Bull DPS 7 Series

MANAGEMENT SUMMARY

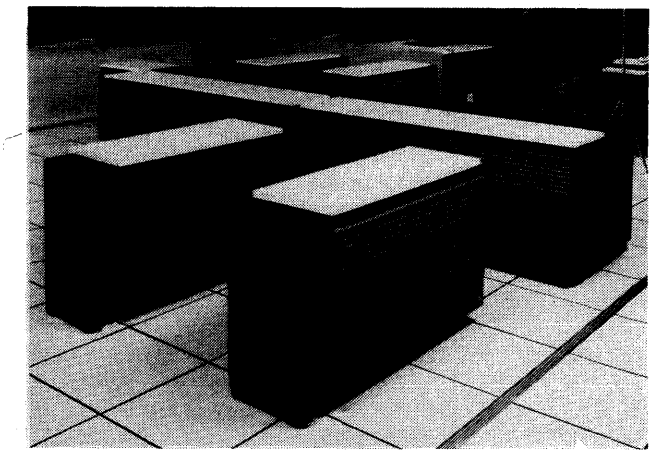
Bull announced a restructured DPS 7 Series at Sicob in Paris during September 1984. The range now consists of 10 models. Eight of these are renumbered systems from the older DPS 7 line to which have been added increased main memory capacities and other hardware enhancements. Two models are genuine new entry-level and top-end dual- and quadri-processor models. The current DPS 7 Series covers a much wider power range than previously.

The Bull company is divided into 4 groups: Bull Systémes, responsible for mainframes including the DPS 7 and DPS 8, and minicomputers such as the DPS 4 and DPS 6; Bull Sems, which deals with minicomputers such as the SM 90, Mitra, and Solar; Bull Peripheriques, responsible for peripherals such as disks, printers, and magnetic tape units; and Bull Transac which produces the Micral microcomputer, Questar terminals, and office automation and banking equipment. Bull has approximately 26,000 employees worldwide in 75 countries, and in 1983 achieved a turnover of 11.600 FF million.

The DPS 7 Series is divided into three subgroups: the single-processor DPS 7/X07 models; the 7/X17 single- and dual-processor models; and the 7/X27 twin systems which are fault-tolerant versions of the 7/X17 models.

The difference between the subgroups of the DPS 7 series is mainly in hardware. The 7/X17 and 7/X27 models have input/output processors; the 7/X07 models do not. However, the machines offer complete compatibility at the operating system level (all machines run GCOS 7) 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 ➤



The Bull DPS 7/827 quadri-processor system shown is the largest of 10 models within the DPS 7 Series. The configuration includes 4 service and unit record processor cabinets.

The DPS 7 Series of 10 compatible models contains single-, dual-, and quadri-processor systems divided into 3 subgroups and offering a high degree of reliability through redundancy. All models run under the same operating system, GCOS 7. The series is suitable for the medium to large central user who needs distributed processing and networking capabilities.

MODELS: DPS 7/107S, 7/307, 7/407, 7/507, 7/617, 7/717, 7/817, 7/627, 7/727, 7/827.
CONFIGURATION: From 2 to 16 megabytes of main memory, and 2 to 32 I/O channels.
COMPETITION: IBM 4300 Series and equivalent ranges.
PRICE: Purchase prices range from approximately 1.100.000 FF for the entry-level DPS 7/107S, to over 6.000.000 FF.

CHARACTERISTICS

MANUFACTURER: Bull, 121 avenue Malakoff, 75116, Paris, France. Telephone (01) 502 1080.

