Bull DPS 7 Series

MANAGEMENT SUMMARY

The Bull DPS 7 series comprises eight machines, which can be divided into two series at the hardware level—the upper range and the lower range. The upper range consists of the 7/60P, 7/70, 7/80 and 7/82. The lower range comprises the 7/35, 7/45, 7/55 and 7/65, all announced more recently than the upper range, except for the 7/60P.

For the most part, the DPS 7 Series competes on a performance level with the IBM 4300 Series (see the Performance Comparison Chart). However, at the top end, the 7/82 is roughly on a par with the IBM 3031 AP in terms of performance.

The difference between the upper and lower ranges of the DPS 7 series is mainly in hardware. The upper models have input/output processors; the lower models do not. However, the machines offer complete compatibility at the operating system level (all machines except the 7/82 run GCOS 64-E) and at the networking level, where Bull offers networking software under the DSA label.

The markets covered by the DPS 7 are medium to large organizations which need a centralized system, but which can also use other Bull products in a distributed fashion, most likely using the DSA networking facilities.

MODELS 7/35, 7/45, 7/55, 7/65

The lower models—that is the 7/35, 7/45, 7/55 and 7/65—fit in the field broadly covered by IBM's 4331-2 and 4341-1. All run only under the GCOS 64-E operating system except the 7/65 which also offers OS 2000 for ex-Honeywell 200 and 2000 users. All the machines are microcoded.

Bull has made good use of modern machine architecture in the DPS 7. Multiprocessing and simultaneity are evidence of this. Although the lower models do not have input/output processors nor cache memory, the lack of this hardware probably does not have any great effect on the performance of the machines.

The DPS series comprises eight machines. All are multiprocessor, multitasking machines suited to the medium to large central user who also requires distributed processing and networking capabilities.

MODELS: DPS 7/35, 7/45, 7/55, 7/65, 7/60P, 7/70, 7/80, and 7/82.
CONFIGURATION: From 1 to 8 megabytes of main memory and 2 to 32 I/O channels.
COMPETITION: IBM 4300 Series and equivalent ranges.
PRICE: Purchase prices range from approximately FF 2.500.000 to over FF 5.700.000.

CHARACTERISTICS

MANUFACTURER: Bull, 94, avenue Gambetta, B.P. 33, 75960 Paris, Cedex 20, France, Telephone 360.02.22 Telex 220 898 F.

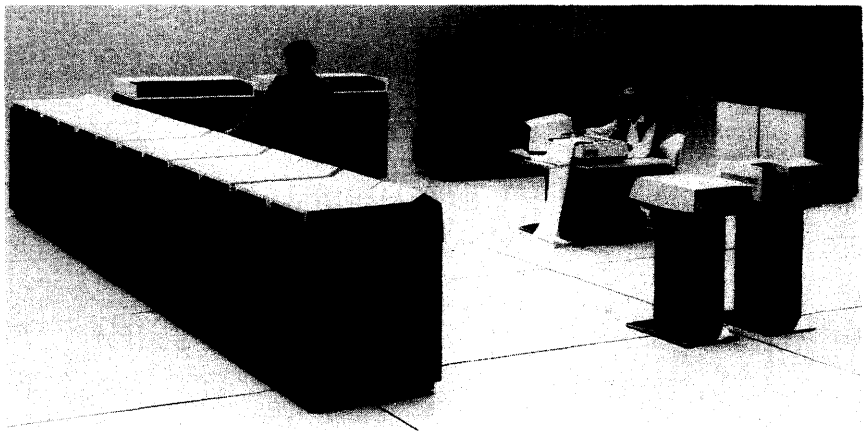
MODELS: DPS 7/35, 7/45, 7/55, 7/65, 7/60P, 7/70, 7/80, and 7/82.

DATE ANNOUNCED: 7/35, 7/45—October 1981; 7/55—April 1982; 7/65—January 1981; 7/60P—April 1982; 7/70—January 1980; 7/80 and 7/82—September 1979.

DATE OF FIRST DELIVERY: 7/35 and 7/45—September 1980; 7/55—July 1982; 7/65—February 1981; 7/60P—November 1982; 7/70, 7/80 and 7/82—fourth quarter 1980.

DATA FORMATS

BASIC UNIT: 8-bit byte plus one parity bit. Data paths are four bytes (32 bits) wide, while addresses and commands use an independent 28-bit path. Data can be interpreted as binary, decimal, hexidecimal, or alphanumeric. Data bits are interpreted in groups of four (packed decimal) or eight (alphanumeric EBCDIC), or in strings of 16 to 64 bits (binary digits). The strings can be interpreted as signed or fixed-point operands with single (16-bit) or double (32-bit) precision formats. The scientific instruction set, used for floating-point operations, provides the capability for 128-bit quad words.



DPS 7 configurations come in such a variety that there isn't any typical system, but this one can be considered representative.

Bull DPS 7 Series

CHARACTERISTICS OF THE DPS 7 SERIES

MODEL	DPS 7/35	DPS 7/45	DPS 7/55	DPS 7/65	DPS 7/60P	DPS 7/70	DPS 7/80	DPS 7/82
Operating System	GCOS 64-E	GCOS 64-E	GCOS 64-E	GCOS 64-E PM 200/0	GCOS 64-E SIRIS 3-E SIRIS 8-E	GCOS 64-E SIRIS 3-E SIRIS 8-E	GCOS 64-E SIRIS 3-E SIRIS 8-E	SIRIS 8-E
Memory Size (megabytes)	1/2/3	2/3/4	2/3/4	2/3/4	2/3/4	2/3/4	3/4	4/8
Cycle Times (read/write in nanoseconds)	355/290	355/290	355/290	355/290	960/880	960/880	660/550	660/550
Bytes per cycle	4	4	4	4	8	8	8	8
I/O channels (Integrated & Optional)	2 + 2	2 + 4	4 + 4	4 + 4	4 + 8	4 + 8	4 + 12	4 + 28
Integrated MSP	1	1	—	—	—	—	—	—
Optional Double Channel	1	1	—	—	—	—	—	—
MSP (single- or double-channel)	—	1 to 4	1 to 4	1 to 4	1 to 4	1 to 6	1 to 8	1 to 12
Disk Access (concurrent)	18	18	36	36	36	54	72	108
Capacity (max. in 1000s of MB)	10.5	10.5	22	22	22	33	44	67
SURP	1	1	1	1	1	1	1	1
Additional URP	—	1	1	1	1	1	2	5
Single LOS MTP	1	1	2	2	2	4	4	8
		or	or	or	or	or	or	or
Double LOS MTP		1	1	1	1	2	2	4
Tape Units (minimum)	0	0	0	0	1	1	1	1
Tape Units (maximum)	8	16	16	16	16	32	32	64
Optional DCP	2	2	2	2	1	1	1	—
Lines per DCP	10	12	12	12	15	15	15	—
Network Processors	1	1	1	2	2	2	4	4
Lines per System	64	64	128	128	128	256	512	512

MSP =Mass Storage Processor
SURP =Service and Unit Record Processor
MTP =Magnetic Tape Processor
URP =Unit Record Processor
DCP =Data Communication Processor

In addition to the central processor, the DPS 7 uses three other process types—a peripheral processor, a network processor and a service processor.

The service and peripheral processors are standard equipment, but the network processor and additional processors are options.

Simultaneity is achieved at two basic levels: within the main processor and by concurrent operation with the main processor of service, peripheral and, if fitted, network processors. These ancillary processors all have intelligence and some memory and are autonomous within certain limits. The main processor also has an ability to carry out a number of operations in parallel—such as fetching and decoding instructions, performing arithmetic/logical operations, and finding main memory addresses.

Main memory is MOS and ranges from one to three megabytes on the 7/35, two to four megabytes on the 7/45 and between two and four megabytes on the 7/55 and 7/65. In all cases, it is very fast.

Links between memory and all the processors, excluding the main processor, are provided by channels with a total

FIXED-POINT OPERANDS: 1 to 16 bytes (1 to 31 digits plus sign) in packed decimal; one halfword (15 bits plus sign) or one word (31 bits plus sign) in binary.

FLOATING-POINT OPERANDS: one, two, three, or four words, consisting of a sign bit, a 7-bit exponent, and a 24-bit, 56-bit, or 112-bit fraction.

INSTRUCTIONS: The DPS 7 systems are microcoded machines that can serve as upgrades to either IRIS or Level 64 and 64/DPS systems by executing the appropriate instruction set.

INTERNAL CODE: EBCDIC.

MAIN STORAGE

Memory is organized into consecutively-numbered byte locations. Four-byte blocks are always accessed regardless of operand size. Halfword (16-bit) operands must begin on even-numbered byte locations, and full-word (32-bit) and double word (64-bit) operands must begin on byte locations divisible by four.

TYPE: 64K-bit MOS chips. Current Mode Logic (CML), a fast, low power, low heat technology is used. CML has a propagation time of one nanosecond per logic port. In addition, the DPS 7 uses a multilayer micropackaging technique that allows 10,000 to 15,000 functions per board. The CML technology used is the result of cooperation by Bull in

transfer rate of 6 million bytes/second on the 7/35 and 7/45, and a transfer rate of 11 million bytes/second on the 7/55 and 7/65.

The low end of the range provides data communications through the use of an optional integrated Data Communications Processor and the Network Processor, if this is needed by the user. The Data Communications Processor can connect up to 12 synchronous or asynchronous lines.

The Network Processor provides complete facilities for network control and may also be used as a terminal concentrator or as a switch. There are various models available for the different members of the DPS 7 series. The Datanet 7100, for example, for use with the 7/55 mainly, supports up to 128 communications lines and terminals of different types. All Datanet processors permit connection of the DPS system to the public networks, such as Transpac, DATEX-P and NPDN.

