Cii Honeywell Bull DPS 4

MANAGEMENT SUMMARY

The small-scale DPS 4 multi-processor computer is designed for business data processing and/or data communications and can be operated in normal office environments. Intended as an upgrade for Level 61 and 61/DPS users and their competitive counterparts, the DPS 4 provides improved price/performance, Level 61 application software compatibility, and support for up to 13 concurrent batch, interactive, and communications programs.

Announced by Cii Honeywell Bull in November 1980, the DPS 4 provides a smooth Level 61 user migration path to the Level 62. CII-HB emphasizes that the compatibility of the DPS 4 and Level 62 enables DPS 4 equipment to run alongside and in conjunction with existing Level 62 small computers.

The Italian-developed and built DPS 4 is a bus-oriented system using a minimum of three processors dedicated to handling instruction execution, input/output, and disk files. In addition, optional processors are available for multi-line communications, emulation, and foreign disk files. Each system can have multiple CPU's.

Software support for the DPS 4 system centers on the GCOS operating system. Based on the Level 62 operating system, DPS 4 GCOS is a modular, interrupt-driven operating system that can support up to 13 concurrent batch and communications programs. It features spooling, dynamic memory allocation, automatic job scheduling, and fail-soft facilities that allow the system to

Based on a new multi-processor architecture, the DPS 4 provides a natural growth path from the Level 61 and other competitive small business computers. Offering improved price/performance as well as operating system and application software compatibility, the DPS 4 has a 32-bit system bus connecting from three to five specialized processors and memory units. The machine architecture, in conjunction with the GCOS 4 operating system, supports multiprogramming of up to 13 interactive job streams. A minimum system with three processors and 512K bytes of memory, 160 megabytes of disk storage, video console, two workstations, and a 600 lines per minute printer is priced at FF 559,159.

CHARACTERISTICS

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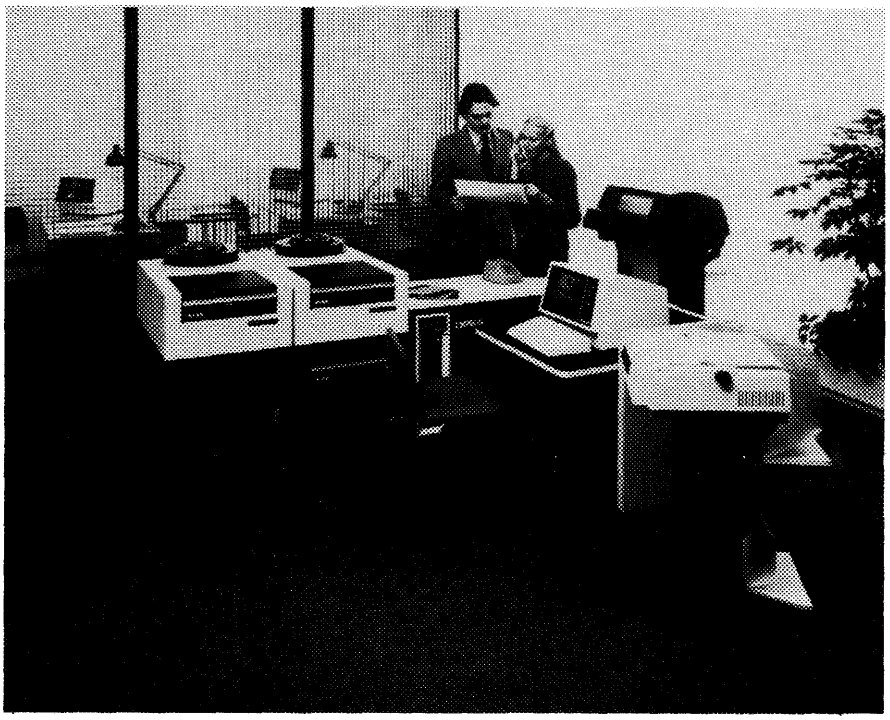
VENDOR: Cii Honeywell Bull, 94, avenue Gambetta, B.P. 33, 75960 Paris, Cedex 20, France. Telephone 360.02.22. Telex 220 898 F.

MODELS: The DPS 4 is a modular multiprogramming system consisting of three independent processors dedicated to various tasks. An entry-level DPS 4 system can be expanded to include up to two CPU's, one main memory unit, and a network processor.



The small size of Cii Honeywell Bull's DPS 4 multiprocessor computer, its modular construction, and ease of operation make it a system as much for the office environment as for the traditional DP department. Pictured left is a system with 460 megabytes of removable disk storage, video console, and two system printers. Visual display terminals can be seen in the adjoining office area.

