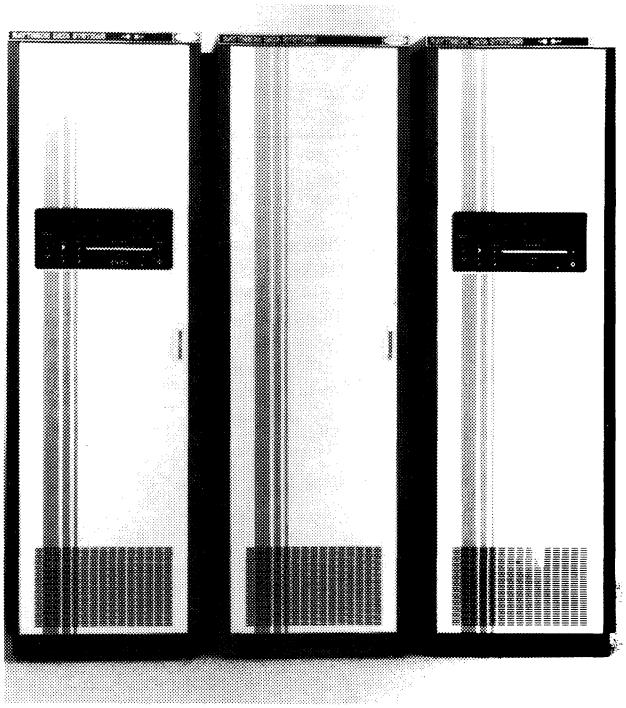
Raytheon Data Systems
Raynet Network Processing Systems



This basic one-for-one redundant Raynet system includes primary and backup processing units on the left and right, and a Modem Switching Device in the center. In this particular configuration, up to 31 full duplex communications lines can be supported. The back-up processing unit provides a hot-standby architecture for fail-safe operation in critical environments; switchover is automatic upon any system component failure.

A family of remote communications processors designed to perform data concentration, protocol conversion, network management, store-and-forward message switching, and similar tasks in a single- or multiple-mainframe network.

System hardware consists of up to 3 processing units, each of which can provide 256K bytes of main memory and support up to 47 full-duplex communications lines. Full or partial system redundancy can be supported.

A non-redundant Raynet/I that supports 15 communications lines and includes network management and remote concentration capabilities is priced at $55,000, plus $11,000 for operating software.

A fully-redundant Raynet/III that supports 15 lines and includes multiple host access and protocol conversion functions is priced at $174,000, plus $17,500 for operating software.

Leasing arrangements and maintenance contracts are available.

MANAGEMENT SUMMARY

The Raytheon Raynet family is a series of network processing systems that perform remote concentration, communications processing, and message switching functions. Raynet systems are installed in locations remote from the host site and communicate with the host via communications lines. In a network with a large terminal population, a Raynet system, by concentrating data transmitted between itself and the terminals into fewer high-speed lines to the host, can make more productive use of communications lines. The Raynet system can also provide increased network monitoring and control capabilities for the network, and can offload the host system and/or its front-end processor from some communications processing tasks. In an expanding network, the Raynet may be able to forestall the replacement of a host or front-end processor that would otherwise have reached its physical line capacity or become overloaded by communications processing requirements.

In certain configurations, a Raynet system can also be used to integrate non-compatible mainframes, including IBM, Univac, and compatible systems, into a single network, with transparency to all involved hosts. In this type of ➢

CHARACTERISTICS

VENDOR: Raytheon Data Systems Company, Minicomputer/Communications Operation, 360 Forbes Boulevard, Mansfield, MA 02048. Telephone (617) 339-5731.

DATE OF ANNOUNCEMENT: February 1979.

DATE OF FIRST DELIVERY: Raynet/I—March 1979; Raynet/II—second quarter 1980; Raynet/III—third quarter 1980; Raynet/IV—first quarter 1981 (projected); Raynet/V—fourth quarter 1981 (projected).

NUMBER DELIVERED TO DATE: 76.

SERVICED BY: Raytheon Data Systems.

