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RSX-11M and RSX-11M PLUS marketing guide

RSX-11M AND RSX-11M-PLUS
MARKETING GUIDE

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SECTION 1
INTRODUCTION

Objectives — Provide general "what is RSX-11M V3.2 and RSX-11M-PLUS and what were its design and development considerations."

INTRODUCTION

Why Two RSX-11M Based Operating Systems?

The release of RSX-11M V3.2 and RSX-11M-PLUS V1.0 provides DIGITAL with a powerful 1-2 punch.

RSX-11M V3.2 evolved from RSX-11M V3.1—the industry standard for real-time multitasking operating systems. Responding to the demands of our user community, RSX-11M V3.2 provides key software features unavailable in V3.1—an improved sysgen process, a new terminal driver, enhanced print spooler, and a plethora of utility and executive enhancements. These features, coupled with the completeness and reputation of RSX-11M V3.1, insure that V3.2 maintains a leading edge against the competition.

But why RSX-11M-PLUS?

In light of the superior quality and basic architecture of RSX-11M and the expanded memory and power of the PDP-11/70, the goal for RSX-11M-PLUS was clear: use all the hardware capabilities of our highest performing PDP-11 to provide an application engine that is unbeatable in the 16-bit computer market.

As soon as the PDP-11/70 was introduced, RSX-11M's speed and reputation made it a natural complement to the 11/70's architecture. However, RSX-11M has always supported systems as small as a 32 Kb PDP-11/04. This small-system requirement has held RSX-11M back; thus, its full potential on a 2 megabyte PDP-11/70 could never be realized.

Although RSX-11M's performance on small and medium PDP-11s is outstanding, its medium-system design does not optimize PDP-11/70 capabilities. RSX-11M-PLUS solves RSX-11M medium-system design limitations such as re-entrant task support, overlapped disk seeks, and a shortage of "pool" space (Dynamic Storage Region). With RSX-11M-PLUS, terminals and/or tasks can now be added to PDP-11/70 systems, without pool space worries.

Thus, instead of compromising our larger systems at the expense of the smaller ones, or vice versa, RSX-11M is offered in two versions: RSX-11M V3.2 for small and medium systems and RSX-11M-PLUS for PDP-11/70 systems. This offering allows us to engineer and sell the right operating system to yield the highest possible performance from our hardware systems.

Is RSX-11M-PLUS a New Operating System?

Yes and no. RSX-11M-PLUS is *not* a new operating system because it provides RSX-11M design philosophy, system calls, utilities, documentation, etc..

RSX-11M and M-PLUS offer compatibility that is unsurpassed by any two DIGITAL operating systems. All non-privileged tasks (for instance, a FORTRAN compiler and run-time system, the RMS-11 file system, and most user applications) that run on RSX-11M run directly on RSX-11M-PLUS without source changes, without reassemblies, even without re-taskbuilding! Privileged code, such as device drivers, require only minor modifications. These changes require about the same level of effort from your customer as was needed to upgrade RSX-11M Version 2 to Version 3.

RSX-11M-PLUS *is* new because the internal operating system data structures have been expanded to offer additional features over RSX-11M V3.2. These features include an easy-to-use DCL command interface, overlapped disk seeks, complete batch and transparent spooling utilities, CPU time, connect time, and pages printed accounting capabilities, and re-entrant task support.

M-PLUS is new because we now offer an operating system that allows PDP-11/70 systems to realize their full potential.

M-PLUS Markets

RSX-11M-PLUS and RSX-11M markets are basically the same. These markets include data acquisition, real-time control, communications processing, and application base systems. We expect M-PLUS to excel especially in markets that require a strong base on which to run applications. M-PLUS is truly the best 16-bit "Application Engine" available in the industry. We expect OEMs, system houses, and large companies who have in-house expertise to take RSX-11M-PLUS and put it into almost every application imaginable. Historically, this is how most of our RSX-11M PDP-11/70 systems have been used, despite the previous limitations.

DIGITAL now offers an operating system that not only has the features system designers demand, but one that is matched perfectly to the capabilities of the PDP-11/70.

SECTION 2

RSX-11M V3.2 AND RSX-11M-PLUS PRODUCT DESCRIPTIONS

Objective — Provide a brief overview of RSX-11M and the tools provided that facilitate all phases of system implementation.

RSX-11M V3.2 AND RSX-11M-PLUS PRODUCT DESCRIPTIONS

RSX-11M and RSX-11M-PLUS have the features system designers need for fast and efficient computer system implementation. From system design through program development, design validation, installation, and ongoing system maintenance, RSX-11M has what it takes for "on-time, exceeds-specifications" design and implementation.

SYSTEM DESIGN

The RSX-11M family offers the features and capabilities needed by system designers to build a strong base for their system. Over 22 detailed manuals describe how to implement, optimize, and execute these features, thus providing RSX-11M users with one of the most comprehensive operating systems on the market. (See Section 8 for a complete list of all RSX-11M documentation.)

Event Driven, Priority Based Scheduling

RSX-11M* provides 250 software priority levels that allow concurrent processing of time-critical tasks, interactive terminals, background computation, and batch-like streams. Software priority levels not only allow the system designer to optimize CPU use, but also permit flexible performance tradeoffs that can be tailored to application needs.

Fully Generalized Memory Partition Support

RSX-11M's fully generalized memory partitions allow portions of memory to be dedicated, shared with task subsets, or shared with all tasks. The system designer has the option of explicitly dedicating sections of memory to certain tasks and/or letting the system automatically manage the available memory. During execution, a task can grow or shrink dynamically, create a separate data area (region), remap to address an existing area, or send an area to another task. These features guarantee maximum performance for a given amount of memory.

At the designer's option:

- tasks can be rolled out to disk (checkpointed) when more important tasks need memory space
- tasks can timeshare processor time using a round-robin scheduler
- tasks sharing a memory partition can be shuffled to eliminate holes between tasks to make room for additional tasks
- tasks of equal priority sharing a partition may be rolled out to disk to allow equal access to memory and CPU resources.

The system designer can include resident libraries and common data areas in memory partitions. Because only one copy of a routine or data is being shared by many tasks, optimal memory use can be achieved.

Device I/O Independence and Flexibility

Since RSX-11M tasks reference logical device numbers, not physical unit numbers, an operator can redirect all I/O from one device to another for any task. Device I/O independence results in more general, more easily written programs, and more flexible hardware configuration design.

Multiple File Systems with Options

As described below under *File Handling Capability*, RSX-11M provides two file handling systems: FCS and RMS-11. These systems and their options permit a system designer to make speed vs. memory performance tradeoffs (pre-accessed directories, large directory reads, and dedicated file systems for each disk).

* By RSX-11M we mean both RSX-11M and RSX-11M-PLUS

Print Spooler
The print spooler collects tasks to be output to relatively slow line printers in a disk file. When the task completes, the print despooler routine prints all spooled files. This feature allows programs to run to completion at full computer speed without tying up memory resources waiting for line printers.

Multitasking Real-Time Capabilities
RSX-11M allows full multitasking and provides a complete set of system features for intertask coordination, control, and synchronization.

For complete flexibility in scheduling tasks, the system designer has the priority scheduler and, working within a given priority range, the round-robin scheduler. Memory management hardware protection ensures the integrity of a task.

Task synchronization is provided through local, group, and global event flags. System directives allow a task to alter another task's priority; run, suspend, resume, or abort another task; send messages to another task; and send the address of large data areas to other tasks. System directives also allow a task to spawn another task(s) and to receive a status report when the spawned task(s) completes.

In addition to the wide variety of device drivers provided for DIGITAL's real-time devices (A/D, D/A, programmable clocks and watch-dog timers), user-supplied custom hardware can also be supported. Complete documentation for writing I/O device drivers and RSX-11M system support, such as connect-to-hardware interrupt system call, is provided.

RSX-11M is a Multiuser System
RSX-11M and RSX-11M-PLUS maintain data and system integrity in multiuser development and application environments through such features as password protection, separate user file directories, disk swapping, and round-robin scheduling. These features, coupled with hardware memory management protection, provide a system that not only protects each user, but also protects the operating system. For applications requiring complete protection, terminals can be designated as slaves, with all input and output from each slave terminal controlled by a single "master" task.

Round robin scheduling, disk swapping during terminal input waits, and disk swapping for equal priority tasks sharing a memory partition allow users to share system resources transparently. The user-oriented terminal handler provides many convenience features, such as scrolling support, which are useful in a program development system.

Operating System Services
RSX-11M provides system directives (calls), utility programs, and an indirect command file processor for users and user tasks. These operating system services simplify and expedite program development.

System Calls — System calls allow tasks to:

- obtain task and system information
- measure time intervals
- perform physical or logical file and record I/O
- synchronize and communicate with other tasks
- manipulate the task's logical and virtual address space
- exit, suspend, and resume task execution

Utility Programs — RSX-11M is a mature system offering a complete set of utility programs that simplify operations.

Indirect Command File Processor — The RSX-11M indirect command file processing capability allows any series of terminal commands to be entered into a disk file, permitting repeated and/or automatic execution of command strings. An indirect command file can contain operator queries, symbol setting, testing and substitution, branching, and subroutines.

The indirect command file is processed as though the commands were actually being entered by a user through a terminal. This capability, similar to a multistream batch, allows often repeated command sequences to be processed automatically. Indirect command files increase program and system development accuracy and simplify program maintenance.

File Handling Capability

RSX-11M provides a sophisticated on-disk structure and two file handling services that allow the system designer to make various speed-size vs. functionality tradeoffs.

FILES-11 On-Disk Structure — FILES-11 identifies files by name, type, and revision level designation. The list of files is maintained in directories that are identified by a group/owner number.

File protection is provided through an access key, which allows read, write, extend, or delete privileges to each of four separate groups:

File protection is provided through an access key, which allows read, write, extend, or delete privileges to each of four separate groups:

- System—system managers who possess privileged access to many system function files
- Owner—the user who creates the file
- Group—the group of users of which the file owner is a member
- World—all system users

File Control Service (FCS) — The basic file handling system on RSX-11M systems is FCS, which is a subset of RMS-11. FCS allows record and/or block oriented operations by regarding logical records as data units structured according to application requirements, rather than as physical blocks of data on a particular storage medium.

FCS supports sequential and random file access. A collection of data consisting of distinct logical records can be written to and retrieved from a file without requiring that the user know the exact format in which it was written.

Magnetic tape also can be supported by RSX-11M as a file device. As magnetic tape is not a random access device, it cannot contain FILES-11 structures. Instead, tapes conform to the ANSI Standard Magnetic Tape file formats (Level 3).

RMS and RMS-11K — RMS-11 is a superset of the FCS file system and is compatible with FCS written files. Additionally, RMS-11 supports RMS-11K, which allows multikeyed ISAM files. The RMS-11 system offers extended features beyond FCS with a nominal increase in memory size and execution speed. When talking to a sales prospect, RMS would be mentioned usually as part of a complete COBOL, BASIC-PLUS-2, SORT, RPG II, or DATATRIEVE package. These package descriptions are beyond the scope of this document.

NOTE

See *Data Services Management Marketing Guide* for a detailed description of RMS-11 and RMS-11K (Order Number EA 09791 20).

Reliability

The many years RSX-11M has been in the field and the large number of active installations attest to its high reliability. By offering such features as disk write-check support, disk ECC correction and offset recovery support, powerfail/restart support, and extensive error logging capabilites, a system designer is given a solid base on which to build a truly reliable system.

CODING AND PROGRAM DEVELOPMENT

RSX-11M systems provide the facilities needed by users to successfully convert the system design into a running system. Coding and program development are augmented by a comprehensive documentation set, which includes an optional system design and logic manual describing the inner details of executive operation. (See Section 8 for a complete list of RSX-11M documentation.)

Powerful Terminal Interface

RSX-11M's terminal driver is an excellent man/machine interface through which terminal users are provided access to the system. The user-oriented terminal interface has the features users need: the ability to make fast, neat, typing correction, the ability to quickly scan large documents, and help texts.

The powerful Monitor Console Routine (MCR) command language provides concisely formatted commands and logical defaults for missing arguments. The terminal driver supports full-duplex operation and type-ahead for application programs.

Choice of Two Supported Editors

RSX-11M systems give users a choice of two sophisticated editors: EDI and EDT. These editors provide high-level features common to large systems, such as string substitutions, macro capabilities, and fast search capabilities.

EDI is a line text editor, which means that EDI maintains an internal pointer to the current line that is being acted upon. EDT is DIGITAL's new line and text editor that is found on IAS, RSTS/E, and TRAX operating systems. EDI and EDT allow for fast and easy program and data entry and modification.

Sophisticated MACRO Assembler

The RSX-11M MACRO assembler offers capabilites normally found only on mainframes. These capabilities include:

- an alphabetized, formatted symbol table
- a cross reference listing of symbols
- relocatable object modules
- global symbols for linking independent modules
- conditional assembly directives
- program sectioning directives
- user-defined macros and macro libraries, including nested macros

Task Builder

The RSX-11M task builder links multiple object modules and connects them into executable task images. It provides a memory allocation map showing the modules in the resulting task image, the value of all global symbols, and a global cross-reference. The taskbuilder builds task images that use disk and/or memory resident overlays, thus providing advanced overlay constructions.

System Library Routines

DIGITAL-supplied system library routines reduce program development time. Standard sharable routines available to users include routines that:

- save and restore register contents for control transfers to subroutines
- perform single- and double-precision integer multiplication and division
- convert ASCII input data to binary and Radix-50 format, and vice versa
- convert and format output data to produce text for a readable printout or display
- manage the dynamic memory space available for tasks that require small-to-moderate amounts of resident memory for data manipulation
- manage memory and disk file storage for tasks that require large amounts of memory for data that must be transferred between memory and a disk work file
- obtain a command line from a terminal, indirect command file, or an on-line storage medium
- separate a command line into the appropriate dataset descriptions required by the file system for opening a file
- separate a user-defined command line with user-defined command syntax that includes built-in variables

Choice of Languages

In addition to the supplied MACRO-11, RSX-11M supports:

- FORTRAN IV
- FORTRAN IV-PLUS
- BASIC-11
- BASIC-PLUS-2
- PDP-11 COBOL
- RPG II
- CORAL 66

The wide array of RSX-11M supported languages allows your customer to choose the right language for a specific application.

TESTING AND DESIGN VALIDATION

RSX-11M provides many utilities to facilitate the testing and design validation phase of system development.

DMP, Dump Utility

DMP converts ASCII or binary files into readable listings to help verify proper file and record definitions and operations.

ZAP, PAT, and SLP Patch Utilities

RSX-11M program patching is facilitated by the ZAP, PAT, and SLP utilities. These utilities facilitate patching task images or data files, relocatable binary object modules, and source files. The SLP utility maintains an audit trail for source files, which helps control program development and testing.

CMP, Compare Utility

CMP compares two ASCII files, record by record, and lists differences, greatly facilitating application debugging.

RMDEMO

RMDEMO dynamically displays vital system statistics on a video terminal. RMDEMO allows the system designer to see when tasks are interfering with each other, when dynamic storage is running low, disks are becoming full, etc., helping the designer tune the system for optimum performance. Specifically RMDEMO shows:

- date and time
- currently active task
- a graphic map showing how tasks are mapped in physical memory
- the number of active tasks in memory and the number waiting on disk for memory space
- the amount of system dynamic storage (pool), including the largest block size and the number of fragments
- the number of free blocks on the system disk and other mounted disks
- the number of system errors encountered

ODT, On-line Debugging Technique

ODT allows a programmer to examine, alter, search, and execute locations or pieces of programs, which simplifies program checkout. Through keyboard interaction users can:

- examine and alter any location in a program
- run all or any portion of the program using the breakpoint and single step feature
- search the program for words having a specified bit pattern
- search the program for instructions that reference a specific address
- calculate offsets and displacements from locations
- examine or write a constant into a specific address range

CDA, Crash Dump Analyzer

The CDA utility helps locate the cause of a system crash. It reads the contents of a system memory dump, formats the information, and outputs the following information to a printer for evaluation:

- all memory management and hardware register contents
- the system stack
- task control blocks for each active task
- contents of the clock queue
- information on all devices in the system
- contents of physical memory
- task headers for each task in memory
- contents of each Partition Control Block
- contents of the system dynamic storage region
- contents of the system task directory for all tasks

Because system crashes can occur when user modifications to the executive are made or when privileged tasks mapped into the system data structures are made but are not yet debugged, the CDA is a valuable tool that helps eliminate "unexplainable" system failures.

INSTALLATION AND TUNING

Being able to fine tune a system that meets your customer's performance requirements and expectations is, of course, a vital aspect in the selling process. RSX-11M systems provide the necessary tools to facilitate the installation and tuning process.

After basic system requirements have been met, the rest of the system configuration process is a series of tradeoffs that you and your customer must make.

Memory Use

Many of the parameters of RSX-11M can be varied to get the best possible performance. These include memory partition sizes, priorities, round-robin scheduling, and swapping parameters. Memory allocations are completely flexible, so they can be adjusted to your customer's needs.

The size of memory partitions, the priorities assigned to each task, and the round-robin scheduling and disk swapping parameters can vary to provide the best possible performance for your customer's system.

Size of File System

The size of the file system, directory techniques, and replicated file systems are a few of the memory vs. speed tradeoffs that can be made during system installation and tuning.