COMPANY LOCATIONS: *Algeria:* Cii Honeywell Bull, 5 rue de Nîmes, B.P. 126, Ferhat-Boussad-Alger. *Argentina:* Bull Argentina S.A.C.I., Carlos Pellegrin 1363, 10th Piso, 1011 Buenos Aires. *Austria:* Honeywell Bull AG, Linke Wienzeile 236, A-1150 Vienna 15. Telephone (0222) 853641. *Belgium:* Honeywell Bull SA, Avenue Marnix 28, B-1050 Brussels. Telephone (02) 513 6860. *Brazil:* Honeywell Bull do Brasil SA, Avenida Angelica 903, CEP 01227 São Paulo. *Cameroon:* Cii Honeywell Bull S.A.R.L., Immeuble Viazzi et Aubriet, B.P. 2552, Bonanjo Douala. *Denmark:* Honeywell Bull A/S, Otto Monsteds Plads 9, DK-1563 Copenhagen V. Telephone (03) 151507. *Gabon:* Cii Honeywell Bull Gabon S.A.R.L., Immeuble "Independance," B.P. 2260 Libreville. *Greece:* Honeywell Bull AE, Syngrou 44, B.P. 2527, Athens 403. Telephone (01) 923 9991. *Iraq:* Cii Honeywell Bull, Hai Al Jamea, District (Mahala) 911, Zukaku 27, B.P. 5850, Baghdad. *Ivory Coast:* Cii Honeywell Bull SA, Immeuble Nour-al-Hayat 01, B.P. 1580, Abidjan. *Lebanon:* Honeywell Bull S.A.R.L., Immeuble "Union des Assurances de Paris," Rue de Rome, Place Wardieh, B.P. 11.5811, Beirut. *Luxembourg:* Honeywell Bull SA, 2 rue Bertholet, Luxembourg. Telephone 23951. *Madagascar:* Honeywell Bull SA, 12 rue de Nice, B.P. 252, Antananarivo. *Morocco:* Honeywell Bull SA, 644 boulevard Mohamed V, B.P. 2218, Casablanca. *Netherlands:* Honeywell Bull n.v., Vliegtuigstraat 26, B.P. 9039, 1066 AA Amsterdam. Telephone (020) 510 1911. *Niger:* Honeywell Bull S.A.R.L., B.P. 12013 Niamey. *Norway:* Honeywell Bull A/S, Tollbugt 32, Postboks 470, Sentrum, 0105 Oslo 1. Telephone (02) 418030. *Portugal:* Sociedade Portuguesa Honeywell Bull LDA, Avenida 5 de Outubro, 35-6, 1000 Lisbon. Telephone (01) 534181. *Spain:* Honeywell Bull SA, Arturo Sorio N 107, Madrid 27. Telephone (01) 413 1213. *Sweden:* Honeywell Bull AB, Sveavagen 163, Box 23 137, S-10435 Stockholm. Telephone (08) 736 0400. *Switzerland:* Honeywell Bull Schweiz AG, Wengistr. 28, ➤

Bull DPS 7 Series

CHARACTERISTICS OF THE BULL DPS 7 SERIES

Model	7/107S	7/307	7/407	7/507	7/617	7/717	7/817	7/627	7/727	7/827
Central processors	1	1	1	1	1	1	2	2	2	4
Cycle time, ns	390	360	240	140	150	107.5	107.5	150	107.5	107.5
Main memory										
Minimum, MB	2	2	2	2	2	4	6	4	8	12
Maximum, MB	4	4	6	8	8	8	10	16	16	16
Read cycle time, ns	355	355	355	355	NA	NA	NA	NA	NA	NA
Write cycle time, ns	290	290	290	290	NA	NA	NA	NA	NA	NA
Cache memory, KB	0	0	0	0	16	16	32	32	32	64
Input/Output										
I/O Channels (integrated & optional)	2+2	2+2	4+4	4+4	0	0	0	0	0	0
I/O Processors	0	0	0	0	4-12	4-16	8-16	8-24	8-32	16-32
Disk processors (DP)	2	2	4	4	0	0	0	0	0	0
Single-channel DPs	0	0	0	0	6	8	8	12	16	16
Dual-channel DPs	0	0	0	0	3	4	4	6	8	8
Disk drives, max.	8	18	36	36	54	72	72	81	108	108
Magnetic tape adapter	1	1	1	1	0	0	0	0	0	0
Single-access MTP	0	1	2	2	2	4	4	4	8	8
Dual-access MTP	0	0	1	1	1	2	2	2	4	4
Magnetic tapes, max.	4	12	20	20	16	32	32	32	64	64
Communications Processors (12 lines)	2	2	2	2	0	0	0	0	0	0
Network Processor	0	1	1	2	2	2	4	4	4	4
NP lines	0	64	128	128	128	256	512	128	256	512
Operating System										
GCOS 7-ES	Yes	Yes	Yes	No	No	No	No	No	No	No
GCOS 7-MS	No	Yes	Yes	Yes	Yes	No	No	No	No	No
GCOS 7-LS	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes

DP—Disk Processor
MTP—Magnetic Tape Processor
NP—Network Processor

NA—Not available.

can also use other Bull products in a distributed fashion, most likely using the DSA networking facilities. With the introduction of the 3 fault-tolerant 7/X27 models at the top end of the series, Bull is also aiming at large companies which require a high degree of system reliability.

