

Honeywell Series 60 Level 64

MANAGEMENT SUMMARY

Although the Honeywell Series 60 Level 64 has been an active product since April 1974, the present product line represents a new "generation" of systems. While the products are essentially built on a single processor, internal modifications and extensions actually divide the Level 64 into two sub-lines. The first sub-line consists of the Full Range Level 64 systems, while the second sub-line consists of the Distributed Processing Systems (DPS). The Full Range processors are no longer marketed. However, all options and features are offered for those who wish to upgrade their present systems.

When the Full Range Level 64 was announced in February 1978, it represented a new way for the medium scale systems to be marketed. Under this marketing scheme, the Level 64 equipment was offered as one highly modular system in place of the series of five submodels that previously made up the product line.

The Full Range policy also marked a new marketing thrust. Previously, Honeywell offered the Full Range Level 64 primarily as an upgrade system to convert its large base of Series 200/2000 computer users to newer hardware. A substantial percentage of the installed Level 64 systems were emulating Honeywell 200/2000 systems, despite the fact that greater performance could be obtained by operating under Level 64 GCOS in native mode. With the conversion of a majority of its Series 200/2000 sites to Full Range Level 64 hardware, Honeywell sought new accounts and increased the configuration latitude of the Level 64 to well beyond the five previous submodel packages that were designed to replace specific 200/2000 configurations. ➤

The Honeywell Level 64 is a medium scale computer system offered in two distributed processing (DPS) versions, the DPS-320 and the DPS-350. Made in France by CII-Honeywell Bull, the Level 64 features up to two megabytes of main memory, performance enhancement features, and execution of up to 31 concurrent jobs under Release 400 of the GCOS operating system.

CHARACTERISTICS

MANUFACTURER: Honeywell Information Systems, Inc., 200 Smith Street, Waltham, Massachusetts 02154. Telephone (617) 890-8400.

MODELS: DPS-320 with three performance levels; and DPS-350 with two performance levels. The Full Range processors are no longer available. All options and upgrades to these processors are still being offered.

DATE ANNOUNCED: Series 60, Level 64 Full Range System, February 1978; DPS-320 and DPS-350, March 1979. The Level 64 was originally announced in April 1974.

DATE OF FIRST DELIVERY: Series 60 Level 64 Full Range System with five performance levels, late 1978; DPS-320 and DPS-350, late 1979. (First delivery of older Level 64 models was January 1975.)

NUMBER INSTALLED TO DATE: 270 (USA); 610 (outside USA).

DATA FORMATS

BASIC UNIT: 8-bit byte plus one parity bit. The data paths are four bytes (32 bits) wide. ➤



The Level 64 configuration shown is typical and consists of a DPS-320 processor with 640K bytes of main memory, 300 megabytes of disk storage, 1600 lpm line printer, console display screen and 30 cps console printer with keyboard, 500 cpm card reader, and three 120KBS MTU0410 Magnetic Tape Drives.

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CHARACTERISTICS OF THE LEVEL 64 SYSTEMS

	Level 64 DPS-320			Level 64 DPS-350	
CENTRAL PROCESSOR					
Performance extension level	1	2	3	1	2
Percent increase over base	—	39	72	—	25
KOPS (K operations/sec.)	NA	NA	NA	NA	NA
Cycle time	500	500	430	430	340
MAIN STORAGE					
Type	LSI MOS	LSI MOS	LSI MOS	LSI MOS	LSI MOS
Read cycle time, nanoseconds	1000	1000	860	860	680
Write cycle time, nanoseconds	1000	1000	980	980	880
Minimum capacity, bytes	512K	512K	512K	512K	512K
Maximum capacity, megabytes	1	1	1	2	2
Bytes fetched per cycle	4	4	4	4	4
CONTROL MEMORY					
Type	Bipolar	Bipolar	Bipolar	Bipolar	Bipolar
Access time, nanoseconds	175	175	155	155	140
Capacity, bytes	40K-64K	40K-64K	40K-64K	40K-64K	40K-64K
Bytes fetched per cycle	4	4	4	4	4
CONFIGURATION					
Mass storage processors (max.)	1	2	2	2	3
Disk drives (max.)	8	16	16	16	24
Magnetic tape processors (max.)	1	1	2	2	2
Magnetic tape drives (max.)	8	8	16	16	16
Unit record processors (max.)	1	2	2	2	2
Unit record devices (max.)	5 (2 printers)	8 (3 printers)	8 (4 printers)	8 (4 printers)	8 (4 printers)
Communications controllers (max.)	1	2	2	2	3
Communications lines (max.)	14	28	28	28	42

► The basic Level 64 DPS system includes 64K bytes of memory, one integrated mass storage processor, one integrated unit record processor, a console, and the addressing capability for up to 128K bytes of memory.