Software for the lower-end models of the DPS 7 series is dominated by the GCOS 64-E operating system which is common to all members of the series. GCOS 64-E's main job is optimizing program handling and dividing programs into segments which are fully relocatable and can be swapped in and out of memory as needed. Optimization of the processes associated with tasks—that is, getting them in and out of memory and synchronizing the in-out phase—is effected through firmware. When a program can be broken down into a number of subtasks that can be executed in parallel, the firmware synchronizes the operation.

Languages are also a strength of the Bull DPS 7 series. Cobol, Fortran, RPG2, PL/1 are available and software for interactive use includes Basic and APL. Menu-driven facilities include a command language generator and interactive data management utilities. Four packages are offered for data management, and Wordpro is offered for document handling.

The DPS 7 range offers a very wide variety of peripherals with the accent on disks and terminals. (Full details are in the Characteristics section.)

DPS 7 systems can be coupled to share peripherals. Such configurations enable peripheral and network processors to be switched between two DPS 7 systems.

MODELS 7/60P, 7/70, 7/80 and 7/82

Apart from the 7/60P, the higher models constitute the older and, in general, more powerful machines of the DPS 7 range. They differ from the lower range mainly in that they all have input/output processors and cache memories as standard equipment. Compatibility between the two ranges exists at operating system and other software levels and in use of the Bull network system, DSA. Apart from these differences, the 7/60P, 7/70, 7/80 and 7/82 are identical to the lower models.

The 7/60P and 7/70 have exactly the same memory capacity alternatives as the 7/55 and 7/65: two, three or four

Europe, Honeywell in the United States, and the Nippon Electric Company in Japan. Micropackaging is the result of research and development work at Bull laboratories.

CYCLE TIME: See characteristics table.

CAPACITY: See characteristics table.

CHECKING: Each item of data stored in memory units, cache memory, and control store is accompanied by a Hamming code (one byte for every 8 data bytes) which permits the correction of single-bit errors and the detection of double-bit errors. Data paths, and particularly, the bus, perform parity checks to ensure data integrity. All registers and calculation circuits include a key check.

Diagnostic microprograms are launched at each system initialization or at the operator's request, by the main processors and by peripheral processors to verify their operation. The support system launches checkpoints when there is an irrecoverable error or a power loss.

In the event of an error, a retry is automatic. The retry can be initiated by firmware for a microinstruction or an instruction, or by software for a group of instructions or input/output commands. Retries can be initiated several times. Whenever an error is detected and a retry is attempted, the event is recorded in an error log. An error report, subsequently produced, indicates the origin of each error and speeds up diagnosis and allows fast, corrective intervention.

STORAGE PROTECTION: In the GCOS 64 environment, to avoid artificial restrictions on the placement of segments in memory, the DPS 7 protects every segment individually with an automatic system of rings and protection levels. This protection system, implemented by hardware and firmware, protects segments on the basis of the information they contain rather then their physical location.

The main processor, while executing a process, may be at one of four levels of privilege, called "rings." Rings are numbered from zero to three, with zero being the most privileged. A ring number is allocated to each segment when it is created and, when the process is entered, the main processor adopts this ring number. Each segment is allocated three protection levels, one for each possible use; read, write, or execute. Each level can be anywhere within the range of zero to three. At every reference to an address in a segment, the protection level for the relevant type of use is checked against the current ring number of the main processor. Access is only allowed under the following conditions: for read and write access, the ring number is less than or equal to the protection level; for execute access, the ring number is within the range between the write and execute protection levels. At linking time, the programmer specifies protection levels; this permits him to control access to his program segments from other active programs.

An extension to the protection system is the ability to flag segments as completely unwritable. This feature guards against the most frequently encountered programming errors. The compilers always generate code and data in separate segments. By flagging the code segments as unwritable, the system prevents the code from being modified during execution.

RESERVED STORAGE: There is a reserved area in main memory for channel programs and tables describing the actual configuration. The boundary address is held in a special register (BAR). This reserved area is of variable length, approximately 20K bytes.

CENTRAL PROCESSOR

DPS 7 central processors are composed of seven "minimachines," a control store and a processor bus on all models,

megabytes. The 7/80 can have three or four megabytes and the 7/82, four or eight megabytes. Despite this capacity comparability, the 7/60P and 7/70 belong more to the very powerful centralized system category than the DPS 7 lower range machines. This power difference is substantially achieved by the provision of cache memory and up to four input/output processors. The central processor does not access main memory directly, but obtains its data and programs from cache memory when possible. "Possible" in this case means the probability of the required program or data being there. The phrase "high probability" is used by Bull. With a cycle time in the order of 120 to 210 nanoseconds, dependent on the machine, the net increase in speed is claimed to be up to five times greater than with ordinary memory.

Fast program and data access is of little value if queues are prevalent elsewhere. The DPS 7 systems with I/O processors take steps to avoid such congestion. There can be up to 16 such processors, each linked to a specific peripheral or network processor. Input/output processors handle programs demanding access to a channel, and they do this very well by handling up to 230 channel programs per second. Each channel processor has its own memory and firmware.

COMPETITION

The DPS 7 range competes with the 4320, 4330, 4340 and 4360 models of the IBM 4300 Series. Other competition is provided by the Burroughs B1900, B2900, B3900 and B4900, the Hewlett Packard 3000 Series, and the Sperry System 80.

ADVANTAGES AND RESTRICTIONS

The Bull DPS 7 Series provides a wide range of languages and applications packages. Both compiled and interpreted languages are available, including Cobol, Fortran and Basic.

There is full operating system compatibility between all models with the exception of the most powerful model, the 7/82. Users can, therefore, upgrade an entry-level system with no change to the software, all the way up to the 7/82 model which does require software alteration.

USER REACTION

Thirty-two DPS 7 users with a total of 37 installed systems responded to Datapro's 1983 survey of French computer users. The systems had been installed for an average of 19.3 months, and 53 percent of them had been purchased.

Under expansion plans, almost 67 percent said they planned to expand their data communications facilities and 42 percent said they planned to expand their system hardware.

Nearly 70 percent of the users listed good response time as a significant advantage of the system, and almost 55 percent listed easy system expansion/reconfiguration as an advantage.

and a 16K-byte cache memory on models 7/60P, 7/70, 7/80 and 7/82. This processing "system" is connected, via its cache memory, where applicable, with the central bus, which also services main memory and any input/output processors. The I/O processors, only present on the upper range of the DPS 7 series, have their own control stores and main memories, are connected to the peripheral processors, which also have their own control stores and main memories. This distributed architecture enables various subsystems to operate simultaneously, allows subsystems to communicate with each other without tying up the main processor, and provides flexibility in distributed processing network environments.

The seven minimachines in the main processor are as follows:

- **Pilot machine (PIM): The PIM retrieves microinstruction sequences from the control store and routes them to the appropriate minimachines. Microprograms are composed of two or more 56-bit words, each protected by an 8-bit autocorrection code.**
- **Address Calculation Machine (ACM): The ACM handles all address translations and includes the base registers and an associative memory that stores up to 128 descriptors. The ACM also handles data protection by checking rings (under GCOS) or keys (under SIRIS).**
- **Data and Instruction Management Machine (DIM): The DIM provides the interface between the cache memory and the other mini-machines and includes a 32-byte lookahead buffer that often allows it to begin interpreting another instruction while a previous instruction is still being executed.**
- **Arithmetic and Logic Machine (ALM): The ALM includes the data registers and executes fixed-point, decimal, and logic operations.**
- **Scientific Calculation Machine (SCM): The SCM executes floating-point operations.**
- **Timer: Using the main clock as a reference, the timer transmits a master frequency along the processor bus and also provides various types of information, such as real time, elapsed time, and process time.**
- **Maintenance Interface Machine (MIM): The MIM provides the interface between the main processor and the service processor for system initialization and testing.**

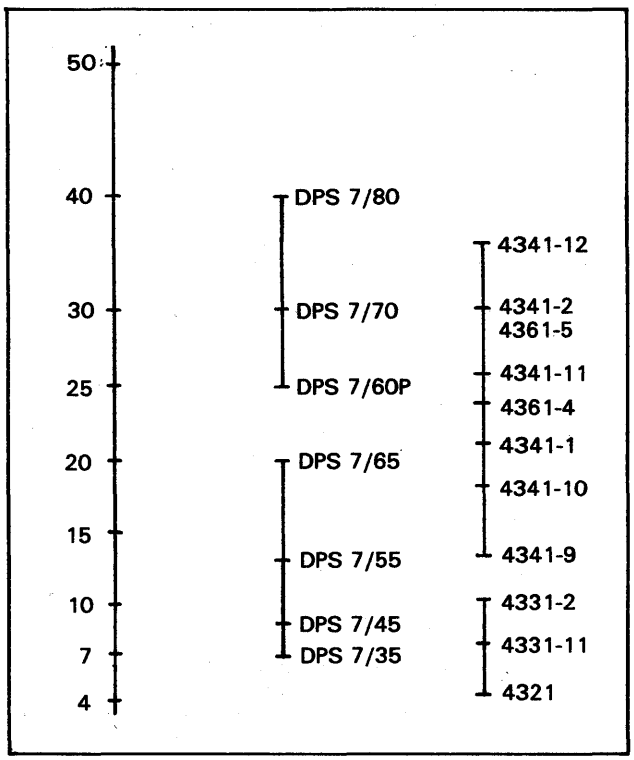
CONTROL STORAGE: Control store contains firmware held in 56-bit words. Each word contains the instructions to be executed by the minimachines during a single cycle. The sequencing of firmware instructions is controlled by the Pilot machine. Short instructions require two microcode words; more complex instructions can require several dozen.

