Data General Nova Series

MANAGEMENT SUMMARY

The Nova series of computers has proven to be such a successful product line for Data General that new members are still being introduced eight years after its inception. The latest product, the Nova 3/D, is an enhanced version of the older Nova 3/12, offering memory protection and 32K NMOS memory boards in addition to the long list of Nova 3/12 features already available.

Many changes have taken place in the Nova series over the past several years, but none was more significant than the recent retirement from active marketing of all the Nova processors except the Nova 3 line. Among those retired were the Nova 2/4 and 2/10; the Nova 800 Jumbo, 820, 830, and 840; and the Nova 1200, 1200 Jumbo, 1210, and 1220. These systems are now available from Data General on a request-only basis. Their principal characteristics are summarized in the table on the next page.

Data General restated its largely OEM position in October 1975 with the introduction of the Nova 3 series minicomputers, complete with semiconductor memories built around 4K RAM chips of DG's own manufacture. There had been some speculation that the Eclipse series computers, introduced in October 1974 (Report M11-304-201), would mark the beginning of the end of the popular Nova line and perhaps also a major marketing shift toward the end user. As it has turned out, the Eclipse line is being marketed primarily for specific scientific and commercial applications, while the solidly established Nova line continues to prosper and maintains its primarily OEM orientation.

The very popular Nova line of 16-bit minicomputers has been enhanced and streamlined with the addition of the Nova 3/D and the retirement from active marketing of all models except the Nova 3's. The currently active Nova line consists of the four-slot Model 3/4 and the 12-slot Models 3/12 and 3/D. The new Nova 3/D offers memory protection as a standard feature.

CHARACTERISTICS

MANUFACTURER: Data General Corporation, Route 9, Westboro, Massachusetts 01581. Telephone (617) 366-8911.

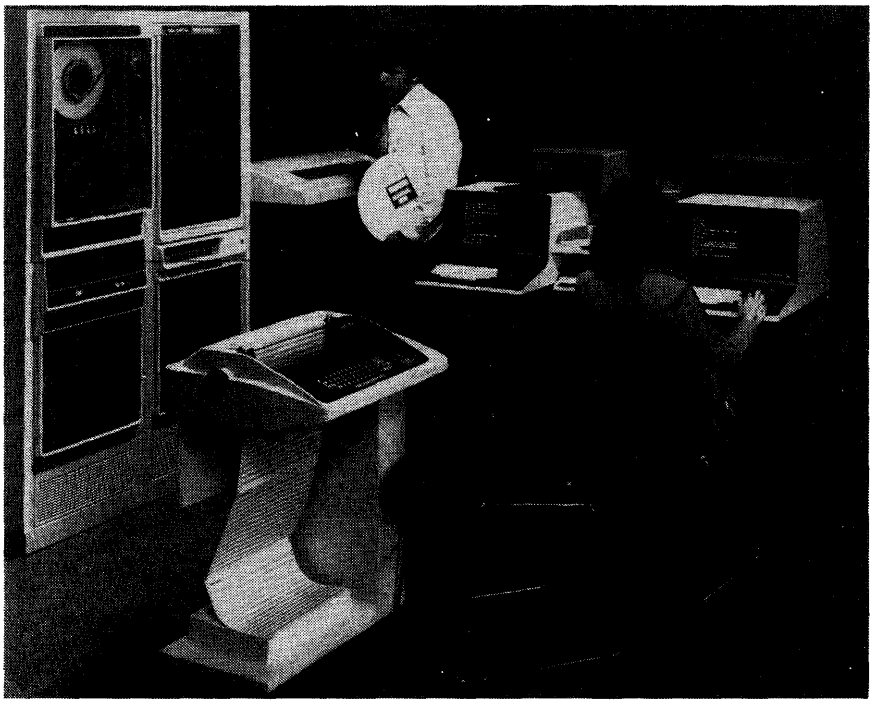
Data General is a leading manufacturer of minicomputers, peripherals, and associated equipment. The company maintains sales offies in most major North American cities and in South America, Europe, and Australia. Manufacturing operations are located in Southboro, Masachusetts; Westbrook, Maine; Portsmouth, New Hampshire; and Sunnyvale, California. Assembly operations are also performed in Hong Kong and in Thailand.

MODELS: Nova 3/4, 3/12, and 3/D. Older models, although not actively marketed, are still available from Data General. (See Summary Data table on the next page.) Reference to them in this report, however, is limited to historical comment.

DATE ANNOUNCED: Nova 3/4 and Nova 3/12, October 1975; Nova 3/D, August 1976.

DATE OF FIRST DELIVERY: Nova 3/4 and Nova 3/12, April 1976; Nova 3/D, July 1976.

NUMBER INSTALLED TO DATE: Data General claims that more than 25,000 Nova systems of all models have been installed since their introduction in 1968.



The Nova 3/D, with system features such as concurrent batch, multiterminal operations, and high-density NMOS memories, is the top of the current Nova line. In the near future it will probably be surrounded with Data General-designed and manufactured peripherals. Prominent in this photo is the recently released Dasher terminal printer, designed and built by Data General.

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SUMMARY DATA FOR NOVA MODELS

	Nova 2/4*	Nova 2/10*	Nova 3/4	Nova 3/12	Nova 3/D	Nova 800*	Nova 820*	Nova 830*	Nova 840*	Nova 1200*	Nova 1210*	Nova 1220*
Announced	6/73	6/73	10/75	10/75	8/76	10/70	11/71	11/74	3/73	10/70	11/71	11/71
First Delivery	10/73	10/73	4/76	4/76	7/76	3/71	4/72	NA	6/73	12/70	2/72	3/72
Basic Purchase Price	$3,500 (4KW)	$4,400 (4KW)	$2,600 (4KW)	$3,600 (4KW)	$12,000 (32KW)	$7,450 (4KW)	$7,500 (8KW)	$12,650 (16KW core+MMPU)	$16,530	$5,100 (4KW)	$4,000 (4KW)	$4,900 (4KW)
Available Chassis Slots	2	8	2	10	8	4	7	12	12	5	2	8
Number Installed	Over 25,000 of all models											

*Not being actively marketed; available from Data General for OEM and end user market on request.

The Nova 3's are available in the 4-slot Model 3/4 and the 12-slot Models 3/12 and 3/D. All of these models are built around the same processor, but the Nova 3/12 and 3/D can be enhanced with extra features such as 128K words of memory and memory mapping. Additionally, the Nova 3/D can be enhanced with memory protection. With the addition of memory mapping and memory protection, a Nova 3/12 becomes a Nova 3/D.

The memory management and protection unit (MMPU) of the Nova 3/D provides address validity protection, thus preventing users from addressing areas outside the assigned user space. This feature, coupled with the mapped version of RDOS, allows foreground and background processing, with each partition having a hardware fence to guarantee its own integrity.

The Nova 3 processor has the same architecture as the older Novas plus one important extra: stack hardware similar to that used in the Eclipse processor. A Trap instruction has also been added. But the Nova 3's are *not* the same as, or even scaled-down versions of, the Eclipse CPU. The Eclipse is microprogrammable, while the Nova 3 is not.

The stack capabilities were added to the Nova 3 to improve its performance in real-time applications, using Nova operating systems such as RDOS. This operating system uses software-implemented queues (stacks) for real-time control, and implementing the basic stack function in the Nova 3 hardware substantially reduces operating system overhead.

Nearly overshadowing the Nova 3 introduction in October 1975 was Data General's concurrent announcement of 700-nanosecond semiconductor memories for the new systems, manufactured by DG itself and based on 4K dynamic MOS RAM chips from its Sunnyvale, California plant. Data General has manufactured its own peripherals and core memories for some time, and has also been manufacturing TTL components in Sunnyvale. Just in case, however, a compatible (but not second-sourced) semiconductor memory, which uses MOS chips supplied by Texas Instruments, is also offered.

DATA FORMATS

BASIC UNIT: 16-bit word or 8-bit byte.

FIXED-POINT OPERANDS: 16-bit words can be interpreted as signed or unsigned binary numbers, logical words, memory addresses, or portions of decimal character strings.

Decimal numbers can be either character decimal or packed decimal. In character decimal format, each digit is an 8-bit ASCII character, and the sign is either carried separately as an extra character at the beginning or end of the decimal string or by modifying either the first or last digit in the string. The packed decimal format places each digit in 4-bit hexadecimal code with a separate sign character at one end of the string.

FLOATING-POINT OPERANDS: 32-bit single-precision operands with a 7-bit exponent and signed 24-bit fraction; and 64-bit double-precision operands with a 7-bit exponent and signed 56-bit fraction. All Nova processors can implement single and double-precision floating-point arithmetic through software subroutines. With the optional floating point unit (FPU), single- and double-precision arithmetic can be handled by the hardware.

INSTRUCTIONS: One-word instructions. There are four basic instruction types; each with different formats: Jump and Modify Memory, Move Data, I/O, and Arithmetic and Logic. In all instructions, bits 0-2 specify the instruction type.

In the Jump and Modify instructions, bits 3 and 4 identify the specific function (op code), and the rest of the word contains information used to calculate the effective address. This information consists of an 8-bit displacement, a 2-bit index register specification, and a 1-bit indicator to specify direct or indirect addressing. In Move Data instructions, bits 3 and 4 address an accumulator, and the rest of the word is identical in structure to the Jump and Modify type above. For I/O instructions, bits 5-9 specify the function (indication of transfer direction, selection of an I/O device register, and/or specification of an operation). Bits 3 and 4 select an accumulator for transfer, and bits 10-15 indicate a specific device. Arithmetic and Logic instructions use bits 1 and 2 to identify an accumulator containing a second operand (if present), bits 5-7 to specify primary function, and the rest of the word to specify secondary functions, if any.

For all memory reference instructions, bits 5-15 are used for addressing, using bits 8-15 as the displacement or direct address. Each instruction can address 256 words directly, or can use either relative or base register addressing.

INTERNAL CODE: ASCII and binary.

