

Since the VAX-11/782 relies upon asymmetric multiprocessor technology to achieve its performance enhancements, the actual performance realized depends upon workload characteristics. For multiprocessing to effectively improve system performance, the workload needs to be compute-intensive. If the workload is strictly I/O-bound, then multiprocessing will not increase system throughput (multiprocessing will not make the disks spin faster). However, it should be noted that an application with concurrent interactive terminal sessions and computational work is very likely to show increased system throughput on the VAX-11/782. The addition of a processor that cannot be interrupted for I/O guarantees CPU cycles for computational work.

In addition, the workload must be heavily multistreamed. This means that there must be multiple jobs ready to be executed at all times to achieve the maximum benefit from the system's processing power. An application with one large computational job would not gain by running multiprocessing, unless it could be divided into a number of simultaneous jobs. Also, a workload with many jobs that require service by the primary processor will not gain by executing on an attached processor system.

A clear advantage of the VAX-11/782 system is the ability of all programs (all users) to access a single file system. Certainly, two entirely independent machines will provide much more throughput than an attached processor system. However, two autonomous systems are more costly than an attached processor system and do not provide the same powerful capability to share data among programs.

In summary, an ideal workload for the VAX-11/782 would consist entirely of compute-intensive programs. A workload consisting of a mix of I/O and computation is also a real winner. Refer to the Performance section of the VAX-11/782 Sales Guide for further details on VAX-11/782 performance.

For detailed information and configuration requirements on the VAX-11/782 Attached Processor System, refer to the *VAX System and Options Summary, the VAX Hardware Handbook,* and the *VAX Technical Summary.*

DATA COMMUNICATIONS

There are many ways in which VAX/VMS systems can communicate with each other and with other vendors' machines. The following descriptions outline the most useful ways to use both hardware and software. The selection will, of course, depend upon your customer's requirement and level of sophistication. The specifications given in this section are maximum hardware specifications, independent of software support. Check the product SPD for information on software support.

VAX Family Communications Interfaces

The **DMR11** is a microprocessor-based, high-performance, communications interface for connecting a VAX system to either another VAX family system or a PDP-11 system. It implements DIGITAL's DDCMP protocol including all character and message formatting, error checking, and retransmission control. The DMR11 supports both local and remote interconnection over a serial synchronous link with transmission rates up to one Mbit per second. It is fully supported by DECnet/VAX for communications with other DECnet systems.

The **DMP11** is a multipoint version of the DMR11. It supports local or remote network configurations of up to 32 tributaries and one control station. The control DMP11 performs the required polling in microcode for reduced host overhead. It uses a dynamic polling algorithm that adjusts polling frequency for each tributary as a function of response history.

The **DUP11** is a single-line, program-controlled, double-buffered communications device that connects to the VAX UNIBUS for serial synchronous communication. It has facilities for executing bit- or byte-oriented protocols. Software is available that implements the IBM 3271, ADCCP, and DDCMP protocols. The Digital PACKETnet Services Interface (PSI) is available for linking VAX system to X.25 networks.

The **DZ11** is a buffered, multiplexed interface between eight or sixteen asynchronous serial communications channels (per module) and the VAX family processors. It features programmable speeds up to 9600 bits/s and formats on a per-line basis. A 64-character first-in/first-out buffer is provided in the hardware (for each eight lines) to hold characters as they are received. Local operation can use either EIA/CCITT interfaces or 20mA current loop signaling, depending on the DZ11 model selected. DZ11 models with EIA/CCITT interfaces include modem control.

The **KMS11** is a microprocessor-based, programmable, communications front-end processor that attaches to the VAX UNIBUS. It can transmit and receive at data rates up to 56 Kbits per second for up to eight full-duplex lines. Modem control is supported for full-duplex or half-duplex operation over switched or private lines.

The KMS11 has facilities for executing bit- or byte-oriented protocols. Software is available that implements the IBM 3271, IBM 2780, and IBM 3780 bisynchronous protocols. The DIGITAL PACKETnet Services Interface (PSI) is available for linking VAX systems to X.25 networks using up to two lines per KMS11.

VAX-11/780 Specific Interfaces

The **MA780** multiport memory enables up to four VAX-11/780 processors to share a bank of up to eight Mbytes of memory for multicomputer applications. The VAX/VMS operating system fully supports MA780-configured systems. Applications built around multiple cooperating processes can be reconfigured to run on a multiple CPU system without special program modification. Specifically, VAX/VMS supports using MA780 configurations for shared code and interprocessor communications using shared-data regions, VMS mailboxes, and common event flags.[1]

1 This description does not apply to the MA780 as it is implemented in the VAX-11/782 attached processor system. For more detailed information on the VAX-11/782, refer to the product description section.

The **DR780** is an interface for DIGITAL-supported and customer-developed devices that connects directly to the VAX-11/780 Synchronous Backplane Interconnect (SBI) internal bus for very high performance data transfers at rates up to 6.67 MB/s. The DR780 also supports 32-bit parallel high-speed interprocessor communications with a second VAX-11/780 system also equipped with a DR780. It is fully software-supported by the VAX/VMS operating system with a simple, easy-to-use I/O driver and a library of high-level language support routines.

The **PCL** is a high-speed parallel communications link that connects multiple PDP-11 or VAX-11/780 processors locally. As many as sixteen processors can be connected using a PCL time-division-multiplexed (TDM) bus. The maximum TDM bus bandwidth is one Mbyte per second. Because T-type connections are used, any processor connected to the TDM bus can be powered on or off, or additional processors incorporated, without disrupting the ongoing communications. The VAX/VMS operating system supports PCL operation with a simple, easy-to-use I/O driver that can be accessed with QIO level calls from MACRO as well as by high-level languages.

VAX-11/730 Specific Interface

The **DMF32** is a multifunction interface with eight serial asynchronous ports and one serial synchronous port for DMA. An additional, parallel port can be used to support a lineprinter or can be used a generalpurpose interface. The DMF32 is integral to the VAX-11/730 system.

The asynchronous multiplexer contains eight transmit and eight receive lines. Each pair of lines may be programmed to operate at one of fifteen baud rates ranging from 50 bits per second to 19,200 bits per second. Two of the eight lines are equipped with both split speed capability and modem control. Transmission can be selected as DMA or silo operation for maximum throughput.

The synchronous interface is a single-line, full modem, DMA communications device, fully supported by DECnet-VAX. The DMA transfers are double-buffered; that is, both the transmitter and the receiver have two sets of byte count and buffer address registers. Low-level support for the following synchronous protocols is provided: DDCMP, SDLC, and HDLC. The synchronous line knows enough about each protocol to frame the messages, generate and check the CRC, and send these messages via DMA to and from host memory. All message acknowledgements and higher level network functions are performed by host level software.

The DMA lineprinter interface is an enhanced version of the LP11 interface and will control the LP32 model printers.

The 16-bit parallel interface is an enhanced version of the DR11-C. It is compatible with the DR11-C, but can also support silo mode, half-duplex, or double-buffered DMA transfer in half-duplex. These new features result in reduced interrupt overhead and high throughput. The parallel interface shares hardware with the lineprinter interface; therefore, both cannot be used concurrently.

The DMF32 multifunction interface will be supported on VAX-11/780 and VAX-11/750 systems in the future.

THE VAX/VMS SOFTWARE SYSTEM

Highlights of VAX/VMS Version 3.0

VAX/VMS Version 3.0 has been designed to add a number of significant enhancements to previous VAX/VMS versions as well as to broaden the range of supported hardware. With this announcement, your customers can be assured of complete compatibility with our previous versions, continued high product quality and performance, and total support for the new VAX-11/730 and VAX-11/782 systems.

New VAX/VMS version 3.0 features:

- A variety of enhancements to both VAX/VMS and RMS for support of the new C language processor
- Enhancements to Digital Command Language (DCL)
- Lock management service
- Enhancements to the Runtime library
- MONITOR utility (replaces DISPLAY utility)
- Symbolic debugger ability to display source line (COBOL and FORTRAN only)
- Enhancements to the linker and image activator for sharable images
- RMS File Definition Language (FDL) and new utilities
- Further enhancements to backup and restore, including image mode backup and journaling
- Optimized terminal driver

Additional hardware supported under VAX/VMS version 3 includes the following:

- VAX-11/730
- VAX-11/782
- FP750 floating-point accelerator
- FP730 floating-point accelerator
- DW750 UNIBUS adapter
- DW750 UNIBUS adapter
- KE780 G_ and H_ extended floating-point data types
- DMP11 multidrop synchronous communications interface
- DMF32 multifunction interface
- IDC integrated disk controller
- 64K bit chip memory

Because all VAX processors run under the VAX/VMS operating system there is total compatibility across the entire VAX family. Benefits of a single operating system for a family of processors include the following:

- Applications developed on one VAX family processor can be easily transported and executed on another
- Customers can upgrade without reprogramming
- Operators have to learn only one set of instructions
- Programmers learn only one system command language (DCL)
- There is no need to retrain applications programmers when moving from one system to another

The VAX/VMS Virtual Memory Operating System

Virtual memory is an interaction between hardware and software that allows the physical memory of a system to be logically extended onto disk space. From the programmer's viewpoint, these secondary storage locations are treated as though they are physical memory. This design provides some obvious advantages to the user:

- Virtual memory gives the user the ability to write and execute arbitrarily large programs without having to worry about address space limitations. The VAX system actually provides more virtual memory addresses than physical addresses (the opposite is true of PDP-11 systems). The system hardware and software cooperate to translate the virtual memory requirements of the user's program into whatever physical memory is available on the system, transparent to the user. Operating under the VAX/VMS virtual memory operating system results in higher programmer productivity and satisfaction.
- Virtual memory allows large and perhaps infrequently used programs to be executed without the need to purchase more memory.
- The paging algorithm used by VAX's virtual memory management allows the system manager to tailor the system to his particular application needs. This is done by manipulating the working set limit of individual users (the maximum amount of physical memory in which a particular job can execute) to achieve the right trade-off between the performance of a single program and the performance of the entire system in a multiuser environment.
- The paging and swapping algorithms allow more programs to execute than the available physical memory would allow if all programs had to be totally resident. In addition to providing a larger addressing space, virtual memory systems need hold only a portion of a program in physical memory at a time. Efficient memory management enables the system to map several programs into memory at once.
- The paging algorithm minimizes disk overhead. During execution, pages that have been removed from the working set remain temporarily in memory. If these pages are needed by a program, the pager first checks to determine if they are still in memory. If so, the pager can reassign them to the working set without reading them back from disk. In addition, the pager keeps track of modified pages so that only those pages that have been changed are ever written to disk.
- Extensive system management capabilities give users the ability to control program behavior. A user can establish page cluster sizes that minimize disk accesses. In addition, a user can lock pages in the working set. A privileged user can lock pages or even an entire working set in physical memory (never to be swapped out) to maximize program performance.

Processes

When a user logs onto a VAX/VMS system, a process (or job) is created. In VAX/VMS, the concept of a process is separated into two basic aspects: the image that executes and the virtual address space and control information (referred to as process context) that provide the environment required for image execution.

For example, system and user programs exist under VAX/VMS as image files. An image file is the result of linking one or more object modules together. The image file is loaded by the image activator and executes in the context of the process. Thus, the process executes all of the images needed to perform the user's requests. For example, if the user chooses to edit, assemble, and link a source program, the process executes three images: the editor, the assembler, and the linker—all of which run in the user's process context.

Virtual Address Space

Virtual address space is defined as all possible virtual addresses that an image executing in the context of a process can use to identify instructions and data. Since VAX processors are byte-oriented, that is, they address data and instructions on byte boundaries, and since VAX systems use the full 32-bit architecture to define addresses, the available virtual address space of the system is an array of bytes labeled 0 through 2^{32} -1, or 4.3 Gbytes.

Figure 1-18 illustrates how the VAX's four-gigabyte virtual address space is allocated between the VAX/VMS operating system and each process.

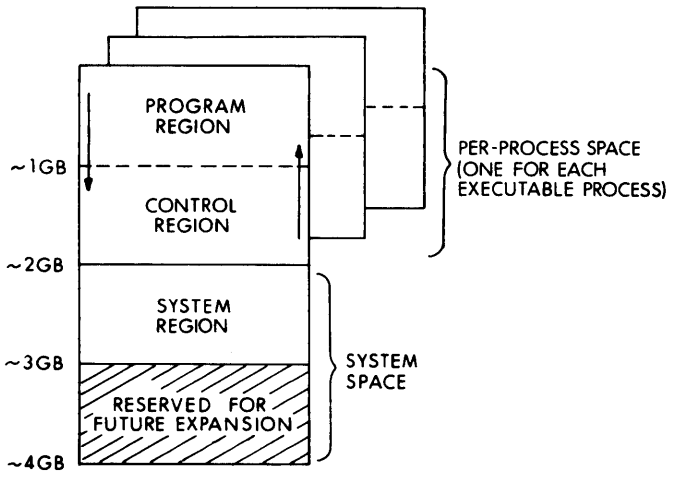

Figure 1-18 Virtual Address Space

The VAX/VMS virtual address space is divided into four regions, each approximately one gigabyte long. The top one-gigabyte region is reserved for future system expansion. Addresses in the System Region are used by the VAX/VMS operating system software. Process virtual address space (addresses available for user code) comprises the lower two gigabytes—the Control Region and the Program Region. Note that two gigabytes is substantially larger than what current applications practically use, given current memory and disk capacities. The Control Region contains information maintained by the system on behalf of the process (context information and user stacks — one per access mode per process). The Program Region contains information maintained by the system on behalf of the user image currently being executed.

Memory Management

Memory management involves the cooperation of both the VAX hardware and the VAX/VMS software to control the pages of a process (through image activation and paging) and to provide protection. The VAX memory management architecture is integral to the virtual memory operating system, from which VMS derives its basic operation.

Pages

In the VAX system, a process's virtual memory is subdivided into pages of 512 contiguous bytes. This number, which is conveniently small to make efficient use of memory, corresponds to the addressable units of a file; that is, it is the size of a physical block on a disk. This simplifies mapping virtual addresses to physical addresses, a task easily handled by the memory management facilities. In addition, a user can trade off memory efficiency for disk I/O efficiency by using the page clustering feature, which allows them to bring in more than one page at a time from disk.

Image Activation

The image activator is responsible for making an image capable of running in the context of the requesting process. The image activator locates the image and sets up the proper control information. In the case of shared images, the image activator also allocates virtual memory at runtime.

Paging

Paging is the transparent moving of pages to and from secondary storage when they are needed. As a process executes, it touches various pages within its virtual address space. These pages are then brought in from secondary storage and become part of the working set. If the working set is full, an old pages is written out to secondary storage to make room for a new page. A maximum working set size, that is, the maximum amount of physical memory a process may use is usually set by the system manager for each process so that individual processes will not use too much physical memory (and thereby degrade the execution of other processes). However, the system manager may assign a large maximum working set size to a realtime process. The system manager has the option of setting the dynamic working set adjustment feature. This automaticly adjusts the working set size within certain limits, in order to help balance swapping and paging activities. Thus, the system manager has great flexibility in maximizing overall system performance by balancing physical and virtual memory utilization.

While the system will handle all the virtual-to-physical translations automatically, the user can control the paging structure of a process by setting a page cluster size at link time. This causes multiple pages to be read from disk to memory and reduces disk traffic. In addition, users can lock pages in the working set. Privileged users can lock pages or even their entire working set in memory to gain maximum program performance.

Protection

Four hierarchical access modes provide protection for the system. These modes, from most to least privileged, are as follows: kernel, executive, supervisor, and user.

Each page table entry contains a code specifying, for each mode, the type of access allowed to the associated memory page—read-only, read-write, and no access. The design is hierarchical: if a less privileged mode can access a page, then a more privileged mode can also access that page.

The VAX/VMS executive is part of every process's virtual address space. However, individual pages are protected by different access modes. For example:

- I/O drivers and scheduler are accessible in kernel mode only.
- record manager executes in both executive and kernel modes.
- command language interpreters run in supervisor, executive, and kernel modes.
- user software and utility programs usually execute in user mode. The system manager can, however, assign privileges to users allowing them to access pages at higher levels.

The access modes determine only access to pages; they do not affect the virtual space in which programs are mapped, as on the PDP-11 systems. By assigning appropriate access modes to pages of a process, the system manage protects the operating system from users who could inadvertently (or deliberately) destroy operating-system information.

Hardware instructions to change access mode allow a user image to request system services which execute at more privileged access modes. In addition, some system services request execution of user image code at more privileged access modes. These services verify that the process has the necessary privilege.

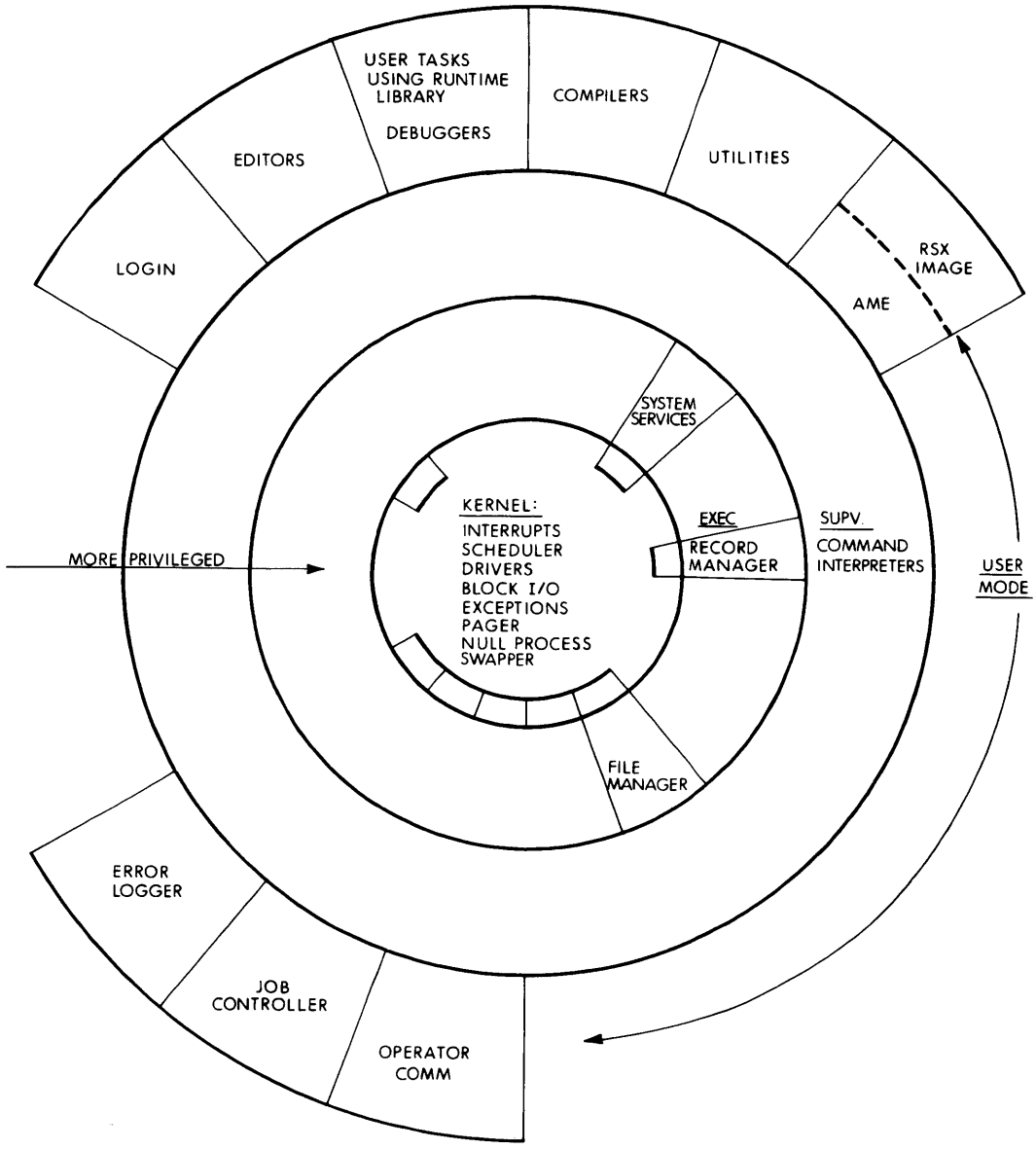

Figure 1-19 VAX/VMS's Use of Hierarchical Access Modes

Scheduling and Swapping

VAX/VMS's scheduler and swapper are responsible for ensuring, in a multiprogramming environment, that processes receive processor time appropriate for their priority (controlled by assignment), and appropriate for their ability to execute (controlled by system events).

The VAX/VMS scheduler is responsible for determining the order in which processes will be executed. It uses fixed priorities for realtime applications and recomputed priorities for interactive and batch processes.

Scheduling is priority-ordered, preemptive, round-robin/timeslicing, and event-driven. The VAX/VMS operating system defines 32 levels of priority. Although some operating systems define many more levels, experience indicates that the number of useful, operator-manageable priority levels is significantly less than 32. Any number of processes can execute at each level.

Of the 32 software priority levels, zero through 15 are reserved for user processes and 16 through 31 are reserved for realtime processes. Once a priority is assigned to a process, either at login time, by the system manager, or by privileged system service, the system does not modify it.

Swapping involves the moving of a process's entire working set in and out of memory in a multiuser environment. The processes that reside in physical memory at any given time constitute what is called the balance set. The balance set varies as a function of the system load and the available physical memory of the system. Maintenance of the balance set is handled by the swapper, whose function is to keep the system scheduler supplied with executable processes by removing and adding processes to the balance set. The VAX processor provides special instructions that aid specifically in rapid and efficient process scheduling.

The VAX/VMS scheduler guarantees execution for some minimum amount of time for any process that it brings into memory from disk, thus avoiding a condition known as thrashing. Thrashing occurs when a system attempts to spread processor time among so many users so quickly that the disk is unable to keep up with swapping requests. Consequently, the processor spends most of its time servicing and waiting for disk transfers, rather than executing user processes.

VAX-11/730 Dual-RL02 Configuration

The following two sections on tailoring VAX/VMS and layered product support are only applicable to the VAX-11/730 basic, single-cabinet, dual-RL02 configuration. This is because the capacity of the RL02 disk limits layered product support on this configuration. They do not apply to the VAX-11/730 RL02/R80 configuration, which has no tailoring facility. Note that the layered products supported by the VAX-11/730 RL02/R80 configuration is not a subset.

VAX/VMS and Layered Product Support on the Dual-RL02 VAX-11/730 Configuration

VAX/VMS V3.0 is supported on a single RL02 disk, for application execution or for program development. This leaves the second RL02 disk drive free for mounting private user volumes.

The following group of layered products is available in the development environment on the VAX-11/730 dual-RL02 package system:

- VAX-11 BASIC
- VAX-11 COBOL
- VAX-11 FORTRAN
- VAX-11 PASCAL

Any one of these layered products, or any one of these layered products in combination with DECnet-VAX is available. The MACRO assembler and the RTL (Runtime Library) are present as a bundled part of VAX/VMS.

This gives the customer a low-end VAX development system with MACRO, a communication capability, if required, and the choice of one of four high-level languages.

Layered products can only be installed to the system disk. Due to space constraints, there is no guarantee that layered products will install if user code and data reside on the system disk.

The tailoring facility can be used to tailor other environments, for example, an execution environment for running application code. Note that the application code must not be dependent on optional software products being present, that is, installed, for execution.

Tailoring VAX/VMS on the VAX-11/730 Dual-RL02 System

The VAX/VMS tailoring facility is only required (and therefore available) on the VAX-11/730 basic, single-cabinet, dual-RL02 configuration. It is not supported on other processor or disk configurations.

Tailoring VAX/VMS on the VAX-11/730 dual-RL02 configuration allows customers to enjoy the full functionality of VAX/VMS, while providing a compact version of the operating system tailored to their needs on one RL02 disk cartridge.

Tailoring is made possible by dividing the VAX/VMS operating system into three savesets (container files produced by the BACKUP utility): the required saveset, the library saveset, and the optional saveset. The required and library savesets are distributed to each VAX-11/730 customer on a primary RL02 disk cartridge, which contains 98 percent of the VAX/VMS operating system. The optional saveset is available to all VAX-11/730 customers as an option on a second RL02 disk cartridge. Note that the customer's license is for the complete VAX/VMS operating system, including the optional saveset on the second RL02 disk cartridge.

The library saveset includes the development environment, the system library, the HELP facility, DECnet, additional development tools, and the UETP. The optional saveset includes the RSX development tools, BLISS support files, EDTCAI, some obsolete utilities, coding examples, and the system executive map. The contents of the savesets were chosen on the basis of historical use—it is anticipated that most VAX-11/730 customers will not need the files on the optional RL02 disk cartridge and will not order it.

The required saveset installs to the system disk, and the library saveset installs to the library disk. At installation time the system is tailored to include a default set of files that will provide an immediately useful environment for most VAX-11/730 users. The library disk is read-only and files should not be deleted from it. If needed, the user may further tailor the system by copying additional files from the library disk or by deleting unnecessary files from the system disk.

Once the user's system has been tailored to meet his needs, he still enjoys the potential of having any VAX/VMS feature resident on the system, although not all features simultaneously. The end result of tailoring the VAX-11/730 system provides the user with a one volume subset of VAX/VMS to run on his system. This leaves the second RL02 disk drive free for mounting private volumes.

SYSTEM SERVICES

VAX/VMS system services provide the kind of facilities that users working on other systems would normally have to program themselves. Although most system services are employed by the operating system itself on behalf of logged-on users, many are generally available that provide techniques to be used in application programs. All VAX/VMS system services can be called from all native-mode languages, using the standard calling procedure.

An example of such a service is the Logical Name Service which allows user-specified names to be assigned to actual file names or devices. For example, when using logical names such as INFILE or OUTFILE, programmers can develop application programs without having to reference specific devices or files required to run that program. Prior to program execution, the user ASSIGNs the names of the actual files and/or devices to the logical names that were used in the program. The result is an easy programming technique that saves both recompilation and programming time.

SET PRIVILEGE is another example of a commonly used system service which allows a process to enable or disable specified privileges.

While many system services are available and suitable for programming, the general use of certain services must be restricted to privileged users in order to protect the performance of the system and the integrity of user processes.

For those users who need to extend the range of system services, VAX/VMS allows programmers to create their own application-specific service routines, which can also be called by any application program.

For a complete list and more details on VAX/VMS services, refer to the *VAX/VMS System Services Reference Manual.*

I/O MANAGEMENT

Device Management

VAX/VMS supports a growing number of peripheral devices via device drivers—software that performs the physical device I/O. Such software eliminates the need for users to be familiar with the particular mechanics of device I/O. Instead, users simply call standard system I/O services.

While VAX/VMS provides drivers for most DIGITAL standard peripherals, users interfacing their own devices can implement system-level drivers by following the procedures defined in the *VAX/VMS Guide to Writing a Device Driver* manual.

File Management

VAX/VMS has a powerful file manager, Files-11, that provides a facility for accessing, creating, extending, and deleting files. Designed into the file system is a scheme for volume and file protection that allows the owner of a file to deny all access or certain kinds of access to all users, others in the group, the system, and the owner.

ODS-1 is the ondisk structure supported by RSX-11M and RSX-11M-PLUS. ODS Level 2 is an extension of Files-11 ODS Level 2 and is upward compatible with Level 1. The default for creation of disks by VAX/VMS is ODS Level 2. However, VAX/VMS also supports creation of Level 1 user disks for transportability. The VAX/VMS operating system transparently reads either ODS-1- or ODS-2-formatted disks; however, these cannot be mixed on the same volume.

The VAX/VMS ondisk structure supports volume sets containing up to 255 volumes. A volume set is defined as a logical storage entity made up of a collection of related volumes. A volume is a single physical unit of storage—for instance, a disk pack. Files of any organization can span any number of volumes within a volume set. They can be explicitly placed and allocated on a particular volume or volume set. A volume set can contain a mix of disk device types and can be extended by adding more volumes after initial definition.

VAX/VMS includes VAX-11 Record Management Service (RMS), a file access method with an extended syntax interface to all high-level languages. RMS supports sequential record access to sequential file organizations, sequential and random record access to relative file organizations, sequential and random access to multikey indexed files, and concurrent file access with record-level locking. Multikey indexed file processing includes incremental reorganization. VAX-11 RMS also supports transparent file access to and from remote DECnet systems.

Additional file management features include:

- Alphabetically ordered directories for faster search.
- Redundant recording of critical information (index file header and home block) for improved reliability (loss of this information is fatal to the entire volume).
- Transparent allocation/deallocation of storage space and user-controlled file placement.
- Efficient file handling of large files (theoretically 2^{32} blocks in one file, 2.2×10^{12} bytes) and large disks (also 2^{32}).

- Dynamic bad-block handling.
- File protection via user identification codes and passwords and by read/write protection in four hierarchical categories (system, group, owner, world).
- A utility to verify volume integrity.
- Multilevel directory trees—any directory can contain a subdirectory (only supported with ODS Level 2) up to a maximum of eight levels.
- File and Memory Dump utility.
- File Transfer (to perform PIP and FILEX functions).
- File Differences utility that contrasts two files.
- the BACKUP and RESTORE facility provides for backing up and restoring a volume and offers the option of condensing the free disk space.
- Enforcement of disk quotas.
- Support for wildcard specifiers.

Interprocess Communication

VAX/VMS provides a number of methods by which processes can communicate with one another:

- Implicit communication using shared files or shared memory (the Runtime Library is an example of system code that is shared in the process part of the address space). Note that memory data can be shared between native and compatibility-mode programs, but code can not because the instruction sets are different.
- Cooperating processes can synchronize using common event flags.
- Cooperating processes, using the lock management service, can synchronize access to shared resources.
- Message communication is allowed through mailboxes. A mailbox is a buffer in virtual memory that is treated as if it were a record-oriented I/O device. Mailboxes are accessed through the VAX/VMS operating system's I/O system, and processes can communicate by reading and writing messages through a mailbox. This method provides more protection, but also requires more system overhead than other methods.
- VAX/VMS support for MA780 multiport memory means that both user data and subroutines can reside in shared memory. Using this information pool is similar to sharing a disk file or local memory on a single processor. Access is accomplished by using the global shared memory feature of the VAX/VMS operating system. For example, once a global area is initialized by a native-mode application program, it would then be accessible to other native-mode programs.
- DECnet-VAX interfaces are a standard part of VAX/VMS version 3.0. These interfaces provide additional mechanisms for intertask communication. Refer to the discussion on DECnet-VAX in the Product Description section of this Sales Guide for detailed information.

To minimize software complications, shared memory is accessible only though application programs. Shared subroutines can execute out of multiport memory, but the user must write an application task to load data or code into (or retrieve them from) a shared memory area.

VAX/VMS itself does not use the shared memory in its dynamic page pool of available memory, and no part of the operating system will reside in shared memory. Each CPU in the multiport system operates independently, using its own copy of VAX/VMS stored in its local memory.[1]

1 This description does not apply to the MA780 as it is implemented in the VAX-11/782 attached processor system. For more detailed information on the VAX-11/782, refer to the product description section.

VAX/VMS Lock Management Service

The VAX/VMS lock management service or semaphore facility provides a means by which cooperating users may synchronize access to shared resources. By allowing users to develop complex and sophisticated resource-sharing applications, such as database systems, the VAX/VMS lock management service provides for an almost unlimited range of granularity in defining and locking a resource as well as a flexible choice of locking modes.

A resource can be any readable or writable entity on VAX/VMS (for example, files, data structures, and databases). The lock management service does not directly control access to resources; rather, it provides a mechanism for assigning names to resources that are then stored in a common namespace. All users that access the resources must use the VAX/VMS lock management service for it to be effective.

The resource namespace is tree-structured, that is, it is hierarchically organized with an arbitrary number of levels. Each name can have a number of "branch" names; these in turn can have a number of branches; the process continues in a way that parallels the organization of the actual resource. A lock can be granted on a name at any level of this hierarchy. The only names affected by the lock are the specified name and those beneath it in the hierarchy. In this way, a resource can be defined and access to it controlled to any depth of granularity required by an application and still allow concurrent access by multiple processes.

The lock mode of a lock determines whether or not the resource can be shared with other lock requests. The six lock modes are as follows: null (no access), concurrent read, concurrent write, protected read, protected write, and exclusive (write access only). For detailed information on the VAX/VMS lock management service, refer to the *VAX Software Handbook*.

USER/SYSTEM COMMUNICATION METHODS

Interactive Capabilities

To use the system, each user logs in by typing an identifying user name, account number (optional), and a password. If the user is authorized, access is granted and the resources of the system are available for use. The login process provides efficient performance and response time, even in environments where many accounts are defined.

VAX/VMS supports two interactive interfaces between the user and the system—the DIGITAL Command Language (DCL) and the RSX-11M MCR language.

DIGITAL Command Language (DCL)

DCL is a set of English-like commands that a user types to initiate and control system operations. The language makes it easy for new users to become acquainted with the system because it prompts for information needed to complete a command operation. In addition, DCL provides an extensive HELP facility for those who are not familiar with command formats. DCL commands are usable in both the interactive and the batch environments because the verbs are identical for both environments. This means that users only need to learn one language.

DCL commands provide:

- Program development and execution control: invoke the compilers, the assembler, the editors, the linker, and user-written programs; stop and continue program execution
- Resource allocation: allocate and deallocate devices, mount and dismount volumes
- Environmental control: assign and deassign logical names, set and show parameters such as terminal type, default directory, quotas, etc.
- File maintenance: create, copy, type, print, rename, and delete files; list directories and subdirectories, initialize volumes, recover previously allocated but unused disk space

- Phone: to hold an interactive terminal conversation with another user
- Operational control: log in and log out, submit batch jobs, send messages to the operator
- Command language extension: assign logical names to file specifications, assign symbolic names to character strings or numeric values, create and execute command procedures, create user-defined commands

One of the many flexible DCL features is the use of wildcard specifiers. Wildcard characters can be specified in place of the directory, filename, filetype, or version number fields of a file specification, reducing the number of keystrokes required. For example, a wildcard can cause the DIRECTORY command to list all the files that satisfy or contradict the given components.

The two wildcard characters are the asterisk (*), which matches the missing component with a string of any length (including the null string), and the percent sign (%), which matches a single character (the null string does not match).

MCR Command Language

For those users already familiar with RSX-11M operation, or for those who will be taking advantage of the RSX-11 Host Development capabilities of VAX/VMS, the RSX-11M MCR command language is also fully supported by VAX/VMS.

Users can choose either the DCL or MCR command language for interactive work. However, for the most part, those wanting to utilize the full range of VAX/VMS facilities will use DCL.

BATCH Capabilities

VAX/VMS supports an extensive batch facility that uses the same command language as the interactive operations.

Batch facilities under VAX/VMS include the following:

- **Multistream Batch.** Jobs may be submitted to batch streams from the interactive environment using a terminal command, from another batch job, or by any program using a system call. Submitted batch jobs are queued and a time may be specified after which a batch job will execute. The operator controls the number of batch jobs that may run concurrently. Whenever that limit is exceeded, remaining jobs are held in a queue until a batch stream becomes available.
- **Job Control.** The method chosen to submit a batch job does not affect the structure of the application program. The user can control the flow of the batch job by specifying what error conditions will cause the job to stop and by suspending execution (using a $MOUNT command) until an operator loads a device.
- **Conditional Branching.** The user can specify in a batch stream where in the stream program control should transfer on command errors or errors returned by programs that are executed in the stream.
- **Spooled Printing.** Printer output is generally first spooled to a file-structured volume, unless the privileged program allocates a printer. Print jobs, that is, one or more files to be printed together, can be submitted from a terminal, from another batch job, from any program using a system call, or automatically at the end of the batch job. Multiple print queues are also available. The operator defines the number of queues, and the user indicates in the print command which one is to be used. If there is more than one printer included in the system configuration, the user is also able to balance the load among printers with the use of multiple print queues.
- **Spooled Input.** Input spooling is available from the cardreader.

- **Operator Control.** The operator can control batch jobs and print jobs and the execution of the users' jobs, that is, the operator can abort a job or change its priority.
- **Accounting.** Batch accounting includes user and account identification, connect time, CPU usage, I/O usage, and page listing count.

In addition to the batch capabilities just described, command procedures are supported by the command language. A command procedure is a file that contains a sequence of commands. It is implemented as an indirect command file and can be initiated from an active terminal or from within a batch stream. Command procedures are most often used as an easy method of invoking a series of frequently required commands.

Batch command files and command procedures are completely compatible. Command procedures are executed immediately, within the context of the initiating process and from an active terminal and can, therefore, request and receive user responses during processing. Batch jobs are queued and executed as detached processes under control of the system.

The command language used interactively at a terminal and batch command files/batch procedures are actually the same. This means that users do not have to learn two command languages. In other words, the same commands a user issues from a terminal can be issued in batch mode.

CAPABILITIES FOR THE SYSTEM MANAGER

Automatic SYSGEN

At installation time, no SYSGEN is required. The system manager can elect to use either a DIGITAL-distributed standard system, which automatically configures the system to reflect the actual working hardware configuration, or he can define unique system parameters that affect configuration, device, and environment availability.

Resource Monitoring and Control

VAX/VMS controls the use of certain system services by privileges and resource quotas assigned to a user by the system manager. Program execution control, interprocess control, access to the system, and access to files and devices are controlled by several distinct privileges. These privileges can be assigned singly or in a set of multiple privileges. Resource quotas include limits on the number of simultaneously open files, the number of created subprocesses, and the amount of disk space any user can control.

VAX/VMS allows the system manager to authorize system users, determine quotas to control virtual memory usage, and define privileges and priority for each user.

System managers also set disk usage quotas to monitor and control the usage of disk space on a per-user basis. Quota control is enabled and managed on a per volume or volume set basis. Each volume or volume set that has quotas enabled contains a quota file. The quota file lists space authorization and usage for each user allowed to allocate space on that volume or volume set.

This facility allows system managers to list the current usage and quotas; add, remove, or modify authorizations; and reconstruct the usage data from the files on the volume. Permission to modify the quota file is controlled by the protection of that file. In general, this means that only the owner of the volume and system managers will be allowed to modify the quota file.

Being able to set disk quotas is of interest mainly to managers in the general purpose and educational timesharing markets, those who need to provide input to a user's accounting and billing mechanism as well as to safeguard the system against hostile or careless users.

A CPU time quota may also be specified and enforced on a per user basis. If the user exceeds the allocated maximum CPU time, the process is suspended.

Automated Test Software
VAX/VMS also includes an automated collection of test software called the User Environment Test Package (UETP). The UETP is designed to validate the installation and proper functioning of major hardware and software system components. The package is normally executed by Field Service at installation time, yet the system manager can rerun this test online at any given time to insure that the system is properly running. This procedure constitutes a significant, but not exhaustive, test of the system in the user environment and takes usually 45 minutes to run.

Unattended Operation
One of the many features that attracts system managers to VAX/VMS is that the system was designed to operate in an unattended environment. Even without an operator, a VAX system is productive. VAX/VMS features which support this include:

- Automatic reboot
- Power/fail recovery (with the memory battery backup option)
- Startup command files (for remote disks)
- Disk spindown (from remote locations)
- Time-of-year clock

CAPABILITIES FOR THE SYSTEM PROGRAMMER

User-Supplied Devices
Many DIGITAL customers, typically OEMs, will want to interface unique devices to VAX systems. The software which allows the system to access those devices can be developed in two ways: either by writing a driver to support that device, or by using the map to I/O page and connect to interrupt facility in VAX/VMS.

User-Implemented Device Drivers
One way for customers to interface a "foreign" device to VAX is to actually write a unique device driver and incorporate the program with the other standard VAX/VMS drivers. DIGITAL has documented this procedure in the manual, *VAX/VMS Guide to Writing a Device Driver.*

Map to I/O page and Connect to Interrupt
The other facility available in VAX/VMS enables realtime application programs to control and respond to a device, without using the Queue I/O system service or a user-written device driver. This capability is especially useful to realtime programmers, allowing them to control process execution in response to external events, and to simplify their task when developing device support.

Four major capabilities this service offers are:

- Ability to respond to an interrupt within the shortest possible time on VAX hardware without writing a device driver
- Ability to preempt lower-priority system processing to handle a realtime event
- Ability to buffer data from a device in realtime and to return the data to a user process at a later time

User-Implemented System Services

Just as a user can implement system-level device drivers, sophisticated programmers can extend the VAX/VMS system services by creating their own application-specific service routines, callable from any application program.

The System Dump Analyzer (SDA)

The System Dump Analyzer utility can help the systems programmer and manager determine the cause of an operating system crash. When the operating system fails, it writes information concerning its status at the time of the crash to a predefined system dump file. The SDA examines and formats the contents of this file. With the help of SDA commands, parts of the formatted system dump file can be displayed on a CRT or hardcopy terminal.

The SDA is intended to be used primarily by DIGITAL Software Support specialists, who are best qualified to interpret the information it generates. However, system programmers who are writing special device drivers may benefit from the assistance of the SDA, especially when debugging their programs.

CAPABILITIES FOR THE APPLICATION PROGRAMMER

Program Development Tools

VAX/VMS provides a comprehensive set of tools for developing both VAX programs and host development programs. These tools include programming languages, a symbolic debugger, text editors, a linker, a librarian, a patch utility, a runtime library, a file differences utility, and remote terminal capability.

The text editors can be used to create memos, documentation, and data files, and source program modules for any language processor. The linker, librarian, debugger, and runtime library are used only in conjunction with the VAX language processors.

For host development programming, VAX/VMS provides the following compatibility-mode utilities: a file dump utility (DMP), the EDI editor, a file transfer utility (FLX), a librarian, the MACRO-11 assembler, a patch utility, a file copy utility (PIP), a batch-oriented text editor (SLP), a task-builder, a file maintenance utility, and a cross-reference processor. RMS-11 V1.8 and RMS-11K running in compatibility mode are also provided as part of the host development tools.

Text Editors

VAX/VMS supports three text editors: two interactive text editors (EDT and SOS) and a batch-oriented text editor (SLP).

The DIGITAL Standard Editor, EDT, is the default interactive editor. EDT's power allows:

- Screen and keypad editing on ANSI video terminals (EDT is also supported on the hardcopy LA100, LA120, LA36, LA38 terminals)
- Multiple buffers, including a default MAIN buffer and a large number of user-created buffers
- Editing procedures, called macros, written by the user and called when the editing session begins

EDT accepts multiple commands per line and is sharable among many users on timesharing systems. In addition, there is a pattern matching and replacement capability and an exhaustive range of commands, including insert and change commands. An easy-to-use HELP facility is available to guide unsophisticated users through EDT's extensive editing features.

Note that the system reads keypad edits made from the terminal character by character, not line by line. The net result is that keypad editing creates more overhead time for the processor.

An EDTCAI computer-aided instruction course is included with VAX/VMS. This means that first-time users can quickly and easily become familiar with the DIGITAL Standard Editor. The course consists of four online modules that are designed to help users learn to:

- Invoke and terminate a session with EDT
- Use the VT100 keypad mode editing
- Use line mode editing
- Use multibuffer editing

The EDTCAI course can be completed in about three hours and will run on ANSI video terminals. (Note that the keypad editing module only runs on a VT100.) Due to the graphic and animated data displayed during the sessions, the VT100 terminal is recommended for most effective use. Terminals should be run at rates of 600 to 2,400 baud.

SOS is an interactive text editor that enables the programmer to create and modify text files using commands entered from either a hardcopy or video terminal. The user can insert, delete, and replace lines; find and substitute strings; or modify the text one character at a time. Lines can be identified by line number, relative position, or by contents. An adjacent group of lines can be copied or transferred from one place to another. Editing can be done in any order in the file. Editor parameters can be set to user-specified values, and the current values can be shown. User-specific parameters can be set automatically at editor startup.

SLP is the batch-oriented, programmed text editor that enables a user to modify an existing file by supplying a command file containing a list of the modifications to be made. The command file provides a reliable way to duplicate the changes made to a file at a later time or on another system. SLP provides a formal record of changes made to files, both in the source file and in an audit trail listing, a feature useful in tracking the stages of large programming projects.

The **T**ext **E**ditor and **CO**rrector (TECO) editor is also included with each VAX/VMS license; however, it is not supported under the VAX/VMS operating system. TECO is a character-oriented text editor that enables advanced users to edit any ASCII text with a minimum of effort. One or more characters in a line can be modified without retyping the rest of the line. TECO does not require that line numbers or any other extraneous information be associated with the text.

Compilers

VAX/VMS supports a broad range of high-performance, quality languages, all of which take full advantage of VAX/VMS system services and the VAX instruction set. Compilation speeds for most are typically 2,000 to 3,000 lines per minute. The features and benefits of each language are presented separately in the pages ahead.

Linker

The VAX/VMS Linker is a program development tool that takes the output of a language processor and binds it into either an executable image that can be directly executed on VAX hardware, or a sharable image that can in turn be linked with other object modules to create an executable image.

The Symbolic Debugger

The VAX Symbolic Debugger is another reason why VAX programmers develop and maintain applications quickly and easily. When linked with a native program image, the symbolic debugger allows developers to monitor the flow of program execution interactively from a terminal keyboard, making it easy for a programmer to retrace all steps leading up to a trouble spot.

The symbolic debugger can be used interactively, or it can be controlled from a command procedure file. The debugging language is similar to the VAX/VMS command language. Expressions and data references are similar to those of the source language used to create the image being debugged. Debugging commands include the ability to start and interrupt program execution; to step through instruction sequences; to call routines; to set break or trace points; to set default modes; to define symbols; and to deposit, examine, or evaluate virtual memory locations.

Runtime Library

The VAX-11 Runtime Library (RTL) is a collection of general-purpose and language-specific procedures that are available to any native-mode program, regardless of the source language in which the program was written. The RTL is a sharable image containing frequently used runtime procedures. The same routines found in the RTL can be found in a system object library. However, a system object library contains routines not found in the RTL. The RTL allows:

- A single copy of the library to be shared by all processes
- Installation of a new library without the need to relink existing programs

The Runtime library includes:

- Mathematical procedures
- Resource allocation procedures
- General utility procedures
- Condition handling facilities procedures
- Language-independent support procedures
- String handling procedures
- Language-specific support procedures
- Screen package

Librarian Utility

Using the VAX/VMS Librarian utility, VAX programmers can create and maintain library files. These comprise object, macro, help, or text modules that can be helpful to other system users. A library gathers these modules into a single accessible place, where they can be called as procedures from any application program.

The Librarian actually exists in two forms: as a utility invoked by DCL commands and as a set of user-callable procedures from any language. Both forms permit users to create modules, insert/delete/replace modules by name, extract lists, etc.

Executable Image Patch Utility

PATCH is a utility that assists in ongoing program test and debug. PATCH can be used to correct programming errors in native-mode image files, without reassembling or recompiling and relinking the program. Its features include symbolic instruction and automatic creation/use of patch area. Symbols available to the symbolic debugger are also available at PATCH-time.

File Differences Utility

VAX/VMS also provides a file differences utility (DIF) that is able to contrast two files by automatically aligning matching text and by optionally ignoring comments, empty records, trailing blanks or multiple blanks. The output file can produce either a file-by-file list of differences, an interleaved list of differences, or a list with change bars. In addition, DIF output can also produce a batch editor command input file.

DEC/CMS

DIGITAL Equipment Corporation Code Management System (DEC/CMS) is an optional set of commands supported by the VAX/VMS operating system to help software engineers understand, coordinate, and control ongoing software development projects.

All the text files for each software development project are stored in a project library. Each project has its own library, and each library can include ASCII text files, source programs, command files, documentation, and test data.

Each DEC/CMS command is invoked from the operating system's command level to perform a specific function, such as reserving a file for modification or obtaining a report on development status. Each command returns to the operating system's command level where the user can edit, compile, and test in the usual manner. Since DEC/CMS works with sequential ASCII files, all of the usual editors and compilers can still be used.

ADDITIONAL VAX/VMS FEATURES AND UTILITIES

RUNOFF Utility

VAX-11 RUNOFF is a document-formatting utility used to print output files in a format that resembles manually typed pages. The input to RUNOFF is a file containing the text of the document and the RUNOFF instructions. The output file is the print-ready document.

Some of the standard RUNOFF features include:

- A standard typewriter page size of 8½" x 11"
- Sequential page numbering
- Page width of 60 characters
- Single spacing
- Automatic tab settings
- Automatic space filling and justifying

A RUNOFF-processed document can be updated without extensive retyping because textual changes (made with the text editors) do not affect the basic design.

MAIL Utility

VAX/VMS includes a comprehensive electronic mail utility that allows multinode communication; that is, users can send stored messages to other users on the system or to any other VAX system that is connected via DECnet. Messages can be created, read, sent, edited, filed, forwarded, deleted, printed and answered. In addition, the user can get a directory of all the messages he has received or search for a particular message.

Phone Utility

The Phone utility allows users to "talk" interactively to other users on the system or to any other VAX system that is connected via DECnet. It emulates the normal phone system in that users can dial, answer, have conference calls, etc.

VAX INFORMATION MANAGEMENT

Information management refers to the complete set of software capabilities that a computer system provides for handling and managing data. Information management software usually falls into three general levels of capabilities:

- file management
- data management
- database management

File management, the most basic software capability, requires programmers to deal with data in single unrelated files using traditional programming languages like COBOL and FORTRAN. Most file management software requires each application program to precisely describe the data—how it will be used—within the logic of the program. Data security is usually provided by the operating system or by the application program itself.

As data management systems become more sophisticated, they support more user-oriented tools, for example, query languages and report writers; aids for the programmer, such as the ability to deal with logical records through the use of data dictionaries; additional security features; and a higher degree of program/data independence.

Database management, the most sophisticated level, allows for true program/data independence. It also provides comprehensive security and data integrity features, along with sophisticated techniques for modeling data structures and data relationships.