Bull has made good use of modern machine architecture in the DPS 7. Multiprocessing and simultaneity are evidence of this. Although the 7/X07 models lack input/output processors and cache memory, this probably does not have any great effect on the performance of the machines.

In addition to 1, 2, or 4 central processors, a Bull DPS 7 system contains a number of other processors for specific functions, including the input/output processor, disk processor, magnetic tape processor, unit record processor, communications processor, and network processor.

Simultaneity is achieved at 2 basic levels: within the main processor and by concurrent operation with the main processor of peripheral and network processors. These ancillary processors all have intelligence and some memory and are autonomous within certain limits. The main processor

8021 Zurich. Telephone (01) 242 1233. *West Germany:* Honeywell Bull AG, Theodor-Heuss-Strasse 60-66, D-5000 Cologne (Porz). Telephone (02203) 3050.

DISTRIBUTORS: Bull has agents in the following countries: Bahrain, Bolivia, Chile, Finland, Hong Kong, India, Indonesia, Kuwait, Mauritius, Paraguay, Peru, Saudi Arabia, United Arab Emirates, United Kingdom, and United States of America.

MODELS: DPS 7/107S, 7/307, 7/407, 7/507, 7/617, 7/717, 7/817, 7/627, 7/727, 7/827.

DATE ANNOUNCED: September 1984.

SCHEDULED DELIVERY: 7/X07: February 1985; 7/X17, 7/X27: April 1985.

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, hexadecimal, 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)

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.

7/X07 SUBGROUP

The 7/X07 group comprises 4 models, the 7/107S, 7/307, 7/407, and 7/507. The 7/107S is a newly developed entry-level system, while the 7/307, 7/407, and 7/507 are based on the old 7/35, 7/45, and 7/55 models respectively.

Each model has a basic 2M bytes of main memory, expandable to 4M bytes on the 7/107S and 7/307, to 6M bytes on the 7/407, and to 8M bytes on the 7/507.

Peripherals are connected into the system through input/output channels, of which the 7/107S and 7/307 offer 4, and the 7/407 and 7/507 provide 8. The 7/107S differs from the other 7/X07 models in that it contains an integrated disk processor, which is optional on the other systems. All machines contain as standard a magnetic tape adaptor through which magnetic tape processors are connected, and one unit record device which supports card readers and diskette drives. All four 7/X07 models include 2 communications processors with a total of 12 lines, and with the exception of the 7/107S, a network processor is also standard.

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 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.

7/X17 SUBGROUP

The 7/617, 7/717, and 7/817 are broadly based on the upper range members of the old DPS 7 Series, that is 7/60P, 7/70, 7/80, and 7/82. The 7/617 and 7/717 are both single-processor systems which comprise up to 8M bytes of main memory, one 16K-byte block of cache memory, 4 standard I/O processors, 2 network processors, and a number of disk, magnetic tape, and unit record processors. The dual-processor 7/817 in its basic configuration comprises 6M bytes of main memory, 2 blocks of cache memory, 8 I/O processors, and 4 network processors. Main memory can be expanded to 10M bytes. An additional eight I/O processors can be supported. Disk, magnetic tape, and unit record processors are available.

7/X27 SUBGROUP

The three 7/X27 models, the 7/627, 7/727, and 7/827, are fully redundant versions of the 7/617, 7/717, and 7/817 systems respectively. For example, the 7/727 configuration can contain twice as many processors and peripherals as the 7/717: 2 central processors, 8M to 16M bytes of main memory, 2 blocks of cache memory, from 8 to 32 I/O

precision formats. The scientific instruction set, used for floating-point operations, provides the capability for 128-bit quad words.

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: 1, 2, 3, or 4 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 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 4.