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	MANUFACTURER
MAGNETIC TAPE EQUIPMENT		
6020	Transport and controller; industry-compatible, 7-track, NRZI, 10.5-inch reels, 75 ips, 556/800 bpi, vacuum columns, 8 drives per controller; 42/60 KBS	Data General
6021	Transport and controller; industry-compatible, 9-track, NRZI, 10.5-inch reels, 75 ips, 800 bpi, vacuum columns, 8 drives per controller; 60 KBS	Data General
6022/6024	Transport; industry-compatible, 7-track, 75 ips, NRZI, 10.5-inch reels, 556/800 bpi; vacuum columns; 42/60 KBS (6024 is for use with 4030 magnetic tape subsystems)	Data General
6023/6025	Transport; industry-compatible, 9-track, 75 ips, NRZI, 10.5-inch reels, 800 bpi; vacuum columns; 60 KBS (6025 is for use with 4030 magnetic tape subsystems)	Data General
4196/4196A	Transport and controller; industry-compatible, 9-track, PE, 10.5-inch reels, read after write, 45 ips, 1600 bpi, 4 drives per controller; 72 KBS	Wangco
4196B	Transport; industry-compatible, 9-track, PE, 10.5-inch reels, read after write, 45 ips, 1600 bpi; 72 KBS	Wangco
4076/4080/81/84/87/88/89	Cassette tape subsystem; includes controller for up to 8 drives, and 1, 2, or 3 drives, record & file length variable from 4 to 8192 bytes; DMA interface; 30 ips; 100K bytes per tape average, 134K bytes maximum; 1600 bytes per second	Data General
LINE PRINTERS		
4034C	Serial; 5 x 7 dot matrix, 132 positions, 64 ASCII character set, 10 characters per inch, 6 lines per inch; 165 cps	Centronics
4034D	Serial; 9 x 7 dot matrix, 132 positions, 64 ASCII character set, 10 characters per inch, 6 lines per inch, 4- to 14.8-inch paper; 165 cps	Centronics
4215	Drum; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 600 lpm	Dataproducts 2260
4216	Drum; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 436 lpm	Dataproducts 2260
4218	Drum; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12 channel VFU; 300 lpm	Dataproducts 2230
4219	Drum; 136 positions, 96 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12 channel VFU; 240 lpm	Dataproducts 2230
CARD EQUIPMENT		
4016D/I	Reader; 80-column, punched card (4016D) or mark sense (4016I), 550-card hopper and stacker, 12-bit parallel; 285 cpm	Documation M200
4016E/J	Reader; 80-column, punched card (4016E) or mark sense (4016J), 100-card hopper and stacker, 12-bit parallel; 400 cpm	Documation
4016F	Reader; 80-column, punched card, 1000-card hopper and stacker, 12-bit parallel; 600 cpm	Documation
4016G	Reader; 80-column, punched card, 1000-card hopper and stacker, 12-bit parallel; 1000 cpm	Documation
PAPER TAPE EQUIPMENT		
6013	Reader; fanfold tape, 8-channel; 400 cps	Data General
4012A/B	Punch; fanfold tape, 8-channel; 63.3 cps	Teletype
TERMINALS		
6012	CRT display/keyboard, 1920 characters, 24 lines by 80 characters, 64 ASCII character set, 5 x 7 dot matrix, variable codes, local editing, EIA or 20-ma current loop interface, full or half-duplex; up to 4800 bps	Data General
6040, 6041, 6042, 6043	Terminal printer, 5 x 7 dot matrix, inclined right 10 degrees, 132 positions, 96 character set (128 opt.), 10 characters per inch, 6 lines per inch, 40-character buffer, 4- to 15-inch forms; receive only (6041 & 6043); standard typewriter keyboard (6040 & 6042); RS-232C, 20-ma current loop interfaces; 60 or 30 cps (6040 & 6041); 10, 15, or 30 cps (6042 & 6043)	Data General
6052	CRT display/keyboard, 1920 characters, 24 lines by 80 characters, 64 ASCII character set, 5 x 7 dot matrix, detachable teletype style keyboard, 8 ftn. keys, 11 key data entry pad, EIA or 20 ma current loop interface, full duplex, Dasher attachment, up to 19.6K bps (sync)	Data General
6053	Same as 6052 except 96 ASCII character set, 5 x 8 dot matrix, detachable typewriter style keyboard, 11 ftn. keys, and other features such as direct cursor positioning and programmable intensity	Data General
PLOTTER		
4017E	Plotter; 11-inch 2-fold paper, drum-type, 120-foot X-axis; 0.005-inch (4017E), 0.010-inch (4017E-A), 0.10-mm (4017E-B), or 0.25-mm (4017E-C) step size; 300 steps per second	Houston Instruments

In all, three different memories are available with the Nova 3's: the 700-nanosecond semiconductor memory, an 800-nanosecond core memory, and a 1000-nanosecond core memory. All are intermixable in a single computer. The MOS memory is available in 8K, 16K or 32K increments; the 800-nanosecond core memory in 8K increments; and the 1000-nanosecond memory in 16K increments. A parity option is available with the MOS memory only.

MAIN STORAGE

TYPE: Core and 4K-chip MOS RAM; the chip employs N-channel, silicon-gate technology. NMOS requires 64 refresh cycles every 2.4 milliseconds.

CYCLE TIME: Please refer to the following table.

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When the original Nova minicomputer—forerunner of a family that at one time included 11 active models—was introduced in September 1968, it was based upon a 16-bit word length at a time when most manufacturers were busily developing 12-bit machines (e.g., DEC's PDP-8 family). Less than a year later, Data General introduced the Supernova, a machine with more than three times the speed of the original Nova and with unusually strong processing capabilities for a minicomputer of that day. That machine subsequently was followed by the Supernova SC, the first commercial minicomputer to employ semiconductor main memory. The Supernova SC extended the upper limit of the Nova family to nearly seven times its original processor capability.

Also announced in October 1970, with the Supernova SC, were the Nova 1200 and Nova 800, using 1200-nanosecond and 800-nanosecond core memories, respectively. About a year later, the Models 1200 and 800 were, in turn, redefined by the 1210, 1220, 1230, and 820. The primary distinction between these models and the earlier 1200 and 800 systems lies in mechanical packaging that permits more economical production and assembly methods.

With the addition of the larger Model 840 (800-nanosecond memory) in April 1973 and the low-priced Nova 2/4 and 2/10 (1-microsecond or 800-nanosecond memories) in June 1973, Data General focused its marketing attention on the 2/4 and 2/10 for orders of five or more units and on the 840 system for heavy processing requirements. A 1-microsecond version of the 840, designated the 830, was introduced in November 1974.

The Models 3/12 and 3/D mark the top of the current Nova line with the largest main memory capacities among the Novas and with processor speeds suitable for the most demanding applications in the minicomputer arena. Dual-processor, shared-disc Nova 840 and Nova 2/10 configurations, announced in early 1974, have now been largely supplanted by comparable systems employing the Nova 3/12 and 3/D.

Although processor options and configuration rules are not the same among various members of the Nova family, all employ the same basic 16-bit architecture, with four accumulators for computational use (two of which can be used for index registers), an I/O Bus, either a standard or high-speed Direct Memory Access (DMA) data channel, common 15-inch-square PC board packaging design, and strong communications capabilities. The actual number of devices that can be configured with any Nova system depends upon the number of available plug-in circuit board "slots" in the chassis. Only the Nova 3/12 and 3/D can have both core main memory and semiconductor RAM.

The Nova family of minicomputers is heavily used in control/monitoring systems, industrial testing, data acquisition/analysis, and various other scientific and educational applications. More recently, Novas have been appearing in genral business or accounting applica-

Memory type:	Core	Core	NMOS
Module size, words	8K	16K	All
Cycle time, nanoseconds	800	1000	700
Access time, nanoseconds	400	500	400

CAPACITY: 4096 to 32,768 words for the Nova 3/4; 4096 to 131,072 words for the Nova 3/12 with MMU (memory management unit); and 32,768 words to 131,072 words for the Nova 3/D with MMPU (memory management and protection unit). Available memory increments include 8K- and 16K-word core modules and 8K, 16K, and 32K NMOS modules. Modules of different sizes and types can be intermixed in the same processor in Nova 3/12 and 3/D systems.

CHECKING: Parity is optional on the Nova 3. If implemented, one parity bit is associated with each 16-bit word of parity memory. Core memory is available without parity only. NMOS is available with or without parity. Both parity and non-parity memories can be mixed in the same processor. The parity bit is added by the parity controller to each 16-bit word written into parity memory and checked when read by the same controller. The parity controller ignores access to non-parity memory.

Parity may be either even or odd, the choice being under program control.

STORAGE PROTECTION: A memory management and protection unit (MMPU) is available on the Nova 3/D for expanding the memory capacity to 128K words, protecting memory, and restricting physical-level I/O device access from user programs. The MMPU divides main memory into 1K-word pages, and can protect individual pages through software support under the Real-Time Disc Operating System (RDOS).

In addition to the storage protection, the Nova MMPU also provides three other forms of system protection: I/O protection, validity protection, and runaway defer protection. I/O protection prevents the use of any specified I/O device; any instruction attempting to address the protected device causes a system interrupt. Validity protection is used in conjunction with memory mapping and can be extended to any 1024-word page in memory by mapping it to page 127; this indicates that the page is protected and, if addressed by any means, causes a system interrupt. Runaway defer protection prevents infinite indirect loops by counting the number of consecutive times a particular address is referenced through a defer (indirect) cycle; if addressed 17 times consecutively, a system interrupt is generated.

The memory management unit (MMU) for the Nova 3/12 functions similarly to the MMPU, but without the validity protection feature.

Both the MMU and MMPU can hold two program maps and two data channel maps at the same time. Each map consists of 32 1K pages. Although both data channel maps can be enabled at the same time, only one program map may be enabled.

RESERVED STORAGE: Certain low-end memory locations are reserved for use during interrupt servicing, MMPU protection processing, stack fault processing, and power failure. Sixteen locations are reserved for increment and decrement registers.

CENTRAL PROCESSORS

GENERAL: The original Nova family utilized a single basic design, with the processor, memory modules, and communications/peripheral interfaces each contained on one or more 15-inch-square boards. These boards plug into slots in the Nova chassis, with its distinctive backplane wiring and power supply.

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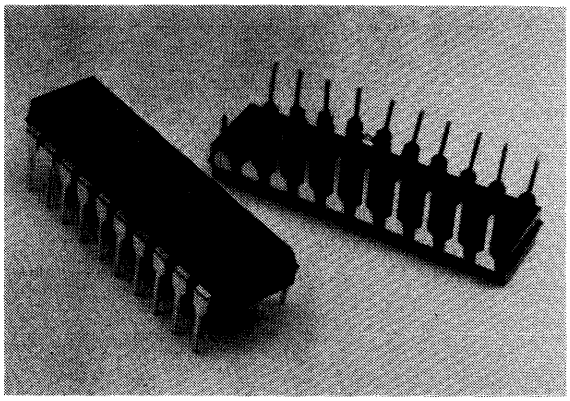
tions, including multi-user, CRT-based systems. The majority of Nova users are either OEM buyers building systems for resale or end users building their own control systems or small business systems. The Nova 3/D, with multiprogramming capability, high-level language processors, and high performance, is moving strongly into the sophisticated end-user market.

The Nova 3/4 is priced competitively with several microcomputers, but offers better price/performance characteristics plus the availability of high-level languages and fully developed Nova software. The Nova 3/12, with its 128K-word memory capacity and memory mapping option, is intended for use in real-time applications such as front-ends, store-and-forward applications, and process control systems. The 3/12 has been in use as a communications front-end processor since April 1975, serving as the heart of DG's DCU/50 Data Control Unit, a user-programmable communications controller that operates in parallel with a central processor and permits a throughput of up to 48K characters per second. The Nova 3/D is almost identical to the Nova 3/12, but offers memory protection, a feature previously available only with the Nova 830 and 840.

Competition for the Nova line comes from a large number of other manufacturers. Nearly every mini maker has at least one model that competes with one or more members of the Nova family. DEC's PDP-11 family competes fully across the line, the Nova 3/4 competing with the PDP-11/03, 11/04, and 11/05, and the 3/12 directed against the PDP-11/35 and some 11/45 systems.

