ICL 2900 Series, Models 2903 & 2904

MANAGEMENT SUMMARY

The low end of the ICL 2900 New Range currently consists of three models, the 2903 Model 20, the 2903 Model 30, and the 2904. The entire 2900 Series constitutes ICL's replacement for its earlier 1900 Series and System 4 computers. Specifically, the 2903 and 2904 fit into the group spanned by the low-cost 1901A and the disc-based 1901S systems through the more costly 1902A.

The ICL 2903 and 2904 can be characterized as a family of small to medium-scale business computer systems that can handle traditional batch data processing and remote job entry, as well as interactive file processing and on-line data entry. On all but the entry-level model, these functions can be performed concurrently.

The original 2903 was announced at the Hanover, Germany trade fair in April 1973. It was renamed the 2903 Model 30 when an entry-level version was introduced in January 1976 and named the 2903 Model 20.

The purpose of the Model 20 was to capture the first-time, entry-level market that had been exploited by IBM with the System/32, and earlier with the System/3, and to lock in users to the ICL line. To that end, the Model 20 is a reduced-performance 2903 offered in a limited configuration. It is, however, expandable to the standard 2903 status and is expected to serve as a base of user accounts to which larger 2903/2904 (or other 2900 Series) systems can be sold.

Four months after the 2903 Model 20 was announced, ICL introduced the 2904 as an enhanced version of the ▷

The ICL 2903 and 2904 systems, the smallest members of the ICL 2900 Series, combine batch data processing, interactive inquiry, and on-line data entry capabilities in an attractive package. With memory sizes ranging from 64K to 384K characters, the systems are appealing to first-time computer users as well as those moving up from small ICL 1900 Series systems.

CHARACTERISTICS

MANUFACTURER: International Computers Limited, ICL House, Putney, London, SW15 1SW, England. Telephone (01) 788-7272. ICL has offices in over 80 countries throughout the world.

**MODELS:** 2903 Model 20, 2903 Model 30, and 2904.

DATE ANNOUNCED: The 2903 Model 30 was announced in April 1973, the 2903 Model 20 in January 1976, and the 2904 in May 1976.

DATE OF FIRST DELIVERY: The 2903 Model 30 was first delivered in January 1974, the 2903 Model 20 in March 1976, and the 2904 in November 1976.

NUMBER INSTALLED TO DATE: 2903 Model 30—1,620; 2903 Model 20—170; 2904—80.

DATA FORMATS

BASIC UNIT: 24-bit word, consisting of four 6-bit characters and two transparent parity bits. Characters are represented in 6-bit BCD (binary-coded decimal) format. ▶
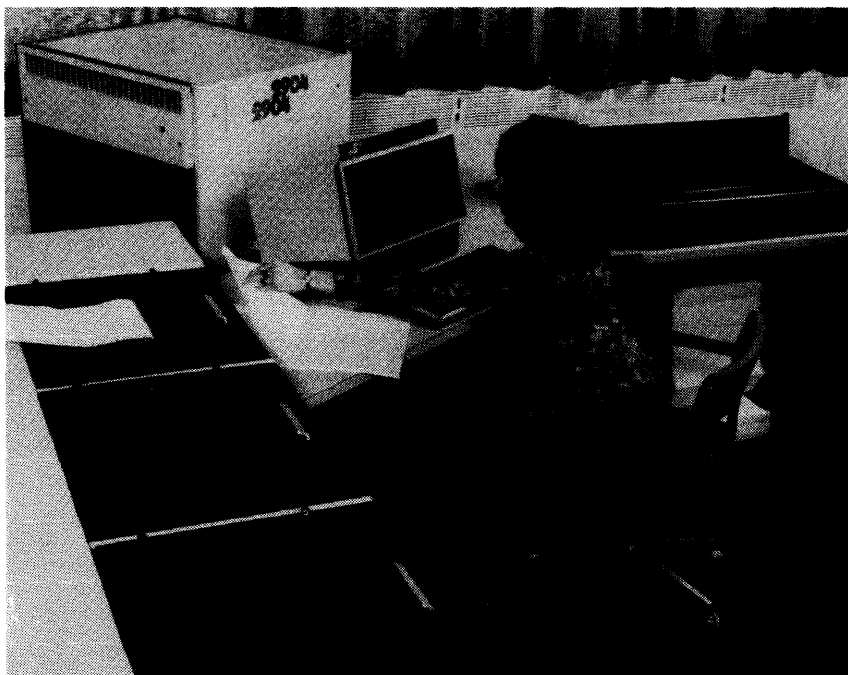
The ICL 2904, announced in May 1976, features improved microcode that can provide up to 80 percent faster performance than the 2903 Model 30. In addition, the 2904 has twice the memory capacity of the 2903 —96K words—and more communications capabilities. This 2904 system includes, left to right, a 9.8-million character FEDS disc unit, a 300-card/minute card reader, console hard copy unit, video console, and a 300-lines/minute line printer; not visible are the 60-million character EDS disc drives. The cabinet behind the video console is the storage extension unit required for memory over 48K. The CPU is housed under and to the right of the hard copy unit.

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▷ 2903 Model 30. Designed to provide existing and prospective 2903 users with a well-defined upgrade path, the 2904 offers increased throughput, memory, and disc storage.

CONFIGURATIONS

The 2903 Model 20 system has a modified, less expensive CPU that provides about 73 percent of the performance attained from the standard 2903 Model 30 CPU. It is available in two basic configurations. One version includes a 64K-character CPU, a video console, two Direct Data Entry (DDE) terminals, a 300-cpm card reader, a 150-lpm line printer, and one 9.8-million-character fixed/exchangeable disc storage (FEDS) unit that uses an IBM 5440-type disc cartridge. This system can be expanded to 80K characters, four DDE terminals, two FEDS disc units, and a 300-lpm printer.

The second version is similar to the first, but in lieu of the DDE terminals, an Integrated Communications Controller is provided for local attachment of up to four Visual Display Units (VDU's) for on-line file inquiry/transaction processing. This version can be enhanced to include remote terminals and remote job entry links; however, unlike the Model 30, the Model 20 cannot support remote terminals and RJE concurrently.