VAX INFORMATION MANAGEMENT PRODUCTS

The architecture of the VAX information management products was developed on the principle that no single approach to information is appropriate for the typical user's combination of application needs. The modular design makes it possible to apply the technology best-suited for filling the needs of an application. The components are a series of building blocks that fit into a well-defined software structure.

The components of the architecture are arranged in layers above the operating system. Each layer has specific capabilities. The layered structure of the architecture makes it possible for the components on one level to use the facilities of other components.

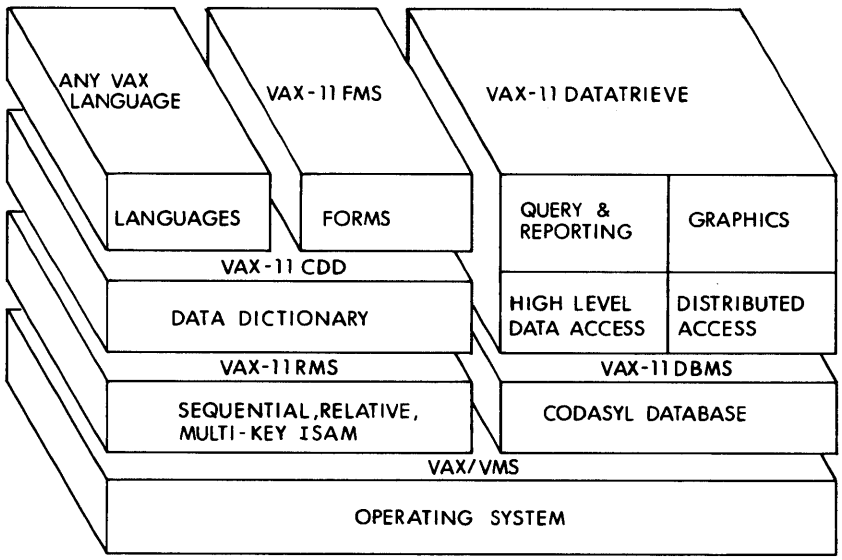

Figure 1-20 Products of the Architecture

On the top layer, the VAX languages and VAX-11 Forms Management System (FMS) provide a user interface for interactive and language-callable video forms. VAX-11 DATATRIEVE supports English-like queries, hardcopy reports, and graphics.

On the next level, the VAX-11 Common Data Dictionary (CDD) integrates the other components of the architecture. The CDD provides a facility for storing logical-to-physical data definitions.

Also on this level are the VAX-11 DATATRIEVE high-level and distributed data access facilities. High-level access allows the user to access data without having to specify the data characteristics, that is, filetype, keys, node name, and so forth. DATATRIEVE uses the definitions stored in the CDD to locate the data. This high-level data access facility also supports a "relational join" capability that can be used to dynamically link related records. Users do not have to determine in advance the records they want to link. Using a relational join, the high-level access facility is capable of making these associations dynamically.

The distributed data access facility retrieves data from remote VAX-11 nodes running VAX-11 DATATRIEVE. The process is totally transparent to the user. A remote query looks just like a local query.

The lowest level consists of two online multiuser data management facilities: VAX-11 RMS (Record Management Services) and VAX-11 DBMS (Database Management System).

The VAX programming languages are a basic part of the VAX system architecture and are integrated into the information architecture. Language support for high-level and direct access to VAX-11 RMS files and VAX-11 DBMS data structures is provided through the VAX standard calling interface to VAX-11 DATATRIEVE. The calls use the same English-like syntax as interactive DATATRIEVE. Programmers can concentrate on coding the procedural part of the application and can call DATATRIEVE to supply a high-level, conditional, value-based data access.

VAX-11 FMS

VAX-11 FMS provides a forms management capability for programming languages and VAX-11 DATATRIEVE. It provides video form support for applications on VT100, VT125, and VT52 video terminals. FMS forms are defined interactively and then stored in a FMS forms library. At runtime, VAX-11 FMS works as a forms management software front end. It passes data between user programs and a video terminal on a per-field or per-form basis.

The process works exactly the same way when FMS forms are used with VAX-11 DATATRIEVE. If a form name is used as part of a DATATRIEVE definition, the VAX-11 DATATRIEVE facility will automatically use the form to collect, display, or modify the associated data.

VAX-11 DATATRIEVE

VAX-11 DATATRIEVE is a complete data management facility that provides both interactive and program-callable access to data in RMS file organization or in more complex, interrelated DBMS database structures. It is a comprehensive query and report writer with full update capabilities. It also includes an integrated graphics capability and forms support through FMS.

VAX-11 CDD

The VAX-11 CDD is the keystone of the architecture. The CDD is essential to the operation of VAX-11 DATATRIEVE and VAX-11 DBMS. VAX-11 DATATRIEVE statements refer to data definitions in the Common Data Dictionary. The CDD is also used to store sequences of VAX-11 DATATRIEVE statements as procedures that can be invoked interactively or from application programs; in addition, the CDD stores database definitions that VAX-11 DBMS needs to create, access, and maintain databases.

VAX-11 RMS

VAX-11 RMS is a file access method which supports sequential record access to sequential file organizations, sequential and random record access to relative file organizations, sequential and random access to multikey indexed files, and concurrent file access with record-level locking. Multikey indexed file processing includes incremental reorganization. VAX-11 RMS also supports transparent file access to and from remote DECnet systems. Nearly all VAX languages provide extended syntax for access to VAX-11 RMS features.

VAX-11 DBMS

VAX-11 DBMS is a full-scale CODASYL-compliant database management system based on the March 1981 Working Document of the ANSI Data Definition Committee. It is a new implementation with many special ease-of-use and performance features. The VAX information architecture allows DBMS data to be accessed directly from programming languages or through VAX-11 DATATRIEVE.

VAX-11 SORT/MERGE

VAX-11 SORT/MERGE is a native-mode utility that can be run interactively, as a batch job, or called from a user-written VAX-11 native-mode program.

The SORT utility allows the user to reorder data from one to ten input files into a single output file in a sequence based upon user-specified key fields within the input data records. If the user does not wish to physically reorder the input file, SORT can be used to extract key information and generate a permanent file. The permanent file can then be used to access the original input file in the order of the key information in the sorted file.

The MERGE utility allows the user to merge data from two to ten similarly sorted input files according to user-defined key fields into a single output file. In order to be merged, the input files must all be in the same sequence, that is, the key fields must be the same as those used to sort the files.

For more detailed information on DIGITAL'S information management products, refer to the *VAX Software Handbook*, the *VAX Technical Summary*, and the *Information Management Sales Guide.*

DISTRIBUTED PROCESSING AND NETWORKING

INTRODUCTION

DIGITAL produces powerful technology that permits the linking of computers and terminals into flexible configurations called networks. Networks can vastly increase the efficiency and cost-effectiveness of data processing operations.

No matter where processors or terminals are located relative to one another—around the plant or around the world—they can, given the proper circumstances, be connected in ways that allow the exchange of information, files, programs and control, and the sharing of peripherals. When they are networked, small computers can access the powerful capabilities of mainframes, while large computers can take advantage of smaller dedicated systems that have been chosen for specific application environments.

Distributed Processing is the general term used to describe the placement of computers where they are needed, whether on the floor of a manufacturing plant, in an accounting department, in a laboratory, or in a home office. As organizations become more complex or develop more sophisticated demands for their computer resources, the ability to network processors and share resources becomes increasingly important.

DIGITAL has the distributed processing and networking products to provide customers with these essential capabilities. First is the series of products known as DECnet, DIGITAL's network software for interconnecting DIGITAL computers. Maing use of the wide variety of CPU classes, architectures, power, etc., DECnet Phase III allows users to connect DIGITAL computers into a dynamic network that can adapt to a user's changing needs.

The second way to interconnect computer systems is by using the series of protocol emulators called Internets. Internets provide a way for DIGITAL computers and terminals to communicate with those of CDC, IBM, and UNIVAC. For example, users of IBM mainframes could efficiently distribute a number of DIGITAL minicomputers to local application sites, while maintaining a link to the central computer via DIGITAL's Internet products.

The third way to interconnect computer systems is through Public Packet-Switched Networks (PPSNs). PPSNs, which are provided by common carriers, are designed specifically for data transmission. DIGITAL's VAX Packetnet System Interface (PSI) conforms to the CCITT X.25 recommendation; it currently allows VAX family computers to communicate over public data networks in the United States, the United Kingdom, Germany, and France.

NETWORKING CONCEPTS

Nodes communicate based on some combination of physical and logical connections. Physical connections are actual circuits between nodes, whether permanent or temporary. Logical connection implies that two nodes are able to communicate whether or not they have a direct physical connection.

There are two types of lines which connect nodes in a network: point-to-point and multipoint. A single point-to-point line connects two adjacent nodes.

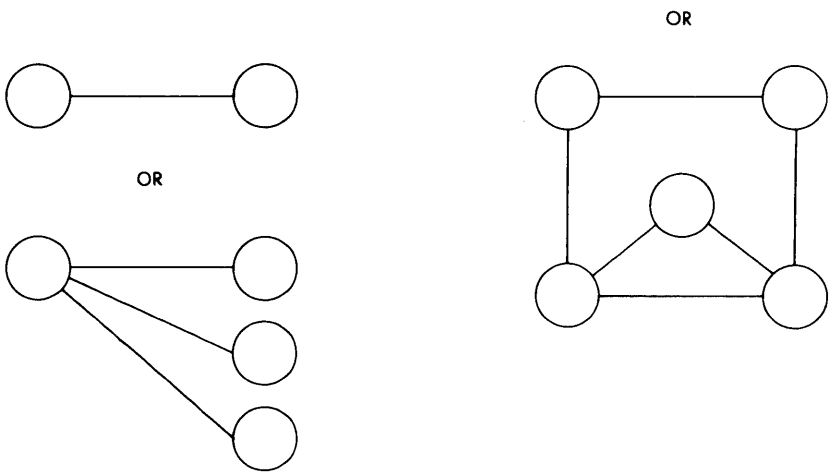

Figure 1-21 Point-to-point physical line

A multipoint (sometimes called multidrop) line is a single line shared by several nodes. One node is designated the control station, or master, and the others are the tributaries or slaves. Access to the network and message traffic is controlled by the master by polling; that is, it queries the tributary computer nodes to see if they have messages to send.

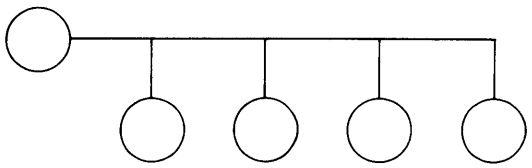

Figure 1-22 Multipoint physical line

Point-to-point lines allow only adjacent nodes to communicate. In order for messages to travel across a series of point-to-point lines, intervening nodes must be capable of passing messages along. This capability, called routing, allows nonadjacent nodes to communicate via logical links with other nodes several links away.

DECnet Phase III provides for communication among non-adjacent nodes with adaptive routing. Messages are routed through the network over the least-cost path(s), as defined by the user. If either a node or a line in this preferred path goes down, the network automatically routes over the next least-cost path.

DIGITAL NETWORK ARCHITECTURE

The DIGITAL Network Architecture (DNA) is a set of protocols (rules) governing the format, control, and sequencing of message exchange for all DECnet implementations. DNA controls all data that travel throughout a DECnet network and provides a modular design for DECnet.

DNA is system-independent. It enables a variety of DIGITAL computers, running a variety of DIGITAL operating systems, to be linked together in a DECnet network.

The functional components of DNA are defined within the following seven distinct layers: the User Layer, the Network Management Layer, the Network Application Layer, the Network Service Layer, the Transport Layer, the Data Link Layer, and the Physical Link Layer.

Each layer is made up of modules that perform a well-defined set of network functions, presenting an additional level of capability to the next highest layer. DNA defines two kinds of relationships between the functional modules that make up the network layers:

- Interfaces—relationships between different modules within a node. Typically, a module in one layer will interface with a module in the layer below it to receive a service.
- Protocols—relationships between equivalent modules in different nodes. Protocols define message formats and the rules for message exchange.

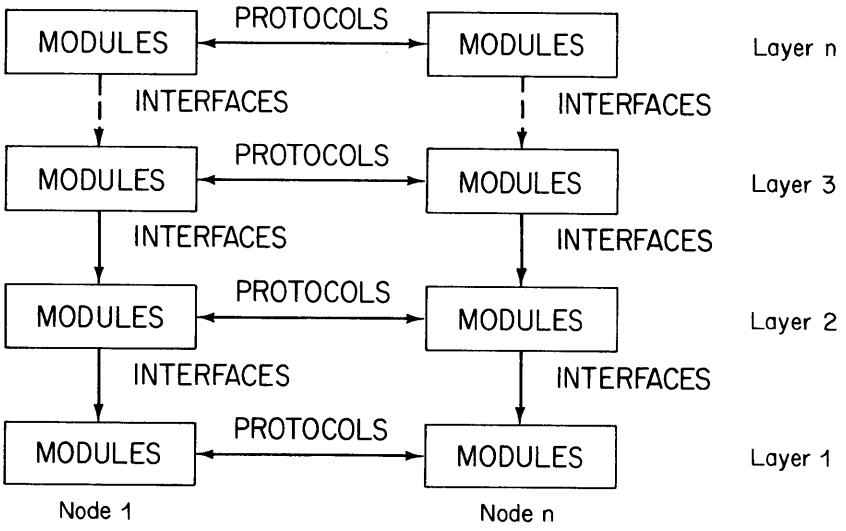

Figure 1-23 Interfaces and Protocols

DECNET COMMUNICATIONS SOFTWARE

DECnet communications software provides user interfaces similar to those provided by DIGITAL's operating systems. To program task-to-task communication or remote file access, programmers use calls formatted for the operating system in which the program will run. The logical link between two programs is like an I/O channel over which programs can send and receive data. Using DECnet software for task-to-task communication is like doing I/O with other peripheral drivers. Terminal users invoke DECnet utilities consistent with local operating system conventions.

All DECnet-VAX interfaces are standard in VAX/VMS V3.0 for use on a local, stand-alone system. With the incorporation of a DECnet-VAX license and additional network software, these same interfaces permit inter-system communication. As a result, users can develop tasks and procedures for operation on a single system and later on, as their needs grow, they can build a network and still use the same programs and procedures without modification in many cases.

Product Capabilities

The network functions available to a DECnet-VAX user depend, in part, on the configuration of the rest of the network. Each DECnet product offers its own functions and its own set of features to the user. Networks consisting entirely of DECnet-VAX Phase III nodes have all the functions described in the following section describing DECNET-VAX Phase III communications software. Networks that combine DECnet-VAX nodes with other DECnet products may limit the functions available to the DECnet-VAX user because some DECnet-VAX features may not be supported by all DECnet products. Conversely, a user of another DECnet implementation will not necessarily have access to all DECnet-VAX functions.

The goal of DECnet-VAX is to provide a network capability that is extremely easy to use. Task-to-task communications and file access between systems is virtually transparent; the intersystem facilities appear to be no different from the intrasystem interprocess communication and file access facilities. Programs executing in VAX native mode, for example, can make use of the following network facilities:

- **Interprocess (Task-to-Task) Communications**— Programs executing on one system can exchange data with programs executing on other systems.

- **Intersystem File Transfer**—A program or user can transfer an entire data file from one system to another.
- **Intersystem Resource Sharing**—Programs executing on one system can access files and devices physically located at other systems in the network. Access to devices in other systems is provided through the file system of the target node and is subject to that system's file system restrictions.
- **Routing**—If the source node and the target node are not directly connected, intermediate nodes will direct data packets to the correct target node.
- **Multipoint**—Several tributary nodes share a common communications line. For all but the most high-performance applications, multipoint is a good choice to cut communications costs.
- **Network Command Terminal**—A terminal on one VAX system can appear to be connected to another VAX system in the network.
- **Downline System Loading**—Initial load images for RSX-11S systems in the network can be stored on the host VAX system and loaded into an adjacent PDP-11 system configured for the RSX-11S operating system.
- **Downline Taskloading**—Program images for RSX-11S systems in the network can be stored on the host VAX system and loaded on request into PDP-11 systems configured for the RSX-11S operating system.
- **Downline Command File Loading**—Command-language users can send command files to a remote node to be executed there; however, no status information or error messages are returned.

DECNET-VAX PHASE III COMMUNICATIONS SOFTWARE

With DECnet-VAX Phase III communications software, a suitably configured VAX/VMS system can participate as a routing node in a DECnet computer network. The VAX/VMS system can communicate with other DECnet systems on VAX/VMS systems; PDP-11 computer systems running RSTS/E, RSX-11M, RSX-11S, RSX-11M-PLUS, and RT-11 operating systems; or on DECSYSTEM-20 systems running the TOPS-20 operating system.

The following functions are supported by DECnet Phase III software.

Access Control

Access control is the method by which network users are screened before gaining access to network facilities. With the appropriate access control information, a user program can log into a remote system and access any of the remote system's resources. To login successfully, the accessing program must have either an account or access to a guest account on the remote system.

Remote File Access

All DECnet systems support exchange of sequential ASCII files. The DECnet software handles compatibility issues among operating systems by translating the file syntax of the sending node into a common network syntax and then appropriately retranslating at the receiving end for that node. The transfer of file types other than sequential ASCII can also be supported between particular operating systems. Between two VAX/VMS systems, for example, sequential or relative files with fixed-length, variable-length, or variable-length-with-fixed-control field records can be transferred. Similarly, multikey indexed files with variable- or fixed- length records are supported.

The Remote File Access capability is implemented by such features as file transfer, remote command file submission/execution, downline taskloading, and terminal-to-terminal communication.

DECnet-VAX software supports file transfers between locally supported File Control Services (FCS) devices and the file systems of other DECnet nodes, system command files to be submitted to a remote node for execution, and command files to be received from other systems for execution.

File Handling Using a Terminal
By using DECnet-VAX DIGITAL Command Language (DCL) commands, the user can copy files from one node to another, delete files stored on a remote node, and transfer a command file to another node and then execute the command file on the remote node.

File Handling Using Record Management Services
A wide range of VAX-11 Record Management Services (RMS) can be used to handle files and records stored on remote nodes. At the file level, these operations include opening, closing, creating, deleting, and updating files stored on remote nodes. Indexed Sequential Access Method (ISAM) files are supported by DECnet-VAX software as part of its RMS support, thereby allowing remote node manipulation of those files organized by this very useful file structure. Also, at the record level, RMS can be used to read, write, update, and delete records stored on remote nodes.

Network Command Terminal Facility
With the Network Command Terminal facility, local users can log onto and use remote VAX systems as though they were local. Network Command Terminals are a software capability and require no special hardware. They provide virtual terminal communication between VAX/VMS systems. Intermediate nodes (that is, nodes that are neither source nor destinations nodes, but are in the message path) can be running DECnet-VAX or other DECnet Phase III software.

Adaptive Routing
Adaptive routing is a key feature of any DECnet Phase III network. With DECnet-VAX Phase III software, a VAX system can act as a hub node. A hub node routes all messages to their proper destinations without the need for a direct, physical line between the originating node and the terminating node.

If a line goes down, a DECnet Phase III system will automatically reroute the communication over another line, transparently to the user. This feature enables network managers to easily reroute traffic to avoid a troublesome line or to run diagnostics on such a line.

Network Management
The Network Control Program (NCP) performs three primary functions: displaying statistical and error information, controlling network components, and testing network operation. These functions can be performed locally or executed at any remote Phase III node that supports these functions.

Task-to-Task Communications
DECnet-VAX provides task-to-task communication, enabling cooperating programs to exchange data. Task-to-task communication is a method of creating a logical link between two tasks, exchanging data between the tasks, and disconnecting the link when the communication is complete. Any VAX language programmer can write programs that perform task-to-task communication.

INTERNET PRODUCTS

DIGITAL's Internet family of products supports the interconnection of DIGITAL computers and DIGITAL networks to systems built by other manufacturers. Internets give data processing managers the freedom to choose mainframes and minicomputers on the basis of application needs, with the assurance that reliable links can be established between systems.

Internet products emulate common communications protocols. They are data transfer facilitators rather than hardware emulators. While they appear to other vendors' computers to be supported devices, they are, in fact, parts of powerful DIGITAL systems. They provide transparent communication with the equipment of other vendors and, at the same time, offer the flexibility of local file systems, many different languages, and a wide selection of computing power.

VAX-11 2780/3780 Emulator

The VAX-11 2780/3780 protocol emulator provides the VAX/VMS user with a mechanism for transferring files between a VAX system and another system equipped to handle IBM 2780 or 3780 communications protocols. It does this by emulating the IBM Binary Synchronous Communications (BISYNC) protocol used by a 2780 or 3780 Remote Batch Terminal.

The emulator can be invoked either interactively, by a command procedure, or by a combination of command procedures. The emulator's command set is designed to facilitate the sharing of a communication line by several users. With the appropriate modem options, the emulator is capable of automatically answering incoming calls.

The VAX-11 2780/3780 protocol emulator can be used in conjunction with DECnet networks, meaning that VAX systems in a DIGITAL network can also communicate with IBM systems.

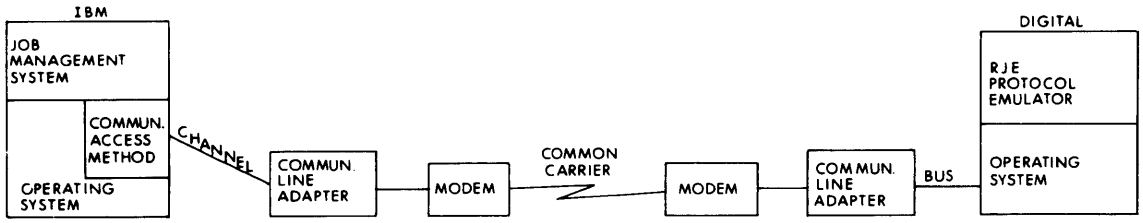

Figure 1-24 VAX 2780/3780 Protocol Emulator

VAX-11 3271 Protocol Emulator

The VAX-11 3271 protocol emulator provides VAX system users with an interactive program-to-program link to an IBM mainframe. This emulator enables a user application program on a VAX system to exchange data with a program running under CICS or IMS on an IBM host (System/370). Using two application programs—one for the DIGITAL side and one for the IBM side—the VAX system user can both send and receive data.

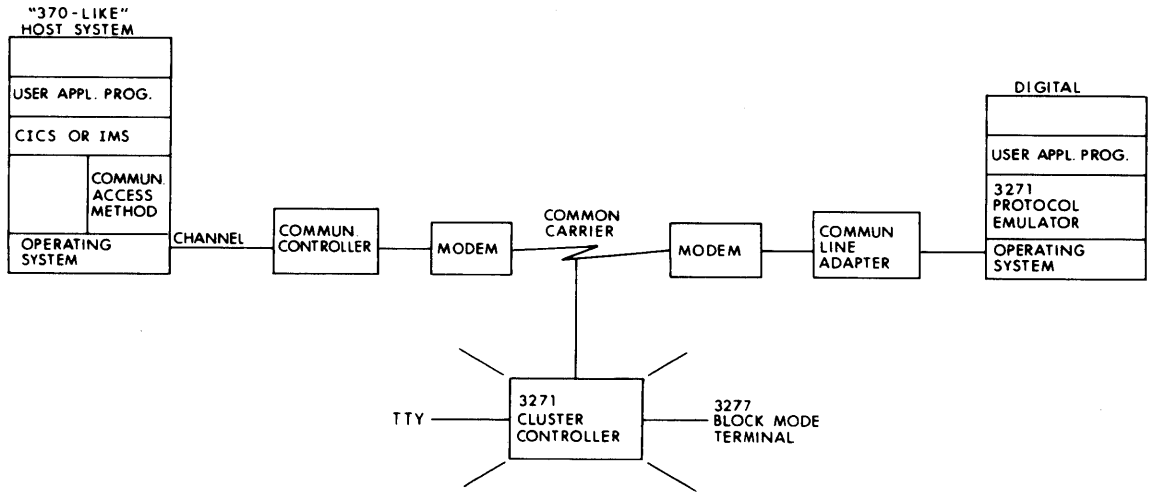

Figure 1-25 VAX 3271 Protocol Emulator

MUX200/VAX Multiterminal Emulator

The MUX200/VAX multiterminal emulator is a VAX-based software package that provides communication with CDC-6000 series systems, CYBER series systems, or other host computer systems capable of using 200 UT mode 4A communications protocols.

Any VAX interactive terminal can be used to control remote job entry or to communicate at command level with the host system. Input files can be sent from, and output files received onto, any VAX-supported mass storage, unit record, or terminal device.

With the MUX200/VAX emulator, several users can communicate simultaneously with a host system over a single line. The VAX/VMS system, using a single physical drop, appears to the host as a number of multidrops and terminals on the circuit.

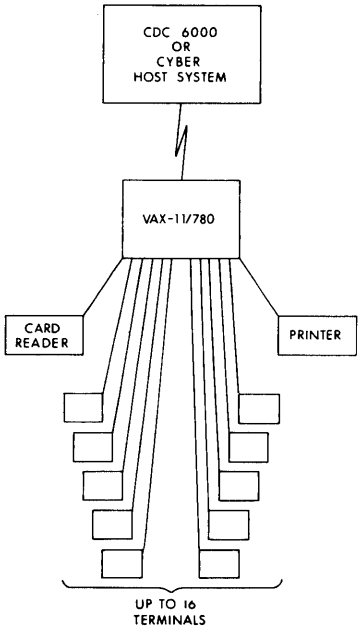

Figure 1-26 MUX200/VAX Multiterminal Emulator

PACKETNET PRODUCTS

In the 1970s, the International Telephone and Telegraph Consultative Committee (CCITT) developed a series of recommendations for standard communication protocols that could be used by common carriers to provide data communications services. Known as X.25, this recommendation defines the interface of computers to public packet-switched networks (PPSNs). The CCITT has also developed a second set of protocols (X.3, X.28, and X.29) that specifies the direct interface of asynchronous terminals to the PPSN. These three protocols make up the Interactive Terminal Interface (ITI).

The fundamental technology used in public data networks is called packet switching. With it, user data and the accompanying control information needed to ensure delivery to the correct location are formed into discrete entities—packets. The network dynamically interleaves the packets of many users over shared transmission facilities and routes the packets to their destinations. Unlike conventional telephone setups, wherein the user is charged for both connect time and distance, regardless of the amount of data passed, charges in public data networks are determined by connect time and volume of data sent, regardless of distance. This is advantageous for dispersed organizations and certain traffic classes.

X.25 is rapidly becoming the standard international communications protocol. Whereas a manufacturer-specific protocol limits one's choice of vendors, an international recommendation like X.25 gives the users the ability to communicate between multiple system vendors. The only restriction is that they all "talk X.25". X.25 ensures data integrity while simultaneously relieving users of any concern about input and output speeds of the various processors in the network.

Public data networks are currently operational in the United States (the Telenet and Tymnet networks), France (the Transpac network), Germany (the Datex network), and the United Kingdom (the PSS network). Other public data networks about to become operational include Canada, Holland, Switzerland, Italy, and Australia. Refer to the SPD for the latest list of supported countries.

DIGITAL's Packetnet products provide customers with yet another choice for distributing their computing in creative, cost-saving ways. X.25 will soon be integrated into the DIGITAL Network Architecture, reaffirming the DIGITAL commitment to provide customers a choice of standard international approaches to distributed computing.

VAX-11 PSI

VAX-11 PSI (Packetnet System Interface) allows a suitably configured VAX/VMS system to connect to Public Packet Switching Networks (PPSNs) conforming to the CCITT recommendation X.25. Access to VAX-11 PSI is supported for VAX/VMS user programs written in VAX-11 MACRO and native-mode high-level languages. VAX-11 PSI supports process-to-process and remote terminal communications via the network. VAX-11 PSI products are currently available for use in the United States, France, Germany, and the United Kingdom. However, refer to the SPD for the latest list of supported countries since PSI products in several other countries are about to become operational.

For interprocess communication, application programs use VAX/VMS System Services to set up and break connections with the network, to send and receive data, and to issue control and synchronization requests.

To remote terminal users, VAX/VMS appears similar to that of local terminals—application programs need not be aware that access to the terminal is via the VAX-11 PSI software.

LOCAL-AREA NETWORKS

A comprehensive interactive and distributed computing strategy requires a plan for local networks. This would be useful in such areas as cooperating single-user stations, distributed data processing, or multiterminal access. These and other applications characterized by burstly traffic at high peak data rates lend themselves to a local network solution.

DNA (DIGITAL Network Architecture) and DECnet products today embrace a wide range of communications technologies. Within DNA, DECnet will be extended to include Ethernet channels, just as it is currently being extended for X.25 links. Like X.25, it can be incorporated into DNA as an alternative protocol, providing customers with additional flexibility.

The Local-Area Network program is intended to augment, not replace, other Distributed Processing programs. Ethernet is an additional capability to be provided within DNA. DIGITAL will have products that implement the Ethernet specification within the next 12 to 18 months.

For detailed information on DIGITAL'S distributed processing and networking products, refer to the *VAX Software Handbook*, the *VAX Technical Summary*, and the *Distributed Processing and Networks Sales Guide.*

VAX LANGUAGES

VAX/VMS includes both the tools and power for a complete program development environment. In addition to the VAX-11 MACRO assembly language, VAX/VMS supports those optional high-level programming languages commonly used in developing a variety of applications. With its wide range of language support, VAX/VMS now offers VAX users the choice of the right language for the right application.

VAX/VMS provides two programming environments—the VAX language environment and the host development environment. VAX-11 BASIC, VAX-11 COBOL, VAX-11 C, VAX-11 FORTRAN, VAX-11 PASCAL, VAX-11 PL/I, VAX-11 BLISS-32, VAX-11 BLISS-16, VAX-11 CORAL 66, VAX-11 MACRO, and VAX-11 DSM are all fully supported VAX languages that generate native mode object code (except for BLISS-16) and execute in native mode (except for CORAL 66). PDP-11 FORTRAN IV/VAX to RSX and MACRO-11 are fully supported host development languages that execute in compatibility mode and generate compatibility mode object code.

THE VAX LANGUAGES

VAX-11 BASIC

VAX-11 BASIC, Version 1.4 is the native mode BASIC language offering for VAX/VMS. VAX-11 BASIC provides the high programmer productivity characteristics of all DIGITAL BASIC offerings and the immediate mode processing necessary for efficient BASIC program development. Because of its high performance and breadth of function, VAX-11 BASIC is an ideal language for a wide variety of applications across market areas. VAX-11 BASIC is designed to meet the needs of both technical and commercial users in applications as diverse as process control and insurance.

VAX-11 BASIC takes full advantage of VAX floating point and character instructions as well as virtual memory. BASIC also allows the user to take full advantage of the VAX-11 Symbolic Debugger and the complex mathematical routines in the VAX-11 Runtime Library.

VAX-11 BASIC is a superset of PDP-11 BASIC-11, BASIC-PLUS and BASIC-PLUS-2 and is designed to ease the transition for users moving programs written in BASIC from the PDP-11 to

VAX. A translator utility is included with VAX-11 BASIC for users moving programs from BASIC-PLUS on RSTS/E to VAX-11 BASIC. A separately packaged BASIC-11 translator is also available in the BASIC translator package. RSTS/E BASIC-PLUS and BASIC-PLUS-2 users will find support of CVT, FIELD, virtual arrays, and selected RSTS/E nonprivileged SYS calls in VAX-11 BASIC. Users moving programs and data across implementations should consult the BASIC transportability package. In addition to the capabilities of BASIC-PLUS-2, VAX-11 BASIC offers:

- Fast program linkage
- Typical compilation speeds of up to 3000 lines per minute—at least ten times faster than compilation speeds for PDP-11 BASIC-PLUS and BASIC-PLUS-2
- Direct execution of unnumbered statements (immediate mode)
- Sharable native mode code
- LOAD to access previously compiled subprograms at RUN time
- Interactive text editing
- RUN command
- Word (16-bit) integer and longword (32-bit) integer support for both compatibility with the PDP-11s and greater significance
- CALLs to and from external subroutines in other VAX languages

Other important BASIC features include:

- Extensive string handling features
- Matrix handling facilities
- Access to system services as CALLS or function references
- Program segmentation
- Enhanced CALL
- Cross reference and resequencer facilities
- Integrated HELP
- Chaining

File Handling

VAX-11 BASIC gives access to the VAX-11 RMS file and record processing options. VAX-11 BASIC has an OPEN statement that allows specification of file organization, access modes, file sharing record formats, size, and allocation. At the record level, a programmer can FIND, GET, PUT, UPDATE, or RESTORE any record in a file either sequentially or randomly.

Long Variable Names

VAX-11 BASIC allows variable names of up to 31 alphanumeric characters including underscore and periods. This feature greatly enhances readability of programs.

Dynamic String Handling

The BASIC programmer can easily manipulate strings of alphanumeric characters. The VAX-11 BASIC language includes string operators to concatenate and compare strings, functions to convert strings to and from numeric values, and functions to analyze the composition of strings.

Print Using

The PRINT USING statement allows the programmer to control the appearance and location of data on an output line to create complex lists, tables, reports, and forms.

Source Program Libraries
VAX-11 BASIC has an APPEND command that provides a mechanism for writing modular, reliable, and maintainable programs by eliminating duplication of source code. A section of program text that is used by several program units, such as a COMMON block specification, can be created and maintained as a separate source file. All program units which reference the COMMON block then merely APPEND this common file.

The LOAD Command
A major goal of VAX-11 BASIC is to support a program development environment. The LOAD command allows a user to stay in BASIC, even when a program under development involves several separately compiled BASIC subroutines. When a RUN command is issued, any BASIC modules moved into memory by the previous LOAD command are automatically bound together with the module under development, and the resulting in-memory image begins execution; that is, the user is not required to leave BASIC, invoke the LINKER, and use the DCL $RUN command. This considerably speeds program development.

Once an application has been checked out, a final call on the LINKER can be used to create a sharable native mode executable image for production use.

Calling External Subprograms and Functions
VAX-11 BASIC has both an external program CALL statement and an external function call that provide the interface to the common language environment.

Sharable Reentrant Programs
All code produced by VAX-11 BASIC is sharable, position-independent, and reentrant. These features allow users to write subprograms and place them in sharable libraries for use by any native language product.

COMMON Statement
VAX-11 BASIC supports a COMMON statement that can be used to share data among subprograms in an image. Furthermore, by using a global section, data in a COMMON can be shared among cooperating processes.

Debugging Facilities
VAX-11 BASIC debugging facilities include diagnostic messages and use of the VAX Symbolic Debugger. The DEBUG program lets the programmer set breakpoints and trace points, and examine and modify the contents of locations dynamically when executing the program.

Migration to VAX/VMS
During the VAX-11 BASIC Field Test, numerous sites moved programs from BASIC-PLUS-2 and BASIC-PLUS (on PDP-11 systems) to VAX-11 BASIC. A typical site converted literally hundreds of programs with few difficulties. Minor changes were made to BASIC-PLUS-2 programs—error checking in VAX-11 BASIC caught actual bugs in many "working" programs. BASIC-PLUS programs were converted to EXTEND mode (or run through the BASIC-PLUS to VAX-11 BASIC translator) and then modified as though they were in BASIC-PLUS-2. Files were then copied over on tape or by using DECnet, and the programs were RUN under VAX-11 BASIC. In the event errors were detected by BASIC, the online HELP facility was used to determine any additional changes needed for correct compilation.

Certain features are carried through from PDP-11 BASIC-PLUS/PLUS-2 to VAX-11 BASIC in order to make the move to VAX easier. These include:

- BASIC-PLUS to VAX-11 BASIC Translator Utility
- Program RESEQUENCE utility from BASIC-PLUS-2, V1.6

- FIELD statement
- CVT, SWAP, and MAGTAPE functions
- Foreign buffer support
- String arithmetic
- Numerous nonprivileged RSTS/E SYS calls
- Virtual arrays

VAX-11 COBOL

VAX-11 COBOL, Version 2.0, is a high-performance implementation of COBOL that brings the vAX-11 even more competitively into the commercial marketplace. VAX-11 COBOL is based on American National Standard Programming Language COBOL, X3.23-1974, the industrywide accepted standard for COBOL. Most features planned for the next COBOL standard, based on the specifications in the Draft Proposed Revised X3.23 American National Standard Programming Language COBOL, are also included.

VAX-11 COBOL is a leadership product that not only is based on the existing COBOL standard, but also supports most features in the next COBOL standard. VAX-11 COBOL is designed to allow users to move easily from the PDP-11 COBOL or VAX-11 COBOL-74 since it follows the existing ANSI COBOL standard.

VAX-11 COBOL users will find that the SORT/MERGE facility, Report Writer facility, packed-decimal support, EBCDIC collating sequence, and single-quote-delimited nonnumeric literals result in greater compatibility with IBM COBOL implementations.

VAX-11 COBOL supports an embedded Data Manipulation Language (DML) interface to VAX-11 DBMS, DIGITAL's CODASYL-compliant Database Management System. The COPY FROM DICTIONARY statement, a DIGITAL extension to COBOL, is a feature that provides access to common record definitions stored in the VAX-11 Common Data Dictionary. These two facilities provide access to the VAX-11 Information Architecture from COBOL.

VAX-11 COBOL provides the following general features:

- High-speed compilation and program execution.
- Compilation speeds are around 3,000 lines per minute.
- Tests with the U.S. Steel Benchmark yield results of 303 (decimal subscripts) and 840 (binary subscripts) on a VAX-11/780. Compare this to PDP-11 COBOL, and VAX-11 COBOL-74 figures of 62 and 89 (decimal subscripts) respectively. These results far exceed benchmarks done on other minicomputer COBOL products and indicate our strength in competing with mid-range IBM offerings.
- Full use of the VAX-11 Common Runtime Library
- Data types, providing full support for compatibility with both IBM and other COBOL implementations.
- Direct calls to VAX/VMS System services
- Calls to an by external subroutines in COBOL and other VAX languages
- Use of VAX/VMS utilities including SORT/MERGE and VAX Symbolic Debugger
- VAX-11 RMS facilities for I/O management
- Transparent access to DECnet
- Complete utilization of VAX-11 instruction set

VAX-11 COBOL provides high-level support for the features defined in the following modules of the 1974 ANSI COBOL standard:

- Nucleus Module
- Table Handling Module
- Sequential I/O Module
- Relative I/O Module
- Indexed I/O Module
- Report Writer Module
- SORT/MERGE
- Segmentation Module
- Library Module
- Interprogram Communication

Powerful new features include support for:

- COBOL Data Manipulation Language (DML) for database applications
- Structured programming features including the EVALUATE statement, scope-delimiter statements, inline PERFORM, contained (nested) programs, and the INITIALIZE statement.
- Report Writer features for automatic report-structuring/generation applications
- External data and files features
- File sharing and record locking for interactive file applications
- Symbolic characters for graphic applications
- ACCEPT AT END for interactive terminal applications
- Conditional compilation facility for improved programmer productivity

VAX-11 COBOL supports the following DIGITAL extensions to COBOL:

- RMS-STS, RMS-STV, and RMS-FILENAME special registers
- File sharing and record locking features
- VALUE IS EXTERNAL - access to link-time constants
- USAGE IS POINTER - address data type
- VALUE IS REFERENCE - compile-time address evaluation
- SET TO REFERENCE - runtime address evaluation
- Thirty-one character user-names
- Single-quote-delimited non-numeric literals
- Hyphen/underscore equivalencing in user-names

The VAX-11 COBOL product includes a COBOL compiler, the REFORMAT Utility, and the VAX-11 COBOL-74 Translator Utility. The REFORMAT Utility converts source programs from DIGITAL terminal format to ANSI-standard COBOL format, and vice versa. The VAX-11 COBOL-74 Translator Utility is used for converting PDP-11 COBOL and VAX-11 COBOL-74 specific features to VAX-11 COBOL.

Because of its high level of functionality and performance, VAX-11 COBOL is an outstanding language offering for both new and existing commercial users of VAX/VMS. Its design ensures minimal conflicts with the existing COBOL standard, while providing the enhanced functionality planned for the upcoming standard. High speed compilation and execution make VAX-11 COBOL a highly competitive product for commercial applications.

Customers considering DIGITAL VAX-11 offerings should be directed to VAX-11 COBOL, Version 2.0. Existing VAX-11 COBOL-74 customers are encouraged to upgrade to VAX-11 COBOL. Upgrade kits are available for this purpose.

For those GSG customers who absolutely require a validated ANSI '74 COBOL compiler on the VAX-11 which conforms to FIPS PUB21-1, continue to bid VAX-11 COBOL-74. Until VAX-11 COBOL is successfully validated against the upcoming ANSI standard, VAX-11 COBOL-74 will continue to be sold and supported as a Category A product, but only to GSG customers.

In cases where you have an opportunity to influence an RFP or where a government agency wishes to purchase our new VAX-11 COBOL, you should advise your customer to formally waive the ANSI '74 requirement and specify that either an ANSI '74 compiler or a compiler based on the draft ANSI standard is acceptable.

For further information or clarification, contact the GSG product line.

VAX-11 C

VAX-11 C is a general-purpose programming language featuring modern control and data structures, and a rich variety of operators for economy of expression. It combines many of the features of a high-level language with the generality of MACRO. VAX-11 C is a complete implementation of the C language developed at Bell Laboratories (as described in "The C Programming Language", by Kernighan and Ritchie) and includes recently-defined extensions.

The VAX-11 C language offers the programmer several advantages, including generation of optimized, sharable, position-independent native VAX code, fast compilation speeds, plus the ease and flexibility of development that goes along with using a language that is integrated within the VAX/VMS environment.

Features of the VAX-11 C language include:

- Modern control constructs for efficient, structured programs
- A rich variety of simple and concise operators
- User-defined, or "enumerated" (ENUM) data types
- An extensive library of runtime support routines, including standard I/O, math and string functions, and access to the VAX-11 Common Runtime Library
- Runtime support to aid UNIX [1] to VAX/VMS migration, including emulation of many UNIX-specific routines.
- Generation of some debug and traceback records for VAX-11 Symbolic Debugger support
- Extensive global and local optimization of generated code for reduced code size and increased execution speed
- Compiler-generated listings with several options

The C programming language was originally developed at Bell Laboratories for creating the UNIX operating system, and it has become the language of choice for many applications developed on that system. As an aid to migrating programs from UNIX systems to VAX/VMS, the VAX-11 C runtime library includes many of the UNIX-specific C routines, emulated to run under VAX/VMS. In addition, VAX-11 C allows UNIX-style stream I/O access to VAX-11 record formats. For more information concerning the UNIX operating system, refer to the TIG product line statement in this Sales Guide.

VAX-11 FORTRAN

VAX-11 FORTRAN, Version 3.0 conforms to the FORTRAN language specified by the latest ANSI FORTRAN standard, X3.9-1978. Most importantly, it conforms to this standard at the full language level. In terms of ANSI conformance, no competitor can offer a FORTRAN product superior to the one we now have.

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1 UNIX is a trademark of Bell Telephone Laboratories, Inc.

For users of both the previous version of VAX-11 FORTRAN and PDP-11 FORTRAN IV and PDP-11 FORTRAN 77, there is an important compatibility message: VAX-11 FORTRAN Version 3.0 is a true superset of both Version 2.0 and PDP-11 FORTRANs. Further, since the new ANSI standard has several differences with the previous standard, VAX-11 FORTRAN provides optional, switch-selectable support for programs conforming to the previous ANSI standard, X3.9-1966. Thus, programs write for older compilers both on PDP-11 systems and on other vendors' equipment can be easily transported to VAX systems.

Beyond conforming to full language FORTRAN-77, VAX-11 FORTRAN provides a number of extensions beyond the standard. These extensions include:

- Namelist facility
- Extended language syntax providing access to VAX-11 DBMS through a Data Manipulation Language (DML) preprocessor
- Language elements for keyed and sequential access to VAX-11 RMS multi-key indexed files
- A set of data types beyond those specified for full language FORTRAN-77:
  - LOGICAL*1, BYTE
  - LOGICAL*2
  - INTEGER*2
  - COMPLEX*16, DOUBLE COMPLEX
- Explicit specification of storage allocation units for data types (e.g., REAL*8, INTEGER*4)
- Data initialization in type declaration statements
- DO WHILE, ENDO statements
- Bit manipulation functions
- Hexadecimal and octal constants and Z and O format edit descriptions applicable to all data types
- ENCODE, DECODE statements
- ACCEPT, TYPE input/output statements
- DEFINE FILE statement
- USEROPEN subroutine invocation at file OPEN time
- INCLUDE statement
- 31-character identifiers which may include dollar sign ($) and underline (_)
- Comments allowed at end of each source line
- Debug statements in source

While all of these extensions beyond the ANSI FORTRAN standard are significant, note in particular the fact that VAX-11 FORTRAN provides language elements that allow access to VAX-11 RMS multikey indexed files. This powerful facility allows FORTRAN to be used in applications not normally associated with the language. Through extended FORTRAN language syntax, randomly addressable RMS indexed files can be accessed, modified, and maintained through the use of logical key values that identify individual records.

VAX-11 FORTRAN also provides language elements that support the VAX-11 extended range and extended precision floating point architectural features (G_ floating and H_ floating data types). However, use of these features on the VAX-11/780 and VAX-11/750 requires the extended floating point hardware option.

This sharable, reentrant compiler continues to take advantage of the VAX floating point and character string instruction sets and the VAX/VMS virtual memory operating system. It further provides:

- Support for calls to VAX/VMS system service procedures
- Generation of symbol tables for the VAX Symbolic Debugger
- Generation of sharable code
- Up to 255 actual arguments in a CALL statement
- Up to 250 named COMMON blocks per program

Finally, VAX-11 FORTRAN is a highly optimizing compiler. The optimizations it performs include:

- Constant folding
- Optimizations of arithmetic IF, logical IF, and block IF-THEN-ELSE
- Inline expansion of statement functions
- COMMON subexpression elimination
- Removal of invariant expressions from DO loops
- Allocation of general registers across DO loops
- Flow-boolean optimization
- Jump/branch instruction resolution
- Peephole optimization

File Manipulation

VAX-11 FORTRAN has OPEN and CLOSE statements that extend the file manipulating characteristics of the FORTRAN language. The OPEN statement can contain file attribute specifications that control file creation or subsequent processing. They can govern file organization (sequential, relative, or indexed); method of access (sequential, direct, or keyed); protection (read-only, read/write); record type (fixed, variable); record size; and file allocation or extension.

The program can also specify whether the file can be shared, and whether the file is to be deleted or saved when closed. The OPEN statement additionally specifies the statement to which control is transferred if an error is detected during OPEN.

Source Program Libraries

VAX-11 FORTRAN has an INCLUDE statement that provides a mechanism for writing modular, reliable, and maintainable programs by eliminating duplication of source code. A section of program text that is used by several program units, such as a COMMON block specification, can be created and maintained as a separate source file. All program units that reference the COMMON block then merely INCLUDE this common file. INCLUDE also allows users to include modules from text libraries. VAX-11 FORTRAN provides a text library, that contains FORTRAN source code for many VAX/VMS system symbols.

Calling External Functions and Procedures

VAX-11 FORTRAN has both an external program CALL statement and an external function call that provide the interface to the common language environment.

Sharable Programs

The FORTRAN language can be used to create sharable programs. VAX-11 FORTRAN subprograms can be placed in sharable image libraries created by the linker. These can be made available to any program written in a native programming language.

Debugging Facilities

VAX-11 FORTRAN debugging facilities include diagnostic messages, conditional compilation flags, and use of the VAX Symbolic Debugger. The DEBUG program lets the programmer set breakpoints and trace points, and examine and modify the contents of locations dynamically when executing the program. It can also display FORTRAN source statements and reference arrays symbolically.

In summary, VAX-11 FORTRAN is best characterized by the following two statements:

- VAX-11 FORTRAN is a full language FORTRAN-77 implementation conforming to the latest ANSI FORTRAN standard
- It is a highly optimizing compiler that provides language facilities beyond the ANSI standard, including language elements for access to multikeyed VAX-11 RMS indexed files

VAX-11 PASCAL

VAX-11 PASCAL is an optional language processing system whose implementation is a superset of the PASCAL language as defined in the *PASCAL User Manual and Report* (K. Jensen and N. Wirth). VAX-11 PASCAL is a re-entrant compiler suited for a variety of applications from instructional use to systems programming and research applications. Major features of the language include:

- Block structuring through the use of the BEGIN...END compound statement to allow easy logic flow
- Data types INTEGER, REAL, CHAR, and BOOLEAN which may be user-defined
- Data structuring including the ability to declare and use pointers, records, files and arrays
- Predefined procedures and functions to deal with I/O handling and data manipulation

VAX-11 PASCAL takes advantage of the VAX hardware floating point and character instructions, as well as the virtual memory capabilities of the VAX/VMS operating system. Features common to other languages of VAX/VMS are also available through VAX-11 PASCAL including:

- VAX-11 Symbolic Debugger support
- Separate compilation of modules
- Standard CALL interface to routines written in other languages
- Access to VAX/VMS system services

File Manipulation

VAX-11 PASCAL has OPEN, CLOSE, and FIND I/O procedures that extend the I/O capabilities of the PASCAL language. The OPEN procedure can contain file attributes that define the creation or subsequent processing of the file. The FIND procedure is an extension to the language for direct access to sequential files of fixed length records. The standard I/O procedures GET, PUT, READ, WRITE, READLN, and WRITELN are also available in VAX-11 PASCAL.

Separate Compilation

VAX-11 PASCAL permits separate compilation of procedures and functions (routines). Such a separate compilation unit is termed a MODULE and several routines may be part of a MODULE. Each MODULE is eventually embedded in a host or main program.