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 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 stored data is monitored by a Hamming code (one byte for every 8 data bytes) which corrects single-bit errors and detects double-bit errors. Parity checks are performed 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 7 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 4 levels of privilege, called "rings." Rings are numbered from 0 to 3, with 0 being the most privileged. A ring number is allocated to each segment when it is created and,

processors, up to 108 disk drives and 64 magnetic tape units, and 4 network processors handling a maximum of 256 communications lines. The largest model, the 7/827, is a quadri-processor system which provides full duplication of the 7/817 except that main memory ranges from a basic 12M to 16M bytes, and not to 20M bytes as might be expected.

SOFTWARE

Software for the DPS 7 Series is dominated by the GCOS 7 operating system for all models. GCOS 7 is compatible with the GCOS 64 operating system under which the previous DPS 7 machines ran. Software written for Level 64 and 64/DPS systems can be used on DPS 7 models.

GCOS 7'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, and 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 2 DPS 7 systems.

COMPETITIVE POSITION

The DPS 7 Series competes with the IBM 4300 Series. Specifically, the 7/507 competes with the 4341 Model Group 1; the 7/617 is comparable to the 4361 Model Group 5; and the 7/817 competes with the 4381. Other competition includes the Siemens 7.500 Series, the Hewlett-Packard 3000 Series, and the Sperry System 80 which is, like the DPS 7, specifically designed for distributed processing applications, and offers a wide range of I/O configurations.

ADVANTAGES AND RESTRICTIONS

Bull has greatly increased the power range of the DPS 7 Series with the introduction of new entry-level and top-end models in the restructured line. The 10 models run under the same operating system, GCOS 7, and users can therefore upgrade an entry-level model through to the 7/827 with little or no change in software.

when the process is entered, the main processor adopts this ring number. Each segment is allocated 3 protection levels, one for each possible use. Each level can be anywhere within the range of 0 to 3. 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 20KB.

CENTRAL PROCESSOR

The 7/107S, 7/307, 7/407, and 7/507 are single-processor systems, as are the 7/617 and 7/717. The 7/817 is a dual-processor machine. The 7/X27 systems are fault-tolerant versions of the 7/X17 models. The 7/627 and 7/727 have 2 central processors, and the 7/827 is a quadri-processor system.

DPS 7 central processors are composed of 7 "minimachines," a control store and a processor bus on all models, and cache memory on the 7/X17 and 7/X27 models. 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, which are not present on the 7/X07 systems, have their own control stores and main memories, and 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 7 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.**
- **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 look-ahead buffer that often allows it to begin interpreting another instruction while a previous instruction is still being executed.**

Bull DPS 7 Series

The models provide a wide range of languages and applications packages. Both compiled and interpreted languages are available, including Cobol, Fortran, and Basic.

USER REACTION

The 1984 Datapro Survey of French Users of Computer Systems brought responses from 34 Bull DPS 7 users. The average system life was 1 year and 10 months. Users of fourteen DPS 7s had purchased their systems, 15 were leased from a third party, and 5 were leased from Bull. Major applications areas included accounting/billing, order processing/inventory control, payroll/personnel, and purchasing.

During 1984, over half of the users intended to expand their data communications facilities, and the same number wanted to increase hardware capabilities.

To the question "Did the system do what you expected it to do?", 25 users said "Yes", 1 said "No", and 8 considered that it was too soon to judge. When asked if they would recommend the system to another user, 25 would, 2 would not, and 7 were undecided.

Users were asked to evaluate the different aspects of their systems under the headings Excellent, Good, Fair, and Poor. The weighted average obtained is based on a scale of 4.0 for Excellent. The system ratings are summarized in the following table.

Ease of Operation	2.94
Reliability of Mainframe	3.06
Reliability of Peripherals	2.91
Maintenance Service:	
Responsiveness	2.82
Effectiveness	2.85
Technical Support:	
Troubleshooting	2.42
Education	2.52
Documentation	2.27
Manufacturer's Software:	
Operating System	3.15
Compilers & Assemblers	3.19
Applications Programs	2.70
Compatibility of Terminals/Peripherals	2.70
Program and/or Data File Compatibility as promised	2.89
Power/energy Efficiency	2.74
Cost Reduction due to Productivity Aids	2.18
Software and Support Promised by Vendor	2.69
Ease of Programming	2.88
Ease of Conversion	2.80
Overall Satisfaction	2.88 □

- **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 2 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 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 7, while providing software access to the firmware functions of the DPS 7.