Either of the two Model 20 variants can be enhanced to include the facilities offered on the other, but the maximum memory size of 80K characters limits actual concurrency of facilities.

The standard 2903 Model 30 can handle a batch job, input/output spooling, direct data entry, and on-line transaction processing, or it can be dedicated as a data-entry system with up to eight DDE stations. A larger system can extend the range of these functions and also remote job entry or links to other computer systems. The largest configurations are capable of all the foregoing plus batch stream multiprogramming of up to four concurrent tasks.

A basic Model 30 system, configured to run under the minimum executive program (Executive 0, the only price-bundled executive) consists of an 80K-character CPU; a 10-million-character integrated disc unit physically compatible with the IBM 5440 Disk Cartridge; a 300-lpm, 132-column line printer; a 300-cpm integrated card reader; and an operator's video console and three DDE terminals.

A more typical Model 30 has a 112K-character CPU; two or more 60-million-character Exchangeable Disc Store (EDS-60) disc drives (physically compatible with the IBM 2314); a 300-lpm line printer; a 300-cpm card reader; a video console and three DDE terminals; and four VDU's for file inquiry and update. This system runs under Executive 1.

The 2903 Model 30 is upgradeable to a 192K-character CPU and can handle a 600-cpm card reader, a 600-lpm line printer, up to eight DDE stations, and up to 240- ▷

▶ FIXED-POINT OPERANDS: One word, 23 data bits plus a sign bit. Products and dividends are 46 bits plus sign. By subroutine, double-precision fixed-point operations are possible, using 46-bit-plus-sign operands and 69-bit-plus-sign products and dividends.

FLOATING-POINT OPERANDS: Two words, 37-bit fraction and 8-bit signed exponent; performed by executive subroutine ("extracode") or directly by microcode.

INSTRUCTIONS: All 2903 and 2904 instructions are one word long. Memory reference instructions have 12-bit operation codes and 12 addressing bits, while branch instructions have 9-bit operation codes and 15 addressing bits.

INTERNAL CODE: 6-bit extended BCD.

MAIN STORAGE

TYPE: MOS.

CYCLE TIME: 1140 nanoseconds per 24-bit word.

CAPACITY: The basic 2903 Model 20 is supplied with 16,384 words (24-bit) of main memory, expandable to 20,480. In the 2903 Model 30, 20,480 words are included with the basic system, with expansion capabilities to 49,152 words in 4096-word increments. The 2904 basic system includes 32,768 words of memory, and can be expanded to 98,304 words, in 8,192-word increments up to 40,960 words, and thereafter in 12,288-word increments up to 98,304 words. All main storage up to 48K is accommodated by the standard system cabinet; storage above 48K for the Model 2904 is held in an extension cabinet.

CHECKING: Two parity bits per word are standard. The processor halts upon detection of a parity error in an area of store occupied by the executive. If an error occurs in the user program area, the program is suspended by the Executive, which displays the error and its location on the video console.

STORAGE PROTECTION: None. However, since each program's addresses are relative to the contents of its own datum and limit registers (which determine relative address zero and thus assure program relocatability), proper control of these registers' contents provides adequate protection.

RESERVED STORAGE: The initial eight words of each program's storage area are reserved for use as general registers. These are addressed by three bits of arithmetic, logical, and shift instructions. Three of these registers (1, 2, and 3) can be addressed by two bits in arithmetic, logical, and shift instructions for the purpose of modifying the address denoted in the instruction.

CENTRAL PROCESSOR

GENERAL: The ICL 2903 Model 20 is an entry-level system with a restricted range of peripherals. Its performance level is about 30 percent less than that of the 2903 Model 30. COBOL and RPG2 are the programming languages offered for the 2903 Model 20. The 2903 Model 20 is intended for use as a single-job, batch-oriented system with inquiry programs or spoolers operating in background mode, as a direct data entry (DDE) system with a spooler operating in the background, or as a batch system with RJE facilities for distributed processing. Model 20 CPU's can be field-upgraded to standard 2903 status as found in the 2903 Model 30 CPU.

The ICL 2903 Model 30 is a small to medium-scale business data processing machine designed to implement high-level languages (primarily RPG2, but also COBOL and FORTRAN) and to provide: 1) batch job processing, 2) concurrent I/O spooling, 3) interactive file transaction proc- ▶

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CHARACTERISTICS OF THE 2903/2904

	2903 Model 20	2903 Model 30	2904
Storage type	MOS	MOS	MOS
Word length, bits*	24	24	24
Cycle time, microseconds	1.14	1.14	1.14
Available capacities, words	16K, 20K	20K, 24K, 28K, 32K, 36K, 40K, 44K, 48K	32K, 40K, 48K, 60K, 72K, 84K, 96K
Control storage, words	8K	4K, 8K, 12K	12K, 16K
Access time, microseconds	.57	.57	.57
Add time, microseconds	21.9	17.7	9.3
Operating systems	Exec 0, 1	Exec 0, 1, 2	Exec 1, 2
Programming languages	RPG2, COBOL	RPG2, COBOL, FORTRAN	RPG2, COBOL, FORTRAN

*32-bit word machine microprogrammed to run in 24-bit word mode.

▷ million characters of exchangeable disc storage. The system is field-upgradeable to a 2904.

Besides uniquely combining the three DP functions— processing batch jobs, handling inquiry transactions, and accepting direct data entry—the 2903 is unusual in that it permits the RPG2 or COBOL programming language to be used to program the functions of on-line display terminals. Also valuable to users who may see the need to upgrade from cartridge to pack disc storage is ICL's pledge of direct-access compatibility, which it calls "unified direct-access standards" (UDAS). UDAS guarantees that application programs will be independent of the type of direct-access storage used.

The ICL 2904, announced in May 1976, represents an enhancement to the "standard" 2903 system. Featuring new, improved microcoding, the 2904 offers up to 80 percent faster performance; greater memory capacity, up from 192K to 384K characters; and more communications capabilities. The 2904 is expected to be the replacement for the standard 2903, especially in larger systems with main memory capacities above 128K characters. In fact, the *minimum* 2904 memory size is 128K characters.

A basic 2904 system includes a 128K-character CPU; integrated 300-lpm, 132-column line printer; integrated 300-cpm card reader; and a controller for the 30- or 60- million-character EDS disc pack drives. Memory is expandable in 32K-character increments up to 160K characters and then in 48K increments up to the maximum 384K.