Calling External Procedures

Programs written in VAX-11 PASCAL can CALL system services and routines written in other high-level languages through the use of the standard VAX calling procedures. Three parameter

specifications (%DESCR, %IMMED, and %STDESCR) are added to the PASCAL language to denote the method of argument passing when calling a system service or a procedure or function not written in PASCAL.

Debugging Facilities
VAX-11 PASCAL debugging facilities include compile-time and runtime diagnostic messages, conditional compilation switches, and full support by the VAX-11 Symbolic Debugger.

Library Support
Library support includes a special PASCAL library supplied with the compiler and installed in the system library.

VAX-11 PL/I
VAX-11 PL/I is an optional language package whose compiler supports the PL/I language defined in the American National Standard (ANSI) General Purpose Subset. This subset, defined by ANSI standard X3.74, is a proper subset of the full ANSI PL/I (ANSI X3.53-1976).

The General Purpose Subset includes the most widely used features of full PL/I and is well suited for use in commercial, scientific, and systems programming applications. As such, it is easy to learn, less error-prone and more transportable than full ANSI PL/I.

VAX-11 extensions to the subset provide additional language features that allow PL/I programmers to take full advantage of the VAX/VMS's system services and features. Extensions provided include selected features of full PL/I that were excluded from the subset because of their implementation cost on computers with restricted memory and/or address space.

VAX-11 PL/I programmers can thus choose to restrict their programs to the General Purpose Subset, ensuring compatibility with other implementations of the subset; or they can take advantage of full PL/I features and VAX-11 extensions in programming applications.

Data Structuring
Data processing applications can take advantage of PL/I's extensive character-handling functions and data structuring capabilities. By declaring variables within a structure, the program can easily refer to entire records or to fields within records by referring to the name of the structure or to the name of a variable within it.

Record Management
VAX-11 PL/I provides extensive access to the features of VAX-11 Record Management Services (RMS). By specification of ENVIRONMENT options or special options supplied for input/output statements, PL/I programs can dynamically specify RMS optimization parameters and values, spool a file to a printer or batch job queue, and set or change the protection on a file.

VAX-11 PL/I supports all of RMS's file organizations, including sequential, relative, and indexed sequential. VAX-11 PL/I also permits block input/output operations. Using PL/I statements, a program can read, write, delete, and update records. Using built-in file handling functions, a program can call RMS file handling services to delete, rename and make directory entries for a file.

Array Handling
Scientific applications can use PL/I's array-handling capabilities to define arrays of up to eight dimensions. Common arithmetic and trigonometric functions are defined within the language. VAX-11 PL/I supports all VAX hardware floating point data types.

System Programming

System programming applications can use PL/I language features to allocate storage dynamically, process linked lists and queues, and perform a wide range of bit-string functions and operations.

In addition, VAX-11 extensions to the language provide a simple means to refer to VAX/VMS system global symbols and data structures. VAX-11 PL/I programs can take advantage of the VAX-11 linker's allocation of storage by defining variables as read-only or as global symbols.

Full access to all of VAX/VMS's services and procedures is possible through VAX-11 PL/I extensions to support the VAX-11 Procedure Calling Standard. Procedures written in PL/I can call and be called by procedures written in any other native mode language.

Error and Condition Handling

VAX-11 PL/I generates traceback records in the object module of a PL/I procedure, so that when an error occurs at run time, the VAX-11 condition handling facility can report on the error and provide a module traceback.

Within the PL/I language, extensive condition handling capabilities are available via the ON statement. This allows a program to define the action to take in the event of hardware arithmetic exceptions and errors that occur during file processing. VAX-11 extensions to the ON statement permit the specification of condition handlers for any specific hardware or software condition that can occur.

Debugging Facilities

The PL/I compiler generates useful diagnostics signalling syntactical errors and language violations. Most compiler messages are two or three lines long and provide information on how to correct the indicated error.

Programs written in PL/I can also be debugged by using all the standard features of the VAX-11 Symbolic Debugger. Programmers can set breakpoints in PL/I programs, examine and change any variables, and monitor the calls and function references that occur.

Libraries

VAX-11 PL/I is fully compatible with the VAX-11 Run-Time Library and provides additional run-time procedures for language support.

Source file library support is provided by the %INCLUDE statement, which allows a program to specify at compile time an external file from which source statements are to be read.

Performance

The VAX-11 PL/I compiler is a sharable, native VAX/VMS image that can be run on any VAX/VMS configuration. It produces optimized, sharable, VAX object code that is runtime compatible with the entire family of VAX language products as well as with the VAX-11 Runtime Library. The compiled code makes full use of the VAX family architecture and VAX/VMS features.

The degree of optimization performed by the compiler can be controlled by the user at compile time, by qualifiers on the PL/I command.

VAX-11 BLISS-32

VAX-11 BLISS-32 is an optional, high-level systems implementation language for the VAX family. It was specifically designed for developing software such as operating system modules, compilers, realtime processors, and utilities. The BLISS-32 compiler runs in native mode under VAX/VMS.

VAX-11 BLISS-32 contains many of the features of high-level languages, that is, DO loops, IF-THEN-ELSE statements, automatic stack and register allocations, and mechanisms for defining and calling routines while providing the flexibility, efficiency and access to hardware expected from assembly language. For example, the BLISS programmer can directly reference addresses and other low-level machine attributes as if working in assembly language. Yet a single line of BLISS code is equivalent to many lines of assembly language code. Programs written in BLISS-32 are also more readable than MACRO programs. This makes them easier to maintain. And BLISS-32 code compiles into little more space than assembler code. The BLISS-32 programmer can also work with macros, library facilities, compile-time facilities, and a choice of data structures. BLISS-32 provides extensive exception handling features, error detection and messages, and supports block structure and state-of-the-art control structures.

VAX-11 BLISS-32 can be used as an alternative to assembly language coding in all except the most machine-dependent systems programming applications. With the ease of high-level language and assembly language flexibility, BLISS-32 helps programmers be more productive, shortens project development times, and lowers maintenance costs.

The VAX-11 BLISS-32 language processor offers programmers the following features:

- program execution on architecturally different machines with little or no modification
- construction of complex expressions in which several different kinds of operations can be performed in a single program statement
- exploitation of high-level language constructs

BLISS-32 was not intended to replace any of the VAX-11 languages, but to complement them. Programs written in other VAX-11 languages can call BLISS-32 routines through the standard VAX-11 calling sequence. Programs using BLISS-32 may access the common language environment.

Primary users of VAX-11 BLISS-32 will be VAX customers who do significant software development in the area of operating system modules, compilers, realtime processors, and utilities. Other BLISS-32 users will be looking for gains in programmer productivity and software quality, as well as for long-term reduction of software maintenance costs.

VAX-11 CORAL 66

VAX-11 CORAL 66 is a high-level programming language derived from JOVIAL and ALGOL-60. In 1970, CORAL was established as the standard military realtime and systems-implementation language by the U.K. Government, and has British Standards Institute approval. (International Standards Organization (ISO) approval is currently being requested.)

Following its widespread use in military projects, it has since been adopted by many companies for industrial process control, research and commercial applications around the world.

DIGITAL first implemented CORAL 66 as a PDP-11 compiler in 1976 (now at Version 3 level). The VAX implementation is based on the PDP-11 version. The VAX-11 CORAL 66 implementation compiles in compatibility mode and generates native mode object code. Like the PDP-11 version, VAX-11 CORAL 66 conforms fully to the U.K. Government's Official Definition for the language, and will be officially approved.

Major features of the language include:

- Block structuring through the use of the BEGIN...END compound statement to allow easy logic flow

- Data types integer, real, byte, character string
- Supports data structures
- Comprehensive Runtime Library, giving access to all VAX/VMS functions

VAX-11 CORAL 66 takes advantage of the VAX hardware floating-point and character instruction sets and the virtual memory capabilities of the VAX/VMS operating system. Many features common to other VAX/VMS languages are available through VAX-11 CORAL 66, such as:

- Separate compilation of modules
- CALL interface to routines written in other languages
- Access to VAX/VMS system services

File Manipulation

The VAX-11 CORAL 66 Run-Time Library includes the following I/O procedures:

- Render an I/O device accessible by a program
- Create a new file
- Open an existing file for read/write access
- Obtain file identification information
- Close, extend or erase a file
- Disassociate an I/O device from a program

In addition, there is an extensive set of I/O procedures for the input and output (both to files and terminals) of records, blocks, characters, integers and reals.

Separate Compilation

VAX-11 CORAL 66 permits separate compilation of procedures and functions (routines). Each compilation unit is termed a "SEGMENT," with segments individually compiled and later combined into a single program.

Calling External Procedures

Programs written in VAX-11 CORAL 66 can CALL system services and routines written in other high-level languages through the use of the standard VAX calling procedures.

VAX/VMS System Services

VAX-11 CORAL 66 has full access to VAX/VMS system services. This includes provisions for the CORAL 66 programmer to interrogate the status return using the VAX/VMS symbolics.

Library Support

VAX-11 CORAL 66 supports its own Runtime Library, as well as the VAX/VMS system services and Runtime Library.

Debugging Facilities

VAX-11 CORAL 66 debugging facilities include compile-time and run-time diagnostic messages and conditional compilation switches. Generation of TRACEBACK records for the VAX Symbolic Debugger is a compile-time option, that allows line mode debugging of the program.

VAX-11 MACRO

The VAX-11 MACRO assembler accepts one or more source modules written in MACRO assembly language and produces relocatable object module and symbol table and optional assembly listing. VAX-11 MACRO is similar to PDP-11 MACRO, but its instruction mnemonics

correspond to the VAX native instructions. VAX-11 MACRO is characterized by the following:

- Relocatable object modules
- Global symbols for linking separately assembled object programs
- Global arithmetic, global assignment operator, global label operator, and default global declarations
- User-defined macros
- Multiple macro libraries with fast access structure
- Conditional assembly directives
- Assembly and listing control functions
- Alphabetized, formatted symbol table listing
- Default error listing on command output device
- A Cross Reference Table (CREF) symbol listing

Symbols and Symbol Definitions

Three types of symbols can be defined for use within MACRO source programs: permanent symbols, user-defined symbols, and macro symbols. Permanent symbols consist of the VAX instruction mnemonics and MACRO directives; they do not have to be defined by the user. User-defined symbols are those used as labels or defined by direct assignment. Macro symbols are those used as macro names.

MACRO maintains a symbol table for each type of symbol. The value of a symbol depends on its use in the program. To determine the value of a symbol in the operator field, the assembler searches the macro symbol table, user symbol table, and permanent symbol table, in that order. To determine the value of the symbol used in the operand field, the assembler searches the user table and the permanent symbol table, in that order. These search orders allow redefinition of permanent symbol table entries as user-defined or macro symbols.

User-defined symbols are either internal or external (global) to a source program module. An internal symbol definition is limited to the module in which it appears. Internal symbols are temporary definitions that are resolved by the assembler.

A global symbol can be defined in one source program module and referenced with another. Global symbols are preserved in the object module and are not resolved until the object modules are linked into an executable program. With some exceptions, all user-defined symbols are internal unless explicitly defined as being global.

Directives

A program statement can contain one of three different operators: a macro call, a VAX instruction mnemonic, or an assembler directive. MACRO includes directives for:

- Listing control
- Functional specification
- Data storage allocation
- Radix and numeric usage declarations
- Location counter control
- Program termination
- Program boundaries information
- Program sectioning
- Global symbol definition
- Conditional assembly

- Macro definition
- Macro attributes
- Macro message control
- Repeat block definition
- Macro libraries

Listing Control Directives
Several listing control directives are provided in MACRO to control the content, format, and pagination of all listing output that is generated during assembly. Facilities also exist for titling object modules and presenting other identification information in the listing output.

The listing control options can also be specified at assembly time though switch options included in the listing file specification in the command string issued to the MACRO assembler. The use of these switch options overrides all corresponding listing control directives in the source program.

Conditional Assembly Directives
Conditional assembly directives enable the programmer to include or exclude blocks of source code during the assembly process, based on the evaluation of stated condition tests within the body of the program. This capability allows several variations of a program to be generated from the same source module.

The user can define a conditional assembly block of code, and within that block, issue subconditional directives. Subconditional directives can indicate the conditional or unconditional assembly of an alternate or noncontiguous body of code within the conditional assembly block. Conditional assembly directives can be nested.

Macro Definitions and Repeat Blocks
In assembly language programming, it is often convenient and desirable to generate a recurring coding sequence by invoking a single statement within the program. In order to do this, the desired coding sequence is first established with dummy arguments as a macro definition. Once a macro has been defined, a single statement calling the macro by name with a list of real arguments (replacing the corresponding dummy arguments in the macro definition) generates the desired coding sequence or macro expansion. MACRO automatically creates unique symbols where a label is required in an expanded macro to avoid duplicate label specifications. Macros can be nested; that is, the definition of one macro can include a call to another.

An indefinite repeat block is a structure that is similar to a macro definition, except that it has only one dummy argument. At each expansion of the indefinite repeat range, this dummy argument is replaced with successive elements of a specified real argument list. This type of macro definition does not require calling the macro by name, as required in the expansion of conventional macros. An indefinite repeat block can appear within or outside of another macro definition, indefinite repeat block, or repeat block.

Macro Calls and Structured Macro Libraries
A program can call macros that are not defined in that program. A user can create libraries of macro definitions, and MACRO will look up definitions in one or more given library files when the calls are encountered in the program. Each library file contains an index of the macro definitions it contains to enable MACRO to find the definitions quickly.

Program Sectioning
The MACRO program sectioning directives are used to declare names for program sections

and to establish certain program section attributes. These program section attributes are used when the program is linked into an image.

The program sectioning directive allows the user to exercise complete control over the virtual memory allocation of a program, since any program attributes are established through this directive are passed to the linker. For example, if a programmer is writing multiuser programs, the program sections containing only instructions can be declared separately from the sections containing only data. Furthermore, these program sections can be declared as read-only code, qualifying them for use as protected, re-entrant programs.

VAX-11 DSM

VAX-11 DSM provides an additional language processing system as well as data management capabilities for the VAX/VMS environment. VAX-11 DSM is a high-level, multiuser interpretive language that is particularly well-suited for the manipulation of variable-length string data in either a technical or commercial environment. Interpretive processing means that each line of a DSM routine is translated into machine-readable form and executed immediately. Routines written in an interpreted language like DSM do not need to be compiled or linked, making it easy to write, debug, edit and run a routine in one interactive session. Basic features of the DSM system include:

- An extended version of the ANSI Standard MUMPS language
- A language precompiler
- A subset of the I/O options of VAX/VMS
- Support of the VAX-11 Procedure Calling Standard
- Code and data sharing through VAX/VMS global sections
- A journaling facility for database backup
- Independent job control
- Utilities for system maintenance, status information, routine backup, and journaling control

System and Library Utilities

The VAX-11 DSM software package includes a number of utility routines. These utilities are written in the DSM language and are provided to help the application programmer and system manager develop and maintain the software and data for their application.

These utilities fall into two categories: library utilities and system utilities. Library utilities perform general services in the following four categories:

- Procedures affecting routines
- Procedures affecting globals
- Numeric conversion
- Miscellaneous stand-alone

System utilities perform services in the following areas:

- Journaling control
- System information
- Job control and other maintenance operations

HOST DEVELOPMENT LANGUAGES

PDP-11 FORTRAN IV/VAX to RSX

PDP-11 FORTRAN IV/VAX to RSX is an extended FORTRAN IV processor based on the former ANSI standard FORTRAN X3.9-1966. It supports mixed-mode arithmetic, extended in-

put/output facilities for data formatting, error condition transfer statements, bit manipulation, library usage, and several debugging facilities. The PDP-11 FORTRAN IV compiler and its runtime system run in compatibility mode under the RSX-11M Applications Migration Executive (AME) and produce code that can be transported to an RSX-11M, RSX-11M-PLUS, or RSX-11S target system or executed in compatibility mode.

MACRO-11

MACRO-11, the PDP-11 assembly language, is included with the VAX/VMS operating system. The MACRO-11 compiler and its runtime system run in compatibility mode under the RSX-11M Applications Migration Executive (AME) and produce code that can be transported to an RSX-11M, RSX-11M-PLUS, or RSX-11S target system or executed in compatibility mode.

VAX-11 BLISS-16

VAX-11 BLISS-16 is an optional, high-level systems implementation language especially intended for the development of systems software such as operating systems, compilers, runtime system components, database and file systems, communications software, and utilities for use on PDP-11 hardware systems. The BLISS-16 compiler runs in native mode under the VAX/VMS operating system and translates BLISS-16 source programs into relocatable PDP-11 object modules optimized for time and space efficiency.

OFFICE PLUS PRODUCTS

VAX-11 DECmail

VAX-11 DECmail is a comprehensive stand-alone, single-node electronic mail and filing system that runs under the VAX/VMS operating system concurrently with other VAX/VMS applications. DECmail gives users the ability to create, edit, send, receive, and process messages, memos, and documents on a single VAX computer system. In addition, DECmail also includes a sophisticated filing system that provides the ability to store, search, and retrieve messages held in system-provided and/or user-created electronic file folders.

The basic elements of DECmail include a powerful dual-mode command interface (menu-mode & command mode), a flexible full-screen text editor, and a sophisticated easy-to-use filing system. DECmail also provides a comprehensive HELP facility and an assortment of user and system management utilities.

DECset

The DECset Integrated Publishing ™ System is a VAX/VMS hardware and software system that provides total text and document management. The DECset user can combine text and information from a variety of different word processors and office data processing systems, even in geographically different locations. DECset automatically formats text, prepares it for final publication, and can transmit it to local or remote output and storage devices, including word processors, lineprinters, magnetic tape transports, and disk drives.

For more detailed information on both DECmail and DECset, refer to the *Office Systems Sales Guide.*

SECTION 2
VAX SYSTEM DEPENDABILITY
(RELIABILITY, AVAILABILITY, MAINTAINABILITY)

Part of the customer's cost of owning a computer system includes expenses that result whenever the system is not running an application as intended. To the customer, a dependable operation directly translates into increased user and application productivity, financial gain, and overall satisfaction. To DIGITAL, it means happier customers and fewer service calls. Obviously, keeping system availability and reliability high so that the customer can keep his applications running correctly benefits our users and ourselves. That's why the policy for VAX systems has been "quality insurance upfront." Build the right dependability features into the system to begin with so that system reliability and easy servicing are part of the total design.

VAX Dependability Goals

Ideally, the most dependable operating environment would be one where the customer never encounters a system error and never experiences a system failure[1]. Realistically, no computer system can attain this ideal. Equipment breakdowns, external environmental problems, even internal design errors will cause any computer system to fail sometime. So the best goal is to achieve an operating environment where:

- Error recovery happens so quickly that the error does not cause a failure.
- Failure conditions are remedied so fast that the customer may not be aware they have happened.

Because of careful cooperation between VAX hardware and software, VAX systems perform continual checking, detecting, and correcting of error conditions. The result is a fault-tolerant, user-forgiving environment where errors are corrected before they impede system operation. Whenever a failure does occur, VAX maintenance operations proceed quickly and easily. Components are tested and repaired in minimal time, often without disturbing users or bringing the system down.

Customer Benefits

Decisive action to integrate dependability features into VAX systems at the design stage gives VAX systems a level of dependability that surpasses what most of our competitors can offer.

The customer's direct benefits are better system reliability, improved system availability and easier component maintainability.

- Reliability is a measure of the amount of time between system failures. A reliable system gives the customer long periods of uninterrupted service.
- Availability is measured by the percentage of time the system is able to perform an application in the way the customer intended, taking into account repair time due to failures. An available system is a system up and running and executing the application as planned.
- Maintainability is measured by how long it takes to repair a failed system as well as by the degree to which the system is available in some degraded form while maintenance is being performed. A maintainable system uses a design and packaging that encourages fewer, faster maintenance steps, performed with better diagnostic tools. It means quick and skillful repair, performed with minimal disruption of ongoing work.

Reliability, availability, and maintainability are often represented numerically. Reliability is measured as mean time between failures (MTBF), where a higher number implies a more reliable system. Maintainability is measured as mean time to repair (MTTR), where a low number indicates faster servicing. Availability is measured in percent as a function of the two, MTBF/(MTBF+MTTR), where a larger percentage reflects a more available system. Keep in mind that such numbers are statistical in nature and apply only over a statistically significant

1 An error is defined as a nonconformance to specifications and a failure is defined as an interruption in service. Because of dynamic error correction by VAX hardware and software, not all errors cause failures.

sample (i.e., a large number of systems over a long period of time). To avoid misconceptions, be sure to consider the customer's environment (power, room, air conditioning, etc.) and application requirements.

Summary Chart

The following chart lists VAX family dependability features under the main benefits of Reliability, Availability, and Maintainability. For processor-specific dependability features, refer to Section 1 of this Sales Guide, Product Description. Because of the VAX design, that is, complete coordination and cooperation of hardware and software, most features contribute to multiple categories. A brief explanation of the chart categories follows the text. For detailed information, refer to the *VAX Hardware Handbook.*

	REL	AVAIL	MAIN
Error Detection and Reporting			
Consistency Checking/Error Checking		x	x
Exception Handling	x	x	
Parity and Protocol Checks		x	x
Error Correcting Code		x	x
Mass Storage I/O Verification	x		x
System Verification (UETP)	x		x
System Exerciser	x		x
Automatic Online Error Logging		x	x
Machine Checks	x	x	
System Identification			
Hardware Register			x
Application Error Detection	x		
Deadlock Detection	x	x	x
Error Analysis and Recovery			
System Dump Analyzer		x	x
Error Log Reporting Program		x	x
Instruction Retry		x	x
Nonfatal Bugchecks	x	x	
Automatic Stack Expansion	x	x	
Unattended Automatic System Restart		x	x
Automatic Reconfiguration		x	
Diagnostic Console		x	x
Remote Diagnosis/Remote Support		x	x
Dynamic Bad Block Handling		x	
Bad Memory Page Replacement	x	x	
Mass Storage Error Recovery	x	x	
Redundant Recording of Critical Disk Information	x		
Selective Hardware Disabling		x	x
Data Integrity			
Memory Management Hardware	x	x	
Quotas and Privileges	x	x	
Access Control to Files and Volumes	x	x	
Disk Volume Protection	x	x	

	REL	AVAIL	MAIN
Maintenance Aids			
Improved System Packaging	x	x	x
Online Functional Diagnostics		x	x
Fault-Isolation Diagnostics		x	x
Online Update and Maintenance		x	x
Updates and Patches		x	x
High Resolution Interval Clock			x
Maintenance Registers			x

ERROR DETECTION AND REPORTING FEATURES

Logic in the VAX hardware and software monitors system operation and distinguishes error conditions from normal system operation. The VAX/VMS operating system then records and reports detected error occurrences.

Consistency Checking/Error Checking

Continual consistency and error checking by VAX hardware and software increase data reliability by preventing certain error conditions from propagating through a database or a system. Checks detect abnormal instruction uses, transient and permanent hardware errors, and illegal arithmetic conditions. Specific checks include arithmetic traps, limit checking traps, reserved operand traps, special instruction checks, as well as internal consistency checks.

Exception Handling

When any of the above consistency checks detect an error, VAX/VMS uses a uniform condition handling facility to manage both the hardware and software exceptions. Because the exception-handling facility is uniformly consistent within the VAX system design, operation is more predictable and reliable.

Parity and Protocol Checks

VAX systems perform parity checks on MASSBUS data, control and address translation, UNIBUS address translation, memory cache data and address, address translation buffer transactions, microcode and user control store.

Error Correcting Code

Memory error correcting code (ECC) automatically corrects all single-bit memory errors and detects double-bit memory errors. The code will also detect all greater than double-bit errors if the number of errors is even. Disk error correcting code detects most errors and corrects errors in a single error burst of up to 11 bits. ECC provides protection from nonrepeatable errors by automatically correcting data. Detections and corrections are noted in the error log as a preventive maintenance aid.

Mass Storage I/O Verification

I/O verification for mass storage peripherals is supported by the VAX/VMS device drivers. The hardware compares each block for equivalence immediately after the block is read or written. This capability increases reliability, though at the expense of the time required to complete the read or write operation.

System Verification (UETP)
The VAX/VMS operating system contains an automated collection of verification software called the User Environment Test Package (UETP). The UETP provides a comprehensive and systematic exercising of major peripheral devices and software components by running most of the VAX/VMS utilities, calling most of the VAX/VMS System Services and I/O services, each with a wide range of parameters, and by comparing the results to known answers. The system reports errors to the error-log and to the console terminal as execution proceeds.

The UETP is not designed to replace diagnostics, but serves as a means of verifying that that operating system software is correctly installed.

System Exerciser
The System Exerciser diagnostic program performs testing of various subsystems of a VAX system in a user environment operating under VAX/VMS. It verifies hardware system integrity, or indicates those subsystems that may be failing or whose performance may be deteriorating. This testing is done automatically utilizing online diagnostic programs to perform the actual testing.

Automatic Online Error-Logging
Error-logging, a software tool used to monitor error occurrences, is an integral part of the VAX/VMS operating system. The error-logging process is continual. The operating system accepts signals from the hardware and records CPU, memory, I/O, and software errors in an online log file. At the same time, the error-logger notes as much information as possible about the state of the system at the time of an error. If no errors occur over a period of time, the error-logger simply notes the time-of-day in the log file to record that the error-logging process is running. In the special case of ECC corrected memory errors, if the error rate exceeds the threshold value, no more ECC log entries are made for a period of time. A utility program is available to convert the log file into a meaningful format and summary that can be printed for later study.

Machine Checks
Machine checks are hardware errors detected by the central processor and reported to VAX/VMS. VAX/VMS categorizes the error and takes appropriate action. In many cases, the instruction in error is retried and operation continues normally (transient error). If the instruction retry fails, VAX/VMS attempts to limit the effects of the error to a single process.

System Identification (SID) Hardware Register
This register maintains information pertinent to the system processor type and revision number. This information may be examined, during the software error-logging process, for example, to determine the engineering status of the processor.

Application Error Detection
VMS (and the Optional Software Products) provide extensive checking for errors in application software. For example the parameters passed to the System Services are checked for correctness before the service is attempted, thereby preventing the whole operating system (as well as the Application) from being vulnerable to incorrectly coded programs. Additionally, tools such as the MACRO assembler and the Linker provide a high level of error detection so as to minimize the creation of erroneous application software. This later class of error detection includes program syntax errors, corrupted files (system libraries and/or user files), and the inconsistency between separately compiled programs.

Deadlock Detection

VMS V3.0 provides a general set of services (known as a Lock manager) for synchronization of multiple processes and for queuing upon the availability of (named) resources they require. One of the more severe problems that can occur in such environments is known as a deadlock, where each process is waiting for an event that none can declare to have occured. The VMS Lock Manager can detect the occurrence of such a situation, preventing it from rendering the application unusable.

ERROR ANALYSIS AND RECOVERY FEATURES

VAX system hardware and software determines the source of an error and its extent and impact on the user's operation. Often the system can correct the error or mask its effects.

System Dump Analyzer

The System Dump Analyzer (SDA) is a VAX/VMS utility that helps determine the cause of an operating system failure. When an internal error interferes with normal operations, the operating system writes information concerning its status at the time of failure to a predefined system dump file. The Analyzer examines and formats the content of this file. With the help of the SDA commands, a user can display parts of the formatted system dump file on a video display terminal, or can create a hard copy listing. In addition to analyzing the system dump file, the System Dump Analyzer can perform its operations on a running system without interrupting system operation.

Error Log Reporting Program

A VAX/VMS utility program, called the System Error Analyzer, is available to convert the error log file into a meaningful format and summary that can be printed for study.

Instruction Retry

If a hardware-detected error, such as a machine check, interrupts the execution of an instruction, the system in some cases re-executes the instruction. Assuming the error is transient, normal operation continues. If the instruction cannot be retried or if the retry fails, VAX/VMS attempts to limit the failure to the user process currently executing; if the operating system is executing, the system is automatically rebootstrapped.

Nonfatal Bugchecks

When an error condition is detected by hardware or software and VAX/VMS determines that it affects only a single process, that process is removed from the system without affecting continued normal operation of the executive or other processes. The error is also logged in the system error log.

Automatic Stack Expansion

The VAX/VMS operating system automatically extends user stack space as needed.

Unattended Automatic System Restart

Automatic system restart capabilities bring the system online, without operator intervention, after a system failure caused by a power interruption or a fatal software error. If the optional memory battery backup was able to preserve the contents of memory during the outage, the time-of-year clock with its own battery backup of up to 100 hours allows VAX/VMS to recover the correct date and time once power is returned. A special memory configuration register indicates to the recovery software whether data in memory was lost.

Automatic Reconfiguration
The VAX/VMS operating system allows users to continue working even though some of the hardware components have failed. Modification of the system configuration, both manually and automatically at system start-up time, provides a reliable subset of the system, that can be used until maintenance is performed on the failed components.

Diagnostic Console
The diagnostic console, standard on the VAX-11/780 and VAX-11/730 and part of the Remote Diagnosis Module Option on the VAX-11/750, accesses the central processor's major buses and key control points through a special internal diagnostic bus. Operator diagnostics are implemented through simple keyboard commands. The diagnostic console can also serve as an operator console and as a user terminal.

Remote Diagnosis/Remote Support
Remote diagnosis (VAX-11/780 and VAX-11/750) and remote support (VAX-11/730) are available as options to customers in North America and parts of Europe. They lower customers' maintenance costs and increase overall system availability.

Dynamic Bad Block Handling
Bad blocks may occur when a disk surface becomes worn, or as a result of a failure in the disk drive that performed the data transfer. When the hardware detects a bad block during an I/O operation, the VAX/VMS operating system marks the header of the file in which the error occurred. When the file is eventually deallocated, the system checks the file header to see if any bad blocks exist in the file. If so, they are designated "permanently in use" and are not allocated for use by other files.

Bad Memory Page Replacement
When bad pages are detected, they are placed on a bad page list, both during bootstrapping and during normal system operation.

Mass Storage Error Recovery
The operating system always attempts recovery from nonfatal disk and tape errors. If an error occurs during an I/O operation, the error is signalled by the hardware and the operation retried by VAX/VMS, using all the available hardware recovery mechanisms.

Redundant Recording of Critical Disk Information
Critical information, such as the home block and index file header disk information, is redundantly recorded to allow its reliable recovery in the event of accidental destruction.

Selective Hardware Disabling
Several hardware elements, that is, the memory management, cache, translation buffer, and optional floating-point accelerator, can be disabled by diagnostics to aid in isolating hardware problems. With the exception of memory management and the floating point accelerator, these elements are also dynamically disabled by VAX/VMS to allow continued operation at a reduced level of performance.

DATA INTEGRITY
Through hardware access protection and software enforced privileges, the VAX/VMS operating system prevents processes from interfering with one another or with critical system data.

Memory Management Hardware

The system's memory management hardware defines four hierarchical modes of memory access privilege: kernel, executive, supervisor, and user. Read and write access to memory is designated separately for each mode.

The VAX/VMS operating system is designed so that its critical components run in the most privileged access modes (kernel and executive). Thus, the system is well protected against read/write operations by any users not having the privilege to execute programs at the same levels. This "layered" design ensures system protection, and improves overall data reliability and integrity.

Quotas and Privileges

VAX/VMS uses a system of quotas to protect the use of shared system resources such as system dynamic memory and page file space. Quotas are assigned on a per-process basis. Thus, a given process cannot stop normal system operation by depleting shared resources.

User processes are prevented from affecting each other or the operating system both by hardware access protection and by a set of software-enforced privileges. A process which unintentionally or maliciously violates the protection rules is notified of the error and can take appropriate recovery actions without affecting the rest of the system.

Access Control to Files and Volumes

The VAX/VMS operating system provides protection on a per-file basis. Users can be assigned read/write access to other users' data and files in an individually controlled manner. These controls may also be applied on a volume wide basis.

Disk Volume Protection

The VMS file system provides the ability for the system manager to establish how much of a volume may be used by each user. This disk-quota mechanism can be used to prevent one application from consuming all of the available data storage, at the expense of others.

Each time a volume is mounted on a VMS system, it is automatically checked for consistency of the file structure and (in many cases) is repaired automatically. Such structure repair is often necessary after a failure of the whole system while files were in use.

Another feature of the VMS file system is known as Mount Verification. This entails checking (after a transient condition such as power failure of the system or the drive) that the volume that was in use before the transient is the one that is now about to be used again. Thus, if for some reason the previous volume was removed and another substituted, VMS is able to prevent the accidental corruption of that new volume.

MAINTENANCE AIDS

VAX family system packaging and diagnostic tools speed system repair operations and increase availability.

Improved System Packaging

The physical packaging of the VAX family processors has been designed so that all components are highly reliable and easily accessible for servicing. All VAX systems meet applicable Underwriters Laboratories (U.S.A.), Canadian Standards Association (CSA), and international standards (IEC). Improved system-packaging features include easy access to system components, improved air flow inside system cabinets, sensors to detect environmental emergency conditions, fast, easy option replacement, and modular power supply.

Online Functional Diagnostics
One of the most impressive features of VAX systems is the ability to run functional diagnostics online under VAX/VMS. This means many problems can be isolated without taking the system down for stand-alone use.

Fault-Isolation Diagnostics
Once functional diagnostics have isolated faults to a particular subsystem or device, fault-isolation diagnostics can be run to pinpoint the problem to the smallest possible element. Fault-isolation diagnostics may be executed at the site or via a remote diagnostic port, if the system has the remote diagnostic option.

Online Software Update and Maintenance
The system operator can perform software update and maintenance activities without bringing the system down for stand-alone use. Software updates are distributed in machine readable form, that is, on floppy disk or tape cartridge. The operator can update software modules on disk with patches and replacement modules, concurrent with normal system activities. Note that a rebootstrap operation may be necessary to activate the newly installed modules.

The system operator can also perform software maintenance procedures online. The operator can perform disk backup concurrent with normal activities. Because these activities are performed online, both system availability and maintainability are increased.

These software updates are performed in such a way that, if there is a power failure during the operation, they can be continued when the system is restarted.

Updates and Patches
VAX/VMS implements a system of updates and patches. The executive is under revision control, in that each patch automatically checks for required previous patches and updates the current revision number. The patches are always distributed and applied in machine readable form, thus eliminating the possibility of introducing errors during transcription.

High Resolution Interval Clock (1 μsec)
An interval clock is used by diagnostics to test time-dependent functions without requiring machine specific timing loops in programs. It is also used by VAX/VMS to time-stamp operations.

Maintenance Registers
The maintenance registers contain bus-specific maintenance information and can be examined at the time of an error to help determine the cause.

SECTION 3
PERFORMANCE

There is no final performance data available for publication at this time. The Performance Section of this Sales Guide will be published and distributed shortly as a separate package.

SECTION 4
SYSTEM SELECTION

The following section is intended to provides some general guidelines on how to determine the best system for your customer's needs. This is not a substitute for Sales Training, but a guide to help you. You should begin by examining the needs of your customer and then matching those needs to the featues of the appropriate DIGITAL operating system. Next, the layered software products are chosen. Finally, the processor itself is selected from among DIGITAL'S three processor families, the PDP-11 family, the VAX family, and the DECsystem-10/DECSYSTEM-20 family.

In categorizing your customer's needs, you should first determine the primary application of the system, i.e., sensor-based I/O, scientific computation, or general-purpose timesharing. The following charts summarize the features of each of the DIGITAL operating systems that might fit your customer's needs given his primary application.

Sensor-based I/O Chart

RSX-11M	RSX-11M-PLUS	VAX/VMS
multiple realtime programs	multiple realtime programs	multiple realtime programs
N/A	N/A	large memories and large programs
low-high sensor I/O throughput	low-high sensor I/O throughput	low-high sensor I/O throughput
fast sensor I/O response	fast sensor I/O response	very fast sensor I/O response
N/A	N/A	wide word architecture (32-bit)
extensive tailoring by customer	extensive tailoring by customer	some tailoring by customer
small program development	medium program development	large program development
N/A	accounting	accounting
variable file structure	variable file structure	variable file structure
N/A	disk shadowing	N/A
N/A	N/A	multivolume files
limited batch capabilities	full batch capabilities	full batch capabilities
limited capacity timesharing	moderate capacity timesharing	high capacity timesharing
medium configurations	large configurations	large configurations

Scientific Computation Chart

RSX-11M	RSX-11M-PLUS	VAX/VMS	TOP-10	TOPS-20
small number of user	medium number of users	large number of users	large number of users	large number of users
small-medium programs	small-medium programs	large to very large programs	large programs	large programs
medium configurations	medium configurations	large configurations	large configurations	large configurations
variable files	variable files	variable files	variable files	variable files
limited batch capabilities	full batch capabilities	full batch capabilities	full batch capabilities	full batch capabilities
limited capacity timesharing	moderate capacity timesharing	high capacity timesharing	very high capacity timesharing	very high capacity timesharing
access to some third party scientific software	access to some third party scientific software	access to large numbers of third party scientific software	access to large numbers of third party scientific software	access to large numbers of third party scientific software
medium precision	medium precision	high precision	high precision	high precision
numerous protocols to foreign vendors	numerous protocols to foreign vendors	numerous protocols to foreign vendors	protocol to IBM only	protocol to IBM only

General-purpose Timesharing Chart

RSX-11M	RSX-11M-PLUS	RSTS/E	VAX/VMS	TOPS-10	TOPS-20
limited capacity timesharing	moderate capacity timesharing	moderate-large capacity timesharing	large capacity timesharing	very large capacity timesharing	very large capacity timesharing
small number of users	medium number of users	large number of users	large number of users	large number of users	large number of users
limited batch capabilities	full batch capabilities	full batch capabilities	full batch capabilities	full batch capabilities	full batch capabilities
small-medium programs	small-medium programs	medium programs	large-very large programs	large programs	large programs
variable files	variable files	variable files	variable files	variable files	variable files
moderately approachable	moderately approachable	highly approachable	highly approachable	approachable	highly approachable
small database capacity	small database capacity	N/A	medium database capacity	large database capacity	large database capacity
multilanguage	multilanguage	multilanguage	multilanguage	multilanguage	multilanguage
numerous protocols to foreign vendors	numerous protocols to foreign vendors	protocol to IBM only	numerous protocols to foreign vendors	protocol to IBM only	protocol to IBM only
N/A	N/A	N/A	wide word architecture (32-bit)	wide word architecture (36-bit)	wide word architecture (36-bit)
N/A	N/A	dedicated timesharing	N/A	N/A	dedicated timesharing

Considerations in Processor Selection

Primary considerations in selecting a processor include: memory requirements, software support, mass storage requirements, communications requirements, and options support. Secondary considerations include: growth potential, throughput, cost/budget, delivery/availability, competition. In some cases, the operating system itself will determine the processor.

For an up-to-date listing of layered software products supported by VAX/VMS as well as optional hardware products supported by VAX family systems, refer to the *VAX Systems and Options Summary*. For an up-to-date listing of layered software products supported by RT-11, RSX-11M, RSX-11M-PLUS, and RSTS/E as well as optional hardware products supported by PDP-11 family systems, refer to the *PDP-11 Systems and Options Summaries*. For an up-to-date listing of layered software products supported by TOPS-10 and TOPS-20 as well as optional hardware products supported by DECsystem-10 and DECSYSTEM-20 family systems, refer to the *Large Systems Product Summary*.

CONSIDERATIONS FOR THE DECSYSTEM 10/DECSYSTEM 20 USER

A number of factors will point you in the direction of either a DECsystem 10 or DECSYSTEM 20 solution to your customer's needs. Some of these factors are as follows:

- when your customer needs a mainframe vs. a minicomputer
- when your customer wants to include a mainframe in a large distributed processing system
- when your customer needs a very large number of simultaneous users often doing very different jobs (wide-band timesharing)

- when your customer has a very large or multiple database application
- when your customer needs to customize his operating system (TOPS-10)
- when your customer needs high-throughput (due to front-end processor technology) nodes in a distributed system

DECsystem-10 and DECSYSTEM-20 systems are often used as the largest node in distributed processing networks. In situations where programs need to be transported from a DECsystem-10 or a DECSYSTEM-20 to a VAX family system you should consult your Software Specialist.

CONSIDERATIONS FOR THE PDP-11 USER

A number of factors will point you in the direction of A PDP-11 family solution to your customer's needs. Some of these factors are as follows:

- when your customer wants to make use of an already existing software base
- when your customer requires smaller amounts of power and speed
- when price is a major consideration
- when your customer's programs are small and dedicated

However, there are situations where PDP-11 family users will want to upgrade to the VAX family. Conveniently, one of the major features of the VAX family is its compatibility with the PDP-11 family. Not only was it important for DIGITAL to take advantage of its years of software development on the PDP-11, it was equally important that we provide our PDP-11 customers who want to preserve their software investment with a migration path.

Reasons Why PDP-11 Users Consider Migrating to Vax

Some of the main reasons that PDP-11 users consider VAX in their computer acquisition plans are because of the large address space and high performance that VAX offers. If the PDP-11 system is becoming saturated, or if applications need larger address space than the PDP-11 operating systems offer, or if there just isn't any more room to add new applications, VAX can be the answer.

There are several classes of customers in this group of potential VAX owners:

- Customers who may want to buy a VAX system to supplement their PDP-11. In this case, a VAX system and the PDP-11 will coexist in the customer's environment, possibly connected together using DECnet. Applications can be migrated to the VAX system from the PDP-11, or else new applications will be developed on VAX while leaving the PDP-11 to do its present work. Some customers can even use their PDP-11 as a backup system and develop an application that runs on both.
- Customers who may want to replace their PDP-11 systems and cannot keep both the PDP-11 and VAX systems for cost reasons.
- Customers who ultimately will want to migrate all applications to VAX, but in the interim will keep their PDP-11 system until their applications are converted and additional VAX systems are acquired.

Migration to VAX/VMS from PDP-11 Operating Systems

TO: VAX/VMS	FROM: RSX-11M RSX-11M-PLUS	FROM: RSTS/E	FROM: DSM
VAX Languages			
EXEC CALLS	Edit	Edit	N/A
VAX-11 FORTRAN (from FORTRAN 77)	Recompile/ Relink	Recompile/ Relink	N/A
VAX-11 FORTRAN (from FORTRAN IV)	Recompile/ Relink	Recompile/ Relink	N/A
VAX-11 BASIC (from BASIC-PLUS-2)	Recompile/ Relink	Recompile/ Relink	N/A
VAX-11 BASIC (from BASIC-PLUS)	N/A	BASIC Translation Utility Compile/ Link	N/A
VAX-11 COBOL (from PDP-11 COBOL)	COBOL Translation Utility/ Recompile/ Relink	COBOL Translation Utility/ Recompile/ Relink	N/A
VAX-11 CORAL 66	Recompile/ Relink[1]	N/A	N/A
VAX-11 DSM	N/A	N/A	Edit Reload Database
Host Development Languages			
FORTRAN IV-PLUS to RSX[2]	No effort	Recompile/ Relink	N/A
File Management			
ODS1	Same	Convert	N/A
RMS	Same	Same	Must Learn
Command Languages			
DCL	M−Similar M+−Similar	Must Learn	Must Learn
MCR	Same	N/A	N/A
Editor			
Interactive/ Video (EDT)	Similar	Similar	Must Learn
Batch-oriented	Same	Must learn	Must Learn

1 Not from RSX-11M-PLUS.

2 Note that the virtual array capability of PDP-11 FORTRAN IV and PDP-11 FORTRAN 77 is not available in the VAX/VMS host development environment.

The following chart presents a comparison of DIGITAL operating system features.

A COMPARISON OF DIGITAL OPERATING SYSTEMS

Key to table:
X Yes
— No
N/A Not Applicable

	VAX/VMS V3.0	RSX-11M V4.0	RSX-11 M-PLUS V2.0	RSTS/E V7.1	TOPS-10 V7.01	TOPS-20 V5.0
Configuration						
Executive Size	64-96 KB	16-40 KB	40-64 KB	48-96 KB	320 KB	400 KB
Number of User Jobs	1-512	1-50	1-75	1-63	80-275	60-128
Number of Users	1-100	1-64	1-256	1-127	80-275	60-128
Scheduling						
Realtime/Priority-Driven	X	X	X	-	X	-
Time Slice/Timesharing	X	X	X	X	X	X
Dynamic Recomputing	X	-	-	X	X	X
Class & Resource Scheduling	-	-	-	-	X	X
Memory Management						
System Type	Virtual	Mapped	Mapped	Mapped	Virtual	Virtual
Page Size	512 bytes	N/A	N/A	N/A	512 words	512 words
Swapping	X	X	X	X	X	X
Overlays	N/A	X	X	X	X	X
Mapped Segments per Process	Many	8	8/16	8	Many	Many
Virtual Arrays	N/A	X	X	X	X	X
Shared Data	X	X	X	X	X	X
Shared Code	X	X	X	X	X	X
Auto SYSGEN	X	Opt	Opt	-	-	X
Password Protection	X	X	X	X	X	X
Disk Quotas	X	-	-	X	X	X
CPU Time Quotas	X	-	X	-	X	X
Working Memory Size Quotas	X	-	-	X	X	Auto
Lock Pages in Working Set	X	N/A	N/A	N/A	X	-
Lock Pages in Memory	X	N/A	N/A	N/A	X	-
Lock Image in Memory	X	X	X	X	X	-
Online System Tuning	X	-	X	X	X	X
Operating System Sources	Opt	Opt	Opt	Opt	Standard	Opt
Multiprocessor Support	Asymmetric and Symmetric Tools		-	-	Full Symmetric	-
Number of processors supported	2	N/A	N/A	N/A	6	N/A
Interprocess Communication						
Shared Files	X	X	X	X	X	X
Mailboxes (messages)	X	X	X	X	X	X
Event Flags	X	X	X	N/A	X	X
Lock Management Service	X	-	-	-	X	X
Common Data Areas	X	X	X	X	X	X

FOR INTERNAL USE ONLY

	VAX/VMS V3.0	RSX-11M V4.0	RSX-11 M-PLUS V2.0	RSTS/E V7.1	TOPS-10 V7.01	TOPS-20 V5.0
Command Language						
DCL	X	X	X	X	-	X
MCR	X	X	X	X	-	-
CCL	-	-	-	X	X	-
HELP Facilities	X	X	X	X	X	X
Batch						
Indirect Command Files	X	X	X	-	X	X
Multistream	X	-	X	X	X	X
General Error-Go To	X	-	X	-	X	X
Specific Error-Go To	X	-	-	-	X	X
Auto Checkpointing	-	-	-	-	X	X
Spooling						
Multiple Queues	X	X	X	X	X	X
Time Controls	X	X	X	X	X	X
Priority Controls	X	X	X	X	X	X
Form-type Controls	-	X	X	X	X	X
Spool to/from IBM	-	-	-	-	-	X
Language Support						
APL	-	-	-	X	X	X
BASIC	X	X	X	X	X	X
BLISS	X	-	-	-	X	X
COBOL	X	X	X	X	X	X
CORAL 66	X	X	X	-	-	-
C	X	-	-	-	-	-
DIBOL	X	-	-	X	-	-
FORTRAN	X	X	X	X	X	X
MACRO	X	X	X	X	X	X
PASCAL	X	-	-	-	-	-
PL/I	X	-	-	-	-	-
RPG II	-	X	-	X	-	-
DSM	X	-	-	-	-	-
Networking (DECnet)						
Task-to-Task	X	X	X	X	X	X
Network Command Terminals	X	X	X	X	-	X
File Transfer	X	X	X	X	X	X
Command/Batch File Submission	X	X	X	X	-	X
Command/Batch File Execution	X	X	X	X	-	X
Remote File Access	X	X	X	X	X	X
Downline System Loading	X (RSX-11S)	X	X	-	-	X
Downline Task Loading	-	X	X	-	-	X
Resource Sharing	X	X	X	X	X	X
Mail	X	X	X	-	-	-

	VAX/VMS V3.0	RSX-11M V4.0	RSX-11 M-PLUS V2.0	RSTS/E V7.1	TOPS-10 V7.01	TOPS-20 V5.0
Internets						
2780/3780	X	X	X	X	X	X
SNA	-	X	-	-	-	-
MUX200	X	X	-	-	-	-
RJE/HASP	-	X	X	-	-	X
UNIVAC 1004	-	X	-	-	-	-
3271	X	X	X	X	-	-
ARPANET	-	-	-	-	X	X
Packetnets						
X.25	X	X	X	-	-	-
Utilities						
User Mail	X	-	-	-	-	X
Phone	X	-	-	-	-	-
Word Processing Interface	X	X	X	X	X	X
File Differences	X	X	X	X	X	X
Symbolic Debugger	X	-	-	X	X	X
Native Language Debugger	X	-	-	-	X	X
Linker	X	X	X	X	X	X
Runtime Library	X	X	X	-	X	X
Librarian	X	X	X	X	X	X
Command Language Procedures	X	-	-	-	N/A	N/A
Analyze RMS Structures	X	N/A	N/A	N/A	X	X
RUNOFF	X	-	-	X	X	X
Data Management						
Record Management Services (RMS)	X	X	X	X	X	X
File Access						
Sequential	X	X	X	X	X	X
Relative	X	X	X	X	X	X
Indexed	X	X	X	X	X	X
Stream	X	-	-	X	X	X
Multivolume Files						
Disk	X	-	-	-	X	X
ANSI Magtape	X	X	X	PIP only	X	X
Incremental Backup and Restore	X	X	X	-	X	X
Auto Disk Archival	-	-	-	-	-	X
File Protection						
Read	X	X	X	X	X	X
Write	X	X	X	X	X	X
Execute	X	-	-	X	-	X
Extend	-	X	X	-	-	-
Delete	X	X	X	X	X	X

	VAX/VMS V3.0	RSX-11M V4.0	RSX-11 M-PLUS V2.0	RSTS/E V7.1	TOPS-10 V7.01	TOPS-20 V5.0
DATATRIEVE	X	X	X	X	-	-
Report Writer	X	X	X	X	X	X
SORT Utility	X	X	X	X	X	X
MERGE Utility	X	-	-	-	X	X
Forms Management System (FMS)	X	X	X	X	-	-
Database Management System (DBMS)	X	X	X	-	X	X
Common Data Dictionary (CDD)	X	-	-	-	-	-
Accounting						
Connect Time	X	-	X	X	X	X
CPU Time	X	-	X	X	X	X
Memory Usage	-	-	X	X	X	-
Disk Usage	X	-	-	X	X	X
Continuous Evaluation & Logging	-	-	-	-	X	X
Printer Usage	-	-	-	-	X	X
Archival Usage	-	-	-	-	-	X
Tape Usage	-	-	-	-	X	X
Reporting	X	X	X	X	-	-
System Monitoring	X	X	X	X	X	X
Resource Monitoring	X	X	X	X	X	X
Realtime Support						
A/D Support	X	X	X	-	X	-
D/A Support	X	X	X	-	X	-
Digital I/O Support	X	X	X	-	X	-
RAMP Features						
Online Diagnostics	X	X	X	X	X	X
Error Logging	X	X	X	X	X	X
Automatic Restart	X	-	-	X	X	X
System Dump Analyzer	X	X	X	X	X	X
Dynamic Reconfiguration	X	-	X	-	X	X

The following charts present a comparison of DIGITAL system hardware features, from the PDP-11/24 to the DECsystem 10/DECSYSTEM 20.