QIO Speed Optimizations

Use of more memory can speed execution of the calling mechanism for issuing queued I/O requests (QIOs). Preallocated I/O packets, block transfer speed optimizations, and overlapped I/O completions are some of the implementation specific tradeoffs available at installation time.

RMDEMO

As described above, RMDEMO provides a graphic picture of the system under loaded conditions. As variables are changed, RMDEMO helps indicate the resulting effects, thus aiding system installation and tuning.

ONGOING SYSTEM MAINTENANCE

Error logging, maintenance utilities, system manager programs, and auto patching are some of the tools RSX-11M provides to support on-going system maintenance.

Error Logging

Error logging utilities keep a running history of all device errors, timeouts, undefined interrupts, and parity errors. Hardware malfunctions are recorded, and corrective action can often be taken before the problem becomes serious.

One of RSX-11M's error log utilities produces formatted reports of the error log history file. This utility allows data to be sorted by time, device type, or device-specific errors.

LBR, Librarian Utility

LBR is a maintenance program used for creating, modifying, updating, listing, and extracting modules to maintain library files. LBR, which handles object and macro libraries, permits simple and straightforward library maintenance.

DSC, Disk Save and Compress Utility

This program saves the contents of a disk onto another disk or tape and consolidates fragmented files into contiguous files. Using DSC regularly minimizes the possibility of losing valuable data or program development time.

BAD, Bad Block Locator Utility
The BAD utility finds bad blocks on a disk media and passes the information to the file system so that bad blocks are not allocated to files.

VFY, File Structure Verification Utility
The VFY utility understands FILES-11 on-disk structure and thus can read a volume to verify the integrity of a disk directory structure, pointers, and linkages. With VFY, problems with a disk file structure can be detected early and often corrected without losing data.

System Manager Programs
Several programs are included to help the system manager maintain control of and provide access to the system.

These programs let the system manager maintain a list of valid user passwords, broadcast messages to all terminals, and stop the system after automatically issuing timed warning messages.

The indirect command file processor (previously discussed under *Design*) allows all day-to-day, week-to-week, etc. maintenance activities to be stored as automated command sequences. Using the automatic scheduling feature of the RUN command, these procedures can be initiated automatically at the specified intervals.

Auto Patch
Software Services provides a subscription service for a quarterly distribution of all patches in machine readable format. The system building process (SYSGEN) patches the system automatically, using the patches supplied.

SECTION 3

WHAT'S NEW IN 3.2?

Objective — Provide a brief precis of Version 3.2 features and enhancements.

WHAT'S NEW IN 3.2?

Version 3.2 is the fifth, best, and most comprehensive release of RSX-11M. It rounds out RSX-11M's feature list and provides enhancements that answer many of the requests of our user community. A better SYSGEN, a better terminal driver, a better print spooler, a faster disk back-up utility, and more dynamic storage (pool) are exactly what our users want. It's hard to improve upon the best, but V3.2 has done it!

SYSGEN

The SYSGEN process, which builds the operating system to match customer requirements, has been greatly improved. SYSGEN can now be driven by a disk file that contains answers to SYSGEN questions. Thus, initial SYSGENs, minor modifications to a standard SYSGEN, or multiple SYSGENs can be accomplished by a simple edit of the answer file.

The SYSGEN process also provides a new format for questions regarding peripheral devices that eliminates all questions regarding devices that your customer's system does not have. These improvements provide easier, faster, and less tedious SYSGENs.

Terminal Driver

A completely new terminal driver added to Version 3.2 is designed specifically for high throughput on mapped, multiterminal systems. The terminal driver provides a separate buffer area of up to 9 Kb, which is used for terminal I/O. This buffer provides two benefits: it eliminates the use of dynamic storage (pool) for terminal I/O and it allows complete lines to be buffered on input and output. Now tasks can be checkpointed during terminal I/O waits and the Direct Memory Access (DMA) capability of the DH11 terminal interface can be used.

This new terminal driver also supports type-ahead for application tasks, full-duplex communication, and ANSI escape sequences. Enhancements made in character processing during interrupt functions yield a two-fold improvement in character throughput over Version 3.1.

Print Spooler

The new print spooler has exactly what customers want. It allows users to print files with the following modifiers:

- print after a specified time
- specify forms
- put an entry on hold
- specify a print priority
- get multiple copies
- optionally delete files after printing

There are additional commands to delete an entry, list the print queue, and stop and restart the printer. This new spooler supports multiple printers and print queues and maintains the print queue on disk, not in system dynamic storage (pool). This change, coupled with the terminal driver, which no longer uses pool, allows an RSX-11M V3.2 system to accomodate more active terminals and tasks.

Improved Utilities

Many improvements have been made to the RSX-11M utilities, with the new fast disk backup utility (BRU) being the most exciting.

- BRU

  BRU backs up an RP06 disk to TU45 tape in less than an hour, which is approximately a 4 to 1 improvement over the current DSC program. BRU also supports incremental backups (such

as backing up only the files that have been modified since the previous backup), which greatly reduces the amount of time required for proper disk backup.

- FLX

  FLX, a file transfer program, now can write RT-11 format for RX02, RK06/07, RL01 disks, and TU58 cartridge tapes. An inhibit rewind switch has been added and a 1600 bpi option is included to allow fast magtape operation.

- SLP

  SLP, the source line input utility, now processes 132 character input lines (as opposed to 80 characters in V3.1) and checksum characters to insure the accuracy of corrections.

- BAD

  The BAD utility, which checks for bad blocks by writing, reading, and recording any bad block locations, now accepts manual entry of bad block information.

- DMP

  The DMP file dump utility provides detailed listings of file headers for FILES-11 files.

- PIP

  PIP, the Peripheral Interchange Program, now provides users with the option of saving the original creation date while copying files, and has the ability to truncate a file back to its logical End-of-File. PIP allows selective deletes by listing each file name and soliciting a yes or no response. If wild card specifiers are used to delete files, PIP now lists each file deleted.

Executive Enhancements and Other Improvements

The basic functionality of the RSX-11M executive has been expanded to include:

Parent Offspring Task Relationships — New system directives allow tasks to be spawned from a master task, with the master task receiving status notification when spawned tasks exit. A CONNECT directive allows other spawned tasks to be notified when a task exits. These enhancements allow simpler, more straightforward multitasking synchronization schemes.

STOP Bit Synchronization — New STOP bit synchronization directives, which mirror the current WAIT directives, allow a task to stop and become eligible for checkpointing until a predefined condition, such as receiving a message from another task, is satisfied.

Two-Four Window Support — The file system has been modified to minimize window turning (an extra disk read to locate the disk address of a desired data block) in large contiguous files. Previously, a retrieval pointer in a file window could only "see" 256 contiguous blocks. Although a file window normally has seven retrieval pointers, references to a record in a file outside of this contiguous block would cause the system to do an extra read operation. RSX-11M Version 3.2 can now "see" up to 65,000 contiguous blocks per retrieval pointer, which greatly improves file throughput for large files.

QIO Processing Restructured — The QIO (queued input and output) processing logic has been reorganized, providing users with a more logical structure for writing ACPs (Ancillary Control Processors).

Expanded HELP File — The on-line HELP file has been enlarged to include more information, thus minimizing the amount of time users must reference the documentation set.

Console Log File — A pseudo device driver has been included that intercepts all messages destined for the system console terminal and logs them into a disk file as a permanent record.

The Console Log File provides the additional benefit of allowing the system console to be used as a normal terminal.

KMC11 Line Printer Driver — A new driver is supplied that allows up to eight line printers to be controlled from a KMC11 microprocessor. The KMC11 eliminates the need for character interrupts from printers, freeing the processor for more useful work.

SECTION 4

WHAT IS RSX-11M-PLUS VERSION 1?

Objective — Provide a brief summary of RSX-11M-PLUS design objectives, enhancements, and features.

WHAT IS RSX-11M-PLUS VERSION 1?

RSX-11M-PLUS is just what you would expect if you gave the team that developed RSX-11M a free hand to start with a PDP-11/70, RSX-11M V3.1, and over two years to develop an M-based system that gets the most from the 22-bit addressing, 4-megabyte PDP-11/70. RSX-11M-PLUS offers all the features of RSX-11M Version 3.2, *plus*:

- Ease of use improvements
- Enhancements that make the most of large memory, multiuser machines
- Expanded capabilities users expect from a PDP-11/70 class system

Ease of Use

Many improvements were incorporated into RSX-11M-PLUS to provide a system that is easier to use. Some of the more notable enhancements are:

Command Language — RSX-11M-PLUS implements two command interfaces: DCL and MCR. DCL (DIGITAL Command Language) is the command language used by TRAX, RT-11, IAS and VAX/VMS, and as such has many common commands. DCL's strong suit is that it is easy to use. Its commands have a logical, consistent form that makes them easy to learn, and even improvise, without referring to manuals. DCL prompts for missing arguments, leading the user along the way.

The traditional MCR command syntax provides an alternate interface that is concise and common to RSX-11M V3.2 systems.

Since both command languages are supported, users can interact with RSX-11M-PLUS with whichever command language is most familiar. And for those customers who may use more than one operating system, confusion over "which system takes which command" is avoided.

SYSGEN — Because M-PLUS runs only on large systems, SYSGEN is an easier and quicker process. Many SYSGEN questions that were designed previously to save every possible word of memory for small RSX-11M systems are now inappropriate for M-PLUS, and thus have been eliminated. Because of the increased memory available on M-PLUS systems, the larger versions of the assembler, task builder, and utility programs can be used to make SYSGEN run considerably faster.

RSX-11M V3.1 Compatibility — M-PLUS is a strict superset of RSX-11M Version 3.1. All non-privileged tasks that run on V3.1 also run on M-PLUS, without retaskbuilding. The data structures in RSX-11M-PLUS have been expanded in some areas, requiring users to make only minor modifications to privileged code, such as device drivers.

Performance on Large Memory Systems

This is the real meat of M-PLUS, the reason that it was produced. The following list includes some of the improvements made with one goal in mind—get the most power and throughput possible from a PDP-11/70.

Overlapped Seeks — Overlapped seeks are executed for RP05/06, RM02/03, and RK06/07 disks. Throughput gains on the order of 30% are possible for systems with multiple disks on a controller if there are sufficient I/O requests to keep two (or more) drives busy.

Re-entrant Task Support — Better use of memory is accomplished by separating pure (read only) and impure (read/write) sections of tasks. When the first copy of a re-entrant task is executed, one copy of the pure and impure sections are loaded into memory. When subsequent copies of such a task are required, only the impure section is loaded. All users share the pure section, thereby making more efficient use of memory.

Checkpointable Libraries, Commons, and Dynamic Regions — Shared libraries, pure sections of reentrant tasks, common data areas, and PLAS Dynamic Regions can now be checkpointed (rolled out) to disk when they are not being used. These tasks can be brought back into memory automatically when an executing task references them. Shared areas also can be shuffled to compact memory and remove "holes" between tasks. This new capability in M-PLUS helps get the most efficient use of memory resources.

Supervisor Mode Libraries — M-PLUS allows users to use the extra set of memory mapping registers available on the PDP-11/70. These supervisor mode registers can be mapped by M-PLUS to map-read libraries of user code, the RSX-11M file system (FCS), or other application code. This capability gives an M-PLUS task a full 64 Kb of normal programming address space, plus an extra 64 Kb of read-only routines. With optimal library sizes, a user task can now directly address twice as much memory. (This is in addition to the existing RSX-11M memory management directives, PLAS, which allow a task larger than 64 Kb to be entirely memory resident with memory resident overlays).

Re-entrant task support, checkpointable libraries, commons, and dynamic regions, and supervisor mode libraries permit more tasks to share memory more efficiently. And more memory means more performance.

Increased Dynamic Storage Region (Pool) — M-PLUS now has separate hardware memory mapping for the executive code (I space) and the executive pool (D space). This separation of data and the use of extra memory management registers allows M-PLUS to devote a full 32 Kb to system pool. This is in addition to the amount of system pool that has been freed by the terminal handler and print spooler. These three modifications net a tremendous increase (at least double) in the amount of pool on an M-PLUS system compared to an RSX-11M Version 3.1 system.

What does extra pool mean? Extra pool means more terminals and more active tasks. RSX-11M-PLUS now supports approximately twice as many terminals and active tasks as were supported by an RSX-11M Version 3.1 system.

Expanded Capabilities

M-PLUS provides capabilities that are expected by a large PDP-11/70 system user.

Batch and Spooling — A complete batch facility has been provided for M-PLUS that is similar in format and power to the VAX/VMS batch. Batch commands, formatted in DCL command language, pass status to the batch processor as each batch step is accomplished, allowing conditionalized branching. The batch processor collects all print files from a batch stream and spools them to a log file. The queue manager provided with M-PLUS gives the system operator complete control over multiple batch streams and print queues.

Accounting — M-PLUS maintains a record of per user CPU time, connect time, and pages printed. This information can be processed through user-supplied routines, such as a billing program, and made available to users.

Error Log Improvements — The M-PLUS error log has been improved. In addition to recording pertinent data for a failing device, it now records a complete snapshot of all mass storage activity at the time an error occurs. This feature allows any system cross dependencies to be pinpointed more easily.

Virtual Terminal Support — M-PLUS allows for the creation of virtual terminal tasks that are capable of controlling terminal I/O for other tasks. Virtual terminal support provides users with an extremely flexible and convenient method for program-to-program I/O. This feature, coupled with parent offspring tasking, allows applications to be partitioned into subsections for clean, structured implementation.

Shadowed Disks — For applications that require high data reliability, M-PLUS supports shadowed disk pairs. (I.e., a drive is allocated to be a shadow of the primary device. Shadowed disks are also known as mirror volumes.) All writes to the primary disk also are written automatically to the shadow volume. If an unrecoverable error is encountered while reading the primary disk, the system switches to the shadow disk. An RSX-11M on-line utility brings a replacement media back up to a shadowed copy dynamically, without taking down the application.

Transparent Spooling — Transparent spooling causes any FCS- or RMS-directed files output to a line printer to be redirected automatically to a spool disk file. When the file is closed, it is passed to the queue manager for spooling to the printer.

SECTION 5
INTERNAL PRODUCT POSITIONING

Objective — To provide the field with an overview of how RSX-11M is positioned internally and how it looks and performs compared to other DIGITAL products.

INTERNAL PRODUCT POSITIONING

Other than RSX-11M and RSX-11M-PLUS, DIGITAL's alternative operating systems that your customer may consider are RT-11, TRAX, RSTS/E, IAS, and VAX/VMS. This section explains when RSX-11M or RSX-11M-PLUS should or should not be chosen.

RSX-11M or RSX-11M-PLUS?

In a vast majority of cases, choosing between RSX-11M and RSX-11M-PLUS is simple. How much memory is required now and in the future? If the answer is more than 248 Kb, then a 22-bit addressing processor such as a PDP-11/70 is required, and thus, RSX-11M-PLUS. If the processor offered has only 18-bit addressing, such as a PDP-11/34, then RSX-11M should be quoted.

Small machines must always use RSX-11M. Big machines almost always use RSX-11M-PLUS. There are three *rare* exceptions for PDP-11/70 type systems.

1. If the application is simple (only a few tasks) but requires very large data areas in memory or the high speed I/O capabilities of the MASSBUS, then the M-PLUS features aimed at supporting many tasks might not be worth the extra software license charge. This is, however, an unlikely situation, and generally M-PLUS should be quoted.
2. Older devices are not supported by RSX-11M-PLUS; thus, if your customer is contemplating an upgrade to RSX-11M-PLUS from RSX-11M, make sure there is a clear understanding of which devices are supported by M-PLUS. If your customer does choose to upgrade and a device is not supported on M-PLUS, the existing RSX-11M driver can be converted to an M-PLUS driver. The changes are not significant and the M-PLUS documentation includes a guide for writing a device driver.
3. Some layered software products are not available on RSX-11M-PLUS. Check Table 5-2 at the end of this section to verify if the required software is available on the quoted system. Because this list is subject to change due to new product announcements, consult your product line representative to confirm product support.

RT-11

RT-11 is simple and fast, but is not well suited for multitasking. If the end use of the system is to accomplish one specific simple task, then RT-11 is the right system. If multiple tasks are required to accomplish the application, and/or if multiple terminals are to be supported, then RSX-11M is the proper system.

TRAX

TRAX is a very specific product aimed at very specific applications requiring high throughput. If your customers' needs are transaction processing, then TRAX usually is the answer.

As an application engine, RSX-11M-PLUS could have a transaction processing application built on top of it, but your customer would have to do a considerable amount of sophisticated application design and coding to get an M-PLUS system up to the level of a TRAX system.

The only time a transaction processing application might be right for M-PLUS is if the requirements above and beyond the transaction processing capabilities cannot be handled by TRAX. This type of application would be cost effective only to a systems house, large company, or an OEM customer who would use their application software on many systems.

RSTS/E (CTS-500)

In a pure timesharing environment, particularly when BASIC-PLUS is the primary language, RSTS/E should always be chosen over RSX-11M. RSTS/E is a very mature, complete, approachable, and reliable commercial system. Considerable effort has been put into RSTS/E to tune it for commercial general-purpose applications.