The control store of the main processor is loaded when the system is initialized. It may contain up to 64K words, enabling the execution of the IRIS 80, IRIS 60, or 64/DPS instruction set. Depending on the model, it employs TTL (transistor-to-transistor logic) or CML (Current Mode Logic) technology. Each firmware word is accompanied by 8 bits of autocorrection code.

Firmware is also used in the DPS 7 to perform functions traditionally performed by software. These include task management, procedure calls, data protection, etc. The use of firmware also permits the DPS 7 to implement the machine instruction sets of the 64/DPS running under GCOS 64-E, and IRIS systems running under SIRIS 3-E or SIRIS 8-E while providing software access to the firmware functions of the DPS 7.

Bull DPS 7 Series

PERFORMANCE COMPARISON CHART



Power scale in business applications under GCOS 64-E vs 4300 under DOS/VSE

The only major complaints: 76 percent said equipment installation was late and 24 percent said delivery of required software was late.

Here's how the users rated their systems overall:

	WA*
Ease of operation	2.76
Reliability of mainframe	2.91
Reliability of peripherals	2.72
Maintenance service:	
Responsiveness	2.36
Effectiveness	2.24
Technical support:	
Trouble-shooting	2.09
Education	2.15
Documentation	1.97
Manufacturers software:	
Operating system	2.91
Compiler & assemblers	2.88
Application programs	2.81
Ease of programming	2.85
Ease of conversion	2.75
Overall satisfaction	2.63

*Weighted Average on a scale of 4.0 for Excellent.

To the question, "Would you recommend the system to another user?", over 60 percent said "yes." □

The main processor is capable of recognizing and controlling a task, a unit of a program more significant than a single instruction. A task is a sequence of interdependent instructions. A program can comprise a number of tasks, each able to execute in parallel with the others (multitasking).

This parallel execution of tasks requires a dispatching mechanism. On traditional machines, this mechanism required software intervention. On the DPS 7, it is a built-in firmware function of the main processor.

A task may be activated simultaneously by a number of different programs, and it is the activations or occurrences of the task that must be controlled by the system. The DPS 7 recognizes and controls a task occurrence as a "process" needing the services of the main processor.

Many such processes can be simultaneously known to the DPS 7 and their execution synchronized according to a multi-level priority system.

A process consists of all the data and executable code associated with a task plus a process control block, a data structure recognized and manipulated by firmware. When the process stops running for any reason, a snapshot is taken of the main processor's status and stored in the process control block. When the process is restarted, the main processor is reset using the snapshot and the process continues where it left off. The mechanism for storing and reloading the process is completely automatic and works without any software intervention.

The GCOS 64-E operating system makes use of the task management mechanisms implemented in firmware.

The DPS 7 uses firmware-controlled semaphores to interpret external events such as physical input/output termination, peripheral interrupts, operator interrupts and messages from terminals. Using semaphores, it also synchronizes the execution of competing processes, passes messages between processes, and controls competing demands for system services.

A semaphore is a group of words containing a counter and a pointer to an associated queue. When the semaphore counter is negative, all the resources associated with it are busy and processes are awaiting completion. When the counter is positive, all processes are satisfied and resources are free. When the counter is zero, all resources are busy but no processes are waiting. This mechanism can be used in any situation involving processes waiting for the completion of any operation.

The DPS 7 provides an automatic firmware-implemented feature called the "call/exit" mechanism which is available with the GCOS 64-E environment. Between entry to and exit from a procedure, the call to that procedure is represented by a record containing a work area, a save area, and a communications area. Whenever a call instruction is executed, this record is created and placed in a last-in-first-out (LIFO) queue called a stack. Whenever an exit instruction is executed, the last record placed in the stack is removed. There is one stack for each active process, and whenever a process is initiated, it is automatically provided with extra segments for the stack.

After a call instruction, the record placed in the stack contains all the local variables for the calling procedure, the contents of all the main processor's registers at the time of the call, the contents of the main processor's instruction counter at the time of the call, and any parameters to be passed to the called procedure.

When the exit instruction is executed, the registers and instruction counter are automatically restored from the record removed from the stack so that the calling procedures can continue processing.

REGISTERS: There are eight 32-bit Base Registers for internal address computation, sixteen 32-bit General Registers for data handling and indexing, four 64-bit Scientific Registers for floating point data handling, one 32-bit Stack Register pointing to the stack associated with the running process, and one 28-bit Boundary Address Register holding the lowest absolute main memory address accessible by software.

ADDRESSING: When memory is allocated by the SIRIS 3-E or SIRIS 8-E operating system, the addressing mode is the same as that used on IRIS hardware: partition relative addressing under SIRIS 3-E and virtual memory paging under SIRIS 8-E. In each case, addressing is handled by specialized firmware.

Running under GCOS 64-E, the relative addressing mechanism is based on segmentation and its aim is to make optimum use of memory space. Each program running under GCOS 64-E on the DPS 7 is executed as a collection of fully relocatable segments. A segment may reside in different places. As a program is being executed, its constituent segments may be moved around memory to make room for other programs, and, at a given point in time, some of its segments may even be temporarily removed from memory and placed on disk.

To avoid having to split a frequently used routine between two segments, segments can vary in size. Machine instructions used in the GCOS 64 environment refer to segment-relative addresses, without reference to the physical location of the referenced operand. The absolute address is calculated as the instruction is executed using a segment descriptor and a displacement within the segment. High-speed registers assist in address development.

The address information is resolved dynamically during execution. A special associative memory within the address calculation machine of the main processor contains the absolute addresses of the last 128 referenced segments to speed up second and subsequent references to a segment.

The compilers available with GCOS 64-E perform the segmentation of programs. This takes place either automatically or under the control of the programmer. It takes place at source level, and the fact that segments can vary in length ensures that a piece of logic, such as a loop, will not be split between two segments. This unusual feature significantly reduces program execution time.

INDEXING: 15 levels.

INSTRUCTION REPERTOIRE: The DPS 7, when running under GCOS 64-E, executes the 64/DPS instruction set. The repertoire consists of 195 instructions, including operations for address computations, and arithmetic instructions for performing decimal and binary operations on packed or unpacked data. Operands can be binary, fixed-point, or decimal in packed or unpacked format; bytes; byte strings; or bit strings. The Scientific Instruction Set adds 26 instructions to the standard set. In addition, the microcode of the Model 7/65 can implement the 200/2000 "Program Mode" option, and execute the 200/2000 instruction set.

CACHE MEMORY: Models DPS 7/60P, 7/70, 7/80, and the biprocessor model DPS 7/82 have cache memory units. These units provide very fast access storage for data and instructions. Data and instructions stored in cache can be made available to the main processor up to five times as quickly as would be the case if they were retrieved from main memory. Cache memory is implemented in CML technology.

Data is held in cache memory in blocks of 16 consecutive bytes accompanied by autocorrection code. The 1024 16-byte blocks provide a capacity of 16K bytes. For reference purposes, cache memory is divided into 256 areas of four blocks each.

Associated with each 16-byte block is a register containing the most significant bits of the main memory address of the data contained in the block. The total of 1024 registers constitutes the cache memory directory.

Data is retrieved from cache memory using the main memory address of that data. The middle 8 bits of the address indicate the area (0 to 255) containing the required data. The value contained in the most significant 4 bits of the address is compared with the content of the 4 registers associated with the area.

A request for data from a main processor leads first to a search in cache memory. If the data is not found, the request is sent to the bus and a search is simultaneously launched in the main memory, and in the case of a dual processor system (DPS 7/82), in the other cache memory. When found, the 16-byte block containing the requested information is placed in the 4-block area indicated by its address. Within this area, it will replace the 16-byte block least recently accessed. The most significant bits of its address are placed in the corresponding register.

Cache memory is used for both reading and writing purposes. If the value of data replaced in cache memory has been modified, a main memory rewriting operation is launched via the bus.

INTERRUPTS: There are no interrupts as such. Any hardware or software event is handled through semaphores, combined with a masking feature used when high priority events occur.

INPUT/OUTPUT CONTROL

I/O CHANNELS AND PROCESSORS: The number of channels on the various machines ranges from two standard and two optional on the 7/35 to four standard and 28 optional on the 7/82. I/O on the lower range machines (7/35, 7/45, 7/55, 7/65) is somewhat different than the implementation on the upper range (7/60P, 7/70, 7/80, and 7/82) because those in the lower range do not have I/O processors. However, the principle is the same throughout the entire DPS 7 series.

All models must have a service/unit record processor and a mass storage processor, but, apart from these, the configuration can be tailored to suit the user, particularly on the larger and more powerful systems.

One service and unit record processor (SURP) is always integrated into a DPS 7 model but additional units can be added on most models. The SURP handles two essential functions:

- As a service processor, it carries out both system initialization and maintenance, using dedicated channels to the main and peripheral processors.
- As a unit record processor, it controls card readers, punches, printers, and the system console. Under GCOS 64-, it can also be used to connect floppy disk drives and a communications processor.

The mass storage processor is integrated in the 7/35 and 7/45 models. On the other machines, the 7/55, 7/65, 7/60P, 7/70, 7/80, and 7/82, either single-, or dual-channel mass storage processors (sometimes called disk processors) can be used, except that the permitted maximum number of disk accesses must not be exceeded. The difference is that a single-channel processor controls up to 9 disk accesses and a dual-channel processor can monitor up to 18. The dual-channel controller also allows simultaneous access in read and write modes to the same disk unit.