A COMPARISON OF SYSTEM HARDWARE FEATURES

	PDP-11/24	PDP-11/34	PDP-11/44	PDP-11/70	PDP-11/23	PDP-11/23-PLUS
HISTORY						
Product Announced	MAR 1981	FEB 1976	NOV 1979	FEB 1975	OCT 1979	NOV 1981
First Customer Ship	MAR 1981	FEB 1976	JUN 1980	APRIL 1975	OCT 1979	JAN 1982
CPU						
Data Transfers	16 bits	16 bits	16 bits	16 bits	16 bits	16 bits
Register Length	16 bits	16 bits	16 bits	16 bits	16 bits	16 bits
Maximum Program Size	64 KB	64 KB	64 KB 128 KB[1]	64 KB 128 KB[1]	64 KB	64 KB
Physical Address Size	22 bits	18 bits	22 bits	22 bits	18 bits	22 bits
General Purpose Registers	9[2]	9[2]	10[3]	16[4]	9[2]	9[2]
Hardware Interrupt Levels	4	4	4	4	4	4
Software Interrupt Levels	None	None	3	3	None	None
Clocks	KW11-L (standard) KW11-P (optional)	KW11-P (optional)	KW11-L (standard) KW11-P (optional)	KW11-L (standard) KW11-P (optional)	Line Clock (standard) KWV11 (optional)	Line Clock (standard)
Operating Modes	Kernel User	Kernel User	Kernel Supervisor User	Kernel Supervisor User	Kernel User	Kernel User
Standard Diagnostic Load Device	N/A	N/A	TU58	N/A	N/A	N/A
INSTRUCTION SET						
Total Number Instructions	400	400	400	400	400	400
Data Types	3[5]	3[5]	3[5]	3[5]	3[5]	3[5]
Addressing Modes	8	8	8	8	8	8
Commercial Instruction Set	Optional	N/A	Optional	N/A	N/A	Optional
Integral Floating Point	N/A	N/A	N/A	N/A	N/A	N/A
Instruction Prefetch	No	No	No	No	No	No
PROCESSOR OPTIONS						
Floating Point	KEF11 or FPF11	FP11-A	FP11-F	FP11-C	KEF11 or FPF11	KEF11 or FPF11
User Control Store	N/A	N/A	N/A	N/A	N/A	N/A
Size	N/A	N/A	N/A	N/A	N/A	N/A
Word Size	N/A	N/A	N/A	N/A	N/A	N/A

	PDP-11/24	PDP-11/34	PDP-11/44	PDP-11/70	PDP-11/23	PDP-11/23-PLUS
MEMORY						
Memory Type	Parity MOS	Parity MOS	ECC MOS	ECC MOS	MOS	Parity MOS
Maximum Memory Supported	1 MB	256 KB	1 MB	4 MB	256 KB	4MB
Minimum Memory Supported	265 KB	64 KB	256 KB	512 KB	64 KB	128 KB
Memory Management	Mapped	Mapped	Mapped	Mapped	Mapped	Mapped
Memory Data Bus Width	16 bits	16 bits	16 bits	32 bits	16 bits	16 bits
Interleaving	N/A	N/A	Optional	Optional	N/A	N/A
MOS Battery Backup	Optional	Optional	Optional	Optional	N/A	N/A
Multiport Memory	N/A	N/A	N/A	N/A	N/A	N/A
Cache	N/A	Optional 2 KB	Standard 8 KB	Standard 2 KB	N/A	N/A
Access Time	385 ns	440 ns	340 ns	410 ns	210 ns	240 ns
Main Memory Cycle Time	510 ns	775 ns	490 ns	940 ns	500 ns	560 ns
I/O Subsystems						
LSI-11 BUS(es)	None	None	None	None	One	One (extended)
UNIBUS(es)	One	One	One	One	None	None
MASSBUS(es)	Optional	Optional	Yes	Up to 4	None	None
High-Speed Parallel Interface	DR11	DR11	DR11	DR11	DRV11-J	DRV11-J
Maximum System Throughput Rate	2.2 MB/s	2.2 MB/s	1.5 MB/s	3.5 MB/s	2.2 MB/s	2.2 MB/s
Communications Front-ends	N/A	N/A	N/A	N/A	N/A	N/A
Maintenance Aids	Auto-Diagnosis	Auto-Diagnosis	Remote Diagnosis (Optional)	Remote Diagnosis (Optional)	Auto-Diagnosis	Auto-Diagnosis

1 Both the 11/44 and the 11/70 provide separate instruction and data space support under RSX-11M-PLUS.

2 6 general purpose registers, 2 stack pointers, and a program counter.

3 6 general purpose registers, 3 stack pointers, and a program counter.

4 12 general purpose registers, 3 stack pointers, and a program counter.

5 Byte, word, and longword, plus F_floating and D_floating with the optional floating point.

	VAX-11/730	VAX-11/750	VAX-11/780	VAX-11/782	DECsystem 10/ DECSYSTEM 20
HISTORY					
Product Announced	APRIL 1982	OCT 1980	OCT 1977	FEB 1982	JUNE 1975
First Customer Ship	MAY 1982	NOV 1980	FEB 1978	JUNE 1982	SEPT 1975
CPU					
Data Transfers	32 bits	32 bits	32 & 64 bits	32 & 64 bits	176 bits
Register Length	32 bits	32 bits	32 bits	32 bits	36 bits
Maximum Program Size	2 GB	2 GB	2 GB	32 MB	
Physical Address Size	24 bits	24 bits	32 bits	32 bits	22 bits
General Purpose Registers	16	16	16	32 (16 per CPU)	8 sets of 16
Hardware Interrupt Levels	16	16	16	16	7
Software Interrupt Levels	15	15	15	15	7
Clocks	Interval Timer T.O.Y. (standard)	Prog. RT T.O.Y. (standard)	Prog. RT T.O.Y. (standard)	Prog. RT T.O.Y. (standard)	Prog. RT T.O.Y. (standard)
Operating Modes	Kernel Executive Supervisor User	Kernel Executive Supervisor User	Kernel Executive Supervisor User	Kernel Executive Supervisor User[6]	Kernel Executive Supervisor User
Standard Diagnostic Load Device	TU58	TU58	RX01	RX01	RP06
INSTRUCTION SET					
Total Number Instructions	248 Native + PDP-11 Subset	248 Native + PDP-11 Subset	248 Native + PDP-11 Subset	248 Native + PDP-11 Subset	398
Data Types	9[7]	9[7]	9[7]	9[7]	6[8]
Addressing Modes	13	13	13	13	7
Commercial Instruction Set	Standard	Standard	Standard	Standard	Standard
Integral Floating Point	Standard	Standard	Standard	Standard	Standard
Instruction Prefetch	Yes	Yes	Yes	Yes	Yes
PROCESSOR OPTIONS					
Floating Point	FP730	FP750	FP780	FP782	N/A
User Control Store	N/A	KU750	KU780	For use with KE780 only	N/A
Size	N/A	1K word	2K words	N/A	N/A
Word Size	N/A	80 bits	99 bits	N/A	N/A

	VAX-11/730	VAX-11/750	VAX-11/780	VAX-11/782	DECsystem 10/ DECSYSTEM 20
MEMORY					
Memory Type	ECC MOS	ECC MOS	ECC MOS	ECC MOS	ECC MOS/ Core
Maximum Memory Supported	5 MB	8 MB	8 MB (12 MB)[9]	8 MB[10]	12 MB
Minimum Memory Supported	1 MB	1 MB	512 KB	512 KB	1 MB
Memory Management	Virtual	Virtual	Virtual	Virtual	VIrtual
Memory Data Bus Width	32 bits	32 bits	32 bits	32 bits	36 bits
Interleaving	N/A	N/A	Optional	N/A	Standard
MOS Battery Backup	N/A	Optional	Optional	Standard	N/A
Multiport Memory	N/A	N/A	MA780	MA780	MH10/MH20
Cache	N/A	Standard 4 KB	Standard 8 KB	Standard 8 KB per CPU	Standard 8 KB
Access Time	N/A	400 ns	280 ns	280 ns	168 ns
Main Memory Cycle Time	810 ns	640 ns	600 ns	600 ns	833 ns
I/O Subsystems					
UNIBUS(es)	One	One	Up to 4	Up to 4	Up to 4
MASSBUS(es)	N/A	Up to 3	Up to 4	Up to 4	Up to 8
High-Speed Parallel Interface	DMF32	DR11	DR11 DR780	DR11	N/A
Maximum System Throughput Rate	TBD	5 MB /s	13 MB/s	13 MB/s	18 MB/s
Communications Front-ends	N/A	N/A	N/A	N/A	Up to 4
Maintenance Aids	Remote Support[11]	Remote Diagnosis[11]	Remote Diagnosis[11]	Remote Diagnosis	Remote Diagnosis

6 The VAX-11/782 primary processor supports all four operating modes. However, the secondary processor does not support kernel mode.

7 Bit, byte, word, longword, quadword, F_floating, D_floating, G_floating, and H_floating.

8 Bit, byte, word, halfword, F_floating, and D_floating.

9 The VAX-11/780 supports up to a total of 8 MB of local memory. An additional 4 MB of memory is supported using the MA780 multiport memory option, giving a maximum system total of 12 MB of supported memory.

10 The VAX-11/782 supports up to a total of 8 MB of shared memory using four MA780s.

11 Remote Diagnosis/Remote Support is a feature of optional VAX Field Service agreements.

SECTION 5
COMPETITION

Following are competitive summaries for five of the vendors who compete with our VAX family: Prime, SEL, Perkin Elmer, IBM, and Wang. These summaries list key comparison points and general sales strategies. Additional competitive information is provided in the competitive package distributed in your "Anouncement Package" and will also be distributed in future issues of *Competitive Update*.

Analysts responsible for tracking competitors are:

Competitive Analyst	Area of Responsibility	DTN/Location
Technical		
Martin Harrison	Prime	231-7194
	SEL-Gould	MR1-1/A95
	Perkin Elmer	
Commercial		
Roger Bisbo	IBM S/38	264-6777
		MK1-2/N38
Rick Case	IBM, Office	264-7307
		MK1-2/N38
Peter Parsons	Wang	264-7989
		MK1-2/N38

PRIME

Company History

Prime was founded in 1972, and its first virtual system, the PRIME 300, was introduced in 1973.

Prime's revenue for 1980 was $267.6M, which produces a compound growth rate of 69 percent over the preceding two years. Its revenue for 1981 was $364.8M, with a growth rate of 36 percent; Prime has not seen the rapid growth in 1981 that it experienced previously. Prime publicly attributed this decline to "sluggish global economic performance, uncertainty over U.S. capital spending incentives, and heightened tension in Western Europe."

Prime has implemented several strategies to counteract this decline. They have honed down their product offerings by discontinuing the Prime 450 and Prime 650; they have upgraded their remaining products. They now compete more directly with our VAX products.

Prime currently is focusing their marketing on end-user sales, specifically in CAD/CAM, office automation, and transaction-processing applications. They are negotiating joint marketing agreements with several third-party software houses (CIS, HENCO, ISSCO) to keep software development costs lower, while penetrating these selected markets.

To date, 92 percent of Prime's sales are attributed to end users, with the remaining 8 percent reflecting OEM business that is primarily focused in commercial applications.

Prime Systems Features

- 32-bit architecture
- 8 Mbyte maximum physical memory limit
- I/O bandwidth of 2.5 Mbytes-per-second to 8 Mbytes-per-second
- Virtual memory systems
- 512 Mbyte virtual address space
- Single operating system (PRIMOS)
- Multiterminal, interactive systems
- Range of software packages including communications (PRIMENET), CODASYL DBMS, office automation
- Bipolar cache memory (2 Kbytes to 32 Kbytes)

Prime Systems Strengths

- Comprehensive communications offerings (PRIMENET with X.25, RJE packages, 3270 By-sync Emulator)
- Comprehensive applications packages (TAPS Terminal Application Processing System, office automation, DBMS)

Prime Systems Weaknesses

- Low technical/realtime business; lack high-performance realtime interface hardware, multi-port memory
- Lack of user controls on operating system
- High maintenance costs (8 to 10 percent of purchase price)
- High memory costs
- Lack special peripherals; no CSS capability

Prime's Marketing and Sales Strategies

Prime targets its sales at large FORTUNE 500 companies and engineering firms and at research labs and service bureaus requiring general purpose computational power. Prime is not predominately in any one market area; it competes with all of DIGITAL's product lines to some extent.

Prime offers a wide range of software packages, many through joint agreements with engineering firms and third-party vendors. Prime claims software functionality, price/performance, compatibility, and an easy migration path using upgrades, etc.

Prime will offer heavy discounting and price allowances to gain sales.

DIGITAL's Counter Strategy

Prime tends to overadvertise their performance capabilities. Benchmark results show that we outperform them in multiuser environments and in stand-alone FORTRAN and COBOL environments, up and down the line.

Our VAX/VMS operating system is much more sophisticated and flexible (supporting realtime, general purpose timesharing, and batch modes concurrently), and we have a broader spectrum of layered products with more functionality.

We also have much greater support capability: more than ten times the service people and many more service locations than Prime. We offer ongoing software product services for all our software products. Prime offers software services for only a few—and at high cost, which will offset the price reductions they may make.

We have 25 years of industry experience and leadership with continued financial growth. Stress our technicalogical leadership and vast expenditures in research and development.

Product Comparison

Following are the key comparison points for our newest VAX family system, the VAX-11/730, versus Prime 150/250 systems, and some detailed information regarding the VAX-11/782 versus Prime 850 systems.

VAX-11/730 vs. Prime 150/250

Feature	VAX-11/730	Prime 150/250
Memory:	64K chips	16K chips
	1 MB minimum	256 KB/512 KB minimum
	5 MB maximum	1 MB maximum
Battery Backup Unit:	N/A	Optional
Disk:		
Minimum Entry:	20 MB	32 MB
Other Capacities:	10, 27, 121 MB	64, 80, 96, 300 MB
Minimum # Lines:	8	8
Cache:	No	2 KB
Console Terminal:	LA120	Optional/Standard
FPA:	Optional	N/A
Remote diagnosis:	Yes	No central RD facility
Basic Cabinets:	One; 42-inch-high	One; 60-inch-high

VAX-11/782 vs. Prime 850

PRIME 850 BASIC FEATURES

- 8 Mbyte maximum memory
- Runs under PRIMOS Operating System
- Two instruction processing units (IPUs)
  - Multistream architecture enables two programs to run simultaneously
  - Retains Prime 750 I/O structure—single 16-bit bus; 8 Mbytes-per-second transfer input, 5.5 Mbytes-per-second output
- 32 Kbyte cache (16 Kbytes on each 750)
- Software-compatible with other Prime systems
- Conventional Schottky TTL logic, but uses 64 K MOS RAM chips
- 1 Mbyte memory boards
- Claims support of up to 128 interactive users
- Performance advantage over a single Prime 750 depends on application *environment*, i.e.,
  - +60 to 70 percent in computation-intensive, multiprogramming environments
  - 30 to 40 percent in I/O-intensive, multiprogramming environments
  - 0 to 10 percent in serial, stand-alone environments

PRIME 850 STRENGTHS

- Provides more flexible configurations than the VAX-11/782, i.e., no multiport requirements, various memory configurations possible
- Will be less expensive than the VAX-11/782 after Prime discounts

PRIME 850 DEFICIENCIES

- The VAX-11/782 should outperform the Prime 850 in most applications
- The VAX/VMS operating system is more versatile and sophisticated than PRIMOS
- Inferior I/O capabilities: lower I/O bandwidth should give the VAX-11/782 the advantage
- Limited application software
- Limited visibility as a vendor
- Limited customer support capabilities

PRIME 850 MARKETING STRATEGIES

- Target markets include Prime's traditional base of engineering firms, research labs, service bureaus where Prime is selling computational power, and large FORTUNE 500 companies; Prime is using their 850 and their office systems software to penetrate these accounts.
- Prime is using the Prime 850 to pursue business with high computational requirements.
- Prime is pushing the Prime 850 as a single system to go after new business, not as an upgrade for Prime 750 users.

SELLING AGAINST THE PRIME 850

- *Stress the flexibility of the VAX-11/782 approach.* Digital customers can upgrade their VAX-11/780 or they can buy a VAX-11/782 system or they can buy a VAX-11/780 now and the VAX-11/782 upgrade in the future. With Prime, there is no easy upgrade from the Prime 750 to Prime 850, and Prime is not encouraging this.
- *Stress Information Management Architecture.* DIGITAL has an architecture for handling information management and a commitment to further development. We have many products: VAX-11 DBMS, VAX-11 CDD, and VAX-11 DATATRIEVE. Our products are newer and more integrated: application languages can call DATATRIEVE, which in turn can access DBMS.

- *Stress support.* DIGITAL's customer support capability represents a major advantage over Prime. We have 11,000 field service engineers—more than ten times as many services people as Prime in the United States and worldwide. We also have many more service locations. We offer ongoing software product services for all our software products. Prime only offers software services for a few products, and these are very expensive.
- *Stress DIGITAL's 25 years of leadership,* i.e., our corporate stability, our continued financial growth and our wide range of proven and, in many cases, de facto standard products.

PRIME 850 TYPICAL ENTRY-LEVEL CONFIGURATION

- $409K
- Prime 850
- 300 Mbyte disk
- 800/1,600 b/in, 75 in/s tape
- 16 asynchronous lines

SYSTEMS ENGINEERING LABS (SEL)

SEL Company History

Systems Engineering Labs, located in Ft. Lauderdale, Florida, is now part of Gould, Inc. In 1980, Gould Electronics, a division representing 31.6 percent of total Gould revenue, acquired five related companies, of which SEL was one.

In 1980, SEL's total revenue approached $80M. Allowing for inflation, this represents a growth of between 15 and 18 percent. The non-U.S. revenue component was 26 percent of the total.

As part of Gould, SEL has the backing and resource capability of a $2.2-billion-dollar company whose net sales growth has averaged five percent per annum over the last five years. Although Gould's net earning dropped two percentage points, they increased their R&D expenditures by 24 percent.

SEL concentrates its energies on five well-defined vertical market areas: simulation, laboratory computation, energy monitoring and control, industrial automation, and CAD/CAM. SEL's computer expertise complements Gould Electronics' product offering in the fields of industrial automation and government systems. These markets rely heavily on realtime system response, and SEL's products have been specifically designed to meet this need. Since the acquisition by Gould, SEL's announced plans have been to expand existing markets rather than to pursue diversification.

Positioning: SEL vs. DIGITAL

VAX Systems	SEL Systems
VAX-11/782	32/87 Systems
VAX-11/780	32/77, 32/7780 Systems
VAX-11/750	32/30A (Maxibox), 32/77 Systems
VAX-11/730	32/27 Box and Systems

SEL SYSTEMS FEATURES

- 32-bit machines
- 32-bit data paths with 19-bit addressing
- 16 Mbyte maximum physical memory limit
- Built around single high-speed internal synchronous bus (SEL Bus) with maximum transfer rate of 26.6 Mbytes-per-second
- Nonvirtual memory systems (maximum program size of 1 Mbyte)
- I/O processor (IOP) supports up to 124 devices; maximum of four per CPU
- Family is based on realtime orientation plus custom I/O support
- Two operating systems (RTM and MPX-32)

SEL SYSTEMS STRENGTHS

- Configuration/pricing flexibility (willingness to accommodate customer requirements for custom gear, attachments, and price)
- Operating-system simplicity for realtime I/O
- SEL Bus data rate of 26.6 Mbytes-per-second
- 16 Mbyte physical memory

SEL SYSTEMS WEAKNESSES

- Expensive add-ons (memory, peripherals)
- Limited choice of peripherals

- Very limited communications support (no networking or X.25)
- Limited breadth of software offerings (i.e., no PL/I, Common Data Dictionary, CODASYL DBMS, forms management, or query/report writer)
- Difficult for software development
- Limited RAMP; no remote diagnosis or telephone support
- Only 36 direct sales and service offices worldwide
- Limited reference base
- No office products

SEL's Marketing and Sales Strategy

SEL's customer base is concentrated on a few technically competent OEMs and laboratory and engineering-oriented end users who are largely self-sufficient. SEL deals in large CPU-volume business that is mostly contract-based.

SEL prices their configurations attractively and flexibly to accommodate customer demands. They will stress price and performance in a sale—in particular, their realtime interrupt response and their 26-Mbyte SEL Bus.

We face stiff competition from SEL. SEL will continue to dominate their markets owing to customer investment and perceived VAX-11 product inadequacies (i.e., lack of realtime capability).

DIGITAL's Counter Strategy

Our advantages are breadth of software capability and experience.

Stress VAX/VMS operating-system sophistication and capability. We can provide the "single vendor" solution.

VAX virtual memory means large program capacity and no overlays. VAX systems provide a range of user controls, resource quotas, privileges, and system-performance tuning metrics to customize the user environment. VAX systems can support realtime, timesharing, and batch operations concurrently.

SEL focuses only on realtime. Their customer base is sophisticated, but it must be, to attain the performance advantages they quote.

Conversely, VAX systems are easy to use. Stress DCL (DIGITAL Command Language) functionality. There is a solid base of software available on all VAX systems, not only for specific application uses but for fast and easy program development. Third-party vendors add significantly to the range of software we already provide.

We have extensive RAMP features, support, and services. Because of their size, SEL has not been able to provide these, and their customers' maintenance costs run high because of it.

We have the experience and resources to reduce our customer's cost of ownership.

Product Comparison
Following are the key comparison points for our two newest VAX family members versus SEL systems.

VAX-11/730 vs. SEL 32/27

Feature	VAX-11/730	SEL 32/27
Physical CPU Size:	10 1/2 inches × 19 inches (RETMA-compatible)	15 1/2 inches × 19 inches (RETMA-compatible)
Cabinet Size:	42-inch-high (special CSS cabs also available)	63-inch-high, 75-inch-high
CPU:	3 HEX boards	3 large boards
Memory:	64K chips 1 MB minimum 5 MB maximum (in CPU box only)	16K chips 256 KB minimum 2 MB maximum (in CPU box)
Power Supply:	60 amps @ + 5 volts	24 amps @ + 5 volts
Current:	single-phase (box and cab)	single-phase (box) three-phase (cab)
Basic I/O Interface:	UNIBUS (1.5 MB/s)	IOP (1.5 MB/s)
FPA:	1 board option	1 board option
Battery Backup Unit:	N/A	optional

VAX-11/782 vs. SEL 32/87

Feature	VAX-11/782	SEL 32/87
Cache:	8 KB two-way set assoc.	16 KB or 32 KB
Maximum I/O Rate:	13.3 MB/s	26.6 MB/s
Memory:	16K chips 8 MB maximum	16K chips 16 MB maximum
Technology:	Schottky TTL	ECL
FPA:	Optional	Yes

PERKIN ELMER

Company History

Perkin Elmer had sales revenues of $996 million in FY80, up almost 36 percent from FY79, leading to profits of $68.3 million.

Perkin Elmer has three major business groups: the Instrumentation Group (33%), the Computer Systems Group (22%), and the Optical Group (33%). The Computer Systems Division specializes in 16-bit and 32-bit minicomputer hardware, software and systems for OEMs (60%) and end users (40%). The market concentration is in simulation, CAD/CAM, industrial process control, and laboratory automation applications. The revenue of this division, totaling $215 million in FY80, has grown in excess of 25 percent for the last two years. It is expected that this growth pattern will continue. More than half of the revenue has come from the technical OEM market.

Although Perkin Elmer has been investing heavily in 32-bit hardware recently, it is expected that over the next two years they will focus on improving their system software. They want to offer flexible programming tools and applications software packages to OEMs and end users alike.

Positioning: Perkin Elmer vs. DIGITAL

VAX Systems	Perkin Elmer Systems
VAX-11/782	N/A
VAX-11/780	PE 3240, PE 3250
VAX-11/750	PE 3210, PE 3220, PE 3230
VAX-11/730	PE 3210 (PE 3210A box)

Perkin Elmer Systems Features

- 32-bit machines
- 24-bit physical addressing
- 6 Mbyte physical memory maximum
- Nonvirtual memory operating system
- No virtual memory management scheme
- Multitasking operating system
- One operating system across family (OS/32)
- Offer UNIX (called "Edition VII Workbench")
- Family of low-speed buses (Multiplexer, 2 Mbyte-per-second) and high-speed buses (EDMA, 8 Mbyte-per-second)
- Cache-oriented (except PE 3210)
- WCS development package (except PE 3210)
- Reliance Transaction-Processing Package
- Optional Remote Diagnostic Service

Perkin Elmer Systems Strengths

- FORTRAN performance (produces optimized code)
- Consistent bus attachment strategy
- IBM communications orientation
- WCS development package (for the PE 3220, 3230, 3240)

Perkin Elmer Systems Weaknesses

- Limited capabilities of software offerings in general
- No PL/I
- Limited memory RAMP features
- No networking architecture or products
- No virtual memory operating system (physical memory needed to run large programs)
- OS/32 not designed for timesharing (customer must purchase an optional monitor to attain)
- Few third-party software packages
- No office systems (capabilities)

Perkin Elmer's Marketing and Sales Strategies

Strategically, Perkin Elmer plans to be aggressive on their mid-range to low-range 32-bit products. Unlike other minicomputer vendors, Perkin Elmer does not have a high-end 32-bit machine. Their intended goal is to become the alternate supplier of 32-bit minicomputers to the technical market, with special emphasis on OEMs (they view themselves as the second 32-bit minicomputer manufacturer, with DIGITAL first).

They have had a competitive edge in such specific market applications as simulation, defense-oriented contracts, and discrete instrumentation (laboratory) markets. Their effectiveness in supporting large scale government projects through their marketing and sales organization usually wins them large sales orders.

Perkin Elmer typically gets in the door with their lower prices, then sells performance. They typically want to run a benchmark and push their FORTRAN.

Their version of UNIX also appeals to a segment of the market not addressed by their OS/32 operating system.

DIGITAL's Counter Strategy

Stress that we are in the computer business only; we are not a computer "division," we don't diversify into instrumentation, etc. We can offer a total, single-vendor solution.

Perkin Elmer's concept of performance means running small FORTRAN programs at high speeds in a single-user environment. When up against a Perkin Elmer benchmark, be sure to call in a Software Specialist. Stress that VAX systems allow the customer to do more work in a multiuser environment, which is the real meaning of performance.

Our VAX systems excel in ease-of-use features. Virtual memory means the customer can write and execute larger programs faster and easier. Perkin Elmer customers have to resort to overlay techniques and/or purchase additional memory.

We have networking; Perkin Elmer has none. This is a major selling advantage. We also offer a large choice of integrated software products.

And we offer extensive service and support. We have many more service locations and support people than Perkin Elmer.

Product Comparison

Following are the key comparison points for our newest VAX family member, the VAX-11/730, versus Perkin Elmer systems.

VAX-11/730 vs. PE 3210A and 3210

Feature	VAX-11/730	PE 3210A/PE 3210
Physical CPU Size:	10 1/2 inches x 19 inches	13.9 inches x 19 inches
	(RETMA-Compatible)	(RETMA-Compatible)
Cabinet Size:	42-inch-high (special CSS cabs also available)	30-inch-high; 56-inch-high
CPU:	3 boards	4 boards (16 slots)
Memory:	64 K chips	mix of 16 K for first 1 Mbyte and 64 K chips for remainder of memory
	1 Mbyte minimum	512 Kbyte minimum
	5 Mbyte maximum	4 Mbyte maximum
Basic I/O Interface:	UNIBUS (1.5 MB/s)	EDMA (8 MB/s)
		Multiplexer (2 MB/s)
FPA:	1 board option	1 board option
Battery Backup Unit:	N/A	Standard (15 minutes)

IBM SYSTEM/38

System/38 has been marketed as IBM General Systems Division's (GSD) premier family of small-business data processing systems. Volume shipments began in the summer of 1980 (about a year late). International Data Corporation estimates that 4,800 were installed worldwide by CY-end 1980. Most of the sales have been to GSD's aging System/3 and larger System/34 accounts. However, System/38 has been sold in quantity to some IBM Data Processing Division (Fortune 500) customers for new application support.

IBM's Reorganization

Owing to IBM'S reorganization, System/38 will be generally available to large accounts. It is expected to appear in significantly more competitive situations.

Competitive Positioning

Competitive positioning places the largest System/38—the Model 5—below the VAX-11/750 in performance. The Model 4 positions against the VAX-11/730, and the Model 3 positions well below it. There is no System/38 that offers VAX-11/780 performance. If IBM is proposing any System/38 model against a VAX-11/780, then they (or we) are misjudging the prospect's data processing requirements.

IBM's System/38 Productivity Message

Productivity is IBM's main marketing message for System/38. They will attempt to cost-justify the sale based on improvements in productivity. The key aspect of System/38 that enhances productivity is its interactiveness. We are the world's leading supplier of interactive computers. It is imperative that this message be clearly articulated in sales situations. System/38 is designed to improve the productivity of "DP professionals" (i.e., programmers). Our products not only improve programmer productivity, but also allow the "unsophisticated user" to easily develop applications. Through the use of tools like VAX-11 DATATRIEVE, end users can meet most of their application requirements without having to resort to scarce (and expensive) DP talent.

System/38 Orientation

Beyond productivity is the issue of System/38's orientation. RPG III and COBOL-74 are the only programming languages available. They are good for implementing basic business functions (payroll, A/R, A/P, etc.), but they provide extremely poor environments to support strategic planning. This form of information processing involves the construction of Decision Support Systems (DSS). DSS implementation requires an easy-to-use data manipulation language, computational programming languages (FORTRAN, etc.), and graphics. These are not available on System/38. Our products easily support both day-to-day business functions and strategic planning operations.

System/38 Communications Facilities

System/38 communications facilities are primarily based on the old Binary Synchronous Communications (BSC) protocol. IBM's mainstream communications offering is System Network Architecture (SNA). System/38 provides only limited SNA support. About 750 of IBM's thousand-largest customers are committed to SNA for their corporate networks. Lack of intimate SNA integration places System/38 outside IBM's mainstream communications architecture. Our BSC products on VAX systems provide interactive (3270) and batch (2780/3780) connection to IBM mainframes. Through our distributed data access capabilities via VAX-11 DATATRIEVE (and DECnet), we offer far superior peer-to-peer communications support.

Office Automation Support

Office automation support is most notable by its absence. Only one unbundled application package is available. It provides RUNOFF-like capabilities and it's not intended for a heavy typing (i.e., Word Processing) environment. There is also no electronic mail facility for System/38. To make up for these deficiencies, IBM will propose connecting other IBM products (Displaywriters, 5520 Administrative Systems, etc.) to System/38 via BSC. BSC is not a sophisticated communications protocol, and layered application software is required to make these connections useful. This layered software is not available from IBM.

VAX Sales Strategy

Our VAX sales strategy must concentrate on positioning and productivity. Properly positioned, we have a price advantage. IBM will attempt to preempt this advantage with claims of increased productivity. Properly addressed, productivity becomes an issue in our favor. We must portray System/38 as oriented toward tactical data processing, whereas VAX systems support both tactical and strategic information processing. VAX systems offer compatible communications to IBM mainframes and superior peer-to-peer communications facilities. Through DECmail and our other office automation products, we offer office support totally lacking on System/38.

We must sell the total capabilities of VAX systems. IBM will move to restrict the scope of customer expectations to those capabilities provided by System/38. They will push for a quick close of the sale to minimize our ability to fully present our product. They will be selling the companies' top decision makers, and so must we. IBM will propose their own and/or third-party application packages. We must be aware of the client's application requirements and match them to our own and/or the third-party products available for VAX systems.

See the Competitive Package distributed in your "Announcement Package" for additional details on IBM System/38. Watch future issues of *Competitive Update* for additional information.

DIGITAL—IBM PROCESSOR POSITIONING

The chart below shows suggested product positioning between DIGITAL and IBM processors. Because performance data is very limited, this chart should be used as a rough positioning guide only. (Refer also to *Competitive Update*, March 8, 1982.)

HARDWARE PRODUCT POSITIONING

DIGITAL PROCESSOR	MAX MEMORY		IBM PROCESSOR	MAX MEMORY
1091 2060	14MB 14MB	⟷	4341-2	16MB
VAX-11/782* VAX-11/780	8MB 12MB	⟷	4341-11 <4341-1> 4341-10	8MB 4MB 4MB
VAX-11/750 PDP-11/70	8MB 4MB	⟷	4331-2 SYSTEM/38-5	4MB 2MB
VAX-11/730 PDP-11/44	5MB 1MB	⟷	4331-11 SYSTEM/38-4 <4321>	2MB 2MB 1MB
PDP-11/24 PDP-11/23	1MB 1MB	⟷	8100 SYSTEM/38-3 <SERIES/1> SYSTEM/34	2MB 1.5MB .5MB .25MB
DECMATE	64KB	⟷	DISPLAY WRITER	256KB

NOTE THAT THE VAX-11/750 AND 11/730 SUPPORT MUCH MORE MEMORY THAN THE IBM SYSTEMS

<> = PERFORMANCE DATA IS AVAILABLE

IBM Processor	Who to call:	DTN
4300, 8100	Richard Case	264-7307
System/38	Roger Bisbo	264-6777
COEM (Series/1, System/34)	Ken Gontarz	264-8769

* Commercial benchmarks are not yet available on the VAX-11/782. Technical benchmarks show the VAX-11/782 to be from 1.6 to 1.8 times the compute-power of the VAX-11/780. When Commercial benchmarks have been run, future articles in *Competitive Update* will refine the position of the VAX-11/782 against the IBM 4300 line.

FOR INTERNAL USE ONLY

The chart on the previous page shows suggested processor positioning between DIGITAL and IBM. The positioning is estimated from some published benchmark data (*Competitive Update*, October 1980) and customer benchmarks and articles published in the trade press. This represents conservative positioning because extensive benchmarks have not been done.

Product Positioning

It is very important that reasonable CPU positioning be accomplished. The VAX family CPUs are 32-bit virtual architecture machines. As such, they should not be compared to the Series/1, System/34, or even the 8100. They should be compared to the System/38 or the 4300 family. If you allow incorrect positioning of your product against lesser IBM products, you will be at a great disadvantage.

Should you find yourself competing with a VAX system against a Series/1, System/34, or an 8100, either you or the IBM sales representative have misjudged the customer's requirements. You should find out what the customer really needs to do. If IBM is closer to the real need than you are, you should adjust your proposal to a PDP-11. If you are sure the customer really needs a VAX solution, point out the advanced features of VAX that warrant its use over a more limited solution such as a PDP-11 (or Series/1, System/34, etc.).

If you are competing with a VAX system against a 4300, it is still very important that correct product positioning be done. There are many models of the 4300 family ranging in CPU purchase price from $85,000 to $578,800 and in performance from .2 MIPS (millions of instructions per second) to about 1.4 MIPS. If the correct product positioning is not done, you will find yourself competing with a powerful, expensive VAX system against a much less powerful, less expensive 4300. Remember, IBM can always upgrade the customer's CPU later.

The rest of this section will discuss the VAX family positioning to the 4300s.

VAX-11/730 ⟷ 4331-11

The VAX-11/730 should be positioned against the 4331-11 running VM/DOS. The following chart shows the prices of fully configured VAX-11/730 and 4300 systems. Each system is configured with similar amounts of user disk space and terminals.

Wherever possible, full systems should be compared using either five years of charges or cost-of-ownership. IBM processor packages cannot be compared to DIGITAL since we include disk drives and other hardware not included in the IBM CPU. Also, since IBM software charges are monthly and much more expensive than DIGITAL software, time payments should be included.

The 4331-11 and 4321 configurations used in the following chart were published in the March Special Issue of *Competitive Update*.

Users	System	System	Hardware Purchase Totals	Hardware Maint. Monthly Charges	Software License Totals	Software Maint. Monthly Charges	System Lifetime Sum of Charges	System Lifetime Cost of Ownership
4	11/730	R80/RL02	$59,800	$467	$17,790	$340	$123,589	$61,989
8	11/730	R80/RL02	$80,350	$636	$17,790	$340	$153,772	$77,156
16	11/730	R80/RL02	$103,275	$855	$17,790	$340	$189,180	$94,649
8	4331-11	SSX/VSE	$216,563	$1,188	$15,000	$50	$298,850	$158,251
16	4331-11	SSX/VSE	$253,675	$1,441	$15,000	$50	$350,354	$184,651
8	4331-11	VM/370	$228,243	$1,267	$0	$1,990	$414,447	$194,655
16	4331-11	VM/DOS	$291,630	$1,715	$7,404	$2,495	$540,597	$254,969
4	4321	SSX/VSE	$151,529	$870	$15,000	$50	$216,414	$114,646
8	4321	SSX/VSE	$163,133	$936	$15,000	$50	$231,780	$122,657
4	4321	VM/370	$151,529	$870	$0	$1,990	$315,627	$142,659
8	4321	VM/370	$163,133	$936	$0	$1,990	$330,993	$150,670

U.S. List, Basic Monthly Maintenance, License "D" Software, Basic SWS Support

VAX-11/730 systems include CDD and DATATRIEVE; IBM systems do not include comparable software.

As can be seen, any VAX-11/730 system is less expensive than any 4300 system. The VAX-11/730 is very competitive against the 4300 family.

PROCESSORS USED IN CHART

4331-11: The 4331-11 has a maximum memory of 2 megabytes.

4321: The 4321 has a maximum memory of 1 megabyte.

The VAX-11/730 with a maximum memory of 5 megabytes is much more expandable than either the 4331-1 or 4321.

SOFTWARE USED IN CHART

VM/DOS VM/DOS is the only IBM 4300 software which approaches the interactive nature of VAX/VMS. The 4331-11 is the smallest 4300 which has enough memory to run this software. See the October 1980 *Competitive Update* on the 4300 for an extensive analysis of the VM/DOS software compared to VAX/VMS.

VM/370 This is a subset of VM/DOS and does not include keyed file access, record locking, SNA networking, Sort/Merge, and many other features included with VAX/VMS. However, if the customer does not need these features, IBM can bid this software.

SSX/VSE This software is a subject of the DOS/VSE operating system. It is basically a batch or transaction processing system (CICS) which is less than interactive. SSX generally requires software development on a DOS/VSE system with execution only under SSX. Local program development would be difficult or impossible. However, if the customer only wants an execute-only type operating system, this software could be bid.

VAX-11/750 ⟷ 4331-2

Extensive positioning information is available on these two products in the October 20, 1980, *Competitive Update*. When that special issue was published, the only mismatch between the VAX-11/750 and the 4331-2 was in the amount of main memory each could support. With the announcement of extended memory options, the VAX-11/750 can now support up to 8 megabytes. This is twice the maximum memory of the 4331-2 system.

More memory allows the support of more software and more interactive users. Also, the software overhead of the 4300 operating systems is close to one and a quarter megabytes. Thus, this extra memory of the VAX system should give DIGITAL an advantage.

VAX-11/780 ⟷ 4341-1

These products were compared in the October 6, 1980 special Issue of *Competitive Update*. IBM has moved to introduce two new 4300s into this performance space:

4341-10, with 15 percent less power than a 4341-1
4341-11, with 25 percent more power than a 4341-1

Benchmarks have shown that the performance of the VAX-11/780 and the 4341-1 vary greatly depending on customer requirements. Conservative positioning should continue to place these two processors against each other.

It should be noted, however, that the 4341-10 and the 4341-1 can support only four megabytes of memory. The 4341-11 supports a maximum of eight megabytes. The VAX-11/780 supports eight megabytes of private memory and an additional four megabytes of shared memory. That, and high IBM software memory overhead, can be an advantage to DIGITAL.

VAX-11/782 ⟷ ????

Benchmarks comparing the VAX-11/782 and the 4300 family are unavailable. The VAX-11/782 is expected to provide increased performance in a CPU-intensive environment compared to the VAX-11/780. The positioning of the VAX-11/782 is less concrete. This VAX system could be placed against a 4341-11 or a 4341-2. The 4341-11 supports up to eight megabytes and the 4341-2 supports up to 16 megabytes of main memory. Since the VAX-11/782 supports eight megabytes, conservative positioning is against the 4341-11.

The VAX-11/782 is substantially less expensive than either of these 4300s.

Additional positioning information will be published in *Competitive Update*.

THE WANG "VS" FAMILY

Summary

Although the VS family cannot match the range and depth of functionality of the VAX family, Wang constantly tries to position their VS against the VAX family when forced to compete with DIGITAL rather than IBM.

Even when we cannot push Wang's positioning of the VS down to a more realistic level of the PDP-11 family in functionality, performance, and price, we still have an outstandingly superior competitive product with the VAX family in all three of these categories.

This analysis details our superior product capability with the extended VAX product family offering:

- greater functionality
- equal or higher performance
- lower price

Functionality—Wang VS Family

As stated in the November 9, 1981, *Competitive Update*:

Wang has consistently positioned the VS product against IBM products, including the System/38, S/370s, and 4300. Against DIGITAL, Wang will try to position the VS against the VAX line by promoting 32-bit CPUs/software; however, this position is incorrect. Only the VS 100 and VS 90 combine both 32-bit hardware architecture with the 32-bit software architecture found on all the VS systems.

The software functionality of the VS systems approaches a 1975 vintage RSTS/E system despite a 32-bit software. The VS systems should be positioned against DIGITAL's PDP-11/24 to PDP-11/44 range. If the software matures and is delivered as Wang announced over two years ago, a large VS 100 might eventually compete effectively with the VAX-11/750 for commercial solutions. For now, the VS should be positioned against the low- to mid-range UNIBUS-11 systems to achieve a realistic match of both functionality and performance.

NEW VS ANNOUNCEMENTS

Wang announced a new VS system called VS 90. The new VS 90 is the entry level system for Wang's 32-bit hardware and software system, the VS 100. In fact, the new VS 90 is a VS 100 without cache memory.

The VS 90 is bundled as follows:

- CPU with 1 Mbyte memory and cab (expandable to 4 Mbyte)
- IOPS (input/output processors)
  (1) For up to 4 disk drives
  (1) For up to 4 tape drives
  (1) for up to 16 workstations or printers
- One archiving workstation (includes floppy)
- Operating system
- One optional language (COBOL, RPG II, BASIC, FORTRAN-66, or PL/I)

This bundled package (no disk included) sells for $73,000 with monthly maintenance of $450.

Other announcements for the VS family include:

- VS 90 upgrade package to the VS 100 (32 KByte cache included) priced at $30,000
- VS 100 memory expanded to 8 Mbyte and repriced to $16K per megabyte down from the average $22-24K per megabyte

- New IOPs for their disk drives with a slightly lower price of $3,750
- Price reduction of their 288 Mbyte disk drive from $34,000 to $23,000
- PL/I started shipping as of January, 1982, according to Wang
- A replacement product for ADMS, which was pulled off the market in November, 1981, because it failed to work. As of April, 1982, Wang will offer Cincom's TOTAL for all VS systems. The Total Data Base Management System (DBMS) will cost $12,500 for VS 50, $16,150 for VS 80, and $19,800 for the VS 90 and VS 100.

In addition to these announcements, Wang is also marketing a new networking concept called "Remote Wangnet Plan" which is built around the VS system, acting as a host for networking multiple Wang systems.

The Remote Wangnet Plan should not be confused with Wang's other Wangnet product, i.e., the cable. The only similarity between the two products is their names. Neither the Remote Wangnet Plan nor the Wangnet cable are installable today.

The Remote Wangnet Plan is intended to build a networking capability over an extended period of time. Although the hardware is available today to build the network, the software is not yet in place to implement the network. The Remote Wangnet Plan is not likely to be announced officially by Wang because Wang probably feels many customers would be surprised to find that Wang did not already offer this capability. Instead, Wang sales will offer this capability to sophisticated customers as the software becomes available this next fall and winter.

FUNCTIONAL SUMMARY

Although the VS family is reaching a higher level of maturity as a distributed data processing system, with the actual delivery of some products that were delayed and Wang's continuing promises for TOTAL (DBMS) and networking enhancements, the VS still cannot match the range and depth of our VAX family.

It should be noted that the VS 50 and VS 80 are not fully compatible with the VS 90 and VS 100. Because only the 90 and 100 have a true 32-bit hardware implementation, there are minor conversions required moving upward from the 50 and 80 to the 90 and 100 models.

Of these full 32-bit processors, there are very few installed. The VS 90 was just announced and it is unlikely any are installed. While the VS 100 has been shipping for just over a year, it is estimated that there are less than 500 installed worldwide.

With such a limited installation record, it is extremely difficult to obtain significant feedback as to the full functional capabilities of Wang's full 32-bit architecture in the VS 100.

Not only is it difficult to determine the functional capabilities of the existing deliverable systems and options because of the lack of industry experience using them, it is next to impossible to predict how future enhancements (namely TOTAL (DBMS) and Remote Wangnet Plan Networking) will affect the total functionality of the VS family.

Most existing users of the VS 100 as reported by *Computer World*, 11/19/81, are not planning functional extensions until they fully understand the announced, but as yet undocumented, functional specifications of existing systems.

By contrast, the VAX family has over 5,000 installations and is completely compatible from the VAX-11/730 up to the VAX-11/782. The proven capability of the VAX family should mandate a DIGITAL solution today and for the next 12 to 18 months as well.

Although the full functionality of the Wang VS family is not detailable completely, the following limitations and knock-offs are easily recognizable as deficiencies today:

- Wang's Field Services capabilities are still limited as compared to DIGITAL. With more than four times as many field service technicians and twice as many per installation, DIGITAL can provide the best support. With guaranteed response times, remote diagnosis, as well as a more mature product, only DIGITAL can provide a total product and service offering.
- As above, DIGITAL's software support is far superior. With ten times the installation rate of VAX systems as compared with the VS 90 and 100, only DIGITAL can provide the in-depth knowledge for successful implementation of distributed data processing on 32-bit maxi/minicomputers.
- DIGITAL provides reliable software delivery. Wang has missed shipment commitments on the VS 100, FORTRAN-77 (still not delivered), PL/I, ADMS, DBMS, and networking architecture.
- Through third party development, DIGITAL provides at least a 20-fold opportunity for application solution potential. We have been shipping VAX systems for 3 years while Wang has only been shipping VS 100s for a year.
- Although the VS operating system is said to be good for forms generation, program development, and friendly user interfaces, the following knock-offs exist:
  - — Despite a virtual system, the maximum virtual image is limited to 1 Mbyte. The VAX virtual image is only limited by your disk size.
  - — Paging space on disk is pre-allocated at SYSGEN time and allocated on a workstation basis. This means the user's programs may not be transportable to other working areas.
- Wang does not offer the following features on the VS that are offered by the VAX:

CODASYL DBMS	PASCAL
QUERY/DATATRIEVE	CORAL 66
GRAPHICS	BLISS 32
DECSET	FORTRAN 77

- Wang's upgrades are expensive:
  - — Memory—$16K per Mbyte, between 77 percent and 128 percent higher than DIGITAL
  - — Terminals—$3,700 vs. $2,200 VT100s
  - — Communications—expensive and rigid on VS
- Upward/downward growth with full compatibility—the VAX range from the VAX-11/730 up to the VAX-11/782 is unapproachable from Wang. The VS 50 and VS 80 are not fully compatible with the VS 90 and VS 100.
- DIGITAL has superior networking:
  - — Proven and installable
  - — Peer to peer/interactive—VS uses a master slave networking scheme
  - — Cost effective

Note: See *Competitive Update* (November 9, 1981) for additional VS networking limitations.

Performance

Performance testing of the VS family has never been published and queries to the major competitive consultants have not provided any substantial information on VS performance.

One consultant with the Gartner Group stated that Wang typically overstates their performance capabilities, and with so few VS 100s installed, it is very difficult to estimate actual VS performance.

It is estimated by this author that the VAX-11/730 will provide equal or greater performance than the VS90, and the VAX-11/750 will provide equal or greater performance than the VS 100.

Pricing

VS 50 and VS 80 pricing has not changed from November, 1981, and the *Office Plus Competitive Update* (11/9/81) should be consulted for these prices as well as pricing on VS options and accessories.

Figures 5-1 and 5-2 provide a graphic illustration of VAX family and VS pricing for both purchase price and 5 year cost of ownership as well. From the pricing graphs, the following summation can be made:

- The VAX-11/730 and the VAX-11/750 are less expensive than both the VS 90 and VS 100. The larger the system in number of terminals, the greater the cost-savings with a DIGITAL VAX solution.

