

RT-11

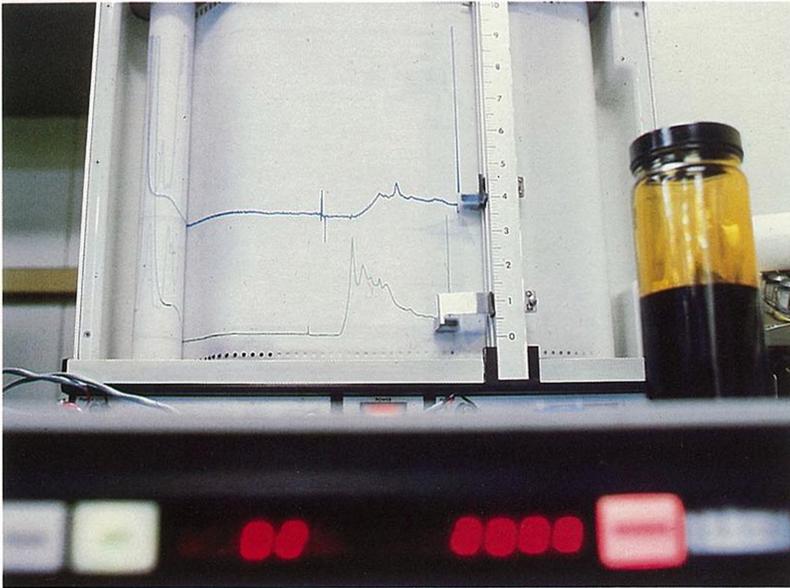


Single-User Realtime System

digital



Small, Fast, Reliable Realtime Systems



In single-user realtime situations, Digital's RT-11 system is a fast, reliable, and very economical way to gather information or control processes. It's easy to learn and use, and can function alone or as part of a distributed processing network.

That's why RT-11 fills the realtime needs in more than 20,000 installations around the world.

Realtime Waits for No System

RT-11's realtime input, processing, and output are extremely efficient. Because RT-11 occupies a minimum of memory, many of your realtime programs can be entirely resident in main memory. This means the system doesn't have to delay processing while getting instructions from secondary storage.

That's important, because when you have to collect data **now** or forever lose it, your system must be fast.

Speed is vital, but without reliable software all you'll get are fast mistakes. Years of development and use have made RT-11 as dependable as it is fast. Coupled with Digital's trustworthy hardware, it provides exemplary realtime service.

And although RT-11 is Digital's smallest operating system for PDP-11s, its sophistication rivals that of considerably larger systems.

Programmers will find a complete set of program development tools that includes a choice of three text editors, file and device maintenance utilities, an on-line debugger, and a number of patch utilities. RT-11 supports MACRO-11 assembly language and the high-level languages, single- and multiuser BASIC-11, FORTRAN IV, and APL-11. Digital's Forms Management System, FMS-11, is also available.

User training time is minimal because of RT-11's concise keyboard commands. With the indirect command file feature common command sequences can be executed by typing a single word. This saves time on the job and reduces the number of steps for which the user is responsible.

Because it has features normally found on larger systems and because it's so easy to learn, RT-11 serves very well as a development system, too.

Compact, Yet Versatile

Despite its size RT-11 is extremely versatile. It's available in three versions: the single-job monitor, foreground/background monitor, and foreground/background monitor with extended memory for systems with greater than 64 Kbytes of main memory.

With foreground/background and extended memory you can run a realtime and a general-purpose program simultaneously. For instance, people can interactively develop a program on RT-11 while the system monitors and controls an ongoing industrial or research process. Properly written programs created on a single-job RT-11 system can run unmodified in the larger monitors.

Consider the flexibility in RT-11 configurations, whether you are buying your first computer system or are expanding an existing operation. Each RT-11 system can support up to 16 terminals. With DECnet/RT, Digital's advanced networking software, RT-11 systems can be linked with other Digital operating systems for network operation. Using Internet protocol emulators RT-11 can efficiently communicate with IBM mainframe systems or other systems that support Binary Synchronous Communication (BSC) protocols.

Small, fast, and reliable, RT-11 emphasizes efficient use of system resources. It's compact and low-priced, yet delivers first-rate realtime performance.

RT-11 Concentrates Computing Power



A traditional newspaper adage perfectly describes RT-11's major role: Get it fast, get it straight, and get it out.

The "it" for RT-11 is data concerning realtime events.

Every realtime application includes two stages: first, the acquisition of data from an ongoing event and second, the immediate processing or storage of that data.

Realtime data processing can determine almost instantly whether action should be taken to affect the event being monitored. It can then take that action.

RT-11 Is the Choice for Single-User Realtime Applications

There are operating systems that can accommodate an amazing number of simultaneous users. Digital's RSX-11 or VAX/VMS systems, for example, are ideal for situations requiring multiuser, multiprogramming capabilities.

But in a single-user environment RT-11 is the choice. Here's why.

RT-11 was designed specifically to allow one person to execute one realtime program at a time. Although enhancements have increased RT-11's versatility, the original emphasis remains.

This means RT-11's minimum memory requirements are considerably less than those of timesharing or multiuser operating systems. Yet it has features you would expect from a much larger system. Features such as high-level language and multiterminal support, a strong editor, and distributed data processing capabilities. You gain economy of size without sacrificing sophistication.

Limited memory requirements mean RT-11 can run successfully on small low-cost hardware configurations, saving money and space.