Magnetic tape processors are offered in three types:

- Type 1: one level of simultaneity, handles up to eight 9-track PE/NRZ tape drives of 800/1600 bpi, and supports transfer rates of 120K and 200K bytes per second.
- Types 2 and 3: handle 9-track PE/GCR (phase encoded/group coded recording) drives with 800 or 1600/6250 bpi and transfer rates up to 780K bytes per second at 6250 bpi. One of these types provides one level of simultaneity and the other type, two. The processor with one level of simultaneity supports 8 drives and the processor with two levels of simultaneity supports 16 drives.

Communications on the DPS 7 series are handled by optional data communications processors and by optional network processors. The integrated communications processor is optional on all machines except the 7/82, where communications are managed by one or more network processors.

I/O PROCESSORS: These are provided on the 7/60P, 7/70, 7/80 and 7/82. The I/O channels provided on the lower range of machines are effectively replaced by I/O processors on the upper range of systems. Each I/O processor has a control store of 4K-bit words, a main memory of 2K bytes, and a maintenance interface. Via a common memory interface unit, the I/O processor can transfer data to either the cache memory or the system's main memory. Four I/O processors are standard, the 7/60 and 7/70 can have up to 12, and the 7/80 up to 16.

Via the I/O processors, the upper range of DPS 7 systems support four types of peripheral processors: unit record, mass storage, tape, and network. The integrated unit record processor supports the system console, card units, printers, diskette drives, and optionally, a DCC4370 communications controller.

To help assure system availability, the DPS 7 includes special channels that allow diagnostic tests to be run and the system to be reconfigured without interrupting user service. A remote maintenance service allows the console operator to connect the DPS 7 to a Bull center, enabling specialists to monitor system performance, initiate diagnostics, and recommend solutions to problems.

An input/output operation is handled in upper range machines by an input/output processor and a peripheral or network processor. The input/output processor controls access to main or cache memory resulting from the execution of a channel program associated with an I/O request and generated by the main processor. The main functions of the I/O processor are consequently the reading or writing of data and the reading of channel commands. The peripheral or network processor controls the exchange of data with the peripheral or network component involved in the request.

Each input/output processor in an upper range DPS 7 system is a fully independent processor controlling the transfer of data in parallel with other I/O processors in an I/O processor group. An I/O processor group can contain up to 16 I/O processors and an upper range DPS 7 system can contain one or two groups depending on the model.

The operation of an I/O processor is managed by firmware held in a control store of 4K words. Each word contains 48 bits plus 8 autocorrection bits.

An I/O processor also has a memory of 2K bytes for holding sequences of channel commands being executed and data in transit. Data can be sent to main memory or cache memory in blocks of 16 bytes, a block size which optimizes the bus. This transfer is independent of the transfer speeds of individual peripherals.

Transfers of data to main or cache memory are controlled by a memory interface unit which is common to a group of I/O processors. Each I/O processor group also contains a maintenance interface which enables the service processor to initialize and test I/O processors. Each I/O processor, and consequently each channel, has a throughout of up to 2.5 million bytes per second. The throughput of a group of I/O processors is up to 29 million bytes per second. These rates permit the execution of more than 300 channel programs per second on a group of I/O processors.

A peripheral or network processor is connected to an input/output processor via a PSI (Peripheral Standard Interface) channel. This channel provides a data path for the transfer of one byte of data plus parity and the transfer of a control signal indicating the sending of a byte, acceptance of a byte, etc. The PSI standard specifies the protocol used in a data transfer to start the execution of a channel program, chain commands, multiplex several channel programs, etc.

After generating a channel program and requesting its execution, a main processor does not intervene further. Consequently, input/output operations can be executed in parallel with main processing. When a channel program has terminated, the I/O processor informs the Pilot machine.

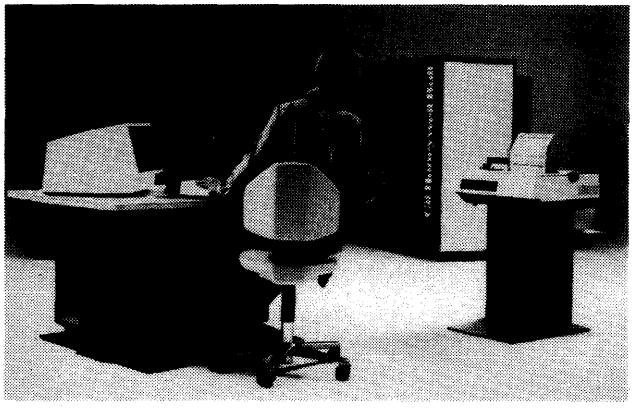
Another important feature of the upper range DPS 7 architecture is that there is no direct link between peripherals and main processors. Via the bus, a main processor can launch an input/output operation on any peripheral and the disconnection of a main processor in a dual processor configuration does not affect the availability of peripherals to the other main processors.

Peripheral devices and network components on the DPS 7 upper range are controlled by specialized peripheral and network processors. Each processor is conected via a channel to an input/output processor in the central system. It manages the simultaneous operation of peripherals in complete independence of the main processors.

On the upper range of machines, the Unit record, mass storage, magnetic tape and network processors function in the same way as that already detailed for the lower range machines.

SIMULTANEOUS OPERATONS: The peripheral processing subsystems operate simultaneously with the central processor. Each subsystem operates under control of a microprogrammed peripheral processor. Each peripheral processor contains its own arithmetic and logic unit, read/write memory, and read-only memory and is attached to the central system through a high speed channel. The maximum total data rate for each of these systems is listed in the Characteristics table. All devices and terminals attached to a unit record processor can operate concurrently. Mechanical operations on a disk or tape subsystem, such as seek and rewind, can proceed simultaneously with a data transfer on the same subsystem.

Bull DPS 7 Series



The DPS 7/80 provides about 1.3 times the performance of the DPS 7/70.

MASS STORAGE

Bull currently offers three disk-pack drives for the DPS 7 systems. Capabilities range from 200 million bytes to 635 million bytes per drive. Transfer rates range from 806,000 bytes/second to 1,200,000 bytes/second.

MSU0395 MASS STORAGE UNIT: This unit contains 300 million bytes of data in removable disks.

MSU0455 MASS STORAGE UNIT: This unit uses packs with 12 disks and 19 recording surfaces to store up to 200 million bytes of data. Average seek time is 30 milliseconds, average rotational delay is 8.3 milliseconds. The transfer rate is 806,000 bytes/second. Rotational speed is 3600 rpm. During data transfer on one drive, a simultaneous seek operation can be performed one all other drives on the same Mass Storage Processor. Features include offsetting of heads under system control when initial read attempts fail, the insertion of checking codes during write operations, and a write protect capability. The drive uses Type M4451 disk packs. Recording format is 822 tracks, including 14 spares.

MSU0555 MASS STORAGE UNIT: This unit comprises a cabinet housing two 635-megabyte fixed disk packs, yielding a total unformatted storage capacity of 1270 million bytes. Each disk pack has 20 data surfaces, with 19,060 bytes per track and 1676 tracks per surface. Average seek time is 25 milliseconds, average rotational delay is 8.3 milliseconds. The peak transfer rate is 1,200,000 bytes/second. Rotational speed is 3600 rpm. Each pack is accessed individually by a direct attachment to the mass storage processor. The validity of recorded information is ensured by the insertion of characters of check information (EDAC) code: Error Detection and Automatic Correction). In each block of data, data integrity is enhanced by the automatic detection of defective tracks and the bypassing of these areas when writing to disk. A write protect capability allows the user to protect the disk packs individually against inadvertent writing. On-line error and status reporting to the central system allows software-controlled diagnosis of the electronics. A built-in hardware diagnostic capability supports rapid off-line diagnosis and testing.

INPUT/OUTPUT UNITS

MAGNETIC TAPE UNITS: Bull currently offers five magnetic tape drives for the DPS 7. Two can read/write in the following mode: 9-track, 1600 bpi, phase-encoded; and three of them in 9-track, 6250 bpi group-coded recording mode.

MTP 4270/4275 MAGNETIC TAPE PROCESSOR: This processor controls 9-track tape with a recording density of 800 or 1600 bpi controlling simultaneously up to 8 tape units.

MTP 4475/4575 MAGNETIC TAPE PROCESSORS: These units control 9-track tapes with recording densities of 800, 1600 or 6250 bpi. The MTP 4475 controls up to eight units in its single access version; the dual access version MTP 4575 controls up to 16 units. The MTP 4575 is connected to the central system of the DPS 7 via two input/output processors.

Each MTP can be fitted with an optional manual channel switch permitting it to be shared by two DPS 7 systems in a coupled configuration.

MTU0432 MAGNETIC TAPE UNIT: This unit operates at 75 inches/second and transfers data at 120 kilobytes/second at 1600 bpi. Error correcting features include read after write. Up to eight drives can be connected to an MTP controller.

MTU0532 MAGNETIC TAPE UNIT: This unit has the same specifications as the MTU0432, except that it operates at 125 inches/second and transfers data at 200 kilobytes/second at 1600 bpi.

MTU0337 MAGNETIC TAPE UNIT: This unit operates at 37.5 inches/second with a maximum transfer rate of 234,000 bytes/second. Recording mode is 1600 bpi PE (Phrase Encoded) or 6250 bpi GCR (Group Coded Recording).

MTU0437 MAGNETIC TAPE UNIT: This unit has the same specifications as the MTU0335, except that it operates at 75 inches/second and can attain a maximum transfer rate of 469,000 bytes/second.

MTU0537 MAGNETIC TAPE UNIT: This unit has the same specifications as the MTU0337 and MTU0437 except that the operation speed is 125 inches/second, yielding a maximum transfer rate of 781,000 bytes/second.

UNIT RECORD PROCESSOR: This integrated controller has five device ports plus ports dedicated to the console and communications. A second processor, the URP 4371, can be added, providing three more device ports plus a second communications port. Each peripheral device connects to a device port via an addressing attachment.