The DIGITAL VAX family offers the best possible solution for any customer considering the VAX and Wang's VS family. The VAX offers:

- superior functionality
- equal or higher performance
- lower price

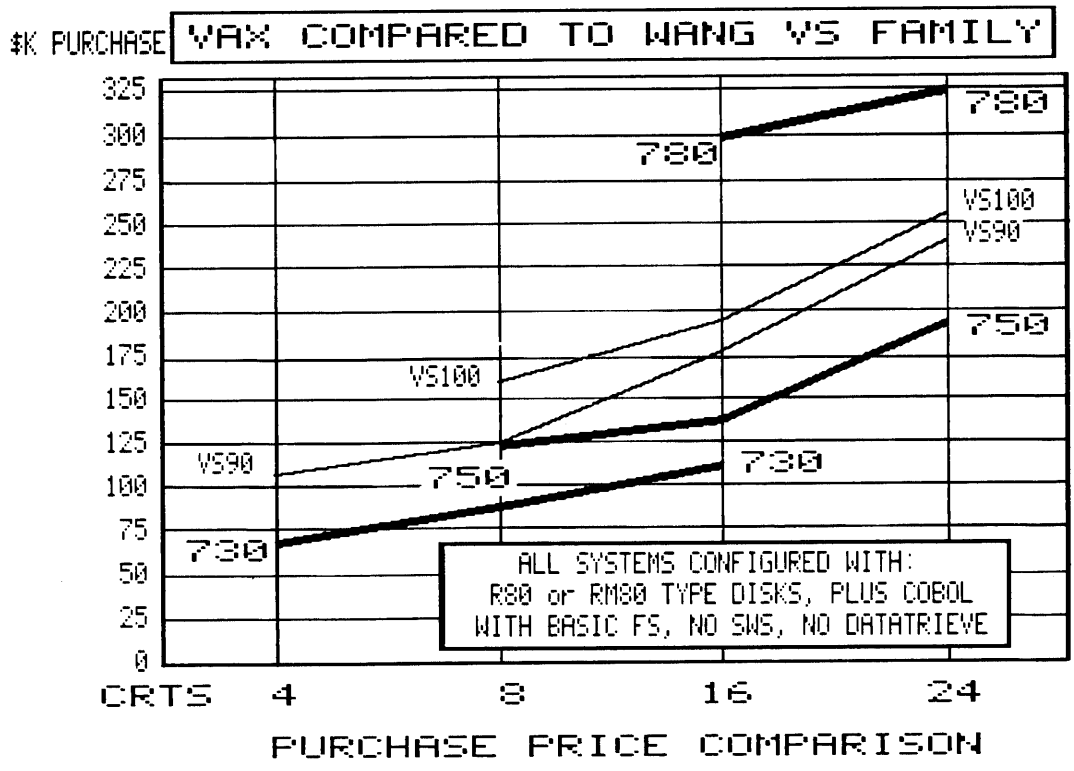


Figure 5-1

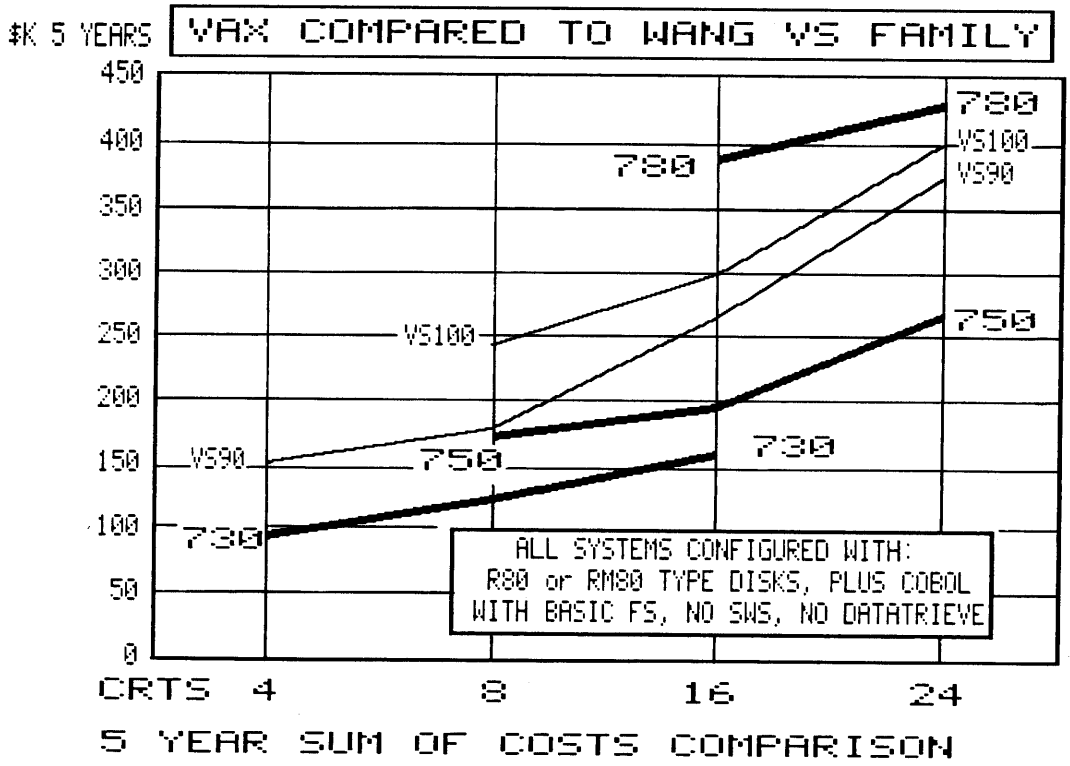

$K 5 YEARS
VAX COMPARED TO WANG VS FAMILY
450
400
350
300
250
200
150
100
50
0
780
VS100
VS90
780
VS100
750
VS90
750
730
730
ALL SYSTEMS CONFIGURED WITH:
R80 or RM80 TYPE DISKS, PLUS COBOL
WITH BASIC FS, NO SWS, NO DATATRIEVE
CRTS 4
8
16
24
5 YEAR SUM OF COSTS COMPARISON

Figure 5-2

SECTION 6
PRODUCT PROFILES

VAX FAMILY CHARACTERISTICS

Contemporary 32-bit Design

32-bit design is the technology of the future for high-end minicomputers. Your customers can feel secure knowing that *all* VAX family members employ a 32-bit architecture as the design base for their implementation.

Range of Processing Power

VAX processors and packaged systems give customers the ability to select a system that is just right for their needs. At the low end, the VAX-11/730 provides a low-cost entry into the family; the VAX-11/750 offers a midrange combination of price and performance; and at the high-end, the VAX-11/780 and the VAX-11/782 Attached Processor System support the capacity and workload of very-high-performance machines. All VAX processors are available in a number of packaged systems that are totally software-compatible and come with a range of peripheral options.

Single Operating System

VAX/VMS is the single operating system for the entire range of VAX family computer systems. Guaranteed current and future compatibility protects your customer's investment.

Multi-Operating Environment

VAX processors and VAX/VMS are designed to simultaneously support realtime, batch, and timesharing applications. User-defined and system-defined priorities allocate system resources so that system performance, response time, and productivity are constantly being optimized for specific configuration and workload requirements. A MONITOR utility shows internal system activity to a VAX system operator or system manager for better and easier system management.

Sophisticated Virtual Memory Management

VAX virtual memory allows VAX processors to execute user programs of up to two gigabytes in length. Programmers spend more time designing and implementing their applications and less time worrying about memory management. Applications come online faster, resulting in higher programmer productivity and satisfaction.

Rich Instruction Set

The VAX instruction set provides 248 standard instructions and 56 G_ and H_ extended floating point instructions designed to meet the requirements of a high-performance virtual memory operating system. Many instructions were designed specifically to improve the performance of high-level language operations. These instructions produced a more compact and efficiently compiled code.

Extensive Parity Checking

All VAX family systems have extensive parity checking, providing the customer with the security of systemwide reliability checks which ensure data integrity.

Consistent Command Language

The DIGITAL Command Language (DCL) gives all VAX system users consistent control over the operating environment. The DCL HELP feature makes the command language very easy for users to learn and utilize. No retraining or relearning is necessary when a user moves or upgrades from one VAX system to another.

Extensive Networking Capabilities

All VAX systems can be connected using Networks that include DIGITAL-to-DIGITAL and DIGITAL-to-non-DIGITAL system links. VAX/VMS operates in complete harmony with the DIGITAL Network Architecture, giving your customers the opportunity to grow within a distributed environment without costly conversions or development.

Compatibility with the PDP-11 Family

VAX processors enjoy a high degree of compatibility with DIGITAL's PDP-11 computer family. They use the same DIGITAL Command Language; the instruction sets are very similar; and VAX systems employ the same disk structure used on PDP-11s running the RSX-11 operating system so that transferring and sharing data files is easily accomplished.

VAX SOFTWARE CHARACTERISTICS

Multi-Language Support

VAX/VMS supports a number of popular high-level programming languages including FORTRAN, COBOL, BASIC, PL/I, CORAL, BLISS, C, and PASCAL. The VAX versions all meet or surpass industry standards. Not only will your customers more than likely already be familiar with a VAX language, they will be working with the industry's most current specifications.

Standard Symbolic Debugger

All native VAX programming languages use the same Symbolic Debugger which permits program debugging through the use of source-code statement numbers and data names. This can greatly improve productivity through simplified source-code debugging and reduced development time and expense.

DECnet

All VAX family system support DECnet, a powerful networking system for multiprocessor communications, resource sharing, and backup. DECnet allows the VAX customer to enjoy the cost savings of localized computing power, while maintaining centralized control.

Standard System Services

Many of the system services used by the VAX/VMS operating system are generally available to system users through the systemwide calling sequence. This saves programmers from having to recreate and debug the same routines that are often needed by their application programs.

Integrated Information Management

All VAX systems support a complete and highly integrated set of information management products called the VAX information architecture. Forms management (VAX-11 FMS), sophisticated query and report writing (VAX-11 DATATRIEVE), common data dictionary (VAX-11 CDD), file and record management (VAX-11 RMS), and CODASYL database management (VAX-11 DBMS) simplify the needs of all system users (from casual end user to programmer) for managing and reporting on data.

The VAX family's information management solutions range from simple file management to complex CODASYL data base management. The customer can choose the interface (forms, graphics, query, etc.) and the data structure that best suits each application need.

Distributed Data Processing

The VAX information products support distributed data processing through VAX-11 DATATRIEVE's distributed data access facility using DECnet. This ensures a cost-effective, simple approach for managing the communication among distributed applications.

VAX Call Standard

The VAX information management products are designed to interact with any VAX language that adheres to the VAX system's calling standard. Having a single calling standard reduces programmer training and improves productivity.

Software Utilities

All VAX systems provide a full complement of utility programs for application development and general user operations. These are completely tested, integrated, compatible, software packages. They are part of each VAX system package and are fully supported by DIGITAL. Your customers have from the start what they need to make full use of the system.

VAX/VMS Memory Management

The VAX/VMS memory management system allows the user to lock pages into the working set (never to be paged out) and to lock a working set into physical memory (never to be swapped out). This allows the user's time-critical programs to execute at maximum throughput for cost-effective performance.

VAX HARDWARE CHARACTERISTICS

High Maximum System Throughput Rates

All three VAX family processors have impressively high maximum system throughput rates, for example, 5 Mbytes per second on the VAX-11/750, and 13.3 Mbytes per second on the VAX-11/780. This gives the VAX customer the high performance necessary for efficient, cost-effective I/O processing.

Single Vendor Support

ALL VAX packaged systems support additional memory and an extensive array of peripherals that match the performance and user requirements of the particular VAX processor. Customers can enjoy the security of buying all their system resources from a single reliable vendor.

Floating-Point Accelerator

All VAX family processors support a floating-point accelerator option that greatly reduces execution times for single- and double-precision floating-point computation. The G_ and H_ extended floating-point data types are standard on the VAX-11/730 and optional on the VAX-11/780.

VAX SUPPORT CAPABILITIES AND SERVICES

Extensive Integrated RAMP Features

VAX systems utilize extensive RAMP features including diagnostics and error-logging and correcting routines that can help users anticipate and correct system problems before they become the kind of major problems that can force a costly, unscheduled shutdown. Complete diagnostic software (like the User Environmental Test Package and the VAX-11/730 Customer Runnable Diagnostics) gives customers the ability to independently test and validate full system operation, often without hampering normal system use.

Remote Diagnosis/Remote Support Capability

The Remote Diagnosis (VAX-11/780 and VAX-11/750 systems) and Remote Support (VAX-11/730) capabilities help reduce customer maintenance costs and system downtime.

Customer Service Organizations

Digital's service organizations support all customer needs for training, repair servicing, spare parts, customization, and documentation. A vast number of Field Service locations and personnel provide timely, effective response to help minimize customer inconvenience from downtime or unscheduled remedial service. The Customer Education Network provides superior, practical instruction to customers at all levels of operating and management personnel. An excellent staff of Software Specialists is available locally to consult with customers on system software issues. And the Computer Special Systems custom design group is available on a contract basis to provide hardware or software to customer specification.

SECTION 7
PRODUCT LINE POSITION STATEMENTS

COMMERCIAL SERVICES INDUSTRIAL GROUP (CSI)

Good Luck! Strong selling! May there be many victories!

The CSI Financial Marketplace is in the midst of a dynamic metamorphosis. The once neat boundaries between the old established classes of financial institutions such as securities and commodities brokerage houses, insurance companies, banks, and real estate investment firms are rapidly disappearing. Today, we see firms such as Sears, Baldwin Piano, National Steel, and Gulf & Western offering more financial services than our traditional banks.

The Banking Lobby in Washington, D.C., in pushing the government to deregulate the industry so that banks can compete against the "unregulated" financial institutions such as Merrill Lynch and Sears. These "unregulated" financial institutions offer more investment services than do many of the banks. You can go to Merrill Lynch, for example, if you are interested in securities brokerage and trading, cash management or investment management services, commodities brokerage, or executive relocation services. In addition, Sears would provide you savings and loan operations along with credit and charage cards. The race for the "Financial Supermarket" is clearly on.

The Financial Supermarkets are being built from within, for example, Citicorp and E.F. Hutton, and they are being built through acquisition, for example, Sears acquired Dean Witter, American Express acquired Shearson and Loeb Rhoades, while Prudential acquired Bache Group. No matter how they are being built, survival in this highly competitive marketplace is dependent upon the rapid development and delivery of custom quality services to their clients. The volume, complexity, and time factor constraints in processing transactions determine automation as the only viable means of delivering these services. DEC-CSI is in a unique position to capitalize on the needs of this emerging industry.

The market leaders are pursuing two diverse approaches to the automation problem. Mellon Bank and Morgan Guaranty and Trust are attempting to use **centralized mainframes** to provide these services, capitalizing on their past investments. This approach is clearly nearsighted in that it is fraught with rigid system requirements, poor ability to customize services; inability to respond to a fickle demanding client; data base integration and coordinating complexities; and a quality of service decline produced by an increase in kinds of services and service loads.

The other approach is to develop new services on departmental systems and make them available to their internal staff and customers over an integrated network. These "service deivery networks" require a high degree of flexibility and approachability for non-data processing professionals—"the common man." Over the next five years, more than 50,000 professionals in these industries will be given access to these networks through departmental systems and personal workstations.

Because of our thrust to win the Financial Supermarket customer interface or customer information delivery applicatons, the following three groups of people are key in the sale of "service delivery networks":

- The "ultimate" end-user, that is, the Account Relationship Officer
- Senior Business Management (Senior or Executive Vice President and above) who are responsible for:
  - — new customer business/service offerings,
  - — customer servicing and management,
  - — and corporate profit and loss
- Data Processing Managers and Technicians

The extensiveness and complexity of the sale depends upon the number and size of the departments involved and the importance of the business area to the financial institution. In any case, the key is to sell the essential benefits of our products in the context of each group's own business needs and responsiblities. To illustrate this point, let's use the uncommon example of selling VAX Common Data Dictonary to the customer account relationship area.

- To the Customer Relationship Officer:

  You might sell the benefit of the VAX CDD's management of data, the faster locaton and dissemination of data, and the delivery of the latest most up to date data item. For the Relationship Officer, this means that when the customer calls up, he can give the best information over the telephone without wasteful delays. A new service can be sold more quickly or a brewing potential problem can be addressed in a timely informed manner with the latest information made available to the relationship officer.

- To the Senior Manager in Charge of New Customer Business:

  You might sell the benefit of the VAX CDD's organization and management of information that facilitates the usage of the corporation's information to provide faster new customer services. In addition, the VAX CDD will permit the quick location of data where it exists around the organization so that individual service profitability and particular customer buying habits and profitability can be examined. Also, VAX CDD means that the quality, speed and accuracy of the information available to the Relationship Officers is better in addressing customer needs or concerns. Happier satisfied customers will buy more new services from the institution. New customers will be attracted by the influence of these satisfied customers.

- To Data Processing Managers and Techniques:

  You might sell the benefits of the VAX CDD implementation and benefits on file and database design especially over networks. VAX CDD's benefits to program design and documentation might be highlighted. The VAX CDD as a system management tools should be stressed.

All of theses three groups must understand why the product is **important to them directly.** Any of the three groups can be instrumental in winning/realizing a sale.

We offer a unique 1-2-3 punch, growing stronger in time, to address these needs. The VAX family, our strength in information management and our prowess in integrated networking, give us an unbeatable combination to offer the industry. It is a clear "all for one; one for all" situation. The combination of the three help make the sale for any one. And, the strength of any one pulls the sale of the others.

The VAX-11/730 is the low-cost departmental system and the office automation departmental machine. Add to the VAX-11/780 DATATRIEVE, FMS, and our OFFICE PLUS products in a DECNET network, and you have an unbeatable offering to start the building of a "SERVICE DELIVERY NETWORK." Combine with this a VT100 on the professional's desk, and you can control the desks of the professionals who use these networks. "All for one; and one for all" is a winning product combination in the marketplace with the VAX-11/730 being the lead machine.

However, in this emerging marketplace, the strength of our products in and of themselves will not be sufficient without you. You must sell tough and be strong. We can win every battle if our warriors use their superior tools well. The competition will come from all sectors into this marketplace. The prize is too large for them to stay out. Probable scenarios are:[1]

- **WANG** will come from their leadership in word processing. They will attempt to build their DP offerings and attack the Office Automation market with Wangnet, Alliance, and the a new workstation.

1 For competitive responses to these actions, contact either your product line representative or the appropriate competitive analysts for assistance & strategies.

- **XEROX** will come from its strength and knowledge of business office needs and products. They will expand their workstation and office product offerings. They will demonstrate Ethernet and tout the benefits of "local area networks." Finally, they may reenter the DP market as a subordinate to their other primary approach.
- The **Micro Suppliers** will puch up and combine their electronics into inexpensive capable workstations and computers.
- **AT&T** and the other **switch and communications vendors** will move from their strength in communications and customer products to attempt to capture the office business.
- **IBM and Japan Inc.** will attempt to come from any direction which appears to offer opportunity.
- The other **mini-maxi computer companies** will try to follow DEC and IBM with cheaper and faster products.

We've got the best combination of products! You are the better sales people! We should win!

The "service delivery network" approach may be characterized as follows:

- Rapid evolution to highly distributed styles of computing that require integrated networks.
- A rapidly emerging awareness of the broad applicability of personal and departmental computers to leverage professionals.
- An evolution to personal computers and professional workstations.

The CSI strategy is to pursue those pieces of the "service delivery network" that provide services to the following groups of Financial Supermarket customers:

- Large Corporations
- Other Banks and Financial Institutions
- High-Net-Worth Individuals

The business applications which are most crucial to us are those that directly interface to the financial institutions' customers. We want to own the customer-interface and customer-information-services within the institutions. In addition, we want to control all distributed networks that directly service these institutions' customers, for example, International Banking. Typically, these applications involve the following processes:

- **Moving** funds from one place to another (mobility), for example, funds transfer, wire services
- **Transforming** assets from one financial instrument to another, (liquidity), for example, Yen to gold, foreign exchange, securities exchange, and portfolio management.
- **Providing information about money** (where assets are located, in what form, decision support information to be used in making investment decisions), for example, historical research, cash management, securities/commodities trading.
- **Office Communicaitions** between the financial institution's professionals, who are managing customers' accounts, and the customer, for example, customer account and relationship services.

The Computer Services Industry (CSI-PL/105) area within the CSI group is also emphasizing the VAX family of products to major computer services marketplace organizations such as Strategic Information, ADP, UCC and General Electric. The marketplace focus of VAX will be on the VAX-11/782 and VAX-11/780 for central-site processing network-functions in the end-user area. The OEM reseller portion will focus on the VAX-11/750 and VAX-11/730 for Distributed Data Processing/Data Base uses as well as for Office Automation.

The sales-strategy product-positioning for the VAX-11/782 attached processor system should focus upon central-site requirements with compute-intensive applications such as econometric-financial modeling and engineering applications. The VAX-11/780 should be positioned for both central site processing where a variable CPU-I/O relationship is critical to processing requirements and related network management.

The VAX-11/730 and VAX-11/750 should be positioned in the OEM reseller areas where small (<6 users) or medium (<16 users) systems are required for Office Automation/special applications (econometric/database) systems.

The average sales cycle can be optimized with those prospective customers who are currently VAX users and are in the reseller market with DEC products, either 16 and/or 32-bits.

Competitors such as HP, WANG and IBM are aggressively pursuing the OEM reseller market with offerings emphasizing personal and low-midrange systems for an office environment. The advantage of the DEC capabilities over the competition in the reseller areas encompass:

- VAX family of systems.
- VAX/VMS common operating system to protect software investment and hardware level migration, especially in reseller areas.
- VAX/VMS application development software such as Information Management Products intended to either complement and/or substitute for "custom" applications without high maintenance costs.
- The integrated VAX office packages currently being offered for office-automation environment convering integrated WP/DP, EMS, Information Management and Activity Management.
- The DECnet communications network capabilities for DEC hardware family integration as well as Internet features (non-DEC-to-DEC network) and Packetnet (x.25, etc.) for multinational coverage.

MANUFACTURING, DISTRIBUTION & CONTROL PRODUCTS GROUP (MDC)

Marketplace

The MDC marketplace is divided into four industry segments: Chemical/Pharmaceutical, Electrical/Electronics, Transportation, and Emerging Industries. These industries have a high requirement for manufacturing automation and must rely on this automation to remain competitive and to realize long-term growth rates. MDC has identified three segments of target opportunity which fully define computer usage in the factory environment. These segments are:

- Realtime Monitoring and Control—computers are used as an integral part of the manufacturing process. This type of application is found in highly repetitive processes, for example, batch chemical production.
- Manufacturing, Planning and Management—computers are used to manage and plan the manufacturing process. This type of application is found in complex, but nonautomated operations, for example, DIGITAL manufacturing.
- Office/DP—computers are used to move qualitative data throughout the (manufacturing) environment.

The Unified Plant Management (UPM) concept provides our customers with a strategic framework to build an automated manufacturing environment. Unified Plant Management means tying together all of the information and control data within a manufacturing organization at all levels and then integrating them into the rest of the corporate structure.

Market Strategy

MDC is unique among the members of the Commercial Group in that we must address the needs of both the typical commercial customers as well as the technical realtime users. The VAX architecture enables us to address both disciplines. It supports gathering data in realtime and integrating computers and terminals into one information network.

DECdataway

The DECdataway Systems enable you to integrate communications software, fully programmable, remote computers and a variety of input/output devices into a user-friendly, highly flexible local-area network that uses VAX hosts.

VMCS

VMCS is an interactive manufacturing management system that provides automated tools for managing a company's investment in materials, production equipment, and people. VMCS is distinguished among manufacturing software systems because it is interactive and modular. Available on DIGITAL's VAX family of computers, VMCS consists of six modules:

- Inventory Management Systems
- Manufacturing Standards Data BAse
- Materials Requirements Planning and Master Production Scheduling
- Capacity Requirements Planning
- Shop Floor Control
- Purchasing

Note: VMCS is not supported in Europe and GIA.

VAX Information Architecture

The VAX Information Architecture provides commercial functionality across a range of products unequalled in the industry. VAX-11 DBMS, VAX-11 CDD, and VAX-11 DATATRIEVE provide design flexibility and productivity tools. Owing to the implementation of the CDD which is

the hub of the Information Architecture, the architecture provides increased data security, integration, and control. This process is known to architecture provides a major link in an office network by allowing data to be shared easily.

VAX-11 DECmail

The VAX-11 DECmail product allows the manufacturing industries to easily send and receive information from the factory floor and the corporate headquarters. DEC's strong communication products easily allow the integration of word processing systems (DECmate, DECWORD, and DECWORD/DP) into the electronic mail network.

Communication Products

Communication capabilities on the VAX family of processors extends the power of these computers to the manufacturing floor across a DIGITAL-TO-DIGITAL environment, enables information transfer to non-DIGITAL systems, and allows the user the flexibility of designing systems across public packet-switched networks. The VAX product set includes phase III DECnet which extends DECnets capabilities to include:

- Adaptive Routing
- Network Command Terminals
- Multipoint Devices
- Network Management

Also supported in a VMS environment are internet products for communicating from a plant's host manufacturing system to its corporate mainframes. Products which support this connection to IBM are:

- VAX-11 2780/3780 for file transfer
- VAX-11 3271 protocol emulator for interactive support

Other DIGITAL systems support special purpose packages to CDC and UNIVAC that can be used to front-end communications to a VMS system. The range of communication products on VMS systems permits the network design to interface to public packet-switched networks using VAX-11 PSI.

VAX Hardware Systems

The VAX-11/730 will be the vehicle that will enable MDC to expand our customer base to include those application environments that require the functionality and flexibility of the VAX architecture, but not necessarily the raw processing power of the VAX-11/750 or VAX-11/780. It is important that the VAX-11/730 supports the same VMS operating system as the VAX-11/750 and the VAX-11/780.

The VAX-11/782 is a tightly coupled, asymmetric multiprocessor or attached processor. This member of the VAX family supplies expansion capabilities to a highly computationally intense environment that requires access to common data. This allows our customers to expand their current VAX-11/780 systems by buying a VAX-11/782 upgrade.

With DEC's strong communication products, it is easy to build an information network tying together all the data throughout the corporation, from the factory floor through the corporate headquarters. The easy accessibility of data at all levels of the organization leads to increased productivity at each level, and thus for the entire corporation.

Sales Strategy

Since the primary design objective of the VAX family was to have a set of systems with a single operating system (VAX/VMS), there should be little distinction between the operational

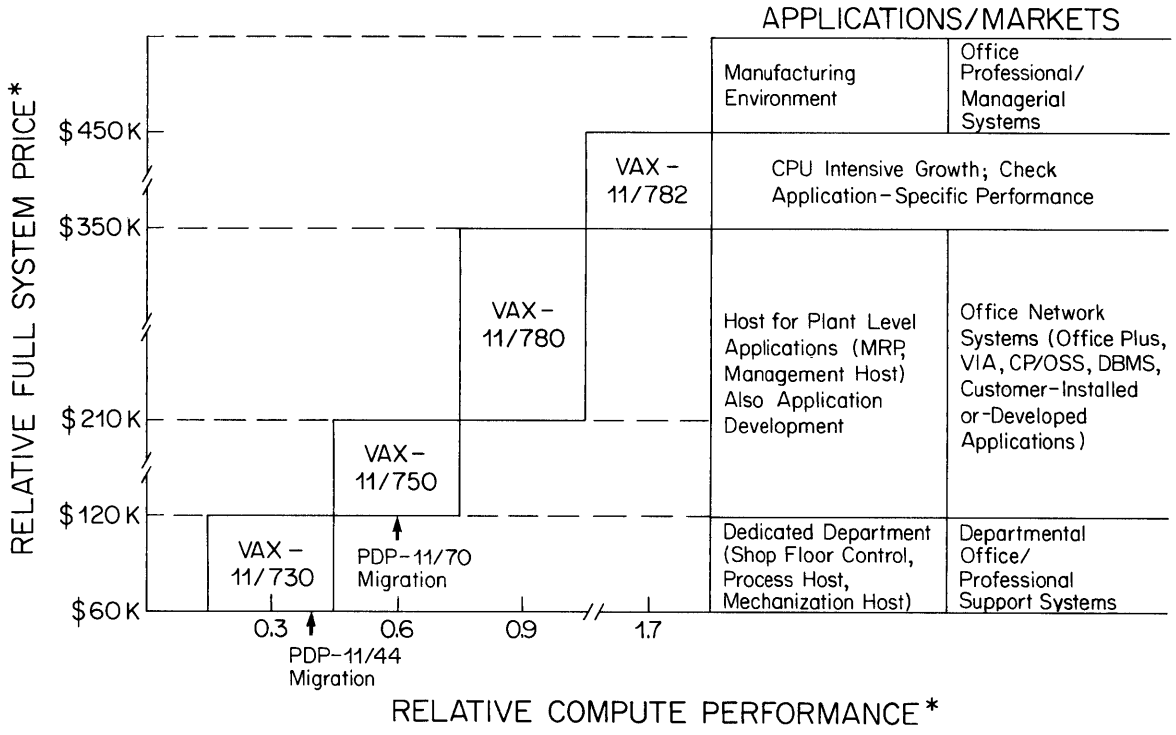
environments other than CPU power. The addition of the VAX-11/730 and VAX-11/782 will enable us to supply more applicable solutions to our manufacturing customers. UPM brochures are available to support this sales strategy.

Competition
Our major competitors in the same market space as the VAX family are IBM, Hewlett-Packard, and Prime. For specific competitive information on the VAX family, VMS, or any of the layered products, refer to Section 5, Competition, in this Sales Guide.

Product Line Support
The VAX family and the layered products are supported by the Technical and Marketing Support Group (TAMS). The contacts are as follows:

Toni Lee Rudnicki	Commercial Products (Office-PLUS, VAX Information Architecture, etc.)
Dennis Phelan	Communication Products
Howard Coffman	VAX family, VMS
Yogesh Chandra	DECdataway
Joanne Griffin	VMCS

MANUFACTURING, DISTRIBUTION AND CONTROL
PROCESSOR POSITION ESTIMATE



* Actual price and performance will vary based on application and configuration.

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PUBLISHING AND BROADCAST INDUSTRIES GROUP (PBI)

Marketplace

The Publishing and Broadcast Industries Group is chartered to market DIGITAL's products in the newspaper, publishing, broadcast and cable television markets. PBI has been a leading supplier to the newspaper market for some 15 years beginning with the PDP-5. In today's environment, VAX family products play an increasingly important role in our product offerings to that market. The entire range of VAX systems from the VAX-11/730 to the VAX-11/782 are used in applications such as archiving published stories in an on-line library system at Oklahoma Publishing Co., controlling circulation of the product and meeting the data processing needs that exist in all businesses. An increasing number of VAx systems are also being sold for videotex applications at companies like Time Inc.

The VAX family also plays an important part in PBI's more recent entry into the cable television industry. Presently, several major multiple-system operators, including Storer Broadcasting, have installed VAX-11/750 and VAX-11/780 systems to meet their needs in the areas of subscriber management, construction management, data processing and other major applications in this rapidly growing industry. The VAX-11/730 will be welcomed as an entry level system for customers who cannot presently justify the more expensive VAX systems.

DECset, a major part of DIGITAL's OFFICE PLUS architecture, is the publishing system for major corporations with text management needs such as General Electric's installation at Lynchburg, Virginia and our own internal documentation groups. DECset brings to OFFICE PLUS the ability to accept both DIGITAL and non-DIGITAL word processor input, manage documents and typeset the finished product ready for printing. DECset is presently available for the VAX-11/750 and VAX-11/780.

Marketing Strategy

VAX family products are marketed to all segments within the PBI chartered market areas. VAX is the product to sell to the customer who is developing new applications that will have to grow with his business. The common operating system, VMS, permits an application to be developed to run on any member of the VAX family. This is a very attractive feature for customers with diversified data processing needs; it allows them to select the right amount of computer power for the need without the expense of redeveloping the application software. In newspaper chains, for example, this means that one set of application software can be used in small, medium and large papers throughout the chain. Important messages to convey when presenting DIGITAL's VAX family are: the compatibility of the VAX systems offerings, along with the networking capabilities of DECnet to other VAX systems; and, in newspapers, to existing PDP-11/70 production systems; and the programmer productivity aids built into VAX/VMS.

VAX-11/780 Systems

The VAX-11/780 is the product to meet customer needs in corporate text management applications, medium-sized newspapers, and in larger cable operation environments. Larger than the VAX-11/750 or VAX-11/730, the VAX-11/780's database capabilities are important to the text management and newspaper applications as well as to videotex. It's ability to handle multiple terminals is extremely important to the cable industry.

VAX-11/782 Systems

For larger newpapers and cable operations as well or in multiple application environments, the VAX-11/782 is also expected to be useful in videotex database applications.

VAX-11/750 Systems
The VAX-11/750 works well in departmental text management applications and in newspaper data processing environments and in more moderately sized cable operations as well. The VMS operating system compatibility up and down the VAX line, along with DECnet communication, means that a customer can invest in the size machine needed now without fear of future growth needs.

VAX-11/730 Systems
With the introduction of the VAX-11/730, customers will now be able to take advantage of the VAX/VMS virtual memory system at smaller levels of need and at lower cost. Smaller, more affordable videotex packages will become available, and cable MSOs will be able to place local computer power in the smallest of their operating systems with complete compatibility of databases throughout their systems. In addition, the power and the affordability of the VAX-11/730 should alloy fears in the newspaper industry about what may or may not happen in the long term to their PDP-11/70 systems.

Installation/Availability
Contact the product line for specific information.

Special Development For VAX Family
There are currently two DECset Integrated Publishing™ system packaged configurations. One for the VAX-11/780 and one for the VAX-11/750. Enhancements to the DECset system can be expected as a matter of course.

PBI has always had industry specific products to enhance corporate offerings in its respective marketplaces. Our philosophy regarding the VAX family is no different. Starting with the newly acquired newspaper library package from Batelle Columbus Laboratories and moving on to the expected pagination package for DECset and third-party packages for videotex, to circulation and cable-unique applications, we will continue to develop quality supplemental products to meet the unique computation needs of our customers.

Sales Strategy
PBI currently sells the full range of DIGITAL's 16-bit and 32-bit systems. Particular emphasis is placed on the high end of the PDP-11 line and all members of the VAX family. There is currently no LCG activity within our marketplace.

System Selection
Two major considerations affect system selection within our marketplace. The fiest is the type and amount of Terminal I/O. The second is data base size and desired retrieval techniques. PBI also offers a range of market specific application software and utilities across a wide range of CPU types. High availability is also becoming an issue. For detailed configuration help on any specific application, contact the product line.

Transportability Strategy
in the newspaper market we have developed a set of new products which will rely on DIGITAL's Network Architecture to provide the needed interconnect compatibility. In other applications and markets, the benefit of software migration up and down families of systems as well as between 16-bit and 32-bit products will be stressed.

D.N.A. products such as "DX", DECnet, and 2780/3780 are all in use in every market.

Features And Benefits
The rich range of our product set, combined with the proven value and quality of our customer services group, allows DIGITAL to meet customer needs more completely than any other vendor. This allows customers to derive the following benefits: first, the ability to select the most appropriately sized and priced "point solution," while knowing that any system can be easily interconnected and integrated into a network; second, our approach of offering customizable tools and associated services (except CSS) allows customers to tailor our products to meet their needs; third, the customer can feel confident that by doing business with DIGITAL he will continually be supplied with state of the art products that will address all of their Data Processing and automation needs (DIGITAL's OFFICE PLUS program is a good example of this commitment); lastly, DIGITAL's networking leadership will allow customers the flexibility they need and cannot get from other approaches such as S.N.A.

Where To Find Leads
For DECset two avenues are open. The first is through the more traditional avenues such as the DP or Operations department. In particular, division level managers are usually required to approve these expenditures since DECset is not a Department level system. The second avenue is through the In-Plant print shop. In the first case we expect that DECset would be sold as part of the DIGITAL OFFICE PLUS umbrella, especially where large document management or foreign word processing compatibility are key issues. In the Cable T.V. and Broadcast Conglomerates market, the traditional MIS and DP departments are the appropriate avenues. On CATV, cash management applications and subscriber billing provide a good starting point.

In the other markets DIGITAL's Networking products and range of compatible systems are key.

In the Newspaper market, Publishers and General Managers are the target audience with the "Electronic Newsroom" being the current "hot" topic of interest, along with integrated newspaper solutions for the future.

Product Line Specific Literature
Cable—Industry brochure outlining our approach to the industry and DIGITAL benefits in development will be completed in the Spring.

DECset—The DECset brochure from the OFFICE PLUS brochure set is the primary selling tool along with the DECset slide show. A videotape demonstration is in development for the Spring.

Newspaper—An overall Newspaper Industry brochure defining the integrated newspaper environment of the future is in development for Spring completion.

Product specific-brochures will be developed as VAX specific application products become ready for introduction.

Competition
Besides the traditional competitors we see in all DIGITAL markets, PBI sees more unique competitors in its marketplace and also sees some unique characteristics of our traditional competitors.

Cable
IBM—Has declared an interest in this market, but does not as yet have any industry-specific products. This is expected to change in the next several months with joint-marketing ventures.

Tandem—The dual processor argument holds up well in an environment where downtime of the computer may mean downtime of the entire operation. They remain vulnerable on traditional issues such as support.

Industry-specific competitiors—Such as Cable Data, Gill Mangement, Oak, and others cannot bring the resources to bear on customers' problems that DIGITAL and VAx architecture can. They mah be strong on individual point solutions, but cannot talk computing-strategy, architecture, growth, and communications in any meaningful way.

DECset

IBM—Strongly declared in the Office environment; they have no product with the capabilities of DECset.

WANG—They are strongly ensconsed in the word processing environment; however, the capability of DECset to communicate with foreign word processors can get DIGITAL into the account and bring other OFFICE PLUS products along with it.

Traditional typesetters—And newspaper-like text managers simply do not have the database, office, communications, and flexibility offered by a VAx layered product for the office environment.

Newspaper

IBM—The only real competitors to VAX in the newspaper business offices, data processing environment, IBM has neither the background in newspaper production nor the ability to put together an integrated newspaper strategy that address the concerns and needs of the 1980s and the electronic publishing era.

Product Line Support

Pre-Sales Support—Support is available from the product line on an as-requested basis. Each market has its own team of specialists available to meet the unique needs of the industries/applications they support.

Demos—Can be arranged at the product line in Merrimack with appropriate notice through the sales support contacts.

Post-sales—Training, consultation, and service support are all available in forms especially tailored to the unique needs of the markets served.

Advertising—Product advertising for DECset will continue to concentrate on MIS and text management in publications designed to reach the MIS director.

Cable industry advertising will be aimed at MSO upper level management and designed to create an image of DIGITAL as the company that can design systems to meet the specific needs of the industry.

Newspaper—Our VAX strategy will be implemented here in terms of integrated newspaper systems. At one time PDP-11 based TMS systems were all we offered the newspaper industry. With the VAX system integrated into our strategy, we have become a much stronger force in a market where the point-solution competitors such as ATEX and CSI are now left behind.

Product Line Contacts

Group	
Joe Ford	Group Manager
Allan McDonald	Group Marketing Manager
Len Major	Finance & Administration Manager
Terry Clarkson	Credit Manager
Don Byrne	Office of Sales Programs Manager
Glen Gernamowski	Contracts Negotiator

Herb Luther	World Wide Business Manager
Merle Wagner	U.S. Field Service Manager

DECset

Dennis Fiore	Industry Manager
Steve Early	Sales Support Manager
Dick Powell	Market Planning Manager

Media

Bob Cohen	Industry Manager
Jack Shriver	Marketing Operations Manager
Dick Falt	Operations Manager

Cable

Dick Rose	Marketing Manager
Jane Eisenberg	Operations Manager
Skip Bollinger	Technical Hardware Consultant
Dave Smith	Marketing Specialist

Newspaper

Curt Anderson	Marketing Manager
Barbara Thompson	Marketing Planning Specialist

Summary—PBI

VAX-11/782

Newspapers	To extend compute bound VAX-11/780 systems in data processing applications.
Cable TV	In data processing applications needing increased compute power over the VAX-11/780.

VAX-11/780

Newspapers	Medium to large newspapers for data processing, library and circulation applications up to 48 users.
Cable TV	Subscriber-management applications with up to 60 users.
DECset	Document-management applications with up to 24 users.

VAX-11/750

Newspapers	Medium newspapers for data processing, library and circulation applications with up to 32 users.
Cable TV	30 user subscriber management systems.
DECset	Document management systems with up to 12 users.

VAX-11/730

Newspapers	Small newspapers for DP and library applications up to 16 users.
Cable TV	Pending benchmark data it is expected that the VAX-11/730 will serve as a subscriber magnem system for up to 15 users.

TELECOMMUNICATIONS INDUSTRY GROUP (TIG)

The VAX Family

With the recent announcement of the VAX-11/782 and the current announcement of the VAX-11/730, the VAX family of 32-bit processors now comprises four members. Whenever a VAX system is being proposed as a solution to our customers needs, care must be taken to propose the correct family member.

The following guidelines are suggested to differentiate among these systems:

Performance

- The VAX-11/730 has been shown to operate at approximately 30% of the capacity of a VAX-11/780.
- The VAX-11/750 has been shown to operate at approximately 60% of the capacity of a VAX-11/780.
- The VAX-11/780 has run Whetstone benchmarks at rates varying between 900 KIPS and 1.1 MIPS. *
- The VAX-11/782 can operate at between 1.5 and 1.8 times the capacity of the VAX-11/780.

* The use of MIPS (million instructions per second) and KIPS (thousand instructions per second) can be misleading because the instructions executed on a VAX and those executed on other processors differ greatly in their relative power.

Price Range

The relative price ranges for the VAX family members are shown on the following chart.

Please read all of the footnotes and take them into consideration before citing specific data.

I/O Bus Structures

- The VAX-11/730 utilizes the UNIBUS and a new bus, called the accelerator bus, which lends access to two ports, the Integrated Disk Controller and the Floating-Point Accelerator ports. It can operate with a bandwidth of up to 6 Megagytes/second. The VAX-11/730 has no MASSBUS capability.
- The VAX-11/750, VAX-11/780 and the VAX-11/782 utilize both the UNIBUS and the MASSBUS.

Processor Footprint

- The VAX-11/730 is contained in a 10½" rack mountable box. It forms the nucleus of Packaged Systems that will be housed in cabinets that are 22" wide, 30" deep and 42" tall. It uses single-phase power.
- The VAX-11/750 CPU is housed in a cabinet that is 29" wide, 30" deep, 42" tall. It uses single-phase and triple-phase power.
- The VAX-11/780 CPU cabinet is 60" tall, 47" wide and 30" deep. It uses triple-phase power.
- The VAX-11/782 comprises two VAX-11/780 CPU cabinets and an MA780 cabinet, which is 26" wide, 30" deep, and 60" tall. It uses triple-phase power.

Migration

- The VAX-11/730 is an excellent choice for migrating from PDP-11/34 and PDP-11/44 applications.

- The VAX-11/750 is an excellent choice for migrating from small to medium PDP-11/70 applications.
- The VAX-11/780 is an excellent choice for migrating from large PDP-11/70 applications.
- The VAX-11/782 is an upward extension of VAX-11/780 applications. Likely candidates for VAX-11/782 usage are current VAX-11/780 users who:
  - — Are compute bound, as opposed to I/O bound, with a large computational load.
  - — Are running multistream applications that lend themselves to being split up and executed on two processors.
  - — Require access to a common file system.

Applications
The following chart which depicts price ranges also suggests typical applications.

The Marketplace
The Telecommunications Industry Group provides computer systems, support materials, and support services to all sectors of the worldwide telecommunication industry. TIG addresses this worldwide market by focusing on particular market segments:

Networks—Computer products, systems and services that support the basic telephone network functions or are used as integral components of the telephone companies' network architecture.

Internal Data Processing—Computer systems, products and services for the internal automation of administrative, operational and office functions.

Enhanced Services—Enhanced, value-added computer systems that support those products or services offered by telecommunications providers in unregulated, freely competitive markets.

Marketing Strategy
The products being announced for the VAX family in April 1982, significantly enhance the applicability and useability of an already rich and powerful product set. They complement the current capabilities for office systems, information management, data processing, distributed processing, networking and value-added systems. These products profoundly demonstrates our commitment to the VAX family and our goal for it to be THE computer family for the 80s and 90s.

As the smallest member of the VAX family, the VAX-11/730 clearly demonstrates that the full VAX/VMS architecture can be implemented in both small and reasonable priced packages. Providing one-third the performance of the VAX-11/780 at one-fourth the price, the VAX-11/730 system is housed in a single cabinet that is 42″ tall and only 22″ wide.

The VAX-11/730 will permit our customers to bring the power of the VAX closer to the work source. It can leave the "computer room" and move to the office, warehouse, plant, customer premises or remote location. With the VAX networking capability, it can provide stand-alone computing or perform as a powerful front-end processor to larger capability for tailoring VMS to fit the specific needs of installations with the dual RL02 system.

This capability is very critical in implementing physically smaller VAX family members to compete with the Motorola 6800 and the INTEL 432. The Integrated Disk Controller (IDC) of the VAX-11/730, with its high data rate, enhances the performance of this VAX by reducing the I/O bottleneck for disk-intensive applications.

Another enhancement for the VAX-11/730 is the DMF32, also known as the COMBO board. With its dynamic selection of DMA or silo-mode output, more terminals can be concurrently active with improved system response times. This device, in conjunction with the improvements made to the VMS terminal handler, gives the VAX-11/730 impressive terminal handling capabilities.

Just as the VAX-11/730 demonstrates the expansion of the VAX family toward smaller systems, the VAX-11/782 demonstrates our resolve to offer systems with computational power that is greater than that of the VAX-11/780. In all segments of our market, especially in the Enhanced Services areas, more processing power than can be provided by one VAX-11/780 is desperately needed. Acting as an attached processor system, the VAX-11/782 will greatly improve our customers' ability to develop applications with the VAX family where there is a high demand for significantly increased levels of raw CPU power. The VAX-11/782 will enable DEC to compete more effectively in the high-end systems where IBM is our primary competition.

C Compiler

TIG takes great satisfaction in the accouncement of the VMX C-Compiler. This makes available the features and capabilities of this popular structured programming language in the context of the commercial strengths of the VMS operating system. The availability of C on VMS will be of particular benefit in those sales situations where the customer uses UNIX as his program development system, yet requires a more stable production environment for execution of his application. While UNIX offers a strong development environment, its drawbacks in the application/production environment have been well documented. Now such a shop has the option to develop C programs in either the UNIX or VMS environment and distribute applications to run in the robust and highly reliable production environment of VMS.

In addition, the language reference manual provided with VMS C furnishes a clear, concise introduction to the language. Such an aid has been sadly lacking in the industry.

TIG views the VMS C-Compiler as the initial step in expanding the attractiveness of the market for VMS to include UNIX users within the Bell System and other telephone industry customers.

Sales Strategy

Some of TIG's Major Strategic Goals will enable TIG to engage in high-volume, high-risk, high payoff business:

- strengthen "Planning Partner" relationships with major TIG accounts
- establish an image as an innovative, leading commercial vendor
- produce the required competitive products
- maximize profits in mature businesses (Network Support Systems) to invest in large project development (PBX, ACS, Videotex)
- initiate programs to develop product group personnel to meet increasing demands of growing business
- position, rather than compete with, AT&T developed processors

The major effort for the Telephone Equipment Manufacturers will be at the de elopment locations. These typically are laboratories such as Bell Laboratories, Automatic Electric Laboratories of General Telephone, and Bell Northern Research Laboratories of Bell Canada. For these customers, we will promote the architectural innovations of the VAX family, its ability to handle large programs, and to significantly increase throughput capabilities. We will also emphasize strongly the improvements in reliability and maintainability that we have made in both hardware and software. For the non-Bell manufacturers, we will emphasize the software operating

system and language capabilities of VAX/VMS, in addition to the recently announced enhancements to the VMS product set. The VAX systems will be promoted as more-value-for-the-money machines and upward extensions of the PDP-11 architecture.

Laboratory salespeople will be encouraged to approach groups developing new projects. These typically will be large database or communications-oriented systems. Reliability and maintainability features will also be stressed when talking to the purchasing and maintenance people within the Telephone Equipment Manufacturers' organizations. The VAX family will be billed as evidence of DIGITAL's continuing commitment to improved price/performance and reliability. We believe that the VAX-11/780 has appeared to these customers as a leader in its field, that the VAX-11/750 has extended this tradition and reputation, and that the recently announced VAX-11/730 will even further enhance this hard-earned but well-deserved image in the marketplace.

UNIX Strategy

UNIX is the appropriate operating system for an identifiable subset of the TIG VAX market; this subset includes computer science research, program development, and other environments in which UNIX has had an historical foothold and/or best meets the needs of the customer for a simple and flexible set of software tools. There exists another segment of the VAX market wherein we have marketed and will continue to successfully market VMS for applications within both the Bell System and independent telephone companies worldwide. Such applications for VMS generally involve the need for a general-purpose operating system in a production (versus development) environment with high availability and integrity requirements.

In separating the UNIX and VMS markets, it is clearly the goal of TIG to sell an all-DEC solution, both hardware *and* software, whenever possible when appropriate to the needs of our customers. Where UNIX is a reasonable solution for the customer, it is our goal and our mission in TIG to ensure that the VAX hardware provides superior UNIX performance characteristics over competitive equipment. In order to accommodate those customer environments in which both UNIX and VMS systems must co-exist and to encourage intelligent migration of existing applications from UNIX to VMS, a subset of UNIX features is being provided in VMS through a phased program of enhancements. The first of these is the VMS C-Compiler available with VMS 3.0.