SYSTEM ARCHITECTURE

The 2903/2904 processor has 24-bit memory words, and each word is divided into four 6-bit characters—exactly the data structure of the earlier ICL 1900 Series. But the 2903's storage is actually 32 bits wide (8 bits are not used). This fact, coupled with the facts that program registers on the 2903 are held in main storage and that ICL does not make the 1900 Series assembly language (or any assembly language) available for the 2903, prompts a brief discussion of these technical points. ▷

▶ essing, 4) direct data entry, and 5) remote job entry. The degree to which these processes can be accomplished is determined by the Executive program chosen, the store size, and the supporting peripheral configuration.

The ICL 2904 CPU is an enhanced version of the standard 2903 CPU that provides an 80 percent higher performance level. In addition, the 2904 can address up to 96K words compared to the 48K words addressable by the standard 2903 CPU.

CONTROL STORAGE: Implemented in the same technology, and located below and isolated from the user store (memory), the control storage is 32 bits wide with no specific format. The normal complement of control storage is 4096 words; implementation of direct data entry capabilities requires an additional 4096 words. The control storage has an access time of 570 nanoseconds and is addressed by the order code processor section of the CPU.

REGISTERS: Only the program registers (eight per program, in the first eight words of each program's storage area) are user-addressable. Six nonaddressable registers are included in the processor's microcode, including a program address register, main and intermediate accumulators, instruction register, and datum register. Three of the general registers can be used for indexing.

ADDRESSING: The ICL 2903 and 2904 computers are programmable only through higher-level languages. ICL does not recommend programming at the machine or assembler level and has released no details concerning the internal operations.

INSTRUCTION REPERTOIRE: A total of 111 instructions are available, including 85 fixed-point arithmetic, branching, shifting, logical, and code conversion (between decimal and binary) instructions; 11 input/output instructions; 4 control instructions; and 8 floating-point arithmetic instructions which invoke "extracode."

As mentioned previously, ICL recommends that the 2903 and 2904 computers be programmed only through higher-level languages and has not released detailed information concerning the instruction set.

PHYSICAL SPECIFICATIONS: The 2903 and 2904 CPU's and consoles are assembled in desk cabinets with free-standing associated peripheral devices placed on either side. The basic system is 79 inches wide, 32 inches deep, and 39 inches high. Weight of the basic system is 1166 pounds. The basic system requires a floor area of approximately 11 feet by 10 feet. Fixed-exchangeable disc storage (FEDS) units are 24 inches wide, 32 inches deep, 39 inches ▶

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Designed as an entry-level system, the ICL 2903 Model 20 is actually a reduced-performance 2903 Model 30 and is available only in limited configurations. The system can be field-upgraded to standard 2903 status when users' requirements increase. This installation includes, from left to right, a DDE station, two 9.8-million character FEDS disc units (the optional FEDS unit at the left incorporates a storage rack for the removable packs), a 300-card/minute card reader, the CPU (part of which is also under the card reader), the video console, and a 300-lines/minute line printer. The storage cabinets in the rear are not part of the installation.

▷ The 32-bit-wide memory is divided into two portions: 1) the Writeable Control Storage section, used to hold the 32-bit firmware control words that implement most 2903 instructions, or "order codes"; and 2) the user memory, which is structured as a 24-bit word memory. Keep in mind that most popular large business computers in the world (e.g., the IBM System/370's and ICL's larger 2900's) use 32-bit words consisting of four 8-bit characters. It would be a fairly simple step for ICL to "widen" the 2903's user memory to 32 bits at any time—especially since the program registers would automatically be widened in the process, since they are implemented in main storage. In addition, as long as nonavailability of an assembler limits compatibility with the 1900 Series to high-level languages, user programs will probably require little more than recompilation if the 2903's user word size is ever widened to 32 bits.

PERIPHERALS AND COMMUNICATIONS

All 2903/2904 systems include an operator's video console with a monitor that can display 20 lines of 50 characters each, a 64-character keyboard, function keys, and indicators for system control. Keyboard-entered control messages are displayed on the screen along with system responses and reports from the system.

An integrated 300-cpm card reader is included with each 2903/2904 system. A non-integrated 600-cpm card reader is available for 2903 Model 30 and 2904 systems and is attached via a standard interface coupler.

An integrated 300-lpm line printer is standard on all systems except the 2903 Model 20 which employs a 150- ▷

▶ high, and weigh 638 pounds. Disc storage units with removeable packs (EDS-60 and EDS-30) are 33 inches wide, 42 inches high, 25.5 inches deep, and weigh 650 pounds.

Voltage provisions to meet a specific country's power requirement are provided. No special environment beyond normal office conditions is required.

INPUT/OUTPUT CONTROL

I/O CHANNELS: Separate peripheral controllers are used. Four of these are for the standard peripherals: disc, integrated card reader, integrated line printer, and video operator's console. Additional controllers can be added, up to a total of 13, for VDU's, communications, DDE's, Executive console hard copy, and 1900 Series standard interface devices. Each operates at the appropriate peripheral unit speed. Access to the OCP (Order Code Processor) is handled automatically by the processor's priority net. Interrupts usually occur after block data transfers, and are handled by branches to Executive routines.

SIMULTANEOUS OPERATIONS: On the smaller 2903 configurations, all the attached devices can operate simultaneously. On larger systems, depending on the mix of peripherals, this is not always possible, especially with disc and magnetic tape devices.

CONFIGURATION RULES: For the 2903 Model 30 and the 2904, a maximum of 13 I/O controllers must be chosen from among: 1) up to seven controllers for the following peripherals: video console, FEDS, any card reader, any line printer, DDE, EDS 30 or 60 disc drives, and console hard copy; and 2) six other controllers which can include local and/or remote communications VDU terminals, remote computer links, and 1900 standard interface controllers. A Store Enhancement Plane is required on a standard 2903 Model 30 with DDE stations when the user memory exceeds 20K words. This Plane is a standard item on 2904 systems.