CRU0301 CARD READER: This table-top unit reads at 300 cards/minute and has 1000-card input and output hoppers. Options include IBM and Honeywell mark sensing adapters.

CRU0501 CARD READER: This table-top unit reads at 500 cards/minute, but otherwise is the same as the CRU0301.

CRU1050 CARD READER: This unit reads at 1050 cards/minute and has a 3000-card input hopper and a 2500-card output stacker. In addition to reading 80-column cards punched in either Hollerith or binary, the unit can be equipped to read 51-column cards and 40-column mark sense cards. Each column is read twice and, in Hollerith mode, characters are checked for validity. When an error is detected, the reader, under software control, can either offset the card in the stacker or stop.

PCU0120 CARD PUNCH: This unit punches 120 cards/minute and has a 1600-card input hopper and a 1500-card output stacker. Cards can be punched in Hollerith or binary. When an error is detected, the punch can be told either to offset the card in the stacker or to stop. The unit automatically skips leading blank columns at high speed, resulting in higher punching rates.

DDU4050/4056 DISKETTE DRIVES: These diskette drives are connected to the CPU via the Service and Unit Record Processor or an additional Unit Record Processor. One diskette drive unit may be connected to each Unit Record Processor. The diskette is double-sided, each side containing 77 tracks with 26 sectors per track and 128 bytes per sector. Only 74 of the tracks are used for data. Total data capacity per diskette is 492,544 bytes. Rotational speed is 360 revolutions per minute, and the transfer rate is 32.2 kilobytes per second. The 4056 is a dual density version, providing 985,088 bytes of storage capacity.

PRU 0705 BELT PRINTER: This uses print belts with flexible fingers, a system already in a range of Bull products. The nominal speed of the PRU 0705 is 650 lines per minute, the speed depending on the belt type and character set used:

48-character set—750 lpm
63-character set—650 lpm
94-character set—500 lpm

Belts are provided for individual countries and also for accounting applications. There are 136 print positions per line at 10 characters per inch. An English or French operator panel is offered.

PRU 1105 BELT PRINTER: This is a 900 line/minute version of the PRU 0705 which uses a 63-character set.

PRU 1505 BELT PRINTER: This is a 1200 line/minute version of the PRU 0705 which uses a 63-character set.

PRU1600 PRINTER UNIT: Using an interchangeable print belt, this unit operates at speeds up to 1600 lines/minute. The standard belt contains 63 OCR-B characters, but belts can contain as many as 240 different characters. To increase speed, special belts can be designed so that the most used characters are repeated at different frequencies according to their use. The belts are identified by a magnetic code recorded on their base, and the printer uses this code to make sure it has the correct belt image stored in its buffer. Belt images are loaded into the buffer by the operating system. Bull says the unit produces smear-free printing because the fingers containing the characters are so flexible that they are monentarily immobilized when struck by a hammer.

Parameters for number of lines per inch (6 or 8) and vertical form positioning, including skipping, are under program control. An overtemperature control, however, can slow the skipping speed or halt the printer if the operating temperature exceeds preset limits. Skipping speed normally ranges from 23.5 inches/second for one to three lines up to 90 inches/second for more than six lines.

Standard line length is 136 positions, optionally expandable to 160 positions. The pitch is 10 characters/inch. Forms can range from 4 to 18.25 inches in width and from 4 to 16 inches in length. By leaving the cabinet door open, forms up to 22 inches wide and 24 inches long can be stacked externally. The unit can print one original and up to five carbon copies or 10 self-carbon copies.

COMMUNICATIONS CONTROL

The DCC 4270, 4271 and 4370 Communications Controllers interface with the Service and Unit Record Processor and, through optional Communication Processors, provide up to 15 lines at a maximum speed of 19,200 bits per second in any mixture of synchronous and asynchronous modes.

In addition to directly supporting terminals, a DPS 7 system can support one or more remote batch, interactive job entry, or transaction processing Mini 6 satellite systems. DPS 7 systems can also be configured into dual, coupled systems that can share the same data base and peripherals.

The main item of hardware for handling communications on the DPS 7 is the Datanet 7100 network processor, based on the Mini 6. Datanet 7102 and 7103 models include a teleprinter console and a single or double diskette drive. The 7102 controls up to 48 lines, the 7103 up to 128 lines. The models also differ in terms of processing power and minimum memory size (96K and 128K). The 7102 has an option for loading its software remotely; this feature is standard on the 7103.

DATANET 7100: This is the generic name for three models of network controller built round a modular central processor and having a "Megabus" to which all the hardware elements are connected.

DATANET 7101: This model has up to 512K words of memory, 2 couplers for host computers, up to 24 lines, console, and 512K diskette. Primary and secondary networks can be controlled through microprocessor based controllers.

DATANET 7102: This model is the same as the 7101, except that it has up to 768K words of memory, up to 64 lines, and one or two diskettes.

DATANET 7103: This model is identical to the 7102 with the following exceptions—up to 4 couplers can be used and there may be up to 128 lines.

Using the DATANET 7100 makes it possible to respond to and support the following types of terminals and operation:

- Asynchronous, character mode line procedure

  KSR 33/35
  TN 300/1200
  TTU/8124/8126
  DTU 7172 (DTU 7171 mode)

- VIP synchronous line procedure

  VIP 7001/7002
  VIP 770/7760
  TTU 8221/8223
  STS 2840

- QUESTAR-T Range

  DKU 7001/7005/7007/7008
  TCU 7021/7022/7042/7043

- Satellite Systems

  TTS 7800
  Mini 6 DSS
  61 DPS

OPERATING SYSTEM

The GCOS 64-E operating system is the principal DPS 7 operating system. The biprocessor model DPS 7/82, however, runs under SIRIS 8-E.

GCOS 64 RELEASE 1-E: Release 1-E provides concurrent support for batch job streams, one compatibility-mode job stream (Series 200/2000 mode), a system input reader, a system output writer, communications, and a transaction processing system. Additional batch job streams can be run in place of other activities up to a maximum of five. The sixth job slot is always taken by the output writer.

Up to 64 jobs can be loaded under Release 1E. Based on their priorities, these jobs will be started as job slots become available. Jobs are divided into job steps (individual pro-

grams), and job steps into processes (tasks). Steps of a job are run sequentially, but processes within steps are executed in parallel whenever possible.

Automatic memory management is based upon variable length program segments rather than fixed length pages. The compilers automatically divide a program into segments, placing code (always reentrant) and data into different segments. Optionally, the programmer can define the segments he wants. Cobol programs normally are segmented by section. Fortran programs at natural boundaries, and RPG II programs by logical functions.

GCOS 64 supports any combination of batch, interactive, or service activities, such as multiple output writers. Each program can be divided into job steps, each with its own separate set of segment tables. The maximum number of job steps in the system is 256, effectively providing the nucleus of a virtual memory system with multiple virtual spaces.

GCOS uses segment-relative addressing. Each address includes a segment number. When an address is referenced, GCOS first checks an associative memory containing the absolute addresses of the last eight segments referenced. If the segment is in real memory, GCOS places the real address in an index register. If the segment is on disk, GCOS brings it into real memory. If the segment's address is not in the associative memory, GCOS refers to a complete table of segments to locate it on disk and then brings it into real memory. If there is not enough space for the segment in memory, GCOS first tries to make adequate space by reorganizing memory. If this approach fails, GCOS will remove the least-active segment from memory to create space.

Each segment is protected by a four-level ring system. Rings are numbered 0 to 3, with 0 the most privileged level. Each possible use of the segment—read, write, or execute—is assigned a protection level. When an address is referenced, the appropriate protection level is compared to the current ring number of the central processor. Access is allowed only if the ring number is less than or equal to the protection level. Code is always assigned protection level 0, which effectively makes it unwritable and prevents accidental or unauthorized alterations. Rings 0 and 1 are reserved for system software, 2 and 3 for application programs.

DPS 7 integrity features include error logging, file security, and recovery routines. Whenever the firmware of the DPS 7 system discovers an error, it notifies the appropriate routine. This notification takes place whether the firmware recovered the error or not, so that GCOS is always of the state of the system. The routines diagnose the error and update an error accounting area in memory. Error accounting information is used to keep track of the state of all system components and to update a permanent accounting file. This permanent file eases routine maintenance of the system; extensive error accounting information allows failing components to be identified and replaced before they cause problems.

GCOS 64 also includes a variety of file security aids. A save/restore utility is available for taking security copies of files, and both copies and saved generations of a file can be included in the system catalog.

GCOS includes journal functions to speed file recovery and/or fast restart after program failure. The journals are used to save all the file updates and/or all record values before update. The journals, often with the catalog and restore utility, provide all the information necessary to rebuild a damaged file. The journals provide the automatic restart capabilities of GCOS by providing all functions necessary to automatically reposition the program and any associated files.

To reduce the possibility of a system failure, GCOS 64 provides a fast recovery facility in rerun support. Rerun support allows processing to be restarted immediately, either at the beginning of the job step or at the last checkpoint. The restart procedure includes automatic repositioning of the user's files and the recovery of all files and queues used by the system, including the input reader and output writer files. The output writer can restart printing at any specified block.

Job flow through the DPS 7 system is controlled by GCOS job management. The input reader reads the job input while other jobs are executing and translates the job control information into an internal format to speed job processing. A job scheduler schedules the execution of the job using a system of job classes and priorities within each class. Resources are allocated at file, volume, and device levels to each job step, and deallocated when each job step is completed. Job accounting information is collected at all stages of the job's passage through the system. Job accounting information, along with the results of the job, is provided by the output writer, asynchronously with job execution.