Our strategy recognizes that VAX markets for both UNIX and VMS will continue to grow and is thus aimed at ensuring DEC market share through superior hardware performance and/or software capability as appropriate to either operating system environment.

Migration

For the telephone equipment manufacturers, the similarity of the PDP-11 and the VAX instruction sets provides a relatively easy migration path. For those customers, particularly at Bell Laboratories, who will be writing their own operating system, the demonstrated ability of PDP-11 programmers to program the VAX easily should assure a reasonable migration path. As a backup strategy, we will reveal the techniques that we used to provide RSX-11M emulation on the VAX architecture. This may allow the PDP-11 based UNIX operating system to be emulated on VAX systems until a native mode operating system can be developed. In addition to an operating system, the special C-Compiler has been developed for VAX systems. For other telephone equipment manufacturers, RSX-11M emulation will provide a reasonable bridge. We are pursuing the migration of existing projects from PDP-11/70s to VAX systems.

For the telephone equipment manufacturers' market, migration will take place primarily at the MACRO assembler level. The similarities in architecture between VAX and PDP-11s should make this migration relatively easy. The non-Bell manufacturers may use this emulation capa-

bility of VAX in order to achieve migration of initial applications. However, since we see VAX tending primarily to new applications, the effort of migrating existing programs from the PDP-11/70 or other PDP-11 processors should be minimal. For the OTC market, where programming is primarily in high-level languages, migration should be relatively straightforward. The standard user-interface and similarities between RSX-11M and VAX/VMS facilities should assist greatly in facilitating this migration.

Competition

IBM is the leading computer vendor to AT&T. They have been successful in their traditional space—accounting, using high-level selling combined with a high level of Customer Satisfaction. However, IBM's market has been undergoing change. DEC is entering the office space via UNIX based trails, and Amdahl has replaced a significant number of CPU's at AT&T. In fact, at AT&T headquarters, no IBM processors remain!

IBM's strategy is to move into DEC's traditional areas of strength—UNIX based systems. They have been doing this by promoting database consolidation with multiple applications running as one processor. They have also developed UNIX* on 370 architecture to challenge DEC's once exclusive advantage. They win with DB size and cost-per-megabyte advantage.

IBM would like to see AT&T's processor, the 3B, be the approved minicomputer architecture within AT&T, and IBM as the approved mainframe architecture.

The major competition for the VAX family is viewed as being IBM, Interdata, Hewlett Packard and PRIME. Because of enhanced features in VAX/VMS, the VAX systems can be sold into commercial and EDP applications, in addition to its traditional strongholds of realtime and scientific applications.

There is a significant body of competitive information that has been amassed since the introduction of the VAX-11/780. A large amount of such information is available with regards to the VAX vs. IBM 4331-2 and 4341-2. Contact George Hays at 264-4890 for details.

Product Line Support

Presales Support

Customer related sales support involving functional explanations of the VAX-11/780, the VAX-11/750 and the recently announced VAX-11/730, are available from people in the Sales Support groups reporting Bob Schmitt. These people and their market segments are: Networks Marketing—Chris Fillios; External Ventures—Bob Tirman; Internal Data Processing—Terry Lawrence.

The TIG systems Engineering Group is chartered with providing technical support to the TIG Marketing Groups. Recent and future developments to the VAX family hardware are covered by Alan Belancik; software developments are covered by Red Crossman; Al Ryder acts as a consultant for Systems Analysis.

Demos And Benchmarks

VAX systems are available for benchmarks and customer demonstrations for the Product Line. The TIG Product Line has several VAX systems of its own. In addition, arrangements can be made to use equipment operated by the Commercial Group. TIG currently has two VAX-11/730 surrogate systems in addition to the other larger VAXs. The VAX-11/730 surrogates will be replaced by production units when they become available (Q183). contact your particular TIG Marketing Group to arrange for a demonstration or benchmark.

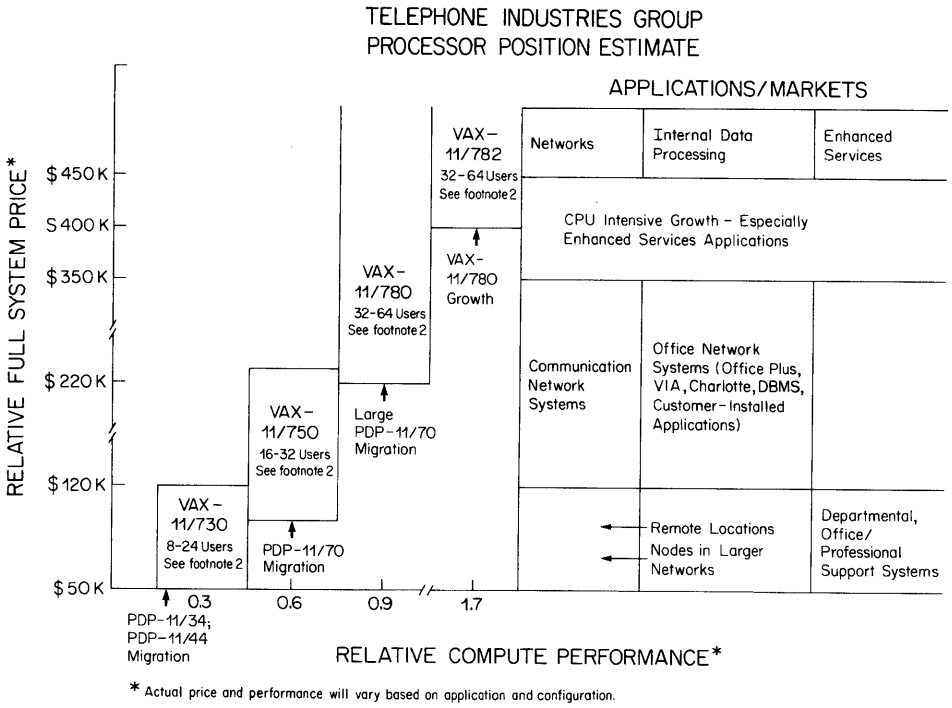
Postsales Support

Postsales maintenance support will be supplied by the Telecommunications Industry Group Field-Service Product-Support Group; contact Del Prothero at 223-5905 for information. Other types of postsale support will be provided by the marketing groups.

Contacts

All of the contacts listed below are prepared to offer assistance to the salesforce in their efforts to sell VAX products. Please call them whenever you feel the need. They will either have the answer, find the answer or refer you to someone who does have the answer to your question or need.

In Merrimack (MK1-1):		
Product Group Manager	Patrick Courtin	264-5048
Bell Business Manager	Ken Goldner	264-5069
BTL	Bernie Toth	264-4492
WECO	Ron Calabraro	264-5071
AT&T	Glenn Boston	264-5063
Bell Marketing Manager	Bob Schmitt	264-5085
Independent TELCOs	Mike Mensh	264-5062
Systems Engineering	Bill Munson	264-7436
Systems Analysis	Al Ryder	264-5049
VAX Hardware	Alan Belancik	264-5033
VAX Software	Red Crossman	264-7825
In Geneva:		
European Marketing	Dallas Kirk	9-011-41-22-933-311
European Systems Eng.	Alex Zwahlen	9-011-41-22-933-311



1 The price ranges shown on the chart above are intended to depict the possible prices of Packages Systems *with* added peripherals, expansion hardware and communication devices.

2 The number of terminals that can be connected to a VAX system is vastly different than the numbers of concurrent users that can be effectively supported by the system. Results vary greatly with your specific application.

3 The price ranges DO overlap. For a particular price level, there may be two VAX processors that suit the customers' needs.

FOR INTERNAL USE ONLY

COMMERCIAL OEM GROUP (COEM)

Marketplace

Commercial OEMs view of the market is through the OEM. For us to be successful, we must understand the requirements of both the OEM and end-user customer.

There are two major channels of distribution servicing the VAX market—Direct and Resellers. We have defined the Resellers into the following segments:

- Traditional OEMs—Small businesses, technically oriented, selling medium systems with some applications modifications.
- Distributors—Traditional OEMs who have qualified as Authorized DIGITAL Computer Distributors.
- Industry Hooks—Large, well-established firms selling to a large, independent customer base.

We sell all of the VAX systems into all markets through our resellers, with heavy concentration in the distribution and services segments. Common applications include order entry, payroll, billing, inventory control, and general ledger. In addition, over seventy percent of our OEMs have established expertise in at least one vertical market. As our VAX processors and new and larger disks continue to evolve and become available over the next several years, they will represent the majority of our systems-sales dollars.

Marketing Strategy

Commercial OEM sees the VAX-11/730 as a key migration system for those OEMs who need upward compatibility. With the advent of VAX-DIBOL and the VAX-11/730, we expect a significant increase in our 32-bit system revenue.

A key message to convey to your customer is the "family" concept. We now offer a wide range of 32-bit processors to suit your customer application needs, starting with the high-end-VAX-11/780, moving to the mid-range VAX-11/750 and then down to the low-end VAX-11/730, commercial OEM feels our 32-bit offerings provide a wide range of flexible, sophisticated systems that allow our customers to match their market needs.

One Operating System Advantage

Along with the family message, reinforce the one operating system concept. This means there is one, and only one, operating system (VAX/VMS) that runs across our current products. There are other VAX systems still in development stages, and even these systems are planned to support VAX/VMS as the only operating system.

Compatibility Is Key

VAX/VMS means software compatibility. Your OEM can develop his application software on one VAX and run the same software on another larger or smaller processor without modifying the code. Both development and maintenance advantages ($$) are now more available to your OEM. Performance, peripherals and speed will be gating factors in system selection.

The use of the denser 64 K chip memory on the VAX-11/730 represents a first for our 32-bit products and the corporation. This technology gives greatee performance at a lower price and expands the memory system maximum to five megabytes. Your OEM can have larger programs resident in memory and more jobs running concurrently, allowing more efficient system usage. The VAX-11/730 is also the first VAX packaged system to be offered in a single 40" high cabinet. This small footprint will allow maximum flexibility in a commercial environment.

The Bounded System Benefit

A key message to convey to your customer is the bounded system approach. The VAX-11/730 is complete in one 40" high cabinet bringing the benefits derived from manufacturing economies of scale. This means less inventory, better availability, and lower prices for your customer. Obviously, the economies in the system allow for only limited expansion through the system cabinet; however, the important message is that the VAX-11/730 will support UNIBUS peripherals and offers additional capabilities through the expansion cabinet. Your OEM will be able to add other UNIBUS peripherals—disks and tapes. We expect many of our OEMs will add another RA80 disk, providing an additional 121 Megabytes of fixed storage. Consult the *VAX Systems and Options Summary* for specific configuration detail.

Sales Strategy

It is estimated that the VAX-11/730 will provide one-third of the VAX-11/780 performance and one-half of the VAX-11/750 performance on a CPU to CPU comparison. For those Commercial OEMs whose needs exceed the PDP-11/44 performance, we recommend the VAX-11/730. The cost of converting 16-bit software should certainly be considered. There are several conversion utilities and migration aids available to help this process along.

For those COEMs who need a lower cost entry level VAX, the VAX-11/730 is a clear winner. Those COEMs who hesitated to buy a VAX-11/750 because of size will now find a smaller system at an affordable price. Also those OEMs who bought a VAX-11/750 and have developed a marketplace for a smaller VAX are now able to move their software to the VAX-11/730.

Currently we are not forecasting any VAX-11/730 box or package systems #1 (dual RL02s). If you feel a significant need exists for either of these versions of the VAX-11/730, please contact your Regional Marketing Specialist.

Although there are no definite boundaries as to when you should sell one VAX system over the other, here are some general system guidelines to help you work with your OEMs.

	VAX-11/780	**VAX-11/750**	**VAX-11/730**
MLP Range	$225K-$400K	$90K-$200K	$40K-$100K
# of Terminals (Application dependent)	24-96	16-48	8-24
Memory Size-Limit (Using 64K chips)	32 MB	8 MB	5 MB
Performance	1.0	.6	.3
Peripherals	MASSBUS/ UNIBUS	MASSBUS/ UNIBUS	UNIBUS only
Migration From	PDP-11/70 & VAX-11/750	PDP-11/70	Entry System/ PDP-11/44

Competition

As our VAX OEMs mature in size and markets, they will sell more into the Fortune 2000 and larger companies. It is for this reason that we see more (primary) competition coming from IBM (System 38 - 4300 and other series). But we also expect to see the Data General MV8000 and MV6000, the H/P and the Prime series (250 through 850) in the competitive arena. Consult Section 5 of this Sales Guide, Competition, for more details.

- **Product Line Support**

Please continue to contact your Regional Marketing Specialist for support with all VAX sales. Good Selling!

EDUCATION COMPUTER SYSTEMS GROUP (ECS)

Marketplace

Existing Markets Description

The market areas covered by ECS include all levels of educational institutions:

- universities
- colleges (4-year and 2-year)
- secondary schools
- industrial training schools

At each of these institution levels there are two primary application functions to be accomplished, administrative processing and academic computing.

Customer needs and application solutions vary according to institution size; the needs and budget of a major 30,000-student university differ greatly from those of a 1000-student private college. Because of this range of budgets and user-population, there is the need for dedicated administrative or academic systems besides those which combine both applications on a single system. The combination of these application alternatives and institutional levels yield the various marketing strategies of ECS. Although a strategy is possible for each level of institution for each of the three alternatives; dedicated academic, administrative, or the two combined, not all possible alternatives are viable for the complement of available DIGITAL systems. This section discusses only those alternatives that are pursued by ECS.

The administrative requirements of any institution of whatever size include many of the following:

- database
- query facility for non-data-processing personnel
- screen formatter for data entry and validation
- application packages
- student records
- registration/scheduling
- grading
- attendance
- complete financial processing
- continued emphasis on COBOL
- language implementation
- execution performance
- ease of conversion

The academic requirements are more varied since they must satisfy both student instructional and faculty research computing. The primary market needs focus on the following:

- languages for program development instruction (FORTRAN, COBOL, BASIC, PASCAL, ALGOL, RPG, PL/1).
- compiler efficiency rather than object program speed for student instruction.
- computation performance for advanced student and research computing.
- combination of minimum response time and maximum system job throughput.

A combined system servicing an entire campus must provide support for the varied activities of many diverse and often contradictory user-requirements: for example, users executing large computational programs as distinct from introductory programmers requiring responsive editing capabilities. Systems purchased to satisfy the needs of an individual department will likely be more limited in scope and diversity of application.

ECS Primary Market Segment Strategies

University Academic

University systems are purchased both by the central computing facility and by individual academic departments wanting to control funding expenditures and user-service. Most universities already have at least one mainframe installed in the computer center. These mainframes are primarily IBM; however, other vendors such as CDC, ICL and SEIMENS are frequently encountered. Because available DIGITAL systems are not typically one-for-one equivalents in terms of capacity, power or compatibility, and because of the range and diversity of academic environment factors, DIGITAL's primary sales strategy is to offload or supplement that mainframe rather than replace it. Both the VAX-11/780 and VAX-11/750 support this primary ECS strategy.

Off-loading typically enables the university to provide better response time, both for interactive use and for job-turnaround, and to reduce the cost of service to its user community.

Additionally, universities have found that to accommodate an increase in the number of users, the purchase of an offload system provides a cost-effective alternative to a mainframe upgrade. This is because the VAX-11/780 or VAX-11/750 cost less than many intended mainframe upgrades and provide the capability to service more users for that cost.

As the volume of academic processing continues to increase, the acceptance of distributed computing as a preferable alternative also increases. Many universities are advocating the purchase of systems on a departmental basis to satisfy the processing requirements common to the department members, both students and faculty. The VAX-11/750 and VAX-11/730 provide logical solutions to the needs of high-volume departments such as mathematics, computer science and business. Pricing and number of users supported on these systems are in line with the needs of these departments. The VAX-11/730 will be especially applicable as a single user computer science workstation, giving full VAX/VMS or UNIX functionality at a price that allows researchers to have their own stand-alone systems. A key to justifying VAX family members as departmental systems will be the growing need to network the widely distributed computing resources found on the campus.

Colleges

Due to limitations in budget and number of users serviced, the college market typically combines instructional and administrative applications on a single computer system. There are, however, situations where two distinct systems will be preferred, often for reasons of security. The VAX-11/730 capabilities will allow us to be more competitive in these situations. VAX-11/780 and VAX-11/750 systems will more often fit where combined systems are being proposed.

The availability of various administrative packages is instrumental in marketing a system as a combined solution to the college marketplace. VAX/VMS and RSTS/E both provide such alternatives in offering, for example, POISE on VAX/VMS and RSTS/E. The VAX Information Architecture offers, in addition, a powerful set of tools including a full CODASYL compliant DBMS, FMS, callable DATATRIEVE with networking capabilities, and powerful COBOL execute performance. As the commercial functionality of VAX/VMS grows, the trend in this market will be away from RSTS/E to VAX/VMS.

Secondary Schools
Large metropolitan school districts or regional centers typically provide separate systems for instructional and administrative processing. Since instructional computing at the secondary school level does not exploit the virtual features of VMS, the academic requirement is best addressed by RSTS/E. The availability of third party languages such as WATFOR and WATBOL are ideally suited to the simple, introductory, programming requirements of this segment.

Due to budgetary limitations, small to medium school districts typically purchase a combined academic/administrative system. This segment of the market is primarily addressed by RSTS/E, again due to the presence of administrative applications already available (for example, SYSTEMS-11), but there will clearly be situations where the customer will prefer the tools and functionality available with VAX/VMS. The announcement of the VAX-11/730 and the tools in the VAX Information Architecture will allow us to address this need.

For academic-only systems RSTS/E is the leading product. Where budgetary constraints exist, typically less than $100K, RSTS/E returns the best cost-per-terminal-user price investment. Additionally, the virtual features and large program space of a VMS system are not appropriate to the introductory programming needs of secondary school students.

Is the VAX-11/730 Market Different from the VAX-11/780 and VAX-11/750? How does it impact the VAX-11/780, VAX-11/750, PDP-11 and DECSYSTEM-20 Markets?
Initially, the VAX-11/780 extended the PDP-11 product range, providing sales opportunities in the university offload market segment for large, predominently FORTRAN applications. The maturing of VMS and its layered products has extended the range of VAX systems well beyond FORTRAN exclusive applications into general timesharing at the computer center or departmental level. The VAX-11/750 broadened this market space to more departments, with reduced budgets that require smaller systems for fewer users. The lower entry price for a VAX/VMS system has created the opportunity for smaller institutions to pursue distributed computing. The VAX-11/730 continues this process downward, especially into the area of small clusters of stand-alone workstations in computer science. The range of VAX family members provides greater flexibility to all institutions in selecting and combining VMS systems to address their specific application, size and budget needs.

Specific Product Line Strategies Within PL Group
The new VAX family features and members, affecting all ECS markets, have been designed to strengthen the VAX where it is already the industry leader, while extending its applicability into new areas.

The VAX-11/782 will allow us to project a new high performance image. The initial, primary impact will be to upgrade those customers who have run out of CPU cycles on their installed VAX-11/780 systems.

The VAX-11/730 will primarily be aimed at:
- computer science workstation—network research
- small computer science and math departments

The VAX Information Architecture supplies the tools to allow us to be successful in that part of the administrative market, characterised by customers who prefer to write their own application software.

The increased memory size and new packaged systems announced for the VAX-11/750 will allow the customer more flexibility and growth with this system, making it a better solution for a college or large department within a university.

Installation Build-Up, Geographic Targets
The VAX-11/730 and the VAX-11/782, as well as the VAX-11/750 and VAX-11/780, will be marketed to all U.S. and international areas supported by ECS sales representatives. Delivery availability may be staggered, based on Field Service support availability. Additionally, VAX-11/782 configurations will be limited to 4 Mbytes at first customer ship.

Product Line Marketing Message
With the new announcements to the VAX family, including VAX/VMS V3, VAX-11/782, VAX-11/730, and the VAX Information Architecture, the VAX family can be sold across the entire ECS marketplace.

VAX/VMS provides virtual capabilities and extremely sophisticated but simple user-interface. It is usable by high school students and equally suited to use by graduate level university students. In addition to the broad range of DIGITAL supported software, VAX/VMS provides a breadth of third party software often demanded and greatly appreciated by colleges and universities. It is the availability of these programs (for example, NAG, BMDP, GPSS, etc.) that often determine the successful sale of a VAX system. The richness of the computing availability, including such features as full function languages, good batch controls, and a breadth of applications software, distinguishes VAX/VMS from other systems. VAX/VMS should be presented as the functionally richest and most mature operating system marketed on any 32-bit minicomputer.

Perhaps the most significant marketing message regarding the VAX family is its enhancement of the distributed-processing phenomenon. Colleges can select compatible systems to satisfy budgets at various levels and vital to the philosophy of distributed university computing is the capability of the VAX family to integrate systems scattered among various, distinct departments into a cohesive, cooperating system. This message becomes even more important with the proliferation of microcomputers that we are witnessing at university campuses. There is general agreement that an integrated networking plan is an absolute requirement. DEC is in a unique position to meet those needs with our wide set of products including networks, WPS, DECmail, etc.

VAX/VMS addresses the administrative needs of higher education primarily with the powerful set of tools available in the VAX Information Architecture. As such it is more appropriate as a replacement system for a college that is experienced in administrative processing than as the first computer installation, but the addition of a supported database product, DBMS, allows VMS to be fully responsive to the needs of all administrative customers. As user and third-party-developed administrative applications continue to appear, and as VMS continues to mature in future releases, it will occupy a broader portion of the combined academic/administrative segment.

A primary benefit of RSTS/E is its low cost per terminal-user. RSTS/E provides timesharing best at a lower price per user than any other DIGITAL software system. RSTS/E provides non-virtual multi-language timesharing suited to the instructional needs of secondary schools and first-time college systems where these users typically do not require the sophistication that a virtual system can provide. The students in these segments develop simple, short, introductory programs, and thus are more interested in response time to trivial editing than in the availability of potentially huge, shared, re-entrant programs. These users also have a relatively small programming staff and thus are more interested in administrative applications that require little tailoring than in high performance tools to assist in the full development of administrative applications.

Thus RSTS/E continues to be suited to users interested in relatively unsophisticated, yet highly interactive and responsive timesharing at the lowest possible price. These customers choose to satisfy more users for a given budget than to provide a higher degree of computing power and functionality to fewer users for that same budget amount.

Throughout the selling cycle it is essential to focus on true customer needs rather than on product attributes. In this process it is important to discuss both immediate and long-term applications needs. In this way the features of each system can be matched against the user requirements, expectations and budget.

Product Positioning

An essential factor in determining product positioning is to examine the results of a relevant workload. The ECS workload, discussed in the Performance Section of this Sales Guide, is typical of the workload of a system used in a combined administrative and academic environment. It includes administrative file processing, student timesharing in multiple languages, and computational programs typical of academic problem-solving. Refer to the performance section for specific results and conclusions of the performance study.

In addition to the specific results of the performance study, there are some positioning guidelines that can be defined and utilized in the selection of the winning system. The following issues are key to this positioning:

- large program requirement
- administrative application availability
- budget requirements
- number of users

If the users require administrative tools, such as COBOL, DATATRIEVE and FMS, the primary offering should be a VMS system, as these tools are much more extensive in VAX/VMS than in RSTS/E. If the requirement exists for database management, then the choice is also narrowed to only VAX/VMS.

If users applications require programs larger than 64 Kbytes, then RSTS/E is not appropriate. It is important to consider future applications requirements in this decision, as customers typically purchase a system for at least five years. It is also appropriate to differentiate a real need for large programs from an emotional need for virtual memory or from competitive pressure. If the application is introductory program development, then the capability to conveniently service more users with minimal response delays and maximum ease and productivity should be more relevant than the number of bits in the word. Rarely does an introductory student write a program which approaches, let alone exceeds, the maximum available on RSTS/E or a 16-bit processor.

Budget will usually be the deciding factor when more than one system of the VAX family appears to fill all other requirements. However, it is important to balance initial cost against the capability to conveniently expand the system later.

With respect to number of users, some benchmarks and installation, following:

PDP-11/70

The MASSBUS capabilities and 4 Mbytes memory available on the PDP-11/70 can support up to 60 introductory instructional jobs. These will typically be for the secondary and college level, rather than for universities. The maximum number of users is reduced to 32-48 as increased administrative users are supported. This is because administrative users introduce large programs that affect swapping and increase file processing. The maximum memory used for these workloads will rarely exceed 1-1.5 Mbytes.

PDP-11/44
The PDP-11/44 supports up to one megabyte of memory and thus provides very good RSTS/E functionality. Since it is considerably slower than the PDP-11/70, due to the lack of MASSBUS and also to he slower processor speed, the PDP-11/44 is better suited for fewer users or for a predominently academic timesharing environment. In this environment the PDP-11/44 can be expected to support 32-40 users, depending on the job and language mix. As the percentage of editing and student BASIC-PLUS programming increases, so does the number of users.

VAX Family
The VAX family systems are appropriate where large program size and advanced problem solving capabilities are required for relatively experienced users. This includes large COBOL administrative programs as well as complex FORTRAN applications. In addition, if languagees such as BLISS, PASCAL or PL/1 are required, VMS is the answer.

VAX-11/782
The VAX-11/782 supports up to 120 users, depending on the load. The VAX-11/782 is positioned at about the same number of light users as the VAX-11/780, but as the compute load becomes heavier, the VAX-11/782 can, of course, supply more CPU cycles. It will be necessary to carefully study the projected work load to determine the correct product.

VAX-11/780
The VAX-11/780 has successfully provided at least 80 users with acceptable response time and consistent performance across the entire workload. In situations where the individual user load is light, as many as 120 users have been accomodated.

VAX-11/750
With similar peripherals, the VAX-11/750 can support about half the active users as the VAX-11/780.

VAX-11/730
The VAX-11/730 is packaged with eight asynchronous lines and an R80 disk in the system cabinet. This is a natural size for this system. With the addition of extra DMF32 multiplexor boards and disk drives, a 24-32 user system can be configured. The dual RL02 system will support from two to four users, and is primarily an entry level system.

Product Selection

Where To Find Qualified Leads
Consult the Target Account Program Notebook, available from the CCS Office of Sales program Manager.

Title & Level Of Management To Call On And Needed To Close Sales
Sales to education customers require various levels of selling and techniques. It is important to sell to both the data processing personnel and the system users for both academic and administrative usage. These individuals will be concerned with the functional and technical aspects of the product for their unique requirements.

Management in Education is concerned with issues such as service, reliability, life cycle cost of ownership, and job opportunities for the students trained on a DIGITAL system. This group should be made to perceive DIGITAL as a comprehensive vendor in both educational computing and the industrial/professional market in general.

The selling cycle includes various presentations, demos, and consultations with business and financial managers, registrars, academic deans, faculty and selection committee members as well as data processing or computer center management and staff.

Product Line Specific Literature
A complete and up-to-date list of ECS literature is published quarterly in the ECS Newsletter. Refer to the Newsletter for available promotional material.

Primary Features & Benefits To Emphasize
For the majority of users the most important feature of the VMS is that it is now available on a growing family of compatible systems. The obvious benefit is the flexibility which this affords the user to select the system or combination of systems to address his specific application and budget requirements, both for now and for years to come.

VMS provides a strong complement of languages to address the advanced timesharing needs of a broad range of higher education customers. Since these languages are written in native mode, they exploit the full virtual 32-bit capabilities of the VAX architecture. This translates into excellent computational and execution performance.

VMS systems support large numbers of users at a cost of $4.5-5.5K per user. For university users, this effectively means an increase of users for less than the price of an upgrade to the installed mainframe.

VMS provides extensive tuning facilities that enable the user to adjust system performance to the dynamic and volatile environment typical of educational computing. This means predictable performance in an unpredictable environment.

VMS has been recognized as a very easy system to learn and use. This translates into productivity from day one for novice student programmers as well as for experienced applications developers. Ultimately that means user-acceptance, leading to follow-on system sales, a DIGITAL and customer benefit.

What Does This Market Currently Use For Its Computing Needs?
Vax family prospects currently use a variety of computing facilities. For universities these systems will be sold to offload or augment the capabilities of installed mainframes. For colleges, VAX family members will likely be a replacement alternative to second generation or 16-bit minicomputers.

Competition
Our main competition continues to be Prime. This is expected to continue since the VAX and Prime families overlap significantly. However, VAX can be expected to outperform Prime in the education marketplace. Refer to the Competitive Section in this Sales Guide for further information.

The IBM 4300 is encountered to a lesser degree in university sales. Here price/performance and cost-per-user are winning themes.

Previously HP has been a strong competitor for the RSTS/E system. It is expected that when HP announces a 32-bit system, it will compete with the comparable VAX family member. However, we do not expect HP's relative lack of interest in the education marketplace to change with the introduction of a new system.

Contact your Regional Operations Manager to discuss competitive issues relative to your situation.

Presales Support

PL Support Training Plans

The ECS Newsletter will be used as a continuing vehicle for strategy statements and relevant product and reference information. In addition, the corporate self-study guide, handbooks, etc. should be used for non-market specific product information.

Demos & Benchmarks

ECS currently has both a large VAX-11/780 system and a VAX-11/750 system installed for product line demos, benchmarks and performance tuning. Though ECS does not have its own VAX-11/730, arrangements will be made when necessary for VAX-11/730 benchmarks. Typically, demonstrations do not warrant a tailored configuration; the software capability rather than a specific processor is primarily being demonstrated. Demos should be performed remotely to the ECS VAX-11/780 system at a customer site or on an existing field demonstration.

You are encouraged to make early contact with our Regional Operations Manager and the ECS Technical Services Group to co-ordinate whatever demonstration or benchmarking assistance you need.

Contacts In The Product Line

Contact	Issue
Regional Operations Manager	Sales references, strategy and general business issues.
Marketing Technical Support	Product and technical issues.
Regional order Processing	Delivery and scheduling.

ENGINEERING SYSTEMS GROUP (ESG)

ESG strongly welcomes the VAX-11/730 and all the other elements of the Spring 1982 VAX Family Announcement. Taken together, these elements represent a major extension to the VAX family, which has already proven itself to be the standard for the engineering marketplace.

Following is ESG's position with respect to each major element of the family announcement:

VAX-11/730 Systems

With the VAX-11/730, VAX-family functionality has been extended downward into a whole new price range. Now the ability to run even the largest engineering application is affordable by a much wider range of companies and departments. It also provides the capability to bring the power of VAX much closer to the individual user or work unit.

The key selling characteristics of the VAX-11/730 are:

- Software compatibility with the rest of the VAX family; this means that all engineering applications developed or available on VAX-11/782s, VAX-11/780s or VAX-11/750s will run on the VAX-11/730 without conversion.
- VAX functionality and power in the price range of the PDP-11/44.
- Availability of FP730, DMF32 and 64K-chip memory, which together set a new performance and technology standard.

You should expect most VAX-11/730 sales to come from two typical engineering environments:

- The large customer seeking to distribute VAX power further down into its user organization via multiple VAX-11/730 systems. Generally, this customer will already own (or be simultaneously considering) one or more larger VAX systems and will be seeking to decentralize primarily the interactive portions of selected critical applications and general-purpose FORTRAN timesharing. DECnet, of course, makes it possible to preserve departmental centralization of what makes sense: standards, common project data, access to other computing resources, etc.

  We have already seen this scenario unfold with the VAX-11/750, VAX-11/780, and VAX-11/782; the VAX-11/730 simply makes the decentralized scenario more acceptable in large accounts. ESG will be leveraging this decentralized scenario by targeting selected applications and graphics-related peripherals that will simplify your customer's job in building VAX-satellite networks using VAX-11/730s.
- The small customer seeking primarily interactive FORTRAN computing to support a variety of engineering activities. Previously, this customer would have selected a PDP-11/44 and maintained a link to a service bureau for large jobs; with the VAX-11/730, it may also be feasible to bring the service-bureau work in-house.

  Because the nature of engineering computing is so data-intensive, we anticipate that the great majority of VAX-11/730 systems sold in engineering will be of the R80/RL02 package. We expect a very limited demand for the dual-RL02 package (in fact we would urge you to involve pre-sales software support in any proposal activity involving that package to ensure that it will meet customer expectations).

VAX-11/780 Enhancements

Taken together, these announcements have the net impact of significantly enhancing the VAX-11/780's price/performance against competition for new system sales and also of providing upgrade alternatives for your installed VAX-11/780 accounts. Effectively, they also represent an upward performance extension for the VAX family.

- The VAX-11/782 provides an attached VAX-11/780 processor to off-load compute-bound jobs from a primary VAX-11/780's job mix. Since compute-bound applications are highly characteristic of the engineering environment, we expect that typical customers will find their throughput with a VAX-11/782 to be at least 1.6 times that of a single VAX-11/780 for their multiuser workloads—clearly a price/performance win. Many engineering applications that in the past were run at off-hours because they were too CPU intensive will be runnable during the daytime with marginal impact on interactive performance.
- The DMF32 (COMBO), because of its DMA capability, will significantly offload the VAX-11/70 CPU of asynchronous terminal-handling overhead, synchronous communications and lineprinter output overhead. This will result in more CPU capacity for useful work and hence higher throughput when this product becomes available on the VAX-11/780.
- The new VAX memories based on 64K chips provide the ability to configure VAX-11/780 systems with greater than eight MB of memory. More importantly, the redesigned memory controller supports interleaved fetch, thus providing a relatively small but important performance boost. When available, the expanded memory capabilities will enhance the performance of large engineering applications.

VAX-11/750 Enhancements

The 64K-chip memories are also available for the VAX-11/750, complementing the recently-announced FP750. On the VAX-11/750, the memory controller was predesigned for 64K-chip support, so there is no associated performance boost. However, the major impact of the new arrays is that they remove the 2-Mbyte ceiling on VAX-11/750 systems, which had been a limiting factor in engineering environments. We expect that most new VAX-11/750 systems will now be ordered with an average of 2.5-4.0 Mbytes of main memory; also, your installed VAX-11/750 accounts now represent substantial upgrade potential.

When available on the VAX-11/750, the DMF32 will have a significant impact on system throughput by offloading asynchronous and synchronous overhead. The impact on VAX-11/750 performance will be analogous to the impact of the DMF32 on the VAX-11/780.

VMS Version 3.0

VMS Version 3.0 includes several features of benefit to engineering customers:

- Improvements to the terminal handler resulting in significantly reduced asynchronous overhead and greater throughput (or more low-level usage terminals with same net load on CPU)
- Ease of use enhancements to DCL including a command language editor
- Performance-monitoring enhancements including the ability to log information about a running system and analyze it later
- Better system accounting features including image-level accounting so that system resources can be monitored more accurately
- Variable size swap-slots to help reduce wasted disk storage space and eliminate artificial working set limitations
- New sysgen features to improve memory utilization
- A number of layered products are being announced. Some, such as FORTRAN V3.0, the new C compiler, and DEC/CMS, will be important to almost all engineering customers; the others (COBOL V2.0, PASCAL V2.0, and FMS V2.0) will be important to smaller subsets of your customers/prospects.

Summary

With these announcements, DEC has moved a big step ahead in its offering for the engineering marketplace. You can now offer your customers:

- A state-of-the-art system family that spans a sixfold performance range, from the VAX-11/730 to the VAX-11/782...with full VMS functionality and applications capability across the range
- The richness of VMS and its layered languages, data management and communications facilities
- An unequalled yet still-growing range of engineering applications software geared to engineering support in a variety of disciplines

P/L Contact

For additional information contact your appropriate Regional Marketing Representative.

Good Selling!

GOVERNMENT SYSTEMS GROUP (GSG)

Marketplace

The Government Systems Group will sell the entire VAX family in all its major markets. These markets include direct sales to National Governments for Defense and Automatic Data Processing applications and Defense contractor systems sold for USA-DOD, Canadian-DND and NATO programs.

Defense applications include Command, Control and Communications, Intelligence and weapons systems. ADP applications include integrated data processing and office information systems in both standalone and distributed environments.

The introduction of the VAX-11/730 will open many new market areas to VAX family solutions since it offers full VAX functionality system at a low price. The VAX-11/730 will be targeted to areas of multiple-CPU buys where VAX-11/780 and VAX-11/750 performance is not required as well as applications where the VAX-11/730 offers a better price/performance fit.

The VAX-11/782 attached processor system broadens the VAX family on the high-end offering a significant performance enhancement to the VAX-11/780. The attached processor upgrade-kit will be sold into compute-intensive environments to existing VAX-11/780 users. Thus, the customer can realize a 50%-80% performance upgrade without replicating existing hardware peripherals or databases. Further, government funding justification requirements for VAX-11/782 procurement are much less rigorous for an upgrade than for a completely new system. The product line must be contacted to support the sales force in customer qualification and to assist in benchmarks, etc.

This family approach is particularly attractive because of the common VAX/VMS operating system and complete transportability of the software across the VAX family.

Marketing Strategy

DIGITAL's leadership in offering families of interactive, high-performance, easy-to-use systems for distributed processing will continue throughout the 80's and 90's with the VAX family. The VAX family is extremely well-suited to all government marketplaces and will become our primary product offering well before the end of the decade. The introduction of the VAX-11/730 further establishes our commitment of providing a full range of 32-bit systems with unparalleled price/performance and complete compatibility across family members.

In Defense application areas, we will be targeting the 32-bit family for new programs and projects. We will continue to employ a dual strategy of going directly to the users during requirements-definition-planning (stressing the VAX family architecture as the preferred product solution), followed by calling on the defense contractors bidding the programs.

The availability of a rack-mountable 10½" box version of the VAX-11/730, in addition to the rack-mountable VAX-11/751, will enhance our opportunity for further penetration into OEM environments as well as where ruggedized and Tempest equipment is required. GSG will continue to sell large VAXs on their performance capabilities as 32-bit software development machines for major programs and projects. Developed software can then be transferred to smaller VAX family members, particularly the VAX-11/730, for implementation. The VAX-11/730 offers great flexibility for multiple sites requiring enhanced I/O handling.

Since the Defense market is best characterized as a loosely coupled group of heterogeneous computer networks, our emphasis will be on the interconnect capabilities of VAX for providing extensive distributed processing systems tailored to the customer's environments.

In the ADP application areas, we will continue to promote the application advantages of the 32-bit architecture (for example, large programs, easier conversions) and to influence incorporation of such requirements into project specifications. The VAX-11/730 will be stressed in application environments where there is heavy emphasis on remote job entry and enhanced terminal handling capability. The VAX-11/782 will allow the customer to extend their existing capability where a single VAX-11/780 requires performance improvement.

Product Positioning by Market Area

Defense Markets
The VAX-11/730 should be sold where size, price and I/O handling are the most important factors. This new VAX offering will make an excellent front-end machine, analyst workstation, DECnet node, remote concentrator, dedicated program development or runtime machine. For new programs and projects, the VAX-11/750 should remain the first consideration as the primary CPU because of its price/performance factor. The VAX-11/780 will continue to be sold where performance is key. The entire range of UNIBUS PDP-11s will continue to be offered to existing programs when their performance is appropriate and where a solid software base already exists.

In selected market areas where 32-bit systems are not required for front-ending, 16-bit machines can be used for handling dedicated, interrupt-intensive applications such as I/O, networking, communications, and special terminal handling.

ADP Markets
The VAX-11/730 will allow DIGITAL to enter new markets where price has been a major obstacle. With complete VAX/VMS functionality in one cabinet, this new offering will serve as an excellent workstation, remote concentrator, or node in a network. The VAX-11/780 will be offered when benchmarks dictate higher performance and will serve as a development machine in most cases. The VAX-11/750 will serve as a high performance production machine.

VAX will be sold when the customer is planning long term (5 years or VAX-more) programs that will require ongoing deliveries of systems. The PDP-11 family will continue to be sold where a commitment has already been made to a 16-bit architecture.

Primary Features to Emphasize
In the Defense marketplace, we will emphasize 32-bit system features and advantages, lower software life cycle-costs through totally transportable software, price/performance, RAMP program, VAX information architecture, new technology, software development capabilities, "familiness," and high throughput. The uniqueness of many VAX features that are standard with DIGITAL but lacking on many minicomputers and mainframes can enable us to influence lock-out specifications.

ADP will emphasize approachability, reliability, performance, and growth and family compatibility for distributed processing applications. In particular, we will stress the wide variety of VAX commercial software including COBOL, BASIC, FMS, DATATRIEVE, and DBMS.

Primary features of the VAX-11/730 to emphasize are the following:

- No special environmental restrictions (goes where you work)
- Full VAX/VMS functionality
- Integrated disk controller optimized for faster disk access
- Better terminal handling capability with the DMF32
- First VAX for less than $30K
- 10.5" rack-mountable box version

- Complete package system in one 40"H cabinet

Primary features of the VAX-11/782 to emphasize are the following:

- A performance upgrade for compute-intensive applications
- Easy procurement as an upgrade to an existing computer installation
- Field installed with minimal system interruption
- Full VAX/VMS functionality, a family member

Migration

Applications are transportable between the VAX-11/730, VAX-11/750, VAX-11/751, VAX-11/780, and VAX-11/782 with ease since VAX/VMS runs on all systems. In fact, the VAX-11/780 can be sold as a program development machine with production VAX-11/750, VAX-11/751, and VAX-11/730s as deployed systems.

Migration of applications to VAXs from PDP-11s is not expected. Our primary marketing strategy for VAX is to stress new applications rather than the conversion market. Hence, we will stress the compatibility of the PDP-11 and VAX families.

For PDP-11 customers who have implemented applications in high-level languages such as COBOL, FORTRAN, and BASIC and do wish to migrate, the VAX family is certainly a feasible alternative.

Coordination with CSS

In all cases, the responsible GSG Product Line Marketing Manager should be contacted as early in the sales cycle as possible so that proper coordination of potentially complex issues can be handled in a straightforward and consistent manner.

In general, CSS will be used when existing CSS products are needed or when there is a need for a specialized interface.

Competition

In the ADP market, the major competitors are IBM, Hewlett-Packard, PRIME, and Wang. The major Defense Systems competitors are Honeywell, CDC and Univac, SEL and Perkin Elmer.

In all cases, DIGITAL can point to and capitalize on an impressive commitment to interactive distributed processing. The VAX hardware family and VAX/VMS operating system were designed and developed together to provide a total systems approach to interactive computing. Layered software products and evolving hardware technology will continue to enhance the family.

In the government marketplace our greatest strength with VAX lies in the DIGITAL family approach and our software/hardware architecture design. We must also concentrate on those features that are standard on the VAX family, but not available on other minicomputers or mainframes, in particular:

- Advanced virtual memory
- Extensive RAMP features in both hardware and software
- Range of family members with multiple levels of functionality

Finally, the ability to interface a communications front-end can be stressed since government protocol requirements are often specialized.

Product Line Support

Presales Support
Local Software Services personnel should be used as your primary resource for presentations, configuration aid, and other presales efforts. Additional support can be provided and coordinated through your existing Product Line Sales Support contacts.

Demos and Benchmarks
The field software support organization will usually handle all the basic benchmark and demonstration requirements. Additional help will be provided by the GSG Technical Support Group when special consultation in the areas of fine tuning, optimization, coordination of machine resources, etc., is needed.

For the majority of benchmarks, we will use existing District VAX-11/780 machines. For critical VAX-11/730 benchmarks we can make use of GSG's own VAX-11/730 in Hudson. Further, demonstrations usually revolve around VAX/VMS software functionality, and this can be adequately demonstrated on existing VAX-11/780s. This approach will remain the strategy until we have a sufficient number of VAX-11/730s in the field.

Contacts In Product Line
Continue to use your existing market area and geographical area contacts! They will evaluate and coordinate any additional technical support that may be needed whether within the GSG organization or in other corporate resource organizations.

Sell...

VAX-11/782	• As an upgrade to existing VAX-11/780 where more computes are required • As an upgrade to existing VAX-11/780 when funding for new procurement is not available • Into a compute-intensive environment • As a system when more MIPS are required for multi-stream applications
VAX-11/780	• As the mainline CPU for large systems • As having the most mature set of VAX peripherals and interconnects • As upgradeable to VAX-11/782 at reasonable cost
VAX-11/751	• As rack-mountable VAX • As small footprint VAX • As embedded VAX • As ruggedized • Meets RFI/EMI cabinet form factor
VAX-11/750	• When a cost effective, MASSBUS or multiple UNIBUS VAX is required • For remote sites where VAX-11/730 is not powerful enough • As stand-alone, many terminal supporter • As a dedicated high-speed data collection system

VAX-11/730	• As dedicated sites (local or remote) or for dedicated applications • For networks of work stations/small processors • As driver for high-resolution, interactive, graphic stations • For a small number (<8) of users in a bounded environment • For use in open office working environments • As rack-mountable or embedded dedicated processor

For Intra-Room Connection, Sell...

PCL	• When it is fast enough • When cost is a principle factor • To mix VAXs and PDP-11s • When distance does not exceed 700 meters
DMR11	• When it is fast enough • For DECnet (DDCMP) at low cost • When PCL is too expensive • For unlimited distance

LABORATORY DATA PRODUCTS GROUP (LDP)

The extension of the VAX family and the evolving maturity of VMS and DECnet will provide LDP with the products necessary in order to continue to be a major factor in the research market where department computational/communication network needs are strongest.

VMS Version 3.0

Performance enhancements, new utilities, and new device drivers make VMS V3.0 one of the most significant releases in the evolution of VMS as the industry's most outstanding operating system. The support of VMS across the product spectrum from the VAX-11/730 up to the VAX-11/782 attached processor system is a landmark accomplishment in providing a consistent user-interface and a compatible operating system environment (from a low-priced entry level 32-bit system all the way to a sophisticated tightly coupled attached processor system). The price/performance alternatives under a constant operating system environment allow a high degree of flexibility to pick the right configuration for the application.

DECnet Phase III

Only Digital Equipment Corporation can provide the capability to share peer level VAX resources and to distribute computational power down to the individual user, while maintaining dynamic routing discipline over the organization's data processing facilities. The recent announcement of the Office-PLUS set of products (DECWORD, DECmail, etc.) and the VAX Information Management set of products (DBMS, CDD, DATATRIEVE, etc.) enhances the VAX family capacity to provide a set of alternatives for our research community to configure the right set of products for all its department applications (whether it be program development, data acquisition, data analysis, word processing, electronic mail, or database management). The wide variety of point-to-point, multidrop, internet options provides network flexibility heretofore not possible.

VAX-11/730

The VAX-11/730 is the entry-level VAX that provides the capability to move VAX power down to the project or section level, and allows small groups of people to take personal control over the resources that were shared by a much larger group in the past. The packaging and price make minimum space and cost demands on project-level efforts that require the power and sophistication of a large computer supporting VAX/VMS.

When the user requirements so dictate, the VAX-11/730 with DECnet support can provide to a small group of users a very powerful remote host with access to higher performance members of the VAX family.

VAX-11/750

The mid-range system of the VAX family comes into its own with the introduction of the floating point-option, 64 K bit chip memory, and the enhancements in VMS V3.0. The VAX-11/750 was embraced by the research community as an excellent price-competitive shared system with the footprint and peripheral complement to satisfy many project needs and user communities. The VAX-11/750, residing between the VAX-11/730 and the VAX-11/780, provides significant configuration alternatives to the research department managers.

The support of larger disk and tapes and the capability to network to other VAX family members allows the VAX-11/750 to be configured as a department host or a department node, as the set of applications demand.

VAX-11/780
The VAX family member that set the research world standard in 32-bit systems is still growing and setting new standards. Besides incorporating the ever expanding technology, such as new computational format (G_ and H_ floating point), new peripheral products (RP07, RM80, RM05, etc.), and enhanced VMS, the VAX-11/780 has established an operational history of reliability and maintainability unequaled in the industry. The VAX-11/780 provides the widest I/O flexibility of any of the VAX family members to configure systems that can be dedicated to unique applications with shared memory (MA780) and high bandwidth ports (DR780), over and above what is available on UNIBUS and MASSBUS ports.

Multiprocessing
The new hardware and software technology available with VMS V3.0 expands the performance capability and opens a growth path to the VAX-11/780.

The VAX-11/782 attached processor system is a natural extension of the ability of VMS to incorporate operating system features that allow one VAX-11/780 to manage another VAX-11/780 and to offload computational requests to that resource. The use of shared memory (MA780) as residence for VMS to manage two VAX-11/780s reflects DIGITAL's technology investment in multiprocessing for large systems, as was accomplished under TOPS-10 on the DEC-10 products.

The VAX-11/782 attached processor system alternative is an excellent add-on performance enhancement for compute-bound VAX-11/780 single processor systems. The attached processor upgrade is totally transparent to terminal users on the existing installed system.

Languages
A network of systems or a stand-alone system is only as good as the efficiency of the higher-level languages that are used on the system. COBOL V2.0, FORTRAN V3.0 and the new VAX-11 C V1.0 are all offered to provide improved performance in their respective higher level language environments.

Remember that the VAX-11/VMS Runtime Library provides the most integrated language and development environment choices for your customers.

University/Medical Research
We target on leaders in the University/Medical market such as MIT, Texas A&M, Purdue, Cornell, Ohio State and RPI who are VAX sites now and potential VAX family product sites in the future.