For the 2903 Model 20, the rules are simpler. Since two versions are available, additions are possible up to the limits for the model: a maximum of 20K words of memory, 4 DDE stations, one 300-lpm printer, two 9.8-million-character FEDS cartridge disc drives, and four VDU's (locally and/or remotely connected on one I/O controller of each type.) RJE applications require an additional communications controller. In cases where remote communications facilities and an RJE link are required, a Peripheral Enhancement Plane must be provided.

The 2903 Model 20 can be field-upgraded to 2903 Model 30 status. When this change is implemented, all configuration rules pertaining to the larger system apply.

MASS STORAGE

CARTRIDGE DISC SUBSYSTEMS: Two models of fixed/exchangeable disc storage (FEDS) units are available as integrated peripherals. The standard FEDS unit includes one fixed and one removable IBM 5440-type disc cartridge and has a total formatted data capacity of 4.9 million characters. Up to two such drives can be connected to any 2903 or 2904 system. A 4.9-million-character, single-platter, removable-cartridge disc drive employing an IBM 5540-type disc cartridge is also offered for 2903 Model 30 and 2904 systems. Up to three of these drives may be connected to the system in addition to the standard 9.8-million-character drive. For the larger systems, no more than two 9.8-million-character drives and no more than four drives of any type can be connected, yielding a maximum FEDS disc capacity of 29.4 million characters (9.8 + 9.8 + 4.9 + 4.9).

All units feature a shared access mechanism. Data is recorded on both surfaces of each disc at 512 characters per block (sector), 12 sectors per track, and 400 tracks per surface. ▶

▷ lpm printer that can be upgraded to 300 lpm. A non-integrated, buffered 600-lpm printer is also available for the 2903 Model 30 and 2904 systems, and a 1500-lpm buffered printer is offered for the 2904.

Direct-access storage for all systems is provided by a fully integrated 9.8-million-character fixed/exchangeable disc storage (FEDS) unit. One additional FEDS unit can be attached to a Model 20 system for a total of 19.6 million characters of storage. Up to three additional FEDS units can be attached to the Model 30 and 2904; however, only one of the additional drives has both a fixed and an exchangeable disc. The other two drives carry only an exchangeable disc providing a maximum of 29.4 million characters of on-line FEDS storage.

Additional disc storage can be attained on 2903 Model 30 and 2904 systems by the addition of Exchangeable Disc Store (EDS) disc pack drives. The 2903 Model 30 will accommodate up to four EDS 60 (60 million characters each) or up to eight EDS 30 (30 million characters each) disc drives. On the 2904, up to eight EDS 30 or EDS 60 drives can be attached. Alternatively, these drives can be used instead of the FEDS drives to provide a storage capacity range of from 60-million to 480-million characters of on-line storage.

Magnetic tape storage is available to 2903 Model 30 and 2904 system users. The tape system consists of a tape control unit with one integrated tape transport and up to five additional tape transports. The standard recording mode is 9-track, phase encoded at 1600 bpi. The maximum transfer rate is 80,000 characters/second. NRZI recording is optionally available at 800 bpi with a maximum transfer rate of 40,000 characters/second.

Compatible 1900 Series standard interface peripherals available for the 2903 Model 30 and 2904 include a card punch, paper tape reader and punch, and a graphics plotter. The 2903 Model 20 will not support the larger EDS 30 or EDS 60 disc drives or any standard interface peripherals.

An outstanding feature of the 2903/2904 range is its Direct Data Entry (DDE) capability. Data entered through the DDE terminals is verified and transferred directly onto specified disc files. Data entry can be performed simultaneously with regular processing tasks so a system can perform as both a multi-access key-to-disc system for data capture and as a general-purpose batch and/or communications oriented computer system. The terminals can also be used for file inquiry functions. Up to eight DDE terminals (four on 2903 Model 20 systems) can be connected to the processor.

Visual Display Units (VDU's) can be connected to 2903 Model 30 and 2904 systems to provide general inquiry and interrogation functions or specialized communications such as on-line order entry. The maximum practical number of VDU's that can be connected is dependent upon such factors as workload and response times re- ▷

▶ Average head positioning time is 40 milliseconds, and average rotational delay is 12.5 milliseconds. Data transfer rate is 416K characters per second. The FEDS cartridge disc drives are manufactured by Data Recording Instrument Company (DRI), a former U.K. subsidiary of ICL.

DISC PACK SUBSYSTEMS: The 2903 Model 30 will accommodate up to four EDS 30 or EDS 60 disc pack units; the 2904 will accommodate up to eight EDS 30 or EDS 60 disc pack units. These drives use disc packs physically identical to the 11-disc packs used on IBM 2314 and 2319 drives, but the EDS 60 packs are recorded at twice the IBM track density (406 rather than 203 addressable tracks) to hold 60 million characters each. Four EDS 60's attached to a 2903 system raise the total disc storage capacity to 245.6 million characters. The EDS 60 has a 35-millisecond average head-positioning time and a 12.5-millisecond average rotational delay, with a data transfer rate of 416K characters per second, the same as for the FEDS units. EDS disc drives are connected through the integrated EDS 30/60 coupler.

EDS 30 discs are derived from EDS 60's by inhibiting alternate tracks. Thus, except for having only half the EDS 60 storage capacity, the EDS 30's characteristics are identical; it uses 203 addressable tracks and stores 30.7 million characters.

Neither unit can be connected to a 2903 Model 20. The EDS 60 and EDS 30 drives are manufactured by Control Data Corporation.

INPUT/OUTPUT UNITS

2510/2511 MAGNETIC TAPE SYSTEM: Provides 9-track, 1600-bpi phase-encoded or optionally, 800-bpi NRZI recording on standard ½-inch magnetic tape. The 2510 consists of a controller and an integrated transport in the same cabinet. Up to five additional 2511 single transport drives can be connected to a 2510 allowing for a maximum of a controller and six transports for any one system. Tape speed is 37.5 inches/second and rewind speed is 150 inches/second. Data transfer rate is 80,000 characters/second for phase-encoded recording or 40,000 characters/second with the NRZI option. Each transport can have automatic tape loading.

241X LINE PRINTER: As the standard integrated line printer with the 2903 Model 20, this unit can be supplied to operate at 150 or 300 lpm; with the 2903 Model 30 and the 2904, this unit operates at 300 lpm. A maximum of two 241X printers is permitted; however, only one can be of the integrated type.