The file management routines of GCOS handle allocation and deallocation of space for files, automatic label checking, automatic volume recognition, control of multiple concurrent accesses to files, control of multiple concurrent record access to a file and control of multiple copies and generations of files through the catalog. Additionally, they provide various access methods to different file organizations and also file and volume utilities to support file housekeeping.

GCOS allocates resources to job steps rather than to whole jos to ensure effective use of the available resources. Space is allocated for files, and files are assigned to programs at the start of the job step requesting them. The files are then unassigned, and space for temporary files is normally released as soon as the job step has completed.

When assigning a file, the user defines the file as either permanent or temporary. If the user wishes to retain a temporary file for several job steps, a parameter in the ASSIGN statement prevents the file space from being released until the end of the job.

To request space for a file, the user specifies the type of device, the identity of the volume, and the amount of space required. GCOS then searches the specified volume and automatically allocates any space available. Disk space need not be contiguous; GCOS can allocate space for a file using up to five separate areas on any one volume, and can spread the file over a number of volumes if required. On magnetic tape, GCOS supports any number of files on a single tape.

When a new file is created, file management automatically creates the apropriate labels, and these are subsequently checked every time the file is opened for processing. On disk, labels are stored in a special area called the volume table of contents (VTOC). On tape, the labels are created at the head and the tail of each file.

Disk files are sharable under DPS 7 GCOS. However, if file sharing is required, multiple access can occur only in read mode. If different jobs are to be run in parallel, GCOS provides General Access Control. GAC ensures:

- Prevention of uncontrolled file updates.
- Coherent values of data stored in one or more files or databases, where such items are linked by logical relationships.

GAC is needed only when concurrent updates are required. The sharing of a file in read mode only does not require any special action or the use of GAC.

Volume mounting and dismounting is controlled automatically by the system, and warnings are given if the wrong volume is used. This control is based on the volume label, which contains a unique identifier for each volume. When a volume is mounted, the automatic volume recognition feature reads its label and the identifier is stored. When space is requested or a file is opened on a specific volume, the file management system is aware of its status. If the volume is not mounted, an operator message is issued.

Among the file characteristics recorded in the file catalog are the generation number and copy number of each file. The records for different generations and copies of the same file are linked together, and the catalog automatically controls the numbering and deletion of the file generations to maintain the number of generations specified by the user. Each record also contains a list of the volumes on which that copy of the file resides.

To access the latest generation of a cataloged file, the user's program refers to a file by name. This program's internal name is matched to the external name of the required file when the file is assigned to that program, and the external name is used to access the catalog. The catalog automatically provides the latest generation of the required file, and supplies the file access system with the identifiers of the volume(s) on which that generation resides. Since automatic volume recognition has recorded the address of the device on which each volume is mounted, and the file label indicates the extent of the file, access to the file is complete.

The main file access system of GCOS 64, the Universal File Access System (UFAS), replaces random, sequential, and indexed sequential files. UFAS satisfies all the requirements of the ANSI Mass Storage Task Group recommendations for sequential, relative, and indexed access. It is independent of device characteristics, file organization, media addresses, and media formats.

Programs can access data sequentially, randomly by key, directly, or directly by relative position on the same UFAS file. The access method can change every time the file is accessed. UFAS file scan can be indexed or nonindexed; if indexes are used, they can be multiple-level, and records with indexes can be intermixed with records without indexes. UFAS can handle fixed-length, variable-length, and dynamically variable records, and a UFAS file can contain a mixture of different record types.

The file organization of a UFAS disk file is based on control intervals and control areas containing embedded freespace, thereby eliminating the need for overflow areas. When records are inserted into a UFAS file, they can be physically located in their logical positions on the file; access time is reduced and the need for frequent reorganization removed. In addition, the physical record sizes in a UFAS file are independent of the lengths of the logical records. When the file is moved from one medium to another, the physical record size can change to adapt to the new medium without affecting the file or the programs using it.

UFAS has been enhanced to include access to specific file items by any one of 15 characteristics without a prior sort. A new dynamic file extension facility allows extension of files as required.

In addition, GCOS offers a very flexible method for file indexing called the Multiple Logic Data Store (MLDS), which has the following characteristics:

- Random access using the primary index and the symbolic key
- Random access using the secondary index (8 maximum) and the symbolic key
- Sequential access using the primary or secondary index and the symbolic key
- Physical sequential access (by record loading order) RPG II
- Random access by relative address (RPG II)
- Loading of records sorted on the primary key or unsorted
- Automatic update of the primary index at each insertion of a new record
- Independent creation of secondary indexes
- Each secondary index is an independent file
- Deferred update of secondary indexes
- Several logical records can have the same secondary key value
- Management of complementary records dependent on a primary record
- Creation of one or more secondary indexes for complementary records
- Creation of one or more secondary indexes for primary records
- Creation of one or more secondary indexes for primary or complementary records which meet a user-defined criterion
- Primary or secondary index at two levels
- Index (primary or secondary) input by logical record
- Intensive use of the hardware operation for key search
- Global or distributed primary index
- Compatibility with Levels 61 or 62
- Capability to catalog an access path to the file records (access authorization to an index)
- Independence of the file in relation to the medium by use of a type of relative addressing in the indexes
- MILDS is supported by the Cobol and RPG II languages

GCOS also supports classical files with the Basic File Access System (BFAS). BFAS includes three subsystems:

- Basic Sequential Access, which supports sequential files on disk units EBCDIC code and on tape using either EBCDIC or ASCII code. Records can be fixed, variable, or undefined.
- Basic Indexed Sequential Access, which supports indexed sequential files on disk. Files can have up to six levels of index, with the highest-level index being resident in memory. Overflow space can be reserved within the prime data areas, on separate cylinders within the file.
- Basic Direct Access, which supports access by relative record number and by complete or partial physical address to disk-based files. Basic Direct Access includes a number of established randomizing algorithms.

A fourth set of access methods, the Honeywell File Access System (HFAS), gives full access to files in the format used on Series 200/2000 systems. HFAS includes all the features available with BFAS.

SIRIS 8 RELEASE 1-E: The SIRIS 8 environment provides SIRIS 8 users with compatibility between IRIS 80 and the DPS 7/82. It provides for the transfer of applications, files, and operating procedures without conversion. Compatibility is ensured for all application programs, at source, object or executable level and for the command language processed on IRIS 80 under SIRIS 8 C 10/VCAM.

The SIRIS 8 environment firmware allows the execution of "user" instructions in IRIS 80 code and provides management of IRIS 80 format memory addressing and associated protection.

It also includes privileged instructions different from the IRIS privileged instructions, enabling access to microprogrammed functions such as management and synchronization of processes, input/output operation, etc.

SIRIS 8-E is mainly an adaptation of SIRIS 8 C-10/VCAM to the following interfaces: system support, and the DPS 7 input/output system. The interfaces with user applications have been retained to ensure compatibility between IRIS 80 under SIRIS 8-E and the DPS 7 under SIRIS 8 environment. The software functionality provided is that of the SIRIS 8 C 1-/VCAM version.

The physical memory accessible by SIRIS 8-E is 8 million bytes, and the virtual space addressable by each task is 16 million bytes, the same as for SIRIS 8C10. SIRIS 8-E enables biprocessor and bisystem operation. Access to a network is via a DATANET 7100 which uses the VCAM interface of SIRIS 8-E. The terminals of the IRIS line are connected either directly to the DATANET 7100 or to the 7100 via the DN 2640 controlled by MCR3. The IRIS 80 user will have his network unmodified after migration to DPS 7, which supports the DATANET 2640 and all associated terminals.

DATA COMMUNICATIONS SOFTWARE

The GCOS data communications software, together with the communications hardware and firmware, handles networks up to 15 lines, with up to 32 terminals per line on the DCC4100 Integrated Communications Controller. A network can include switched, private, and direct-connect lines as well as a variety of terminal types.

GCOS provides two methods of interfacing the user programs with the communications controller.

The *Message Access Method* handles a system of queues to provide a buffered interface between the data communications network and the user's programs, allowing serial or selective processing of messages.

The *Transaction Driven System (TDS Standard Processor)* is a conversational system for handling a message entered by a user via a terminal, the initiation of a processing routine specific to that type of message, the processing of the message, and the response sent to the terminal. A library of mostly user-written transaction processing routines (TPRs) correspond to the various types of messages accepted by the system. TDS can handle several dozen different transaction types in a single session. Time and memory space are optimized by utilizing a single copy of a TPR even though the requests for that TPR may come from different terminals. TDS provides a batch interface allowing batch programs to interface with it as though they were terminals. This facility is particularly useful in debugging the transaction system without incurring real-time constraints. TDS has access to all files supported by GCOS as well as concurrent access control, journalization, and file recovery of UFAS files. Security is provided through controlled file access and authority codes. All input messages to TDS are journalized to guard against information loss.

A *TDS Extended Processor* handles access to an IDS II database. Otherwise, specifications are the same as for the standard processor.

The *Remote Batch Facility (RBF)* enables remote job entry from a Level 6 card reader, cassette, or disk file to a DPS 7 and output return to a Level 6 printer or disk file for later printing. RBF consists of RBF/6, which runs under GCOS 64, and RBF/64, which runs on the Level 6 under control of GCOS 6 Mod 400. RBF operates under synchronous transmission using two or four wire connection in half duplex mode up to 9600 bps. The DPS 7 host can support up to six Level 6 systems acting as RBF terminals each on a separate line and on a concurrent basis.