Target Accounts in the scientific disciplines are given top consideration to influence other universities in their communications, computer planning. Stanford, Georgia Tech., U of Illinois, U of Michigan, U of Southern California, U of California (Berkley), U of Florida, Carnegie Mellon, U of Texas (Austin), U of Minnesota, Cal. Tech., Washington U., U of Washington, Columbia and Tokyo University are all target accounts. They are all schools where we see an application change from street research to investment in computer aided design (CAD) and computer graphics, primarily in the Mechanical Engineering departments. The other scientific departments, i.e., Chemistry, Physics, Biochemistry, Astronomy, Psychology, Agriculture, are continuing to invest in state-of-the-art computers and look to DEC to provide a solution for their needs. With all four VAX family systems, DECnet (the leading edge in network protocols), the VAX family software products Office Plus products, and the VAX Information Architecture products provide the most flexible, friendly, compatible set of research tools that these university departments as well as the whole university is projected to need.

These schools are moving cautiously at this time, and we must provide insight into our directions so that any current investments our customers make will provide access to compatibility and a good return on future investments.

Government Research

LDP has established the VAX family as the department-level distributed solution at a large number of government laboratories such as Los Alamos National Labs, Sandia, Brookhaven, CERN, Stanford, and Lawrence Livermore. With the introduction of the VAX-11/750 and the VAX-11/730, the distributed solution is now being pushed down to the section-level and project-level, retaining the VAX/VMS environment and the rapid acceptance of networking of family members through DECnet.

As more VAX family members populate these sites, the DEC solution becomes a defacto standard. Our government customers are buying into our future directions to provide a total DEC solution from the desk all the way to the central system.

These government labs are technically qualified and we should work hand in hand with them to provide the computation and communications needs they require. Our success there will spill over into the university and industrial research markets.

As the labs strive for more individual and organizational productivity in their respective research areas, they recognize that DEC is the only vendor with the interactive networking product spread that can satisfy their distributed data processing requirements.

The alternative growth paths offered within the VAX family with the VAX-11/782 attached processor, and the investment in advanced technology committed to provide additional VAX family members, should keep these customers within the DEC installed base for years to come.

Industrial Research

The fastest growth market segment for LDP is in the Industrial Research area where competitive pressures force industrial giants to strive for automation of processes and to obtain more productivity from their research organizations.

LDP is targeting specific industries that are identified as growth, profitable, competitive companies with a high percentage of R&D within their budgets. At the top of this list is the Electricals/Electronics group personified by G.E., Bell Labs, ITT, Matsushita, etc. The Chemicals Group is the second largest market segment for LDP with Dupont, Monsanto, Diamond Shamrock, Eli Lilly, Dow, Takeda, Sankyo, etc. as representative customers.

The Chemicals Group has been impacted by legislation that requires greater control over their research data such as TOSCA (Toxic Substances Control Act) and GLP (Good Laboratories Practice). This provides an opportunity for vendor companies like DEC to provide an organizational network of compatible computers within their research labs to establish standards and control, without disrupting the interactive nature of research applications.

The pharmaceuticals industry like the chemical industry appears to be entering a heavy period of R&D investment as they push from symptomatic-treatment product research to disease-cause product research. These industries require networked systems to provide the legislated central control over research data. The VAX family products will provide the necessary tools for basic research in universities.

DIGITAL has the opportunity to lead these customers into the VAX family solution for their department needs.

We will target between 30 and 40 corporations that have high R&D budgets in these industries and provide a closer relationship through national account management, target accounts, etc., to lead them into the VAX family networked systems. These will allow them to extend their current systems; and they will also tend to keep IBM from moving into these distributed department systems.

Our LDP direction is clearly to build on the success of the first VAX (11/780) and extend the installed base of PDP-11s and VAXs to the 32-bit solution, VMS and DECnet. The continued investment and enhancement of the 32-bit offering provide the most expansible product offering that DIGITAL has ever had.

The Installed Base Marketing Group, employing mass media marketing techniques (direct mail, "800" number, etc.), provides the marketing support to qualify and assists the sale of add-ons, upgrades and enhancements to installed accounts. This sales partnership can retain the DEC presence at your accounts and allow you more time to devote to new account efforts and to develop and realize our potential in capturing and expanding our market share.

LDP has led the way within the corporation to provide specific configurations for the technical and financial alternatives to migrate your accounts to the VAX family, for example the VAX-11/750 upgrade and the VAX-11/780 upgrade.

Within the VAX family, LDP has led the support of upgrade alternatives such as the VAX-11/782 attached processor system. The variety of memory and storage alternatives in the VAX family, along with the application products in Office-PLUS and the VAX Information Architecture, provide excellent revenue sources to satisfy your customers growth needs and your own personal sales goals.

Installed Base Marketing within LDP is a professional, responsive organization that will complement your sales efforts. We will aggressively promote and sell the products required to satisfy you and your customers' needs.

MEDICAL SYSTEMS GROUP (MSG)

Introduction

MSG is highly committed to the VAX family of hardware and software products. We will aggressively pursue new opportunities to market the rull range of VAX products to both our new and existing markets. To gain market share, it is important that we stress the expanded breadth of the VAX-11/730, VMS V3.0, VAX Information Architecture, and OFFICE PLUS. In addition, we must continue to deliver a strong distributed processing message. For MSG, a large portion of VAX business over the next few years will come from new opportunities where we are currently selling DIGITAL products.

Marketing Strategy

MSG has chosen to target its marketing efforts in two segments of the health services industry, Hospitals and the Occupational Health Departments of major corporations.

MSG has established the following Marketing Goals:

- To become the leading supplier, direct to end-users, of Distributed Hospital Information Processing Systems including application software at each node, and
- To become the leading supplier, direct to end-users, of Occupational Health Information Systems.

In addition, we will:

- Maintain DIGITAL's already established position as a major supplier of information processing tools to the health services industry through both the OEM and end-user channels, and
- Identify new opportunity areas where MSG can obtain a leadership position as an end-user supplier.

These two programs, pursued simultaneously, create an attractive mix of one traditional, relatively stable market, and one emerging, high growth market. MSG's resources available for product development and marketing, combined with the strong VAX product set, are sufficient to achieve a leadership position in both targeted markets.

The Markets

Hospitals

Hospitals account for the vast majority of computer-related expenditures in the health care field. The worldwide hospital information processing market is approximately $1,300 million per year. The U.S. market is estimated to be over $800 million annually and growing at an 19% annual rate. The market is highly fragmented: no hardware vendor, software house, or shared service has over a 20% share of the total market.

Three key characteristics of this market should be noted:

- Spending is concentrated in the medium and large hospitals. In the U.S., for example, while only 30% of the hospitals are over 200 beds in size, these hospitals represent over 75% of spending for information processing.
- The market is geographically concentrated since hospitals are concentrated in the major metropolitan areas and larger cities.
- The market is generally application-software-oriented. Most hospitals prefer a "solution" that includes application software. Few hospitals wish to develop their own new application software package.

The hospital market is best viewed as segmented by the type of application within the hospital. Hospital information processing applications can be put into three broad categories:

- Departmental Systems
- Interdepartmental and Communications
- Accounting and Finance

MSG will be focusing on the Departmental and Interdepartmental applications listed below:

- Departmental Applications—The three primary medical departments in hospitals are radiology, laboratory, and pharmacy. Together these departments represent about 18% of the total hospital expenditures for information processing.

  The benefits these customers hope to realize from computerization are: reduced clerical time for professional people, expanded capability of the department without increased labor, better records, and improved patient care. In addition, the above mentioned departments have specialized workstations such as Image Processing and Lab Analysis Instruments that they may which to connect to a Department Computer. The primary decision-maker for purchasing departmental computer systems is the department head.

- Interdepartmental and Communications—This category consists of three major applications: ADT (Admissions, Discharge and Transfer), Medical Records, Order Entry and Communications. These applications represent 29% of the hospital market. They involve the handling of large data files and communications among many departments within the hospital.

  The benefits derived by the customer from these applications are: higher availability of data, reduced risk of error, reduced clerical effort, and better patient care.

  Department heads and the hospital's administrative staff are all heavily involved in a decision to purchase an interdepartmental system. Therefore, the decision-making process can be lengthy and complex.

The hospital environment requires substantial control of patient data by both the specific hospital department (Radiology, Laboratory, etc.) and by the central hospital administration. In the past, control of information was either identified as the department head having control or the administration having control. Computer technology has not, in the past, been sophisticated enough to provide distributed networking that would allow both the department head and administration to receive the appropriate information in an integrated system.

MSG's Radiology System will be the first of a series of MSG developed applications. These applications will all communicate and share data with other as well as transmit data to any non-DIGITAL systems in the hospital.

We believe that DIGITAL's VAX products and distributed and networking expertise, combined with MSG's application software, can solve the hospital's dilemma today by providing a relatively easy, cost-effective method for automating their extensive data processing requirements and for providing hospitals with a logical growth path toward an integrated hospital system.

Occupational Health Departments

Laws regulating health hazards in the industrial environment have created a strong demand for computer-based "occupational health systems." In the U.S., court decisions, union pressures, and social pressures have reinforced the need for occupational health systems. A demand for these systems is also emerging in Europe and several GIA countries.

MSG plans to aggressively pursue this new and rapidly growing market. Our long-term goals are to become the leading supplier of occupational health computer systems, to set the standard for occupational health system capabilities, to penetrate large accounts worldwide, and to establish a profitable, high-volume business in this market.

To achieve these objectives, MSG is developing an occupational health application software package based on VAX products. This application system will be applicable across multiple industries, meet a broad set of desired occupational health system requirements, be easily installed and supported, and be tailored, if desired, via PL90.

Our sales effort will focus initially on Fortune 500 companies in the paper, chemical, petrochemical, rubber and plastic, glass, and electronic industries. Relatively new companies have implemented a comprehensive computer-based occupational health system. Most plants have only a manual system today. Except for the HEMS and COHESS systems developed by Amoco and Diamond Shamrock repsectively for their internal use, there are no comprehensive occupational health systems on the market today. Both HEMS and COHESS are expensive, rather inflexible, and run on IBM mainframes. The other source of competition in this market is the internal data processing staff of the potential customer. Many of the best prospects for our product will be companies that have failed in their attempt to develop an occupational health system because of a lack of expertise in medical computing.

Our occupational health system is being developed with the same layered software architecture used in all MSG-developed applications packages. It will run on all VAX processors, but because of the volume of disk storage that will be required at most companies, it will be marketed initially on VAX-11/750s and VAX-11/780s.

Key Product Strategy

The enhancements in VMS combined with the introduction of the VAX-11/730 and DMF32 Communications Board will help our goal for bringing the VAX family to our targeted Medical Markets. The introduction of the VAX-11/750 showed DIGITAL's commitment to the VAX architecture. Now with the introduction of the VAX-11/730 and the VAX-11/782, DIGITAL has a family of VAXs that implies there will be many more to come. Of the many newly announced products, the three most important to our medical applications strategy are: VMS V3.0, DMF-32, and the VAX-11/730.

VMS V3.0—The performance enhancements, new utilities, and new device drivers in VMS V3A are significant in the evolution of VMS as the industry's most outstanding operating system. A capability of providing a consistent user-interface and a compatible operating system environment from the VAX-11/730 to the VAX-11/782 attached processor system allows our customers in the Hospital and Occupational Health markets to pick the right configuration for the application.

In particular, the performance enhancements of disk and terminal I/O are extremely important to customers in our medical markets. With these changes the perceived performance of VAX-11 DSM has increased. This means that migration from DSM-11 is a more viable alternative for the many users wishing to leave the restricted DSM-11 environment.

DMF32—The DMF32, available first on the VAX-11/730, and later on the VAX-11/750 and VAX-11/780, will be of special interest to hospitals. We see a greater need in the hospital market to put more terminals on a system than in many other areas of DIGITAL's business. The "free" synchronous communications port providing by the DMF32 will help our distributed systems focus by encouraging our customers to add DECnet. Since the greatest improvement in I/O is seen with large amounts of data per transfer, we will see a greater demand for the DMF32 where menus and other screen driver functions are important. Our own radiology application is one example.

VAX-11/730—Today, we sell more PDP-11/44s in MSG than any other 16- or 32-bit processor. With the introduction of the VAX-11/730, there is a migration path to the VAX family for PDP-11/44 users. This is a particularly attractive opportunity for DSM-11 users. The VAX-11/730 can be used with our radiology package for small departments where up to 16 I/O ports are sufficient. We also expect a lot of interest in this processor from our OEMs and tools market. The VAX-11/730 is not expected to be used in the occupational health market because of the processing and disk-storage requirements.

In addition to the three new products mentioned above, there are other products that are significant to MSG's customers.

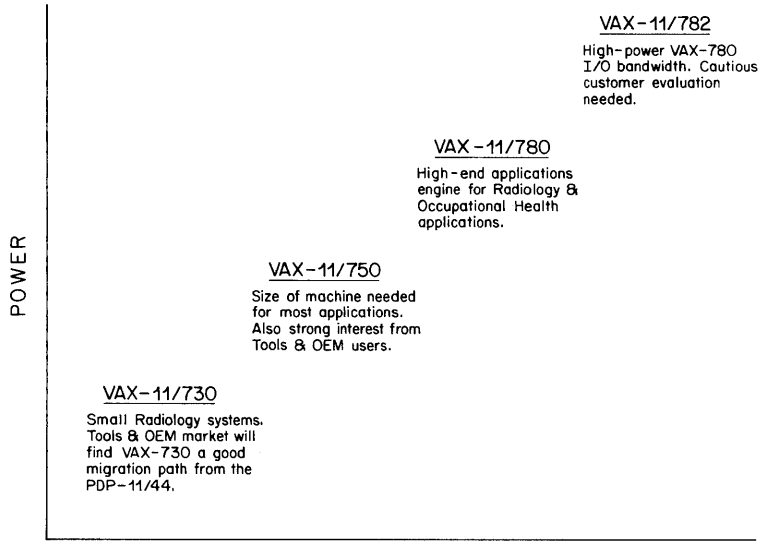
VAX-11/750 & VAX-11/780—These established VAX CPUs will continue to be important to MSG. The Occupational Health application needs the power of these larger machines. A full spectrum of capabilities are now available with the introduction of 64K rams allowing five MB of memory and larger disks on the VAX-11/750. this will allow a radiology or occupational health department to choose just the right CPU and configuration to meet its needs. The VAX-11/782 offers computation-intensive users a 60 to 80 percent performance improvement over the VAX-11/780 at only 40 percent additional cost. The VAX-11/782 comprises two VAX-11/780s and up to 8 Mbytes of MA780 shared memory. All peripheral devices are connected to one of the CPUs, which functions as the primary processor. The second CPU, which is attached to the primary processor, provides additional computational power.

MSG sales personnel should carefully screen VAX-11/782 prospective customers to make sure that they can benefit from the increased power of this machine. Many medical applications are I/O intensive, and the VAX-11/782 has the same I/O bandwidth as the VAX-11/780.

OFFICE PLUS—il is the first office product to be layered on the VAX. This product will be very useful on a Departmental system used in conjunction with our medical applications.

VAX Information-Architecture—The addition of VAX-11 DBMS will allow MSG to establish a presence in those hospitals where a CODASYL database management system is required for the central Hospital Information System. The new VAX information-management products complement MSG's VAX-11 DSM product by providing a complete range of data management tools.

VAX CPU POSITIONING



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Competition

Competition within the hospital marketplace can best be assessed by dividing the competition into three categories:

- Mainframe Manufacturers
- Minicomputer Manufacturers
- Shared Services

Listed below are the significant highlights of the competition in each category.

Mainframe Manufacturers—In general, the mainframe manufacturers have entered the hospital market through the financial and administrative environment. The four major competitors in this area are IBM, Burroughs, NCR, and Honeywell. IBM is estimated to have a 19% share of the market. They are involved in most areas of hospital information processing with the major emphasis on accounting and finance. The three other mainframe manufacturers are estimated to have a combined market share of 26%. They are focused only on the accounting and financial applications segment.

Our posture: We will initially avoid head-to-head competition with the mainframe manufacturers by concentrating on departmental applications and distributed processing.

Minicomputer Manufacturers—Historically, the minicomputer manufacturers have been MSG's major competitors since MSG has only been active in the sophisticated "tools" market for departmental and interdepartmental applictions. TANDEM and Data General have been our major competitors. TANDEM has "high availability" features and its own version of the MUMPS language; and Data General, through Meditech, offers MUMPS and MUMPS-based applications-software products.

Hewlett Packard is planning a major thrust into the marketplace with a hospital information system based on their HP3000 series. However, their first application introductions are in the accounting and finance area.

Our posture: DIGITAL has a larger market share than any of the above individual competitors. MSG will challenge the competition by offering fully supported and more flexible application software products, better distributed-processing capabilities, and superior hardware products.

Shared-Services and Software Houses—There is a substantial contingent of shared-services and software houses supplying the hospital market. These firms are responding to the market requirement for applications software and support. Among these are several MSG OEMs.

Our posture: We believe that there will continue to be a strong market for the services and products of these firms on the part of hospitals that require custom software development, or who do not wish to operate their own equipment. We will compete with these companies based on lower cost per-patient-day and the breadth of DIGITAL's product offerings.

Product Line Contacts—Your MSG Operations Specialist is your focal point for assistance within the Product Line. They have the knowledge to locate the resources you need.

TECHNICAL VOLUME GROUP (TVG)

Introduction

The Technical Volume Group is strongly committed to VAX. The acceptance of this family of products has contributed substantially to the success of TVG. We believe that the VAX-11/782, VAX-11/780, VAX-11/750 and the newly announced VAX-11/730 will permit us to enjoy even more success in the future.

Today we have an edge over our traditional minicomputer competitors with our VAX family. We face, however, serious threats from the 32-bit systems vendors and from the ubiquitous chip suppliers. It is essential that we penetrate the new and existing applications with VAX systems NOW!

For TVG, a large portion of VAX business over the next few years will continue to come from existing customers. The VAX family and the VAX-11/730 in particular will also permit you to open up new accounts. These new opportunities will translate into increased market share. It is our belief that PDP-11 sales will remain strong and that a slow migration to VAX will occur. The VAX-11/730 will accelerate this process somewhat and it is important that 16-bit customers be kept abreast of VAX developments so that when they are ready to move, VAX will be the system of choice.

There will be more VAX family members in the future; however, the time to get customers started on VAX is now. With the combination of the present products and the promise of more to come, we believe you have the tools to win the business.

TVG VAX Marketplace

VAX systems will continue to be sold in a wide variety of OEM applications such as CAD/CAM, process control, simulation, seismic and automatic test equipment. With the availability of the VAX-11/730, the expectation is that there will be volume opportunities like those experienced with PDP-11 products today.

The reasons TVG customers select VAX are generally the same, such as:

- need for a family of processors
- need for large program space
- need increased performance
- ease of programming and use
- multiple language support
- wants technological leadership
- end-user pressure

More and more applications will be implemented onto 32-bit machines. The objective is for you to be there first with VAX.

VAX-11/730

The announcement of the VAX-11/730 again confirms DIGITAL's commitment to implementing the VAX architecture on a family of products. With the VAX-11/730 you will have a smaller, less expensive and fully compatible VAX/VMS system to introduce to your accounts. For the first time you have a VAX system with a PDP-11 price and form factor. This combination will permit you to address volume sales opportunities where previously it may not have been possible.

The introduction of the DMF32 communication adapter will substantially improve asynchronous terminal performance on the VAX-11/730 and, when available, on the rest of the VAX family.

When appropriate, the VAX-11/730's floating point capability can be enhanced with the addition of a Floating Point Accelerator, the FP730. The FP730 will have the flexibility of handling multiple floating point formats, such as F_, D_, G_ and H_.

Competition

VAX-11/730 competition will come primarily from two places. On the low-end-there will be the semiconductor vendors like Intel (432) and Motorola (MC68000). They will be stressing functionality, low cost, and the ability to design to specific needs. The major risks a customer faces in pursuing this kind of strategy are total costs and time to market. It is a classic "make or buy" kind of decision.

The choice on the level of integration is dependent upon several factors. Each of these factors is valued differently for each customer. The following chart summarizes what customers are "most likely" to do:

FACTOR	MOST LIKELY TO CHOOSE
Low Volume	Systems
High Volume (>500 systems)	Chips
Packaging Flexibility	Chips
Functionality Flexibility	Chips
Lowest Development Cost	Systems
Lowest Unit Cost	Chips
Clear Migration Path	Systems
Maintainability	Systems
Software Availability	Systems
Lowest Support Costs	Systems

What should be emphasized with customers is the true costs of developing a product from the chips up. The inclination is to not consider all relevant costs: true design and development costs, the cost of being late to market, the utilization cost of the company's time and talent, and the long term support cost. When all of these costs are considered, it is quite possible that the chip alternative will not look so attractive.

Competition from the established 32-bit systems vendors will be intense. Perkin-Elmer with the 3210 and SEL with their 3227 will pose serious threats to the VAX-11/730.

Our competitors will emphasize:

- low price
- high performance

We should stress the following to address these arguments:

- The VAX-11/730 is competitively prices — box less than $30K, systems less than $40K.
- Superior VAX systems performance — there is more to performance than throughput of a simple FORTRAN program.

In addition, VAX has:

- more compilers and programming tools
- more user level softare
- greater addressability and program size (in some cases)
- virtual architecture, newer technology
- ease of use advantages

- more comprehensive customer support
- superior networking capabilities

We believe that most customers in many different markets are looking for more than just iron.

The competitive section of this guide has more competitive information.

VAX-11/750

Since its introduction in October 1980, the VAX-11/750 has proven to be popular with TVG customers in many different markets worldwide. Both Project (Systems House) and Product (Volume) OEMs have found the VAX-11/750 suitable to their application needs. New OEM products based on the VAX-11/750 are now offered in many application areas such as CAD/CAM, seismic analysis, simulation and ATE.

The VAX-11/750 has provided an attractive price alternative to those VAX-11/780 customers who do not need the performance or the expansion afforded by the VAX-11/780, but who still want a compatible VAX machine in the medium price/performance range.

Enhancements To VAX-11/750

In order to provide additional configuration flexibility,, additional packaged system is being offered on VAX-11/750. The new packaged system offers the RM05 (256MB removable) disk, the TU77 Tape Drive and 3 Mbytes of memory.

With the implementation of 64 K memory chips, the maximum memory on the VAX-11/750 increases to 8 MB. Also, a second UNIBUS is now available on the system. Both of these enhancements, and the already announced FP750, provide additional capacity and flexibility.

The VAX-11/750 remains strategically an important product that will continue to be enhanced in the future.

VAX-11/780

The first member of the VAX family, the VAX-11/780 will continue to be enhanced. It is an extremely successful product with a large number of Technical Volume customers. Additionally, the VAX-11/780 is favored as a software development machine for smaller VAX as well-as PDP-11 machines.

VAX-11/782 Attached Processor

The VAX-11/782 attached processor system utilizing two VAX-11/780 processors was announced recently. It offers performance ofpabilities beyond the VAX-11/780.

A Technical Volume Customer can acquire a VAX-11/782 system by upgrading a VAX-11/780 or by ordering one of the three packaged systems that have been announced.

VAX-11/782 is capable of offering up to 1.8 times the performance of a single VAX-11/780 system in a heavily multiprogrammed job environment running a number of compute-intensive processes concurrently. The VAX-11/782 will be utilized in many of the same applications as the VAX-11/780. Seismic analysis, power monitoring and control, CAD/CAM and software development, present some of the application areas that can benefit from the increased performance of the VAX-11/782.

VMS

The new release of VMS contains a number of features that increases its usefulness in the TVG Market. In particular, changes in how swapping and paging space on disk are handled allow VMS to run on much smaller disks than previously possible. By using this feature, and the new installation procedure for RL02 VAX-11/730 systems, it is reasonable to run a "stripped" VMS

using a single 10 MB RL02 as the system disk. This stripped VMS still contains almost all of the functionality of VMS, but leaves out the less commonly used utilities, such as those that support the RSX-11M program development. If all of the VMS utilities are needed, about one and a half RL02s will be needed (15 MB).

VAX/VMS V3 also contains a new set of system services generically called the Lock Manager. These provide what is known as a "semaphore" mechanism. This mechanism makes the writing of complex multi-tasking applications considerably easier. The system builder has a more straightforward and flexible technique for controlling access to shared resources, for example, shared areas of memory.

Some of the other features of V3 that will be important to our customers are:

PHONE	A "conference call" interterminal communication utility.
MONITOR	A greatly enhanced system-performance monitoring tool.
DEBUG	A new feature allows viewing the original source-code while debugging a COBOL or FORTRAN program.
DUAL-PORTING	Allows limited support of dual-ported MASSBUS disks.
MAGTAPE	Support of the new FIPS standard for magnetic tape handling.
DCL EDITOR	Allows adding new commands to DCL.
TERMINAL PERFORMANCE	The asynchronous terminal driver in VMS has been rewritten to improve performance. The actual performance enhancement (response time) is heavily application-dependent.

A variety of new layered products were announced with V3. Some of the more important are:

DEC/CMS	A code management system that can increase programmer productivity and give better project management.
PASCAL	A high-performance, full-feature PASCAL compiler. Runtime performance has been substantially improved over the previous version.
FORTRAN	New features, including NAMELIST, and faster formatted I/O.
C	A compiler for the C language.

With this release of VAX/VMS and its layered products, we can supply a VAX-11 solution for an even wider range of applications.

Product Positioning

The following chart should assist you in making appropriate product recommendations for customers. The chart does not attempt to address every aspect of selection. Each customer will have their own particular criteria and priorities.

	11/44	11/730	11/750	11/780	11/782
CPU Form Factor	10.5"H 19"W	10.5"H 19"W	31"H 19"W	H9640 Cabinet	Two H9640 Cabinets
Memory					
Minimum	256KB	1MB(64K)	1MB(64K)	1MB(16K)	1MG(16K)
Maximum	1MB	5MB	8MB	8MB	8MB
Increments	256KB	1MB	1MB	256KB	256KB
Cache	8K	None	4K	8K	8K per CPU
Expansion	1 UNIBUS	1 UNIBUS	2 UNIBUS 3MASSBUS	4 UNIBUS 4 MASSBUS	4 UNIBUS 4 MASSBUS

Performance (11/780=1.0)	11/44	11/730	11/750	11/780	11/782
Whetstone (avg).	.29	.26	.64	1.0	(application dependent)
Interger (avg.)	.51	.28	.63	1.0	
Floating Point (avg.)	.27	.25	.62	1.0	Up to 1.8
Entry (MLP)	$29.3K	$28.5K W/VMS DZ	$37K	$137K	$180K (upgrade kit)
DZ Software Cost	$4K (RSX)	Included	$10K	$10K	$10K
Product Positioning Criteria	PDP-11 functionality	VAX in PDP Price/ Perform. Range PDP-11 form factor G_ and H_ floating point formats	Mid-range Price Perform. MASSBUS Peripherals	High Performance Configuration Flexibility Support for high speed interfaces	Largest VAX System Extended VAX-11/780 performance

* NOTE: This data should be used with great discretion. Performance means something different to each customer. The comparison is doubly complicated by the architectural differences between VAX and PDP-11 processors. Testing using an actual system is the only way to get an accurate picture of how your customer's application will perform.

Presales Support

In the U.S. you can obtain product line presales support through your Regional Marketing contact in Owen Brown's group. If your situation requires additional help, they will guide you to the right people and will assist in coordinating the follow-up activity. In Europe, Graham Smith will direct you to the right person for assistance. GIA assistance will come from Hector Bueno's group.

We urge you to involve pre-sales software support in any proposal activity involving the VAX-11/730 dual RL02 Packaged System. The disk capacity of this package may limit the number or type of layered products that can be run on this system.

Benchmarks And Demonstration Machines

Demonstration and benchmarks can be arranged through Phil Thornton, (617)493-3556/DTN: 223-2556, in Maynard. The procedures for benchmark and demonstrations are outlined in the ADDED VALUE article dated May 9, 1979. Our Demo Room is equipped as follows:

VAX-11/780 Configurations

- VAX-11/780 CPU with 2 MB ECC MOS memory
- FP780 Floating Point Accelerator
- RM03 Disk Drive
- RP06 Disk Drive
- H7112-A Battery Backup
- LP11-ZA 132 Col/96 Char/435 LPM Lineprinter
- TU77 800/1600 BPI Magtape Transport
- TE16 800/1600 BPI Magtape Transport

- (6) DZ11-E 8-Line EIA Multiplexers
- DMC11 (DECnet Link)
- DZ11-C 8-Line EIA Multiplexer
- (15) VT100 Video Display Terminals
- (5) VT52 Video Display Terminals
- (2) LA120 Hardcopy Terminals
- (8)Vadic Modems (300 Baud)
- KU780 12KB User Control Store
- (2) DF03-AC (300/1200 Baud)

VAX-11/750 Configuration

- VAX-11/750 CPU With 2MB Memory
- FPA750 Floating Point
- (1) RK07 Disk Drive
- RM80 Disk Drive
- TS11-CA Magtape Transport
- DZ11-A 8-Line Asynchronous EIA Multiplexer
- LP05 Lineprinter
- DMC11 (DECnet Link)
- LA120 Hardcopy Terminal
- (2) VT100 Video Display Terminals

VAX-11/730 Configuration

- VAX-11/730 CPU With 4MB Memory
- FPA730 Floating Point
- (3) RL02 Disk Drives
- (2) RK07 Disk Drives
- DZ11-A 8-Line Asynchronous EIA Multiplexer
- (1) VT100 Video Display Terminal
- DMR11 Communications Interface

For European benchmarks and demonstrations, please call Paul Massiglia in Munich (tel. #49-89-302031), Phil Starmer in Reading (tel. #44-734588051) or Brian Rees (tel. #41-1-8169111) in Zurich. VAX-11/782, VAX-11/780 and VAX-11/750 machines are available in Munich and Reading for benchmarks.

COMPUTER SPECIAL SYSTEMS (CSS)

Introduction

The Computer Special Systems product line is devoted to filling those customer needs not otherwise satisfied by DIGITAL's standard volume offerings. In doing this, CSS engages in two mutually complementary and supportive businesses:

- Application Systems: special hardware and software, or complete systems for specific customer applications
- Products: a wide range of hardware and software products that are application-oriented or complement DIGITAL's standard product offerings

To meet customer requirements in the applications systems business, CSS offers a worldwide resource in terms of hardware and software engineering and manufacturing. Customer requirements may range from designing customized hardware or software, for a special application, to producing a complete system. The quantities may range from a single unit to multiple unit production (Engineering Repeat Products). Thus, CSS is DIGITAL's own special engineering and systems house.

In the product business, CSS sells a line of low-volume products that complement DIGITAL's higher-volume offerings. These cross-marketed products are DIGITAL products, marketed through CSS. These products are available regionally, or on a worldwide basis, and appear in standard DIGITAL literature, handbooks, and price lists.

Market Profile

CSS sells into and supports most of the market areas in which DIGITAL is active. However, CSS tends to specialize in market areas where it has specific capabilities, where there is a particular need for what CSS offers, and where there is conformity to our marketing strategy. On a worldwide basis, the market areas addressed by CSS vary, depending on the local market requirements.

Historically, some areas of strong CSS involvement included the industrial, OEM, and telephone utility markets. This trend continues today. CSS VAX products are currently installed at VAX-11/780 and VAX-11/750 sites where systems are used in sophisticated simulation and laboratory data acquistion applications. In several cases, the functionality, availability, and actual implementation of these CSS product offerings made the VAX sale possible.

Marketing Position

All CSS organizations worldwide acknowledge the importance of the VAX family and recognize that the addition of the VAX-11/730 further strengthens DIGITAL's position in the 32-bit marketplace. These organizations have agreed on product-line position relative to all VAX systems, and today CSS defines its role in the total VAX program as that of an integral VAX product line. To demonstrate our product line commitment to VAX, CSS is prepared to make the following products, services, and support capabilities available across all product lines for their VAX sales efforts.

New Products

In the area of new product design, CSS will continue its current efforts to quality-selected existing corporate and CSS products for VAX system integration and support. Our primary objective is to provide the best CSS product complement to the VAX family offerings, and we anticipate that each new CSS product development will be reviewed for its possible implementation on VAX systems.

In addition to these product offerings, CSS also has the expertise necessary to complete new hardware or software design, provide project management services, and develop specific application svstems.

Custom Design-Repeat Potential

A custom software, hardware, or system requirement that has repeat potential will receive priority for new design work since a repeat application obviously helps DIGITAL use CSS resources more efficiently. CSS has demonstrated ability in several new design areas, and is interested in pursuing new VAX design (within this repeat concept) of the following type:

- Application Software
- UNIBUS, MASSBUS Device Support
- Special Interfaces
- Communications
- Microprocessor-Oriented Subsystems

VAX Support Statement

CSS has been actively involved with the VAX-11/730 development program, participating in corporate VAX committees established to review all major strategy, development, and promotional VAX plans. As a member of these committees, CSS remains aware of all VAX activities and maintains frequent and open communication with other corporate product lines. This ongoing interaction has proven valuable in defining a CSS VAX support plan.

The objective of our plan is to provide timely, complete, and appropriate CSS support worldwide for the VAX family. Based on this, an implementtion plan has been formulated so CSS can meet our stated corporate VAX marketing goals. CSS has proven experience with the VAX-11/780 and VAX-11/750; we have taken the following measures to continue this success and to support our envolvement in VAX-11/730 sales efforts:

- A VAX-11/730 prototype system, owned by CSS, is running in our Hudson, N.H. facility. This system has been used by our devlopment organizations to perform verification testing on all CSS VAX devices.
- Additional VAX-11/730 systems have been ordered through FY83 to support VAX development efforts worldwide.
- Extensive training of development, support, and marketing personnel has been conducted to ensue the necessary support skills are in place for all VAX family members. Trained "VAX teams" exist today in the USA and Europe to support existing CSS VAX products and review new design opportunities.

Recommended Sales Guidelines

When CSS support is required to meet a customer need, it is arranged in one of two ways, depending on whether the need is for a product, or for a special or application system:

CSS products: If the need is for a regular CSS product shown in either the Standard or CSS price list, you may quote directly from the price list, subject to any stated restrictions. One precaution, however: since CSS has products which are offered in some countries and not in others, be sure to use the price list appropriate to the country in question.

Information about all price-listed products may be obtained from CSS product flyers available in all sales offices. If additional information or support is needed, a CSS Marketing Representative should be consulted.

Special requirement: To address a need for special hardware or software, or a custom system, contact a CSS Marketing Representative as early as possible in the sales cycle. The CSS Marketing Representative will:

- Work with you and your product line representative to understand the special needs of your customer and to match those needs to the capabilities of CSS.

- Have the expertise to make accurate evaluations and to assemble the resources necessary for either simple or complex projects before issuing a quote.
- Respond to the exact requirements of the customer and provide a CSS quotation for the specific services to be rendered. This is your commitment from CSS which you use in giving a quotation to your customer.
- Help you with pricing, configuration, delivery, and installation details.
- Alert the Field Service Group of the special nature of the task and work with them to plan and arrange for the appropriate form of Field Service support.

Remember, the earlier CSS is involved in the planning, the more likely CSS will be able to play an effective part in your VAX sale.

Contacts
CSS has Marketing Representatives and marketing specialists located in many of the larger sales offices in the field and assigned to support specified territories. Requests for CSS support should be directed to your local CSS representatives.

FIELD SERVICE

Use DIGITAL Field Service To Help You Sell Hardware

DIGITAL's Field Service Maintenance for the VAX family of computers is priced considerably lower than by most of our competitors. This is a significant selling advantage when comparing similar service offerings. Refer to Section 5 of this Sales Guide, Competition, for more details.

The VAX family of computer systems is fully supported by Field Service. Field Service provides our customers with comprehensive support prior to the sale and after the sale is made. Coverage comes from over 400 locations in 38 countries around the world. Today there are over 12,000 Field Engineers maintaining our products using proven methods of service delivery.

DIGITAL Field Service provides your customer the widest range of service offerings in the industry. Understanding these offerings and the organization that delivers them will be helpful to you in setting the proper expectations and achieving customer satisfaction. SELL SERVICE AT THE SAME TIME YOU SELL HARDWARE. When you are discussing other requirements with your customers, find out what their service needs are. Understanding these needs early and properly qualifying the account will help build a solid team of sales and service.

Presales

Field Service representatives are ready to help you sell VAX systems. Close communication with your Branch Field Service Manager will ensure that expectations are properly set:

- Account Qualification—Make sure that the coverage quoted is consistent with the customer's needs. What is the cost of downtime? What are the hours of usage? What response is needed? How far away is the site from the servicing branch?
- Site Planning—Use the VAX Site Preparation Guide in this initial selling phase. If any unusual conditions seem to exist, contact your branch Field Service Manager
- A little time spent with the customer exploring space, power, and environmental requirements before the system actually arrives will go a long way toward making system installation go smoothly for both you and your customer.
- Special Customer Presentations can be arranged with the Field Service District Marketing Specialist whenever competitive situations occur or the customer has national or international concerns.

Postsales

From the time of the system's arrival at the customer's site, DIGITAL Field Service is committed to helping the customer achieve maximum availability of hardware by providing the following services:

- System installation
- Maintenance contracts
- Product support
- Customer surveys

System Installation

Several changes have been made to improve the quality of VAX family installations. First, Field Service and the manufacturing Final Test Group work together to meet installation procedures and check lists. This ensures that all required tasks are performed either in final testing or during field installation. DIGITAL has set well-defined quality goals to avoid installation problems like missing parts, revision level incompatibility, and manufacturing defects.

The final step is system acceptance. DIGITAL Software Services installs VAX/VMS and uses a comprehensive user-style combination of compilations and sorts called UETP (User Environment Test Package) as a final test of the system.

Maintenance Contracts
DIGITAL Field Service offers the widest range of high quality, cost-effective services in the industry including the DECservice and Basic service agreements. Often in a sales situation, service is the deciding factor in who gets the business, *so know your services and sell them up front.*

DECservice Agreement
The DECService Agreement is DIGITAL's recommended service offering for VAX products, designed to meet the needs of most of our customers. This comprehensive on-site maintenance program includes a variety of services designed to keep the customer's system running at its optimum level while providing maximum protection for the customer's equipment investment. Features include a response commitment defined by your customer's physical location distance from a DIGITAL Service location:

Distance from DIGITAL Office	Maximum Response Time
0-100 Miles	4 Hours
101-200 Miles	8 Hours
Over 200 Miles	16 Hours

NOTE: Since response times may vary outside of the United States, be sure to consult your local Field Service Manager or Marketing Specialist.

Also featured under DECService is a continuous on-going repair assurance, an assigned account representative, all parts and labor, engineering changes, a site management guide and budget planning with a fixed monthly charge.

Basic Service Agreement
The DIGITAL Basic Service agreement provides for an on-site maintenance program that offers economy for customers who:

- Don't require fast defined response time
- Don't require continuous effort outside coverage hours
- Don't require extended coverage hours

A fixed cost is also provided with the BASIC Service agreement for ease in budget planning.

Service Agreement Highlights

Features	DECservice	Basic Service
Standard coverage hours	8AM-5PM, Mon-Fri	8AM-5PM, Mon-Fri
Optional extended coverage	Up to 24 hours, 7 days	None
Parts Included	Yes	Yes
Labor Included	Yes	During coverage hours
Preventive Maintenance included	Yes	Yes
PM schedule extended three hours	Yes	No
Engineering changes included	Yes	Yes

Features	DECservice	Basic Service
Response	Committed Response Times	Priority (typically next day)
Continuous effort	24 hours/day	During coverage hours
Account representative	Yes	Yes
Site Management Guide	Yes	Yes
Action Outage	Accelerated	Yes
DIGITAL Diagnosis Center	Yes	Yes
Minimum Term	1 Year	1 Year
Software Service	No	No

Remote Diagnosis For The VAX-11/780 And VAX-11/750

Automated Remote Diagnosis is the primary sales tool for the VAX-11/780 and the VAX-11/750. It is a standard part of both the DECservice and basic service agreements and is the best method of supplying the highest level of service to your customers. Remote Diagnosis provides increased system availability and stabilized maintenance costs.

Remote Diagnosis provides the customer with the following features:

- 15-minute response time to telephone calls to the DIGITAL Diagnosis Center (DDC)—regardless of when the problem call is placed.
- A centralized, experienced staff available 24 hours per day, seven days per week.
- Preventive maintenance diagnostics run during off hours prior to the site visit.
- Fast, accurate diagnosis.
- Engineers trained especially in the repair of individual devices.
- Backup support (internal technical consultation) provided through a terminal network for serious/intermittent problems.

Remote Diagnosis is provided only under the terms and conditions of a DIGITAL Field Service Agreement. Use Automated Remote Diagnosis as a sales tool for the VAX-11/780 and the VAX-11/750—it results in increased system availability and stabilized maintenance costs.

Customer Runnable Diagnostics For The VAX-11/730

DIGITAL Field Service announces a new service innovation for the VAX-11/730—Customer Runnable Diagnostics (CRDs). CRDs will assist even the nontechnical user in isolating the failing option before calling the local DIGITAL office for remedial service. The diagnostics are user engineered and within 15 minutes they will check out the system and identify the problem option.

Benefits of Customer Runnable Diagnostics include immediate diagnostic response, short diagnosis time (15 minutes), shortened repair time because Field Service engineers come to the customer site with the necessary parts and tools for repair, and an opportunity for customers to maintain more control of their system.

Customer Runnable Diagnostics are provided under the terms and conditions of a DIGITAL Field Service agreement.

Remote Support For The VAX-11/730
All VAX systems can be remotely diagnosed. For the VAX-11/730 we use this technology to provide remote support and Remote Hardware Monitoring.

The Remote Support option, a great benefit to our VAX-11/730 customers, is a service tool providing the DIGITAL Service engineer onsite with an additional technical resource that can be used. It provides for shorter repair times and less downtime as well as stabilizes our customers maintenance costs.

Remote Support and Customer Runnable Diagnostics are available to DIGITAL Field Service Contract customers.

Remote Hardware Monitoring For The VAX-11/730
Remote Hardware Monitoring is a new service feature for our VAX-11/730 DECservice customers using the Remote Support option. Under this new service feature, DIGITAL Field Service will set up a schedule with the customer to run periodic remote hardware checks of the system. Through this procedure, Field Service can watch for any potential problems that may become evident and schedule maintenance before costly downtime occurs.

Diagnostics Licensing
The VAX-11/750 diagnostics are licensed proprietary software. A single-use binary license is included as part of a diagnostic maintenance kit consisting of a diagnostic module (L0006-YA), an extender card (L9101), and the micro diagnostic software (ZE026-DG). The option number for this kit is KC750-FA. Individual components will be available through A&SG to customers who have first purchased the KC750.

The VAX-11/780 diagnostic software is licensed, proprietary software. A single-use binary license is available for the Basic Diagnostic Set (ZE100) and for the Diagnostic Extended Set (ZE014). Both are available from A&SG.

The VAX-11/730 diagnostic software will also be licensed; final pricing and details are not yet available.

For any further information refer to the A&SG section of this guide or consult your local A&SG specialist.

Diagnostic Installation
Your customers should be advised that during installation of the system the diagnostics will be transferred to the VAX/VMS disk pack. There is inherent protection built into the diagnostics that prevents them from writing on disks not properly initialized as diagnostic packs.

The customer does have the option of providing Field Service with a separate pack. The diagnostic kit has been produced to match the customer's configuration; therefore, it occupies only that disk space that is actually required for proper diagnosis and maintenance of customers system.

Product Support
Presales and postsales support teams are located at various level throughout the branches, districts, regions and areas.

If a problem cannot be solved at the local level, our mandatory Action outage-system quickly escalates the problem-solving efforts to higher support-levels until the repair is made. This program ensures the fastest possible repair time for the customer.

Customer Surveys
Ultimately, our customers are the judge of how well we perform. To learn how customers evaluate our efforts, we survey all our service agreement contractees. In this survey, Branch Field Service Managers are judged on their performance. They are required to follow up on any problem areas and report their solutions to upper management.

Reliability, Availability And Maintainability
VAX Family computers support a large number of built-in maintenance features that, combined with Remote Diagnostics, contribute to more reliable, more available, and more stabilized costs for our customers.

For more detailed information on these features, refer to Section 2, RELIABILITY, AVAILABILITY, AND MAINTAINABILITY.

Summary
This is only the beginning effort to make you aware of the resources available for your presales/postsales activities. Many new features have been built into the VAX family of computer systems. In order to get maximum exposure of these advances to customers, it is important that a strong sales/service team be formed. This team must work together to insure customer satisfaction by maximizing hardware availability and stabilizing costs. You can accomplish this by:

- knowing the Field Service organization and its products
- selling service at the time of hardware sales
- being specific when identifying your customer's maintenance needs
- taking advantage of new service innovations
- maintaining communications with the Branch Field Service Managers
- knowing your customer's Account Representatives
- working with Field Service marketing
- keeping Field Service informed of competition

If you need more information, please do not hesitate to contact your Field Service Branch Manager or District Marketing Specialist.

SOFTWARE SERVICES

DIGITAL Software Services can help you sell DIGITAL products. Service makes a significant difference in today's computer-purchasing decisions. The availability of support for products as large and complete as the VAX/VMS family is an important offering in the sales cycle.

Two thousand software people in more than 200 locations worldwide provide presales assistance, software installation, and warranty support. In addition, a family of optional Software Product Services is available to customers for continuing support and for keeping their software up to date and operating efficiently. A range of Professional Services is available to assist VAX customers during any phase of their system analysis, design, or implementation efforts.

Presales support

Software Service specialists are ready to assist you with:

- Technical questions that arise concerning system architecture, database design, system functions, performance, configuration, conversion efforts, compatibility, and system management. Specialists can provide the answers and help you set customer expectations.
- Evaluating customer needs by recommending hardware/software solutions to problems, and advising you on the feasibility and costs of proposed solutions.
- Explaining DIGITAL's software policies, and the available product offerings and services to help you meet your customers' requirements.
- Demonstrations and presentations.

To ensure that specific needs are properly planned, we encourage you to involve Software Services' early in the sales process. Consulting services and contracts must be discussed with local Software Services management before being quoted, to ensure the availability of necessary resources.

Backup Support Resources

The Small Buffer, published weekly, contains useful VAX/VMS information and articles pertinent to both Sales and Software specialists.

The *VAX System Dispatch* provides information to customers on known VAX/VMS and software-related problems and solutions, helpful hints, and workarounds. As part of the warranty and post-warranty services, it includes optional software product data and serves as an information flow between releases and updates. It does not include software or microcode patches.

Demos and Benchmarks

Several Product Groups and sales offices have VAX systems available for demonstrations and benchmarks. Contact your local sales manager or Product Line for availability and scheduling information. VAX Family systems are also available for demonstrations and training in Maynard, Marlboro, Merrimack, Tewksbury, Reading, England, and Munich, Germany.

Professional Services

Professional Services offers specialized applications and system support to help ensure customers' successful use of the VAX/VMS systems. Software specialists can provide advice on system analysis, system/application design review, or system/application integration. Resources are available to perform specific projects and tasks, or to supplement a customer's programming staff. Various types of expertise are available, ranging from that of programmer to project manager. Professional Services is available at resident and per-call rates and also on a fixed-price project basis.

Professional Services offers the Charlotte Package—a customized solution Office System Service that integrates word processing, mail, inter-system communications, customer-developed applications and third-party applications via a simple menu-driven user interface. This service uses standard DIGITAL software as the building blocks.

Two other services are being developed especially for large major accounts in the Office Automation market. First is decision-making support to advise the customer during the presales effort on indepth organizational and application analysis and design to help the customer determine the basic approach to Office Automation.

Second is a startup service to assist the system manager in getting started with DECmail and managing the system effectively.

Consult with your local Software Service office on the availability of all these offerings.

Installation and Warranty Support

Most software shipped on VAX systems is DIGITAL-supported. This means that DIGITAL will provide customers with the warranty support services necessary to ensure that their software products perform to the specifications defined in their Software Product Descriptions (SPDs).

The warranty period for DIGITAL-supported software products is 90 days, which starts after installation is complete, except where otherwise regulated by local law. On DIGITAL-Supported/Customer-Installed software products, the warranty period starts after the customer's first use or 30 days after delivery of the product, whichever comes first.

For those VAX products that require DIGITAL-Installation, a software specialist will install the software and verify that the system is complete. When DIGITAL-Supported/Customer-Installed products are purchased with the operating system, they can be installed as a courtesy. The specialist will review with the customer the DIGITAL software warranty policy and the available Software Product Services.

Specific warranty services are described in the Software Support Categories Addendum to the SPD. Warranty services include telephone assistance and onsite remedial support for software problems of a critical nature. The Colorado Springs Customer Services Support Center, which serves American and Canadian customers, is available twenty-four hours a day, seven days a week on most products. In other countries, telephone support is available during normal working hours from Telephone Support Centers in Europe, Japan, and Australia, as well as from centralized units or at the local level.

Warranty services also include automatic delivery of in-warranty software product and documentation updates (free of charge), and distribution of a periodic newsletter. Users can utilize the formal communication channel called the Software Performance Report (SPR), for suggestions and noncritical questions.

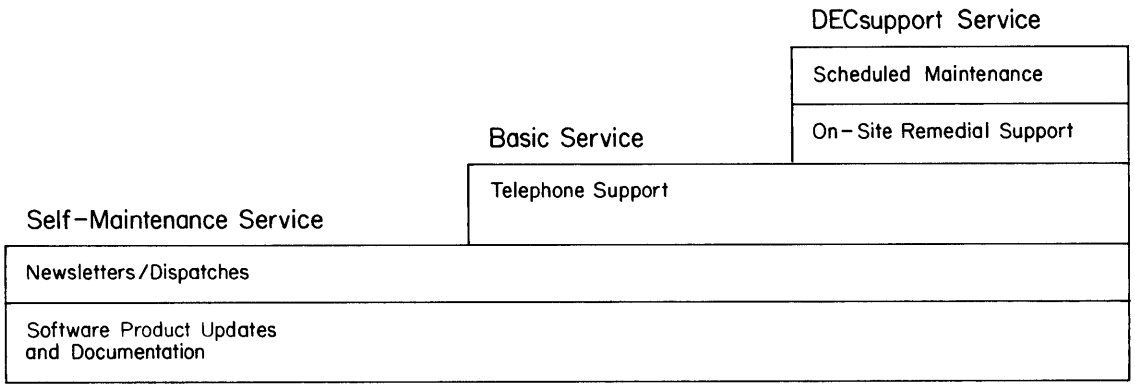
Software Product Services - Extended Support

A range of optional Software Product Services is available to support VAX/VMS customers' continuing needs out of warranty.