2421 SERIAL PRINTER: This is an ASR 33 Teletype associated with the operator's console for hard-copy output. It prints at a speed of 10 characters/second using a standard 64-character set.

2430 HIGH-SPEED TRAIN PRINTER: This fully buffered train printer can be used as an alternative or in addition to the integrated printer. It prints at 1500 lpm with a 64-character EBCDIC set, or at 1100 lpm with a 96-character ASCII set. It is available with either 132 or 160 character positions.

2108 INTEGRATED CARD READER: Integrated with the CPU, this card reader reads 80-column cards at 300 cards/minute. The hopper and stacker each hold up to 400 cards.

2104 CARD READER: The 2104 is a non-integrated card reader that reads 80-column cards at 600 cards/minute. It is attached via a standard interface coupler. The hopper and stacker each hold up to 1000 cards. ▶

quired. VDU's display up to 20 lines of 50 characters each. Termiprinters can be connected to the VDU's to provide hard copy output.

Communications couplers allow the connection of the ICL 7500 Modular Terminal System which supports VDU's, hard copy printers, card readers, and floppy disc drives. An additional communications coupler enables any 2903/2904 system to be used as a remote job entry terminal linked to an ICL or IBM host computer.

The 2903/2904 computers can emulate the ICL 7020 Remote Job Entry system and can be connected to ICL 1900 Series computers via GEORGE 2 or GEORGE 3/4 interfaces, to ICL System 4 computers via J or Multijob interfaces, or to larger ICL 2900 computers via VME/B or VME/K interfaces.

SOFTWARE

There are three operating systems for the 2903 Model 30 and the 2904. Executive 0 is the basic operating system and allows input/output spooling and file inquiry or dedicated direct data entry. The more powerful Executive 1 includes the features of Executive 0 and adds inquiries from visual display terminals, remote job entry capability, and concurrent processing. Executive 2 offers all of the facilities of Executive 1 plus the ability to run four concurrent batch programs.

The Model 20 operating systems are subsets of standard 2903 operating systems, tailored to include only support for those peripherals that are marketed with the system. Further, standard 2903 operating software cannot run on a Model 20, but Model 20 program development can be done in RPG2 and COBOL, and these programs can be executed on both the Model 20 and higher 2903 systems. A series of hardware and software interlocks have been added to preclude use of non-Model 20 software.

Five operating systems are offered with the Model 20. They are based on the standard 2903 Executive 0 and Executive 1. M50 is a single-programming executive based on Executive 0, and can be used for running a single batch stream under either job control language or operator control. Inquiry programs can also be executed and are rolled in and out of memory. M50 can also be used exclusively for direct data entry operations.

Four versions of Executive 1 are available and are known as M10, M15, M20, and M25. M10 can simultaneously run a single batch stream under job control language (JCL) or operator control and also run direct data entry and spooling operations. The batch program can be interrupted, using roll-in/roll-out (RIRO) techniques, by a file inquiry/transaction processing program handling inquiries from the DDE keystations and/or the video console.

M15 is similar to M10 but does not include direct data entry. Instead it provides facilities for handling VDU terminals in conjunction with the RIRO system.

1920 CARD PUNCH: The 1920 punches standard 80-column cards at 100 cards/minute. It is attached via a standard interface coupler. Hopper capacity is 800 cards; stacker capacity is 650 cards.

1916 PAPER TAPE READER: Operating at up to 1000 characters/second, this unit reads odd or even parity 8-level tape. Reel capacity is 700 feet.

1925 PAPER TAPE PUNCH: Punches standard 8-level paper tape at 110 characters/second. Odd or even parity is operator selectable. Spools up to 100 feet in length can be accommodated.

1934 GRAPH PLOTTER: Produces X-Y plots on 120-foot rolls of paper using a drum-type plotting mechanism. Step size is 0.1 mm and plotting speed is 300 steps/second. Data transfer rate is 300 characters/second. Plotting width is 11 inches on 12-inch paper.

2251/1 DIRECT DATA ENTRY KEYSTATION/CRT: These units attach locally to the system at distances of up to 300 feet. Up to four DDE's can be connected to each DDE controller of which there may be two on either the 2903 Model 30 or the 2904, providing up to eight DDE keystations. The 2903 Model 20 will support only four keystations. A DDE keystation/CRT features 51 keys (with shift, 64 characters) and an 8-line, 32-characters-per-line display that can display all 64 characters. The last display line presents 30 characters of commands, replies, or data entry, verification, and editing. These activities are supported by ICL software, which also lets any DDE be designated as a supervisory unit. The designated supervisory unit can be used to initiate batches, create and store format programs, release completed batches for processing, and call up statistics for viewing.

In addition to use as data entry stations, 2251/1 units can be used for file inquiry and update functions. The Inquiry Program can be operated in roll-in/roll-out mode, or locked into memory.

7182/2 AND 7184 VISUAL DISPLAY UNITS (VDU's): These VDU's can be connected locally and/or via data communications lines on all 2903 and 2904 systems to provide on-line file inquiry/update facilities. ICL provides supporting software for these activities. The VDU features a typewriter style keyboard plus numeric keypad (92-character set), keyboard control keys (tab, delete, erase, line controls, etc.), and a 2000-character CRT display. It can operate on 600-, 1200-, 2400-, or 4800-bits/second communications lines. A Termiprinter can be connected to each VDU as a hard-copy output device.

2255/2 OPERATOR'S CONSOLE: This CRT/keyboard has the capacity to present the full character set in 20 lines of 50 characters each. Lines 3, 4, 5, and 6 are used to present short lines of VDU-type information, i.e., inquiry responses. An Executive 1 or 2 system can support immediate console hard copy on a 2421/1 Hard Copy Facility.

COMMUNICATIONS CONTROL

For the 2903 Model 30 abd 2904, local communications (i.e., cable interface attachment of VDU's) proceeds automatically via F1559 Local Communications Controllers. There can be up to four of these per 2903 Model 30 system supporting up to 16 VDU's, and up to six on a 2904, supporting an unspecified number of VDU's. They operate at 4800 bits per second at distances of up to 1000 feet. The DDE terminals, if any, attach to a DDE controller at distances of up to 300 feet.