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 multilevel 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 7 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 7 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: Running under GCOS 7, the relative addressing mechanism is based on segmentation and its aim is to make optimum use of memory space. Each program 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 within 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 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 7 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 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.

CACHE MEMORY: Models DPS 7/617, 7/717, 7/817, 7/627, 7/727, and 7/827 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 5 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 7/617 and 7/717 have a capacity of 16KB, while models 7/627, 7/727, and 7/817 have 32KB of cache memory, and the 7/827 has access to 64KB cache memory. For reference purposes, cache memory is divided into 256 areas of 4 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.

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 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 (in models 7/627, 7/727, 7/817, and 7/827, this procedure is performed in the 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 7/X07 subgroup differs from the 7/X17 and 7/X27 models in containing integrated and optional I/O channels, rather than using I/O processors. The 7/107S and 7/307 have 2 integrated and 2 optional I/O channels, and the 7/407 and 7/507 have 4 integrated and 4 optional channels. The number of I/O processors supported by a system ranges from a minimum of 4 on the 7/617 to a maximum of 32 on the 7/827.

All models contain 1 integrated service and unit record processor (SURP), but, apart from this, the configuration can be tailored to suit the user. Additional service and unit record processors can be added on most models. A SURP handles 2 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, diskettes, printers, and the system console. A communications processor is connected as a standard feature on the 7/107S, and is optional on other 7/X07 systems.

Disk drives are supported by disk processors; the 7/107S has one standard processor and optional processors can be added to all systems. The I/O processor used by the 7/X07 models supports 8 drives. The 7/X17 and 7/X27 subgroups use single-channel and dual-channel processors, the difference between them being 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 3 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 200KB 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 780KB 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 communications processors and by optional network processors. Between 2 and 12 communications processors are available with the 7/107S, 7/307, 7/407, and 7/507. Network processors can be used with all models.

I/O PROCESSORS: These are provided on the 7/X17 and 7/X27 subgroups. Each I/O processor has a control store of 4K-bit words, a main memory of 2KB, 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 on the 7/617 and 7/717, and 8 are standard on the 7/817. The 7/617 and 7/717 can support a total of 12 and 16 respectively, while up to 32 processors are available with the 7/817. I/O processor capabilities for the 7/X27 systems are twice those for the corresponding 7/X17 machines.

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.

Input/output operations are handled in 7/X17 and 7/X27 machines by an input/output processor, and peripheral or network processors. 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 and network processors control the exchange of data with the peripheral or network component involved in the request.

Each input/output processor 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 7/X17 and 7/X27 systems can contain 1 or 2 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 2KB 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 and unit record processor to initialize and test I/O processors. Each I/O processor, and consequently each channel, has a throughout of up to 2.5MB per second. The throughput of a group of I/O processors is up to 20MB per second. These rates permit the execution of more than 300 channel programs per second on a group of I/O processors.

A disk, magnetic tape, or network processor is connected to an I/O 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 for the purpose of executing a channel program, chaining commands, multiplexing 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 7/X17 and 7/X27 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- or quadri-processor configuration does not affect the availability of peripherals to the other main processors.

Peripheral devices and network components on all models are controlled by specialized peripheral and network processors. Each processor is connected either directly to an I/O channel, or to an I/O processor in the central system.

SIMULTANEOUS OPERATONS: The peripheral processing subsystems operate simultaneously with the central processor. Each subsystem operates under control of a microprogrammed disk or magnetic tape 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.

MASS STORAGE

Bull currently offers 3 disk-pack drives for the DPS 7 systems.

MSU0395 MASS STORAGE UNIT: This unit contains 300MB of data in removable disks. Average access time is 38 ms and the transfer rate is 1.2MB per second.

MSU0455 MASS STORAGE UNIT: This unit uses packs with 12 removable disks and 19 recording surfaces to store up to 200MB. Average seek time is 30 milliseconds, average rotational delay is 8.3 milliseconds. The transfer rate is

806KB per 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 635MB fixed disk packs, yielding a total unformatted storage capacity of 1270MB. 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 1.2MB per 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.