Of particular note is one competing company, Digital Computer Controls, which markets "copies" of the Nova computers. DCC's original version, the D-116, is fully hardware- and software-compatible with the Nova 1200 series to the extent that OEM users report buying from both manufacturers and using the systems interchangeably. Data General took exception to the DCC D-116 and was granted an injunction which bars that company from manufacturing the identical computer; DCC appealed the judgement and responded, at least in part, by introducing four other models of Nova-compatible systems which are not copies of the 1200 and offer some of the enhancements found in the new Nova 3's. The latest events in the legal battle between these two companies occurred during late 1976 and early 1977, when Data General and Digital Computer Controls announced a preliminary understanding concerning the acquisition of DCC by Data General and the boards of both companies approved the merger. The stockholders of DCC voted for the merger on January 25, 1977. DCC thus became a wholly owned subsidiary of Data General for the sale price of 290,000 shares of DG stock.

The Nova series features three operating systems—DOS, RTOS, and RDOS/Mapped RDOS. DOS, the Disc Operating System, is diskette-based, while RTOS, the Real-Time Operating System, is memory-based. Both DOS and RTOS are compatible subsets of RDOS, the Real-Time Disc Operating System, which is hard disc-



Data General's 4K, 20-pin RAM used in Nova 3 semiconductor memories is an N-channel, dynamic MOS chip built with silicon-gate architecture. After fabrication in the company's Sunnyvale, California facility, the chips are shipped to the company's Hong Kong subsidiary for wire-bonding and packaging. Completed 4K RAM's are returned to Sunnyvale for testing, then shipped to Data General's main computer manufacturing plant in Southboro, Massachusetts for installation in Nova processors.

The Nova 3 series is mounted on the same 15-inch-square boards, but the architecture is an enhanced version of the earlier Novas featuring stack capabilities (similar to those found in the Eclipse processors) and removable power supplies. The Nova 3/4 is housed in a 4-slot chassis, and both the Nova 3/12 and 3/D are housed in a 12-slot chassis.

Processor options for all Nova 3 models include power monitor/auto restart, hardware multiply/divide, and a real-time clock. The latter attaches and operates like a peripheral device. In addition, the Nova 3/12 and 3/D have a memory allocation/protection option. All Nova 3's also have an automatic program load option.

The power-fail recovery system employs a battery that can maintain 32K words of NMOS memory for up to two hours. Recharge time from the fully depleted state is 24 hours during normal CPU operation. One to two milliseconds are provided for the execution of a save routine during a power failure.

CONTROL STORAGE: None.

REGISTERS: All Nova 3 processors have four 16-bit accumulators and a 15-bit program counter. Two accumulators can be used for address indexing. The Nova 3 computers also have a last-in/first-out (LIFO) push-down stack implemented in any 256 consecutive memory locations and two additional hardware registers, the stack pointer and the frame pointer. The stack pointer identifies the first memory location designated as the stack, and the frame pointer marks intra-stack boundaries to permit several "register saves" to be accumulated in the stack.

The MMPU and MMU dual program maps are each composed of 32 registers, each register controlling a 1K word space. The same is true for the 64 data channel map registers.

Beyond these hardware registers, Nova processors also have 16 reserved memory locations which function as auto-increment or auto-decrement registers when addressed indirectly.

ADDRESSING MODES: All Nova processors have six addressing modes: direct (256 words), indirect (multi-level), indexed, indexed-indirect (pre-indexing), program-relative, and program relative-indirect.

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based. Four high-level languages are available for the Nova Series: Extended ALGOL, Extended BASIC, FORTRAN IV, and FORTRAN 5. An extended assembler, macro assembler, symbolic debugger, communications package, and a library of utilities—sort/merge, plotting routines, commercial subroutines, and text editor—are also available.

In the area of data communications, Data General provides RJE80, the Remote Job Entry Control Program, and CAM, the Communications Access Manager. RJE80 allows for remote job entry and communications between Nova processors and IBM 360/370 systems (in IBM 2780/3780 Mode), or between Nova processors and other Data General computers. CAM supports all types of communications and is designed to work with such hardware units as the DCU/50 Data Control Unit and various asynchronous and synchronous multiplexers.

Data General provides its own maintenance and field support service through about 93 field service centers distributed worldwide, which employ approximately 515 service personnel. Five depot locations—Framingham, Massachusetts; El Segundo, California; Toronto, Canada; Frankfurt, Germany; and London, England—provide comprehensive repair facilities.

With the growing popularity of small business computer systems, many turnkey systems vendors now offer custom solutions to business problems based on Nova series minicomputers.

USER REACTION

Detailed below are the results of Datapro's survey of Nova users taken during August 1976. Included in the survey were 39 users representing a total of 137 installed systems. The breakdown included 68 Nova 2's, 7 Nova 3's, 39 Nova 800's, and 23 Nova 1200's.

Of the 39 users, 36 had purchased their systems and the remaining 3 were on third-party lease. The average memory sizes for the Nova 2, 3, 800, and 1200 systems were 32K words, 32K words, 32K words, and 24K words, respectively. The average period of installation for the systems was two years. The vast majority of users (33) were doing their own programming, with some outside sources being employed. Many users indicated multiple application areas, which we classified in 5 general categories as follows: 20 in general business, 14 in scientific or engineering processing, 11 in real-time processing, 12 in data communications, and 9 in data base management. The overwhelming majority of the systems in the survey were using the RDOS operating system. At least three non-Data General operating systems were also represented in the survey, since some of the configurations were turnkey in nature.

Here's how the Nova users rated their systems. Note that the weighted average ratings are compared with those of the previous year's survey.

When the MMPU or MMU is implemented, the 15-bit logical address coming from the CPU or data channel is translated to a 17-bit physical address. Memory access cycle time is unchanged.

The mapping information needed to service a CPU or data channel request is given to the address translation hardware by the operating system through I/O instructions that reference the address translation hardware. This information is transmitted before the supervisor enables either the user map or the data channel map.

All addresses can be mapped, including those acquired from DMA controllers.

INSTRUCTION REPERTOIRE: All Novas have the same basic complement of 4 Jump and Modify Memory instructions, 2 Move Data instructions, 7 stack processing instructions, 16 I/O instructions, and 8 arithmetic and logic instructions. (There are 256 variations on each of the arithmetic and logic instructions.) Hardware multiply/divide instructions are available as options.

The floating-point processor option adds 31 I/O-format instructions to the basic set; this option is not available for the Nova 3/4.

The MMPU adds 10 I/O-format instructions to the Nova 3/D, and the MMU adds 5 I/O-format instructions to the Nova 3 series.

INSTRUCTION TIMINGS: The timings shown in the accompanying table are for full-word, fixed-point operands, in microseconds, and apply to all of the Nova 3 models.

	700-nsec. NMOS*	800-nsec. Core*	1000-nsec. Core*
Load/Store	1.15	1.45	1.75
Add/Subtract	0.7	0.8	0.95
Multiply/Divide	5.8/6.5	5.9/6.6	6.0/6.8
Compare & Branch	1.7	1.9	1.9

*Average of minimum and maximum values.

INTERRUPTS: A 16-level programmed priority interrupt facility is used to recognize interrupts for I/O operations. Each I/O device is wired to one of 16 bus positions, and is either authorized or denied authorization to interrupt particular service routines by an Interrupt Disable Mask Bit that corresponds to the bus position of the device.

PROCESSOR MODES: The Nova 3/D recognizes either a supervisor or user mode of program execution for use with the memory allocation and protection options. The executive program runs in the supervisor mode, and can write-protect portions of each user's memory area. With this option and operating in user mode, no user can write in a protected area, use more than 16 levels of indirect addressing, or issue I/O instructions.

The Nova 3/D provides four memory maps: two program maps, and two data channel maps. All addresses can be mapped, including those acquired from DMA controllers.

PHYSICAL SPECIFICATIONS: All Nova processors are housed in either 5.25-inch or 10.5-inch high chassis which are 19 inches wide and approximately 23 inches deep. Weights vary from 40 to 130 pounds fully loaded. The expansion chassis weighs 130 pounds fully loaded. The Nova 3/4 requires either 115 volts at 60 Hertz or 110, 220, or 240 volts at 50 Hertz. The Nova 3/12 and 3/D require either 115, 110, 220, or 240 volts at 50 or 60 Hertz. All units are usable internationally. Recommended operating envi-

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	Excellent	Good	Fair	Poor	1976 WA*	1975 WA*
Ease of operation	13	21	2	0	3.3	3.3
Reliability of mainframe	21	13	4	1	3.4	3.5
Reliability of peripherals	8	19	11	1	2.9	2.6
Maintenance service:						
Responsiveness	9	10	10	5	2.7	2.6
Effectiveness	9	13	10	2	2.9	2.4
Technical support	3	10	15	9	2.2	2.2
Manufacturer's software:						
Operating system	11	19	3	0	3.2	3.1
Compilers and assemblers	6	20	6	0	3.0	3.0
Ease of programming	11	20	5	1	3.1	2.8
Ease of conversion	2	14	5	2	2.7	2.6
Overall satisfaction	9	25	2	1	3.1	2.9

*Weighted Average on a scale of 4.0 for Excellent.

These ratings, which range from very good for mainframe reliability to well below par for technical support, can be corroborated by specific comments made by the users. On the positive side, one user described his systems as "reasonably good from an end-user, in-house application perspective." Another praised the "fast operating system." Other specific advantages cited by the Nova users were ease of operation and programming, ease of program development, good price/performance ratio, system flexibility and reliability, reliable mainframe, fast recovery from system crashes, ease of interfacing, and on-line access to programs and data.

A comparison of the weighted averages with those of the previous year's user survey shows overall improvement or maintenance of the status quo in all but one category. Even though Data General has improved in several areas that were troublesome last year, there is still some distance to go before the users will be really satisfied. The maintenance service and technical support ratings tell the story, loud and clear. These ratings can be amplified with some typical user comments: "System's prime problem is lack of technical support," "There is a lack of support from the manufacturer," "Lacks manufacturer technical support and responsibility," "No software support," "Poor documentation and technical support," and "Vendor interface for end-user and small OEM not good."

We think it appropriate to repeat here what we said last year: DG's primary marketing direction is toward the OEM market. This type of user usually is equipped to solve his own technical problems and often supplies his own service from in-house facilities. End users usually expect more support and services from the manufacturer and are often disappointed by "OEM-level" support. If Data General expects to pursue the end user market actively, these criticisms should be noted.

It's clear that Nova users are generally well pleased with the reliability, software, and price/performance of their systems. And it's equally clear that Data General—like so many other minicomputer makers—has plenty of room for improvement in its technical support and maintenance functions.□

ronment for Nova computer systems is between 68 and 86 degrees F., but temperatures between 32 and 130 degrees can be tolerated. A humidity range up to 90 percent noncondensing can be tolerated. Nova 3's can operate effectively at an altitude of up to 10,000 feet. Air conditioning above normal office levels is not required. Power consumption ranges between 175 and 725 watts.