An F1560 Remote Communications Controller establishes a data communications capability. Up to four of these

▷ M20 provides facilities for batch processing and spooling as for M10, plus concurrent remote job entry by emulating an ICL 7020 terminal or an IBM 2780 terminal.

M25 is similar to M20 but provides remote job entry to an ICL System 4.

The initial marketing targets for the 2903 are primarily manufacturing firms. That orientation is borne out by the applications software presently offered. These unbundled packages include Stock Control (inventory), optional on-line stock inquiry and file update for Stock Control, On-Line Order Entry, a Bill of Materials Processor (BOMP), and conventional accounting packages. These programs are supplied with RPG2 source code, and interfaces between them are featured.

Also available are FIND2, a parameter-driven file interrogation system; PROSPER, a batch-job financial modeling program which is available on-line with 1900 Series systems; and PERT, a 13K-word critical path planning package.

Programming languages supported on the 2903 and 2904 systems are RPG2 (which is stressed by the manufacturer), COBOL, and FORTRAN. Pre-delivery RPG2 training and program testing for customer personnel at ICL customer centers are provided free of charge.

Three Executive operating systems (0, 1, and 2) are supported by the usual range of business system computer utilities. Executive 1 and Executive 2 can support immediate console hardcopy output. All Executives maintain a console log on disc for later transfer to the line printer. Used as a remote job entry (RJE) system under Executive 1 and Executive 2, the ICL 2903 appears as an IBM 2780 Data Transmission Terminal to an IBM computer system or as a 7020 terminal to an ICL 1900 or System 4 mainframe.

At the same time the 2904 was introduced, ICL also announced the availability of the IDMS data base management software, developed by Cullinane Corporation (See Report 70E-272-02); the Multiple Transaction System (MTS), which supports up to 40 interactive programs on Model 2904 systems; and an applications manager program, which supervises and monitors the execution of application programs and allocates system resources to improve overall system performance.

COMPATIBILITY

The 2903/2904 data structure allows most ICL 1900 Series software and data files to be transferred to a 2903/2904 system without modification. ICL recommends, however, that programs be recompiled for the 2903/2904. Standard interface peripherals from the 1900 Series can be transferred to the 2903 Model 30 and the 2904. Conversely, there is upward compatibility from the 2903/2904 to the larger 1900 Series systems; some 2904 order codes, however, are not implemented on the 1900, so some programs might require modification. ▷

▶ controllers can be used in a 2903 system. The system can support up to 12 VDU's and/or transparent line-sharing adapters operating over a single communications line or I/O cable. Synchronous or asynchronous operation is supported.

The 7182/01 or 7184/06 Transparent Line-Sharing Adapters (LSA's) attach up to eight VDU's locally at speeds of 2400 or 4800 bits per second and at distances of up to nearly 900 feet.

VDU's are programmed for remote operation using RPG2 or COBOL.

To equip the 2903 as a remote job entry (RJE) system, a remote Communications Controller, supported by a special microcode module, is used to provide synchronous communications at 2400 or 4800 bits/second. The 2903 appears as an IBM 2780 Data Transmission Terminal to an IBM System/360 or 370 computer. RJE to ICL's own 1900 and System 4 computers is also possible, emulating the ICL 7020 terminals. RJE to ICL's larger 2900 Series computers has also been announced, but the type of connection has not yet been declared.

SOFTWARE

OPERATING SYSTEMS: Executives 0, 1, and 2 are the standard operating systems for the 2903 Model 30 and the 2904. Special versions of Executives 0 and 1 are provided for the 2903 Model 20.

Executive 0 is the minimum operating system. It supports either one batch job with concurrent I/O spooling on the disc for the line printer and the card reader (a job control language entry unit) and file inquiry (but only from the console or DDE's), or dedicated direct data entry (DDE). Its minimum storage requirement (in user memory) is 2688 words. To this, add 256 words for journalizing the Video Console Log, 320 words for console file inquiry capability, and 2496 words for input and output spooling; this adds up to 5760 words, without the DDE software loaded. VDU-based inquiry and remote job entry are not possible under Executive 0. DDE software (4416 words for up to two keystations and 448 words for each additional station) is considered applications software, not part of the Executive. A dedicated DDE system with four keystations will require 11,072 words and will fit comfortably into a 16K minimum system.

Executive 1 adds VDU capability and RJE capability to the functions of Executive 0, and makes concurrency possible. But the premium paid is the basic requirement of 4992 words of user memory, plus any storage required for additional features. Thus, a 6144 word executive could result: Floating Point—220 words, Spooling—512 words, Communications —448 words, and Console Hard Copy (if required)—160 words; Console Inquiry is included as standard with Executive 1 and Executive 2. Executive 1 does not support batch stream multiprogramming.

Executive 2 supports all Executive 1 functions, with the addition of console hard copy and batch stream multiprogramming for up to four concurrent tasks as standard functions. The basic module is 224 words larger than Executive 1.

All three executives reside on disc storage of any type and all three can support spooled console output (called journalizing by ICL).

For the 2903 Model 20, file inquiry facilities using ETS-2 standard software are available: 1) under Executive 0 only from console video or DDE's in the inquiry mode; when a batch program is in operation, file inquiry and DDE opera- ▶

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▷ Because the 2903 and 2904 are currently microprogrammed to emulate the 1900 Series, they are not compatible with the larger 2900 models. For information on converting from the 1900 Series to the 2900 Series, see Report 70C-533-10.

Within the 2903/2904 family, Model 20 programs will execute on the Model 30, and, with the exception of ETS1 inquiry programs, all Model 20 and Model 30 programs will execute on the 2904. ETS1 inquiry programs must be recompiled for ETS2 or MTS.

COMPETITION

The 2903 and 2904 systems compete with systems such as the IBM System/3 Model 12 and Model 15, the IBM System/32, the IBM System/370 Model 115, the Univac 90/30, and the Honeywell Series 60 Level 61 and 62.