That's a big plus because RT-11-based systems can comfortably be included in commercial, industrial, or scientific environments. Their size and price also make them economical "personal" computers for managers, engineers, or scientists.

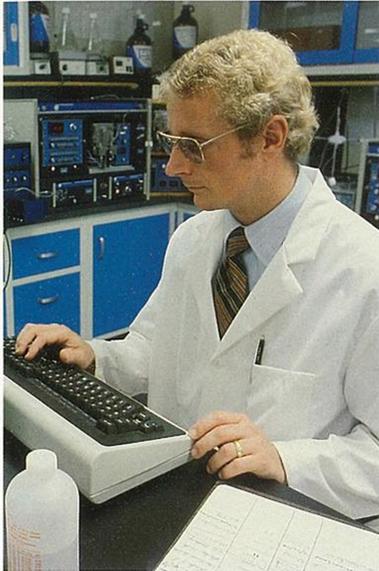
RT-11 MEMORY AND MASS STORAGE

	PDT-11/130	PDT-11/150	PDP-11/03 (LSI-11/2)	PDP-11/23 (LSI-11/23)	PDP-11/34A PDP-11/44 PDP-11/60
Minimum memory	32 Kb	32 Kb	24 Kb (32 Kb for FB)	64 Kb	24 Kb (32 Kb for FB)
Maximum memory	64 Kb	64 Kb	64 Kb	248 Kb Addressable	248 Kb Addressable
XM monitor support	No	No	No	Yes	Yes
Disks supported—capacity	None	RX01†—512 Kb	RX01†—512 Kb RX02†—1 Mb RK05—2.5 Mb RL01—5.2 Mb RL02—10.4 Mb	RX02†—1 Mb RL01—5.2 Mb RL02—10.4 Mb	RX01†—512 Kb RX02†—1 Mb RK05—2.5 Mb RL01—5.2 Mb RL02—10.4 Mb RK06*—14 Mb RK07*—28 Mb
Tapes — recording density (bits/in)/ read-write speed (in/s)	TU58—800/30	None	TU58—800/30	TU58—800/30	TU58—800/30 TU45—800, 1600/75 TS11—1600/45

*RT-11 is not distributed on RK06 or RK07 disk cartridges.

†Dual drive

Note: RT-11 systems require a random access, mass storage device and a separate backup device.
K = 1024; M = K².



Individual users can run their own programs without worrying about interruptions. Using the foreground/background capability they can perform complex calculations or interactive program development while the system monitors a realtime event. Your RT-11 system can take advantage of your mainframe and other systems through Internets or DECnet networking software. And its stand-alone computing power is among the best in its class.

Small Size Means Efficient Memory Usage

An RT-11 monitor is memory-efficient and its resident component occupies as little as 6 Kbytes of main memory. This means fast operation because an entire realtime program can be in main memory, so the system doesn't have to pause while processing to get instructions from secondary storage.

And because of the low monitor overhead of RT-11 it responds very quickly to interrupts when they are necessary.

But what happens to that speed if you have to access your disk? RT-11's contiguous file structure ensures extremely fast storage and retrieval. Data is stored in consecutive blocks on the disk, as opposed to blocks in random locations. Read/write head movement, which wastes time, can be reduced by more than 80 percent.

That makes RT-11 an ideal system for capturing data from high-speed realtime sources.

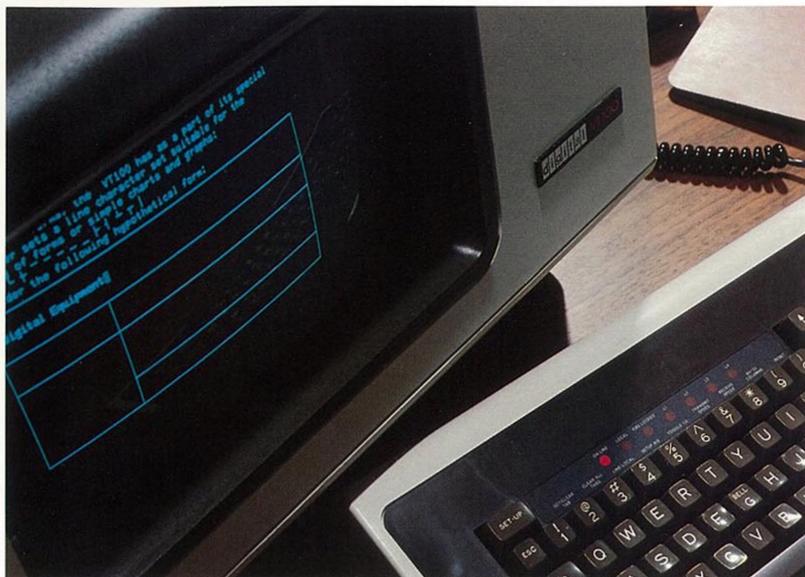
You're also easily able to maintain the largest consecutive number of blank blocks possible on your storage disks. "Squeezing" solves the common problem of small unusable empty spaces between files by consolidating all the empty blocks into one area.

A small system doesn't mean users are restricted to a limited area. Options are available that allow you up to 16 terminals on one RT-11 system. You use one of them, designated the command console, for all your user/system interaction. The others can be used for distributing current realtime data, for data entry, or related functions.

Suppose you are using your RT-11 system to monitor action in a wind tunnel. If design engineers in separate plants need up-to-date information about the test they could tap foreground output via dial-up lines. The data displayed on their terminals is exactly what the sensors in the tunnel are reading. And up to 16 people in 16 different locations can be included. Time, effort, and money are all saved.