Both of the new Level 64 DPS computers have a basic main memory capacity of 512K bytes. The memory is expandable to a maximum of one million bytes in the DPS-320 and two million bytes in the DPS-350. First customer shipments of the DPS-320 and DPS-350 are scheduled for the second and third quarters of 1979, respectively.

Peripherals for the Level 64 Systems include 29-, 70-, 100-, and 200-megabyte disk drives; 7- and 9-track, 37.5-, 75-, and 125-ips, 200-, 556-, 800-, and 1600-bpi magnetic tape drives; 450-, 600-, 650-, 800-, 850-, 1100-, 1200-, and 1600-lpm printers; 300-, 500-, and 1050-cpm card readers; 100-cpm card punch; and communications controllers for up to 14 lines each.

LEVEL 64 SOFTWARE

Software support for the Level 64 systems is based on GCOS Level 64, a disk-based multi-tasking operation system for business-oriented data processing. The original GCOS Level 64 Release 100 was released in Europe in late 1975 by CII, and was intended for emulation of the EDOS operating system used in GE 100 Series ►

► errors are detected and flagged for subsequent error-recovery routines. A parity bit is also appended on all I/O data with continual error testing on I/O control units.

STORAGE PROTECTION: A 4-level ring protection is implemented in system firmware with supporting hardware registers. Data and instruction coding are compiled in two separate segments. Each user program segment has an associated segment descriptor that is stored in tables in main memory. Within each segment descriptor are two 2-bit fields that specify the security level required by a user program to execute or write to a particular segment. Hardware also checks that data addresses generated during program execution do not exceed specified boundaries.

The segment descriptors also contain two bits that override the ring protection scheme by denying execution or write access to a user program.

RESERVED STORAGE: First 16K bytes of memory are reserved for tables and microcode.

CENTRAL PROCESSORS

The Level 64 is a microprogrammed processor composed of two major subsystems, CPU and I/O. The Level 64 CPU is organized into eight functional units; the scratchpad memory, the address control unit, and data management unit, the channel control unit, the panel management unit, the arithmetic and logic unit, the timer unit, and the control store controller. The scratchpad unit contains the register set and working space for microinstruction execution. The address control unit contains the associative (cache) memory and address mapping logic. It generates all effective addresses by combining segment addresses with the relative addresses contained in each instruction. The data ►

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➤ that provide troubleshooting information. Parity is checked on every access to storage, whether mass storage or control storage. Further, parity is checked whenever data is transferred between any two system functional units. Main memory is error-correcting and detecting (EDAC) memory that appends a 6-bit error-correcting code to each 4-byte word. This code permits automatic correction of single-bit errors and flags multiple-bit errors after retrying the access. Main memory can be automatically reconfigured if a permanent error is diagnosed. Blocks of 32K bytes can be bypassed without re-initializing the systems. The Level 64 CPU's also have redundant arithmetic and logic units that duplicate each operation and compare the results.

Internal Diagnostics are performed by two units within the Level 64 systems. The central processor contains microprograms implemented in firmware that checks out individual elements at initialization. The peripheral processors each have similar circuitry for performing selftests.

The Level 64 unit record processor also functions as a system diagnostic processor. If a failure is detected in either the central processor or a peripheral subsystem, diagnostic routines are loaded into the unit record processor read/write memory, enabling it to perform system tests and report results on the system console and remotely through RMS/64.

COMPETITIVE POSITION

The Level 64 DPS-320 is rated about equal to the IBM 4331 in price and performance while the Level 64 DPS-350 reportedly has over 70 percent more internal performance capability than the 4331 at a somewhat higher price. In comparison to Honeywell's existing Level 64 full-range system, a basic DPS-320 has about 50 percent greater internal performance and 5 times the main memory capacity, while its price is about 12 percent lower on a 5-year lease and about 30 percent lower on purchase. The basic DPS-350 offers about 2.6 times the internal performance and 5 times the main memory capacity of the current Level 64 processor, while its price is about 60 percent higher on a 5-year lease and 34 percent higher on purchase.

In addition to the IBM 4331, the DPS series complete with the Univac 90/80, Burroughs B 1855, and at times the DEC VAX 11780 and HP 3000 super minicomputers.

The Full Range models of the Level 64 line offered performance characteristics that compared favorably with the smaller models of the IBM System/370 family (370/115 through 370/148); the Univac 90/30 and 90/60 systems; various models of the Burroughs B 1800, B 2800, and B 3800 systems; and the NCR 8400/8500 family of systems.

CONTRACTS

Honeywell's multiterm contract permits a system with different component lease terms to be covered by one ➤

➤ The keyboard is solid state and includes upper and lower case alphabetic characters, digits, 32 special graphics, and control keys for the printer and console display. The console printer has 80 positions per line and 6 lines per inch. It can produce an original and up to five copies. The CRT console display has a 12 inch diagonal screen, producing 24 lines of 64 characters each. The operator control panel includes power switches, check indicator, and basic operator/system controls.