The *File Transaction Facility (FTF)* enables exchange of DPS 7 and Level 6 sequential disk files. FTF provides data compression during transmission, verification of transfer unit sequence number to ensure that units of file transfer are not lost or duplicated, and a file identification security feature. Up to five transmissions can be handled simultaneously by one copy of the DPS 7 utility program. Any number of users in groups of five may be connected serially. FTF operates under synchronous transmission with two-way alternative transmission on half/full duplex lines at up to 9600 bps. Support of multipoint and dedicated, switched, or direct connections is provided.

DATA BASE MANAGEMENT SOFTWARE

INTEGRATED DATA STORE II (ISD II): The IDS II data base management system includes a data description language for describing the data base and a data manipulation language for accessing data. Data relationships can be multilevel, multipath, tree, network, and compound network structures.

QUERY: The Query file inquiry system is a general-purpose system for handling data from terminals, although it is equally well-suited to use in batch mode. Query is available in two versions: inquiry only—which provides features for searching on selected criteria, sorts, calculations, printing standard or tailored reports, creation of sequential files internal to a procedure or for input to a high-level language program; and inquiry and update—where the inquiry-only version is extended by the addition of a module which permits modification to user records. Query supports BFAS indexed sequential and sequential file organizations, UFAS indexed and sequential organizations and an IDS II Data Base.

PROGRAM PREPARATION FACILITIES

In addition to the high level language (see separate listing below), DPS 7 systems under GCOS provide a static linker, an interactive text editing and operation facility (IOF), and program libraries. The static linker combines the output from language processor runs and program libraries to form an executable version of the program called load module. The processor runs may be from the same or different language compilers.

IOF provides for the interactive use of the GCOS library maintenance routines including the text editor. The text editor permits the user to manipulate lines, characters, and strings of characters with a source data file. IOF also provides for the remote initiation of requests for batch job execution, remote status inquiry and control of job execution, remote scanning of job outputs with control of delivery, and interactive interface with multiple user programs.

GCOS supports three types of program libraries along with maintenance routines for the libraries. Library types include source, compile unit (output from compilers), and load module.

Bull DPS 7 Series

PRODUCTIVITY AIDS

MENU DRIVEN FACILITIES (MDF): These facilities help to make the user as self-sufficient as possible. MDF offers a series of menus, guides, and help facilities and controls the use of the system by defining the environment for each user (file access programs which can be used, for example). MDF is independent of terminal types because it uses the GCOS product FORMS for forms creation and control. MDF is of particular value to the new user because it offers a series of help facilities that allow users to specify their requirements in increasing detail.

FORMS: FORMS provides the programmer with the means to define, build and maintain forms that will be displayed during the execution of transactions. It also handles the display of forms at run time and the transfer of data between the program and the terminal. Running in batch or interactively (under IOF), FORMS creates screen files or lines of source Cobol that can be incorporated into transactions. The images of screens created in this manner are independent of the type of terminal used. It is therefore easy to transfer an application from one type of terminal to another, since personalization is automatic when the application is executed.

WORDPRO: WORDPRO provides functions for editing, formatting, and typesetting documents. An integral part of GCOS 64-E. WORDPRO creates and maintains documents in variable formats, from the simplest to the most complex (letter to complex technical presentation), simultaneously with any other data processing activity. Designed for people with little or no experience in data processing or typesetting, WORDPRO provides them with an easy means of entering and editing text. The security available at the level of WORDPRO is the same as for all information processed in the DPS 7. The documents residing in virtual memory receive the same protection as any other type of work, whether file or program.

PROGRAMMING LANGUAGES

Bull provides Cobol, RPG II, Fortran, Basic, PL/1, APL and GPL (GCOS Programming Language) for the DPS 7.

COBOL: DPS 7 Cobol conforms to ANSI 74 standards, including those of the MSTG (Mass Storage Task Group). An optional Cobol Data Communications Extension program module is available.

The DPS 7 Cobol language processor automatically segments the object programs it produces. Users classify each section of a program's Procedure Division by assigning it a status level between 0 to 99. Sections assigned to level 0 are permanent segments that cannot be overlaid. Sections assigned level numbers between 1 and 49 are fixed segments, and those given numbers above 49 are independent segments and will be selected for overlaying before fixed segments. Unassigned segments are given the default assignment of level 0, and multiple segments may be assigned to the same level. This last feature is important for segments that need to communicate with each other.

Users also control the segmentation process by specifying a maximum size for both procedure and data segments. The compiler produces segments as close as possible to these limits, but they are not regarded as absolute limits. The compiler insures that no data items are split between segments and will override the user-specified limits to reduce the swapping acitivity that would result. Segment sizes are specified in the Environment Division of the program, enabling fine tuning without the need to change the body of the program.

DPS 7 Cobol data communications capabilities include the Message Access Method, which handles all message flow between user programs and the network by establishing queues and operating from these. The Cobol communications facility consists of a Communications Section to describe the queues, and the ENABLE, DISABLE, SEND, and RECEIVE verbs to communicate, via the queues, with the network. The ENABLE and DISABLE verbs are used to open and close the connection between the Message Access Methods and given terminal. The RECEIVE statement causes a message from a specified queue to be passed to the program, and the SEND verb causes a message from the program to be placed in a specified queue. An ACCEPT MESSAGE COUNT statement can also be used to access counts of messages in the queues.

The Cobol Data Communications Extension (CTG/MCS) is an optional extension to the basic Cobol ANS 74 language processor that provides language and functions representing Level 1 support of the Communications Module of the 1974 Cobol ANSI standard. These standards are based on the recommendations of the Communications Task Group (CTG) to the CODASYL Committee, which were subsequently included in the CODASYL Journal of Development for the Cobol language. These language elements include such statements as SEND, RECEIVE, ENABLE, DISABLE, etc., and provide the required prerequisite to use of the Message Access Method (MAM) as well as TDS. In conjunction with Basic Terminal/Network Support (BTNS), MAM serves as the DPS 7 GCOS response to the CTG requirement that the Cobol program interface with a Message Control Supervisor (MCS). These products jointly provide the MCS attributes and functions necessary to conform with the ANS standards.

DPS 7 Cobol is provided with two aids to program debugging. The first is through the use of debugging lines as defined by ANSI. The second is through the use of an interface to the GCOS Debugging Support Processor.

RPG: The *RPG II* language processors used in the DPS 7 system permits the interchange of data files among RPG II, Fortran, and Cobol programs. Object programs written in RPG II can also be linked with programs written in Cobol, Fortran, or other languages.

The RPG II compiler features automatic file manipulation and disk handling, support for sequential, indexed, and relative file organization, physical sequential reading of indexed files, relative access to index files, device independence of sequential files, dynamic table handling capabilities, and the use of standard data management access routines by object programs.

RPG provides support for sequential indexed, relative (indexed sequential), and direct file organization. File access can be physically sequential, sequential by key, direct by key, direct by relative address, or direct by absolute address. RPG also supports the Honeywell file access methods BFAS, HFAS, and UFAS.

RPG uses five files: two work files; a complete unit library for the generated program; and two input files, one for job control and one for input data. The processor accepts data from card, tape, or disk, and its output can be directed to any device supported by the GCOS output writer.

The RPG language processor features a fixed logic cycle that uses default values and specifications for certain control functions. The need to make many processing decisions (such as file selection, record input, input record formatting, and description of matching fields) is eliminated by the fixed logic cycle. Record selection and output are reduced to operations described by previously defined specifications rather than by individual procedural statements. During

each cycle, the fixed logic presents the user with a single input record in the form required for calculations. Any number of output records can be produced by one cycle.

The DPS 7 RPG compiler adapts automatically to the amount of main memory available. If the allocated space is insufficient, GCOS automatic management facilities will allocate more space as it becomes available.

FORTRAN: DPS 7 Fortran meets the ANSI standard for Fortran IV and provides several Honeywell extensions including those designed to improve compatibility with Fortran Y (Series 6000).

The language processor consists of two packages, the FORTRAN compiler and the Fortran run-time package. Fortran requires the implementation of the scientific instruction set. The language processor executes either in compile-only environment (with or without the production of compile units) or in a compile-and-go environment in which the output is submitted directly to a linking loader and the resulting program is executed as part of the job stream.

DPS 7 Fortran produces four levels of diagnostic messages. Level 1 diagnostics point out instances of code usage that could lead to less efficient execution. Level 2 diagnostics warn users of potential error conditions that could result from code usage. Level 3 diagnostics alert users to serious coding mistakes, and Level 4 diagnostics indicate fatal coding errors that would make further processing impossible. Level 4 diagnostics also cause the generation of the object program to be suppressed, but syntax checking continues. All other diagnostics do not affect compilation.

The DPS 7 version segments the compiled output, generating a collection of "compile units" that each represent a program segment, subroutine, or data block. These compile units are written into a temporary library from which they can be cataloged into a permanent library or submitted to a linking loader for execution. The language processor further segments the compile units into code, local data, and global data. This segmentation process permits users to take advantage of the memory management facilities of GCOS and the DPS 7 hardware.

The Fortran library contains routines for many mathematical calculations plus run-time packages to handle Fortran functions such as STOP and PAUSE and dynamic error diagnostics.

BASIC: DPS 7 Basic is an incremental compiler, checking syntax and generating object code at the input of each instruction. Under 64 GCOS-E Basic programs can be developed and executed in either batch or interactive mode.

Interactive mode requires the Interactive Operating Facility (IOF). Basic as implemented in the DPS 7 provides 38 standard mathematical functions and these facilities: GO SUB, used to branch to a subprogram with the program; RETURN, used to return from the subprogram to the main program after a GO SUB statement; and DEF, used to define single-line or multiline user functions. DPS 7 Basic requires the Fortran math library.