Size, speed, and cost — three major considerations. But they're not the whole story.

System Flexibility Allows Tailored Configurations



RT-11 operating systems are available as a single-job monitor, foreground/background monitor, or foreground/background monitor with extended memory.

With the single-job monitor the entire system is devoted to the job at hand. This could be a realtime task such as monitoring a chemical reaction or controlling a production process. Or it could be a human interaction such as program development.

For greater capacity choose the foreground/background or the extended-memory monitor.

Using these monitors RT-11 can run a realtime task in the foreground and allow apparently simultaneous use of the background for another function such as interactive program development. What actually occurs is that the realtime task has priority and will override the background to accomplish its purpose. In many cases this happens so fast that the background user is unaware of it and appears to have the exclusive use of the system.

In foreground/background configurations the background job always uses the command console. The foreground can use any terminal on your RT-11 system, a feature that is very useful when the foreground is producing hard copies of data. You can produce those copies on a hard-copy printer, freeing the command console for uninterrupted background work.

And you can designate any one of your local terminals as the command console at any given time, so you are not restricted to a specific location or a specific device for your background work.

Often the foreground program merely records data, particularly when it is monitoring a high-speed source and processing the information would slow it down. You could then use the background program to perform lengthy data analysis or computations.

To do this, the foreground and background must be able to communicate. Although operating independently, they can transfer data through disk files or a message transmission facility.

Interfaces Provide Links to Realtime Sources

Digital offers many interfaces supported by optional application packages available for your RT-11 system. They are useful in a variety of applications including biomedical research, analytical instrumentation, data collection, data logging, monitoring, industrial testing, engineering, and technical education.

Included are synchronous and asynchronous interfaces, analog-to-digital and digital-to-analog conversion interfaces, and digital parallel input/output interfaces.

Examples of these are:

- AR11 for analog input and output
- DR11 for binary parallel input and output
- AA11 for analog output
- ADK11 for analog input
- IB11 and IBV11 General Purpose Interface Buses for any instrumentation that conforms to the IEEE 488 Bus Standards.

Also available are two programmable clocks, the general-purpose KW11-P and the laboratory-use KW11-K that has a specific range of frequencies, Schmitt trigger, and external input.

To make it easy to attach your instruments, the interfaces use removable, screw-terminal blocks and other plug-in connectors. Suppose you have four instruments which can use the same interface and are used at different times. You could attach connectors to each of them. When you have finished with one and are ready for another, all you have to do is pull out the connector and plug in the next one.

Should you choose to develop your own interfaces, there is extensive documentation that simplifies writing device handlers and interrupt service routines.



It's Easy to Grow, Vertically and Horizontally

You want a system that not only fills as many of your needs as possible right from the start, but also is easy to expand. An RT-11 system meets those requirements because it supports a wide range of processors and peripherals.

Requirements sometimes change, and the single-job RT-11 monitor that fills your needs today may someday require the additional capabilities provided by a foreground/background or extended-memory monitor. An important consideration is that a program properly written on a single-job system will run unaltered as a background program on the larger monitor.

But what if your expansion plans call for the addition of distributed workstations dedicated to specific realtime tasks? Then RT² is your answer.

RT² and RT²/PDT are execute-only subsets of RT-11. They run on LSI-based configurations and on the PDT-11/130 and PDT-11/150 series of intelligent terminals. This means you develop your programs on your RT-11 operating system, then transfer them to the execute-only systems for use. PDT intelligent terminals are used mainly for data entry, in data-base systems, and for local-office processing.

RT² and RT²/PDT have file maintenance utilities and the KED video editor and are available in single-job or foreground/background modes. They cost less than a full RT-11 system, so they're ideal for use in dedicated applications in which frequent change is unlikely and full-system capability unnecessary.

You can use your RT-11 system as part of a larger distributed processing network via the optional communications software packages, DECnet-RT and Internets. This approach improves the flow of information throughout your organization by exchanging data and sharing files and work among different computers in different locations.

Concise Commands Speed Learning and Use

Not all RT-11 system users are computer aces. But with the system's simple, one- or two-word keyboard commands, they don't have to be.

These commands are concise and easily learned. For instance, to get from source code to executing code in RT-11 you need only type EXECUTE. Without this feature you would have to type separate commands to compile the source program and to link the object file.

Another time saver is RT-11's indirect command file feature, which allows you to execute common command sequences with a single command.

For example, every time you start the system you may want to assign a series of logical device names to physical devices and to display on the screen a particular message. If you put the appropriate commands into an indirect command file you can automatically execute the entire file upon starting the system.

Another valuable benefit of indirect files is that users aren't required to know the steps needed to accomplish a goal. Consider research assistants using RT-11 to monitor an experiment. As far as they are concerned, all they have to do is to start the system and perhaps enter some preliminary data. What they don't know, and in fact don't *have* to know, is that RT-11 executed indirect command files that set all the parameters needed to monitor the experiment.

Indirect files can dramatically reduce operating and training time and costs.

Choose A Language That Suits Your Needs



A varied selection of languages enhances RT-11's versatility. The system supports the high-level languages, FORTRAN IV, BASIC-11, MU BASIC-11, and APL-11; and the MACRO assembly language. Digital's Forms Management System, FMS-11, is also available.