COMPATIBILITY FEATURES: The Level 64 processors are equipped with a standard compatibility feature that enables them to execute programs written for Honeywell Series 200/2000 Mod 1 or Series 100 systems.

The capabilities of the Series 200/2000 Program Mode are implemented by hardware/firmware housed in the read-only storage of the central processor and by compatibility routines that reside in system memory. The firmware routines execute Series 200/2000 instructions. Machine instructions, such as input/output operations that cannot be directly executed are passed to the compatibility software routines for interpretation and execution. In simulating Series 200/2000 memory, each Level 64 8-bit byte is formatted as the six data bits and two punctuation bits of a series 200/2000 character position.

Series 200/2000 punched card files and 1/2-inch magnetic tape files, except those recorded at 1200 bits per inch, can be processed in a Level 64 environment without modification. The contents of Series 200/2000 mass storage volumes must be transferred to mass storage volumes compatible with the MSU0310 or MSU0400 Mass Storage Units used with compatibility mode, but the logical file structures of Series 200/2000 files need not be modified.

Series 200/2000 Program Mode operation requires a minimum configuration consisting of Level 64 central processors with the Program Mode feature, an integrated mass storage processor equipped with the series 200/2000 Mode feature and addressing for four mass storage devices, an integrated unit record processor, card reader, printer, and console.

The Series 100 Program Mode is also implemented by a combination of microprogramming in the Level 64 read-only storage and emulation routines in system memory, supplemented by mass storage and optional magnetic tape subsystem compatibility features to allow processing of Series 100 data files.

CONTROL STORAGE: Consists of both bipolar read-only memory (ROM) and firmware routines located in main memory. Routines from either source are executed by the CPU. Read-only memory access time on the Full Range Level 64 is 175 to 145 nanoseconds; on the DPS-320, 175 or 155 nanoseconds; and on the DPS-350 155 or 140 nanoseconds depending on performance enhancement level.

REGISTERS: The Level 64 CPU has 29 registers that are visible only to the operating software. These include 16 32-bit general-purpose registers, 8 32-bit base address registers, 1 32-bit instruction counter, 1 8-bit status register, 1 32-bit stack register, and 1 28-bit base address register, and 1 8-bit hardware control mask register. Eight of the 16 general-purpose registers can be used for address indexing. The Scientific Instruction Set, optional on all Level 64 systems, adds 4 64-bit scratchpad registers to each CPU.

INSTRUCTION REPERTOIRE: The Level 64 CPU's have instruction sets that include arithmetic instruction 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. Operations can be binary, fixed point, or ➤

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➤ support in local Honeywell offices. One user summed it up when he said "We are well satisfied with the system performance, but are not impressed with support." Both users who rated Overall satisfaction as fair indicated that they did so because of dissatisfaction with service.

As is well known to readers of Datapro 70, Honeywell is not alone in the service problem. Honeywell is however, attempting to do something about it. Remote Maintenance System/64 will provide the users with easier access to well qualified engineering staff. Whether this can be translated into positive action within the DP shop remains to be seen.

The users we talked to also identified two projects they want Honeywell to pursue: 1) a well designed screen formatting aid, and 2) further development and extension of Level 64 COBOL. □

➤ and IURP, two MSU0350 Disk Drives with addressing, a PRU0457 Printer with addressing and a console unit with keyboard. The CPS4901 is the same as the CPS4900 except that the MSU0350 and PRU0457 are deleted. Memory expansion on the CPS4900 and CPS4901 is in 64K byte increments up to 512K bytes and in 128K byte or 256K byte increments from 512K bytes to 768K bytes. An additional memory addressing feature is required for each memory increment.

The Level 64 DPS Series consists of two processor models, the DPS-320 and the DPS-350. The basic CPS4924 package includes the DPS-320 processor, 512K bytes of main memory, IMSP, IURP, two I/O channels for IMSP and IURP, a 14 line integrated communications controller and console unit with keyboard and 30-cps printer. The basic CPS4953 package includes the DPS-350 processor and the other items mentioned under the DPS-320. Memory expansion is up to one megabyte for the DPS-320 and up to two megabytes for the DPS-350. Increment size is 256K bytes, with each increment requiring an additional memory addressing feature.

Performance extension levels are covered in the table on pages 70C-480-14B and 70C-480-14c, and in the Central Processor section of this report. Mass storage, unit record, magnetic tape, and communication line maximums are also covered in the table.

Mass storage configuration rules include: each two additional disk drives require a separate addressing feature; the minimum initial disk drive complement is two units; the third mass storage processor (MSP4902) is mutually exclusive with the third data communications controller (DCC4903); only 2 to 8 disk drives may be crossbarred for dual access; MSU0400 is available as an add-on disk only; and mixing of disk units of different types is not recommended although it is allowed.