INPUT/OUTPUT CONTROL

INPUT/OUTPUT CHANNELS: An I/O bus and a Direct Memory Access (DMA) channel are standard on all Novas. Various high-speed options are available. The DMA data channel provides a multiplexer-like capability and can be seized by any device through a data channel request to handle 16-bit data transfers to and from main memory. The DMA channel can be used to increment the contents of storage locations by "1." DMA data rates for all of the Nova 3 models are summarized in the accompanying table.

	700-nsec. NMOS*	800-nsec. Core*	1000-nsec. Core*
Standard in	625K	588K	556K
Standard out	526K	500K	476K
High-speed in	1100K	1000K	909K
High-speed out	1000K	909K	833K
Autoincrement in	455K	432K	397K
Autodecrement out	833K	691K	635K

*Words per second

SIMULTANEOUS OPERATIONS: Memory overlapping is provided on all the Nova 3 series models.

CONFIGURATION RULES: Up to 62 peripheral devices can be attached to the I/O bus. The actual number of devices that can be attached to a particular Nova depends upon the available slots in the basic chassis and any available chassis extensions. The expansion chassis provides an additional 12 slots and mounts above the computer chassis. All processors occupy one slot. Any size memory module also occupies one slot. The price list at the end of this report states the number of slots remaining after the processor and memory requirements for each particular configuration are satisfied. The multiply/divide feature and parity option share the same board as the MMU and MPU; this combined board requires one slot. The MMU and MPU, when both are installed, become the MMPU. The floating-point option requires two slots.

In general, all peripheral I/O interface subassemblies/controllers require one slot. These include applicable units for reel-to-reel magnetic tape drives, cassette drives, printers, punched card equipment, paper tape units, terminals, plotters, and disc units. Also requiring one slot each are the I/O interface subassembly for the real-time clock, the bus control card, various communications controllers, and the DCU/50 Data Control Unit. The programmable interface to an IBM 360/370 requires two slots.

Other available chassis provide additional slot space for special purposes. These include the I/O Bus Switch Chassis, which provides 14 I/O slots, and the communications chassis, which furnishes 16 slots for line interface cards.

MASS STORAGE

All Data General disc subsystems can be accessed by two controllers to allow dual-processor, shared-disc systems. Dual-processor configurations are fully software-supported.

4057 MOVING-HEAD DISC SUBSYSTEM: Consists of a 4046 dual-access adapter and controller and up to four

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4057A 25-megabyte disc drives. The 4057A disc drives use IBM 2316-type II-platter disk packs, recording data on 20 surfaces at 100 tracks/inch and 2200 bits/inch. Average head positioning time is 35 milliseconds, and average rotational delay is 12.5 milliseconds. Data transfer rate is 312K bytes/second. The 4057 controller occupies one slot. The 4057 disc drive is manufactured by Century Data Systems.

6060 AND 6061 DG/DISC STORAGE SUBSYSTEMS: Consist of a 96- or 190-megabyte disc pack drive and a controller for up to four drives. Thus, the same controller can handle from 190 to 764 megabytes of on-line storage. The new drives, announced in December 1976, are 3330-type units designed and manufactured by Data General at its Westbrook, Maine facility. Model 6060 is a 96-megabyte drive, while Model 6061 is capable of storing 190 megabytes. Data density is 4040 bits per inch for both drives, although their track densities are different. The drives employ a servo track-following technique that allows 192 tracks per inch for a total of 411 tracks per surface on the Model 6060, and 370 tracks per inch for a total of 815 tracks per surface on the Model 6061. These are a total of 411 or 815 cylinders, each containing 19 tracks.

The Model 6060 employs an IBM 3336-type pack, while the Model 6061 utilizes an IBM 3336-11-type pack. Each of these disc packs contains 10 platters with 19 usable surfaces. There are 24 sectors per track and 512 bytes per sector, yielding 12,288 bytes per track. Total surface capacity is either 5,050,368 or 10,014,720 bytes per surface, depending on the model. Total formatted drive capacity is 95,956,992 bytes for Model 6060 and 190,279,680 bytes for Model 6061.

Disc rotational speed is 3600 rpm, and average rotational delay is 8.3 milliseconds. Track-to-track head positioning time is 6 milliseconds, average head positioning time is 35 milliseconds, and average access time is 43.3 milliseconds.

The controller employed with these drives can handle up to four Model 6060 or 6061 drives in any combination. Software limitations restrict the number of controllers per system to two. The controller features independent command and read/write channels and reserve-and-trespass capabilities for users to transfer data. In multiple shared-disc environments, privileged file structures are allowed. A new error correction feature makes it possible to detect and correct all error bursts of 11 bits or less.

The new drives replace the 92-megabyte 4231A and B units that were manufactured by Control Data Corporation and utilized by Data General during the past 2½ years. Due to formatting differences, the 4231A and B drives may not be intermixed with the 6060 or 6061 drives on the same controller. The new drives can be configured into any Nova system supported by the RDOS operating system. The drives feature a transfer rate of 806K bytes/second.

6045/46/47/48 CARTRIDGE DISC SUBSYSTEMS: Each subsystem consists of a controller and up to four 10-megabyte, top-loading cartridge disc drives. The four systems, announced in November 1976, are being manufactured at Data General's Westbrooke, Maine facility. These subsystems, configured with one, two, three, and four cartridge disc drives, are respectively designated the Model 6045, 6046, 6047, and 6048.

Each drive employs two platters, one fixed and the other an IBM 5440-type removable cartridge, both mounted on a common spindle. Each platter is capable of storing 5,013,504 bytes, or 2,506,762 bytes per surface. There are 200 tracks per inch, 408 tracks per surface, 408 cylinders per drive, and 4 surfaces per drive. Recording density is 2200 bits per inch. All tracks are divided into 12 sectors of 512 bytes each, yielding a formatted track capacity of 6144 bytes. Each cylinder consists of four tracks, giving a formatted cylinder capacity of 24,576 bytes. Total drive capacity is 10,027,008 bytes.

Drive rotational speed is 2400 rpm. Track-to-track, average, and full-stroke head positioning times are 8, 38, and 70 milliseconds, respectively. The data transfer rate is 312,500 bytes per second. Drive start-up to full operating speed takes 30 seconds, and the drive requires 25 seconds to come to a full stop. All four subsystems are supported under the RDOS and RTOS operating systems.

An add-on drive, the Model 6050, allows field upgrading of already installed cartridge disc subsystems. Dual porting can be implemented by adding the Model 6051 option. The Model 6050-F is an add-on drive for an existing floppy disc subsystem. Any mix of floppy and cartridge disc drives up to a maximum of four is allowable. Likewise, floppy drives can be added to a previously installed cartridge disc subsystem. Diskette drives offer advantages in diagnostic program loading and compact file backup.

6030 FLOPPY DISC SUBSYSTEM: Consists of a four-drive controller and either a 6030 single drive or a 6031 dual drive. Each floppy disc stores up to 315K bytes on 77 tracks. Maximum storage capacity is 1.26 million bytes on a four-drive subsystem. Average head positioning time is 260 milliseconds, and average rotational delay is 83 milliseconds. Data transfer rate is 31K bytes/second. The 6030 drives feature IBM 3740 compatibility and are supported by Data General's RDOS operating system. The controller occupies one slot. The 6030 drives are manufactured by Data General.

INPUT/OUTPUT UNITS

See Peripherals/Terminals table.

Data General is also an OEM peripherals supplier. Its OEM products are covered in Section M13 in Volume 2 of *DATAPRO REPORTS ON MINICOMPUTERS.* Data General also provides a broad array of data acquisition, process control, and analog/digital I/O equipment.

COMMUNICATIONS CONTROL

The DG/CS Communications Subsystem is a hardware and software system that is modular in nature. It is composed of the ALM-16 and ALM-8 Series asynchronous multiplexers, the SLM-2 Series asynchronous multiplexers, the 4251 Communications Chassis, and the DCU/50 Data Control Unit. The CAM Communications Access Manager provides software support for teletypewriter terminals and Bisync line protocol.

Low-to-medium-performance applications use the appropriate multiplexers in the 4251 chassis, which is connected directly to the host computer I/O bus. For high-performance applications, the DCU/50 is inserted as a "peripheral processor" between the host CPU and the communications subsystem.

The DG/CS supports both full- and half-duplex operation. Line interface support is provided for EIA RS-232C/CCITT V.24, 20-ma current loop, and 23-ma current loop.

The DG/CS is supported by the RDOS, mapped RDOS, and RTOS operating systems. Other software support includes Data General's HASP Work Station Emulator, DCU-resident physical I/O routines, and the aforementioned CAM.

DCU/50 DATA CONTROL UNIT: Provides a dedicated communications controller consisting of a Nova processor with a local 4K words of memory on a single card that plugs into the host computer chassis. A DMA interface to the host allows any of the host memory to be "windowed" into the

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DCU/50 address space above 4K to give the DCU access to the host processor's communications buffers without the need to interrupt the host. Communications with the various asynchronous and synchronous line multiplexers is via the DCU/50's I/O bus (separate from that of the host). Control of these multiplexers is in parallel with the main processor. The DCU/50 can be programmed for composite throughputs of up to 48K characters per second over up to 256 asynchronous or synchronous lines. Programming of the DCU/50 can also handle unique protocols and character processing functions. Multiple DCU/50's can be connected to a single Eclipse processor for increased communications loads.

A single DCU/50 can provide 10,000 to 12,000 characters per second of communications throughput with an average of 10 percent computer overhead. The unit is normally used to perform all character-level interrupt processing, control character processing, code translation, error checking, and buffer maintenance.

4263/4264 SLM-2 SYNCHRONOUS LINE MULTIPLEXER: Provides one or two lines with speeds of up to 9600 bps as a stand-alone unit or up to 56,000 bps in conjunction with the DCU/50 and an optional high-speed interface for Bell 303 Series modems. Line operation may be either full- or half-duplex. Full character buffering is offered.

Programmable line characteristics include parity type (even, odd, or none); 6-, 7-, or 8-bit code level; SYN (synchronous) and DLE (delete) characters; transmitter/receiver on or off; and either CRC-16 or CCITT-16 cyclic redundancy check (CRC) polynominals, if the optional CRC Generator/Checker is installed. The internal clock is jumper-selectable to one of eight frequencies from 300 bps to 56,000 bps. Modem control is offered for Bell 201, 203, 208, 209, and 303 or equivalent data sets. Modem control signals include carrier detect, data set ready, ring indicator, request to send, data terminals ready, and clear to send. The RS-232C/CCITT V.24 interface is standard, while an interface for a Bell 303 is optional.

Up to 32 synchronous lines can be supported with the DCU/50 using 4263 dual-line SLM-2. Off-line error detection and diagnostics are a standard feature.

4255/4256 ALM-8 ASYNCHRONOUS LINE MULTIPLEXER: Offers a line speed of 5 to 9600 bps on a program-selectable basis. The 4255 offers eight lines, while the 4256 offers four. Full-character buffering is standard. Line operation may be full- or half-duplex. Full modem control, including automatic answer capabilities for Bell 103, 202, or equivalent data sets, is standard. Modem control signals include carrier detect, ring indicator, data set ready, request to send, data terminal ready, and clear to send.