FORTRAN IV

FORTRAN IV is especially suited for solving engineering and scientific problems. It's based on the former ANSI FORTRAN standard, X3.9-1966, with a significant number of enhancements, particularly in regard to user convenience, performance, and capabilities.

With it you get a subroutine library much more extensive than the ANSI 66 specifications. Some FORTRAN IV subroutines provide access to the operating system, giving you and your program almost full access to all RT-11 system services.

Optional FORTRAN IV subroutine libraries also contain those defined by the Instrument Society of America (ISA) to control instruments for industrial and laboratory applications; realtime collection, control, and data reduction and analysis subroutines; graphics subroutines; the statistical and mathematical Scientific Subroutine Package (SSP) and the Laboratory Subroutine Package (LSP-11) for laboratory data processing.

A large part of realtime work can involve manipulating character information, and with FORTRAN IV you can do this. Also, you can treat bytes as either character or numeric data. FORTRAN IV supports single- or double-precision floating point for extending numerical precision and a set of logical operations to manipulate data types and data operations.

Digital's extensions to the 1966 standard give considerable control over files. You can specify file options at runtime. You can convert data from binary machine format to human-readable characters. You have statements for directly accessing fixed-length records in random access files. And with virtual array support you can set aside memory space for storing large amounts of data.

BASIC-11

Perhaps one of the easiest languages to learn, BASIC-11 supplies capabilities belied by its simple English-like statements.

When developing a program you know your statements are syntactically correct because BASIC-11 tells you immediately if there is a mistake in the line you have just written. There are commands for saving, editing, running, and retrieving your programs. The language supports real, integer, double-precision, and string data types, and you can define your own BASIC-11 functions in your programs.

For your larger applications you can use the chaining and overlay functions. Chaining links programs together by using a set of commands within those programs. You can develop modular programming units, test them, and then through chaining use them in more than one complete program.

In immediate mode, BASIC-11 serves as a calculator. It's a function of the language that requires no user programming, so it's valuable for infrequent calculations that don't have to be saved in memory. Immediate mode is also a valuable tool for debugging programs.

The language is based on standard Dartmouth BASIC and is available for all RT-11 monitors.

MU BASIC-11

Although RT-11 is primarily a single-user system you can employ the Multiuser (MU) BASIC-11 option to accommodate up to eight users. PDP-11/03 floppy disk systems can support up to four users.

MU BASIC-11 is a superset of BASIC-11. Because it equally divides the available memory among users, it is most useful in extended memory configurations of RT-11. It provides file protection and independent access to the system for each user.

In educational environments where there are several students developing low-level BASIC programs, fast response and large amounts of memory available to the individual are not crucial factors. An RT-11 operating system running MU BASIC is an economical alternative to either a more complex system or a group of single-job RT-11s.

An additional valuable use of MU BASIC-11 is as a mini distributed processing system. Because it serves as an unprogrammed calculator in its immediate mode, several people can use the same system to perform complex calculations. RT-11 supports dial-up lines, so you can have up to eight workstations on each system.

Another useful application is program development in the background by more than one person, while the foreground monitors a real-time event. Although the amount of memory available to each individual decreases as more users are added, you can still develop complex programs by using a modular subroutine breakdown.

MU BASIC requires a foreground/background or extended memory RT-11 configuration.

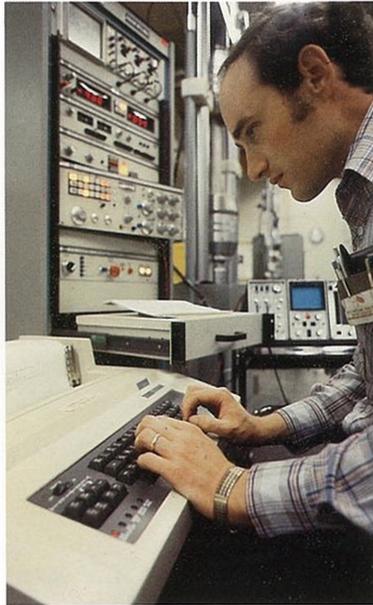
APL-11

One of the beauties of APL-11 is the speed with which new users can begin solving problems and creating elementary programs. And because it is a notational language you can learn almost immediately how to do operations that would be complicated or lengthy in other languages.

Originally conceived as a new mathematical notation, APL-11 has many characters that are mathematical operators used to perform complex operations with very few keystrokes.

APL-11 is particularly strong in scientific, engineering, and mathematical applications. You can use its function-definition mode for constructing and saving full programs. Or you can use its immediate mode as a highly sophisticated calculator to solve very complex equations. To switch from one mode to the other you need strike only a single character.

Clearly, APL-11 is a strong choice for in-lab applications requiring minimum training and maximum usage.



MACRO-11

MACRO-11, a powerful assembly language supplied with RT-11, processes source programs and produces relocatable object modules. It has extensive macro features you can use to code directly and efficiently in machine language. You can define individual macros that describe entire sequences of operations. Define the macro once, and you can use it repeatedly in any subsequent program through a single macro call.

FMS-11

Digital's Forms Management System, FMS-11, gives you the capability to create video forms that are easy to read and use, and resemble traditional paper forms. You can modify the forms without changing the application program. FMS-11 has help facilities and field checking, and reacts rapidly to your inquiries and responses. Its ease of use and structure ensure rapid and efficient movement of data through the application and the system.