Printer configuration rules include: two printers may be attached to the IURP except on the CPS4900 where only one is allowed; printers three and four must be attached to the second unit record processor (URP), URP4901; communications is restricted to one type of protocol when both a drum and a belt printer are selected on a single URP; a Level 64 system must have at least one printer; and each printer requires its own addressing feature.

Punched card equipment configuration rules include: one card reader is required on a Level 64 System; maximum

configurations include two readers and one punch, one reader and one reader/punch, or one reader or reader/punch on CPS4900; and each punched card unit requires its own addressing feature.

Magnetic tape unit (MTU) configuration rules include: MTU0210/0211 drives are configured in clusters of from one to four drives where each MTU0210 can have up to three MTU0211 drives attached; MTU0410 and MTU0500 drives can be mixed on the same magnetic tape processor (MTP); only MTU0410 and MTU0500 can be configured for dual access; track and density options may be mixed on the same MTP; MTU0500 is not allowed on the CPS4900; every four MTU's require an additional addressing feature; up to eight MTU's may be configured per MTP; MTU0210/0211 drives may not be configured for dual access; dual access is not available on CPS4900; the MTP option of IBM/BCD 7 track EBCDIC is required for all 7-track MTU's; the MTP option of NRZI recording mode is required for all 9-track, 800 bpi MTU's and all 7-track options; each MTP in a dual access configuration must have the same options attached; and dual access MTP4910 and MTP4911 require two I/O channels.

Peripheral channel rules include: the MSP4901, MSP4902, URP4901, MTP4901 and MIP4911 all require the I/O expansion unit to be installed; the I/O expansion unit cannot be installed on the CPS4900 or CPS4901 below processor expansion level 2; each additional two channels require their own addressing feature; the specific performance expansion level of CPS4900/CPS4901 dictates which channel qualifier must be installed; and a channel qualifier is required only if three or more channels are configured per system.

MASS STORAGE

MSU0310 MASS STORAGE UNIT: Designed to provide medium-capacity random-access storage in Level 64 systems. Storage capacities for the MSU0310 units vary depending on the formatting conventions of the system in which they are used; capacity is 29.2 million bytes per spindle for Level 64 systems. Each storage unit uses one Honeywell Type M4180 disk pack (or equivalent), whose 11 disks have 20 recording surfaces with 203 tracks per recording surface. Data transfer rates, like storage capacity, depend on the system; for Levels 62 and 64, the rate is 312,500 bytes per second.

Average seek time is 38 milliseconds (minimum seek time is 10 milliseconds and maximum is 62 milliseconds), and average rotational delay is 12.5 milliseconds. While data transfer is taking place on one unit, simultaneous seek operations can be performed on all the other drives attached to a mass storage processor. Data protection is ensured by a validity check code in each record/sector, and write protection is standard to prevent inadvertent writing on specified disk packs. The MSU0310 is manufactured by Magnetic Peripherals Incorporated.

MSU0350 MASS STORAGE UNIT: Provides 70 million bytes (93.1 million characters) of unformatted storage. Through a retrofit kit, the capacity of this drive can be expanded to 100 million bytes (133 million characters). The MSU0350 utilizes a Honeywell M4050 disk pack or equivalent. The M4050 has 19 recording surfaces on 12 platters with 288 tracks (including spares) per surface (411 tracks including spares with retrofit kit). Track-to-track, average, and across-all-tracks head positioning times are 5, 23, and 43 milliseconds, respectively. Average rotational delay is 8.3 milliseconds at the standard 3600 rpm rotational speed. The data transfer rate is 806,000 bytes per second. Dual access capability is available as an option.

While data transfer is taking place on one MSU0350 unit, simultaneous seek operations can be performed on the other

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200/556/800 bpi, 11,250/31,275/45,000 bytes/sec. Rewind speed for the MTU0410 is 450 inches per second. Read-after-write electronics is standard. Dual-access subsystems require an additional integrated channel and can include a maximum of eight drives. Drives with different configurations can be intermixed on the same magnetic tape processor, and the 120KBS MTU0410 drives can be intermixed with 200 KBS MTU0500 drives.

MTU0500 MAGNETIC TAPE UNITS: These are stand-alone 125-ips tape drives for Level 64 systems. They can be used in dual-access applications. The MTU0500 drives are available in four configurations: 9-track, 800/1600 bpi, 100,000/200,000 bytes/sec.; 9-track, 1600 bpi, 200,000 bytes/sec.; 7-track, 556/800 bpi, 52,125/75,000 bytes/sec.; or 7-track, 200/556/800 bpi, 18,750/52,125/75,000 bytes/sec. Rewind speed for the MTU0500 is 500 inches per second. Read-after-write electronics is standard. Dual-access subsystems require an additional integrated channel and can include a maximum of eight drives. Drives with different configurations can be intermixed on the same magnetic tape processor, and the 200KBS MTU0500 drives can be intermixed with 120KBS MTU0410 drives.