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CHARACTERISTICS OF THE DPS 4

SYSTEM CHARACTERISTICS	
Date of introduction	November 20, 1980
Date of first delivery	France and Germany, December 1980
Number installed to date	34 as of March 1981
MAIN STORAGE	
Type	MOS/EDAC
Cycle time, nanoseconds	611
Minimum capacity, bytes	524,288
Maximum capacity, bytes	2,097,152
Increment size, bytes	262,144
Bytes fetched per cycle	4
CENTRAL PROCESSOR	
Number of registers	29 std., 4 opt.
Number of instructions	148 std., 24 opt.
CONTROL MEMORY	
Type	Bipolar
Cycle time, nanoseconds	120 (resident), 350 (transient)
Capacity, K words	64K (resident), 24K (transient)
Bytes fetched per cycle	2 (plus 4 parity bits)
INPUT/OUTPUT CONTROL	
Maximum channels	8
Maximum channel data rate, bytes per second	1,800,000
CONFIGURATION	
Minimum disk capacity, megabytes	160
Maximum disk capacity, megabytes	1,800
Magnetic tape transports, maximum	6
Communications lines, maximum	32

survive certain memory and peripheral failures. To increase user memory, only the supervisor module of GCOS is permanently resident, and it calls the other modules as required.

The spooling feature enhances the multiprogramming capabilities of the DPS 4 by reducing contention for slower peripheral devices and increasing throughput by improving CPU utilization.

GCOS provides three high-level programming languages, COBOL, FORTRAN, and RPG II, for the development of user programs, and the TPS language for the development of interactive communications programs. CII-HB also offers a large number of TRANSIT software conversion routines, which permit users to convert existing programs for operation on DPS 4 systems.

Applications software includes the IMS-TD On-Line Manufacturing Systems: inventory reporting, bill of materials processing, requirements management, material requirements planning, order releasing and simulation, standard cost control and simulation, production data management, work in progress monitoring, and capacity requirements planning.

DATA FORMATS

BASIC UNITS: 8-bit byte (plus parity bit). Each byte can represent one alphanumeric character, two packed BCD digits, or eight binary bits.

FIXED-POINT OPERANDS: 16-bit word in short form, 32-bit doublewords in long form. Operands are interpreted as signed, using the leftmost bit for sign storage.

FLOATING-POINT OPERANDS: 32-bit single-precision numbers or 64-bit double-precision numbers. The exponent is 7 bits including sign, and the fraction is 57 bits including sign.

INSTRUCTIONS: 148 plus 24 for floating point.

INTERNAL CODE: ASCII.

MAIN MEMORY

TYPE: Metal oxide semiconductor (MOS/EDAC) 16K-bit chips; 64K-bit chips are planned for future use.

CYCLE TIME: 611 nanoseconds per 4-byte access.

CAPACITY: 524,288 bytes to 2,097,152 bytes in 256K byte increments.

CHECKING: The Main Memory Unit (MMU) is provided with Error Correcting Code (ECC), which detects all memory parity errors and corrects them automatically. Every instruction extracted is double-checked for accuracy, and errors in reading or writing data are automatically trapped and corrected by the system. In the event of an error in the execution phase, each instruction is retried automatically up to 16 times.

STORAGE PROTECTION: Under IPS, a protective lock on records accessed in update or output mode prevents simultaneous modification of data by two users. The availability of password protection at both terminal and transaction levels allows the selective enforcement of privacy. Additionally, a wide range of safeguards helps ensure the correct handling of data during transaction processing. If an error occurs during the processing of a transaction, user files are not affected; the transaction is terminated and can be performed again. If an error occurs during user file update, access to the user file is inhibited and transactions accessing that file are terminated; log and work files can be used to restore the integrity of the user file. If an error occurs while a transaction is reading a file, the transaction is terminated and the system operator has the option of inhibiting further access to the file.

CENTRAL PROCESSOR

GENERAL: The DPS 4 system architecture is based on a series of processors operating together in a multi-processor environment. The processors are physically separated and independent of one another, but are logically linked by a 32 data-bit (98 bit) wide system bus.

Each processor is specialized and comprises two logical blocks: a Generalized Computing Unit (GCU) which provides universal processing facilities through a generalized micro-instruction set, and special firmware and hardware which 'personalizes' the basic GCU to carry out particular functions. The GCU of every processor consists of a microprocessor, LSI circuits, and both Random Access Memory (RAM) and Read-Only Memory (ROM). Each GCU has its own direct monitor interface and automatically enters

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An entry-level DPS 4 system consists of three dedicated processors, 512K bytes of memory, 160 megabytes of disk storage, video console, two workstations, and a line printer.

A maximum of five dedicated processing units can be connected to the DPS 4 system bus, and main memory can be expanded to a maximum of two megabytes. A maximum of eight communications lines are supported, but 32 additional lines can be provided by adding the Multi-Line Communications Processor. Mass storage can be expanded to 1,800 megabytes, and one additional printer with a speed of 600 lines per minute can be attached. Other peripherals include magnetic tape units and card readers.