Large-System Features Make Programming Easy



Although it is Digital's smallest operating system for the PDP-11 processor family, RT-11's features compare very favorably to those of much larger systems. The combination of these features and the ease of use of the system makes RT-11 an excellent development tool. For instance, many manufacturers develop programs on RT-11 that run on LSI-based configurations not requiring a full-blown operating system of their own.

RT-11 operating systems provide device-independent input/output. Suppose you have a program that requires output to a lineprinter, but the lineprinter is otherwise engaged. Device independence allows you to dynamically direct the output to a disk, thus letting the program continue. You can print the output later. Without this capability the program would not be able to run until the lineprinter was free or the program was changed.

Programmers have a choice of three modes of input/output in RT-11 to meet varied requirements:

- **Synchronous** where user program processing is suspended until the completion of the I/O event. This is the most common and simplest to use.
- **Asynchronous** where an I/O event is started and user program processing continues until a user-defined point is reached. Processing is then suspended until the I/O event is completed.
- **Event-driven** where an I/O event is started and user program processing continues until the I/O event ends. Processing is then interrupted to service the completed I/O event.

You can easily expand your RT-11 system. Not only do you have support for numerous PDP-11 processors and peripherals, you can also interface unique devices by writing a device handler and storing it as a file on the system device.

And when a new peripheral handler is added to your system, properly coded programs can immediately use the device without additional coding or reassembly.

Industry-compatible 7- or 9-track magnetic tape gives you flexibility and versatility in intersystem communication. You can create files using RT-11's subset of ANSI-compatible labels and fixed-length unformatted blocks.

RT-11 has a complete job control subsystem that provides batch mode processing. In foreground/background environments, batch processes job streams in the background, allowing realtime or other jobs to run in the foreground. This is very useful for lengthy tasks that don't require your presence or for frequently run production jobs. Batch also runs on single-job monitors.

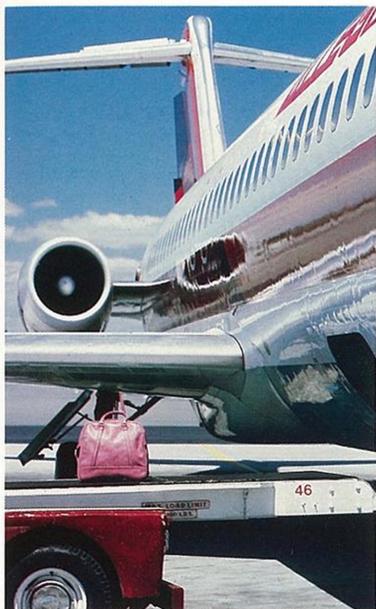
Usually RT-11 is shipped generated and ready to use. However, should you require special features or want to closely match your system to your application, the system generation process can be performed on location. It's a simple question-and-answer dialogue.

Good Utilities Enhance Your RT-11 Use

You want a system that's going to make your program development easier, your everyday use uncomplicated, and your system updating as painless as possible. RT-11 utilities help to give you that system.

Consider RT-11's two editors, the KED keypad editor and the EDIT text editor. Use KED with Digital's VT52-type, VT100 video and VT105 graphics terminals. It has a full set of function keys with which you can quickly and accurately make changes to your files. You see those changes on the screen as soon as you make them and can recover data accidentally erased. And your entire main file is available throughout the editing session.

With hardcopy terminals, use EDIT to interactively create and modify ASCII files such as programs, data files, memos, and reports. EDIT uses both character- and line-oriented commands, with provisions for command interaction, editing macros, and file manipulation. With



it you can locate the text to be changed, execute and verify the change, list an edited page on the console terminal, and send a page of text to the output file.

To ease your program development there are several utilities to help find, diagnose, and correct programming errors. Typical of these is the on-line debugging technique (ODT) with which you can control program execution, examine memory locations and alter their contents, and search an object program for specific words.

Additionally, all languages supported by RT-11 provide you efficient tools that streamline program debugging by minimizing the need to rerun programs. These include BASIC-11 immediate mode and STOP statements; FORTRAN IV error diagnostics, traceback features, conditionally compiled statements, and program execution monitoring; and APL immediate mode and automatic display of immediate function execution results.

These combine with standard system libraries and your own unique macro and object libraries to give you strong development tools. You also have utilities that compare ASCII or binary files and list the differences. This is particularly useful when you have two similar versions of a program to compare.

For day-to-day operation you have solid file-handling capabilities. With them you can move files among your RT-11 devices and between RT-11 and other Digital operating systems. You can protect the files from accidental deletion. You can consolidate free space on your disks. You can list directories of your files by name, type, date, size, or position. Or you can reformat files so they can be used by systems other than RT-11.

System Jobs Increase Capabilities

Also available through system generation are two system jobs, Queue and Error Logger. Either or both will run simultaneously with your foreground and background operation. Queue can also run as a simple foreground job without requiring a system generation.

Using the Queue Package you can transfer data to any valid RT-11 device. For example, you could use it to make copies of long tapes by specifying the system backup device for output. The lineprinter is the default, and RT-11 will automatically transfer responsibility for print commands to Queue when it is running.

Of course, you can output data without the Queue option, but the important point is this: while Queue is taking care of your output, you have full use of the background and the foreground. Without Queue, one of the modes would be occupied producing the output, which could considerably reduce your use of the system.

The Error Logger monitors hardware reliability of your system and keeps a statistical record of all input/output operations and errors on devices it supports. It produces reports that can be useful diagnostic tools.