For commercial applications other than pure timesharing environments, the choice is not as easy. For system houses, large companies, and OEMs who need to build specialized systems, modify the operating system, or support custom devices, M-PLUS is the answer. The strength of M-PLUS is in its generality and power.

Customer sophistication and the number of systems being sold are good indications as to which system should be quoted. The naive customer buying one system as a business computer should always be sold RSTS/E (CTS-500). A sophisticated commercial OEM who needs to make changes to the basic operating system and sells 40 PDP-11/70 systems a year, usually is an M-PLUS customer. The commercial situations that fall in the gray area in between can go either way. The customer's previous experiences and current impressions should be considered, as well as the local DIGITAL and customer software support expertise.

IAS

IAS is a general purpose, multifunction system in an ongoing sense. IAS was designed for sites where many terminals are doing many different, often unrelated activities. IAS systems usually are sold in small quantities (usually one).

M-PLUS, on the other hand, is a general purpose application base on which a specific application-oriented system is built. M-PLUS systems usually are sold in large quantities; the first system being used as a program development system to develop a specific application, and each subsequent system running that application. Most of the terminals on an M-PLUS system are interfaced to the application programs and do not run editors and compilers.

These are only guidelines. Because IAS and M-PLUS have considerable functional overlaps, each system is capable of being used in either of the above situations.

VAX/VMS

At the present time, VAX/VMS is similar to M-PLUS in that they both provide an operating system base around which applications can be built. The decision between the VAX-11 and a PDP-11/70 usually can be made by considering the following factors:

- Task size

  VMS has the capacity to run tasks of almost limitless size. Without overlaying, M-PLUS tasks are limited to 64 Kb plus a maximum possible 64 Kb of libraries.

- Number of users

  Forty terminals on an M-PLUS system is reasonable; if many more are required, think VAX.

- Compatibility with existing PDP-11 systems

  VAX has a relatively high degree of compatibility with PDP-11 systems—but M-PLUS is a PDP-11 operating system. If your customer has many man-years of problem-free applications running on PDP-11 systems, then M-PLUS is probably the right choice.

- Budget

  If an extra $30,000 is not going to hurt the sale potential, then VAX is the answer. It's a more powerful machine with a bright future.

Table 5-1 A Comparison of DIGITAL Operating Systems

	RSX-11M	M-PLUS	IAS	RSTS/E	TRAX	VMS/VMS
Processors						
PDP-11/03						
PDP-11/04	X					
PDP-11/34	X		X	X	X	
PDP-11/60	X		X	X		
PDP-11/70	X	X	X	X	X	
VAX-11						X
Peripherals						
RK05	X	X	X	X		
RK06/07	X	X	X	X	X	X
RL01	X	X	X	X		
RX01	X	X	X	X		X
RX02	X	X		F		
RM02/03	X	X	X	X	X	X
RP05/06	X	X	X	X	X	X
TU45	X	X	X	X	X	X
TE10	X	X	X	X		
TU16	X	X	X	X	X	
TS03	X	X	X	X	X	
TE16	X	X	X	X	X	X
Languages						
MACRO	X	X	X	X	X	X
FORTRAN IV	X	X	X	X		X*
FORTRAN IV-PLUS	X	X	X	X		X
BASIC-11	X	X	X			
BASIC-PLUS				X		
BASIC-PLUS-2	X	X	X	X	X	X*
APL				X		
RPG	X	X	X	X		X*
DIBOL				X		
COBOL	X	X	X	X	X	X
CORAL-66	X	X	X			X*
BLISS						X
PASCAL						X

F Future (no date available)

* Compatibility Mode

	RSX-11M	M-PLUS	IAS	RSTS/E	TRAX	VMS/VMS
File/Data Management						
RMS	X	X	X	X	X	X
DBMS	X	X	X			
SORT	X	X	X	X	X	X
DATATRIEVE	X	X	X	X	X	X*
Other Capabilities and Features						
DECnet	X	F	X	X	F	X
Private Volumes	X	X	X	X	X	X
Multivolumes						X
Output Spooling	X	X	X	X	X	X
User Accounting		X	X	X		X
Virtual Memory						X
PLAS	X	X	X		X	
Re-entrant Tasking		X	X		X	X
Re-entrant OTS	X	X	X	F	X	X
2780 Support	X	F	X	X	F	X
3271 Support	X	F	X	X	X	
RJE/HASP	X		X			
MUX200	X	X	X			X
UN1004	X	X	X			
Virtual Arrays	X	X	X		F	X
Inter-task Communication	X	X	X	X	X	X
Spawned Tasks	X	X	X	X	X	X
Multiterminal I/O	X	X	X	X	X	X
Multiprogramming	X	X	X		X	X
Dynamic System Tuning			X	X		X
Global Common Areas	X	X	X	X	X	X
DCL		X	X		X	X

Table 5-2 RSX-11M Device Support*

	RSX-11M	RSX-11M-PLUS
Communications (Excluding DECnet)		
DL11-E	X	
DP11	X	
DU11	X	
DUP11	X	X
DQ11	X	
DA11-B	X	
DMC11	X	X
Terminal Interfaces		
DJ11	X	X
DH11	X	X
DL11	X	X
DZ11	X	X
Lab and Industrial		
AD01-D	X	
AFC11	X	
UDC11	X	
ICS/ICR	X	
LPS11	X	
AR11	X	
LPA11-K	X	X
IP11	X	X
Miscellaneous		
VT11/VS60	X	
TA11	X	
TC11	X	X
RF11	X	
RS03/04	X	X

* Although some of these devices are obsolete, they are supported by M-PLUS to help existing PDP-11/70 RSX-11M customers upgrade easily.

SECTION 6

RSX-11M V3.2 AND RSX-11M-PLUS PERFORMANCE

Objective — Contrast the performance of RSX-11M-PLUS with RSX-11M and examine the effects the added M-PLUS executive code has on the operating system primitives.

INTRODUCTION

Because RSX-11M and RSX-11M-PLUS are used in various applications, they often perform more than one application and program development concurrently. It is therefore impossible to concisely answer the question, "how will my RSX-11M system perform?"

The performance question is usually answered by contrasting a proposed system solution to similar applications. If the performance requirements are not unique or very demanding, then local software support usually is able to provide advice based on prior experiences.

Since your respective product lines have more experience with varied system configurations, they should be consulted if the performance issue is more complex and/or demanding. If both these avenues fail to provide an answer, then a benchmark should be run.

The following data are presented to help local software support people extrapolate RSX-11M-PLUS performance from previous RSX-11M experience.

Overview of Results

Our customers may think that the new RSX-11M-PLUS features will add significant overhead to the RSX-11M executive. Because system overhead can cause an individual task to appear slower, the benefit of such features as overlapped seeks and re-entrant code may be offset by the slower execution of the individual task. However, the results of the following experiments show quite clearly that an individual task sees an insignificant difference in execution speed, and therefore applications can take advantage of the new RSX-11M-PLUS features without risking slower task performance.

As in all computer systems, efficient use of memory results in optimal total system throughput. As more memory/time is made available to an individual program, the performance of the program increases. (Memory/time = the combination of actual memory and the time this memory is available to the program.)

A single program executing on a machine with sufficient memory to hold the entire program and related system tasks and buffer does not perform better if more memory is added to the system.

However, if 20 programs are trying to execute in only enough memory for 10 programs, then scheduling, checkpointing (swapping), resource sharing, overlapped seeks, etc. become important. This is the type of performance advantage that RSX-11M-PLUS provides for PDP-11/70 users. In general, it does not allow an individual program running stand-alone to execute faster, but rather it makes more memory/time available to each program so that the entire collection of programs execute faster. Specifically, it includes overlapped seeks, re-entrant tasks, checkpointable and shuffleable libraries and commons, and supervisor mode libraries. These features allow more programs to reside in memory, which reduces overlaying and swapping; therefore, applications run better on RSX-11M-PLUS. These features are in addition to the increased dynamic storage (pool) that allows systems limited by pool to have more actual programs or users.

The Experiments

The goal of these experiments was to contrast three critical dimensions of M and M-PLUS: disk response, computation, and terminal characteristics. Two measuring techniques were used: stand-alone benchmarks and Remote Terminal Emulation (RTE).

Stand-alone benchmarks measure the amount of time taken to complete programs started using the indirect command file processor. Two programs were used for this phase, IOX (a macro program that saturates the system with I/O requests driven by ASTs) and Buchholz (a modified version of a job presented by W. Buchholz in *IBM Systems Journal*, Vol. 8, No. 4).

Buchholz accepts run-time parameters to allow different balances of computation (loops containing floating point calculations) and I/O loads (writes and reads to each of four files). Buchholz was also modified to inhibit terminal output if required by a particular experiment.

RTE connects a second computer system's terminal lines to the terminal lines of the system undergoing test. This connection allows the RTE system to transmit separate command strings to individual terminals, thus simulating interactive keyboard input. The terminal lines are driven across DZ11 interfaces at 110 baud (a current restriction in the RTE system). Three scripts were used:

- Create a file—typing input to the EDI editor to create a new file.
- Update a file—performing standard editing functions to an existing file (such as locating a string or top of file).
- FORTRAN development—included a PIP copy, a FORTRAN IV-PLUS compile, a taskbuild, and the running of the Buchholz benchmark (initialized for 80% computation, 20% I/O operations, and terminal output).

These experiments were run on an RSX-11M V3.2 base level 25 operating system (base level 26 will be the released product, 25 does not have 2-4 window support) and RSX-11M-PLUS base level 4 operating system (base level 6 will be the released product). These were normal SYSGENs that included all normal defaults. No effort was made to "tune" either of the systems. The FCP's used (as noted) were FCPMDL (10 Kb) and FCPLRG (14 Kb), which are disk resident overlayed versions of the FILES-11 ACP file system. All experiments were run on a PDP-11/70 with RP05 disks.

NOTE

Do not attempt to extrapolate directly from the following data. The absolute magnitudes of the time scales have been left out intentionally. The intent of the data is to contrast M and M-PLUS under the same conditions and on the same hardware.

DISK RESPONSE

These experiments tallied the number of completed I/O requests when IOX was run for a fixed time. The time periods used for each of these experiments were different, thus no cross-experiment comparisons should be made.

Experiment #1

This experiment measures direct access QIOs without overlapped seeks using two disks.

	Number of QIOs in a Fixed Period
RSX-11M	10,351
RSX-11M-PLUS	10,262

Result — RSX-11M-PLUS shows a less than 1% difference in its ability to process direct access QIOs.

Experiment #2
This workload measures FILES-11 requests without overlapped seeks using two disks.

	Number of Requests in a Fixed Period
RSX-11M	25,977
RSX-11M-PLUS	24,956

Result — RSX-11M-PLUS shows less than a 4% difference in its ability to process FILES-11 requests.

Experiment #3
This experiment measures FILES-11 requests with overlapped seeks on RSX-11M-PLUS using three disks.

	Number of Requests in a Fixed Period
RSX-11M	27,154
RSX-11M-PLUS	28,669

Result — RSX-11M-PLUS shows a 5.6% improvement over RSX-11M in its ability to process FILES-11 requests when overlapped seeks are enabled.

Experiment #4
This experiment measures direct access QIOs on RSX-11M-PLUS with and without overlapped seeks using three disks.

	Number of QIOs in a Fixed Period
RSX-11M-PLUS (no OLS)	12,478
RSX-11M-PLUS (with OLS)	15,936

Result — When doing direct access QIOs, overlapped seeks provide a 27.7% improvement in I/O performance.

Conclusions
The extra code in the RSX-11M-PLUS executive that supports new features produces an insignificant amount of overhead in I/O processing. In addition, *when the I/O load is sufficient to allow the disk queues to be at least one deep*, then the overlapped seek capability in RSX-11M-PLUS provides a 27.7% improvement (i.e., when doing direct access QIO, *not* when doing file structured I/O).

Even the Buchholz program, when tuned to do only I/O operations using unformatted reads and writes, could not keep the disk queues deep enough to allow the benefits of overlapped seeks to be significant.

COMPUTATION

Table 6-1 and Figure 6-1 show the results of computation measurements determined using the Buchholz program (which is tuned to be CPU intensive and does not do terminal I/O). The experiment proves that the computation differences between RSX-11M and RSX-11 M-PLUS are small, thus the two lines are overlayed on the graph.

As shown in Table 6-1, four experiments were done using different memory sizes: one for RSX-11M and three for RSX-11M-PLUS. Since each copy of the program was 24 Kb, checkpointing occurred at 17 copies on the 512 Kb system, 38 copies on the 1024 Kb system, and did not occur on the 1536 Kb system. The time unit used in Table 6-1 is in multiples of the time taken to execute one copy of the CPU-intensive benchmark under RSX-11M-PLUS.

Table 6-1 RSX-11M and M-PLUS Computation Experiments

	Time to Complete			
Number of Copies	**RSX-11M-PLUS 512 Kb**	**RSX-11M 1024 Kb**	**RSX-11M-PLUS 1024 Kb**	**RSX-11M-PLUS 1536 Kb**
1	1	1.01	1	1
10	9.87	9.84	9.87	
15	14.76	14.72	14.78	
20	22.40	19.68	19.71	
30	33.57	29.57	29.57	
40		48.57	48.75	39.98
50				50.09

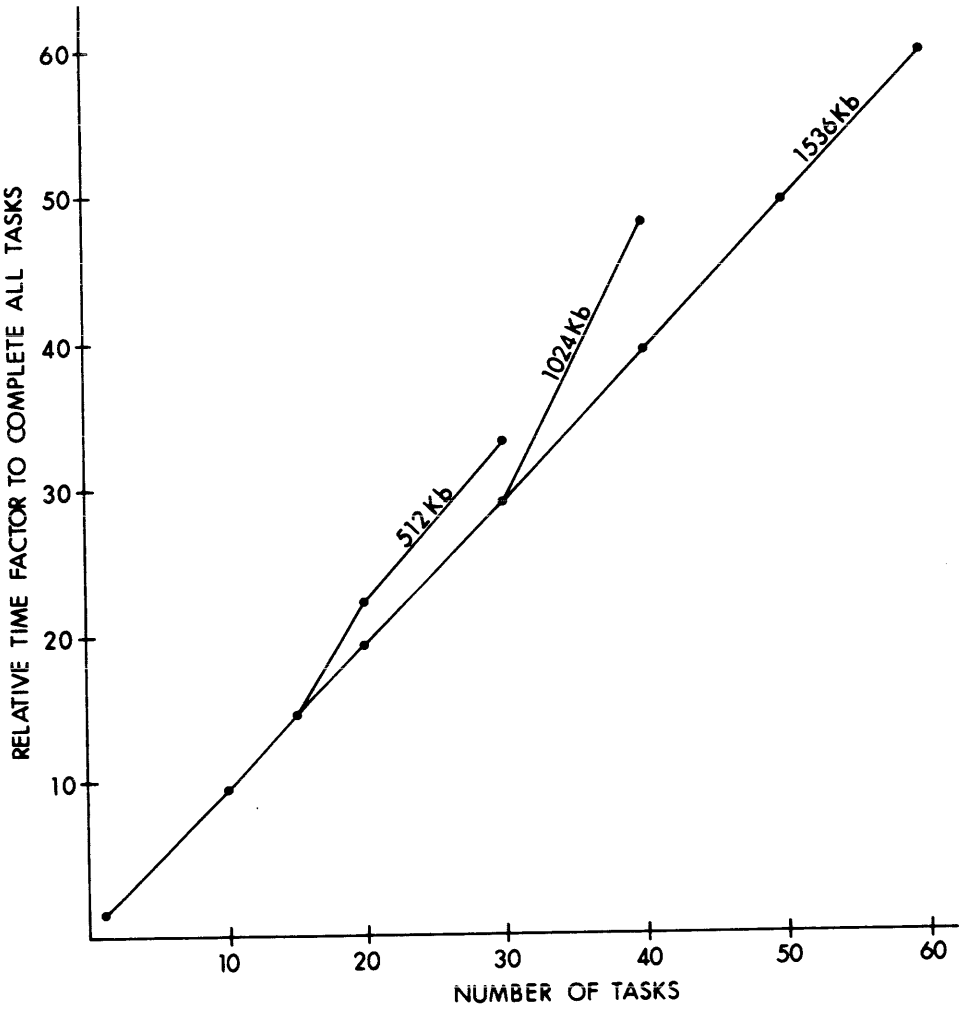

Figure 6-1 RSX-11M and M-PLUS Computation Measurements

Conclusions

Once again, the added features in the new RSX-11M-PLUS executive do not add any appreciable overhead.

Minor points noticeable from this data.

1. Even in this experiment, where the only possible task execution overlap is in the initial task loading, the benefit of multitasking is present. As can be seen from the data, if no checkpointing takes place, it takes less than n times one task to run n tasks.
2. The effect of the extra disk activity to do checkpointing is shown by the two branches from the main graph line.

TERMINAL RESPONSE IN AN INTERACTIVE APPLICATION

Two experiments were run to measure RSX-11M terminal characteristics. One experiment created edits (inputting new text into a file) and the other updated edits (a mixture of operations such as string searches and locating top of files).

Create a file

An M and M-PLUS system were used, each with 512 Kb, one disk, and terminal interfaces operating at 110 baud. The time to complete a script of edit commands divided by the number of responses yields an average response figure. Response figures are shown for varying numbers of users (edit scripts).

