ICL 1900 Series

MANAGEMENT SUMMARY

The ICL 1900 Series is by far the most widely used line of computer equipment produced by any manufacturer based outside the United States. The product line includes a broad array of hardware and software facilities and can handle virtually the full spectrum of business, scientific, and communications applications, at system rental prices ranging from less than $2,000 to more than $150,000 per month.

With nine current processor models, the British-built ICL 1900 Series effectively handles a broad range of workloads and applications. Introduced in 1964, the series has been steadily expanded and improved; it now includes such advanced facilities as virtual storage and front-end communications processors.

BACKGROUND

International Computers Limited, the United Kingdom's principal computer company, was formed through a 1968 merger of International Computers and Tabulators Limited (ICT) and English Electric Computers Limited. Previously, ICT had absorbed the computer interests of EMI, Ferranti, and General Electric (Great Britain), while English Electric had absorbed the computer activities of Elliot Automation, Leo Computers, and Marconi. Thus, ICL today represents a consolidation of most of the United Kingdom's computer development and production resources.

For the fiscal year ended September 30, 1972, ICL reported total sales of $362 million (up 2% from 1971) and earnings of $2.4 million (down 80% from 1971, mainly as a result of nonrecurring special items stemming from activities of past years). The company has approximately 28,000 employees and markets its products in more than 50 countries around the world. Its activities range from basic research through development and manufacturing to the provision of comprehensive post-sales support and service.

CHARACTERISTICS

MANUFACTURER: International Computers Limited, Bridge House, Putney Bridge, London SW6 3JX, England. Telephone 01-788-7272. U.S. office: 555 Madison Avenue, New York, N.Y. 10022. Telephone (212) 758-5220.

MODELS: 1901A, 1902A, 1902S, 1903A, 1903S, 1904A, 1904S, 1906A, and 1906S.

DATA FORMATS

BASIC UNIT: 24-bit word. Each word location in main storage consists of 24 data bits and 1 parity bit, and can hold four 6-bit BCD characters, one single-precision binary operand, one half of a double-precision binary operand, or one instruction.

FIXED-POINT OPERANDS: One or two 24-bit words, with sign in leftmost bit position.

FLOATING-POINT OPERANDS: One word, consisting of 8-bits-plus-sign exponent and 37-bits-plus-sign fraction, in normal precision; two words, consisting of 8-bits-plus-sign exponent and 74-bits-plus-sign fraction, in extended precision.

The small-scale 1901A system is spotlighted in this view of ICL's program testing installation in London. At left is the central processor cabinet, which also houses the line printer. Ranked behind the operator's console are a card reader, paper tape reader/punch, and four magnetic tape drives. At far right are two Twin Exchangeable Disc Store (TEDS) units.

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The 1900 Series was introduced by ICT in September 1964, just five months after IBM announced the System/360. The 1900 Series originally included the 1902, 1903, 1904, 1905, 1906, 1907, and 1909 central processors. The small-scale 1901 processor joined the family a year later. In 1967, ICT added eight more processors: the 1904E, 1904F, 1905E, 1905F, 1906E, 1906F, 1907E, and 1907F. All of these models use discrete-component circuitry and core memories, and all are now out of production.

The first of the currently marketed processor models, the large-scale 1906A, was introduced in October 1967. The smaller 1901A, 1902A, 1903A, and 1904A followed in January 1968. All of these "A" models utilize integrated circuits and faster, more compact core memories, and they provide an average of 2.5 times more processing power than their predecessors.

In April 1971, ICL substantially enhanced the 1900 Series by unveiling the 1902S, 1903S, 1904S, and 1906S processors plus several new peripheral and software products. The new "S" processors offer significant increases in computing and/or input/output speeds over the corresponding "A" models. A curious feature of the "S" series is ICL's use of three different main storage technologies: magnetic core in the 1902S and 1903S, MOS semiconductor in the 1904S, and plated wire in the 1906S.

In performance and price, the current 1900 Series systems span a range nearly as broad as that encompassed by the IBM System/3 Model 10 through the System/370 Model 165. More than 2500 of the 1900 Series computers have been installed to date. ICL markets the 1900 Series throughout most of the world, including Eastern Europe and Russia, but has not yet tackled the U.S. market. Even so, the 1900 Series is of interest to many U.S.-based companies because its broad scope, intrafamily compatibility, and widespread availability make it a strong contender for use in their overseas computing installations.