Utilities make your file maintenance almost automatic. You have the capability to modify any file on any random access storage volume, and you can do it from the console, from an indirect command file, or from a batch stream.

Updating a system can be a tedious, time-consuming process. But your RT-11 system is equipped with tools to make it as easy as possible by using interactive, logical questions and answers.

Whether you are a planner, a programmer, or an application user, you'll be pleased with your RT-11 system because your requirements dictated its design and development.

Distributed Data Processing Puts the Round Pegs in the Round Holes



Streamline your total computer capability and fit it into your organization with distributed data processing. Segment your operations, matching a computer of the right size, price, and capability to each task. Then control the teamwork of these computers to let them share data, peripherals, and programs — so work is done most efficiently and information is made available when and where it's needed.

Distributed data processing capitalizes on the decreasing cost of hardware and simplifies expansion. For example, your plans for the next five years may link increased computing power to greater output of goods or services. Using the distributed data processing concept you can buy only the computers you need now, then add to them as your plans are implemented. Not only will this lower your initial investment, it also will result in lower expansion costs as the price of hardware continues to decline.

Vital parts of the distributed data processing philosophy are flexibility and reliability of communication among systems. And Digital's DECnet and Internet optional communication software packages fill those needs.

Use DECnet-RT for All-Digital Networks

You can use DECnet-RT to connect to a network of Digital computer systems.

DECnet-RT equips you to send messages to and receive them from any terminal user on the network. You can copy or delete files on another system on the network if you have the proper security privileges. Or submit batch and command files to another DECnet system, except another RT-11 system, for execution and storage. Through the task-to-task capability, programs on different systems on the network can exchange messages, even if the programs are written in different languages. And during communication both DECnet systems have full use of their common capabilities.

Also through DECnet-RT you can use the resources of another system. Suppose you're running an experiment or process that will produce masses of data. If your RT-11 system doesn't have enough storage, but another system on the network does, you can transmit the data through DECnet-RT to that system's storage device. Then if you need the data elsewhere you can physically transport it or electronically transfer it if the destination is on the network.

All DECnet products are based on the Digital Network Architecture (DNA), a nonrestrictive strategy for compatibility among different Digital systems, mixed-vendor systems, and different communications schemes.

DNA provides the two keys to successful distributed processing: the ability to tie a large variety of computers into a network and the ability to use new communications technologies and services to reduce data communication costs without having to redesign, restructure, or reprogram the entire network.

And Internets for Mixed-Manufacturer Networks

If you already work with a non-Digital mainframe system you may improve its cost effectiveness by off-loading functions and applications to satellite minicomputers. Protocol emulators, called Internets, serve as the communication link between Digital's and other manufacturers' computers.

RT-11's 2780/3780 emulator package provides a simple means of transferring files to an IBM System/370, or another computer system that supports standard 2780/3780 point-to-point Binary Synchronous Communications (BSC) protocols.



You have greater flexibility and more capabilities with the package than with the IBM terminals it emulates. For example, you have more input/output devices for storage. And your indirect command files can include emulator start-up for unattended operation. During unattended operation, errors could cause a failed procedure to tie up system resources. But you can use the emulator's error recovery procedures to prevent this.

For batch processing, you can use your Internet capability to accomplish remote job entry. Suppose your RT-11 system is gathering data for lengthy scientific computations by a large mainframe. The data can be collected, then transferred offline to the mainframe for processing. Results from the computations can then be received at the RT-11 system.

Whether you use DECnet-RT or Internets, satellite systems are a flexible, cost-effective way to balance your computing capacity with your actual needs. In helping you strike this balance, Digital can give you the quality support that's helped make us the leading small computer manufacturer in the world.



Who's Using RT-11?



The following are three of the many ways RT-11 operating systems are serving realtime needs.

Reacting Fast in the Laboratory

Dr. Bob O'Connell's working area comes down to less than two microns, and one of his requirements is to monitor and record 10,000 samples *per second* from that area.

He is a neurobiologist at the Worcester Foundation for Experimental Biology, researching electrical activity in the nervous system.

One of the traditional problems in such work is that the recording probes are much larger than the neural elements being monitored. They always register electrical activity from more than one element, and equipment is needed to sort signal sources.

But laboratory space is at a premium, and in addition to speed, the equipment has to be physically compact.

RT-11 is the answer. Not only for Dr. O'Connell, but for two other researchers at Worcester equipped with individual RT-11 systems. A fourth researcher uses Digital's Modular Instrument Computer, or MINC system. Built around RT-11, MINC is portable and easy to use, and it combines the best features of desk-top calculator/computers and laboratory minicomputer systems. For large-scale numerical and graphic analysis, they have access to a PDP-11/34 running RT-11.

Dr. O'Connell's system includes a previous version of RT-11 running on a PDP-11/10 with 56 Kbytes of main memory. Of that the foreground/background monitor occupies only 2.4 K. He uses an RK05 disk drive.

According to Bob Sypek, a programmer at the Foundation, there were several reasons why RT-11 was the prime choice.

First, it is a simple operating system to use. The researchers don't have to go through a long dialogue to get on the system and start using it.

Other more important reasons deal with the size and file structure of RT-11.

"From a programming point of view, we use RT-11 because it doesn't get in the way of program function," explains Sypek. "Once RT-11 loads your program into memory, it leaves the environment and will only come back into the picture if you specifically request a service to some I/O device."