UNIT RECORD PROCESSOR (IURP): One integrated, six port unit record processor (IURP) is provided with each Level 64 system. Performance level 2 of the Full Range Level 64 and DPS 320 allows for the attachment of the optional URP4901. The URP4901 provides three additional ports for the CPU. The URP's provide control for card equipment, the system console, and communications controllers.

PRU0457/0657/0857/1107 DRUM PRINTERS: Operate via a 63-character print drum. Rated print speeds are 450 lpm based on 53 contiguous characters, 650 lpm based on 48 contiguous characters, 850 lpm based on 45 contiguous characters, and 1100 lpm based on 39 contiguous characters for the four printers, respectively. The 63-character set contains 10 numeric, 26 alphabetic, and 27 special symbol characters. A manual switch on the PRU0857 and PRU1107 reduces drum speed by approximately 33 percent, providing a better print quality. The PRU0457 can be field upgraded to the PRU0657/0857/1107; the PRU0657 to the PRU0857/1107; and the PRU0857 to the PRU1107.

These printers contain 132 print positions per line. Character spacing is a standard 10 characters per inch. Line spacing is operator selectable at 6 or 8 lines per inch. The PRU0457/0657/0857/1107 are capable of printing one original and up to six carbon copies. Paper width pin to pin is 5.75 to 17.78 inches. Vertical formatting is specified by printer firmware.

PRU0485/0658/0858/1108 DRUM PRINTERS: These are the same as the PRU0457/0657/0857/1107 printers but interface to the Level 64/DPS-320 and DPS-350.

PRU0640/0840 BELT PRINTERS: Rated at 600 lpm, using a 48-character print belt. Available belts include 64-character OCR-B font (Series 200/2000), 63-character OCR-B font (Series 100/400/600/6000), 63-character IBM EBCDIC, 63-character ASCII, 63-character OCR-A numeric, 63-character OCR-A alphanumeric, and 94-character ASCII OCR-B upper/lower case. These printers have 120 print positions per line, optionally expandable to 136. Character spacing is a standard 10 characters per inch. Line spacing is operator selectable at 6 or 8 lines per inch. Programmed operations for the PRU0640/0840 include print and space, space only, skip, and vertical line spacing. Paper slew rate is 25 inches per second after three lines. Paper width, pin to pin, is 4 to 22 inches. One original and five carbon copies can be produced. Vertical formatting is user specified under system control.

PRU1200 BELT PRINTER: Prints 1200 lpm, using a print belt/cartridge with a special 48-character set, and has a burst

speed of 2300 lpm with a limited character set. Printers equipped with this limited set cannot be used as the system printer because they cannot correctly print out the results of system diagnostic routines. Other character sets are optional, including sets with 63, 64, and 96 characters. The standard data format is 136 print positions per line (160 print positions optional), spaced 10 characters per inch, with 6 or 8 lines per inch vertical spacing. The PRU1200 prints on single-part or multipart forms (one original and up to five carbon copies).

The print belt is packaged in a lightweight cartridge designed to facilitate removal, interchange, and storage. Each character on the print belt is mounted on a flexible "finger." During printing, the belt passes continually in front of the print hammers. When the character is struck, the flexibility of the finger causes the character to be immobilized at the moment of impact, reducing ribbon drag and improving print quality. The printer is equipped with an Automatic Standby feature that deactivates the operating mechanism of the printer when it is not being used. Programmed printer operations include recognition of belt type (48-, 63-, 64-, or 96-character set) from a code on the cartridge, print and space, space only, skip vertical line spacing, and error status reporting. The PRU1200 belt printer is field upgradable to the PRU1600 printer.

PRU1600 BELT PRINTER: Prints 1600 lpm, using a print belt-cartridge with a 48-character set, and has a burst speed of 2300 lpm with a limited character set. Printers equipped with this limited set cannot be used as the system printer because they cannot correctly print out the results of system diagnostic routines. Optional character sets include sets with 63, 64, and 96 characters. The standard data format is 136 print positions per line (160 print positions optional), spaced 10 characters per inch, with 6 or 8 lines per inch vertical spacing. The PRU1600 prints on single-part or multi-part forms (one original and up to five carbon copies). Characters are produced by hammer strokes against flexible belt "fingers," each representing one character. The flexibility of the finger causes the character to be immobilized on impact, reducing ribbon drag and improving print quality. The printer includes an Automatic Standby feature that deactivates the operating mechanism when it is not being used. Programmed printer operations include recognition of belt type (48-, 63-, 64-, or 96-character set) from a code on the cartridge, print and space, space only, skip, vertical line spacing, and error status reporting.

CRU0301/0501 CARD READERS: These units read 80-column cards at 300 cpm (CRU0301) or 500 cpm (CRU0501). Both units feature 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. The results of each read are then compared for accuracy. Both the input hopper and output stacker have a capacity of 1000 cards. Warning lights and console messages report a read error, card jam, misfeed, empty hopper, and full stacker.