Number of Users	**1**	**10**	**15**	**20**	**25**	**30**	**32**
RSX-11M	1.58	1.58	1.60	1.61	1.63		
M-PLUS	1.58	1.58	1.58	—	1.60	1.60	1.61

Conlusion

RSX-11M-PLUS shows a slight improvement over RSX-11M. More noticeable, however, is that the response time is not increased when more users are added to either system.

Edit Updates to a File

The response time is a function of the number of users doing edit update functions (locate a string, insert, find top of file, etc.). These are plotted in Figure 6-2.

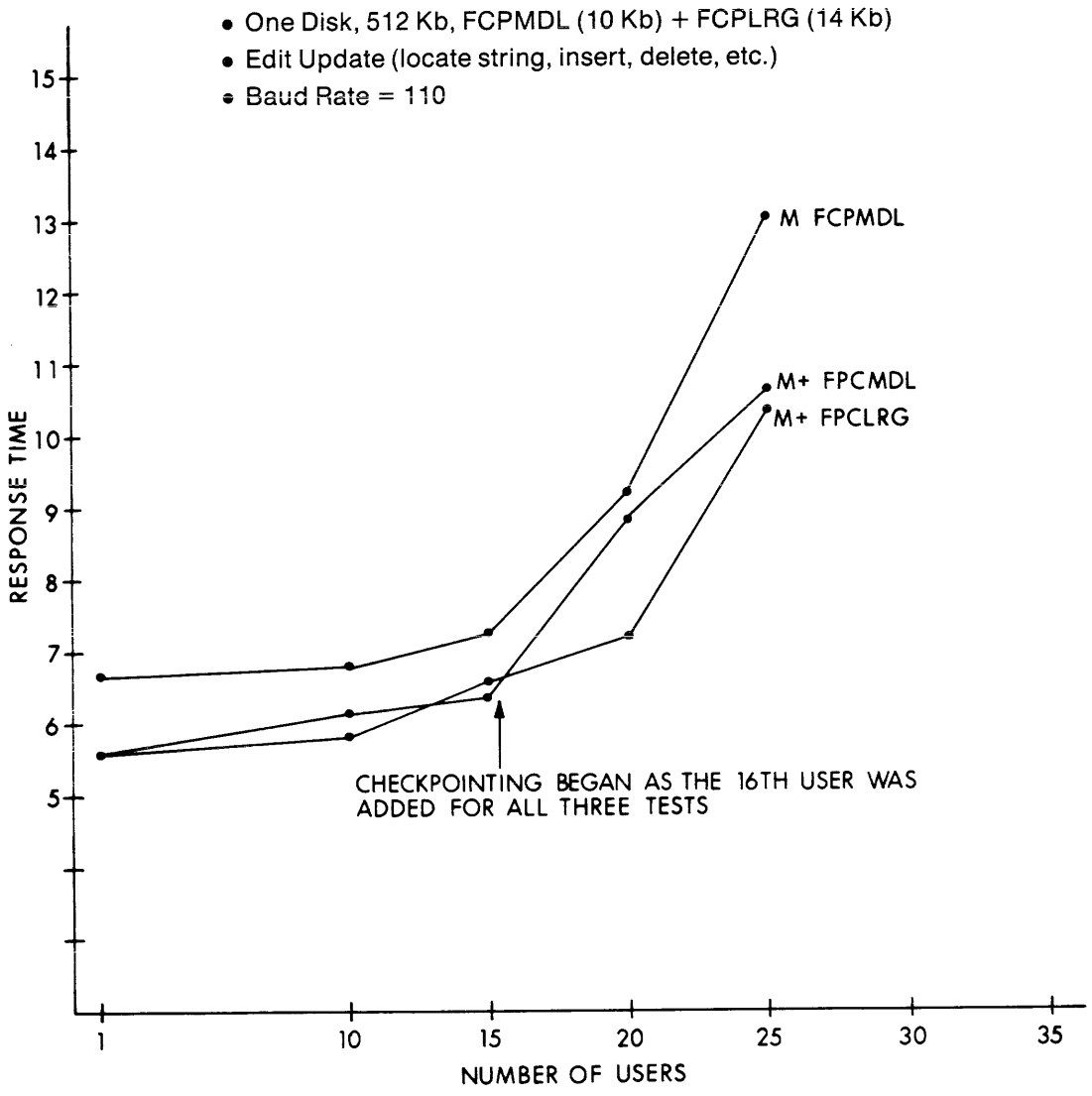

Figure 6-2 RSX-11M Compared to RSX-11M-PLUS

Conclusion

RSX-11M-PLUS shows a minor improvement (about 15%) over RSX-11M.

CONFIGURATION DEPENDENCY

Figure 6-3 exemplifies the configuration dependency, using some of the data gathered for the experiments presented in Figure 6-2.

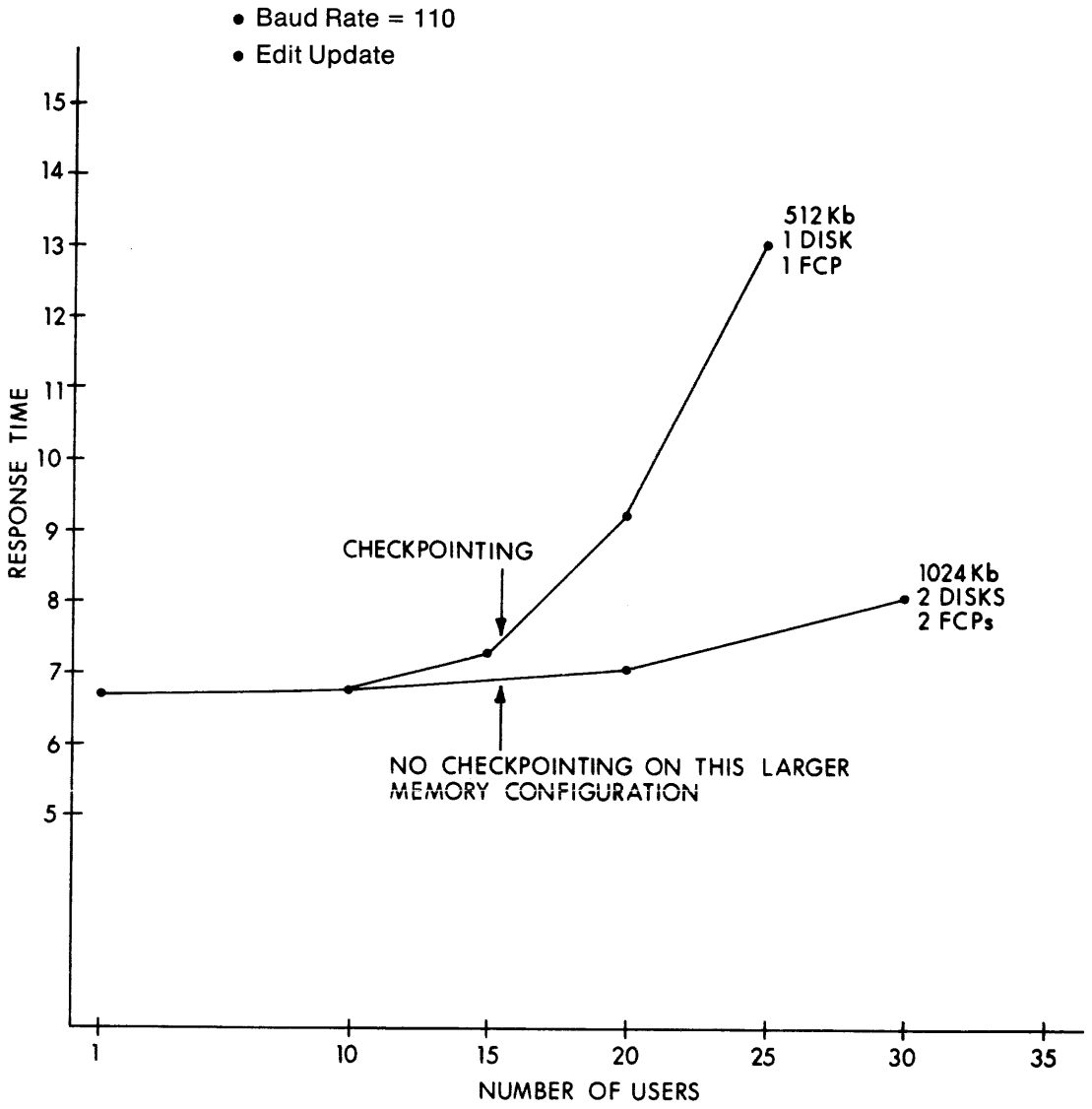

Figure 6-3 RSX-11M Configuration Contrasts

This graph shows the advantage of having sufficient memory to eliminate checkpointing. If the new RSX-11M-PLUS features are used, more tasks can run in memory. This minimizes checkpointing and overlaying, providing advantages similar to those presented in Figure 6-3 (although not as dramatic).

PROGRAM DEVELOPMENT ENVIRONMENT

In the following experiment, a mixture of FORTRAN compilation, execution, and taskbuilding was run in conjunction with edit updates and edit creates. These were run in the ratio of 1:2:2—one user doing a compile, taskbuild, and execution, two users updating, and two users creating files. All tasks were run at the same priority level. The RSX-11M system uses only one disk, while the M-PLUS configuration uses two. In addition, several PIP operations were taking place, for which no statistics were gathered.

The left hand axis of these graphs is in units of "stretch," which is the time taken to run n copies divided by the time required to run one copy. These graphs show the interdependent effects of users doing various program development activities.

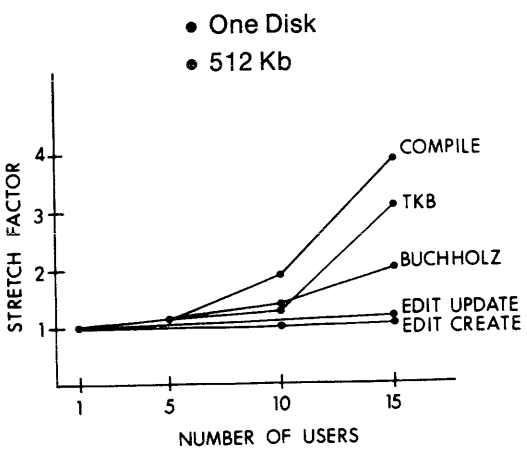

Figure 6-4

RSX-11M Program Development Environment

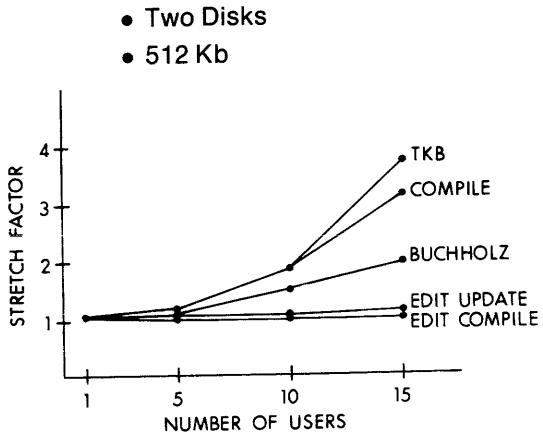

Figure 6-5

RSX-11M-PLUS Program Development Environment (No Overlapped Seeks)

Conclusion

M and M-PLUS (without overlapped seeks) results are about the same. Edit functions, which are primarily terminal I/O limited, are affected only slightly by other system activity. The task-builder and compilers tend to slow down only to the point where n jobs take approximately n times the time for one job. Because the various functions complete sooner than if run serially, these graphs show the advantages of multitasking.

The differences between M and M-PLUS are not noteworthy in this experiment, particularly since none of the M-PLUS features are used.

OVERALL PERFORMANCE CONCLUSIONS

Despite all the added features in RSX-11M-PLUS (with the attendant extra executive code), the kernel operations, which are:

- disk I/O,
- computation, and
- interactive terminal response

are not significantly slower than for RSX-11M. RSX-11M-**PLUS** is the same high performance modular operating system as RSX-11M,

- **PLUS** all the added features
- **PLUS** the ability to provide more memory/time to each task (which means the application as a whole can execute faster)
- **PLUS** the increased dynamic storage region (pool) required to allow large applications with many tasks and users to operate effectively on the PDP-11/70.

SECTION 7

PRODUCT LINE STATEMENTS

Objective — To provide salespeople with individual product line statements and strategies, which are presented in the following format:

- General Comments
- The Marketplace
- Sales Strategy
- Contacts/Resource People

LABORATORY DATA PRODUCTS (LDP)

General Comments

To better address our customers' needs in the research environment, LDP is pleased to welcome RSX-11M-PLUS and RSX-11M V3.2 to our family of products. These products will provide systems with the characteristics required to meet the researcher's needs: an operating system that is easy to use, efficient and provides high system throughput.

The Marketplace

RSX-11M has a large established user base in the LDP environment. We expect a continued interest in medium-size systems sold with RSX-11M.

RSX-11M-PLUS is designed especially to satisfy the performance and system throughput requirements of large PDP-11/70 users. Because RSX-11M-PLUS is upward compatible with RSX-11M, users will be able to migrate easily.

The primary marketplace for M-PLUS will be the large research facilities such as government agencies, universities and industrial R & D labs where applications require a high performance, real-time system. The efficiency, ease of use, and high throughput of RSX-11M-PLUS will allow increased researcher productivity in these areas.

Sales Strategy

M-PLUS will be sold on high end PDP-11/70 systems requiring multiuser support, such as in laboratory data entry systems. M-PLUS will also be a solution for high-speed data acquisition systems where full use of memory and system performance are critical.

RSX-11M will continue to be sold for medium-size applications such as laboratory instrument control. RSX-11M will also be the solution in situations where hardware devices or software products not supported by M-PLUS are required for the applications. (Refer also to the product positioning section of this Marketing Guide.)

Contacts/Resources People

All contacts should be made through your respective marketing support person.

MANUFACTURING, DISTRIBUTION, AND CONTROL (MDC)

General Comments

RSX-11M-PLUS will be an enormously important product in the real-time portion of the MDC marketplace. Many customers have not been able to expand their systems due to RSX-11M limitations. RSX-11M-PLUS removes most of these limitations, without sacrificing any essential RSX-11M features.

The Marketplace

The primary marketplace for RSX-11M-PLUS will be in plant floor applications where there is a need for real-time and data processing. RSX-11M-PLUS is primarily a replacement for RSX-11M on the PDP-11/70 and hence will be used in a host environment most of the time.

Sales Strategy

RSX-11M-PLUS should be sold in applications requiring more than 256 Kb of memory. The primary application will be on a stand-alone machine or a networked host, and because it currently lacks 2780, it cannot be sold stand alone when RJE is a requirement. Care should be taken not to sell RSX-11M-PLUS in 18-bit processors.

There is probably no competitive equivalent to RSX-11M-PLUS in the 16-bit world. While competition will come primarily from IBM and HP, neither of these vendors offers a truly equivalent product that is capable of large memory support, real-time, multiprogramming and communications running concurrently.

Contacts/Resource People

All contacts should be made through your respective marketing support person.

ORIGINAL EQUIPMENT MANUFACTURERS (OEM)

General Comments

The OEM product line believes that the addition of RSX-11M-PLUS and the improvements incorporated into RSX-11M V3.2 are in direct response to customer needs. As such, we expect them to be well received by our customers and therefore welcome these additions to our product offerings.

The Marketplace

Our OEMs cover a wide spectrum of applications and environments. The range of requirements is also obviously varied in terms of size, speed, and scope of features.

Our wide base of existing customers verifies that RSX-11M is, indeed, a well established, reliable operating system. Our customer base has indicated that there could be improvements and we believe the major improvements have been made in Version 3.2.

A portion of our marketplace has expressed a need for larger system support, more terminal support, and higher throughput. Now we can offer M-PLUS to these customers. We expect interest from the larger system users, such as typesetting, communication networks, warehouse/inventory control and even some of the larger process control users.

Sales Strategy

We consider M-PLUS a "big brother" addition to the RSX-11 family and not a replacement for RSX-11M. We will recommend it to high-end users who are not limited by space and feel they need the added functionality.

We will continue to promote RSX-11M as the answer for OEMs wishing to create tailored real-time environments. We already have a large base of customers who believe it is the best tool available, which reinforces our belief that it cannot be matched by our competitors.

In our continuing effort to "supply according to need," we feel these latest offerings enhance our product listing greatly.

Contacts/Resource People

All contacts should be made through your respective marketing support person.

COMMERCIAL SERVICE INDUSTRIES (CSI)

General Comments

DIGITAL's leadership position in real-time communications systems should be strengthened with the introduction of RSX-11M V3.2 and RSX-11M-PLUS V1.0.

The Markeplace

The CSI product line has had considerable success selling RSX-11M for communications/networking applications and transaction processing applications where there are networking, high availability, or other specialized requirements. It is not expected that the new RSX-11M products will open new markets or applications as much as they will emphasize our continuing commitment to communications, 16-bit machines, and quality software.

Sales Strategy

Even with RSX-11M-PLUS's enhanced human engineering, RSX-11M products should be sold to customers with strong systems or advanced applications-level programming expertise.

We see RSTS/E and TRAX tuned for overall systems performance and RSX-11M designed to optimize task-level performance—the type of performance best realized by experienced programmers familiar with real-time operating systems.