"It also means there's no overhead associated with the monitor," he continues. "We can run data acquisition at the maximum speed possible through the hardware, although in this case we would run at only 10,000 samples a second."

RT-11's contiguous file structure was a major consideration. Since Dr. O'Connell's work involves data acquisition at very high speeds, his system must move data out of main memory and into secondary storage very quickly. Because the file blocks are located physically next to each other on the disk, the read/write head movement is minimal.

"When RT-11 requires the disk-drive head to move, it has to move only one track, which takes about 10 milliseconds," Sypek notes. "Using other operating systems [with non-contiguous file structure], we would probably be waiting 50 to 70 milliseconds. RT-11's speed means we can write out the data to the disk as fast as we can sample it."

How important is that? For Dr. O'Connell, the answer is simple:

"If we had to have a system where we had to go away from the actual experimental situation and wait to find out what had happened in our data, we wouldn't be able to do the experiments that we can do."



Thank RT-11 When You Fly Boeing

How do you choose a material for the structural members of an airplane wing? Or the rivets? Or any other part of an aircraft that will travel at great speed over great distances? One thing is certain — whatever is chosen must successfully endure the tremendous loads and stresses of modern flight.

Long before Boeing aircraft fly, many of the materials used to make them are stretched, compressed, twisted, and broken at the Boeing Developmental Center in Seattle, Washington. The aim is to test their limits under conditions that simulate the actual service environment.

RT-11 controls the testing.

Digital Equipment Corporation products form part of the central nervous system of Boeing's multiuser automated test system, designed and manufactured by MTS Systems Corporation of Minneapolis, Minnesota. MTS builds systems for laboratory and industrial fatigue testing of everything from snowmobile seats to new mining equipment.

The Boeing system has three independent material testing stations. They are controlled by an RT-11 extended memory monitor running a variation of Digital's multi-user BASIC-11 (MU BASIC-11). The Digital hardware used includes a PDP-11/34 with 128 Kbytes of main memory, an RL01 mass storage device, and three LA36 hardcopy terminals.

MTS designed and built the device drivers, interfaces, and analog controls that blend their equipment and Digital's products into a powerful tool.

Although primarily a single-user system, RT-11 was chosen for the Boeing application for three important reasons: speed, size, and reliability. John Kirk of MTS, applications engineer for the project, explains.

"MTS has been using RT-11 as a single-user system for about five years now, and it's been very satisfactory for us. Whereas most process control applications require a response time of seconds, the tests we're doing require *very* rapid response — on the order of milliseconds.

"MTS systems are customer-programmable. We're very happy with the BASIC-11 language because it's so easy to write programs with it. Our aim is to make it possible for test engineers to write and successfully run test programs quickly."

In many applications, including Boeing, MTS writes the first application program to bring the system online as soon as possible. All other testing programs have been written by the Boeing test engineers.

MU BASIC-11, a Digital software option that's a superset of BASIC-11, equally divides the available memory among up to eight users. The version running the Boeing test system was customized by MTS to handle fracture, fatigue, tensile, and compressive tests on a wide variety of material.

Because of the MU BASIC-11 option three people can use the same test system for three different functions. For example, two may be testing materials while the third is developing a test program.

And the RT-11 monitor occupies only 15 Kbytes of main memory, so each user has enough main memory available to run significant programs.

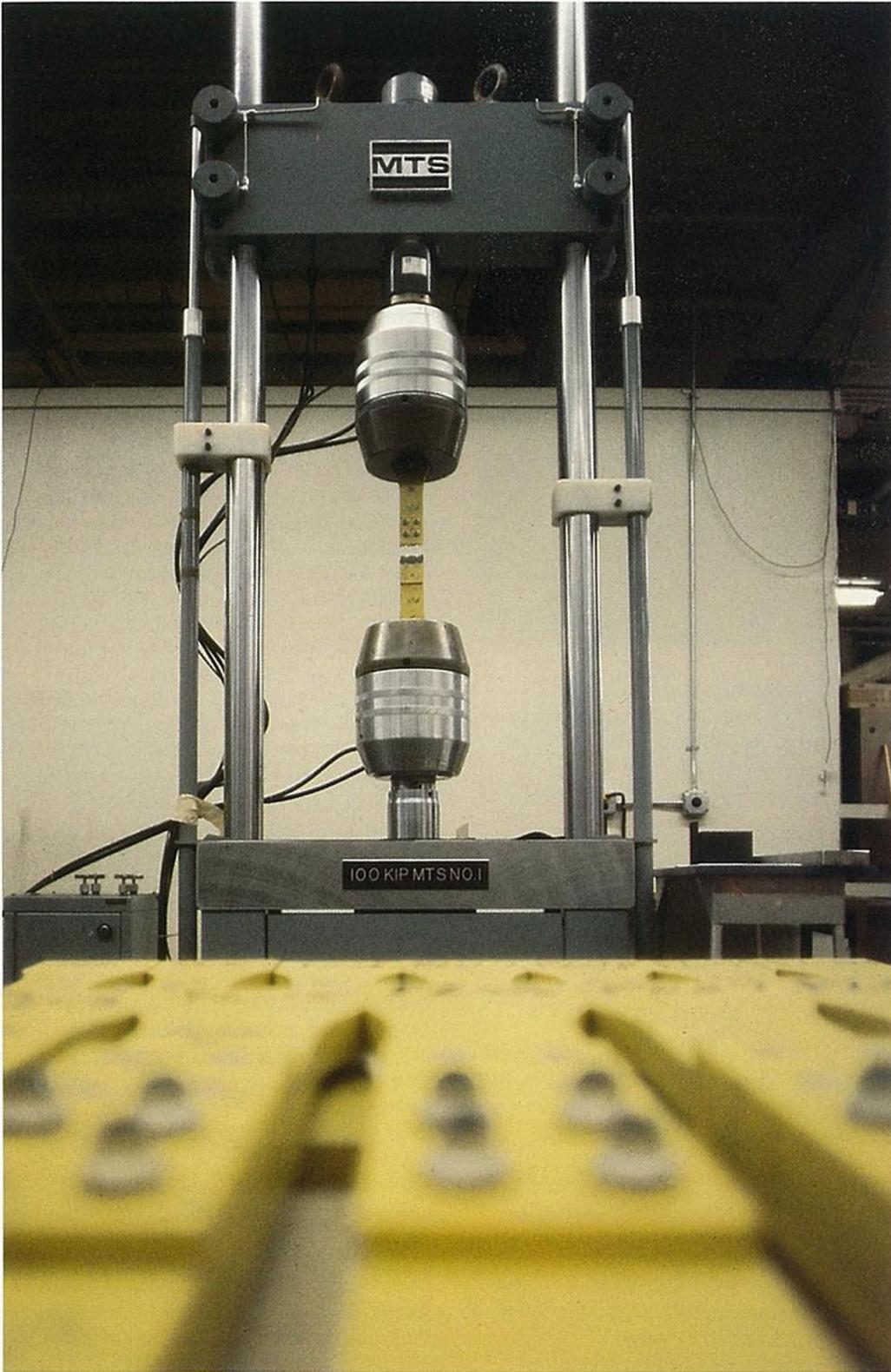
Digital Equipment Corporation's usefulness to MTS and Boeing doesn't end with supplying software and hardware. During the MTS warranty period the company cooperates with DEC service to resolve many computer-related queries.