CRU1050 CARD READER: Reads 80-column or (optionally) 51-column punched cards serially by column at a 1050-cpm rate. Reading is accomplished by a photoelectric technique. The reader has a 3000-card input hopper and a 2500-card output stacker. An optional mark-sense facility for either Honeywell or IBM code is available.

PCU0120 CARD PUNCH: Punches 80-column cards in Hollerith or binary code at a speed of 100 to 400 cpm depending upon the number of columns punched in each card. Both the input hopper and the output stacker have a 1600-card capacity.

CCU0400 COMBINATION CARD READER AND PUNCH: This unit reads 80-column cards serially at 600 cpm and punches 80-column cards serially at 100 to 400

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Each communications line requires a line attachment option which indicates the type (asynchronous or synchronous) and speed of the line. Three terminal support types are provided by Honeywell. Type 1 supports Model 33, 35, 37, and 38 teleprinters; GE Terminus 300 and 1200 VIP7100; and VIP7105. Type 2 supports VIP7700R and VIP7705R while type 3 supports BSC procedure without transparency mode and type 4 BSC procedure with transparency mode.

SOFTWARE

GCOS: All Series 60 systems run under either a subset or the full implementation of the General Comprehensive Operating System (GCOS).

LEVEL 64 GCOS: The most recently released version of Level 64 GCOS is Release 400, which features enhanced multiprogramming capabilities, extension of the universal file access system (UFAS), improved program development capabilities, and enhanced communications capabilities.

Up to 31 concurrent jobs can run under Release 400 compared to 8 under previous releases of the operating system. To implement the maximum number of concurrent jobs, however, the processor must have the maximum memory of 768K bytes and the jobs must be small if substantial degradation is not to occur. In conjunction with multiple concurrent jobs, Release 400 provides CPU dispatching automatic control (DCAC). DCAC allows the user up to three options to control the performance level of a given job or set of jobs so that throughput may be better balanced.

Level 64 GCOS is a disk-based operating system based on multiprogramming and automatic memory management. It is designed to provide compatibility with Honeywell Series 200/2000 Mod 1 MSR and Mod 1 TR operating system and also the OS/2000 operating system.

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

GCOS Level 64, like GCOS Level 62, uses segment-relative addressing to optimize the use of main memory. All programs in a Level 64 system are executed as fully relocatable segments. Level 64 machine instructions refer to segment-relative addresses, without regard to the physical location of the referenced operands. 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 segmentation to follow the logic of the program and ensuring that distinct elements, such as interactive loops, are not split between segments.

When a program is executed, it is first loaded into backing store on disk. GCOS automatically handles the allocation of main memory to the segments as they are referenced. Whenever a new segment is needed, GCOS searches main memory for a large enough space to load the segment. If there is no space large enough, GCOS relocates the segments already in memory to collect all available space into one continuous area. As a last resort, GCOS may remove the least active segment in main memory to make room for a new segment. The removed segment is only written back to the backing store if it has been changed while in memory. Instruction coding is re-entrant and is never modified.

Therefore, these segments never have to be rewritten and can be overlaid. Swapping and moving of the segments is invisible to the programmer, who has apparent access to a memory capacity equal to the size of the backing store.

GCOS Level 64 protects each segment by an automatic system of rings and protection levels. This protection system is implemented in the hardware/firmware of the Level 64 systems, so it applies equally to GCOS software and to the user's own programs.

Level 64 integrity features include error logging, file security, and recovery routines. Whenever the firmware of the Level 64 system discovers an error, it notifies the appropriate routine. This notification takes place whether the firmware recovered the error or not, so that GCOS is always aware of the state of the system. The routines diagnose the error and update an error accounting area in memory. Error accounting information is used to keep track of the state of all system components and to update a permanent accounting file. This permanent file eases routine maintenance of the system; extensive error accounting information allows failing components to be identified and replaced before they cause problems.

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

GCOS includes a journal function to speed file recovery. The journal is used to save all the updates to a file since the last security copy was taken. The journal, together with the catalog and the restore utility, provide all the information needed to rebuild a damaged file to its correct state.

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

Job flow through the Level 64 systems is controlled by GCOS job management. The input reader reads the job input while other jobs are executing and translates the job control information into an internal format to speed job processing. A job scheduler schedules the execution of the job using a system of job classes and priorities within each class. Resources are allocated at file, volume, and device levels to each job step, and deallocated when each job step is completed. Job accounting information is collected at all stages of the job's passage through the system. Job accounting information, along with the results of the job, are provided by the output writer, asynchronously with job execution.

The file management routines of GCOS handle allocation and deallocation of space for files, automatic label checking, automatic volume recognition, control of multiple concurrent accesses to files, 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, and space for temporary files is normally released as soon as the job step has completed.