DDF4051/DDU4055 DISKETTE DRIVE: Capacity of 492KB on one drive. The transfer rate is 31.3KB per second.

DDU4056 DISKETTE DRIVE: Capacity of 985KB on two drives. The transfer rate is 31.3KB per second.

INPUT/OUTPUT UNITS

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.

MTU0320/MTU0321 MAGNETIC TAPE UNITS: These 9-track units operate at 45 inches per second, and transfer data at 72KB per second at 1600 bpi.

MTU0420/MTU0421 MAGNETIC TAPE UNITS: These 9-track units operate at 75 inches per second, and transfer data at 120KB per second at 1600 bpi.

MTU0432 MAGNETIC TAPE UNIT: This unit operates at 75 inches per second and transfers data at 120KB per second at 1600 bpi. Error correcting features include read after write. Up to 8 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 per second and transfers data at 200KB per second at 1600 bpi.

MTU0437 MAGNETIC TAPE UNIT: This unit operates at 75 inches per second, and transfers data at a maximum rate of 468KB per second. Tape density is 1600 or 6250 bpi.

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

UNIT RECORD PROCESSOR: This integrated controller has 5 device ports plus ports dedicated to the console and communications. A second processor, the URP 4371, can be added, providing 3 more device ports plus a second communications port. Each peripheral device connects to a device port via an addressing attachment.

CRU0301 CARD READER: This tabletop unit reads at 300 cards/minute and has 1,000-card input and output hoppers. Options include IBM and Honeywell mark sensing adapters.

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

PRU 0705 BELT PRINTER: This has print belts with flexible fingers, a system already used 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 per minute version of the PRU 0705 which uses a 63-character set.

PRU 1505 BELT PRINTER: This is a 1200 line per 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 per 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 momentarily 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 per second for 1 to 3 lines, up to 90 inches per second for more than 6 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 1 original and up to 5 carbon copies or 10 self-carbon copies.

Bull DPS 7 Series

COMMUNICATIONS CONTROL

The DCC 4270, 4271 and 4370 Communications Controllers interface with the Service and Unit Record Processor. Through optional communication processors on the 7/X07 models, they 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 and DPS 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 except that up to 4 couplers can be used and up to 128 lines can be displayed.

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

- Asynchronous, character mode line procedure

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

- TTY synchronous line procedure

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

- QUESTAR-T Range

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

- Satellite Systems

  TTS 7800
  Mini 6 DSS
  61 DPS

- Public networks

  X.25
  X.21

OPERATING SYSTEM

All DPS 7 models run under the GCOS 7 operating system which is available in three versions according to the size of the machine. GCOS 7-ES (Entry System) is available on the 7/107S, 7/307, and 7/407; GCOS 7-MS (Medium System) runs on the 7/307, 7/407, 7/507, and 7/617; and GCOS 7-LS (Large System) is for models 7/617, 7/717, 7/817, 7/627, 7/727, and 7/827. The LS version can manage a greater number of central processors and terminals.

GCOS 7 is fully compatible with the earlier GCOS 64 operating system. It supports batch, remote batch, transaction, and interactive processing.

Within GCOS 7 are three sets of products for development, production, and information processing.

The development system contains high level languages, program generators, and interactive facilities such as debugging. The production system, which is intended for use in the processing of large amounts of data, includes the database management system, transactional monitor, and recovery tool. The information system is for nonexperienced users and contains a data and document handling system, and a graphics display.

The nucleus within GCOS 7, called System Support, allocates basic system resources, and includes:

—virtual memory manager

—CPU dispatching automatic control manager

—on-line tests and diagnostics

—peripheral interrupt manager

—device, volume, and file manager.

In addition to System Support, Supervisory Functions are available under GCOS 7 for all 3 versions of the operating systems, ES, MS, and LS. These are:

—menus

—job management, including accounting and output reports

—FORMGEN, screen form generator

—security and recovery mechanisms, including logging and checkpoint-restart

—data management including sort and merge of files, and privacy and access rights functions

—program management including library, text editor, linkage editor.