Main memory is currently implemented in large-scale integrated MOS technology with a density of 16K bits per chip; 64K-bit chips are planned for the future. One Main Memory Unit (MMU) can be configured to a DPS 4 system, providing a maximum of two million bytes of memory. Memory can be expanded from 512K bytes in 256K byte increments to 2,048K bytes.

The DPS 4 disk processor can handle up to six 300-megabyte disk drives, for a mass storage capacity of 1,800 megabytes. Peripheral equipment includes one or two 600 lpm printers, magnetic tape units, and card readers.

The Multi-Line Communications Processor (MLCP) provides up to 32 communications lines offering local or remote connection; synchronous, asynchronous, or current loop connection; and throughput of 200K bits per second.

The number of terminals that can be connected to a single line depends on the terminal class. Unbuffered terminals (TTY-like) must be used in point-to-point connections, one terminal to a line. Buffered terminals (VIP-like and ISO-like) are used in multipoint connections, with several terminals on a single line. Computer systems must be used in point-to-point connections, with only one system per line at a time. The GCOS communications system permits different types of terminals to be mixed.

When the operating system is generated, the user must select the number and types of lines as well as the specific types of terminals to be used in the communications network. The following classes of terminals are supported by the DPS 4 hardware and software: TTY-like, VIP-like, ISO-like, and computer systems and terminals that support the IBM HASP multi-leaving and Binary Synchronous Communications protocols.

CII-HB has implemented its Remote Maintenance System (RMS) in the DPS 4, permitting field engineering personnel to diagnose hardware, firmware, software, and operational problems from a remote location. One major benefit that users can derive from RMS is the diagnosis of software problems and implementation of self-diagnostic mode when not executing a system function.

The following processors and logical blocks comprise the main DPS 4 system:

- **Interior Decor Processor (IDP)**
- **Input/Output Processor (IOP)**
- **Disk Processor (DP)**
- **Multi-Line Communications Processor (MLCP)—optional**
- **Main Memory Unit (MMU)**

In addition, an Emulator Processor (EP) and a Foreign Disk Processor (FDP) can be linked to the DPS 4 system bus, which is capable of supporting up to 5 physical processors.

The Interior Decor Processor (IDP) fetches and executes each program instruction. Its microinstruction set is a superset of the Level 62 instruction set; thus full program compatibility at object code level is assured.

The IDP has two levels yielding relative performance measurements equivalent to 120,000 or 191,000 instructions per second. A maximum of two IDPs can be linked to the DPS 4 bus, boosting performance to 348,000 instructions per second.

The functions of the Input/Output Processor (IOP) are to handle the basic input/output of data to and from low speed peripherals (e.g., console, diskettes, card readers, magnetic tapes, printers), and to provide up to eight communications lines which can be used to control local or remote terminals.

The Disk Processor (DP) can handle up to six removable-disk drives of various capacities, the largest a 300-megabyte model. Maximum storage capacity is 1,800 megabytes.

The Main Memory Unit (MMU), providing up to two megabytes of memory, contains its own microprocessor which handles the temporary storage of data and programs in the main memory and controls the flow of information between all the different microprocessors.

The optional Multi-Line Communications Processor (MLCP), which provides up to 32 additional communications lines, offers local or remote connection of any line; synchronous, asynchronous, or current loop connection of any pair of lines; throughput of 200K bits/second; and maximum individual lines speed of 19,200 bits/second. The MLCP also provides all programmed control functions over the whole of its intrinsic communications network (polling, selection, error handling, etc.).

The Emulator Processor (EP) includes a special Interior Decor Processor (IDP) microprogrammed to execute the instruction set of an emulated machine in coexistence with the native IDP.

The Foreign Disk Processor (FDP) enables disk units from another computer to be connected to DPS 4.

PHYSICAL SPECIFICATIONS: DPS 4 central processor systems are supplied in cabinets of different sizes to suit various operating requirements. The smallest cabinet is 1 meter long and may contain 4 processors or logic blocks in

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changes by vendor personnel without the need for site visits or taking the system down for maintenance.

COMPATIBILITY AND COMPETITION

Cii Honeywell Bull introduced the DPS 4 to compete with IBM System/38-1 and /38-2. The DPS 4 is also expected to overlap and therefore compete against the recently introduced Sperry Univac System 80. With deliveries already begun, CII-HB is attacking the IBM System 34 base by taking advantage of delayed IBM System 38 deliveries.