Programmable line characteristics include parity type (odd, even, or none); 5-, 6-, 7-, or 8-bit code level; 1 or 2 stop bits; and the aforementioned line speed. Diagnostics and error detection on an off-line basis are standard. Up to 128 asynchronous lines can be supported with the DCU/50 and 4255. The EIA RS-232C/CCITT V.24 interface is standard.

4257/4258 ALM-16 ASYNCHRONOUS LINE MULTIPLEXER: Provides a line speed of 5 to 9600 bps on a program-selectable basis. The 4257 handles 16 lines, while the 4258 handles 8. Full-character buffering is standard. Line operation may be full- or half-duplex. Programmable line characteristics include parity type (odd, even, or none); 5-, 6-, 7-, or 8-bit code level; 1 or 2 stop bits; and the aforementioned line speed. Diagnostics and error detection on an off-line basis are standard. Up to 256 asynchronous lines can be supported with the DCU/50 and any combination of the 4257 or 4258. Interfacing is by the 4260 4-line, 20-ma current loop module or the 4261 4-line, EIA RS-232C/CCITT V.24 module. Both modules can be intermixed on the same ALM-16 board. Interfacing is also available to a Bell 103 data set for manual answer-only operations.

4010 ASYNCHRONOUS LINE CONTROLLER: Provides a full-duplex current-loop interface for a local 33 ASR, 33 KSR, 35 ASR, or 35 KSR teletypewriter, a local 6012 video display, or a Bell 103 or equivalent data set through the 4023 EIA interface. The 4029 interface provides control for Bell 103, 202, or equivalent data sets with automatic or manual answer. Clock signals required for the 4023 interface are jumper-selectable. Ten standard frequencies between 75 and 9600 bps are available.

4023 ASYNCHRONOUS SINGLE-LINE CONTROLLER: Provides a full-duplex interface for a single Teletype Model 37ASR or 37KSR; 6012 CRT display; or Bell System 103, or equivalent, with manual answer. Standard rate is 150 bps for 10- or 11-unit codes. Other rates are optionally available. The 4029 option adds modem control features for Bell System 202 units with Automatic Answer.

4025 IBM 360/370 PROGRAMMABLE INTERFACE: Attaches to an IBM selector or multiplexer channel, and can simulate the IBM 2803, 2700 series, etc. Operates in multiplexed or burst mode at up to 150,000 bytes per second. A 4025 IBM Software Driver is provided for I/O programming. The 4025 can operate with RDOS or RTOS in a real-time environment. On-line and off-line diagnostics are provided.

4061 ASYNCHRONOUS MULTIPLEXER: Provides interfaces for up to 64 lines (4 lines per subassembly) at speeds from 45 to 9600 bits per second with 5- to 8-level codes. The 4061 is wired with junction panels to provide system expansion capabilities.

4206 MULTIPROCESSOR COMMUNICATIONS ADAPTER: Interconnects up to 15 Nova central processors into multiprocessor rings. The 4206 features simultaneous program-controlled data transmission and reception. Two jumper-selectable modes of operation are available: normal and fast. In normal mode, data is transferred at 625,000 bytes per second. In fast mode, up to 1 million bytes of data are transferred per second. Up to 15 computers are supported in normal mode, while a maximum of four can be sustained in fast mode. The 4206 is fully supported by RTOS and RDOS.

COMMUNICATIONS SOFTWARE

COMMUNICATIONS ACCESS MANAGER (CAM): Supports all types of communications, with or without the DCU/50 Data Control Unit. SLM-2, ALM-8, and ALM-16 are supported under CAM, as well as the DCU/50. CAM is modular and can be generated by the Communications System Generation Program (COMGEN) to include only those program segments required for each individual system. It operates under RTOS, RDOS, or mapped RDOS, and since it uses the operating system's runtime-defined interrupt service, it is brought into main memory from disc only as needed. This frees large segments of memory in a real-time communications system for other processing tasks. Portions of CAM can also reside in the memory of the DCU/50, if it is present, further reducing main memory overhead.

CAM software can support both standard and special user-defined protocols, including Bisync (BSC) and an asynchronous terminal line procedure. Synchronous and asynchronous protocols can be intermixed. Multi-drop lines are supported through polling and selection sequences. Modem control support for auto answer/auto disconnect is a standard feature. CAM provides a queue for I/O completions that permits a single user task to control several asynchronous lines.

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CAM also features a FORTRAN IV or FORTRAN 5 interface, permitting communications I/O in FORTRAN programs.

CAM operates on any Nova processor with 32K bytes of main memory, a real-time clock, and a communications chassis which includes at least one SLM-2, ALM-8, or ALM-16.

REMOTE JOB ENTRY CONTROL PROGRAM (RJE80): Allows for remote job entry and communications between Nova processors and IBM 360/370 systems, or between Nova processors and other Data General computers. Support is provided for four types of RJE systems:

- Point-to-point communications between a Nova or Eclipse emulating an IBM 2780/2780 and an IBM 360/370 host.
- Point-to-point communications between two Data General systems running RJE80.
- Multi-drop Data General systems emulating IBM 3780 slave terminals, communicating with an IBM 360/370 host.
- Multi-drop Data General Systems emulating IBM 3780 slave terminals, communicating with a Nova or Eclipse master system also running RJE80.

RJE80 running under mapped RDOS also allows a user to run one application in either the foreground or background mode while RJE80 runs independently in either mode.

RJE80 is supported by RTOS, RDOS, and mapped RDOS, as well as CAM. Features include horizontal and vertical printer format control; error detection on transmission and reception; and disc, tape, or card transmission to remote systems. Transmission between host systems may be to unattended RJE80 systems, and because of device-independent I/O capabilities, any combination of I/O devices can be utilized without additional software.

Under RTOS, RJE80 requires a 32K-byte Nova with a card reader, line printer, console terminal, real-time clock, 4251 or 4252 communications chassis, and an SLM-2 Synchronous Line Multiplexer.

Under RDOS, RJE80 requires a 48K-byte Nova with 512K bytes of disc storage, a line printer, a console terminal, a real-time clock, a 4251 or 4252 communications chassis, and an SLM-2 Synchronous Line Multiplexer. RJE80 can handle line speeds up to 9600 bps with the SLM-2 or up to 56K bps with the DCU/50 Data Communications Unit and SLM-2 combination. Any modem of the Bell 201, 203, 208, 209, or 303 type, or equivalent, can be utilized.

A library of communications software is available for operation under RDOS, Mapped RDOS, or RTOS. The library includes a Binary Synchronous Communications package callable from FORTRAN programs, device-independent drivers for intercomputer communications, particular multiprocessor Data General configurations and direct channel interfacing to an IBM 360 or 370 system.

SOFTWARE

OPERATING SYSTEMS: Four levels of system control programming are available for various configurations of the Nova systems. Each of these includes an appropriate level of language processors and utility programs.

Real-Time Disc Operating System (RDOS) is a full-scale operating system that supports multi-tasking. It can schedule and allocate program resources to many different subprogram tasks. It is a comprehensive, modular system with a system generation procedure allowing the user to tailor the operating system to his hardware configuration and his application.

RDOS can be used either interactively from a console keyboard or in batch mode from job streams entered via card readers, disc files, cassette files, or magnetic tape files RDOS can simultaneously support both foreground and background tasks, so that users can run two jobs at the same time. The higher-priority job, which is normally a real-time or response-dependent application program, is run in the foreground, while the lower-priority job is run in the background. Data from a background job is typically processed while waiting for an event or for data from the foreground job. Background mode can also be used to develop new programs without interrupting ongoing jobs. Foreground and background programs can be hardware-protected from each other and from the operating system.

RDOS includes a multi-partitioning system that gives users flexibility in overlaying programs from disc into main memory. Large user programs can be segmented into disc-resident overlays to allow efficient use of main memory and to make the programs more manageable. Tasks stored on the disc occupy main memory only when they are ready for execution. The dual-processor, shared-disc feature allows RDOS users to share peripherals and to access common data and programs on disc.

Also available to RDOS users is the Batch command interpreter and job supervisor. Batch calls in and controls execution of user and system programs. Any program that an on-line user can execute interactively from the console can be called. The Batch processor is not an integral part of RDOS and occupies no main memory when it is not being run.

RDOS supports Extended BASIC, Extended FORTRAN IV and 5, and Extended ALGOL.

RDOS operates on any Data General minicomputer with 16K words of main memory, a teletypewriter, and a disk. In addition, RDOS can support additional memory (up to 32K words), 8 disk cartridges or disk pack drives, and 8 magnetic tape transports (either 7- or 9-track). Card readers, line printers, communications equipment, and analog and digital conversion equipment are also supported.

Mapped RDOS, is available on the Nova 3/D to support two-partition multiprogramming with 32K-word user program areas and an operating system area of up to 32K words (typical size is 8K to 12K words). Mapped RDOS provides an extensive file management capability. It features a common I/O interface, checkpointing for a background task, program segmentation, communication between tasks, and compatibility with RTOS and DOS. Mapped RDOS supports systems of up to 128K words, with each partition protected from the remainder of main memory. Mapped RDOS foreground/background designations are merely a reference to the usual priority designations, which are set up by the user and can be altered at any time. The two partitions could even be given equal priority.

Real-Time Operating System (RTOS) is an upward-compatible subset of the Real-Time Disc Operating System (RDOS). RTOS provides standard interrupt servicing, device handling, and executive scheduling functions. Supporting a multi-tasking environment, RTOS sets up multiple execution paths to perform functions nonsequentially. Tasks are scheduled based on their need to use the processor or I/O devices and the availability of those devices. When more than one task is ready to execute, a multi-level priority structure determines processing sequence by insuring that the highest-priority function is serviced first.

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RTOS is modular and re-entrant, and provides the user with a library of modules for system, task, and device processing. It also provides executive functions that schedule task execution. Tasks are scheduled under program or operator control, either after a given time delay, periodically by a real-time clock, or in response to an external event. Once a task begins execution, the task can modify its own priority, can terminate or delay its execution, or can suspend, awaiting the completion of an I/O operation.

In an RTOS-controlled application, asynchronous tasks communicate with each other through an intertask message mechanism. This communication capability makes it possible to coordinate parallel activities controlling the user environment.

RTOS runs on a minimum configuration of 8K words of memory and a real-time clock. It will also support up to 32K words of memory, multiple teletypewriters or CRT's, fixed- and moving-hed discs, magnetic and cassette tape transports, paper tape reader/punches, card readers, line printers, plotters, process I/O equipment, and asynchronous, synchronous, and intercomputer controllers.

Real-time support for the Extended and Macro Assemblers and FORTRAN IV is available under RTOS.

Disc Operating System (DOS) is another upward-compatible subset of the Real-Time Disc Operating System (RDOS). DOS is diskette-based and provides medium-scale program development on a small-scale system. Like its larger brothers, DOS is memory- and file-based. Features provided by DOS include a comprehensive disc and tape file system, device-independent file transparency, multitasking facilities, user program segmentation, and interactive program development via the DOS Command Line Interpreter (CLI). Besides CLI, DOS operates with other Data General system software including the test editor, library file editor, and relocatable loader. DOS supports up to 32K words of memory and the full range of peripherals available from Data General.