GCOS 7-LS also contains the following functions:

—physical memory management mechanism

—multiprocessor management mechanism

—management of over 40 simultaneous interactive users

—virtual memory management of several disks.

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 jobs 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. Space for temporary files is normally released as soon as the job step has been 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 5 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 GCOS 7. 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.
- Establishment of 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 7, 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 includes access to specific file items by any one of 15 characteristics without a prior sort. A 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
- Assigning a secondary index as 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
- Support of MLDS 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.

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 realtime 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 7, and RBF/64, which runs on the Level 6 under control of GCOS 6 Mod 400. RBF operates under synchronous transmission using 2 or 4 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 Transfer 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 5 transmissions can be handled simultaneously by one copy of the DPS 7 utility program. Any number of users in groups of 5 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 (IDS 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 for use in batch mode. Query is available in 2 versions: inquiry only—which provides features for searching on selected criteria; and inquiry and update—which extends the inquiry-only version by the addition of a module that can modify user records. Query supports BFAS indexed sequential and sequential file organizations, UFAS indexed and sequential organizations, and an IDS II Data Base.

PRODUCTIVITY AIDS

SINDIA—a transactional program generator which aids in the development and maintenance of transactional programs under TDS.

DATA DICTIONARY—contains information on a user's files, programs, transactions, procedures, and data.

PROGRAMMING LANGUAGES

Bull provides Cobol, RPG II, Fortran, Basic, Pascal, 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 from 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 file access methods BFAS, and UFAS.

RPG uses 5 files: 2 work files; a complete unit library for the generated program; and 2 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 77 standard and provides several extensions.

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 4 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 GCOS 7, 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. It also offers extensions designed to facilitate structured programming: for example, DO . . . UNTIL. It can call for routines written in Cobol and manipulate standard GCOS 7 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 7 data management.

APL: APL, like Basic, is designed to be used by non-data processing personnel.

APL is implemented in a GCOS 7 interactive environment and from specialized terminals (for example, from the Anderson-Jacobson AJ 510 terminal).

GCOS 7 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.

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.

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.

STA7—an office automation package which is menu-driven and includes prompts and "Help" functions. The package handles text entry and editing, printing, mailing preparation, filing and retrieval, archiving, and electronic mail.

GAV—this provides a dedicated videotex service with the following functions: interface with user applications; screen management; message distribution and handling; videotex services such as document creation and management; and videotex administration including production of statistics.

LIS—a statistical package which produces statistical data in graphs or bar charts, and aids a user in retrieving information from a data base.

FCS—Financial Control System. FCS is a financial language that includes functions for forecasting, tax calculations, inflation accounting, and statistical analysis.

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.

MAINTENANCE: 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.

TRAINING: Courses lasting between 2 and 9 days are available and must be paid for separately by the customer. Introductory courses are run for both hardware and software, and more detailed software courses cover programming using high-level languages, IDS II data base management system, QUERY, MISTRAL, and videotex.

DOCUMENTATION: Complete documentation in French and English can be obtained from the documentation center at the following address: CEDOC, Parc Industriel d'Incarville, B.P. 110, 27100 Le Vaudreuil Ville Nouvelle, France.

PRICING

EQUIPMENT: DPS 7 equipment is available for purchase or for rent under a 1-year, 3-year, or 5-year lease.

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

Bull DPS 7 Series

conversion aids are provided at no additional cost. Monthly license fees are charged for language processors, utilities, application packages, communications software, and advanced job management and file systems.

EQUIPMENT PRICES

		Purchase Price (FF)
DPS 7/107S	2MB main memory, three 300MB disk drives, one 750 lpm printer, and 1 communications processor with 3 lines	1.100.000
DPS 7/507	4MB main memory, 5000MB disk store, one 1200 lpm printer, 1 network processor with 12 lines	4.400.000
DPS 7/717	4MB main memory, 10,000MB disk store, two 1500 lpm printers, 1 network processor with 30 lines	9.500.000
	Typical DPS 7/307 configuration	2.200.000
	Typical DPS 7/617 configuration	5.400.000 ■

BULL DPS 7 Series

Product Enhancement

In September 1984, at Sicob in Paris, Bull announced a restructuring of the DPS 7 Series. The DPS 7 line now consists of ten redesigned models. The series can be divided into three groups: DPS 7/X07 single processors; DPS 7/X17 single and dual processors; and the 7/X27 systems, redundant versions of the 7/X17 models.