Cii Honeywell Bull offers TRANSIT conversion packages enabling users of the IBM System 32, System 360/20, and System 3 to convert RPG II programs and files to DPS 4 RPG. Source COBOL and MiniCOBOL programs can be transferred from Series 200 2000, Level 61, and Level 62 systems to the DPS 4.□

addition to the basic power supply, console and integrated diskette.

The standard cabinet measures 1.5 meters and contains six processors. A third cabinet is available as an extension for larger configurations: also 1.5 meters long, it can contain six extra processors and a power supply. The extra processors may be used to provide additional power and configurability or to provide a high availability or non-stop system.

When maximum availability of system resources is a fundamental requirement, a duplicate (or triplicate) of each processor or logic block can be configured to provide either extra power or idle standby until a major system failure occurs.

REMOTE MAINTENANCE SYSTEM (RMS): A standard feature of the DPS 4 system is CII-HB's Remote Maintenance System (RMS). Designed to provide immediate remote assistance for any problem, it allows CII-HB to access the system, with the user's agreement, to help in problem diagnosis. Three types of service are offered: one that answers how-to-use problems; another that responds to software and firmware needs with a down-the-line patch; and a third that identifies a hardware fault and the required replacement part. CII-HB's access to the system is fully controlled by the user and complete security is assured automatically.

CONTROL STORE: Each generalized computing unit has a control store comprising two areas: resident microcode, stored in 8K bipolar PROMs and transient microcode, stored in 4K MOS RAMs. Up to 64K words are available for resident microcode, with an access time of 120 nanoseconds per word. 24K words of transient microcode are currently implemented, with an access time of 350 nanoseconds per word.

ADDRESSING: Four levels.

INSTRUCTION REPERTOIRE: The DPS 4 has an instruction set that includes arithmetic instructions for performing decimal and binary operations (add, subtract, multiply, and divide) on packed or unpacked data, logical operations, editing functions, and operations for address computations. The IDP executes 148 instructions. Operands can be binary, fixed point or decimal; in packed or unpacked format; on bytes, byte strings, or bit strings. The optional Scientific Instruction Set adds 24 instructions and floating point capabilities.

INTERRUPTS: Interrupt signals are generated by conditions such as successful completion of I/O operations, I/O errors, arithmetic overflow, timer runout, attempts to reference out-of-bounds storage locations, etc. Interrupts are referred to microprogrammed routines located in the GCU read-only memory for initiation of the appropriate servicing routines.

CONSOLE: The console for controlling and communicating with a DPS 4 system consists of devices and elements which allow the operator to start and run the system. System start-up begins with the operator pressing the "Power On" and "reset" buttons on the control panel and continues by means of a simple dialogue between the operator and the system. This system dialogue takes place at the console station, which is either a video or printer console.

SYSTEM OPERATOR PANEL: The system operator panel contains the main power switches (Power On, Power Off, Reset) and status indicator lights (AC PRESENT, DC ON, MAINT, TRAFFIC, SYSTEM ERROR). The system operator panel is positioned in the top left-hand corner on the front of the main cabinet. The panel is built into the front of a drawer that can be opened to display the system fault stautus and power-on clock indicators.

DKU 3002 VIDEO CONSOLE: This video console provides conversational message transfer, status display, and operator control facilities. The console consists of a 12-inch CRT display unit, providing 24 lines of 80 characters each and a separate keyboard with 86 keys with multi-key depression/protection features. The console can generate 95 ASCII upper and lower case characters, and a full 129 ASCII code character-set. A log of the operator/system dialogue is maintained on a system disk file when the video console is used. The log can be recalled interactively on the screen and may also be output on the main system printer.

CSF 3001 PRINTER CONSOLE: This printer console provides the same conversational message transfer, status display and operator facilities as the DKU 3002, but in hard copy form. The printer itself has a dot-matrix serial mechanism with print speeds of 30 or 120 characters per second. The keyboard is divided into two major areas: one is a touch-typing area, which closely resembles a standard typewriter keyboard. The other incorporates keys which provide a number of controls over the functions of a DPS 4 system. Up to four copies can be provided when using multi-part stationery.

INPUT/OUTPUT CONTROL

I/O CHANNELS: The Input/Output Processor (IOP) handles the basic input/output of data to and from unit record devices. The maximum data rate for eight communications lines may not exceed 50K bits/second, and no one line may exceed 9,600 bits/second.

SIMULTANEOUS OPERATIONS: The independent DPS 4 processors are able to work in parallel, executing several diverse operations concurrently. For example, while the appropriate processor (IOP) receives and handles the input data, a disk processor (DP) can take charge of filing other data on magnetic disks; meanwhile, the IDP (Interior Decor Processor) processes other data. The DPS 4 can support a maximum of 13 job streams, including full spooling.