PL/1: GCOS PL/1 meets the ANSI standard. Also, as developed for GCOS 64-E, PL/1 offers extensions designed to facilitate structured programming: for example, DO...UNTIL. It can also call for routines written in Cobol and manipulate standard GCOS 64-E files (BFAS, UFAS, MLDS). PL/1 is also able to manipulate processing of magnetic tapes containing ASCII files or files of a non-standard format or record through the facilities provided by GCOS 64-E data management.

APL: APL is a GCOS 64-E processor which, like BASIC, is designed to be especially used by non-data processing personnel. It makes it possible to rapidly obtain results within good performance and efficiency conditions.

APL is implemented in a GCOS 64-E interactive environment and from specialized terminals (for example, from the Anderson-Jacobson AJ 832 terminal).

GCOS 64-E APL makes it possible to work on scalar variables, vectors, sets and tables with a maximum of 15 dimensions. The usual functions of APL are available and the user may define and integrate his own functions.

The debugging of programs is facilitated by the ability to display intermediate results, stop the execution of a function, or replace standard error messages with a sequence written in APL which explicitly decribes the situation. Finally, the user may interrupt his work and continue later through a "save" function.

Files accessible by APL are sequential files which may be permanent or temporary and which may or may not be cataloged.

GPL: The GCOS Programming Language (GPL) is oriented toward the development of system software. In some ways similar to PL/1, GPL has a free format syntax capable of manipulating strings of bits and list structures and has powerful data declaration and manipulation capabilities.

GPL does not support the processing of floating point numbers. However, it contains instructions necessary for structured programming and also functions for the processing of indexes, bit strings, etc.

CONVERSION AIDS

The TRANSIT software package is a complete conversion package, containing automatic translators for files and source programs written in Cobol and RPG, as well as a comprehensive manual detailing all the steps necessary for complete conversion to a DPS 7 system. The TRANSIT conversion packages allow data files and RPG source programs from IBM System/3 and System/370 to be transferred to a DPS 7 system. In addition, users can migrate from ICL 1900 PLAN to Cobol 74. TRANSIT B and TRANSIT BS-1000 also allow conversion of foreign Cobol and RPG II programs to 64/DPS format. In addition, source Cobol and MiniCobol program can be transferred from Honeywell's Series 200/2000 or Level 64 systems to DPS 7 systems.

REMOTE MAINTENANCE SYSTEM DPS 7: RMS DPS 7 consists of a remote console interface adapter and software diagnostic interface modules combined to provide an extension to the system console for field engineers. The engineers are remotely located and connected via phone lines. Remote Maintenance System DPS 7 provides the ability to troubleshoot hardware and firmware problems as well as software bugs. With this facility, key diagnostic programs that operate under DPS 7 GCOS can be remotely executed and patching of many software difficulties can be accomplished without an on-site visit. Remote Maintenance System DPS 7 operates only when the system is in maintenance mode and provides documentation of all communications via the system console.

APPLICATIONS SOFTWARE

APPLICATIONS: GCOS supports several applications packages that can be run as stand-alone systems or as composite parts of user-designed systems. All of the following packages are written in Cobol and operate under the minimum DP 7 GCOS configuration.

Bull DPS 7 Series

Mistral, an information retrieval package, offers the following features:

- Retrospective search, when a user requires all the information available on a given subject.
- Selective dissemination, when a user needs updating on the latest documentation available in a particular field.

Documents held by Mistral are kept in a document base. Several such bases can be controlled and accessed simultaneously by a large number of users. The system can also be used with public networks via the requisite links. Mistral is interactive at document and interrogation levels so that documents can be entered, modified or deleted using a terminal on which simple screen forms are automatically displayed. For interrogation, users can, in effect, converse with the system using defined procedures.

Distribution Inventory Management System (DIMS)—DIMS is a data-base oriented inventory management system with the following features: seasonal analysis and auto-adaptive exponential smoothing forecasting techniques, choice of replenishment policies, order-quantity and service-level projection and optimization capabilities, and multiple warehouse capability.

Industrial Management System-Transaction Driven (IMS-TD)—IMS-TD comprises a set of programs which offer production managers an approach to problems related to the production of manufactured goods. It demonstrates whether production of the enterprise is able to satisfy commercial objectives, and conversely, it checks that the commercial objectives support production at a satisfactory level. It determines a program for the supply of components (material, parts, ingredients, subassemblies), and provides the information required to coordinate manufacturing and to control the use of production means to avoid bottlenecks.

Accounting and Budget Management (COGEB)—COGEB is a general management system for handling accounting information. COGEB is adaptable to each enterprise through a choice of options and parameters corresponding to working habits. It simplifies the work of accounting departments by using a methodology common to accountants and data processing specialists. Exact and coherent accounting results are produced through checks made on the information before processing.

Statistical and Data Analysis (STATPAC)—STATPAC consists of a set of integrated subroutines for handling base processing of input; conversion of data; descriptive statistics and simple tests such as histograms, contingency tables, graphs, base statistics (average, variance, correlation, covariance, etc.), and base tests for comparing averages of populations (t tests, F tests and T2 tests). STATPAC also handles regression and variance analysis for linear regression, step-by-step regression, polynomial regression, single path variance analysis, and tests on supplementary hypotheses; and multidimensional analysis (main component analysis, factorial analysis, rotation of factors, discriminatory analysis, canonic analysis, etc.).

Project Management (PMCS-X)—PMCS-X aids managers in the complex task of project planning and control. Designed for the end user, PMCS-X includes such project management techniques as multinetwork management and PERT or MMP representation.

Mathematical Library (MATHLIB)—MATHLIB is a set of routines with applications in finance, research and development, engineering, production, market studies, etc. The routines handle matrices, differential equations, analytical and tabulated functions, approximation and interpolation, statistics, chronological series and forecasts, random number generation, and sorting.

Linear Programming (LPI)—LPI provides optimal solutions for the following problems: determination of the mix of ingredients enabling preparation at minimal cost; determination of optimal allocation of resources; choice or rejection of a project; planning for the machines in a factory; assignment of trucks, aircraft, or boats to the best transportation itineraries; decisions for optimal short-term financing, etc.

Application software can be transferred from Level 64, 64/DPS, and IRIS computer systems, where appropriate.

UTILITIES: DPS 7 GCOS provides utilities to assist users in managing data and testing software. The Sort routine can handle up to eight record classes. All files to be sorted must be on disk and organized as sequential, indexed, or relative. Output files are organized sequentially. The Merge routine can process up to five sequentially organized disk input files and can handle up to eight record classes. Omitted records from either the sort or merge routine can be output to an exception file.

PRICING

EQUIPMENT: DSP 7 equipment is available for purchase or for rent under a 1-year, 3-year, or 5-year lease. The 1-year and 3-year basic monthly rentals entitle the user to 176 hours of central processor usage per month with on-call remedial maintenance between the hours of 8 a.m. and 6 p.m. on Mondays through Fridays. For scheduled usage beyond this period, with on-call maintenance service, the user pays an additional charge which is a fixed percentage of the monthly maintenance charge. Alternatively, the user can obtain on-call maintenance service at standard hourly rates.

SOFTWARE: Generally, the basic operating system, basic job management and file systems, programming tools such as linking and debugging aids, the job control language, and conversion aids are provided at no additional cost. A basic kit of documentation is also provided with the system. Monthly license fees are charged for language processors, utilities, application packages, communications software, and advanced job management and file systems. Extra charges also are levied for customer services, such as education, program development, system design, implementation and conversion, and network design.

EQUIPMENT PRICES

		Purchase Price (FF)
DPS 7/35	CPU with two megabytes of memory, two 200 megabyte and two 635 megabyte disk drives, two 468KB tape units, diskette, 1200 lines per minute printer, and six data communication lines via data communication controller.	2.249.757
DPS 7/45	CPU with two megabytes of memory, two 200 megabyte and two 635 megabyte disk drives, two 468KB tape units, diskette, 1200 lines per minute printer, and six data communication lines via data communication controller.	2.446.834

Bull DPS 7 Series

EQUIPMENT PRICES (Continued)

		Purchase Price (FF)
DPS 7/55	CPU with two megabytes of memory, two 200 megabyte and two 635 megabyte disk drives, two 468KB tape units, card reader, 1200 lines per minute printer, and 12 data communication lines via Datanet.	3.276.116
DPS 7/65	CPU with two megabytes of memory, two 200 megabyte and four 635 megabyte disk drives, six 781KB tape units, card reader, 1200 line per minute printer, and 12 data communication lines via Datanet.	4.883.447
DPS 7/ 60P	CPU with two megabytes of memory, dual-channel mass storage processor, two 200MB and six 635MB disk drives, six 781KB tape units, 1200 lpm printer, card reader and 16 data communication lnes via Datanet 7102.	5.773.555

Bull Questar 400 Family

Product Enhancement

Bull has added a new model to the Questar 400 Family, the Questar 420, which is based on an 80286 processor. The Questar 420 has 1MB of memory, expandable to 4MB, and it can support up to two 630KB floppy disk drives and four hard disk drives with a maximum storage capacity of 270MB. It emulates Bull and IBM synchronous/asynchronous terminals and can be integrated into distributed systems that use DSA or SNA architectures. The price of the new model ranges from 62,000 FF to 103,000 FF.

The company has also introduced two versions of the Questar 210 workstation, one with a 12-inch screen and the other with a 14-inch screen. Ranging in price from 9,500 FF to 14,500 FF, the Questar 210 features a rapid screen refresh rate of 70MHz. Both models have standard displays and are available with two different national keyboards. The new controllers for the 210s can control from 8 to 16 terminals in either VIP or X.25 mode.

The entire Questar line boasts improved ergonomics. Bull representatives indicate that within one year the company will offer plug-in cartridges for emulation of 3270, VT-100, and other protocols and that a new card will allow the Micral 30 and 60 PCs to act as Questar terminals. □