CONFIGURATION

Raytheon's Raynet Series is a family of turnkey dedicated communications processing systems based on Raytheon's RDS-7500 minicomputers. The Raynet family currently comes in five models, which utilize similar hardware but vary in the level of functionality supported. Each model is upward-compatible with and cumulatively more powerful than the next lower model. The five models include:

Raynet/I—provides line and message concentration and traffic management for multiple interactive terminals communicating with a single mainframe using a single line protocol.

Raynet/II—provides line and message concentration and traffic management for multiple interactive terminals ➢

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network, the Raynet system permits terminals to operate in a "virtual" mode, in which they can access multiple hosts or multiple channels on a single host for different applications. The Raynet performs all the routing, protocol conversion, and other tasks required with transparency to the terminal operator and the host. This virtual capability reduces the need for "duplicate" hardware or communications lines to be dedicated to specific applications.

The Raynet systems are multiprocessing, multitasking systems that are provided by Raytheon on a turnkey basis. When the Raynet family was introduced in February 1979, the systems were based on Raytheon's RDS-500 minicomputer. However, when Raytheon introduced its new RDS-7500 in August 1980, the Raynet systems were upgraded to the new processor, which provides significantly increased capabilities. For example, in the RDS-7500, the old RDS-500's electromechanical T-Bar switch is replaced by multiple high-speed internal channels for interprocessor communications. Other improvements include increased main memory size (from 128K to 256K) and a new operating system, the Pre-emptive Communications Operating System (PCOS).

The Raynet systems are currently offered in five models that are identical hardware-wise, but are cumulatively more capable in the functions provided by their software. Each model is compatible with, and upgradeable to the next higher model, as well as being expandable within itself in terms of the number of processors, lines, and other features it supports. The Raynet/I is remote concentrator and network manager for single-protocol, single-mainframe networks. The Raynet/II adds the ability to access multiple hosts or multiple applications within a single host, using a single protocol. The Raynet/III adds a multiple-protocol capability. The Raynet/IV provides full store-and-forward message switching functions and provides up to 1200 MB of disk storage for messages. The Raynet/V adds the capability of high-speed node-to-node communications between one Raynet system and another.

Up to three processing units can be included in any of the Raynet systems. All processors may be on-line simultaneously ("active"), or, in environments that require fail-safe operations, one of the processors can be used to provide partial or full back-up to the active processor(s). According to Raytheon's "rule of thumb", the recommended line capacity is 47 full-duplex lines per active processor. In certain specific applications, e.g. PARS networks, Raynet's recommended line capacities can be increased to as much as 63 full-duplex lines per processor. In other cases, especially where wide bandwidths produce a very high transaction volume, the 47-line "rule of thumb" may be reduced.

Unlike certain communications processors, like IBM's 3705, which have line capacity limitations based on aggregate bandwidth, the Raynet systems' throughput is determined by transaction volume. This is because each line adapter in a Raynet system is an independent microprocessor with its own predetermined line capacity.

communicating with multiple mainframes or multiple partitions or applications within the same mainframe, using a single line protocol. Up to 16 hosts per system can be accessed, using simple keyed commands.

***Raynet/III*—provides line and message concentration and traffic management for multiple interactive terminals communicating with multiple mainframes using a variety of protocols. This "virtual terminal" capability permits a terminal to access various applications in non-compatible mainframes; to accomplish this, the Raynet/III provides automatic protocol conversion that is transparent to both the host and the terminal operator.**

***Raynet/IV*—provides a complete message switching system that controls, stores, queues, and routes messages from any terminal or mainframe to any other terminals or mainframes attached to the network via the Raynet/IV system. Terminal-to-terminal, as well as terminal-to-mainframe links are supported. The Raynet/IV accommodates disk storage of up to 1.2 billion bytes to support its message switching functions and limited data base facilities.**

***Raynet/V*—provides for high-speed communications between multiple Raynet nodes, permitting messages to be transmitted from a terminal or mainframe connected to one Raynet/V to terminals or mainframes connected to another Raynet/V, regardless of geographical location. Node-to-node traffic is supported at 50K bps using HDLC.**

Each Raynet system is modular in design and consists of one to three processing units. Each processing unit supports its own power supply, one to four memory modules, one or two Superbusses, one high-speed interprocessor bus, an operator's panel, three feature boards, and communications multiplexers and line adapters for connection of peripheral devices and communications lines. Each processing unit occupies a separate cabinet, which also houses power supplies and boards associated with that processing unit, and up to two communications multiplexers and their associated line adapters. Within each cabinet, the processing unit resides on a single PC board and provides timing and signalling, performs arithmetic calculations, and manipulates data, in response to RDS-7500 software instructions. Multiple processor units can be used to increase the system's level of performance, or to provide partial or total on-line redundancy for critical environments.