USER REACTION

Datapro interviewed six ICL 2903 users in the United States in October 1976. Each had one system. The users included a municipality, two professional societies, a large bank, an engineering firm, and a large beverage distributor. The average installed life for the six systems was slightly over one year. Five of the six used the 2903 systems for traditional accounting functions, i.e., general ledger, accounts receivable, accounts payable, inventory control, etc. The sixth user employed the 2903 solely for one particular application, operating the system as an adjunct to a very large IBM System/370. This user had acquired the 2903 because of the availability from ICL of the specialized applications software package needed for his operations. It is a little sad, therefore, to note that this 2903 system was being phased out because the ICL software package had been successfully transferred to the host system. The spokesman for this company, however, was adamant in pointing out that the decision to turn back the 2903 was purely economic and in no way reflected on its performance, which had been more than satisfactory.

The two professional societies, in addition to conventional accounting functions, were using their systems for member records, publication subscription records, and extensive statistical work directed primarily toward developing membership profiles.

There was little variation among the systems we surveyed, consistent with ICL's policy of marketing standard configurations with limited latitude for expansion. System memory sizes varied between 16K and 32K words, with the average at 24K words. Three systems included two 60-million-character disc pack drives, one had two 60-million-character cartridge disc drives, one had one of each type of disc drive, and one employed only one 9.8-million-character drive. Four of the systems each included two direct data entry terminals.

The responses of the six ICL users to our standard questions are tabulated below. ▷
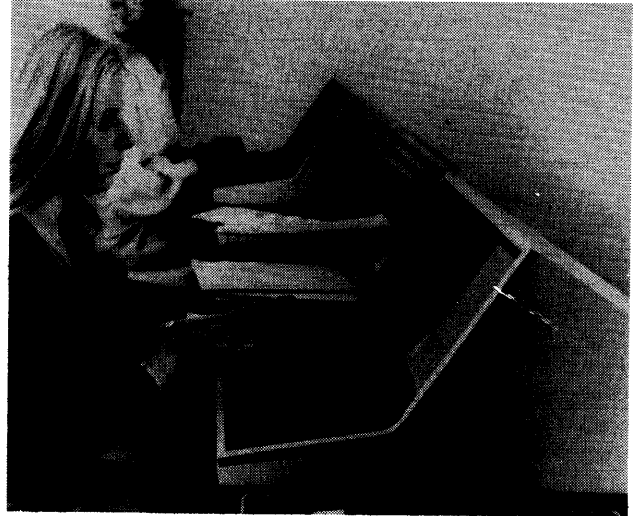
As data is entered at these Direct Data Entry (DDE) terminals, it is verified by the software and transferred to specified disc files. The terminals also can be used for file inquiry functions.

▶ tion are not possible; and 2) under Executive 1 versions M10 (console video and DDE's) and M15 (console video and VDU's).

Five executives are available for the 2903 Model 20; one Executive 0 version designated M50 and four Executive 1 versions designated M10, M15, M20, and M25:

- M10 supports batch, DDE, spooling, and inquiries from console and video; size is 5632 words;

- M15 supports batch, VDU inquiry, and spooling; size is 5440 words;

- M20 supports batch, RJE to 1900, IBM 2780 emulation, and spooling; size is 5760 words;

- M25 supports batch, RJE to System 4, spooling, and IBM 2780 emulation; size is 5760 words;

- M50 supports batch and spooling or dedicated DDE; size is 3328 words.

LANGUAGES: On the 2903 and 2904, ICL is promoting use of its RPG2 language, which is largely compatible with IBM's RPG II. The RPG2 compiler requires 12,032 words of user storage. The language can be used to program the remote use of VDU's and is also compatible with 1900 Series RPG. RPG2 and COBOL are the programming languages offered for the 2903 Model 20.

ICL 2903 COBOL is an extended version of COBOL-61, which is also used as 1900 Series COBOL. Its storage requirements are 13,504 words. Direct-access verbs are optional.

FORTRAN IV for the ICL 2903 accepts disc, card, or paper tape source code and outputs object code to magnetic tape or disc. It requires 10,728 words of storage. A 32K-word compiler with extended disc addressing is also available.

COMMUNICATIONS SOFTWARE: ICL offers communications between 2903 systems and IBM 360/370 host systems, or to IBM System/3's. The 2780 Emulator package requires a 2903 operating under the Executive 1 or Executive 2 operating system. The 2780 Emulator can execute concurrently with other programs. In addition, all IBM 2780 ▶

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	Excellent	Good	Fair	Poor	WA*
Ease of operation	5	1	0	0	3.8
Reliability of mainframe	5	1	0	0	3.8
Reliability of peripherals	2	4	0	0	3.3
Responsiveness of maintenance service	4	2	0	0	3.7
Effectiveness of maintenance service	2	4	0	0	3.3
Technical support	5	1	0	0	3.8
Operating systems	1	4	1	0	3.0
Compilers and assemblers	2	2	0	0	3.5
Applications programs	1	3	0	0	3.3
Ease of programming	2	2	0	0	3.5
Ease of conversion	2	1	0	0	3.7
Overall satisfaction	3	3	0	0	3.5

*Weighted Average on a scale of 4.0 for Excellent.

The weighted averages make it clear that these users were well satisfied with their 2903 systems. All of the users were impressed with the system reliability, particularly that of the CPU. Most were also impressed with the quality of maintenance service and technical support available from ICL, although a few noted an occasional delay if ICL headquarters in England had to be consulted.

Generally, there were no negative comments. Failures had been encountered chiefly during the start-up period and had ceased to be a concern to any of these users. The lone user complaint we received during the interviews concerned the length of time required to install a communications controller and to bring it on-line.

The 2903 and the more recent 2904 have established themselves as viable and cost-effective alternatives to several low and middle-range members of the IBM computer product line. The systems also offer competition to several other established business computer manufacturers such as Honeywell, NCR, and Burroughs. From the reactions of the users, it is apparent that the ICL systems can perform their intended functions reliably. In light of ICL's recent acquisitions of various elements of Singer's discontinued operations, plus its interest in Computer Peripherals, Inc., it would appear that the company seriously intends to extend its presence in the international computer market.□

▶ peripherals, such as card readers, line printers, or card punches, can be emulated; multiple records can be transmitted; printer horizontal format can be controlled; and data from the host system can be spooled.