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CONFIGURATION RULES

An entry-level DPS 4 system comprises three processors, 512K bytes of memory, 160 megabytes of removable disk storage, video console, one workstation, and a line printer. Up to 5 processing units can be connected to the system bus (2 IDPs, 1 IOP, 1 MLCP, 1 DP, or 1 EP as an alternative to the second IDP), and one main memory unit with a maximum capacity of two megabytes. Mass storage can be expanded to 1,800 megabytes, and one additional printer with a speed of 600 lines/minute can be configured to the system. Other peripherals include magnetic tape units and card readers.

MASS STORAGE

MSU0337/0338 MASS STORAGE UNITS: Each unit consists of a five-platter removable disk pack providing 80 million bytes. Two such units can be housed in a cabinet; the MSU0337 is housed in the top drawer, and the MSU0338 in the lower drawer. Capacity per cabinet is 160 million bytes. 19.8 kilobytes of data are recorded per track, with 4040 tracks per pack. Average disk seek time is 300 milliseconds, average latency is 8.3 millseconds, and rotational speed is 3600 rpm. Transfer rate is 1.2 million bytes per second.

MSU0390 MASS STORAGE UNIT: The MSU0390 disk units provide storage capacities of 300 million bytes on a 12-platter removable disk pack. Average access time is 31.3 milliseconds.

DISKETTE UNITS: A central cabinet can house one or two diskette units, offering single-sided, single-density diskettes.

Each single-sided, single-density diskette has 77 tracks. The first is an index track and the last two are reserved for use if errors are found on any of the other tracks. Data is stored in the remaining 74 tracks, giving a total capacity of 240K, 277K, or 296K bytes (depending on the number and length of the sectors into which each track is subdivided). Transfer rate is 32K bytes/second.

INPUT/OUTPUT UNITS

MTU0106/0107 MAGNETIC TAPE UNITS: The MTU0106 master unit supports two tape transports and controls the operation of MTU0107 dual transport slave units. The drives operate at 18.75 ips and are available as 9-track, 1600 bpi, PE, 30,000 bytes/second units, or optionally, as 7-track, 200/556/800 bpi, NRZI units. A 9-track, 800/1600 bpi, NRZI/PE dual density version is also available. Drives of different configurations can be intermixed.

MTU0206/0207 MAGNETIC TAPE UNITS: These units differ from the MTU0106/0107 units only in tape transport sped, which is 37.5 ips, and in data transfer rates, which are twice as high.

CRU500 CARD READER: This unit reads 80-column cards at 500 cpm. The unit features mark-sense options that permit reading of mark-sense cards in either Honeywell or IBM mode. Cards are read column by column, and each column is read twice to eliminate errors. The input hopper and output stacker each hold up to 1000 cards.

CRU0306 CARD READER: This unit reads 96-column cards at a speed of 300 cpm. The CPA2016 addressing feature is required with this reader. The input hopper and output stacker each hold up to 600 cards.

PRU0615 BELT PRINTERS: These belt-type units print 600 lines per minute with a 64-character set. Print format is 132 print positions per line, spaced 10 characters per inch, with 6 or 8 lines per inch vertical spacing.

TERMINALS: DPS 4 will support TTY-like, asynchronous, unbuffered terminals such as TTY33/36/37/38, TN300, TTU8124/8126, TE318, DTS7200, and DTU7170; VIP-like, synchronous, buffered terminals such as VIP7700/7760, VIP7001/7002, KDS7255/7265, KDU7250, Olivetti synchronous buffered terminals such as TCV260/275, TC349 BI, and TC380/800; and other processors and terminals that support IBM's Binary Synchronous Communications protocol including Honeywell Series 60 Level 61, 62, 64, and 66; IBM's System/370 computers and 3741 terminals; and Olivetti's TCV275 terminals in BSC3 mode.

The number of terminals that can be connected to a single line depends on the terminal class. Unbuffered terminals (TTY-like) must be used in point-to-point connections, one terminal to a line. Buffered terminals (VIP-like and ISO-like) are used in multipoint connections, with several terminals on a single line. Computer systems must be used in point-to-point connections, with only one system per line at a time. The GCOS communications system permits different types of terminals to be mixed in the same job stream.

COMMUNICATIONS CONTROL

The Input/Output Processor, common to all DPS 4 systems, provides an initial set of communication line connections that can be used for terminal or computer-to-computer links. It provides up to eight line connections, giving a maximum individual line speed of 9,600 bits per second and a total throughput of 50,000 bits per second.

One Multi-Line Communications Processor may also be connected. This processor supports up to 32 communications lines, giving a maximum line speed of 19,200 bits per second and a total throughput of 200,000 bits per second. The 32 communication lines may all be synchronous, asynchronous, current loop, or a mixture of all three. The DPS 4 provides remote, direct, point-to-point connections to terminals and to other computers.