Contacts/Resources People

All contacts should be made through your respective marketing support person.

GOVERNMENT SYSTEMS GROUP (GSG)

General Comments

The introduction of RSX-11M-PLUS into the government marketplace is seen as an important step in addressing both the general-purpose and application-specific needs of users in a wide variety of environments.

RSX-11M-PLUS brings the Government Systems Group closer to having a single PDP-11 operating system strategy for general-purpose applications development and multiuser systems. Since most of the PDP-11 systems sold by GSG are large configurations based on extended memory and 22-bit addressing, RSX-11M-PLUS is seen as a replacement for RSX-11M and RSTS/E in most cases. RSX-11M need be offered only for a small configuration that does not have 22-bit addressing.

The approachability of RSX-11M-PLUS for the non-systems user who simply wants a good applications engine that provides high performance, and the systems user who is concerned about real-time responsiveness, should be particularly attractive to the average government user.

The Marketplace/Sales Strategy

GSG divides the government marketplace into two major areas: defense systems and ADP systems. The general users in both of of these areas can have their needs more than adequately met by RSX-11M-PLUS.

There are times, however, when careful consideration should be given when positioning RSX-11M-PLUS with other products. There are areas where alternatives may be necessary. In the general case, the only reason for not choosing RSX-11M-PLUS is when the configuration is too small to support it—then RSX-11M should be considered. Also, if the PDP-11 configuration is very large, has complex processing requirements, or is a new application, then the 32-bit VAX/VMS should be considered.

In the defense systems area, special care must be taken if the application is communications intensive, or if the system has an intended command and control mission. In these specific areas, the user is highly systems oriented and usually has a high control of system-level components. These areas are better addressed by IAS. In fact, the real-time subset of IAS is the stated operating system for many existing programs of these types within the defense community. If the application is new and does not need to use an existing base of software, the VAX/VMS approach is preferred because of its 32-bit architecture.

SECTION 8

DOCUMENTATION AND SUPPORTING SERVICES

Objective — To provide general pre- and post-sale information and guidelines, and references to supporting personnel and literature.

RSX-11M AND RSX-11M-PLUS DOCUMENTATION

Introductory Information

RSX-11M/RSX-11S Documentation Directory	AA-2593E-TC
RSX-11M-PLUS Documentation Directory	AA-H426A-TC
RSX-11M Mini-Index	AA-H262A-TC
RSX-11M-PLUS Mini-Index	AA-H429A-TC
RSX-11M V3.2 Master Index	AA-5430C-TC
RSX-11M-PLUS Master Index	AA-H430A-TC
Introduction to RSX-11M	AA-2555C-TC
Introduction to RSX-11M-PLUS	AA-H428A-TC
RSX-11M Beginner's Guide	AA-5245A-TC
RSX-11M/RSX-11S Release Notes	AA-2573E-TC
RSX-11M-PLUS System Release Notes	AA-H427A-TC

Program Development Tools

RSX-11M System Generation Manual	AA-2552D-TC
RSX-11M-PLUS Sysgen Generation and Management Guide	AA-H431A-TC
RSX-11M-PLUS Operating System Manual	AA-H432A-TC
RSX-11M/M-PLUS Executive Reference Manual	AA-H265A-TC
RSX-11M-PLUS Command Language Manual	AA-H433A-TC
RSX-11M/M-PLUS MCR Operations Manual	AA-H263A-TC
RSX-11M-PLUS Batch and Queue Operations Manual	AA-H434A-TC
RSX-11M/M-PLUS Guide to Program Development	AA-H264A-TC
IAS/RSX-11 MACRO-11 Reference Manual	DEC-11-OIMRA-B-D
IAS/RSX-11 ODT Reference Manual	DEC-11-OIODA-B-D
RSX-11M-PLUS Guide to Writing an I/O Driver	AA-H267A-TC
RSX-11M Guide to Writing an I/O Driver	AD-2600D-TC
IAS/RSX-11 I/O Operations Reference Manual	AA-2515D-TC
RSX-11M-PLUS Fault Isolation and System Recovery Guide	AA-H439A-TC
RSX-11M System Generation and Management Guide	AA-H625A-TC

Program Development Tools (continued)

RSX-11M/M-PLUS Task Builder Manual	AA-H266A-TC
RSX-11 Utilities Manual	AA-H268A-TC
RSX-11M/M-PLUS I/O Drivers Reference Manual	AA-H269A-TC
RSX-11M/M-PLUS Error Logging Reference Manual	AA-H270A-TC
RSX-11M/M-PLUS User Mode Diagnostics Reference Manual	AA-H271A-TC
RSX-11M/M-PLUS Crash Dump Analyzer Reference Manual	AA-H272A-TC

Networks

DECnet-11 User's Guide and Programmers's Reference Manual	AA-2611A-TC
DECnet-11M/S Release Notes	AA-3024D-TC
DECnet-11M/S Release Notes Addendum	AD-3024D-T1

Sales Tools

RSX-11M and RSX-11M-PLUS Data Sheet	ED 08252 20
DECnet-11M Phase II Data Sheet	ED 08527 20

RSX-11M and RSX-11M-PLUS SPDs

	SPD Number
BASIC-11/IAS-RSX	14.67.5
BASIC-PLUS-2	14.52.5
PDP-11 COBOL	12.40.10
CORAL-66	14.56.6
DATATRIEVE-11	12.48.2
DBMS-11 RSX-11M Data Base Management System	12.44.0
DECnet-11M	10.75.6
FORTRAN IV-PLUS	14.50.8
FORTRAN IV/IAS-RSX	14.63.4
FORTRAN IV/VAX to RSX	25.17.0
PLOT-11/RSX-11M/RSX-11D/IAS	15.23.1
PLXY11-M	15.17.0
Power Demand Control for RSX-11M	15.75.1
RMS-11K for RSX-11M	12.50.1

RSX-11M and RSX-11M-PLUS SPDs (continued)

RSX-11M	14.35.11
RSX-11M-PLUS	14.70.0
RSX-11M/2780	10.65.3
RSX-11M/3271 Protocol Emulator	10.88.2
RSX-11S	9.21.5
WPS-11M	14.37.3

EDUCATIONAL SERVICES

The RSX-11M curriculum is a comprehensive software training program designed to meet the needs of all levels of RSX-11M users. The sequence consists of self-paced instruction (SPI) and lecture/lab courses that stress practical, job-relevant skills required by RSX-11M operators, users, MACRO-11 and high-level language programmers, applications programmers, system programmers, and system managers.

The total RSX-11M training program consists of five courses. Job requirements dictate the course content, allowing students to choose courses from the sequence appropriate to their needs. The option of combining lecture/lab, audio/visual, and self-paced instruction courses provides students with the freedom to learn at their job sites at their own speeds, yet to benefit from instructor aid and practical experience during classroom and laboratory training.

Before taking any of the RSX-11M courses, the necessary PDP-11 Assembly Language Programming and Programming in MACRO-11 courses, or the appropriate high-level language course, should be taken.

RSX-11M/M-PLUS COURSES

RSX-11M Operator

Format: Lecture/Lab

Estimated Length: Three days

Course Abstract and Audience:

This course is designed for RSX-11M operators. Students receive supervised hands-on training in normal and system crash procedures to perform operator duties and basic procedures. Students learn to start-up and shut-down RSX-11M; to properly mount, dismount, and care for disks and magtapes; to operate line printers, including recovery from paper malfunctions; to initiate, terminate, and control application programs and selected utility programs; and to perform backup operations. Upon course completion, an RSX-11M operator is qualified to implement decisions made by the System Manager.

Course Prerequisite: Introduction to Minicomputers (Audio/Visual)

RSX-11M User

Format: SPI or Lecture/Lab

Estimated Length: Five days

Course Abstract and Audience:

This course, designed for RSX-11M users, applications programmers, system managers, and system programmers, provides a conceptual system overview and teaches students to use the

RSX-11M system for their MACRO-11, FORTRAN, COBOL, and BASIC-PLUS-2 programs. Students learn to interact with RSX-11M using the Monitor Console Route (MCR) commands; to assemble/compile, taskbuild, and execute programs; to use PIP to manipulate files and obtain directory information; to create object libraries with the Librarian Utility; to build and use indirect command files; and to generate disk and core-resident overlays using the Overlay Description Language (ODL).

Upon course completion, students have the skills and knowledge required to take advantage of sytem program development capabilities.

Course Prerequisites:

- Introduction to Minicomputers (Audio/Visual)
- Programming in MACRO-11, FORTRAN IV, or PDP-11 COBOL, and their prerequisites

RSX-11M-PLUS User
Format: Lecture/Lab

Estimated Length: Five days

Course Abstract and Audience:

This course is designed to provide users, application programmers, system programmers, and system managers with a conceptual overview of RSX-11M-PLUS. Students learn to interact with RSX-11M-PLUS using DCL (DIGITAL Console Language); to assemble/compile, link, and execute programs; to manipulate files and obtain directory information; to create MACRO, object, and supervisor mode libraries; to create and use indirect command files and batch streams; and to generate disk- and core-resident overlays.

Course Prerequisites:

- Introduction to Minicomputers (Audio/Visual)
- Programming knowledge of MACRO-11, FORTRAN IV, BASIC-PLUS-2, or COBOL

RSX-11M and RSX-11M-PLUS Programmer
Format: SPI or Lecture/Lab

Estimated Length: Five days

Course Abstract and Audience:

This course is designed to teach programmers and system programmers how MACRO-11 and FORTRAN programmers can use system directives under RSX-11M and RSX-11M-PLUS in their applications programs. Students learn to write programs using executive directives to perform inter/intratask communication; to create and use core-resident libraries and common areas; to write programs using memory management directives to access data areas larger than 64 Kb; to write programs using File Control Services (FCS) for sequential and direct-access files; to list the major differences between FCS and RMS-11; and to use taskbuild options to reduce the size of FORTRAN tasks.

Upon course completion, students can work efficiently on mapped and unmapped RSX-11M systems.

Course Prerequisites:

- Introduction to Minicomputers (Audio/Visual)
- PDP-11 Assembly language Programming
- Programming in MACRO-11
- RSX-11M User or RSX-11M-PLUS User

RSX-11M System Manager
Format: Lecture/Lab

Estimated Length: Two days

Course Abstract and Audience:

This course is designed for system managers who need to consider long-term system management issues and who must be able to generate a system for a specific installation. Students learn to define the file structure on a FILES-11 disk; to explain the system generation process; and to use system diagnostics including error logging, user-mode diagnostics, and crash dump analyzer.

Course Prerequisites:

- Introduction to Minicomputers (Audio/Visual)
- RSX-11M User

RSX-11M System Programmer
Format: Lecture/Lab

Estimated Length: Five days

Course Abstract and Audience:

This course, designed to be taken two or three months after the *RSX-11M and RSX-11M-PLUS Programmer* course, provides MACRO-11 system programmers with a detailed knowledge of RSX-11M system data structures. Students learn to identify various FILES-11 structures and related executive data structures; to identify components of the executive data base and to write privileged tasks that manipulate these components; to identify the appropriate device tables and executive subroutines for writing and adding device drivers; to identify the executive subroutines needed by a task using the connect-to-interrupt executive directive; to perform a system generation; to obtain and interpret error logging reports; to run the user-mode diagnostics package; to obtain a crash dump and identify the various portions of the crash output; to identify the major modules in the executive; and to trace the processing of the executive code common to all system directives.

Course Prerequisites:

- Introduction to Minicomputers (Audio/Visual)
- PDP-11 Assembly Language Programming
- Programming in MACRO-11
- RSX-11M User
- RSX-11M Programmer

RSX-11M-PLUS System Programmer
Format: Lecture/Lab

Estimated Length: Five days

Course Abstract and Audience:

This course parallels the *RSX-11M System Programmer* course. Contact your Educational Services representative for details.

How to Enroll in an Audio/Visual Course
Educational Services has opened an Individualized Learning Center in every training center

where self-paced audio/visual courses can be taken by individual students at their own speed at any time.

When your customers arrive in the Individualized Learning Center, they will have access to a LaBelle unit and a previously reserved audio/visual program. They will receive a personal set of workbooks and related reference materials.

How to Enroll in a Lecture Course
Three training credits are supplied with the purchase of an RSX-11M system. To enroll, contact the Educational Services office for the area nearest you.

Boston: (617)275-5000 ext. 380, 381, 382

New York: (212)971-3545

Chicago: (312)640-5520

San Francisco: (408)984-0200

Washington, DC: (301)459-7900

Canada-Ottawa: (613)592-5111

France: 687-2333

Italy: 92-81-892

Switzerland: 46-41-91

Germany: 35031

Mexico: 905-687-34-22

Japan: 264-7101

United Kingdom: 58-35-55

Sweden: 08/7300 800

The Netherlands: 030-63 12 222

Spain: 733-1900

Australia-Sydney: 439-2377

Australia-Melbourne: 699-2888

SOFTWARE SERVICES

General
Software Services, in anticipation of the service and support needs of DIGITAL's customers and salesforce, has developed and implemented plans to provide services by highly-trained support personnel for RSX-11M and the new RSX-11M-PLUS. Software specialists worldwide have been trained in pre-sales support and "hands on" technical skills. On-going training is also available to specialists.

Software Services is prepared to provide the level of warranty services consistent with DIGITAL's obligation to its customers.

The importance of RSX-11M-PLUS is to maximize PDP-11/70 system performance, particularly in the technical marketplace.

Pre-sales
Pre-sales support is expected to be approximately 40% of the total software support activities for RSX-11M-PLUS. These activities range from technical presentations, configuring information, demos, and benchmarks to information on upgrading RSX-11M to RSX-11M-PLUS.

The software specialist can assist the account representative in setting customer expectations regarding system selection, warranty support, maintenance services, and consulting services to maximize the successful use of the customer's system.

Warranty
Installation and warranty services will continue to be met by a high level of support consistent with DIGITAL's obligation to its customers.

Maintenance
Maintenance service offerings at the present time consist of the RSX-11M Binary Program Update Service or Software Update kits only.

A Binary Program Update Service provides software updates including documentation updates that are released during the subscription year, a technical periodical, and individual responses to software performance reports.

A Software Update kit includes the latest documentation but provides no services.

Offerings for RSX-11M-PLUS are in the planning stage.

Consulting Services
During the pre-sales support, the account representative, together with the specialist and customer, should analyze the customer's needs. Once identified, consulting services and contracts should be discussed with local Software Services management. This insures that the customer's application and development efforts are synchronized with the necessary resources.

Training
Training for RSX-11M and RSX-11M-PLUS has consisted of worldwide seminars on pre-sales support and technical information, slide presentations, Small Buffer articles, and hands-on experience. Formal support-level courses are conducted on an on-going basis.

Back-up Support
Technical support and planning expertise exist within the Maynard/Merrimack Support Group of Software Services to assist field specialists and management. This support consists of a "hot-line," articles in the Small Buffer, and technical support from the Real Time (RSX) Team.

Contacts
As a facility for technical backup, Software Services maintains a special "hot-line" number for its field specialists. Dial 223-5911 (DTN) between the hours of 8:00 a.m. and 5:00 p.m. (Maynard time) Monday through Friday and 223-3500 after hours (to leave a recorded message).

SECTION 9
COMPETITION

Objective — To provide a review of RSX-11M in comparison to competitive product offerings.

NOTE

The following information tends to CHANGE quickly. Note that the press date is March 30, 1979.

USING THIS INFORMATION

The following material is designed to be of general use in most selling situations. Although the following material details weaknesses of the competition, this is for your benefit, not the prospect's. *Never knock the competition.* However, if you know a certain competitor is involved in a selling situation, the way you should use this material is to note particular deficiencies of the competition that may affect the best interests of the prospect, and bring out the necessity of such features for the best solution of the prospect's problem.

Using this approach for DIGITAL and its products as a whole, and in the possible presence of any competition, the following indicates the proper items to emphasize.

How to Win

- Sell DIGITAL's wide range of system choices and clear growth paths.
- Sell the concept of systems optimized for different application environments.
- Use reference accounts in the prospect's industry and do so early in the sales cycle.

How to Win Against Traditional Mainframe Vendors

- Sell DIGITAL's Distributed Data Processing concept.
- Sell initial cost savings, lifetime cost savings, and price/performance benefit factors.
- Sell approachability.
- Sell customers on the added ability to manage their businesses significantly better through interactive computing.

How to Win Against Traditional Minicomputer Vendors

- Sell systems solutions.
- Stress DIGITAL's unbeatable across-the-board performance.
  - — Superior performance in every price/power range.
  - — Superior multiuser as well as stand-alone performance.
- Sell DIGITAL's corporate resources.
- Stress life cost savings and price/performance benefit factors.

Corporate Resources

The depth and breadth of DIGITAL's corporate resources place us in a very favorable position in comparison to other minicomputer vendors. Be sure to stress the following corporate resources in every sales situation:

- A choice of hardware and operating systems to suit particular needs.
- A wide-ranging series of product families. A customer virtually never outgrows DIGITAL, and there are many possibilities for application transportability.
- Customer training courses and facilities unmatched by any other minicomputer company.
- A depth of hardware and software maintenance and support capabilities that cannot be touched by any other minicomputer company.
- PL90 consulting and programming resources for special work, unequaled by any other minicomputer company.
- CSS hardware and turnkey "specials," resources that are the best among all the minicomputer vendors.
- Product lines to focus on and satisfy the needs of specific industries.