UTILITIES: Diagnostics are available in English, French, and German. They, and other utilities, are available for a modest use fee. The other language utilities are: 1) disc file reorganization & sort/merge, 2) RPG2 diagnostics in English, French, or German, 3) COBOL preprocessor, 4) COBOL data name crossreference, 5) COBOL library routine, 6) COBOL disc sort, and 7) a host of general utilities: copiers, formatters, initializers, labelers, dumps, printer/editor, allocators, utilization reporters, loaders, file creators, library maintenance routines, etc.

ICL also offers conversion aids to convert RPG II and COBOL programs written for non-ICL systems. Aids are available for converting source programs written for IBM, Honeywell/GE/Bull, NCR, and Burroughs systems.

The Integrated Data Management System (IDMS) is an adaptation of IDMS by Cullinane Corporation. It is comparable with the recommendations of the CODASYL Database Task Group and can be employed on all ICL 2900 Series systems as well as the older ICL 1900 line. For further details on this popular data base management system, refer to Report 70E-272-02 in the Software section of *DATAPRO 70*.

The Multiple Transaction System (MTS) for 2904 systems can support up to 40 concurrent interactive programs. This software package exploits the communications enhancements found in the 2904, taking advantage of the executive terminal polling capability. MTS automatically adapts to the number of active terminals in the system.

In operation, MTS consists of a message router package that coordinates all terminal activity and communicates with the 2904 executive. The 2904 executive then provides the interface to individually written MTS routines, which format or convert the terminal data for processing by the normal applications programs. MTS routines can be compiled into either RPG2 or COBOL programs.

MTS provides for up to 8 priority programs to be memory-resident and up to 32 additional programs to be rolled in on an as-needed basis.

Existing 2903 systems upgrading to a 2904 can run ETS2 Inquiry Terminal System programs under MTS without change. However, a message router program must be generated specifying the routing that terminal data must take through the network of user programs. If ETS2 programs are recompiled under MTS, ICL claims the resultant object packages will produce faster response times and greater throughput.

APPLICATIONS SOFTWARE: Available in RPG2 code are a Bill of Materials Processor (BOMP), Inventory Control, On-Line Order Entry System, and conventional accounting packages. Available in PLAN (1900 Series assembly language) code are PROSPER and PERT, which require floating-point; linear programming and statistics; the FIND2 file search system; and the COMPAY company payroll program.

For the 2903 Model 20, only the Bill of Materials Processor, Stock Control, FIND2, and COMPAY programs are available.

PRICING

POLICY: ICL offers the 2903 and 2904 systems for either purchase or lease. Maintenance is priced separately for both purchased and leased equipment. Lease terms can vary from one to five years. All software is separately priced and only available on a monthly license basis. The equipment prices shown are for the U.K. only. Prices, terms, and available configurations may vary in other countries to suit local conditions.■

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EQUIPMENT PRICES

		Purchase Price £	Monthly Maint. £	Monthly Rental £
BASIC 2903 MODEL 20 SYSTEM				
2903/22	Processor with 16K-Word CPU and Video Console			
F1551/00	DDE Coupler			
2251/01	DDE Keystations (2)			
2822/1	Fixed/Exchangeable Disc Drive, 9.8M Characters			
2108/02	Card Reader, 300-cpm			
2410/03	Line Printer, 150-lpm			
	TOTAL PRICE	25,830*	226	584*
BASIC 2903 MODEL 30 SYSTEM				
2903/35	Processor with 20K-Word CPU and Video Console			
F1551/00	DDE Coupler			
2251/01	DDE Keystations (4)			
2108/02	Card Reader, 300-cpm			
2412/02	Line Printer, 300-lpm			
F1556/03	Disc Controller			
2814/2	Exchangeable Disc Drives (2), 30M Characters/Drive			
	TOTAL PRICE	58,850*	398	1,312*
BASIC 2904 SYSTEM				
2904/42	Processor with 32K-Word CPU and Video Console			
F1555	Peripheral Enhancement Plane			
F1548	Store Enhancement Plane			
F1551/00	DDE Coupler			
2251/01	DDE Keystations (4)			
2108/02	Card Reader, 300-cpm			
2409/02	Line Printer, 600-lpm			
F1556/06	Disc Controller			
2815/3	Exchangeable Disc Drives (3), 60M Characters/Drive			
	TOTAL PRICE	131,715*	665	3,170*

*Price does not include separately priced software made available only on a monthly license fee basis. The 2903 Model 20 standard Executives are priced from £5 to £40 per month, and language processors and other systems software from £5 to £75 per month. The 2903 Model 30 and 2904 standard Executives are priced from £5 to £95 per month, and language processors and systems software from £5 to £115 per month. Applications software for 2903/2904 systems ranges from £35 to £120 per package per month.

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New Product Announcement

On March 15, 1978, International Computers Ltd. augmented the low end of its 2900 New Range with the announcement of three new models, the 2903/25, 2903/40, and 2904/50. The new models, expected to eventually supplant the existing 2903/20, 2903/30, and 2904 models, provide enhanced communications facilities, a wider selection of peripherals, and a smoother growth path to larger 2900 Series systems. First deliveries of the new models are scheduled to begin in April 1978 at purchase prices ranging from £25,000 to £250,000.

Employing the Peripheral Highway architecture developed for the recently announced ICL 2950 (See Report 70C-533-09), the new models can use 2950 peripherals, including a new 600-lpm printer and a new dual-diskette unit that can provide off-line data interchange with ICL 7502 terminals. A new multi-line communications coupler, available for 2903/40 and 2904/50 models, connects to the Peripheral Highway to provide an additional eight communications channels for interactive video terminals or bulk data transmission. With this coupler, which more than doubles the existing communication capabilities, the larger 2903 Series systems will be able to support over 100 terminals, according to ICL.

Software to exploit the improved hardware capabilities of the new models includes an enhanced version of the Multiple Transaction System (MTS) called MTS 2 and a new Transaction Processing System (TPS). New features included in MTS 2 allow concurrent file accesses from multiple interactive applications, message passing among programs, and remote initiation and control of jobs. The new TPS package is designed to facilitate interactive program development by first-time users.

Increased processor link capabilities for the new models include improved communications with ICL 1900, 2900, System Ten, and 1500 systems. Emulation of HASP multi-leaving procedures is available for the first time.□