Each memory module contains 64K bytes of random access memory, for a maximum of 256K bytes per processor. Each module performs its own error checking and correction routines and controls access to its memory. The memory I/O transfer rate is 45 million bits per second. The memory processor cycle time is 700 nanoseconds. The memory module provides two ports through which memory can be accessed simultaneously, each by a different bus device.

The Superbusses provide the bus structure utilized internally in each processing unit, via which it accesses its own memory and other internal operating modules.

Up to three interprocessor busses (one per processor) may be configured per Raynet system. Each interprocessor bus (IPB) provides an independent high-speed channel that permits multiple processors to communicate with one another or with attached I/O devices. Data is transferred by the bus at essentially memory speeds. Up to 8 devices, such as multiplexers, peripheral controllers, and processing units, may be connected to each bus. The system's modular architecture permits any processing unit to be powered down for maintenance without interfering with IPB operations associated with other processing units.

The operator's panel permits the operator to start, stop, or modify the execution of a program, and to monitor operating

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The system's central processing unit(s) receive and respond to I/O messages as they are presented to the system by each line adapter. Raytheon estimates that for a system that processes incoming messages of an average of 40 characters in length and outgoing messages of an average of 200 characters in length, maximum throughput should be about 40 transactions per second per active processor. This estimate is based on experience in interactive-type airline reservation networks that utilize the PARS protocol. Maximum throughput can be "fine-tuned" through adjustment of buffer sizes and other internal factors. Of course, the ultimate limitation of network throughput lies with the host, which may place restrictions on the network in terms of response time, speed, and/or aggregate throughput.

Many of the first major Raynet users are members of the airline industry, such as TWA and United Airlines, who use the Raynet systems in their airline reservations systems. In their networks, the Raynet system manages the traffic flow to and from a wide variety of PARS users, including airline ticket counters, travel agents, food services, and related businesses. Raytheon's early experiences in this specialty application has gained them a firm foothold in the communications processing marketplace, from which they have been pursuing new target markets, both those with general commercial applications such as manufacturing, finance, and distribution, and those with other specialty applications such as electronic mail.

USER REACTION

In December 1980, Datapro interviewed by phone four users, whose names were provided to us by Raytheon Data Systems. These four users had a total of 45 Raynet systems, which had been installed for between 10 months and 2½ years. Of the 45 systems, 16 were Raynet/I's and 4 were Raynet/II's based on Raytheon's older RDS 500 minicomputer; one user's 25 systems were custom systems based on an enhanced version of the RDS-500. Three of the users were members of the airline industry who were using the Raynet systems as part of airline reservation networks; a fourth user was a distribution firm whose network applications included order entry and processing and inventory management. Three of the users' systems were being maintained by Raytheon's field service personnel; a fourth user did his own system maintenance. These users' ratings were as follows:

	Excellent	Good	Fair	Poor	WA*
Overall performance	2	2	0	0	3.5
Ease of installation	2	2	0	0	3.5
Throughput	2	1	1	0	3.3
Hardware reliability	3	1	0	0	3.8
Promptness	2	1	1	0	3.3
Quality of maintenance	2	0	0	2	2.5
Manufacturer's software	1	2	0	0	3.3
Manufacturer's technical support	2	2	0	0	3.5

*Weighted Average based on a scale of 4.0 for Excellent.

conditions of the system's hardware and software components.

Each feature board contains program logic for specific system functions. The Standard Feature board provides a data I/O exchange program, a console display interface, a hardware bootstrap for the cassette or diskette subsystem used for systems loading, and a 16-level priority interrupt system. The Extended Feature board provides a high-speed multiply and divide capability for fixed-point arithmetic, a parity detection function, and a memory protection utility. The Communications Feature board provides a memory write protect routine, which permits specified areas of memory to be protected; a watch-dog timer, which automatically loads systems programs when certain failures occur; and an interval timer, which enables the system software to track certain events while the system is running, accumulate status and statistics reports on these events, and report them at specified time intervals, all without operator intervention.