Distributed Data Processing Concept

The Distributed Data Processing concept can be used both in terms of *distributed minicomput-*

ers and in terms of *distributed mainframes* of varying sizes. Thus, the concept works well for both the PDP-11s and DECsystem-10/DECSYSTEM-20s. DIGITAL provides customers with the ability to place interactive computing power in whatever amount is needed wherever it is needed. This concept includes ease of use, approachability in general, fast program implementation, and the whole interactive story, which applies to all DIGITAL computers.

NOTE

Please note that throughout this section the prices indicated are current at the time of publication. They are highly subject to change, thus have been provided as a rough indication for comparison purposes only.

IBM

The following shows IBM's principal computer families listed by the division that manufactures them:

Data Processing Division	
360	No longer manufactured
370	Some are no longer manufactured
3030, 4300	The newest product lines
8100	New distributed processing minisystem
General Systems Division	
System/3	No longer manufactured
System/7	Real-time data communications computer; no longer made
Series/1	New mid-range minicomputer
System/32, /34	New small minicomputer systems
System/38	Newest mini/midicomputer system

There is also an Office Products Division (typewriters and copiers) and a Supplies Division.

IBM's sales organization is product-oriented. Salespeople that work for a division sell only that division's products. A D.P. division salesman **could** sell a System/3, but seldom does, owing to commission structure economics. Market specialization is provided by various industry marketing support groups.

Industry Marketing

Understandably, IBM has a large advantage in their installed base—this offers many reference sell accounts, and contributes to a large library of application software. Contributing to this is IBM's willingness to fund and staff various marketing support groups specializing in many industry segments, i.e., banking, finance, manufacturing and distribution, geophysics, medicine, government, education, etc.

These industry market support groups are composed of people with sales and software experience in leading-edge applications within that particular industry's areas of interest. Periodically, classes are held by industry marketing support groups to acquaint salesmen with the latest data processing application developments within a particular industry.

Batch Systems

Keep in mind that the large IBM systems are highly batch-oriented in their basic design philosophy. Although large on-line applications are implemented on IBM systems, this tends to be accomplished by special system software that is layered between the application program and operating system, and, in some respects, has the job of fooling the batch system into thinking it is still doing batch work.

Even where on-line applications have been implemented, they have usually been programmed on a pencil-and-paper form that is keypunched and compiled in batch mode. Although there are elaborate IBM 370 systems for on-line programming and editing, TSO (Time Share Option) and CMS (Conversational Monitor System), they are expensive and require impressively large computer resources in their minimum form. The Series/1 has a more reasonable on-line editor that is popular.

If you are proposing a system with a forms language to mainframe users, you may have to introduce them to the concept. Mainframe users in general are not familiar with forms languages. Although IBM has been recently advertising DMS and DMS/VS (Display Management System), DMS is really only a screen formatter that is written using paper-and-pencil forms and compiled and debugged in batch mode. Another IBM forms language, Video/3270, is designed to make a 3270 feel and act like a keypunch. IMS/DC (IMS's own on-line monitor, often used instead of CICS) has a good screen formatter called a screen mapping facility. None of these has any procedural capability.

It is generally true that mainframe users seldom realize the tremendous programming benefits in interactive systems. This represents what can certainly be called "The Quiet Revolution" in information processing. On-line editing systems, compilers and operating systems tailored for interactive use, the timeshare capability that gives a programmer access to the machine's resources anytime (not just at night and very early morning, when many IBM programmers must do their work) are unknown and unappreciated in the IBM world, and should always be pointed out. Not only do interactive systems offer a more reasonable way of life for programmers, but applications are implemented much faster and less expensively.

IBM Series/1

The Series/1 was announced in November 1976 as a hardware-only system. No operating system was available until June 1977. The S/1 is a true minicomputer. It has real-time/communications/sensor capabilities, all software and support is unbundled, and its price is very competitive. Note that this price includes a "built-in discount." Three models of the S/1 are offered:

S/1	Model 2	Comparable to LSI-11
S/1	Model 3	Comparable to PDP-11/04
S/1	Model 5	Comparable to small PDP-11/34

IBM currently provides three operating systems for the S/1, RPS (Realtime Programming System), EDX (Event Driven Executive), and CPS (Control Program Support). CPS is actually a group of independent functional modules that allow the user to build a tailored operating system or supervisor.

The Series/1 is primarily a PL/1 machine. COBOL support was announced just recently. It has upward source code compatibility with the 370's OS/VS COBOL compiler. As a result, Series/1 programs can be developed on 370 systems. A new Series/1 channel attachment plus COBOL compatibility permits the Series/1 to act as a front-end processor for a 370 system. This begins

to resemble the familiar IBM strategy of promoting superhosts with the 3790 intelligent terminal stations as their version of distributed data processing.

At the present time S/1 COBOL costs $2700 or $62/month. It will not be available until May 1979. It was claimed to be upward compatible with mainframe COBOL, but this would probably require extremely careful programming, and there would still be some file definition incompatibilities.

Series/1 Strengths
- IBM name, support, and user base
- Low prices
- Provides total IBM answer for customers

Series/1 Weaknesses
- Undelivered COBOL product
- Unbundled support that may be less than expected
- Limited commercial software
- No forms language
- No mag tape
- No removable disks
- No quantity price discounts
- Maximum of 256 Kb
- Usually only one batch stream or one interactive development partition supported on RPS; no concurrent batch because of the task build and task management methods used
- No relative addressing, thus no position-independent code. (Makes system management quite inflexible, and task management becomes a manual job performed by the operator.)
- Only one level of overlaying
- No MOS memory error correction option
- Only one level of checkpointing, and then in only one partition
- Generally marginal mechanical design:
  - Floppy disk wearout is a problem because of sharp edges on heads; disk is also hard to load.
  - Lack of air filters makes harsh environment usage doubtful.
  - No slides are provided for rack-mounted units, so maintenance is difficult.
  - Thin cabinet sheet metal often bows with "oil-canning" effect.
  - Cabling often rubs on sharp metal edges.
  - Memory upgrades often require backplane replacement (for higher-density boards).
  - Forms-feeding (top) and other printer functions are difficult.

RSX-11M vs. RPS

This section summarizes RSX-11M advantages and RPS considerations.

RSX-11M Advantages

1. Checkpointing is more flexible under RSX-11M than under RPS. All partitions can be checkpointed, and more than one task can be checkpointed at once. The only limit is the amount of swapping space available. The more advanced functionality of RSX-11M allows more tasks to run concurrently in a given amount of memory, which increases system throughput.

RPS can only checkpoint one partition, which must be determined at initial program load (IPL) time. In addition, the swapping space holds only one task image.

2. RSX-11M V3.1 running on a PDP-11/34A can perform more work per unit time than an RPS Version 1.1 system running on a Series/1 Model 5. This has been shown through benchmarks as well as hands-on experience with both systems, and is especially true in an edit, compile, and run environment. RSX-11M V3.2 terminal handling features will further improve our lead.
3. Multiuser features such as password protected login and file protection codes are optional under RSX-11M. They are unavailable under RPS. Under RSX, many programmers can create and debug programs concurrently, under the same operating system, that will support the finished programs, without concern about the accidental modification of other programmer's files or programs.
4. RSX-11M file names have three parts: root-name, extension, and sequence number. This allows the same program to have several files in different stages. For example, FETCH.FOR is the FORTRAN source file; FETCH.OBJ is the object code produced by the compiler; and FETCH.TSK is the task file ready to run. The sequence number field allows old copies of a file to be saved instead of overwritten. The RSX file name structure and conventions solve many problems associated with the assignment of file names, and simplifies file management activities.
5. In general, the file space is allocated dynamically under RSX-11M. The only exception is when a user requests that a file be preallocated. The amount of disk space saved by dynamic allocation can be substantial. For example, if a program uses five scratch files, one at a time, and space is allocated as needed, the space requirement is one-fifth that of the total amount required if space for all five files had to be allocated before the program could be run.
6. Most RSX files do not have to be contiguous. Task image files are contiguous to decrease the amount of time it takes the system to load them. All non-contiguous files, including preallocated ones, can be expanded as needed.

   In contrast, the Series/1 supports only contiguous, preallocated files, which cannot be expanded.
7. RSX-11M has one extensible command language with syntax and semantics applicable to both interactive and batch processing. Utility programs prompt for commands with a common syntax and appropriate semantics. Some of the benefits of the RSX-11M command language processors over the Series/1 equivalents are: ease of use, fewer mistakes, faster programmer/computer interactions, and less user typing fatigue.

   Under RPS, the system executive, the system utilities and the job stream processor each have their own distinct command languages, with their own syntax.
8. RSX-111M users can extend the command language by installing commonly-used tasks such as the COBOL compiler, the taskbuilder, or the Peripheral Interchange Program. Such tasks can then be run by simply typing the name of the task, which speeds system use by eliminating unnecessary typing.
9. RSX-11M supports user-mode diagnostics. As a result, many tests can be made without bringing down the operating system or waiting for Field Service to run tests.
10. Magnetic tapes are supported in ANSI and DOS-11 formats. This is particularly important because magnetic tape is the most common means of file exchange between systems.
11. PDP-11 FORTRAN IV is a more advanced compiler than RPS FORTRAN. The major advantages are: G format descriptor, complex data type, eight levels of parenthesis in formats, object time formats, encode/decode, and logical*1 variables. Each of these advantages

means that programmers using PDP-11 FORTRAN IV do not have to work as hard or as long writing new programs or converting existing ones.

12. PDP-11 FORTRAN IV-PLUS has even more functions than PDP-11 FORTRAN IV. The major additions include formatted direct I/O and variable formats (e.g., I<i+1>). FORTRAN IV-PLUS is also a very good optimizing compiler.
13. The RSX-11M task builder can handle highly complex overlay requirements through the definition of a number of separate overlay trees. This means that programs that are too large to fit into memory can be split to allow optimal performance.

    The RPS task builder does not allow this amount of control.
14. The RSX-11M task builder can link to an unlimited number of library files, and as many as seven shared memory areas. (The file system and a language OTS count as one shared area.) The shared area limit (one) in the RPS task builder is further aggravated by the inability of the RPS system to allow more than one active shared area for the entire system at any given time. Thus, any two programs that need different shared areas must either not run concurrently or must combine shared areas, which possibly allows one program to access more data than it needs and cuts down the modularity and structure of the system.
15. The RSX-11M batch processor is far more versatile than the RPS batch processor. The RSX batch processor provides conditional commands, branching, error trapping, concurrent execution for tasks, and commands to ask for information. This allows users to set up "canned" procedures, without having to write a specific program. The PDP-11 system generation procedure also uses this method.

    The Series/1 batch processor provides a similar interface, yet can be used only for system generation.
16. RSX-11M supports three editors, the DIGITAL Text Editor, EDT, which is the standard editor offered on most of DIGITAL's operating systems; EDI, which is a line text editor; and SLP, a Source Language Input Program. Other editors available for RSX-11M include the Text Editor and Correction program, TECO, which is a very powerful editor implemented on a wide range of systems, and SOS.

    This is just another example of the variety and flexibility of PDP-11 software product offerings. Users can choose the editor they prefer, or the editor that is best suited for a particular job.

    RPS supports only one text editor. It is offered as a component of the Program Preparation Subsystem package.
17. DIGITAL's editors automatically backup the input files as a hedge against disastrous mistakes. If the user accidentally deletes a large amount of text, the latest backup file is available for a quick recovery.

    RPS users do not have automatic backup. Unless users have the forsight to manually backup the files, the only alternative is to retype the entire text.

RPS Considerations

1. The file structure of RPS allows one more level of directory than RSX-11M: device, volume, and partitioned data set. However, the storage for one task set is a volume. This implies that task sets are global. The extra level of directory structure allows programmers to have fewer files in each directory, which simplifies the act of finding any particular file.
2. RPS supports multitasking within a task set (partition). Because each task runs in the same address space, they are more tightly connected than the RSX-11M equivalent.

   RSX-11M supports multitasking by permitting tasks located in separate address spaces to

cooperate and communicate via SEND and RECEIVE directives. Local, group, and global event flags are provided for task synchronization. System directives allow a task to alter another task's priority, and to run, suspend and resume, and abort execution, send messages, or to send the addresses of large data areas to other tasks. On mapped RSX-11M systems, SEND and RECEIVE support by reference allows part of the address space to be shared.

3. Versions 3 and 4 of RPS support non-contiguous dynamic partitions.

   RSX-11M supports only contiguous task images, which introduces the possibility of memory fragmentation. However, RSX does have a shuffler that combines free space by moving tasks until a space large enough to load the desired task becomes available.

4. The Series/1 Data Set Definition (DSD) concept provides program-independent file names. As a result, source prorams do not have to be edited and recompiled to change a file name. The drawback is that more time is spent opening a file because the system has to find the proper DSD to find the file name.

   RSX-11M system and user programs often ask the user for the file name, which essentially accomplishes the same function as DSD (files do not have to be edited and recompiled).

5. The batch processor command language is similar to OS/370 JCL. This may or may not be an advantage, depending on your point of view.

IBM 8100 Information Systems

On October 3, 1978, IBM announced their new 8100 minicomputer series, "a family of processors designed to meet the diversified requirements of distributed data processing." First customer shipments are scheduled for the third quarter of calendar 1979.

Various elements of the 8100 Information System family will be marketed by the Data Processing division. It is worth recognizing that IBM now aggressively touts the whole distributed data processing concept as "one of the most significant trends in computing today." This can be viewed as confirmation of what DIGITAL has been saying all along. IBM's promotional emphasis seems to be focused on a system solution sell of the whole distributed data processing concept. They claim that their systems approach, "cooperative network processing," is a logical extension of distributed processing, and that they are "taking a new step forward in distributed data processing."

The 8100 can be used either as a 3790 replacement (an IBM 370 satellite), as a stand-alone system, or in 8100-only system networks. The 8100 family includes two processor models with a variety of memory sizes, plus new terminals, printers and mass storage devices. The 8130 (1500 nsec cycle speed and 0.93 Mb I/O bandwidth) offers up to 512 Kb in 256 Kb increments, and the 8140 (800 nsec cycle speed and 1.25 Mb bandwidth) offers up to 512 Kb in 128 Kb increments. Both are expected to fall in the 11/34-11/60 range in performance.

These processors may be purchased, leased on a new 2-year arrangement, or rented on a monthly basis.

IBM speaks in terms of a 6-terminal small system, an 18-terminal larger system or up to 24 3277 terminal systems with a maximum of 31 simultaneously executing programs.

Typical systems, without software, are shown below:

8130 with 512 Kb
1 Mb diskette
64 Mb disk
$29,940 purchase
$780/mo. 2-yr plan
$917/mo. straight rental
Approx. $45,000 equivalent purchase with software.

8140 with 512 Kb
1 Mb diskette
64 Mb disk
$46,980 purchase
$1,520/mo 2-yr plan
Approx. $60,000 equivalent purchase with software.

An additional 256 Kb diskette can be attached to the above systems. 8101 units may be added to increase disk capacity to 320 Mb. IBM offers four big disks, the 23 Mb and 58 Mb combined fixed and moving head units, and the 29 Mb and 64 Mb moving head units.

Supported hardware includes:

8101 disk
64 Mb
Up to 4 with 8140
Up to 2 with 8130
$16,410

8775 CRT terminal (8100 also handles 3270 terminals)
3440 or 2560 characters
Up to 8 display partitions
$3645 for 2560-character version

8809 tape (maximum of 4)
1600 bpi
12.5 and 100 ips
20-160 KB/sec
$10,440

3289 400-lpm printer
3287 90- or 120-lpm printer

All 8100 software, including the operating system, is an unbundled offering. However, it is reasonably complete:

- DPCX—Distributed Processing Control Executive, 370-host-controlled networks.
  - — Growth path for 3790 system
  - — Tightly coupled to 370 host
  - — NO program development
- DPPX—Distributed Processing Programming Executive, stand-alone or distributed networks, $150/month.
  - — General purpose interactive/batch
  - — Stand-alone, peer, or satellite configurations
  - — Supports transaction processing with journaling, logging, roll-forward, screen format development package, and recovery
  - — COBOL, FORTRAN, SORT/MERGE, multikey ISAM
  - — 3270 emulation
  - — RJE
- DPPX/DTMS—Data Base and Transaction Management System, similar to TRAX or CICS, $90/month.

- Host Command Facility, runs on 370 to program and control connected 8100s, $85/month.

Programs written for the 3790 will run on the 8100 (with DPCX).

Note that from $280 minimum to $570 or more per month for software must be added to the hardware system prices in order to piece together a functioning system.

First customer shipments are scheduled for the third quarter of 1979.