Languages operational under DOS include the Macro and Extended Assemblers, BASIC Interpreter, and FORTRAN IV Compiler. File management is provided for both random-access and fixed-length sequential files. A multitask scheduler provides for user-written programs designed to handle multiple terminals, instrumentation and control processes, and complex communications schedulers. Three methods of user program segmentation are employed: chaining, swapping, and overlaying.

DOS requires a Nova with a minimum of 16K words of memory, a real-time clock, a single diskette drive and controller, and a terminal. This configuration can be utilized for user program execution and program development with the Extended Assembler. However, a dual-diskette system is required for DOS generation and for software development using BASIC, FORTRAN IV, or the Macro Assembler.

LANGUAGES: Four high-level compiler languages are available for use on Nova computers: Extended FORTRAN 5, Real-Time FORTRAN IV, Extended BASIC, and Extended ALGOL.

FORTRAN IV includes all the features of standard ANSI FORTRAN. Extensions beyond the standard include re-entrant programs, double-precision and mixed-mode arithmetic, relational and logical operators, extended array capabilities, and abnormal returns. FORTRAN IV also includes additional I/O capabilities beyond those of standard ANSI FORTRAN. A sophisticated file structure with flexible run-time assignment of I/O devices is provided. In addition, FORTRAN IV has simplified I/O procedures through formatted, conversational, and ASCII/binary input/output. FORTRAN IV runs under DOS or RDOS and requires a minimum of 16K words of memory, 128K words of disc storage, and a teletypewriter. The language is also adaptable to real-time usage, and user programs can be run in a multi-tasking environment under RTOS and RDOS. Under RDOS, full program chaining and overlay operations are permitted.

Stand-Alone 15K-Byte FORTRAN is a subset of FORTRAN IV that includes only the basic functions of the FORTRAN IV language.

FORTRAN 5 is a superset of Data General's FORTRAN IV, ANSI FORTRAN, IBM FORTRAN IV (H Extended), and Univac FORTRAN V. Special compiler features include global code optimization, comprehensive error checking and diagnostics, and re-entrant code. Language extensions beyond ANSI FORTRAN include static and dynamic storage allocation, statement functions expanded as in-line code, data initialization in DIMENSION and data type statements, implied Do loops, flexible declaration order, double-precision and complex arithmetics, IMPLICIT statements, Include statement, full mixed-mode arithmetic, extended array manipulation capabilities, generic library functions, simplified I/O, bit manipulation, and multi-tasking capability.

FORTRAN 5 operates on any Data General minicomputer running under RDOS. It requires a minimum of 32K words of main memory, hardware multiply/divide, the floating-point processor, 512K words of disc storage, and a console terminal. FORTRAN 5 software is supplied on either cassette tape or magnetic tape and requires the appropriate tape drive to interface with the system. Conversational I/O requires a printer terminal or video display console.

Extended ALGOL is a superset of ALGOL 60 with capabilities that allow simplified, free-form I/O or formatted output, bit manipulation, manipulation of character-string data, recursive and re-entrant procedures, dynamic storage allocation, n-dimensional arrays, multi-precision arithmetic, dynamic type conversion for program variables, and explication diagnostics. All programs written in standard ALGOL 60 are completely compatible with Data General's Extended Normal prime-time on-call contract service hours are 9 a.m.

Extended BASIC has all the features of Time-Sharing BASIC as well as extended facilities that allow access to Data General I/O peripherals for both data and program files. Supported peripherals include: high-speed paper tape reader/punch, line printer, fixed-head discs, and moving-head disc pack and disc cartridge drives.

Five versions of the Extended BASIC system include:

Single user with disc
Single-user without disc
Multi-user (non-swapping) with disc
Multi-user (non-swapping) without disc
Multi-user (swapping) with disc

The swapping version of Extended BASIC will time-slice main memory among multiple users. Extended BASIC operates under RDOS or DOS.

The *Extended Assembler* is similar to the basic Nova Absolute Assembler in that it converts symbolic assembly statements into machine-executable code. In addition to the Absolute Assembler features, the Extended Assembler also provides relocation, interprogram communication, conditional assembly, and more powerful number definition facilities.

The *Macro Assembler* adds extensive macro capabilities to the facilities of the Extended Assembler.

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UTILITIES: A library of utility programs for the Nova systems include the FORTRAN Commercial Subroutine Package, a superset of IBM's CSP for data and format conversion and extended-precision integer arithmetic. Also included are a batch job control supervisor for executing stacked jobs; a real-time I/O system to support A-D and D-A interfaces and RDOS sort/merge; a text editor for 1 to 20 users; a symbolic debugger; Dataplot, a set of FORTRAN-callable routines for line drawing and axis rotation on digital plotters; and three editing programs—the Macro Editor, the Library File Editor (LFE), and the Octal Editor (OEDIT).

Utilizing simple command string input, the *Macro Editor* edits paper tape input to produce updated paper tape output. The user may define command strings in a special macro register. The command string may then be executed repeatedly by specifying the macro register name in subsequent command strings. A common application for the Macro Editor is the modification of program source tapes in preparation for a new assembly.

LFE allows the user to analyze the contents of a given library file, to merge and update libraries, and to create his own library files.

OEDIT permits the user to examine and modify, in octal, locations on a disc file. A common use of OEDIT is in making simple changes to executable saved files.

APPLICATIONS: No separate applications packages have been announced for the Nova systems to date. Other software consists of about 20 mathematical routines, more than 24 CPU and peripheral device diagnostics, and a variety of language processor libraries, format conversion routines, etc.

PRICING

POLICY: Data General offers the Nova series on a purchase-only basis, with two types of separately priced maintenance agreements: the On-Call Service contract and the Depot Service contract, which involves return of faulty equipment to a designated repair location. In either case, all parts and labor are included at no additional cost.

Normal prime-time on-call contract service hours are 9 a.m. to 5 p.m. Charges quoted in the price list are applicable to customers within 100 miles of a service center. Additional but uniform monthly charges are in effect beyond 100 miles of a Data General service center. These charges are $150 for customers between 100 and 300 miles from the center and $225 for customers beyond 300 miles.

Under a Depot Service contract, any portion of a system may be covered, the minimum contract being $75. The customer assumes all transportation and insurance costs. For non-contract on-site service, the hourly maintenance rates are $40 for prime time and $48 for all other times. A three-hour minimum applies. Depot service hourly labor charges are $30 for prime time and $48 for all other times.

Data General software is licensed and bundled so that it is included without additional charge on a system with sufficient hardware to operate it. For other configurations that include non-Data General equipment, the software is available for a license fee ranging from $5 for object versions of various language processors to $1,000 for full source listings of the FORTRAN or ALGOL library systems. One day on-site consulting service, including RDOS system generation, is billable at $300 plus transportation costs from the nearest office, except for systems costing over $30,000 with a high-speed input device, where the service is free.

The Data General Software Subscription Service provides automatic updates and documentation for Data General software at a price ranging from $50 to $350 per software product, and for $75 per product on any order totalling $1,000 or more.

The Hardware Subscription Service provides automatic updates, additions, and notification of new documentation on all Data General Hardware for a fixed yearly fee. It is available to any owner of Data General equipment. This includes owners who have purchased their equipment through another vendor. Initial subscriptions include updates for one year. Prices are as follows: Nova processors, $980; peripherals, $920; and communications and I/O, $920. Additional log books for any of the above topics are $500 each without updates. Yearly renewal rates are $480 for Nova processors, $420 for peripherals, and $420 for communications and I/O. A 40 percent discount applies for additional updates beyond the first to the same type of log book, ordered at the same time and deliverable to the same address.

Data General provides training courses for customers at its Southboro, Massachusetts headquarters, at its Western Training Center in El Segundo, California, and at its United Kingdom Training Center in Greenford, Middlesex, England. Two training credits are given for each system purchased (end user) or two training credits per purchase agreement (OEM). One training credit entitles a customer to approximately one man-week of training. Schedules for training courses can be obtained at any Data General field office.

Courses currently being offered include: Introduction to Small Computers, 3 days, $175; Introduction to Assembly Language Programming, 10 days, $625; Assembly language Program Implementation, 5 days, $325; FORTRAN Program Implementation, 5 days, $325; RTOS, 5 days, $325; RDOS Assembly, 5 days, $325; RDOS FORTRAN, 5 days, $325; RDOS Systems Programming, 5 days, $375; Real-Time FORTRAN for Industrial Control, 3 days, $225; Small Computer Hardware Fundamentals, 5 days, $300; Nova Multiply/Divide Option, 2 days, $150; Floating Point Unit Option, 3 days, $225; Basic I/O Interfacing, 2 days, $150; Magnetic Tape, 3 days, $275; Data General Cassette, 2 days, $175; Moving-Head Disc, 3 days, $275; Line Printer, 2 days, $175; and Card Reader, 2 days, $175.

On-site training is available when necessary. Costs involve $600 per day (with a three-day minimum) for instructional charges including the instructor's daily expenses, instructor's travel expenses, $100 per weekend for subsistence when incurred, and a per-student charge for actual documentation used.

The Data General Users' Group provides a forum for interchange of programs. The programs are available for a fee to cover reproduction and distribution costs.

Prices shown in the Equipment Prices list are for single-unit quantities. Standard OEM three-to-five quantity discounts of 19 percent apply. Discounts of about 40 percent are available for quantities of 200 or more units.

EQUIPMENT: The following system purchase prices include all required control units, adapters, and cables.

SMALL NOVA 3/12 BATCH CONFIGURATION: Includes Nova 3/12 with 32K words of 700-nanosecond NMOS memory, multiply/divide, auto program load, 30-cps Dasher control terminal, diskette subsystem, card reader, 300-lpm printer, 10-megabyte disc drive, and cabinet. Purchase price is $44,150.

Data General Nova Series

DUAL NOVA 3/12 SYSTEM: Includes two Nova 3/12 computers, each with 32K words of core memory, multiply/divide, auto program load, power monitor, real-time clock, and interprocessor bus. System also includes a 60-cps Dasher console terminal, a DG CRT terminal, 10-megabyte disc drive, diskette subsystem, 300-lpm printer, and cabinet. Purchase price is $64,600.