ARCHITECTURE

Unlike most computer systems unveiled during the past decade, the ICL 1900 Series is distinctively different from IBM computers of both the past and present. In designing the 1900 Series, ICL apparently placed maximum emphasis upon architectural simplicity and intrafamily compatibility – and has achieved these objectives in truly impressive fashion. But the resulting equipment and software, though generally straightforward and effective, is likely to prove disturbingly unfamiliar to users of IBM or IBM-like computers. (For these users, ICL also offers the System 4, a family of computers based on the former RCA Spectra 70 line, now the UNIVAC Series 70.)

INSTRUCTIONS: 1 word. Arithmetic and logical instructions include one 12-bit operand address field and one 3-bit field that specifies one of the eight general registers.

INTERNAL CODE: 6-bit BCD.

MAIN STORAGE

STORAGE TYPE: See table.

CAPACITY: See table.

CYCLE TIME: See table. (Note: 2-way or 4-way interleaving of main storage modules in the 1906A and 1906S considerably reduces their effective cycle times.)

CHECKING: Parity bit with each word is generated during writing and checked during reading.

STORAGE PROTECTION: Provided through datum (base) and limit registers in Models 1902A through 1906S, or through the optional paging mode in Models 1904A through 1906S.

CENTRAL PROCESSORS

REGISTERS: The first eight words of each user program in main storage serve as 24-bit general registers (i.e., accumulators) for that program and its subprograms. The first three registers in each program can also be used as index registers. In Models 1904A through 1906S, eight fast hardware registers are provided to serve as the general registers for the currently active program; since only one set of hardware registers is provided, its contents must be shifted into the first eight main storage locations of the interrupted program whenever an interrupt occurs.

INSTRUCTION REPERTOIRE: The complete 1900 Series instruction set contains approximately 120 instructions and provides facilities for fixed-point binary arithmetic, floating-point binary arithmetic, loading, storing, comparing, branching, shifting, logical operations, decimal-to-binary and binary-to-decimal radix conversions, input/output, and supervisory control. Floating-point arithmetic hardware, however, is an extra-cost option for all models, and the fixed-point multiplication, division, and radix conversion instructions are an extra-cost option for the small-scale Model 1901A.

The arithmetic and logical operations are implemented by microprograms in read-only storage, but the input/output and control instructions are implemented as "Extracodes" (i.e., standard subroutines within the Executive that are executed whenever the instructions are encountered). Floating-point arithmetic instructions can also be implemented as Extracodes in processors that lack the floating-point hardware features.

INSTRUCTION TIMES: See table.

PAGING: Models 1904A through 1906S can be equipped with the optional Paging Unit, after which they can be operated either in the paging mode or in the normal datum/ limit mode. In the paging mode, each program has 3 million words of virtual storage available to it, in 1024-word blocks. (An additional 1 million words are logically addressable, but this area is reserved for system software use.) Both the computer's main memory and the disc or drum backing store (which contains up to 3 million words per program) are divided into pages of