8100 Strengths

- Low cost
- Economical new 2-year lease plan
- Source-code compatibility with 3790 under DPCX
- Advanced 64 Kb chip technology provides inexpensive memory (8130 only)
- High-level software tools
- Transaction processor and screen formatter software
- Virtual terminal hookup to a 370, or on a 370 to an 8100

8100 Weaknesses

- Natural problems arising from entirely new processor using new technology plus new peripherals
- Mid-1979 date for first delivery, with some software scheduled up to February 1980. Backlogs will push delivery for most customers out farther.
- Unknown performance and field behavior
- Maximum of 512 Kb
- If user grows out of an 8100, a major conversion to the program-incompatible 370/303X is the only choice
- No program, file, or user-command compatibility with other IBM systems
- Nonremovable disk
- No disks smaller than 23 Mb for small, dedicated systems
- No dual-ported disks for quick-switchover standby system
- No RPG, BASIC, APL, or PL/1
- No commercial instruction set; not even decimal arithmetic
- 8130 is slower than disk transfer rate, requiring every-other-sector reading
- Languages are incompatible with all other IBM computers.
- No inquiry system
- The 8100 is sold literally on an install-your-own basis (manuals take user through it step by step), leaving potential for customer problems
- No communication with S/1, S/3, S/32, S/34, S/38—only other 8100's or 370/303X's
- Fastest printer is only 400 lpm
- Lacks second-processor standby capability—no bus switches or dual disk porting

HEWLETT-PACKARD

The principal HP competition in the commercial marketplace has been the HP 3000 Series II, and now, the new Series III.

HP reports that the Series III offers twice the throughput of the Series II. This is probably due to the increased memory capacity, which is up from 512 Kb to 2 Mb via the low cost, $8000/256 Kb, 16 Kb chip modules. In a brochure, HP states that similarly configured Series II and Series III systems will have exactly the same performance. The Series II is field-upgradable, with a typical conversion involving the swapping of 6 to 8 CPU boards. It is important to note that a customer owning a 512 Kb Series II system has to pay $27,200 just to get a 512 Kb Series III system—with no increase in performance. The MPEIII operating system now offers private disk packs, tape labeling, and up to 32 local CRTs on one multidrop line. HP is also selling refurbished Series I machines for $65,000 and up.

Key Selling Features

- Languages
  - — COBOL
  - — RPG II
  - — FORTRAN
  - — BASIC
  - — APL
  - — SPL (a BLISS-like systems language)
- Screen Formatting
  - — VIEW/3000, a data entry product that runs stand-alone or can be called from any language but APL
  - — DEL/3000 Data Entry Library, assembly routines callable from any language but APL
- File Support
  - — IMAGE (very much like CINCOM's TOTAL; network/chain structures, but is incompatible with IMAGE on HP 1000 series)
  - — KSAM (sequential, relative, ISAM, multikey ISAM)
- Development Aids:
  - — Text Editor (EDIT/3000)
- Sorting:
  - — SORT/3000 (includes MERGE)
- Multidrop (Multipoint):
  - — MTS/3000 Multipoint Terminal System)

The Manufacturing Market

HP made the conscious decision in the mid-70s to concentrate on the manufacturing marketplace. In order to develop their expertise in this area, they hired a top consulting firm in manufacturing systems to help them design a manufacturing system and to design a marketing and training program. They are now beginning to reap the benefits of that effort with their turnkey package and their extensive manufacturing sales training.

The HP 3000 and HP 1000 are engineered and marketed by two separate divisions. The result is totally incompatible operating systems, languages, and utilities. Only the naming conventions and peripherals have remained common so that both systems have IMAGE data management software and both use common disks, tapes, and terminals.

The HP 3000 has been a commercial machine from its inception. During part of its life it had a small front-end processor that allowed it to attach sensor-based peripherals. This was discontinued in 1978. Sensor-based requirements are now fulfilled by front-ending the HP 3000 with an HP 1000 on a 50-foot coaxial cable and a synchronous interface. This configuration is the only way the HP 3000 can be networked to the HP 1000. The HP 1000 front-end can be attached to sensor-based peripherals or can network other HP 1000s locally or remotely.

DIGITAL has been in the manufacturing marketplace since the start of the company in 1958 when we began selling logic products to build machine control systems. Nearly all DIGITAL products have been used in manufacturing applications. Products such as the PDP-8, introduced in 1965, are still being sold and supported in manufacturing applications. DIGITAL is also still supporting a PDP-1 that is in active use. However, HP has been known to terminate support altogether on an old product.

DIGITAL has a strong computer strategy that includes an extensive computer family, many upward and downward compatibilities, historic product compatibility and growth, and long-term product support. HP, on the other hand, has a limited computer family and no history of interproduct compatibility or long-term support.

HP is severely limited in a situation that requires several different size computers in a distributed system.

MFG/3000 — MFG/3000 uses IMAGE as its data manager. IMAGE has some serious limitations on the number of fields (255) that can be present in any one data base. This limitation forces MFG/3000 to support three data bases. There is heavy redundancy between the Engineering Data Control (EDC) module, which includes the bill of materials, and the Inventory and Order Status (IOS) module. Batch programs must be run to maintain compatibility between data bases.

MFG/3000 does not include several modules that would make up a complete manufacturing system. These are a master scheduling module, a capacity requirement planning module, a purchasing module, and shop-floor control.

MFG/3000 is a batch-oriented or "regenerative" system. This means that changes in scheduling and planning are done periodically, typically once a week, in a large batch run. It does not fully utilize the more efficient "net change" updating technique that allows changes to be made immediately.

MFG/3000 requires the 2645 terminals at $3500 each (before required options) for use with the Inventory and Order Status module.

Installing a system such as the MFG/3000 package is a long commitment, often extending three to five years. HP admits that they have no growth path for the HP 3000 III and that the HP 3000/33, which will eventually run the MFG/3000 software, is half the speed of the 3000 III. Thus a customer should be concerned about whether the HP 3000 solution will be valid by the time the system is implemented fully.

As of January 1979, there are less than a half-dozen industry specialists in place to support MFG/3000. A prospect should consider how far the specialist must travel to be on-site.

The sale of HP's networking product includes the use of some buzzwords such as virtual terminals and route-through, but lacks some basic features that allow easy implementation and maintenance. In all benchmark encounters, DECnet has proved a superior performer over route-through. DECnet is also far easier to use when communicating between two different operating systems.

HP Strengths

- Aggressive, systems selling
- Knowledgeable sales force
- Good data entry package (forms subroutine)
- Generally low prices for the 3000
- Good IBM batch program conversion
- Automatic overlay (not true virtual memory) for big programs
- Free use of machine between order and delivery
- 2780, 3780, and HASP communication
- IMAGE-QUERY combination*
- Re-entrant code*

*These items are, more often than not, contrived selling problems rather than real problems:

If a customer does not really need a DBMS with COBOL-11, we can recommend RMS-11. Then the would-be HP data base/QUERY advantage disappears and may even become a liability because of data base complexity and commitment, and the complexity associated with using the HP QUERY system.

HP has noticed the absence of 3780 communication capability on PDP-11 systems and has been exploiting this by building up 3780 features and benefits. However, note that HP does not have 3270 communication capability—interactive communication capability that often simplifies minicomputer communication at a facility, since the user just connects the DIGITAL system to an existing IBM (303x, 370, 360, S/3, or 8100) terminal line and is in business—interactively. Let's get there first and bring this point out.

HP Weaknesses

- Awkward file calls instead of COBOL verbs for both IMAGE and KSAM; impedes conversion process
- Lower compute-bound COBOL program performance (U. S. Steel)
- Lower multiterminal performance
- Less functionality in almost all COBOL areas
- Journaling, but no automatic software restart/recovery
- Incompatible BASIC among 250, 300, and 3000 systems
- Poor sort performance (2 to 3 times slower)
- A less flexible, less powerful data base management capability than DBMS-11, DBMS-20 or even RMS-11K
- QUERY system that is hard to use and requires use of registers, and more coding than DATATRIEVE
- Support of comparatively few active terminals
- There are reports that HP's virtual memory sometimes thrashes so much that users are forced to rewrite their programs to accommodate the paging, thus defeating the purpose of virtual memory
- Expensive terminals ($2600 up). HP has quoted LA36s when this was a problem, although the new 2621 $1450 CRT terminal may be more often quoted now.
- No 3271 interactive IBM communication capability
- No choice of operating systems; no optimizing for specific application environment requirements
- Less extensive customer educational resources

- Negligible CSS-type resources
- Limited field service support with respect to both geographical and critical coverage

HP 1000 SERIES

HP offers three compatible real-time, scientific computers of increasing performance:

- The "economical" HP 1000-M Series
- The HP 1000-E Series, positioned below the PDP-11/34
- The HP 1000-F Series, positioned between the PDP-11/34 and the PDP-11/60

Hardware Specifics

The HP 1000-F Series:

- Includes a Floating Point Processor with 16 hard-wired instructions.
- Includes a Scientific Instruction Set of nine microcoded trigometric and logarithmic functions.
- Includes a fast FORTRAN processor on nine microcoded, commonly-used, FORTRAN routines, such as array-address calculations.
- Is available only with HP's 350 nanosecond high performance memory.

The following features are available in the older HP 1000-E, as well as in the HP 1000-F:

- Maximum main memory up to 2 Mb
- User microprogramming

RTE-IV Operating System

RTE-IV is HP's disk-based real-time executive operating system used for management of the operations and resources of HP 1000 Model 40 and 45 computer systems and user-assembled systems based on HP 2108, 2109, 2111, 2112, 2113, or 2117 computers.

RTE-IV Strengths

- Reasonably complete real-time operating system
- Compatible with earlier versions of RTE
- Programs can have memory-resident, FORTRAN-accessible data arrays of up to 2 Mb
- Main memory up to 2 Mb
- Competitive graphics capability on the HP 1000-F series Model 45

RTE-IV Weaknesses

- Maximum task size is 54 Kb
- Only single level of overlaying
- Only 64 tasks
- One task per partition uses memory inefficiently (vs. one or more large partitions with shuffling in RSX-11M)
- One-day on-site training is extra cost
- File structure is simplistic
- No PLAS for in-memory overlays or shared common areas (do have 2 Mb array capabilities)
- Poor system security (no login/password support)
- No P/L 90
- Only one editor
- Supports only 16 terminals
- Limited language support (Assembly, FORTRAN IV, and Real-time BASIC)

- Supports only single-stream batch
- No optimizing FORTRAN of the qualify of FORTRAN IV-PLUS
- No error logging
- HP 1000 has no commercial capabilities and HP 3000 has no real-time capabilities—users must buy two separate systems

DIGITAL's Advantages

DIGITAL has some significant advantages over HP 1000 systems:

- Greater floating point precision
- Greater floating point performance
- Extensive family of real-time, scientific computers, including VAX-11 compatibility
- Dual RL01 disks
- More supported languages
- Larger user programs
- More available application packages
- Extensive error logging capabilities

Additional M-PLUS Advantages

- Overlapped disk seeks
- Re-entrant task support
- User accounting
- Shadowed disk support

DATA GENERAL

Overview of DG'S Operating Systems

DG currently markets four operating systems:

- Diskette-Based Operating System (DOS)
- Real-Time Operating System (RTOS)
- Real-Time Disk Operating System (RDOS)
  - — Foreground/background operating; dual programming
  - — Compatible with DOS/RTOS
  - — Supports up to 512 Kb; with memory mapping unit MRDOS (M for Mapped) that enables virtual overlays and window mapping
  - — Interprocessor bus support enables dual-processor, shared disk configuration
  - — Maximum of two concurrent languages
- Advanced Operating System (AOS)
  - — Multifunction (timesharing, real-time, batch)
  - — Multiprogramming
  - — "Heuristic" or adaptive scheduling techniques
  - — Dynamic Memory Management
  - — Demand paging with M/600's Demand Paged Storage Facility
  - — Support for 64 processes; each batch and timesharing user requires two processes each; realistic maximum of 26-30 users

DOS and RTOS are small systems that do not compete with RSX-11M or RSX-11M-PLUS.

Until AOS (Advanced Operating System) was announced for DG's ECLIPSE system in November 1976, RDOS (Real-Time Disk Operating System) was DG's only general-purpose operating system. Thus, RDOS was required to compete against almost every operating system that DIGITAL markets. It is expected that we will continue to see RDOS as an actively marketed product.

RDOS

Summary of Advantages

DIGITAL's RSX-11M operating system enjoys significant advantages over DG's RDOS operating system. When the two systems are competing, we should not allow our prospect to believe that they are "about equal."

The following summary provides descriptions and explanations useful in appraising the software capabilities of RSX-11M and RDOS. We urge you to use these differences and advantages with confidence.

Multiprogramming Capability

RSX-11M	Offers real-time multiprogramming
RDOS	Offers dual programming

Concurrent Language Support

RSX-11M	Supports multilingual programs running concurrently
RDOS	Supports a maximum of two languages concurrently

Supported Languages

RSX-11M	MACRO, FORTRAN IV, FORTRAN IV-PLUS, BASIC-11, BASIC PLUS-2, PDP-11 COBOL, RPG-II, CORAL-66
RDOS	MACRO, DG/L, FORTRAN IV, V, ALGOL; Extended BASIC, Business BASIC, RPG-II, COBOL

Hardware Protection

RSX-11M	Provides multiple levels of hardware protection to ensure each program's integrity
RDOS	Provides hardware protection between the foreground and background *only*

Batch Processing

RSX-11M	Features powerful and flexible batch streams (RSX-11M-PLUS) and Indirect Command Files (RSX-11M V3.2 and RSX-11M-PLUS)
RDOS	Features a single batch stream in a fixed partition

File Management

RSX-11M	RMS-11K, DBMS-11, SORT-11
RDOS	INFOS (C/150 +C/350 *only*), SORT/MERGE

Query/Report Writer	
RSX-11M	Available with DATATRIEVE-11
RDOS	None
Extended Addressing	
RSX-11M	PLAS allows window mapping, virtual overlays, virtual (large) arrays, and large common data area mapping, sending, and receiving.
RDOS	Implementation with window mapping and virtual overlays
Communications	
RSX-11M	IBM 2780, 3271, HASP (not available on RSX-11M-PLUS), MUX200, UN1004
RDOS	IBM 2780/3780, HASP II Emulation
Networking	
RSX-11M	Supports DECnet-11M, Phase 2
RDOS	No networking
User Mode Diagnostics	
RSX-11M	Allows on-line peripheral testing concurrent with normal system tasks
RDOS	No mention of user mode diagnostics
Compatibility	
RSX-11M	Compatible with RSX-11S, IAS, VAX/VMS
RDOS	Compatible with DOS, RTOS
Software	
RSX-11M	Diagnostics available on a variety of disk cartridges and distribution tape
RDOS	*No hard disk* distribution; limited to diskette and tape
System Growth	
RSX-11M	Expansion up to 3.8 Mb memory on the PDP-11/70
RDOS	Expansion up to 512 Kb memory
Future Enhancements	
RSX-11M	Enhancements continue; provides compatible software link with the VAX-11/780
RDOS	No major enhancements are planned; static

Why Compare RSX-11M to RDOS?

RDOS continues to serve the small-to-medium system marketplace that requires a compact, high performance executive. RSX-11M meets the needs of this environment, and offers *significant* advantages over RDOS. We cannot allow our prospects to believe that RDOS is equivalent to RSX-11M.

AOS (ADVANCED OPERATING SYSTEM)

AOS will be the main competition for RSX-11M-PLUS.

Features

- Multifunction operating system with support for batch, timesharing, and real-time environments.
- Multiprogramming executive with file management and communication capabilities.
- Dynamic memory management enables the operating system to choose available pages of memory for program execution.
- Support for demand-paging hardware memory management on M/600 ECLIPSE
- On-line diagnostics enable concurrent task execution with diagnostic programs.
- Available on S/130, S/250, C/350, and M/600 ECLIPSE

Description

AOS is DG's first operating system to support multiprogramming. Unlike foreground/background RDOS, AOS supports a multiuser environment by managing memory and peripheral devices dynamically. AOS allows batch, timesharing, and real-time environments to be intermixed.

AOS supports three process types:

- Resident
  - — Always in memory
  - — Useful for time-critical, real-time requirements
  - — First to receive CPU time & memory
  - — Resident and pre-emptible processes treated as a single priority class
  - — Not assigned heuristically
- Pre-emptible
  - — Normally resident but can be swapped
  - — Useful for less critical event-driven requirements
  - — Priority class assigned by the user from 0 (highest) to 255 (lowest)
  - — Not assigned heuristically
- Swappable
  - — Useful for timesharing and batch jobs
  - — Memory allocated on a round-robin basis of priorities
  - — System resources given only after all resident and pre-emptible processes are blocked (or non-existing)
  - — Only type of process that is scheduled heuristically

File Management

AOS supports DG's multikey ISAM file management system (INFOS) on the C/350 and M/600 commercial ECLIPSE systems. The S/130 and S/250 do not support INFOS—these systems' file access techniques are limited to the language file support.

AOS Demand Paging on the M/600

Demand paging, limited to the M/600 ECLIPSE, is accomplished by the hardware memory management and the AOS executive. When a program is loaded for the first time, only the root segment is loaded. As references are made within the program to locations not yet memory resident, page faults occur. The AOS executive loads the appropriate page and continues

execution. If the process is pre-emptible, the AOS executive marks the pages as swappable. If the page that is loaded has not been modified, it is overwritten. Otherwise, it is written to a swap file.

As a result of demand paging, programs can execute without requiring the entire program to be loaded. This is similar to our overlaying techniques, but their scheme is somewhat easier to use. However, *demand paging does not increase the logical program address space* beyond 64 Kb because of the 16-bit architecture of the M/600.