MAPPED FOREGROUND/BACKGROUND NOVA 3/D SYSTEM: Includes Nova 3/D with 80K words of core memory, power monitor, auto program load, memory management and protection unit, multiply/divide, real-time clock, 10-megabyte disc subsystem, magnetic tape drive, 60-cps Dasher terminal, DG CRT terminal, 300-lpm printer, and cabinet. Purchase price is $60,390.■

EQUIPMENT PRICES

		Purchase Price	Monthly Maint. On-Call Service	Monthly Maint. Factory Service
PROCESSORS				
	Nova 3 processors include four accumulators, I/O system with programmed data transfer, 16-level programmed priority interrupt, extended hardware stack facility, direct memory access channel, external I/O bus connector terminator, programmer's console with lock, power supply, and chassis with slide mounts for 19-inch rack.			
	Nova 3/4 Processor:			
8478	With 4,096 words of 700-nsec. MOS memory and 1 slot available	$ 2,600	$38	$ 19
8479	With 4,096 words of 700-nsec. MOS parity memory, 8536 parity control, 8533 option subassembly, and 1 slot available	3,700	36	18
8480	With 8,192 words of 700-nsec. MOS memory and 2 slots available	3,200	46	23
8481	With 8,192 words of 700-nsec. MOS memory, 8533 option subassembly, and 1 slot available	4,500	44	22
8482	With 8,192 words of 800-nsec. core memory and 2 slots available	3,700	50	25
8483	With 16,384 words of 800-nsec. MOS memory and 2 slots available	4,400	56	28
8484	With 16,384 words of 800-nsec. MOS parity memory, 8536 parity control, 8533 option subassembly, and 1 slot available	6,100	54	27
8485	With 16,384 words of 1000-nsec. core memory and 2 slots available	5,200	60	30
8576	With 32,768 words of 700-nsec. MOS memory and 2 slots available	6,500	84	42
8577	With 32,768 words of 700-nsec. MOS parity memory and 2 slots available	8,800	78	39
	Nova 3/12 Processor:			
8486	With 4,096 words of 700-nsec. MOS memory and 10 slots available	3,600	44	22
8487	With 4,096 words of 700-nsec. MOS parity memory, 8536 parity control, 8533 option subassembly, and 9 slots available	4,700	42	21
8488	With 8,192 words of 700-nsec. MOS memory and 10 slots available	4,200	52	26
8489	With 8,192 words of 700-nsec. MOS parity memory, 8536 parity control, 8533 option subassembly, and 9 slots available	5,500	50	25
8490	With 8,192 words of 800-nsec. core memory and 10 slots available	4,700	56	28
8491	With 16,384 words of 700-nsec. MOS memory and 10 slots available	5,400	62	31
8492	With 16,384 words of 700-nsec. MOS parity memory, 8536 parity control, 8533 option subassembly, and 9 slots available	7,100	60	30
8493	With 16,384 words of 1000-nsec. core memory and 10 slots available	6,200	66	33
8494	With 32,768 words of 700-nsec. MOS memory and 9 slots available	8,100	102	51
8495	With 32,768 words of 700-nsec. MOS parity memory, 8536 parity control, 8533 option subassembly, and 8 slots available	10,800	98	49
8496	With 32,768 words of 1000-nsec core memory and 9 slots available	9,700	110	55
8497	With 32,768 words of 700-nsec. MOS memory and 10 slots available	7,500	102	51
8498	With 32,768 words of 700-nsec. MOS parity memory and 10 slots available	9,800	98	49
	All of the following Nova 3/12 and Nova 3/D configurations include the 8535 memory management unit, 8533 option subassembly, 8530 automatic program load, and 8531 power monitor/automatic restart. All MOS memory includes 8532 battery backup, and MOS parity memory includes 8536 parity control. The Nova 3/D also includes the 8538 memory protection unit as standard.			
	Nova 3/12 configurations:			
8500	With 32,768 words of 700-nsec. MOS memory and 8 available slots	11,400	127	64
8501	With 32,768 words of 700-nsec. MOS parity memory and 9 available slots	13,900	124	62
8502	With 32,768 words of 1000-nsec. core memory and 8 available slots	12,500	135	68
8503	With 49,152 words of 700-nsec. MOS memory and 7 available slots	14,100	151	76
8504	With 49,152 words of 700-nsec. MOS parity memory and 7 available slots	17,600	146	73
8505	With 49,152 words of 1000-nsec. core memory and 7 available slots	16,000	161	81
8506	With 65,536 words of 700-nsec. MOS memory and 6 available slots	16,800	183	92
8507	With 65,536 words of 700-nsec. MOS parity memory and 6 available slots	21,300	177	89
8508	With 65,536 words of 1000-nsec. core memory and 6 available slots	19,500	196	98
8509	With 32,768 words of 700-nsec. MOS memory, 32K words of 1000-nsec. core memory, and 6 available slots	18,400	206	103
8510	With 98,304 words of 700-nsec. MOS memory and 4 available slots	22,200	223	112
8511	With 98,304 words of 700-nsec. MOS parity memory and 4 available slots	28,700	215	108
8512	With 98,304 words of 1000-nsec. core memory and 4 available slots	26,500	240	120
8513	With 49,152 words of 700-nsec. MOS memory, 48K words of 1000-nsec. core memory, and 4 available slots	24,600	257	129
8514	With 131,072 words of 700-nsec. MOS memory and 2 available slots	27,600	279	140
8515	With 131,072 words of 700-nsec. MOS parity memory and 2 available slots	36,100	268	134
8516	With 131,072 words of 1000-nsec. core memory and 2 available slots	33,500	301	151
8517	With 65,536 words of 700-nsec. MOS memory, 64K words of 1000-nsec. core memory, and 2 available slots	30,800	324	162
	Nova 3/D computers:			
8578	with 32,768 words of 1000-nsec. core memory and 8 available slots	12,000	135	68
8579	With 49,152 words of 1000-nsec. core memory and 7 available slots	14,500	160	80
8580	With 65,536 words of 1000-nsec. core memory and 6 available slots	17,000	185	93
8581	With 81,920 words of 1000-nsec. core memory and 5 available slots	19,500	205	103
8582	With 98,304 words of 1000-nsec. core memory and 4 available slots	22,000	225	113
8583	With 131,072 words of 1000-nsec. core memory and 2 available slots	27,000	265	132
8584	With 32,768 words of 700-nsec. MOS parity memory and 9 available slots	14,400	125	63
8585	With 49,152 words of 700-nsec. MOS parity memory and 8 available slots	17,600	155	78
8586	With 65,536 words of 700-nsec. MOS parity memory and 8 available slots	20,800	175	88
8587	With 81,920 words of 700-nsec. MOS parity memory and 7 available slots	24,000	200	100

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint. On-Call Service	Monthly Maint. Factory Service
PROCESSORS (Continued)				
8588	With 98,304 words of 700-nsec. MOS parity memory and 7 available slots	$ 27,200	$ 215	$ 108
8589	With 131,072 words of 700-nsec. MOS parity memory and 6 available slots	33,600	245	123
8590	With 32,768 words of 700-nsec. MOS memory and 9 available slots	12,300	153	77
PROCESSOR OPTIONS				
8530	Automatic Program Load; for devices as specified in programmer's console switches	400	2	1
8531	Power Monitor/Auto-Restart; causes program interrupt when power fails and automatic restart when power is restored	400	1	1
8532	Battery Backup for MOS memory during power failure	500	10	10
8533	Nova 3 computer option subassembly; required by 8534, 8535, and 8536	200	2	1
8534	Multiply/Divide; multiplies two 16-bit numbers to produce a 32-bit product; divides a 32-bit dividend by a 16-bit divisor to produce a quotient and remainder	1,600	13	7
8535	Memory Management Unit; provides for Nova 3/12 memory expansion to 131,072 words, core or MOS or mixed memory modules, and two data channel operation address spaces	2,800	28	14
8536	Parity control option; parity generation and checking for MOS and interrupt generation on error condition in MOS parity memory modules	500	5	3
8537	Nova 3/12 or Nova 3/D expansion chassis; adds 12 I/O subassembly slots and includes I/O bus connector	2,000	20	10
8538	Memory Protection Unit (MPU) for Nova 3/12	1,000	10	5
8539	Floating Point Unit for Nova 3/12 or Nova 3/D	4,000	36	18
MEMORY (for field installation)				
8540	8,192-word, 700-nsec. MOS	1,500	28	14
8541	With parity option	2,100	26	13
8542	8,192-word, 800-nsec. core	2,100	32	16
8543	16,384-word, 700-nsec. MOS	2,700	40	20
8544	With parity option	3,700	38	19
8545	16,384-word, 1000-nsec. core	3,500	44	22
8546	32,768 word, 700-nsec. MOS	7,400	62	31
8547	Without parity	5,400	68	34
MASS STORAGE				
6060	DG/Disc Storage Subsystem; includes 96-megabyte disc pack and controller for up to four 96- and/or 190-megabyte drives; one 3336-type disc pack is included	24,950	220	110
6060-A	Add-on 96-megabyte disc pack drive	20,800	160	80
6061	DG/Disc Storage Subsystem; includes 192-megabyte disc pack drive and controller for up to four 96- and/or 190-megabyte drives; one 3336-11-type disc pack is included	29,950	220	110
6061-A	Add-on 190-megabyte disc pack drive	26,000	160	80
1122-B	One 96-megabyte disc pack	990	NC	NC
1122-A	Four 96-megabyte disc packs	3,600	NC	NC
1123-B	One 190-megabyte disc pack	1,550	NC	NC
1123-A	Four 190-megabyte disc packs	5,800	NC	NC
6045	DG 10-megabyte Cartridge Disc Subsystem; includes one cartridge disc drive with 5 megabytes each of fixed and removable disc storage, controller for four drives, and one certified disc cartridge	10,100	120	60
6045-C	Without certified disc cartridge	9,950	120	60
6046	DG 20-megabyte Cartridge Disc Subsystem; consists of a 6045 system with two drives and two certified disc cartridges	18,250	200	100
6046-C	Without certified disc cartridges	17,950	200	100
6047	DG 30-megabyte Cartridge Disc Subsystem; consists of a 6045 system with three drives and three certified disc cartridges	26,400	280	140
6047-C	Without certified disc cartridges	29,950	280	140
6048	DG 40-megabyte Cartridge Disc Subsystem; consists of a 6045 system with four drives and four certified disc cartridges	34,550	360	180
6048-C	Without certified disc cartridges	33,950	360	180
6050	Add-on 10-megabyte cartridge disc drive for 6045, 6046, or 6047 subsystems; includes power supply and one certified disc cartridge	9,000	80	40
6050-F	Add-on 10-megabyte cartridge disc drive for an existing floppy disc subsystem; includes power supply and one certified disc cartridge	9,600	115	60
6051	Dual port option for 6045, 6046, or 6047 subsystem; includes controller	4,500	50	25
1121B	One 5440-type certified disc cartridge	200	NC	NC
1121A	Six 5440-type certified disc cartridges	960	NC	NC
4046	Disc control for up to four 25-megabyte drives	4,000	32	16
4057	4046 Adapter for up to four 4057A disc drives	6,000	48	24
4057A	Disc drive, similar to IBM 2314; 25 megabytes	11,800	180	90
4057B	One 25-megabyte disc pack; 20-surface nonformatted	525	NC	NC
4057C	Six 25-megabyte disc packs; 20-surface nonformatted	2,800	NC	NC
6030	Dual diskette subsystem including two drives with power supply and control for up to four drives	3,900	45	23
6030-A	Add-on dual diskette drives with chassis and power supply; for single or dual diskette subsystems	3,400	40	20
6030-B	Add-on dual diskette drives with chassis and power supply; for addition to a 10-megabyte cartridge disc subsystem	3,400	40	20
6031	Single diskette subsystem including drive with power supply and control for up to four drives	2,900	40	20
6031-A	Add-on single diskette drive with chassis and power supply; for single or dual diskette subsystems	2,400	35	18
6031-B	Add-on single diskette drive with chassis and power supply; for addition to a 10-megabyte cartridge disc subsystem	2,400	35	18
1098A	Carton of 10 preformatted diskettes with labels and write protect markers	120	NC	NC