Physically, each communications multiplexer, via its associated line adapters, can connect up to 16 communications lines. However, the actual number of lines that can be handled is subject to throughput limitations, which vary depending on data rates, message lengths, message types, and line protocol. From a practical point of view, Raytheon estimates that a Raynet system can provide full services for a maximum of 47 full duplex lines per active processor, in any mix of speeds up to 9600 bps. The highest line speed that can be supported is 56K bps, with appropriate trade-offs in the number of lines that can be accommodated. Line capacity may also be reduced by redundancy requirements or other factors. In certain applications, such as airline reservations, the line capacity of a Raynet system may be able to be increased to as much as 63 full-duplex lines per processor.

Peripherals to the Raynet communications procesors include an internal floppy disk (available in second quarter 1981) or a tape cassette unit for local program loading and storage of diagnostic software and configuration tables a keyboard/display console for system diagnostics and maintenance, status and statistics reporting, and system reconfiguration; a console printer for hard-copy output; and, on the Raynet/IV and Raynet/V systems only, disk storage for store-and-forward message switching and limited data base storage (standard on Raynet/IV, optional on Raynet/V), magnetic tape storage for transaction and traffic archiving (optional on Raynet/IV and Raynet/V). Peripherals can be attached directly to the interprocessor bus or to an adapter in the communications multiplexer, and can be controlled and/or accessed by any processing unit in the Raynet system.

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Raynet systems can provide for partial or complete system redundancy, or "fail-safe" operation, in critical environments. In a two-processor system, one of the processors can be used to provide a 100% hot-standby back-up. In a system with three processors, one of the processors can serve as on-line

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The one user with the custom systems declined to rate the "manufacturer's software" category because all software, including the operating system, had been developed in-house.

All of these users were among the Raynet's first installed customers. As such, each has experienced a very close relationship with Raytheon. Two of the users had particularly high regard for Raytheon, and reported that Raytheon communications specialists in the field are generally at their disposal. These two users also reported that, if a problem could not be handled by field service personnel, Raytheon sent in a "crack team" of systems software people to resolve it.

Advantages of the system, as reported by these four users, include stablization of the network, predictability of throughput, the capability to access multiple mainframes for different applications, an increase in the number of terminals that could be included in the network, and hardware reliability.

Raytheon's maximum throughput estimate of 40 transactions per second is apparently right on target. One user reported that his system frequently handles peaks of 35 transactions per second, and doesn't start to "choke" until it reaches about 42 messages per second; sometimes the line handlers have more trouble with heavy traffic than the central processing unit.

Two of the users reported that installation was easier than expected, and that once the initial system was installed, additional Raynet installations were even easier. One user added that when changes in the network need to be made, the system is also easy to reconfigure. One of the three users who rated hardware reliability as "excellent" said that if there had been a rating higher than "excellent," he would have used it.

On the negative side, these users reported that, in spite of the fact that the Raynets are supposed to be turnkey systems, they have had to provide a lot of technical support themselves. Several have written, or are in the process of writing, software for functions not fully developed by or not available from Raytheon. These included: remote (i.e. using the host console) network management, error detection/checking/recovery schemes, diagnostic routines, and statistics reporting. Simulation of a reconfigured network before it goes on-line and testing of new software or hardware components are left pretty much to the user.

One of the users pointed out that, regardless of the marketing brochures, the system does not operate in an unattended environment, and in fact requires the availability of a fairly sophisticated technical person. In addition, its environmental requirements are as "touchy" as a mainframe's, and it is unlikely that those requirements could be met in an unattended location. Another user pointed out that when his communications specialist from Raytheon is not available, the remaining Raytheon field staff is rather weak. Hardware-wise, the only complaint from these users was the lack of quantity and quality in spare parts.

back-up for the others; although the back-up coverage is less than one-for-one, it guarantees protection from failure of any single system component, substantially reducing the risk of downtime.

When failures do occur, the switch-over to the back-up system is performed automatically under software control or manually by the network operator via the Modem Switching Device (MSD). The MSD is required for partial or full system redundancy and provides a common link between primary and stand-by systems, lines, and devices. For example, the MSD can switch data lines from an active communications multiplexer to its back-up, when a defective network component is detected. Any individual communications line, or a group of lines, may also be switched by the MSD. The Modem Switching Device occupies its own cabinet, which also provides space for up to three communication multiplexers with their adapters.