SOFTWARE

OPERATING SYSTEM: The DPS 4 system runs under the GCOS 4 operating system which is based on the Level 62 GCOS operating system. GCOS 4 features multiprogramming, spooling, dynamic memory management and fail-soft operations. System resources are allocated at the beginning of a job step and de-allocated at the end of a job step. If resources required for a job step are not available, the job step is placed in a "wait queue." The job is automatically started when resources become available. Up to 13 job streams can be processed concurrently, limited only by the amount of physical memory present in the system. GCOS also maintains a "run queue," a list of jobs ready for initiation. Whenever an executing job is interrupted, the operating system selects a ready-to-run job from the run queue and processes the job.

The spooling feature employs a scheduling facility to optimize the use of system resources. It restricts the direct use of slower peripherals (such as card readers, cassette tape drives, diskette drives, and line printers) to system programs called Input Readers (IR's) and Output Writers (OW's).

IR's read input streams job-by-job onto a spooling file. An IR occupies 14K bytes of memory and can be permanently memory resident or used in a roll-in mode so that its memory space is released to user programs when all of the job description statements have been read. When user programs terminate, the IR can be reloaded to process additional job description statements. Two or more IR's can be used concurrently. An OW occupies 17K bytes of memory.

The spooling file is a special sytem file which stores job description statements awaiting execution, data associated with those jobs, and output reports awaiting printing.

The dynamic main memory feature provides automatic memory management. GCOS maintains a map of the locations and sizes of all available memory areas. When a job requires additional memory space, the operating system searches the map for a suitable area and assigns the area to the requesting activity. If no single area is large enough to accommodate the request, GCOS dynamically reallocates memory areas to create one contiguous area large enough to accommodate the request.

GCOS 4 uses segment-relative addressing to optimize the use of main memory. All programs are executed as fully relocatable segments. Machine instructions refer to segment-relative addresses, without regard to the physical location of the referenced operand. A segment may reside anywhere in memory, and at different times may reside in different places.

With GCOS, the segments of a program are defined by the compilers and, optionally, under the control of the programmer. Segments are variable in length, permitting the segmentation to follow the logic of the program and ensuring that distinct elements, such as iterative loops, are not split between segments.

When a program is ready for execution, the Initiator routine first loads a portion of the memory image onto the system disk file and subsequently loads the core image into memory.

Job flow through the 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 jobs 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. 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, 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 16 extents on any one volume, and can spread the file over a number of volumes if required.

When a new file is created, file management automatically creates the appropriate 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 tail of each file. Disk files are shareable under GCOS 4. However, if file protection is required, multiple access can occur only in read mode.

The GCOS 4 data management facilities support five file organizations: sequential, indexed, relative, queued-partitioned, and queued-linked. The latter two organizations are used only by the GCOS operating system and are transparent to the users.

Sequential files are organized soley on the basis of their successive physical locations in the file. The records are also arranged in a logical sequence according to their keys as well as in physical sequence, and are usually read or updated in the same order they appear.

Indexed files are similar to sequential files in that rapid sequential processing is possible. The indexed organization makes it also possible to locate individual records quickly for direct (random) processing. Moreover, new records can be inserted by referring to sequentially ordered indexes associated with the file and physically added at the end of the file. This makes it unnecessary to rewrite the entire file, a process that would usually be requred when adding records to a sequential file. Although the added records are not physically in key sequence, the indexes make it possible to retrieve the added records in key sequence, permitting rapid sequential processing. The retrieval of records added to the file can be accomplished immediately and without any need to sort the index. Two types of records are available for indexed organization: primary records (P-records), which are logical records that have a key and associated disk address in the main index, and complementary records (C-records), which are logical records that do not have index entries in the main index. Each C-record is associated with a P-record via a pointer in the P-record. A C-record can in turn point to another C-record.

The indexed file organization permits up to eight secondary indexes to be created by a utility program that constructs index entries according to a key, other than the prime key, without distinguishing between P-records and C-records.

Relative files are characterized by a predictable relationship between the key of each record and the address of that record on a disk device. This relationship is established by the user. Relative file organization is used when the time required to locate individual records must be kept to an absolute minimum. This technique is useful for direct inquiry and transaction processing systems in which file size is relatively stable and the control field (key) can be easily used to develop a relative record number.

The GCOS fail-soft feature allows the operator to reconfigure at the Main Memory Unit Level in the event of a memory failure, or to bypass or make a substitution for certain malfunctioning processors and peripheral devices. If a memory module fails, only those jobs directly affected by the failure are aborted. The operator can allow unaffected jobs to run to completion and then reconfigure the Main Memory Unit, or all executing jobs can be suspended, memory reconfigured, and suspended jobs restarted.