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CHARACTERISTICS OF THE 1900 SERIES PROCESSOR MODELS

	1901A	1902A	1902S	1903A	1903S	1904A	1904S	1906A	1906S
GENERAL CHARACTERISTICS									
Date of introduction	Jan. 1968	Jan. 1968	Apr. 1971	Jan. 1968	Apr. 1971	Jan. 1968	Apr. 1971	Oct. 1967	Apr. 1971
Monthly mainframe rental (approximate range)	$1,000 to $2,100	$1,700 to $3,400	$3,600 to $6,000	$5,200 to $15,000	$5,600 to $16,000	$8,700 to $23,300	$11,000 to $27,000	Not spec'd.	Not spec'd.
Monthly system rental (range for typical configurations)	$1,700 to $7,000	$4,000 to $10,000	$8,000 to $18,000	$12,000 to $40,000	$13,000 to $42,000	$20,000 to $45,000	$25,000 to $50,000	$45,000 to $140,000	$50,000 to $150,000
MAIN STORAGE									
Storage type	Core	Core	Core	Core	Core	Core	Semicond.	Core	Plated wire
Word size, data bits	24	24	24	24	24	24	24	24	24
Cycle time, microseconds	4.0	6.0	3.0	1.5	1.5	0.75	0.3	0.75	0.3
Words fetched per cycle	1	1	1	1	1	1	1	2	2
Storage interleaving	None	None	None	None	None	None	None	2 or 4-way	2 or 4-way
Available capacities, words	6,144	12,288	16,384	16,384	16,384	32,768	32,768	131,072	131,072
	8,192	16,384	24,576	32,768	32,768	65,536	65,536	196,608	196,608
	12,288	24,576	32,768	49,152	49,152	98,304	98,304	262,144	262,144
	16,384	32,768	49,152	65,536	65,536	131,072	131,072	393,216	393,216
				98,304	98,304	196,608	196,608	524,288	524,288
				131,072	131,072	262,144	262,144		
CENTRAL PROCESSOR									
Add time, microseconds (24-bit binary fields)	26	21*	10*	5.8	5.8	3.0*	2.0*	1.1 or 0.9**	0.8 or 0.6**
Multiply/divide hardware	Optional	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
Floating-point hardware	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional
Real-Time Clock	No	Optional	Optional	Optional	Optional	Standard	Standard	Standard	Standard
Program Timer	No	Optional	Optional	Optional	Optional	Standard	Standard	Standard	Standard
Paging Unit	No	No	No	No	No	Optional	Optional	Optional	Optional
Multiprogramming facilities	No	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
CHANNELS									
No. of integrated I/O adapters	3	0 or 1	0 or 1	-	-	-	-	-	-
No. of standard I/O channels	0 to 4	4 to 7	4 to 8	4 to 12	4 to 12	6 to 18	6 to 18	10 to 24	10 to 24
No. of fast I/O channels	-	-	-	-	0 to 6	4 to 12	4 to 18	4 to 19	4 to 14
No. of high-speed I/O channels	-	-	-	-	-	0 or 1	0 to 2	0 to 5	0 to 5
Maximum total I/O data rate, characters/second	220,000	320,000	600,000	600,000	1,000,000	3,000,000	6,000,000	6,500,000	11,000,000

*Estimated **For 2-way or 4-way main storage interleaving, respectively.

In defiance of the trend toward 8-bit byte-oriented systems, the 1900 Series processors use a fixed 24-bit word length and a 6-bit internal character code. Moreover, all arithmetic is done in fixed-word-length binary mode; no hardware instructions for decimal arithmetic are available. (ICL supplies standard subroutines for performing decimal arithmetic on variable-length fields, but these are comparatively slow.) Thus, the architecture of the central processors seems to be oriented toward scientific rather than business applications – but their effective radix conversion facilities and fast binary arithmetic largely compensate for the lack of decimal arithmetic and make them effective performers in business applications as well.

Multiprogramming is a featured capability of all 1900 Series central processors except the small-scale Model 1901A. Effective storage protection is provided for 4 to 48 independent main programs, depending upon the processor model, and the hardware multiprogramming facilities are well supported by the standard ICL software.

1024 words. The paging hardware and software "map" the blocks of virtual storage into the pages of main memory and the backing store.

Translation between the virtual addresses contained in instructions and real main memory addresses is performed by a hardware-implemented table-lookup process that accesses tables in main memory which are created and maintained by the operating system. The translation is speeded by a group of Current Page Registers (8 in the 1904A and 1904S, 16 in the 1906A and 1906S), which hold the most recently referenced virtual storage block addresses and their main memory equivalents. Whenever a program references a block that is not currently residing in main memory, an interrupt occurs and the required block is fetched from the backing store. A "learning program" in the operating system keeps track of the frequency of block usage and attempts to keep in core memory the blocks which are most likely to be required.

CONSOLE: The 1902A through 1906S central processors are equipped with a console typewriter (a Teletype Model 33 ASR) that is used primarily for communication between the system operator and the Executive. For the 1901A, the console typewriter is an extra-cost item that is required in all disc-oriented systems but is not available in 6K card-only or paper-tape-only systems.

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Other facilities that help to boost the performance of the larger 1900 Series processors include independent, concurrently-operating floating-point arithmetic units (optional for Models 1904A through 1906S), independent channel controllers for high-speed I/O operations (in Models 1903S through 1906S), eight hardware-implemented general registers (in Models 1904A through 1906S), 2-way or 4-way interleaving of main storage accesses (in Models 1906A and 1906S), and paging facilities (optional for Models 1904A through 1906S).

ICL, through its optional Paging Unit, was offering the advantages of virtual storage to large-scale computer users long before IBM added the capability to the System/370 in August 1972. ICL's paging scheme is generally similar to the one employed by IBM. Up to 3 million words of virtual storage are available to each program, in 1024-word blocks. Paging is an automatic function of the hardware and the associated GEORGE 4 operating system, and no changes to existing programs are required when an installation converts to the paging mode of operation.