Language Support

	Scientific ECLIPSE S/130 S/250	Commercial ECLIPSE C/350 M/600
RPG-II		X
COBOL		X
INFOS		X
IDEA		X
SORT MERGE		X
PL/1	X	X
FORTRAN IV	X	X
FORTRAN V	X	X
DG/L	X	X
Extended BASIC	X	X
Assembler	X	X

COMPETIVE OBSERVATIONS

To evaluate AOS, the following topics must be examined:

- multiprogramming support
- memory use
- file management
- heuristic features
- real-time capabilities
- communications

AOS Multiprogramming Support

AOS is a multifunction operating system that supports batch, timesharing, and real-time environments.

AOS supports 64 processes, not 64 programs.

- Since each process can be 64 Kb maximum, the theoretical amount of total memory supported under AOS is 4 Mb.
- AOS uses four system processes for PMGR, UP, EXEC, and SPOOL that requires 256 Kb.
- INFOS and IDEA require one process each.
- Each batch stream uses two processes each, totalling 128 Kb.
- Each general timesharing terminal uses two processes (up to 128 Kb).

- COBOL and IDEA users require one process.
- According to DG, the maximum number of general timesharing terminals is between 26 and 30, depending on the number of batch streams (0-4).

TYPICAL EXAMPLE

30-terminal timesharing system

System Use:

12 Users—IDEA
4 Users—COBOL
10 Users—Editor
2 Users—Command Line Interpreter
2 Users—Debugging Applications
1 Batch Stream—Program Development
1 Batch Stream—Application
1 Communications Link—HASP

Process Count ( ):

AOS (4)
INFOS (1)
IDEA, Global (1)
IDEA users (12)
COBOL applications (4)
Editor use (20)
CLI users (4)
Debugging users (4)
Batch (1)
HASP (55 processes)

Thus, a 30-terminal timesharing system approaches the theoretical limits of the AOS system.

AOS Memory Use
AOS system requires heavy memory overhead.

Resident Memory Requirements

AOS Kernel	90 Kb; minumum AOS overhead regardless of the number of users
AOS processes Databus	11 Kb
INFOS	64 Kb, without buffers
IDEA Global Monitor	14 Kb
Spooler	8 Kb
HASP	30 Kb
Synchronous Line Drivers	2 Kb
TOTAL	219 Kb

Swappable Memory Requirement

IDEA (12 users)	90 Kb
COBOL Application (4 Users unshared)	256 Kb
Editor Users (10)	200 Kb
Debugging users (2)	128 Kb
CLI users	38 Kb
Batch Streams	128 Kb
TOTAL	840 Kb

If a 2:0 swap ratio is assumed for DG's 96 Mb disk, 420 Kb of actual swappable memory is required, which yields 639 Kb of total memory use (Swappable + Resident Memory Requirements).

DG recommends that users "round up" the memory requirement. In this case, DG would recommend that the customer round up 768 Kb, which is the next integral memory configuration.

AOS Minimum Requirements — AOS minimum requirements are high. The following table references the minimum equipment required for software system operation and licensing. If users do not meet the minimum equipment requirements, a program license charge is levied, in addition to any software license fee that is applicable.

Minimum AOS System Configuration

	Memory	Tape	Line Printer	FPP
AOS	128 Kb			
COBOL	192 Kb	X	X	
IDEA	256 Kb	X	X	
INFOS	256 Kb	X	X	
SORT/MERGE	192 Kb	X	X	
FORTRAN V	192 Kb			X
FORTRAN IV	192 Kb			X
PL/1	192 Kb			X
DG/L	192 Kb			
Ext. BASIC	192 Kb			X

Any AOS system must have at least 192 Kb to license the compiler. Tape drive support is available for all commercial languages.

AOS File Management

INFOS — INFOS is DG's only file management system offered exclusively on commercial ECLIPSE systems (C/150, C/350 & M/600) that provides single and multikey ISAM capabilities. DG heavily promotes the DBAM (Data Base Access Method) facility of INFOS, which features:

- database inversion
- multilevel indexing
- space management
- general keys
- partial general records

Interfaces to INFOS are provided by the following:

Language	RDOS/INFOS	AOS/INFOS
ALGOL	No	No
Extended BASIC	No	No
Business BASIC	Yes	No
COBOL	Yes	Yes
DG/L	Yes	Yes
FORTRAN IV	Yes	No
FORTRAN V	Yes	Yes
IDEA	Yes	Yes
MACRO Assembler	Yes	Yes
APL/1	No	Yes
RPG-II	Yes	Yes

Remember that INFOS is not a data base management system:

- Data base systems offer a separation of data definition from programs.
- Data base systems describe the data base with Data Description Languages for both the system and separate applications.
- Data base systems define data items and relationships.
- Data base systems offer greater data security and integrity.

DIGITAL's DBMS-11 is a data base management system conforming to CODASYL specifications; INFOS is not a data base management system, nor does it conform to CODASYL data base management specifications. INFOS resembles closely the capabilities of RMS-11K; however, INFOS does not provide a Query/Report Write facility like DATATRIEVE-11.

Heuristic Features

DG uses the term heuristic to mean "intelligent" or "knowing." It simply refers to an AOS feature whereby what has occurred in an AOS system is recorded and used by the system as the basis for its current and future activities. Despite what DG says, the heuristic features apply only to AOS swappable or timesharing processes. Heuristics do not affect AOS real-time programming capabilities such as resident and pre-emptible processes. *Note this distinction to your prospects.*

DIGITAL has always had similar or identical capabilities in the standard RSTS/E and IAS

operating systems. The heuristic scheduler is a "best guess" feature useful in influencing the frequency and order of execution of timesharing programs.

"Heuristic" is a marketing, eye-catching term that applies to timesharing processes only. In a typical mix, the demands of other types of programs/processes always affect the performance of the timesharing system. Only in a pure timesharing environment does the extra overhead of a heuristic scheduler yield a noticeable effect on system performance. For this reason, RSTS/E and IAS support the heuristic scheduler, and real-time systems, such as RSX-11M and M-PLUS, do not.

AOS Real-Time Capabilities

It has become clear that DG is focusing the emphasis of AOS towards the interactive and computational marketplace. For example, AOS does not support sensor I/O.

AOS Communications Software

AOS supports two forms of batch file transfer information: 2780/3780 and HASP.

These products support bisynchronous communication between DG computers and IBM host systems. No networking or interactive protocol like IBM 3271 is available.

WHY RDOS IS PROPOSED OVER AOS

DG continues to propose RDOS over AOS because of:

- CPU support
- real-time efficiency
- memory-size
- peripheral and software support
- license fee

CPU Support

RDOS	With the exception of microNOVA and M/600 ECLIPSE, RDOS is available on all NOVA and ECLIPSE systems. RDOS can also develop programs for DOS and RTOS-based microNOVA systems.
AOS	AOS is available only on the ECLIPSE series of computers, and is the only operating system on the M/600 ECLIPSE.

Real-time Efficiency

RDOS	RDOS was designed as a small, efficient real-time system.
AOS	AOS was designed primarily for the high performance, multiuser timesharing and batch user—not the real-time user.

Memory Size

RDOS	A minimum system can be configured with 32 Kb. There are no special requirements or recommendations for additional system components for improved system performance.
AOS	The AOS license requires a minimum of 128 Kb. However, 192 Kb is the *minimum* realistic requirement since languages cannot be run with less than that. DG strongly recommends a disk pack subsystem (96 Mb, 192 Mb) for efficient AOS utilization. With the addition of a disk pack subsystem, a tape drive becomes a virtual requirement.

Peripheral Software Support

RDOS

RDOS supports practically *all* DG hardware and software with the exception of PL/1.

AOS

AOS carries no support for:

- Data Acquisition & Control Unit (DAC) for sensor I/O
- Sensor Access Manager (SAM)
- Communications Access Manager (CAM)
- business BASIC
- array processor option

License Fees

RDOS

There is no charge for RDOS software. However, it does not include training credits or software subsystem service. Most languages under RDOS also have no charge. They include FORTRAN IV, FORTRAN V, RPG-II, ALGOL, and extended BASIC. Three compilers are chargeable:

- COBOL ($7,000)
- Business BASIC ($4,000)
- DG/L ($5,000)

AOS

The first license of AOS is priced at $2,500. Subsequent licenses are available at no charge or reduced charges. They include:

- FORTRAN IV ($3,000)
- FORTRAN V ($1,200)
- Extended BASIC ($1,200)
- DG/L ($5,000)
- PL/1 ($4,000)
- COBOL ($4,000)
- RPG ($2,500)
- IDEA ($4,000)

TANDEM

Tandem was founded in 1974 by several high-level HP engineers and the former marketing V.P. of Diablo. Tandem's one product is their NonStop™ multiprocessor system. Their primary marketing emphasis is the cost and inconvenience of hardware downtime.

Tandem's CPUs appear to be in the price/performance range of the PDP-11/34.

Tandem Strengths

- Excellent multiprocessor capabilities; the ability to add new devices without taking the system down
- Up to 16 CPUs
- ANSI-74 COBOL, FORTRAN, TAL
- TAL forms language provides the ability to program entire applications, including procedures, bit operations, arrays
- Good data management system (Enscribe) features sequential, relative, single and multikey ISAM; journaling and file recovery facilities; and DBMS-like schema and data definition language
- Virtual memory operating system, using shared and re-entrant user programs
- Either character-mode or block-mode terminals
- Communications (Envoy); 2780, with autodial and autoanswer; IBM and Burroughs BISYNC; point-to-point and multidrop; 3270 "screen formatter"
- Inquiry/report generator system (Enform)
- Rapid installation (a matter of hours)
- Network software (Expand)

Tandem Weaknesses

- COBOL is not recommended for NonStop programming; FORTRAN is recommended.
- No BASIC
- Multiprocessor checkpointing must be done *in user programs*. (Programmers have difficulty learning multiprocessor checkpointing theory and practice.)
- Operating system does not load-balance or self-optimize. (Programmer must tune system.)
- A multiprocessor "system guru" is required.
- Five operating system releases in seven months.
- System does not use multiple resources to increase performance; duplicate resources are just on hot standby. Disks have second controller that cannot be used until first system is down. No automatic load leveling. Potential exists for undetected failures in unused, hot standby, which would cause a system failure.
- Multiprocessors with the NonStop memory shadowing scheme (periodically copying everything into a second processor) place heavy responsibility on programmers.
- The maximum memory is 2 Mb.
- Journaling but no automatic software restart
- No TRAX-like automatic staging
- Although they call Enscribe a "data base record management system," there is no provision for defining record relationships, and thus is not a full DBMS.
- No job or facilities accounting.
- They have a reputation for overstating their case: they add two bus bandwidths to get 26 Mb; two processors can access the same disk only via the master processor; their "fast" COBOL uses a number that is the compiling rate; every screen line is counted as a transaction.
- Generally limited customer post-sale resources.
- No 3271 interactive IBM link.
- No word processing.

APPENDIX A
SALES PRESENTATION MATERIALS

The following materials can be made into overhead transparencies and used for sales presentations.

Divided into three sections, the slides parallel the discussions presented in Sections 2, 3, and 4 of this Marketing Guide.

RSX-11M and RSX-11M-PLUS

PRODUCT DESCRIPTIONS

RSX-11M and RSX-11M-PLUS "Have What it Takes" For All Phases of Application Development

- Design
- Program Development
- Design Validation
- Installation
- On-going Maintenance

Design

Extensive Documentation

Optimal Resource Utilization

- Event-Driven, Priority-Based Scheduling

- Generalized Memory Partitioning Supports:
  - — Checkpointing
  - — Round-Robin Scheduler Within a Priority
  - — Automatic Memory Compaction
  - — General Sharable Libraries
  - — Shared Data Areas
  - — PLAS Directives for Region Support

- Device I/O Independence and Flexibility

- File System (Choice of Sizes)

- Print Spooler

DESIGN

(continued)

Multitasking Real-Time System

- Hardware Memory Management Protection
- Local, Group, and Global Event Flags
- Task Control Directives
- SEND and RECEIVE Messages or Pointers
- Task Spawning with Exit Status Notification
- Support for Many Real-Time Devices
- Documentation for Users to Interface Their Own Devices

DESIGN

(continued)

Multiuser System for Program Development and Multiterminal Application

- Login Support with Passwords
- Separate Disk Directories
- Public and Private Volumes
- Hardware Memory Management Protection
- Slave Terminals
- Round-Robin Scheduling within a Priority
- Disk Checkpointing During Terminal Waits
- Disk Swapping
- User-Oriented Terminal Handler

DESIGN
(continued)

Operating System Services

- Complete Set of System Calls (Directives) to:

  — Obtain Task and System Information
  — Measure Time Intervals
  — Synchronize and Communicate with Other Tasks
  — Manipulate Task's Logical and Virtual Address
  — Task Initiation and Control

- Complete Set of Utility Programs

- Indirect Command File Processor

DESIGN
(continued)

File Systems

- FILES-11 File Format
  - — Different Protection Levels
- FCS File System
  - — Record and/or Block I/O
  - — Sequential and Random Access
- RMS-11 and RMS-11K
- ANSI Standard Magtape (Level 3)

DESIGN
(continued)

Reliability

- Years of Experience and Improvements
- Thousands of Existing Sites
- Disk Write Checks
- Disk Offset Recovery
- Power Fail/Auto Restart
- User Mode Diagnostics
- Error logging

PROGRAM DEVELOPMENT

Extensive Documentation

Powerful Terminal Interface

- User-Oriented Terminal Interface
- Powerful MCR Command Language

Choice of Two Sophisticated Editors

Full Function Macro Assembler

Flexible Task Builder

- Disk and/or Memory Resident Overlays

System Library Routines

TESTING AND DESIGN VALIDATION

Dump Utility

ZAP, PAT, and SLP Utilities

Compare Utility

RMDEMO

ODT, On-Line Debugger

CDA, Crash Dump Analyzer

INSTALLATION/TUNING

Memory Utilization

File Systems

QIO Speed Optimizations

RMDEMO

ON-GOING SYSTEM MAINTENANCE

Error Logging

Librarian Utility

Disk Save and Compress Utility

Bad Block Locator Utility

File Structure Verification Utility

System Manager Features

- Password Maintenance
- Broadcast
- Shutup
- Indirect Command File Processor
- Automatic Scheduling Using RUN Command

Autopatch

WHAT'S NEW IN 3.2?

RSX-11M V3.2

SYSGEN ANSWER FILES = EASE OF USE

- Supplied Answer Files (DEC or OEM)

- Multiple SYSGENs

- Simple Changes

TERMINAL DRIVER = PERFORMANCE

- Full Duplex
- Task Type-Ahead
- Silos Emptied on Single Interrupt
- DMA on DH11
- ANSI Escape Sequences
- Checkpointing

PRINT SPOOLER = EASE OF USE

- Switches:

  /AFTER
  /FORMS
  /HOLD
  /PRIORITY
  /COPIES
  /DELETE

- Commands:

  LIST
  DELETE
  STOP
  START

- Multiple Queues and Printers

UTILITIES = FASTER OPERATION AND MORE CAPABILITIES

- NEW BRU
  - — (4 times faster)
  - — (incremental)

- FLX
  - — (1600 bpi)
  - — (inhibit rewind switch)
  - — (supports RT-11 format for RX02, RK07, RL01, TU58)

- PIP
  - — (selective deletes)

EXECUTIVE FEATURES = CONTINUED EXCELLENCE AS MULTITASKING REAL-TIME SYSTEM

- Parent/Offspring Tasks
- Stop-Bit Directives
- 2-4 Windows
- Console Log File

POOL SPACE = MORE TASKS AND/OR USERS

- Terminal Handler (Private Pool)
- Spooler (Queue Now on Disk)

WHAT IS RSX-11M-PLUS?

RSX-11M-PLUS

- Minimum System

  — PDP-11/70
  — RP05/06 or RM03
  — 256 Kb
  — Magtape

- Easy to Use

- Performance

- Features

RSX-11M-PLUS IS EASY TO USE

DCL = EASE OF USE AND COMPATIBILITY

SYSGEN = FAST AND EASY

RSX-11M V3.2 COMPATIBILITY =
EASY UPGRADE FOR 11/70 USERS

TRANSPARENT SPOOLING = SIMPLIFIED
PROGRAMMING

RSX-11M-PLUS IS FEATURES

TRUE BATCH AND SPOOLING =
COMPATIBILITY WITH VAX/VMS

ACCOUNTING = PROPERLY ALLOCATED
COMPUTER COSTS

VIRTUAL TERMINAL SUPPORT =
EASY, LOGICAL APPLICATION
IMPLEMENTATION

SHADOWED DISK = DATA INTEGRITY

RSX-11M-PLUS IS PERFORMANCE

OVERLAPPED SEEKS = THROUGHPUT

RE-ENTRANT TASKS = MEMORY = THROUGHPUT

CHECKPOINTING = MEMORY = THROUGHPUT

- Libraries
- Commons
- Regions

SUPERVISOR MODE LIBRARIES = MEMORY = THROUGHPUT

RSX-11M-PLUS IS PERFORMANCE

POOL = MORE USERS AND/OR TASKS

- Executive Use of Instruction/Data Mapping
- Print Spooler (Queue Now on Disk)
- Terminal Driver (Private Pool)
- Secondary Pool (Accounting and File Information)