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programs to interface with it as though they were terminals. This facility is particularly useful in debugging the transaction system without incurring real-time constraints. TDS/64 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/64 are journalized to guard against information loss.

The *Level 64 Remote Batch Facility (RBF)* enables remote job entry from a Level 6 card reader, cassette, or disk file to a Level 64 and output return to a Level 6 printer or disk file for later printing. RBF consists of RPF/6, which runs under Level 64 GCOS, and RBF/64, which runs on the Level 6 under control of GCOS 6 Mod 400. RBF operates under synchronous transmission using two or four wire connection in half duplex mode up to 9600 bps. The Level 64 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 Transmission Facility (FTF)* enables exchange of Level 64 and Level 6 sequential disk files. FTF provides data compression during transmission, verification of transfer unit sequence number to ensure that units of file transfer are not lost or duplicated, and a file identification security feature. Up to five transmissions may be handled simultaneously by one copy of the Level 64 utility program. Any number of users in groups of five may be connected serially. FTF operates under synchronous transmission with two-way alternative transmission on half/full duplex lines at up to 9600 bps. Support of multipoint and dedicated, switched, or direct connections is provided.

The *Data Entry Facility/Interactive Entry Facility (DEF/IEF)* provide a Level 64 host in a distributed systems environment with a clustered, interactive, programmable terminal capability. In this case, IEF is configured as an extension of DEF. DEF/IEF operate under Level 6 GCOS Mod 400 and provide up to 14 VIP7200 Operator Display Stations emulating VIP7700s. The facilities provided for the VIP7200's are enhanced but similar to those of a clustered VIP7700 system. Data entry is interactive with Level 64 applications. Each operator display station has independent access to all Level 64 interactive systems, including TDS and IOF. DEF software can validate and preprocess data as it is entered from the VIP7200 before it is transmitted to the Level 64. IEF uses the Polled VIP Emulator to communicate with a Level 64 utilizing synchronous VIP 7700 line protocol.

Data Base Management Software

Honeywell offers a number of software packages in this category, including Data Management IV, Integrated Data Store II, and Query Driven System.

Data Management IV (DM-IV) is a fully operational on-line, integrated data management system. Data Extraction and updating from data bases with various file organizations and data structures can be directly performed by non-data processing professionals.

DM-IV is CODASYL-oriented and includes common data definition languages for describing schema and subschema views of integrated and/or indexed data files. The system offers several end-user services including the capability to satisfy unanticipated information requirements.

The new DM-IV module enhances the Level 64 systems communications capabilities by combining the strengths of the TDS/64 Transaction-Drive System and the I-D-S-II data base management system. DM-IV offers transaction processing users protected concurrent access to the data base and UFAS files. DM-IV provides for the consolidation and simplification of multiple and repetitive tasks such as

organizing file systems and communications programs. The module also provides for the building of a multi-faceted environment within a single system. A Level 64 system with the DM-IV module in GCOS/64 can support a communications network of 42 lines with up to 32 terminals per line. The network can include switched and private lines as well as a mixture of terminal types. For more information on DM-IV, see Report 70E-480-01.

Integrated Data Store (I-D-S/II) is an enhanced version of I-D-S, a data base management system originally developed by GE. I-D-S/II was released in November 1975, and marks the beginning of an evolution of I-D-S toward conformance with the recommendations of the CODASYL Data Base Task Group. I-D-S/II is fully integrated with Honeywell's COBOL-74 compiler, and user interfaces are also implemented for FORTRAN. I-D-S/II is described in detail in Report 70E-480-01.

The *Query Driven System (QDS)* is a terminal oriented file inquiry update and report writing system for the Level 64. QDS contains the interactive, report, and assistance modes of use. The interactive mode is a prompted message command/response mode for terminal-based file search and updating. The report mode provides a capability for file processing and report generation by means of terminal-built queries using a procedural language. The assistance mode is the sign-on mode and is used for building queries that are later executed under the report mode.

QDS supports Level 64 GCOS BFAS indexed sequential and sequential file organizations and UFAS indexed and sequential organizations.

Program Preparation Facilities

In addition to the high level languages (see separate listing below) Level 64 systems under GCOS provide a static linker, an interactive text editing and operation facility (IOF), and program libraries. The static linker combines the output from language processor runs and program libraries to form an executable version of the program called a load module. The processor runs may be from the same or different language compilers.

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

GCOS Level 64 supports three types of program libraries along with maintenance routines for the libraries. Library types include source, compile unit (output from compilers), and load module.

Programming Languages

Honeywell provides COBOL, RPG, FORTRAN, and BASIC for the Level 64. In each case except BASIC, the Level 64 version is an upward-compatible super-set of the Level 62 version.

Level 64 COBOL, a superset of Level 62 COBOL, is based on ANSI specification X3.23-1974, but adds report writer, automatic segmentation, and data communications enhancements, including an optional COBOL Data Communications Extension program module.