This family of services ranges from a Self-Maintenance contract that provides updated versions of the software and technical information by mail, (for customers who are able to maintain their own system software) to a Basic Service that includes all the components of Self-Maintenance with the addition of telephone support.

The most comprehensive service, DECsupport, incorporates all the offerings of the first two, plus the services of a software specialist to install the software product updates and to provide onsite support for critical situations.

Software Product Updates single major releases of software are also available. No services are included; however, they can be purchased at per-call rates.



Software Product Updates	Automatic distribution of new releases of the software, Program Change Orders (software fixes) and Documentation.
Newsletters/Dispatches	Provide latest information on operating systems and layered software products.
Telephone Support	On DIGITAL's major operating systems and layered products. Talk to a specialist on software usage and remedial questions.
Onsite Remedial Support	A software specialist can go onsite when a critical problem cannot be resolved by telephone support.
Scheduled Maintenance	Periodic onsite visits to monitor and install updates to the operating system and layered products.

Also available are Right-To-Copy Update Options that allow VAX customers to copy Software Product Updates to additional licensed systems.

All VAX Software Product Services (except Software Product Updates) are available at fixed monthly rates or at an annual rate that includes a five-percent prepayment discount. For information concerning the availability of specific software product services consult your local Software Services Office.

Sales Strategy

Involve Software Services during the presales cycle! A software specialist will assist you in configuring the system and defining the appropriate software that will best meet your VAX customer's needs. The specialist will also help you assess your customer's application and support requirements, and prepare a Customer Support Plan to help ensure successful use of the VAX customer's computer system.

Consult with local Software Services managers about Professional Services available to assist your customers! New users might want a specialist working hand-in-hand with their personnel to help reduce learning time and expedite productivity.

Experienced users might wish to use specialists to temporarily supplement their own staff in order to meet critical project completion schedules.

OEMs might require extra support and programming help from specialists during the development cycle of a product to shorten the time it takes to bring a product to market or to make the end product more competitive and self-supportive in the marketplace.

Encourage purchase of a Software Product Service at the time of the system sale! Since many other competitors do not offer similar services, Software Product Services will give you a competitive edge in selling systems. Use Software Product Services to promote your VAX systems sales.

Software Services benefits you can cite to customers are:

- All hardware, software, and related services are available from a single-source vendor.
- Customers can predict and budget their support costs ahead of time.
- Working with DIGITAL specialists, customers can become more knowledgeable about DIGITAL products and services. Initial startup costs and training investments are minimized.
- Professional Services free the customer's staff to concentrate on applications software development.
- Software Product Services enable customers to expand support and keep up-to-date on a continuing basis.
- Telephone support during warranty and under contracts for Basic and DECsupport Service provides fast response to customers' software questions.

Terms and General Conditions

- Software Services contracts can be incorporated into the U.S. Quote/Order Form by reference.
- Information pertaining to contracting for DIGITAL's Software Services should be obtained from the Software Manager in the Local Branch or District Office.
- Scheduling of DIGITAL specialists is subject to availability; adequate notice is requested.
- Rates for Software Services vary by country.

General International Area

- In certain remote locations and in areas serviced by representatives, some services may not be available.
- In locations where there is no DIGITAL office, representatives should contact the Software Manager at GIA headquarters.

Europe

- Services are sold under the conditions of time and materials, subject to local laws.
- Contact the local Software Services Manager for prices, terms, and conditions.

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EDUCATIONAL SERVICES

Overview

DIGITAL understands the value of quality education in maximizing return on your customer's VAX system investment. That is why Educational Services is committed to delivering the finest instructors, courses and facilities available.

Educational Services offers comprehensive and diversified training that will ensure that your customer's system is being operated at top efficiency. Our job related curriculum provides an intensive examination of each VAX system with focus on:

- General computer education
- Software training
- Hardware training
- Management and technical seminars

Our Marketing Representatives are prepared to tailor educational programs to meet the customer's specific needs. A list of Educational Services Marketing Representatives appears at the end of this section. Whether it be prior to installation or upgrading an existing system, give us a call. Educational Services is ready and anxious to support your sales efforts by providing a competitive edge unparalleled in the industry.

In a recent review of customer education programs offered by eight major computer vendors, *DATAQUEST RESEARCH NEWSLETTER* noted that many users were dissatisfied with their present computer systems because some vendors did not provide sufficient support and education. However, their analysis of DIGITAL's Educational Services concluded: "DIGITAL has by far the largest customer education program among the minicomputer manufacturers, offering well over 300 lecture and laboratory courses, various audiovisual training aids, self-paced instruction books, and textbooks from DIGITAL Press..."

Flexible Formats

To satisfy your customer's specific cost requirements and employee needs, DIGITAL's Educational Services offers a variety of instructional formats.

- LECTURE/LAB
  These courses are offered at DIGITAL'S 26 Training Centers and generally give the students intensive hands-on computer experience. Accomplished instructors carefully monitor each student's progress and supervise laboratory exercises using course materials.
- SELF-PACED INSTRUCTION (SPI)
  SPI courses are designed to allow students to select learning units appropriate to them and then to progress at their own rate. These courses are based on successful models of instructional design and come in three formats that include exercises and solutions.

  SPI PRINT includes manuals, audio cassettes, flip charts and tests.

  SPI AUDIOVISUAL is available in 1/2-inch Beta, 1/2-inch VHS, and 3/4-inch UMATIC color-video cassettes as well as LaBelle audio/filmstrip cartridges.

  SPI COMPUTER-BASED INSTRUCTION enables the student to learn about the computer system right on the system itself.

- SEMINARS
  DIGITAL offers two types of seminars to benefit both your technical and nontechnical management staff.

  MANAGEMENT SEMINARS are designed to help the nontechnical supervisory, middle and upper level managers better understand their computer facilities in order that they can make more practical and effective use of them.

  TECHNICAL SEMINARS are aimed at keeping data processing professionals and managers current with the newest applied technologies. The focus is on advanced uses of computer systems.
- ONSITE INSTRUCTION AND EXCLUSIVES
  For your scheduling convenience, DIGITAL's Educational Services can plan to deliver any standard course at your own facility. If you would prefer, we can arrange exclusive courses for you at any of our 26 Training Centers.
- DIGITAL PRESS
  In addition to their many courses and various formats, Educational Services has its own publishing department. DIGITAL Press publishes college texts and professional resources and reference books. Publications cover a broad scope of computing issues and include titles in the areas of computing technology, management and business applications, general computer applications, and the history of computing.

  Formats allow for interchangeable options to meet customers' individualized goals. No matter what VAX training format or option your customer requires, each course offers a high-quality, job-relevant learning experience equating to increased productivity and performance.

Educational Facilities
DIGITAL's Educational Services maintains and staffs 26 fully equipped training centers worldwide, with seven conveniently located in the United States.

Over 1,400 full time professionals are involved in servicing our customers around the world, with more than 500 computer systems solely devoted to hands-on instruction.

Planning a Complete VAX Education Program
Helping your customer plan ahead is the major key to a successful training program. Some important considerations include:

- How many employees need to be trained or updated in each job function?
- What is their level of skill and knowledge?
- What sort of time constraints are placed on each employee?
- Are your customers' time constraints such that it would not be feasible to have employees take a regularly scheduled course? If so, would it be more practical for them to take the course in A/V format? Should it be at one of our individualized Learning Centers at your customer's convenience or in a SPI format at the customer's facility?
- Does another department within your customer's company have similar training needs? If so, a shared onsite course is probably the most economical option.
- How should the customer best use training credits? Usually it is best to apply these credits toward a product-specific course, rather than a generic or software-language course.

Some of your customers can answer these questions readily; others might prefer to take advantage of our experienced Consultant Service. Because the individual needs of each customer differ, we strongly recommend that you call your DIGITAL Training Center and ask to

speak to your Marketing Representative. After discussing your customer's specific project and his staff's present skill levels, you and your Marketing Representative should be able to tailor an effective educational program to fit the customer's unique situation and application.

Benefits To The Customer

Customer benefits of using DIGITAL's Educational Services Department include:

- Job-relevant training when and where it is needed.
- Qualified and experienced assistants to help the customers plan for their training needs.
- Properly trained employees save time mastering their systems.
- Improved employee performance, productivity, and efficiency.
- Protection of the customer's computer investment because every member of the data processing staff can be given the skills and knowledge necessary to achieve maximal performance results. This is the bottom line for the customer: Educational Services is one major way DIGITAL ensures that the customer's computer purchase is a sure and profitable investment.

Benefits To The Salesperson

Customer training is a key component of customer support. Correct analysis of the customer's training needs and the timely, efficient filling of those needs can yield the following benefits:

- Increased follow-on sales, owing to:
  - — Customer satisfaction with DIGITAL's training and support
  - — Customer's investment in training staff on DIGITAL's products makes remaining a customer of DIGITAL highly likely.
- Increased add-on sales: With Educational Services courses, customers are exposed to the full range of features, options, and peripherals available from DIGITAL.
- Improved referral selling because of increased customer satisfaction.
- A competitive edge: The Educational Services Department offers more product-specific courses at more locations throughout the world than most of its competitors. You can maximize sales by emphasizing these training benefits at the beginning of the customer relationship.

VAX/VMS System Training

Format Key

L/L Lecture Lab
SPI Self-Paced Instruction
A/V Audio-visual

Course/Format

- Introduction to Minicomputers—L/L, AV
- Commercial Programming Concepts—L/L
- VAX/VMS Operator—L/L, SPI
- VAX-11 Concepts—L/L, A/V
- VAX-11 Instruction Set—L/L, A/V
- VAX/VMS Utilities and Commands—L/L, SPI

- VAX/VMS System Management—L/L
- Assembly Language Programming in VAX-11 MACRO—L/L
- Programming in FORTRAN IV—L/L, SPI
- BLISS PRIMER—SPI
- Programming in PDP-11 COBOL—L/L
- Programming in BASIC-PLUS-2—L/L
- Programming VMS in VAX-11 FORTRAN/MACRO—L/L, SPI
- Programming VMS in VAX-11 COBOL—L/L, SPI
- Programming VMS in VAX-11 BASIC—L/L, SPI
- Programming in VAX-11 DATATRIEVE—L/L
- VAX-11 DBMS Programmer—L/L
- VAX-11 DBMS Database Administrator—L/L
- VAX/VMS Operating System Internals—L/L
- VAX/VMS DECnet User—L/L
- VAX/VMS Device Driver—L/L

VAX-11 Maintenance Training

- Introduction to DIGITAL Logic—L/L, A/V
- VAX-11/780 Hardware Diagnostic User—L/L
- VAX-11/780 Processor Internals—L/L

For course schedules inside the United States, consult either the *DIGITAL CUSTOMER TRAINING CATALOG* or a copy of the *DIGEST*, a quarterly magazine produced by Educational Services. Training Centers outside the country produce their own schedule listing, similar to the *DIGEST* and the *CUSTOMER TRAINING CATALOG*. Course information is available worldwide by contacting your local Training Center.

Educational Services Training Center Contacts

United States

Region	Function	Name	DTN-EXT.
Northeast	Manager	Rich Wardrop	249-4331
	Mrkt Rep	Kathe Cohen	249-4243
New York	Manager	Barry Rosen	333-3986
	Mrkt Rep	Cathy Serie	333-6775
Mid-Atlantic	Manager	Jim Porter	341-2550
	Mrkt Reps		
	Wash., D.C.	Frank Daloisio	341-2580
	Atlanta	Ron Roggs	351-2322
	Philadelphia	Patricia Benatar	336-2218
Central	Manager	Eric Willard	421-5591
	Mrkt Reps		
	Chicago	Marianne Kidd	421-2262
	Cincinnati	B.J. Bright	432-2290
	Detroit	Monica Aemisegger	

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United States Region	Function	Name	DTN-EXT.
Western	Manager	Bob Mjos	521-2018
	Mrkt Reps		
	Santa Clara	Bob Sansing	521-2135
	Denver	Bruce Pacot	553-2434
Southwest	Manager	George Healey	(213) 937-3870
	Mrkt Reps	Thom Taylor	(outside)
Southern	Manager	John Mitchell	451-2300
	Mrkt Reps		
	Dallas	Luan McBride	451-2309
	Houston	Brenda Ball	441-2355
	Atlanta	Ron Boggs	351-2322

Europe

Belgium
Francis Van Huychem
02 733 9650

England/Ireland
Alan Denny
07 3 458 3555

Finland
Elmer Haekkinen
9 042 3511

France
Jean Pierre Oger
33 6 077 8292

Italy
Cesare Brage
39 026 1797

Netherlands
John Posthumus
34 024 5654

Spain
Emilio Gomez
01 733 1900

Sweden
Tommy Nilsson
08 730 0200

Switzerland
Roni Stebler
01 816 9111

West Germany
Wolfgang Pawlik
089 350 30

General International Area (GIA)

Australia
Paul Williams
61 2 412 5252

Canada
John Rakos
(613) 592-5111

Japan
Gen Narui
81 3 98 9 7111

Mexico
Carlos Ocana
(905) 687 3422

FOR INTERNAL USE ONLY

THE ACCESSORIES AND SUPPLIES GROUP (A&SG)

The Accessories and Supplies Group provides more than 8,000 off-the-shelf products and services such as computer spares and supplies for VAX customers.

Computer Supplies Group Overview

The Computer Supplies Group, Product Line 92, is continually striving to satisfy our VAX customers' needs by offering a complete line of quality computer accessories and supplies especially designed for use with their computer systems.

Our broad spectrum of products and high level of customer service provide a total package enabling our VAX customers to operate their business reliably and efficiently.

Products Line 92 can supply a complete line of media to support current and past DIGITAL mass storage devices. In addition, we offer a full range of system accessories such as media storage cabinets, workstation desks, terminal accessories and ribbons and paper.

The Computer Supplies Group can supply the communication products needed to enable any VAX system or terminal to communicate with any other system or terminal via the standard voice-grade telephone system already installed in all offices. Three devices - two modems and an acoustic coupler support this market.

The Computer Supplies Group provides one-stop shopping for most of your VAX customer's documentation needs.

The products offered can best be described as: Software Manuals and Addendums; Software Documentation Kits; Handbooks, Software Source Microfiche Kits; and Reference Cards and Pocket Guides. Software Source Microfiche Kits are also available for specific software options.

One of the most valuable reference tools available from A&SG, for the VAX customer, is the VAX/VMS Internals and Data Structures Manual. This technical reference guide explains the internal control paths and data structures used by the VAX/VMS operating system. It is available as a bound book (order number AA-1C785A-TE).

Customer Spares Overview

The Customer Spares group, Product Line 75, supports the needs of DIGITAL's technically sophisticated VAX customers who choose to perform their own computer maintenance. This product line through its products and services enables customers to successfully conduct a productive self-maintenance program. Please note that we expect many VAX-11/730 and VAX-11/750 customers to perform their own maintenance.

The product line is organized into three distinct businesses: 1) Self-maintenance products and services (including both hardware and hardware documentation), 2) System Accessories, and 3) Environmental support products.

System Accessories and Environmental Products include those products designed for the hardware builder and allow an easy expansion and reconfiguration of DIGITAL systems and options. These products are actively promoted in the new *DECdirect System Builders Edition Catalog* (EJ-21311) and include enclosures, cabinets, power supplies, cables, power distribution systems, and interfacing devices such as standard modules, and system units.

Spares Product Mix

Spares products and services offered by the Product Line for VAX are described below and enable customers to perform self-maintenance.

Features

- Component and subassembly spares
- Engineer-designed spare kits
- Tools and preventive maintenance (PM) parts
- Test equipment
- Recommended Spares Service
- Maintenance Documentation Service (MDS)
- DEC-O-LOG
- Documentation Kits
- Diagnostics
- Emergency Parts Service
- Parts Availability Service (PAS)

Spares Kits

Customer Spares has developed parts kits which include spare parts for the majority of processors, tape and disk drives, terminals, and other options. These kits have been engineer-designed to provide an efficient and economical means of sparing. Each provides 90 percent level of service for approximately one year, for up to ten units of a particular device; that is, the SRK05 Spares Kit will support ten RK05 drives for one year.

DEC-O-LOG

DEC-O-LOG is a Field Change Order subscription-notification service. DEC-O-LOG provides essential information for all DIGITAL self-maintenance customers and is a summary of FCOs and Engineering Change Orders (ECOs) for CPUs, peripheral options, subassemblies and modules.

Maintenance Documentation Service (MDS)

MDS supports VAX systems with single microfiche library and corresponding update services that include the following data:

- Hardware Manuals
- Illustrated Parts Breakdown
- Wire Lists
- Preventive Maintenance Manuals
- Diagnostic Listings
- Diagnostic Change Orders/Patch Orders
- Field Change Orders

Diagnostics

VAX diagnostic software is available through A&SG and sold under standard software licensing terms and conditions. License registration is managed by A&SG. Diagnostic packaging for VAX systems is structured around macro level system diagnostics and also around micro or CPU extended sets. These two packages are offered separately.

System Accessories Product Mix

Cabinets

There are five families of computer cabinetry offered by Product Line 75 designed and engineered to meet the needs of system builders or specification engineers. These cabinets are:

- The H9614 Series—workstations both split and solid top, stand-alone or in conjunction with H9610 cabinet.
- The H9610 Series—multipurpose, modular cabinets that provide flexibility for growing companies.
- The H9612/13 Series—compact cabinets designed for expanding small systems.
- H9642 Series—versatile cross-products cabinets that provide top and front-loading capabilities.
- H960/67 Series—rugged, reliable cabinets designed for large system-applications.

Expansion Hardware

Product Line 75 offers a large variety of expansion products and mounting hardware for the system-builder including boxes, mounting hardware, card cages, modules and interfaces.

Cables

There are a wide variety of cables for making connections to processor buses, power sources and peripherals in both local and remote applications. Product Line 75 offers many standard 20mA EIA, and general purpose cables as well as a custom cable service.

Environmental System Product Mix

Power Distribution System

Whether your customer is installing a new VAX system, relocating one, or adding to his present installation, use the Power Distribution System to save time and money.

Conventional wiring is expensive to install and uses standard components that vary in quality or may not be designed for computer applications. Future modifications usually mean more downtime and added cost.

DIGITAL'S Power Distribution System, on the other hand, is a compact turnkey system that includes a J-box, an isolation transformer, a system status panel, and cabling and preassembled receptacles for the computer system and its peripherals.

Because the Power Distribution System is modular, your customer can move, change, or add to his installation with minimal effort, downtime, and expense. In addition, your customer is assured the correct wire configuration and phasing because it is specifically designed for computer use.

The Power Distribution Systems status panel not only monitors power, it also provides audio and visual indicators of possible faults or unusual conditions. And as an option, your customer can interface the Power Distribution System to local smoke or fire detectors, sprinklers, air conditioners, and other environmental control devices to provide an extra measure of protection for their installation.

A&SG Ordering Information

A&SG has a team of worldwide specialists and/or business managers to support sales. The salesforce is located throughout the United States, Europe and the General International Area (GIA).

Shipment of VAX accessories and supplies are usually made within 48 hours from the time the order is received at the Nashua warehouse by using the direct-to-factory ordering channels:

- Telephone: A&SG maintains a toll-free number for customers to use when ordering. Within the continental United States and Puerto Rico, customers can call (800) 258-1710. Customers in Alaska, Hawaii and New Hampshire should use (603) 884-6660. Orders placed by telephone cannot exceed $5,000 in gross value.
- Mail: Use the direct mail order address:

  Digital Equipment Corporation
  P.O. Box CS2008
  Nashua, New Hampshire 03061
  Orders places by mail have no maximum value-restriction.
- Direct catalogs: A&SG's direct sales catalogs, DECdirect—Accessories and Supplies Edition and the System Builder Edition. These offer a broad range of computer accessories and supplies items to anyone who uses a DIGITAL computer system and include system options, components, cables, accessories, supplies and maintenance products. Hardware and software documentation is also offered. Order forms are provided inside the catalogs.

  The most recent version of DECdirect (either edition) can be obtained from the Accessories and Supplies Group (U.S. only) by writing to:

  Attn: Circulation Department RQ/W83
  A&SG—Direct Sales Catalog
  Digital Equipment Corporation
  460 Amherst Street
  Nashua, NH 03063

- Accessories and Supplies Centers: Many products are also available through DIGITAL's Accessories and Supplies Centers. These centers will take customers' orders, arrange installation for products ordered, and provide product and configuration information. Call or write to your nearest DIGITAL Accessories and Supplies Center to place an order, to obtain additional information.

  DIGITAL EQUIPMENT CORP.
  5001 B. Forbes Boulevard
  Lanham, MD 20801
  (3001) 459-9272
  Annapolis: (301) 721-2400
  Baltimore: (301) 792-2206

  DIGITAL EQUIPMENT CORP.
  101 Knox Street
  Torrance, CA 90502
  (213) 532-5622

  DIGITAL EQUIPMENT CORP.
  1050 East Remington Road
  Schaumburg, IL 60195
  (312) 640-5612

  DIGITAL EQUIPMENT CORP.
  632 East Caribbean Drive
  Sunnyvale, CA 94086
  (408) 734-4915

- A&SG Price List: The most recent version of the Accessories & Supplies Group Price List contains pricing information, part number listing, and the Terms and Conditions that apply to the A&SG sale.

DECUS

DECUS, Digital Equipment Computer Users Society, is one of the largest and most active user groups in the computer industry. It is a non-profit organization, supported and administered by DIGITAL but actively directed by individuals who have purchased, leased, ordered, or used a DIGITAL computer or who have a bona fide interest in DECUS.

The objectives of DECUS are as follows:

- To advance the effective utilization of computers, components, systems, and software manufactured and marketed by DIGITAL by promoting, in a non-commercial manner, the interchange of information concerning their use.
- To advance the art of computation through mutual education and exchange of ideas and information.
- To establish standards and provide channels to facilitate the exchange of computer programs among DECUS members.
- To provide feedback to DIGITAL on hardware and software needs.
- To reduce the duplicaton of development effort among DECUS members.

DECUS Structure

DECUS is a federation of geographically based chapters, each administered by an elected Executive Board, a DIGITAL Representative, and an Executive Director.

This structure provides DECUS services on a local level to its membership. Following are the current DECUS Chapters and the countries served by each:

DECUS U.S.
One Iron Way
MR2-3/E55
Marlboro, MA 01752
Telephone (617)467-4100

DECUS Canada
P.O. Box 13000
Kanata, Ontario
K2K 2A6
CANADA
Telephone: (613)592-5111
Extension: 2115

DECUS Japan
Sunshine 60
P.O. Box 1135
1-1 Higashi
Ikebukuro-chrome
Toshima-ku
Tokyo 170
JAPAN

DECUS Australia
P.O. Box 384
Chatswood, NSW 2067
Australia
Telephone: (61)2412-5237

DECUS Europe
12 Ave des Morgines
C.P. 510
1213 Petit-Lancy 1/GE
Switzerland
Telephone: (022)93-33-11

Countries Served:
Australia, New Zealand, Singapore, Indonesia, PNG, Malaysia

Countries Served:
Europe, Middle East, North Africa, Russia

Combined membership in DECUS reached close to 52,000 in January, 1982. All DECUS products and services are available to DECUS members only.

Membership is free and voluntary.

All members are invited to take an active interest in the Society by contributing to the Program Library, to chapter newsletters, and by participating in its Special Users Groups and symposia. There are two types of membership—Installation Membership and Associate Membership.

Installation Membership
An organization, institution, or individual who has purchased, leased, or has on-order a computer manufactured by Digital Equipment Corporation is eligible for Installation Membership in DECUS. Membership status is acquired by submitting a written application to the appropriate Chapter Administrator for approval by the Chapter Executive Board.

For each DIGITAL computer owned, an organization may appoint an Installation Delegate to whom DECUS correspondence is directed. The Delegate should be the person who is immediately concerned with the operation of the computer represented and who is willing to take an active part in DECUS activities. The Delegate is entitled to vote on DECUS policies. An organization or company is eligible for as many voting delegates as it has DIGITAL computers. On acceptance of application for membership, literature covering numerous DECUS services is sent to the Installation Delegate for reference and to aid in maintaining active participation in the Society.

Associate Membership
Any person who is not an appointed Installation Delegate but has a bonafide interest in DECUS is eligible for Associate Membership.

To obtain a membership application form, please contact your sales representative or your nearest chapter office.

To further the goals of the society, DECUS serves its members by holding symposia; maintaining a program library; publishing an association newsletter, technical newsletters and books; and supporting a number of subgroups (Special User Groups) for special interests and locations.

- SYMPOSIA
  One of the major, annual activities of the society is sponsoring symposia that are held in each of the DECUS Chapters. These meetings provide an opportunity for users of DIGITAL computers to meet with other users and with DIGITAL management, engineers and customer service representatives. They provide a forum for users to exchange information on techniques and approaches to issues of common interest and to provide feedback to DIGITAL on existing and future products and services. Sessions at symposia include user-driven workshops, tutorials, product panels, as well as application/system-specific presentations. The technical papers and presentations from each symposium are published as DECUS *Proceedings*.

  Two symposia are held each year in the U.S. Chapter; one is held in each of the other four chapters.
- PROGRAM LIBRARY
  Another important activity of the Society is the DECUS Program Library. The Library contains programs written and submitted by users and is maintained and operated as a clearinghouse for user-contributed programs and documents. A wide range of software is available, including languages, editors, numerical functions, utilities, display routines, and various other types of application software.

  Library catalogs are published for PDP-8, PDP-11/VAX, and DECsystem-10/20 programs. They are updated yearly and contain descriptive abstracts and ordering information. Submission standards must be met before programs are accepted into the Library. Review procedures are encouraged to determine whether the program remains in the Library, is changed, or removed. Programs are available to all members on a request basis. Information on the nominal service charge applied to the programs and documentation is published in the Library Catalogs. As of January 1981, the Library contained approximately 1,700 active software packages. A Libaray Catalog may be obtained by contacting your nearest DECUS Chapter Office.

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- PUBLICATIONS
  DECUS publishes society newsletters for each of its chapters. Society members are invited to submit ideas, programming notes, and letters.

  The *Proceedings of the Digital Equipment Computer Users Society* contains papers presented at each of the DECUS symposia. The *Proceedings* are published after each symposium and are sent automatically to symposium attendees. Others may purchase *Proceedings* on a single copy basis, or by subscription for the five *Proceedings* published annually, by submitting a purchase order to DECUS. The DECsystem-10/20 Group publishes bi-annual reports of its sessions at the two U.S. symposia. All *Proceedings* detail information on the work being done in areas of software, hardware, and applications by many members of DECUS.

  Single copies or complete sets of the DECUS symposia *Proceedings* may be obtained by submitting a purchase order to the nearest DECUS Chapter Office. It will provide price and shipping information for the *Proceedings* on request.
- SPECIAL USER GROUPS
  DECUS encourages users with common interests and/or geographical proximity to organize subgroups to explore their individual interests and needs. To this end, two basic categories of Special User Groups exist.

  Special Interest Groups (SIGs)—These groups, having no geographical limitations and organized around a common user interest, promote the interchange of specialized information. Areas of specialization may include application concepts, subject areas such as languages, or specific operating systems. A group of users must petition the Chapter Executive Board for recognition as a Special Interest Group. The group must have a chairperson and its organization must meet the guidelines set by the Chapter Executive Board. SIG members derive numerous benefits from communicating with others who share specialized interests and experiences. SIGs sponsor business meetings, tutorials and workshops at DECUS symposia. SIG members may contribute to newsletters, which most SIGs publish and distribute to their members, participate in SIG sessions and Symposia Review Committees, and serve as reviewers of programs submitted to the DECUS Library.

  Local User Groups (LUGs)—These groups provide an opportunity for people who use DIGITAL's products and share a common interest, geographical area and/or language to exchange hardware and software ideas. Each Local User Group is assigned a representative from the local DIGITAL Sales Offices. It is the representative's responsibility to keep his/her LUG fully informed concerning new products and versions. The representative can be requested to assist in locating speakers for LUG meetings. Generally, the speaker will be obtained from Software Services and/or Field Service. While each LUG is organized differently, they all share an interest in the effective use and suppport of their DIGITAL computers.

SECTION 8
SALES SUPPORT RESOURCES

The following is a list of printed and audiovisual materials for use in presales situations. Please note the addition of several new sales resources especially designed to support VAX-11/730, VAX-11/782, and VAX/VMS version 3.0 sales activities. Product training literature and competitive analysis reports are included.

When ordering any of the materials listed here, send your requests, along with your badge number and cost center, to the appropriate distribution center identified under each section heading.

SALES TRAINING MATERIALS

The following materials are available in your local Field Communication Center. Items marked with (*) may be ordered from Corporate Sales Communications, Sales Training VAX Course Development, Maynard, BG/S51. No order number is required.

VAX-11/780 Training Video Tapes
VAX-11/780 Self-Study Guide
VAX-11/750 Self-Study Guide*
RM80 Self-Study Guide*
VAX Software Self-Study Guide*
Virtual Memory Product Notes*

COMPETITIVE UPDATE

Competitive Update is published by Corporate Sales Communications. Copies can be requested by contacting Carole Fuller, Maynard, PK3-1/K48, (617) 493-2152, DTN-223-2152. No order number is required.

Competitive Slide Sets

The following competitive slide sets are available from Corporate Sales Communications, Maynard, BG/S51.

"Information Management: DIGITAL vs. IBM" Slide/Sync Presentation	EF-16278-05
"Office of the 80s: DIGITAL vs. IBM" Slide/Sync Presentation	EF-16279-05
"IBM vs. DIGITAL Disk" Sound/Sync Presentation	EF-16245-05

SLIDE SETS FOR PRESENTATIONS

Each Unit Manager in the Field has a copy of each of the following two slide sets. Additional copies can be ordered from the Photo Library in Maynard, PK3-2/T14, (617)-493-6763, DTN 223-6763. An accompanying script for each set is available from Printing and Circulation Services in Northboro. Order numbers for slides and scripts are listed below.

	Slide Set	Script
VAX Family Overview Slide Set	10305	EA-19828-18
VAX Family Hardware Slide Set	10307	EA-19830-18

Other slide sets include:

- *DEC Datasystem 700 Slide Set* (each Commercial Sales Unit in the Field has been sent a copy)
- *VAX "Ask Any User" Dual Dissolve Slide Show*, Aug. 1979. Available for $500 from Media Services in Bedford. Contact Kathie Stanton, DTN 249-2068, RCS Code BDFD.

- *DIGITAL in Education Sound-Sync Slide Show* (prepared by ECS) April 1979. Available for $125 from Media Services in Bedford. Contact Kathie Stanton, DTN 249-2068, RCS Code BDFD.
- *Software Services—Applications Consulting Sound-Sync Slide Show* (prepared by SWS). Available for $125 from Media Services in Bedford. Contact Kathie Stanton, DTN 249-2068, RCS Code BDFD.
- *VAX-11 FMS/FMS-11 Slide Show.* Available from Computer Images in Bedford, BU/E36, DTN 249-2621, RCS Code: BDFD. Be sure to include its part number, SE142, with your order.
- *Customer Support for the Life of Your System Slide Show* with script (prepared by SWS). Each Unit Manager in the Field has been sent a copy.

PRINTED PROMOTIONAL MATERIAL

The following materials are available from Printing and Circulation Services in Northboro. Product Line specific materials are noted in parentheses.

Insight

Insight, DIGITAL'S monthly customer newsletter, is sent to each sales office. Any of your prospects can also be added to the circulation list by sending their names and addresses to Lisa Dellechiaie, PK3-2/M88. Additional copies are available from your literature contact.

Brochures

VAX-11/730 Announcement Brochure	EA-22245-18
VAX: The Computer Family for the 1980s	EA-22535-18
VAX. A Sound Investment	EA-17728-18
VAX-11/782 Attached Processor, The Most Powerful VAX Yet	EA-22436-18
The VAX Story Continues, Ask Any User	EA-19101-18
VAX Realtime Capabilities	EA-21718-20
VAX Systems Site Prep Guide	ED-20190-20
VAX Data Processing Capabilities	EA-21224-18
An Educated Approach to Data Processing (ECS)	EA-19060-87
VAX/VMS & PASCAL—A Powerful Relationship (ECS)	EA-17373-87
Customer Services Brochure (SWS)	EA-20362-98
Competitive Edge Brochure (SWS)	EA-21600-98
SPS Uptime is the Best Time of Day (SWS)	EA-21890-09
The Charlotte Package (SWS)	EA-21643-98
Computer Performance Services (SWS)	EJ-N1042-90
MSC/NASTRAN on the VAX-11/780 (ESG)	EC-19813-37
PCB Design Made Easy with the SCI CARDS Program (ESG)	EC-17246-37
PATRAN-G (ESG)	EA-21337-37
ANSYS (ESG)	ED-17689-37
ADLPIPE/DIS (ESG)	ED-20900-37

CC-TEGAS (ESG)	ED-18305-37
Tired of Searching for Engineering Software (ESG)	EA-20922-37
The DeHavilland Profile (ESG)	EA-22290-37
The Transalta Profile (ESG)	EA-20384-3
ESG Overview (ESG)	EA-22291-37
SDRC-CAE (ESG)	EJ-20336-37
Euclid (ESG)	EA-22445-37
IC Design (ESG)	EA-22264-37
Anvil 4000 (ESG)	EA-21942-37
The 11C03 Communications (ESG)	EA-21129-37
Computer Supplies (A&SG)	EA-20757-92
Word Processing Accessories, Supplies and Documentation (A&SG)	EA-19732-92
Quality Control of DIGITAL Magnetic Media Slide Show and Brochure (A&SG)	EA-19233-92
Care and Handling of DIGITAL Magnetic Media Slide Show and Brochure (A&SG)	EA-19232-92
9 Important Questions You Should Ask Before You Buy A 32-Bit OEM Minicomputer (TVG)	EA-22475-04

Flyers

Palette - Drawing and Design (ESG)	EC-22544-37
Mapps (ESG)	ED-22146-37
G/C CUE (ESG)	ED-22207-37
GTSTRUDL (ESG)	ED-20568-37
MSC/NASTRAN (ESG)	EC-19813-37
PSS/E (ESG)	ED-19798-37
AST-1 (ESG)	EJ-20767-37
GS-32 Auto-trol (ESG)	EA-22288-37
Microprocessor Software Development (ESG)	EC-22572-37
IC Design (ESG)	EC-22520-37

Technical Summaries

VAX Technical Summary	EJ-21977-20
VAX-11 DSM Technical Summary (MSG)	EJ-22405-14
VAX/VMS and PASCAL Technical Summary (ECS)	EA-19071-87

Handbooks

VAX Architecture Handbook	EB-19580-20
VAX Hardware Handbook	EB-21710-20
VAX Software Handbook	EB-21812-20
Cables Handbook (A&SG)	EB-19187-75
Maintenance Aids Handbook (A&SG)	EB-20174-75
Hardware Documentation Kit Handbook (A&SG)	EB-19769-75
Spares Kit Handbook (A&SG)	EB-21850-75

Systems and Options Summary

VAX Systems and Options Summary	ED-22424-20

Site Preparation Guide

VAX Site Preparation Guide	EA-22517-20

Sales Guides

VAX Product Sales Guide	EG-21731-18
VAX-11/782 Product Sales Guide	EG-22400-18

Data Sheets/Feature Sheets

VAX/VMS V3	ED-22648-20
DECnet-VAX Phase III Communications	ED-20565-20
DECnet-VAX Phase III V2	ED-22645-20
DR780	ED-21757-20
DW780	ED-18313-18
DW750	ED-21395-20
DMF32	ED-22297-20
MA780	ED-22646-20
KE780	ED-22647-20
MUX200/VAX	ED-17634-18
VAX-11/782	ED-22397-20
VAX-11/780	ED-20567-20
VAX-11/750	ED-20566-20
VAX-11/75	ED-21028-20
VAX-11/730	ED-22630-20

VAX-11 BASIC	ED-19355-20
VAX-11 COBOL V2	ED-22642-20
VAX-11 CORAL 66	ED-19674-20
VAX-11 C	ED-21477-20
VAX-11 DSM (MSG)	ED-20951-20
VAX-11 FORTRAN V3	ED-22643-20
VAX-11 PL/I	ED-19671-20
VAX-11 PASCAL	ED-20092-20
VAX-11 FMS	ED-19398-20
VAX-11 2780/3780	ED-18013-18
VAX-11 3271	ED-20262-20
FP750	ED-21396-20
FP730	ED-22629-20
MA780	ED-22646-20
VAX-11 CDD V2	ED-22644-20
VAX-11 DBMS	ED-21272-20
VAX Information Management	ED-21273-20
VAX-11 DATATRIEVE	ED-21271-20
VAX-11 DEC/CMS	ED-22641-20
Software Services Overview (SWS)	EC-01385-98
Professional Services Overview (SWS)	EC-01386-98
Software Product Services Overview (SWS)	EC-01384-98
Customer Services Feature Sheet (SWS)	ED-01422-94
Software Product Updates (SWS)	ED-21837-09
SPS Self-Maintenance Service for Software (SWS)	ED-21835-09
SPS Basic Service for Software (SWS)	ED-21836-09
SPS DECsupport Service for Software (SWS)	ED-21834-09
Right-to-Copy Service for Software (SWS)	ED-21833-09
SPS Cost Analysis (SWS)	ED-21950-09
OEM SPS Overview (SWS)	EJ-21927-09
Computer Performance Service for VAX-11 Systems (SWS)	EC-22545-90
Remote Diagnosis (FS)	EC-20836-94

Additional Product Line Specific Literature

EDU Magazine (ECS); Issue #30	EJ-21588-87
EDU Magazine (ECS); Issue #31	EJ-22483-87
Iowa State University Application Note (ECS)	ED-19464-87
Graphics Referral Catalog (ESG)	EJ-22380-37
IDEAS—Index and Description of Educational Application Software, Fourth Edition (ECS)	EJ-19645-87
Software Referral Catalog, Eighth Edition (ESG)	EJ-22239-37
SAP6 Software Bulletin (ESG)	EC-17129-37
DECdirect Accessories and Supplies Catalog (A&SG)	EJ-21420-92
Computer Supplies Price List (A&SG)	EE-20366-92
Documentation Products Directory (A&SG)	ED-20291-92
Intro - New Dimension in Data Transmission (DFO Modem Series) (A&SG)	EA-20818-92
Word Processing Accessories, Supplies and Documentation Price List (A&SG)	EE-20365-92
Supporting Products Guide (A&SG)	EJ-20212-92
Supplies Guide (A&SG)	EJ-20059-92
DIGITAL's Cabinets - There's More Than The Eye (A&SG)	EA-21388-75
DIGITAL's Case for Self-Maintenance (A&SG)	EC-20328-75
The Power Distribution System (A&SG)	EJ-20464-75
Conventional Power vs. The Power Distribution System (A&SG)	EA-19184-75
The Power Distribution System an Investment in the Future (A&SG)	EA-19185-75
Self-Maintenance Services from DIGITAL (A&SG)	EA-21442-75
Parts Availability Service (A&SG)	EA-21448-75
DEC-O-LOG FCO Notification Service (A&SG)	EA-21447-75
Maintenance Documentation Service (A&SG)	EA-21449-75
LA34 Complementary and Supporting Guide (A&SG)	EC-21752-75
LA38 Complementary and Supporting Guide (A&SG)	EC-21753-75
VT100 Complementary and Supporting Guide (A&SG)	EC-21754-75
VT132 Complementary and Supporting Guide (A&SG)	EC-21755-75
LA120 Complementary and Supporting Guide (A&SG)	EC-21756-75
Software Services Folder (SWS)	EJ-21828-81
Customer Services Press Kit Folder (SWS)	EJ-20223-94

VAX-11/780-RM05/TU77 (TVG)	ED-21490-04
VAX-11/780-RP07/TU78 (TVG)	ED-21482-04
VAX-11/780-RM80/TU77 (TVG)	ED-21126-04
VAX-11/750-DUAL RK07 (TVG)	ED-21514-04
VAX-11/750-RM03/TS11 (TVG)	ED-21792-04
VAX-11/750-RM80/TS11 (TVG)	ED-21791-04

Educational Services Sales Aids

VAX/VMS System Training	ED-19237-87
VAX/VMS brochure	EA-B4500-12
Educational Services Digest, Training Update and Schedules	EY-CM021-DI

DECUS Proceedings

The Proceedings of the Digital Equipment Computer Users Society (DECUS) document many of the technical papers that are presented at DECUS symposia by users of DIGITAL products and services. The papers listed below may of interest to your customers as well as to other VAX users. They are included in the following volumes of *Proceedings*. Each volume can be purchased from your local DECUS chapter office. No order number is required.

Volume 7, # 4, U.S. Spring

"FORTRAN as a System Programming Language on VAX/VMS"
"Text Formatting on VAX - a Programmable Approach"
"FORTRAN/RMS Interface Techniques"
"Menu Driven Data Entry"
"Microcode Development on VAX-11/780"
"On the Fragmentation of Disk"
"Archiving for VAX"
"FORTRAN Execution Profiles"
"The Expanding Role of Micros For VAX Communications"
"An Implemetation of VAX-IBM Communications"

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"What is 'C'?"
"USE - A Facility For Selective Execution of Lines Within a Command Procedure"
"Using Shared FORTRAN Commons in VMS"
"Image Processing of the 80s Using VAX-11/780"
"VAX/VMS Device Driver For Calcomp Electrostatic Printer/Plotters"
"Using the DR780 as a Shared Device"
"The VAX and Array Processing"

DIGITAL PRESS

The following book is available from Educational Services Order Fulfillment, 12-A Esquire Road, Billerica, Massachusetts 01862.

Computer Programming and Architecture: The VAX-11, by H. Levy and R. Eckhouse	EY-AX008-DP

VAX/VMS SOFTWARE DOCUMENTATION SET

The following list of user documentation is available from the Software Distribution Center (SDC) in Maynard, Massachusetts.

Refer to the A&SG Documentation Products Directory (ED-20291) for a complete listing of the VAX/VMS Software Documentation Set.

VAX-11/780 HARDWARE MANUALS

The following hardware manuals are available from Printing and Circulation Service in Northboro.

Technical Product Desciptions

MA780 Multiport Memory Technical Description	EK-MA780-TD
DR780 General Purpose Interface Technical Description	EK-DR780-TD
FP780 Floating Point Accelerator Technical Description	EK-FP780-TD
DW780 UNIBUS Adapter Technical Description	EK-DW780-TD
MS780 Memory System Technical Description	EK-MS780-TD
KC780 Console Interface Technical Description	EK-KC780-TD
RH780 MASSBUS Adapter Technical Description	EK-RH780-TD
Power System Technical Description	EK-PS780-TD
Diagnostic System Technical Description	EK-DS780-TD
TB/Cache/SBI Control Technical Description	EK-MM780-TD
KA780 CPU Technical Description	EK-KA780-TD

User's Guides

DR780 General Purpose Interface User's Guide	EK-DR780-UG
VAX-11/780 Diagnostic System User's Guide	EK-DS780-UG
VAX-11 Diagnostic System User's Guide	EK-VX11D-UG
System Hardware User	EK-11780-UG

Diagnostic and Maintenance Guides

VAX-11 Diagnostic Design Guide	EK-1VAXD-TM
System Maintenance Guide (FOR INTERNAL USE ONLY)	EK-11780-PG

Site Preparation and Installation Guides

System Installation Manual	EK-SI780-IN
Corporate Site Preparation Guide	EK-OCORP-SP

VAX-11/750 HARDWARE MANUALS

The following hardware manuals are available from Printing and Circulation Service in Northboro.

Technical Product Descriptions

VAX-11/750 Central Processor Unit Technical Description	EK-KA750-TD
VAX-11/750 UNIBUS Interface (UBI) Technical Description	EK-UI750-TD
VAX-11/750 Memory System Technical Description	EK-MS750-TD
VAX-11/750 Power System Technical Description	EK-PS750-TD
VAX-11/750 RH750 MASSBUS Adapter Technical Description	EK-RH750-TD
VAX-11/750 FP750 Floating Point Accelerator Technical Description	EK-FP750-TD

User's Guide

VAX-11/751 User's Guide	EK-11751-UG

Diagnostic and Maintenance Guides

VAX-11/750 Diagnostic System Overview	EK-VXD75-UG
VAX-11/750 Diagnostic System User's Guide	EK-VX11D-UG

Installation Guide

VAX-11/750 Installation and Acceptance Manual	EK-SI750-IN

VAX-11/730 HARDWARE MANUALS

The following hardware manuals are available from Printing and Circulation Service in Northboro.

Technical Product Descriptions

VAX-11/730 Central Processor Unit Technical Description	EK-KA730-TD
VAX-11/730 Memory System Technical Description	EK-MS730-TD
VAX-11/730 FP730 Floating Point Accelerator Technical Description	EK-FP730-TD
VAX-11/730 Integrated Disk Controller Technical Description	EK-RB730-TD

Additional manuals concerning the VAX-11/730 and related hardware will be available in the future.

APPENDIX

LOGIC IMPLEMENTATION ON VAX PROCESSORS

The VAX family CPUS use different logic implementations to accomplish specific goals for price and performance. The VAX-11/780 and the VAX-11/730 both use off-the-shelf, industry-standard integrated circuits, while the VAX-11/750 uses custom large-scale integration (LSI) chips.

Industry-Standard Integrated Circuits

Industry-standard integrated circuits (ICs), available off the shelf from several manufacturers, are the type of logic implemented on both the VAX-11/780 and the VAX-11/730.

The economics of standard off-the-shelf ICs depend on large production quantities because the actual development of a chip is very expensive. For this reason, most of the available standard chips provide very common and general-purpose logical functions such as NAND gates, flip-flops, counters, shift registers.

Some of the advantages of industry-standard ICs are as follows:

- Available from several sources
- Low cost per logic function
- Quick development of logic boards since the components are off-the-shelf

There are several different types of ICs available. These include PALs, used on the VAX-11/730, and bipolar and Schottky TTL, used on the VAX-11/780. DIGITAL's engineers selected TTL technology for the VAX-11/780 because they wanted a reliable and proven design on which to build the completely new VAX system architecture and the VAX/VMS operating system. To lower costs of future VAX systems, our engineers chose the newer, more compact, Programmed Array Logic technology for the VAX-11/730.

Standard Bipolar and Schottky TTL Logic

The VAX-11/780 system uses the proven bipolar TTL and Schottky TTL logic technologies that combine fast switching speed with moderate power consumption. Emitter-coupled logic circuits and custom LSI circuits were used where appropriate to optimize system performance and reliability.

Programmed Array Logic (PAL)

Most of the VAX-11/730 CPU logic is implemented by state-of-the-art Programmed Array Logic (PAL) technology. PALS are "programmed" by DIGITAL to do specific functions in the VAX-11/730, much as a ROM is programmed. Although PALs do not provide the flexibility of the gate-arrays used in the VAX-11/750, they are much less expensive to develop. PAL technology saves up to 75% in parts over conventional Schottky TTL logic, reduces program development time, and consequently reduces product cost. Among the benefits gained by the use of PAL technology are design flexibility, compactness, high speed, and programming ease and efficiency.

LARGE SCALE INTEGRATION (LSI) CIRCUITS

Custom large scale integration (LSI) chips, used by the VAX-11/750, combine several functions on a single chip, thereby reducing the total number of chips needed for a system. This allows the physical size of the processor and its power consumption to be significantly reduced over what they would be, using conventional technology. Because of the high level of specialization, LSI chips are less general purpose in terms of function than ICs and are quite expensive and time-consuming to develop.

Some of the advantages of using custom design LSI chips are as follows:

- Lower assembly costs, because there are fewer components
- Less power consumption
- Less board space required
- Fewer printed circuit boards
- Less cooling needed
- Increased reliability because there are fewer external connections with fewer components

Gate-Array Technology

Most of the VAX-11/750 CPU logic is implemented in custom LSI (Large Scale Integrated) gate-arrays designed by DIGITAL. Gate-array technology is a sophisticated process of manufacturing prefabricated chips with several hundred logic-circuit elements, called gates, which are then interconnected in a custom pattern.

A gate-array is a fixed uniform physical layout of digital logic gates. In the first half of the manufacturing or design process, these gates are unconnected, that is, "blanks." In the second half of the process, the gates are interconnected or "wired up" for a particular logic design. This wiring is done through semiconductor photolithographic techniques. Once the "blank" gate-array semiconductor design was completed, all of the individual VAX-11/750 designs were handled by DIGITAL's Computer-Aided Design system for the wiring.

The interconnection of the gates in the second half of the process transforms the "blank" chip into a highly specialized, custom designed chip. Since only part of the process is unique to each type of chip, chips produced in this manner are referred to as semi-custom. The development costs for semi-custom gate-arrays are therefore significantly lower than for totally LSI devices.

Some of the advantages of using gate-arrays (as in the VAX-11/750) instead of off-the-shelf ICs (as in the VAX-11/780 and VAX-11/730), are as follows:

- One gate-array chip equals about 25 standard IC chips in terms of logic functions
- Power per logic gate for gate-arrays is about 50% that of standard ICs
- The space needed on printed circuit boards for gate-arrays is 20% of that required for standard ICs
- Gate-array circuit reliability, compared to standard ICs, is about four times better
- The cost per gate for gate-arrays is about 50% that of standard ICs