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint. On-Call Service	Monthly Maint. Factory Service
MAGNETIC TAPE EQUIPMENT				
6020	Magnetic tape subsystem; includes 7-track, 75-ips tape transport, switch-selectable at 556 or 800 bpi, and control for up to eight drives	$9,900	$ 90	$ 45
6022	Add-on magnetic tape transport; 7-track, 75 ips, switch-selectable at 556 or 800 bpi	6,700	65	33
6021	Magnetic tape subsystem; includes 9-track, 75-ips tape transport, switch-selectable at 556 or 800 bpi, and control for up to eight drives	9,900	90	45
6023	Add-on magnetic tape transport; 9-track, 75 ips, switch-selectable at 556 or 800 bpi	6,700	65	33
4030	Magnetic tape control for up to eight synchronous read-after-write 7- or 9-track transports	4,000	25	13
6024	6022 magnetic tape transport for use in a 4030 magnetic tape subsystem	6,700	65	33
6025	6023 magnetic tape transport for use in a 4030 magnetic tape subsystem	6,700	65	33
4196	Magnetic tape control for up to four 1600 bpi PE synchronous read-after-write transports	5,000	32	16
4196A	Master magnetic tape drive; 9-track, 45 ips, 1600 bpi PE; for 4196 subsystem	8,500	90	45
4196B	Add-on magnetic tape drive; 9-track, 45 ips, 1600 bpi PE; for 4196 subsystem	6,500	70	35
4075	I/O interface subassembly; must be ordered with cassette control	200	2	1
4076	I/O control for up to eight read-after-write cassette drives	1,500	12	6
4080	First chassis with three cassette drives	3,500	32	16
4087	Add-on chassis with three cassette drives	3,500	32	16
4081	First chassis with one cassette drive	2,000	20	10
4088	Add-on chassis with one cassette drive	2,000	20	10
4084	First chassis with two cassette drives	2,750	26	13
4089	Add-on chassis with two cassette drives	2,750	26	13
4082	Cassette for use with 4080 series	20	NC	NC
LINE PRINTERS				
4014	I/O interface subassembly; must be ordered with incremental plotter and/or line printer control	200	4	2
4034	Line printer control for 4034C or 4034D	1,400	10	5
4034C	Serial 5 x 7 matrix printer; 165 cps; 10 characters per inch; up to 132 characters per line	4,500	40	20
4034D	Serial 7 x 9 matrix printer; 165 cps; 10 characters per inch; up to 132 characters per line	4,900	40	20
4034E	Optional stand for 4034C or 4034D to make unit free-standing	250	NC	NC
4215	Line Printer Subsystem; includes 600-lpm, 136-column, 64-char. set printer and controller	18,000	110	55
4216	Line Printer Subsystem; includes 436-lpm, 136-column, 96-char. set printer and controller	19,900	115	58
4218	Line Printer Subsystem; includes 300-lpm, 136-column, 64-char. set printer and controller	12,500	85	43
4219	Line Printer Subsystem; includes 240-lpm, 136-column, 96-char. set printer and controller	14,400	90	45
4217	Programmable Interval Timer for 4215, 4216, 4218, or 4219 subsystem	900	6	3
4017	Incremental plotter control for all 4017 Series plotters	1,500	10	5
4017E	Incremental plotter with Z-fold paper; 11-inch paper, 300 steps per second; step size 0.005 inch (4017E), 0.01 inch (4017E-A), 0.10 mm (4017E-B), or 0.25 mm (4017E-C)	5,000	100	50
PAPER TAPE EQUIPMENT				
4007	I/O interface subassembly; must be ordered with paper tape reader control (4011) and/or paper tape punch control (4012)	200	4	2
4011	Paper tape reader control for 6013 reader	850	9	5
6013	High-speed paper tape reader; 400 cps, fanfold, 8-channel tape	1,150	12	6
4012	Paper tape punch control for 4012A punch	700	8	4
4012A	High-speed paper tape punch; 63.3 cps, fanfold, 8-channel paper tape	2,400	12	6
4012B	Same as 4012A but for use with 4013 remote-operation modification	2,400	12	6
4013	Remote-operation modification to punch; allows power turn-on/turn-off under program control	300	3	2
PUNCHED CARD EQUIPMENT				
4036	I/O interface subassembly; must be ordered with card reader control (4016)	200	4	2
4016	Card reader control for 4016-type card readers	850	6	3
4016D	Medium-speed punched card reader, 285 cpm	2,900	40	20
4016E	Medium-speed punched card reader, 400 cpm	3,900	55	28
4016F	High-speed punched card reader, 600 cpm	4,100	80	40
4016G	High-speed punched card reader, 1000 cpm	5,000	80	40
4016I	Medium-speed mark sense card reader, 285 cpm	4,100	40	20
4016J	Medium-speed mark sense card reader, 400 cpm	6,000	55	28
TERMINALS				
6012	CRT; 24 lines by 80 characters; 5 x 7 dot matrix char. set; to 4800 bps	2,700	25	13
6042	Dasher terminal printer; 30 cps, KSR	2,400	25	13
6043	Dasher terminal printer, 30 cps, RO	2,200	23	12
6040	Dasher terminal printer, 60 cps, KSR	2,650	28	14
6041	Dasher terminal printer, 60 cps, RO	2,450	26	13
6052	CRT; 24 lines by 80 characters, 5 x 7 dot matrix, 64-char. set; to 19.6K bps	1,990	20	10
6053	CRT; 24 lines by 80 characters, 5 x 8 dot matrix, 96-char. set; additional features such as blink and underscore; to 19.6K bps	2,290	20	10
6054	Printer interface for 6052 or 6053 CRT terminals; to 1200 bps	400	5	3
6055	Printer subsystem for 6052 or 6053; consists of 6054 interface and 6041 Dasher RO terminal	2,500	30	15
COMMUNICATIONS—ASYNCHRONOUS				
4007	I/O interface subassembly. Must be ordered with 4010 asynchronous line controller	200	4	2
4010	Asynchronous line controller for Models 33 ASR and KSR, 35 ASR and KSR, 6012, etc.	150	3	2
4023	EIA voltage I/O interface for Model 37 ASR and 37 KSR teletypewriters, 6012 video display, and Bell System 103 data set or equivalent when manual answer only is used; 150 bps	50	2	1
4029	EIA voltage interface for Bell System 202 data set or equivalent (1200 bps), or 103 data set or equivalent (150 bps)	200	2	1

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint. On-Call Service	Monthly Maint. Factory Service
COMMUNICATIONS—ASYNCHRONOUS (Continued)				
4075	I/O interface subassembly; for 4077 TTY, I/O interface	$ 150	$ 2	$ 1
4077	Teletypewriter I/O interface; same as 4010 except uses same interface subassembly as 4076 cassette controller	150	1	1
4078	EIA-type interface; same as 4023 except for use with 4077 interface	50	—	—
4061	Four-line subsystem of 64-line maximum asynchronous multiplexer with hardware character assembly, disassembly, and buffering; full-duplex operation with transmission characteristics and line speed selectable by jumpers; programmed I/O interface, provided for use with 4050 or 4083 junction panels	1,500	13	7
4063	Same as 4061 except EIA interface is wired for use with 4083 or 4051 junction panels	1,500	13	7
COMMUNICATIONS SUBSYSTEMS				
4250	Data control unit (DCU/50); provides data channel interface to any DG computer	3,000	36	18
4251	4-slot communications chassis for any Nova; includes power supply, terminator card, and cable	1,800	22	11
4253	Add-on 4-slot communications chassis for 4251	1,400	14	7
4255	8-line asynchronous multiplexer; programmable, includes full modem controls, for 4251 systems	2,000	16	8
4256	Same as 4255 except for 4 lines	1,250	16	8
4257	16-line asynchronous multiplexer; programmable, does not include modem controls, for 4251 systems	2,000	20	10
4258	Same as 4257 except for 8 lines	1,300	20	10
4260	4-line current-loop interface for 4257 or 4258 multiplexer; for TTY or 6012 display interface	160	2	1
4261	4-line EIA interface for 4257 or 4258 multiplexer; RS-232C or CCITT V. 24 compatible; for 6012 displays or Bell 103 or equivalent modems (with manual answer only)	160	2	1
4263	2-line synchronous line multiplexer; programmable, for 4251 systems; includes full modem controls	1,500	12	6
4264	Same as 4263 except for 1 line only	1,000	12	6
4265	Current-loop interface for 4263 or 4264; for Bell 303 or equivalent modems	200	2	1
4266	CRC generator/checker for 4263 or 4264	500	4	2
REAL-TIME CLOCKS				
4007	I/O interface subassembly; must be ordered with real-time clock (4008)	200	4	2
4008	Real-time clock; four frequencies selectable under program control; line frequency, 10Hz, 100Hz, or 1000Hz	400	4	3
4075	I/O interface subassembly; must be ordered with real-time clock (4079)	200	2	1
4079	Real-time clock; same as 4008 except uses same I/O interface subassembly as cassette controller (4076)	400	3	2
4065	I/O interface subassembly; must be ordered with programmable interval timer (4068); options 4067 and 4068 cannot both be on the same board	200	2	1
4068	Programmable interval timer; provides a crystal-controlled oscillator with jumper-selectable frequencies (10K Hz, 40K Hz, 80K Hz, 160K Hz, external) plus a 16-bit counting register which may be loaded and read under program control	600	6	3
INTER-COMPUTER INTERFACES				
4025	Programmable interface to any Model IBM 360/370 computer with standard selector or multiplexer channels; capable of supporting multiple devices simultaneously; user supplies driver software for channel interface and sufficient 360/370 computer time for installation and verification of correct operation; does not include installation	7,500	200	100
4206	Multiprocessor communications adapter; up to 15 Nova central processors can be interconnected, with one 4206 adapter for each central processor	2,100	17	9
4240	Interprocessor bus unit for synchronization and communication between two Nova systems (1 slot)	1,900	17	9
8080	I/O bus switch chassis; provides 14 I/O slots; includes power supply, front panel, and selector switch for two computers	4,500	45	23
8081	Bus control cards for 8080; requires two per system	1,700	17	9
GENERAL-PURPOSE INTERFACE				
4040	General-purpose interface board	450	—	—
4190	With 4192 I/O external connector	650	—	—
4041	Registers for 4040 or 4190; 16-bit input and 16-bit output	100	—	—
4042	Data channel connection	300	—	—
4192	General-purpose I/O external connector	300	—	—
CABINETS AND HARDWARE				
1012K	Cabinet; 70.5 inches high; provides 56 inches of rack space; includes blower	950	—	—
1012L	Cabinet; two-bay version of 1012K	1,900	—	—
1012M	Cabinet; 3-bay version of 1012K	2,850	—	—
1012N	Cabinet; half-bay version of 1012K; provides 19.25 inches of rack space	725	—	—
1012P	Cabinet; same as 1012K with power	950	—	—
4116	Blower for 1012 cabinets	150	—	—
1079A	Cabinet; 72.25 inches high; includes refrigeration unit; 1750 watts head load	2,900	30	—
1079B	Cabinet; same as 1079A except with air-to-air heat load	1,950	15	—