The Level 64 COBOL language processor automatically segments the object programs it produces. Users classify

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mode requires the Interactive Operating Facility (IOF). BASIC as implemented in the Level 64 provides 38 standard mathematical functions and these facilities: GO SUB, used to branch to a subprogram within 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. Level 64 BASIC requires the FORTRAN math library.

Conversion Aids

Level 64 GCOS includes an extensive set of programs and file conversion routines, including the following program translators and file translators for older Honeywell equipment; Series 100 COBOL, Series 200 Mod 1 COBOL D and H, Series 200 Mod 1 (MSR) COBOL, Series 200 Mod 1 COBOL F and I, OS/2000 COBOL, Series 100 files and Series 2000 files.

In addition Honeywell offers a System 360/370 to Level 64 COBOL conversion aid (COBTRANS) and a System/3 to Level 64 RPG conversion aid (RPGTRANS). COBTRANS supports input from IBM System 360/370 COBOL D, COBOL E, COBOL F, and COBOL ANSV. Two utilities are available for conversion of System/3 files to the level 64. PKTRANS supports backup tape images of disk models 3340 and 5444. FILTRANS handles all other file conversions from a System/3 to a Level 64.

Remote Maintenance System/64

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/64 provides the ability to troubleshoot hardware and firmware problems as well as software bugs. With this facility, key diagnostic programs that operate under Level 64 GCOS can be remotely executed and patching of many software difficulties can be accomplished without an on-site visit. Remote Maintenance System/64 operates only when the system is in maintenance mode and provides documentation of all communications via the system console.

Applications Software

Honeywell provides a limited number of packages for the Level 64. These include native mode and Series 200/2000 program mode applications. A complete listing of these products can be found in the Equipment Prices section of this report. On-line version of application packages interface to TES.

PRICING

EQUIPMENT: The following systems are representative of the wide range of Series 60 Level 64 configurations. The quoted rental prices are for the basic one year lease and include equipment maintenance.

BASIC LEVEL 64 DISTRIBUTED PROCESSING SYSTEM: Includes DPS-320 CPU with 512K bytes of main memory, addressing for 512K bytes of main memory, integrated mass storage processor, integrated unit record processor, integrated communications controller, integrated console control, console, 30-cps console printer, support for three communications lines, 300-cpm card reader, and three 60 KBS 9 track, 800/1600 bpi, NRZI magnetic tape units and 650-lpm printer. Purchase price is \$125,454 and monthly maintenance is \$1,286. The system can be leased for five years at \$5,192 per month.

ADVANCED LEVEL 64 DISTRIBUTED PROCESSING SYSTEM: Includes DPS-350 CPU with 512K bytes of main memory, addressing for 512K bytes of main memory, integrated mass storage processor, integrated unit record processor, integrated communications controller, integrated console control, console, console printer, 800 megabytes of disk storage (four drives), 1200-lpm line printer, four communications lines, 500-cpm card reader, and five 200-KBS magnetic tape units. Purchase price is \$368,902 and monthly maintenance is \$2,003. The system can be leased for five years at \$9,153 per month.

SUPPORT: Honeywell offers six categories of support products for the Level 64 systems. These products include data services, system engineering, software, education, publications, and supplies.

Data services consists of machine time for predelivery production and checkout, and for overload/peakload situations. Processor time on a 66/40 or 60/60 with 256K of memory is priced at \$93.00 per hour. Charges for on-line peripherals vary from \$2.70 and \$18.50 per hour; for off-line peripherals, \$9.25 to \$24.70 per hour.

System engineering falls into one of eight billable support categories, as described in the following table. Field engineering managers are responsible for the degree of skill required to perform the job; these skill levels may be basic, general, or complex.

	Hourly Rates (3 hr. min.)		
	Basic	General	Complex
Principal or senior technical consultant	\$66	\$76	\$82
Project supervisor or technical consultant	51	58	64
Technical specialist	45	52	58
Systems analyst/senior programmer	39	44	52
Programmer	29	32	39
Computer operator	18	22	22
Administrative aide	16	18	18
Clerical	14	14	14

Monthly charges are 137 to 140 times the hourly rates. These rates do not include supplies.

The basic operating system, basic job management and file systems, programming tools such as linking and debugging aids, the job control language, and conversion aids are provided to all Level 64 users at no additional cost. A basic kit of documentation is also provided with the system. Monthly license fees are charged for language processors, utilities, application packages, communications software, and advanced job management and file systems.

Education services include standard courses, advanced progression training, and self-instruction. Prices vary from \$65 to \$400 for all services except self-instruction. All self-instruction material can be purchased, with fees varying from \$12.95 to \$1,495.

The standard maintenance contract calls for field engineering service between 8 a.m. and 6 p.m. on Mondays through Fridays. The table below gives the surcharge rates as a percentage for service outside the standard period.