Just as other companies on the move, RT-11 is not limiting its options regarding the operating system it uses. But it has no intention of changing for change sake. Kirk sums it up this way:

"The RT-11 software is well proven for us. We have a large number of machines in the field operating very successfully, but we're always looking at what's available in the marketplace. For example we are now designing some applications that use a Digital RSX-11M operating system for laboratory-wide data management and RT-11 for test system control.

"This looks like a good blend because it uses the best features of each operating system, which optimizes the benefits to our customers.

"Right now, RT-11 is the best available for test system control."



Support Services Back You Up



Since 1959, when the PDP-1 was introduced, Digital Equipment Corporation has been developing interactive computer systems for science, engineering, education, government, medicine, manufacturing, distribution, and service industries. Digital products let users match the computer system to the job.

Supporting these powerful computer systems is the complete Digital family of people, products, and services. Digital's resources are truly worldwide. And they are committed to serving you.

Digital's Services Can Help You

Digital's Field Service organization includes more than 8,000 specially trained technicians in 360 locations around the world. These professionals are supported by local inventories and a supply network that radiates throughout the world to provide quality cost-effective support to users of more than 150,000 Digital computers.

Software Services, a global organization with more than 1,500 software professionals, is dedicated to satisfying the diverse software support needs of Digital customers.

Digital's software specialists are experienced in analyzing and designing systems, modifying Digital software to meet special needs, and developing custom applications software.

Wherever the location, whatever the product, all Digital service personnel give you fast response and knowledgeable help with your Digital products.

Start with Your Digital Representative

First study your application and requirements with your Digital sales representative to determine your computing needs. The sales representative can call in software and hardware specialists to answer specific questions. These specialists have two resources to draw on for designing systems. They may use Digital's standard products or they may refer you to an Original Equipment Manufacturer (OEM) whose RT-11-based product more closely matches your application requirements. The Digital OEM Referral Program provides the sales force with current information about RT-11-based systems available in the marketplace.

Once you have determined your requirements you and your sales

representative select a system configuration. Site requirements such as adequate floor space, electrical capacity, air conditioning, and humidity control are reviewed. You also select a Field Service maintenance plan that fits your needs and budget. Your salesperson writes up your order and, if necessary, helps arrange financing.

You can train your personnel by taking advantage of some of the more than 250 comprehensive educational programs that Digital offers at training centers throughout the world. By purchasing an RT-11 system you obtain a training credit to apply to the cost of Digital's courses.

When the system selected warrants or the application is complex, you and your sales representative can request a Customer Support Plan from Digital. An experienced software specialist will investigate your needs and expectations to help you identify your support requirements for success. The Customer Support Plan is an indepth formal document that specifies both Digital's responsibilities and your own in maintaining your system. The plan details the services you will receive, their costs, and when and how they will be delivered.

On delivery, representatives from Digital's customer service organization are at your site to ensure smooth installation.

Following installation, Digital's support organization is available to assist with any special needs that arise during or after the warranty period. A range of post-warranty software product services is available to help you continue support and maintain your software on an ongoing basis. Software consultants and the Computer Special Systems group are also available to help design and build systems to meet individual requirements.

The Digital Equipment Computer Users Society (DECUS) is an independent organization run entirely by user members. DECUS maintains program libraries and other useful materials for users of Digital interactive systems. These resources are available to DECUS members on request. Periodic meetings of DECUS members allow continued interaction and information exchange for Digital users.



digital

DIGITAL EQUIPMENT CORPORATION, MAYNARD, MASSACHUSETTS 01754