INTERACTIVE PROCESSING SYSTEM (IPS): The Interactive Processing System provides comprehensive computing facilities to terminal users. User-written programs and system functions, interactive applications, and batch applications are all equally available to both local and remote terminals.

IPS comprises five sub-modules. The *Interactive System Management* (ISM) and the *Interactive Screen Formatting Service* (ISFS) are always available in an IPS environment. Facilities optionally available include *Interactive Job Management* (IJM), *Transaction Programming System* (TPS), and *Interactive File Service* (IFS).

INTERACTIVE SYSTEM MANAGEMENT (ISM): ISM facilities allow the system administrator to generate the required IPS environment, to maintain the environment and

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to ensure the efficient and satisfactory availability of IPS to its various users, to control the security aspects of IPS, including the creation and maintenance of each user menu, to control passwords to user and file names, and to create back-up copies of the IPS support file after a system failure (such as a power failure) and to restart the interrupted IPS session.

INTERACTIVE SCREEN FORMATTING SERVICE (ISFS): ISFS is used for interactive compilation of screen formats used in data entry and TPS applications.

INTERACTIVE JOB MANAGEMENT (IJM): IJM provides the terminal user with a set of interactive facilities that include text editing and the use of the system's batch processing capabilities. Data entry, verification, editing, display and remote printing are available for both unformatted and formatted subfiles stored within the IPS support file. Unformatted data subfiles contain data entered and edited as complete screens, using one or more screen formats prepared by means of the Interactive Screen Formatting Service (ISFS).

Job descriptions of any type of job can be prepared and submitted for execution under the Interactive Job Management facility. If a terminal user wants to know the status of his submitted jobs, the system will automatically provide this information at specified time intervals, and upon specific request. Reports in the spooling file can be inspected from a terminal and displayed on a screen or printed. Source programs in COBOL, RPG, and FORTRAN can be entered and edited. Programs can be compiled, linked, and tested; any of the standard DPS 4 system control utilities can be used.

TRANSACTION PROCESSING SYSTEM (TPS): TPS permits users to execute real-time functions through a network of terminals. These functions are user-defined interactive transactional programs (ITP's) and are developed using COBOL and an RPG-like language. TPS manages a set of predefined (active) ITP's each of which may access files that have been declared as belonging to the particular environment of the TPS activity.

Multiple ITP's can be initiated through a user terminal. When this condition occurs, the TPS controls and insures the integrity of each active program and its respective file updating requirements. TPS activities can be run concurrently with other batch or communications activities.

TPS currently supports only two terminal families: the VIP 7700 and the DTU7170. Any terminal can directly establish and maintain a dialogue with any other terminal.

INTERACTIVE FILE SERVICE (IFS): IFS allows the interactive creation and updating of indexed data files. It also provides a means of accessing indexed files for on-line inquiry and report generation applications. IFS processing is carried out by using record selection criteria based on the contents of the various types of records present in a file. Up to 32 record types, based on up to 60 code fields, are permitted. Up to five secondary indexes can be used to access records, in addition to the primary index. Both primary and complementary records can be accessed. Report creation can include simple arithmetic operations and the creation of decimal accumulator fields at several control-break levels. IFS sorts records dynamically prior to producing a report—simultaneously sorting records for two or more reports, if necessary.

LANGUAGES: Cii Honeywell Bull provides three popular programming languages for DPS 4 systems: COBOL, RPG, and FORTRAN.

DPS 4 COBOL (ANSI 74): This compiler succeeds CII-HB's COBOL-68 and conforms to American National Standard specification X3.23-1974, which includes several enhancements over the older version. The level of implementation of each of the functional processing modules is as follows:

Module	Level of Implementation
Nucleus	2
Table Handling	1
Sequential I/O	2*
Relative I/O	2*
Indexed I/O	2*
Sort	2
Segmentation	2
Inter-Program Communication	1
Debug	2
Library	1
Communications	2

*Not a complete implementation.

Three modules are incomplete implementations of the indicated levels. The Sequential I/O module omits variable-length and spanned record capabilities, and the indexed I/O module omits ALTERNATE KEY and variable-length record capabilities.

Cii Honeywell Bull, however, has implemented enhancements of its own design in certain modules. The Indexed I/O module has provisions for complementary records, and the Communications module has extensions that improve message processing. In addition, the Nucleus module contains enhancements to some basic functions.

Features not in COBOL-68 and added to the COBOL-74 compiler include: augmented debugging facilities that permit users to specify the debugging techniques in the program and later eliminate them from the final compilation; improved capabilities for terminal communications; the ability to call other programs, including those written in other languages; device independence for sequential files; enhanced text copying capabilities, expanded sequential file functions, and improved indexed I/O techniques that effectively enlarge mass storage capacity.