According to Bull, the new DPS 7 line offers approximately 25 percent price/performance improvement over existing models. The restructured range runs under the GCOS 7 operating system that includes the GCOS 7-ES which is designed for entry-level configurations managing up to 127 terminals. The earlier GCOS 64 operating system is compatible with the new GCOS 7 operating software. The new versions of the Bull DPS 7 systems can be integrated into DSA networks.

The DPS 7 range competes with the IBM 4300 Series. Specifically, the 7/507 competes with the 4341 Model Group 1; the 7/617 competes with the 4361 Model Group 5; and the 7/817 competes with the 4381. The new range of Bull DPS 7 systems are being manufactured at Bull Systèmes' industrial facility at Angers and will be available for delivery in the second quarter of 1985, depending on the model selected.

The 7/X07 Group

The **7/X07 Group** consists of four models: 7/107, 7/307, 7/407, and 7/507. The **7/107** is a newly developed entry-level system that offers 2MB to 4MB of main memory, one integrated disk processor, one optional disk processor, one magnetic tape adaptor, two integrated I/O channels, and two optional I/O channels. Both the integrated disk processor and the optional disk processor are capable of controlling up to eight drives. Communications capabilities in the 7/107 are provided by one or two communications processors capable of supporting 12 lines.

The **7/307** is an enhanced version of the 7/35 of the previous DPS 7 Series, but differs from the 7/35 in that it offers more main memory capacity—2MB to 4MB in contrast to the 7/35's 1MB to 3MB memory. The 7/307 also differs from the 7/35 in that it offers two optional disk processors rather than the 7/35's provision for one integrated and one optional processor.

Based on the previous 7/45, the **7/407** offers increased main memory of 2MB to 6MB, as well as two additional integrated I/O channels and support for up to 36 disk drives. The 7/407 also includes two network processors that can support a total of 128 lines.

The **7/507** is based on the previous 7/55 and is similar to the 7/407; expansion to main memory constitutes the only difference between the models. Main memory in the 7/507 can be extended to 8MB.

The 7/X17 Group

Within the **7/X17 Group** are three models: 7/617, 7/717, and 7/817, all of which are broadly based on the upper range members of the former DPS 7 Series. The **7/617** is a single-processor system with a main memory capacity of 2MB, expandable to 8MB. It also has 16KB cache memory, four to 12 I/O processors, and the capability of supporting up to 54 disk drives and 16 magnetic tape units. Two network processors with a total of 128 lines are included in a 7/617 system. The **7/717** contains 4MB to 8MB of main memory and 16KB of cache memory. It is equipped with four to 16 I/O processors, eight single-channel and four dual-channel disk processors (controlling up to 72 disk drives), a maximum of 32 magnetic tape units, and two network processors with a total of 256 lines.

The **7/817** dual-processor system has a main memory capacity of 6MB to 10MB and a 16KB cache memory. It can support from eight to 16 I/O processors, up to 72 disk drives, up to 32 magnetic tape units, and four network processors with a total of 512 lines.

The 7/X27 Group

The third DPS 7 group consists of three 7/X27 models which are fully redundant versions of the respective 7/X17 models. The **7/627** configuration can contain twice as many processors and peripherals as the 7/617, such as: two central processors; 4MB to 16MB of main memory, two 16KB blocks of cache memory; from eight to 24 I/O processors; up to 108 disk drives and 32 magnetic tape units; and four network processors. The largest model, the **7/827**, is a quadriprocessor system that offers full duplication of the 7/817 with the exception that main memory ranges from a basic 12MB to only 16MB.

BULL DPS 7 Series

Product Enhancement

⊳ Pricing

An entry-level 7/107 system with 2MB of main memory, three 300MB removable disks, and one 750 lpm printer costs approximately 1.100.000 French francs.

A 7/717 system with 4MB of main memory, 10GB disk storage, six magnetic tape units, and two 1500 lpm printers costs 9.500.000 French francs.

Typical configurations of 7/307 cost FF 2.200.000, 7/507 cost FF 4.400.00, and 7/617 cost FF 5.400.000. □