Additional cabinets may be added to the system to house additional communications multiplexers and line adapters. The largest Raynet/I or /II system Raytheon has installed so far is a seven-cabinet system that handles 96 lines.

TRANSMISSION SPECIFICATIONS

Connection of communications lines to a Raynet system requires two separate components: a communication multiplexer (CMX); and a communications adapter, of which there are two types (GPCA and MPCA).

The CMX is a 32-bit, microprogrammable, communications multiplexer and peripheral line controller. Physically, up to 7 CMX's can be connected to each interprocessor bus along with the processor; however, configuration, redundancy, and throughput factors determine the actual number of CMX's that can be handled by the system. Each CMX houses up to 8 GPCA's or 4 MPCA's, providing interfacing for up to 16 full-duplex communications lines, or 32 half-duplex lines. The CMX has 8 16-bit words of random access memory per line, where commands for each line adapter and CMX operating parameters are stored. Each CMX has an aggregate throughput of 800,000 bits per second.

The General Purpose Communications Adapter (GPCA) is a ROM-based microprogrammable communications line adapter that provides line handling services for fixed protocols. The Multiple Protocol Communications Adapter (MPCA) is a RAM-based adapter used for multiple protocols. A wide selection of protocols are supported by the adapters, including ASCII, IBM's Binary Synchronous Communications (BSC) and Synchronous Data Link Control (SDLC), Univac's Uniscope 100/200 line discipline and Universal Data Link Control (UDLC), and the PARS airline reservation system protocol. Support for the CCITT X.25 packet-switching protocol and IBM Systems Network Architecture (SNA) is expected to be released in 1981. The GPCA or MPCA performs character search, transaction, parity checking, block checking, and error flagging functions without software intervention. Each GPCA provides two ports for communications up to 9600 bps; each MPCA provides four ports for communications up to 56K bps. One port is required for each full-duplex line; two half-duplex lines can share a single port.

CONNECTION TO THE HOST: Raynet systems are designed to operate in remote locations and to transfer data over high-speed lines to host systems. A Raynet system appears to a host system as a large terminal controller. To the terminal network, it appears as an interactive host. A Raynet system may be used in any network that operates under the Raytheon-supported protocols, those typically utilized by IBM and Univac mainframes and compatible systems. Each Raynet processing system (except the Raynet/I) can access up to 16 hosts.

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Overall, these comments seem in line with what might be expected from initial users of a system. Raytheon has apparently made every effort to work with its users to their satisfaction. But the users have had to provide support as well. What Raytheon has learned from these users will hopefully be passed on to new customers who will benefit from their experiences.□

SOFTWARE

Raynet systems are provided to the customer on a turnkey basis, and include a complete set of systems, communications, and applications software modified (if necessary) to customer requirements by Raytheon.

Systems software consists of Raytheon's Pre-emptive Communications Operating System (PCOS), plus debug and reconfiguration system utilities. PCOS is a multitasking operating system that provides for all basic system functions, including interprocessor control, file management, task management, memory management, and I/O control. Its multitasking capability permits users to be assigned up to 256 separate priorities to a "virtually unlimited" number of tasks, and to change those priorities on an ongoing basis without interrupting the normal operations of the system.

Communications software provides device handlers for lines to various types of terminals and host mainframes and resides in microcode in the system's communications multiplexers and line adapters. The software provides support for the specific protocols required by the attached devices and performs polling and other communications functions. Polling by the Raynet system is completely "decoupled"; i.e., downline polling is performed independently from host polls, and downline polling needs no host input.

Applications software is written predominantly in assembly language. Seven modules are currently available and provide for network management, network control, connection management, queue processing, system recovery, input processing, output processing.

The network management module supervises a wide range of functions, including line usage monitoring, status and statistics gathering and reporting, circuit diagnostics, and network fault reporting. Status and statistics reports can be produced on demand by the Raynet console operator or a host mainframe operator, or, using the interval timer on the Communications Feature board, at specified time intervals without operator intervention.