The compiler is disk-resident and accepts input from 80- or 96-column cards or from the source unit library disk. It produces object-code modules from disk work files that can be linked into executable load modules. Users can specify different equipment environments at compile time and at execution time. Compilation can be performed from mixed peripheral inputs or the source library, since all input is integrated into common disk work files.

Comprehensive diagnostic and debugging tools are included with DPS 4 COBOL. The diagnostic routines produce listings, data maps, card maps, and cross-reference listings. The debugging routines permit specification of data items and procedures to be monitored during program execution. All debugging statements can be automatically omitted from the compilation once the program is finished.

The DPS 4 COBOL compiler requires 40K bytes of main memory, one line printer, one sequential input device, and two mass storage units.

FORTRAN: DPS 4 FORTRAN is a version of ANSI FORTRAN IV with some extensions. The language processor consists of two packages, the FORTRAN compiler and the FORTRAN run-time package. DPS 4 FORTRAN requires the implementation of the scientific

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instruction set. The language processor executes either in a 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. The compiler produces two levels of diagnostic messages: syntax errors and fatal errors.

The DPS 4 GCOS FORTRAN compiler requires the following resources: 36K byes of memory, a disk workfile, and input/output and listing files.

RPG II: The RPG II compiler used in DPS 4 systems permits the interchange of data files among RPG, FORTRAN, and COBOL programs. Object programs written in RPG can also be linked with programs written in COBOL or FORTRAN.

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 indexed files, device independence of sequential files, dynamic table handling capabilities, and the use of standard data management access routines by object programs.

RPG II uses five files: two work files; a compile 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 II 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 already in the form required for calculations. Any number of output records can be produced by one cycle.

The DPS 4 RPG II compiler occupies 28K bytes of memory, and requires one mass storage unit, one line printer or report out file, and one sequential input device.

CONVERSION SOFTWARE

The TRANSIT software package is a complete conversion package, containing automatic translators for files and source programs written in COBOL, as well as a comprehensive manual detailing all the steps necessary for complete conversion to a DPS 4 system. The TRANSIT conversion packages allow data files and RPG source programs from IBM System/3, System 360/20, and System/32 to be transferred to a DPS 4. Source COBOL and MiniCOBOL programs can be transferred from Cii-HB's Series 200/2000, Level 61, or Level 62 systems to a DPS 4.

UTILITIES: DPS 4 GCOS provides three 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.

The Test Data Generator (TDG) generates data files for debugging user-written programs. TDG produces either indexed or sequential files. The sequential files can be written on disk, tape, or cards; indexed files are only written on disk. The format of the generated records is controlled by definitions submitted to the utility on control cards.

The DPS 4 GCOS Utility package consists of several multi-function utility programs for volume/file management and file/library maintenance. The functions performed by the DPS 4 GCOS utilities include:

- Prepare new disks for use in the system
- Allocate space for new user files and libraries
- De-allocate space for user files and libraries
- Compare any two volumes or files
- Duplicate volumes or files
- Handle all system and user output data via the Output Writer
- Read source decks
- Reproduce source programs
- Copy library members or entire libraries into other libraries
- Move source and object programs between files and libraries
- Merge source programs
- Create indexed files from other file types
- Delete library members
- Re-name source and object programs

APPLICATION PROGRAMS: Program packages available for DPS 4 systems include the CII-HB On-Line Manufacturing System (IMS-TD) which comprises three functionally independent modules offering inventory reporting, bill of materials processing, requirements management, material requirements planning, order releasing and simulation, standard cost control and simulation, production data management, work in progress monitoring, and capacity requirements planning.

Locally developed packages are available in individual countries. To obtain a list of all the packages available in your country, contact the local Cii Honeywell Bull office.

PRICING

POLICY: In common with legal requirements and business practices, the financial arrangements for acquiring DPS 4 differ from country to country. Precise terms must therefore be obtained from the local CII-HB office.

In general, however, hardware and software are priced separately. Hardware can be rented or leased as well as purchased. Software is rented on a monthly basis.

The hardware purchase price may include free maintenance for an initial period after installation with different periods for different categories of equipment.

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Hardware rental periods are usually up to two years; leasing is generally for five years. Non-standard periods are negotiable in each case. The hardware rental charge includes maintenance; the leasing charge does not—a separate maintenance contract involving an additional charge is obligatory.

Services such as training, program development, system/network design, implementation and conversion, are also charged separately.

TYPICAL CONFIGURATIONS: A minimum DPS 4 configuration comprises three processors, 512K bytes of memory, 160 megabytes of disk storage, one video console, two workstations, and one 600-line-per-minute printer and can be purchased for 559,159 French francs.

A medium configuration, comprising four processors, 768K bytes of memory, 900 megabytes of disk storage, one video console, 10 workstations, three remote printers, and one 600-line-per-minute printer can be purchased for 1,229,720 French francs.■