Network control functions include configurational control, host load balancing, message flow control, loopback testing and reporting, fallback and recovery, hardware fault isolation, and command console and printer control. Configuration logic allows the network operator to change the network's configuration data base to activate or deactivate terminal control units, terminal configurations, and/or terminal lines using the back-up processing system while the primary system remains fully operational, then to transfer the updated data base to the active primary system. The host load balancing capability allows line loads to the host to be equalized by selectively rearranging addresses in the network configuration data base without physically reconfiguring the network. Message flow control allows the network operator to regulate the number of messages sent to the host during a single poll. Loopback testing and reporting, fallback and recovery, and hardware fault isolation routines help the system to isolate and recover from network failures, including performance of automatic switchover to back-up systems and/or components.

The connection management module provides for all routing functions on a virtual-connection basis, and accommodates user-specified, applications-dependent, exception-based, and protocol-level routing. The queue processing module takes care of message sequencing and blocking, store-and-forward message switching, and PARS-based unsolicited message processing functions. System recovery routines permit the system to detect faults and initiate restart, recovery, or fall-back procedures.

The input and output processing modules examine the data traffic coming into and going out of the Raynet system on its way to the terminals or the host. Their functions include dispatching error and status messages as appropriate to the terminals and/or host, and, in multiple-protocol environments, performing certain protocol conversion tasks, such as stripping or adding lead characters, required before messages can be routed to their final destinations.

Field-developed software packages are also available through Raytheon. For example, a program written by a user that permits the host computer console to take control of a remote Raynet system and act as its local console is available to other users as a Raytheon licensed program product.

PERIPHERALS

The system console consists of a keyboard/display and, optionally, a desktop printer. Raytheon currently provides a Lear Siegler Model ADM-3A terminal as the display console. The ADM-3A provides a display capacity of 1920 characters and utilizes a 64-character ASCII character set. Centronics or Dataproducts printers are offered. The Centronics unit is a 120-cps impact printer that can print 10 characters per inch over a 132-column print width using a 7-by-7 dot matrix. The Dataproducts units are line printers that come in 300 lpm or 1200 lpm models.

An integral floppy disk drive (available in second quarter 1981) or cassette tape drive can be used as a local program load and storage device.

The disk subsystem is manufactured by Control Data and can contain from one to four 80MB or 300MB drives, for a system capacity of up to 1.2 billion bytes.

The magnetic tape drives provided are 9-track 75 ips units with densities of 800, 1600, or 6250 bpi and data transfer rates of up to 58.6K bps. Up to four drives can be configured with a Raynet system.

PRICING

Raynet systems are available for purchase directly from Raytheon Data Systems, or on a one- to five-year lease arranged through Raytheon's own leasing subsidiary. Maintenance is included in lease contracts; a separate maintenance contract is available for purchased units. Raytheon has over 80 Service Centers in the U.S. plus over 50 Service Centers abroad. Training classes on the Raynet systems are available at Raytheon's Norwood, Massachusetts, headquarters, regional training centers, and individual customer locations.

Raytheon declined to provide complete pricing information, but did furnish purchase prices for the configurations listed below.

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	Purchase	Monthly Maint.
Raynet Communications Processor; non-redundant; supports 15 communications lines; includes processing unit, console display, 120 cps printer, interprocessor bus, 64K bytes of main memory, one communications multiplexer, 8 general purpose communications adapters, integral diskette drive, cabinet, and modem cabling:		
Raynet/I	$55,000	$500
Raynet/II	70,000	570
Raynet/III	75,000	570
Raynet Communications Processor; fully redundant; supports 15 communications lines; includes 2 processing units, one modem switching device, 2 console displays, 2 120-cps printers, three interprocessor busses, 64K bytes of main memory, one communications multiplexer, 16 general purpose communications adapters, integral diskette drive, cabinet, and modem cabling:		
Raynet/I	160,000	900
Raynet/II	170,000	950
Raynet/III	174,000	950
	One-Time License Fee*	**Monthly Maint.**
Pre-emptive Communications Operating System (PCOS); includes typical protocols and line support for 15 lines:		
Raynet/I	$11,000	Contact vendor
Raynet/II	12,500	Contact vendor
Raynet/III	17,500	Contact vendor

*Prices are estimated.■