PERIPHERALS AND COMMUNICATIONS

Users of the ICL 1900 Series can choose from a broad range of disc drives, magnetic tape units, printers, card readers and punches, paper tape readers and punches, and communications equipment, as well as a Universal Document Reader that optically reads marks and/or printed characters from paper documents. ICL's line of Exchangeable Disc Store (EDS) units includes models whose specifications are generally similar to those of the IBM 2311 and 2314, plus a "double-density" version of the 2314-style drive and a low-cost twin-disc unit for use with the small-scale 1901A. Magnetic tape units are offered in both 7-track and 9-track models; all use industry-compatible tape formats and are packaged in clusters consisting of two to six drives plus control unit.

Noteworthy omissions from the current 1900 Series peripheral lineup are high-performance disc drives, magnetic tape units, and printers in the class of IBM's 3330 Disc Storage, 3420 Model 7 Magnetic Tape Unit, and 3211 Printer. The high development cost associated with units of these types has apparently discouraged ICL from producing them, thereby hampering the firm's ability to compete in situations where high-performance peripheral equipment is called for. Also missing from the 1900 Series product line are dual-channel disc or tape controllers that would permit simultaneous read/write operations on two drives in the same subsystem.

For data communications, ICL offers a variety of central-site control equipment plus remote batch terminals, teletypewriters, and CRT display units. Two front-end communications processors are available to lighten

INPUT/OUTPUT CONTROL

I/O CHANNELS: Four basic types of channels are available in the various 1900 Series processor models, in the quantities shown in the table. The channel types can be described as follows:

- **Standard (or "hesitation") channels – Used primarily for character-by-character I/O operations on devices whose data transfer rates do not exceed 50,000 characters/second. In Models 1902A through 1903S, these channels can also operate in "burst" mode to handle magnetic tape and disc units with transfer rates up to 250,000 characters/second. The standard channels share the internal logic of the central processor except in Models 1906A and 1906S, where they are controlled by the autonomous Peripheral Processor Unit (PPU).**
- **Fast channels – Used primarily for magnetic tape and mass storage devices with data transfer rates in the range of 50,000 to 450,000 characters/second. These channels are controlled by independent logic; the 1903S, 1904A, and 1904S use a Peripheral Autonomous Control (PAC) with a 4-character buffer for each channel, while the 1906A and 1906S use the Peripheral Processor Unit (PPU) with an 8-character buffer for each channel.**
- **High-speed channels – Used for high-performance mass storage devices with data transfer rates up to 1.5 million characters/second. Controlled by the PAC in Models 1904A and 1904S and by the PPU in Models 1906A and 1906S.**
- **Integrated adapters – Permit direct connection of certain peripheral devices to the Model 1901A central processor, as described under "Configuration Rules" below. Also, an optional Integrated TEDS Adapter for the Model 1902A or 1902S enables 1901A users to retain their Twin Exchangeable Disc Store units when they move up to the larger system.**

CONFIGURATION RULES: In general, each 1900 Series I/O channel accommodates a single peripheral device or subsystem, subject to the speed limitations mentioned above. No dual-channel peripheral controllers are available, but manual switches enable two or three peripheral devices to share a channel or two central processors to share a peripheral device or subsystem.

The Model 1901A system includes integrated adapters that permit connection of one card reader (the 300-cpm 2105/1 or the 600-cpm 2106/1), one line printer (the 300-lpm 2404 or the 600-lpm 2405), and up to four 2821/1 Twin Exchangeable Disc Store Units. In addition, standard 1900 Series peripheral devices can be connected via up to four standard-interface channels.

SIMULTANEOUS OPERATIONS: Concurrently with computing, a Series 1900 processor can handle one I/O data transfer operation on each installed channel, subject to the maximum total I/O data rate specified in the table.

MASS STORAGE

2802 EXCHANGEABLE DISC STORE (EDS 8): Provides random-access storage for Models 1901A through 1906S on 6-disc packs which are physically interchangeable (but not format-compatible) with the IBM 1316 Disk Pack. Each drive unit accommodates one on-line pack holding

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the load that would otherwise be imposed upon the central processors by multi-line communications networks. Although the 1900 Series communications facilities are entirely adequate for most applications, the ICL System 4 computers are generally more effective in complex real-time environments because of their superior interrupt-handling facilities and multiple sets of general-purpose registers.

SOFTWARE

The 1900 Series software, like the hardware, is designed to satisfy a broad range of applications requirements and workload volumes. Users can choose the facilities that best meet their needs from a wide variety of operating systems, compilers, and applications programs.

A software Executive, required in every 1900 Series installation, complements the hardware by handling functions such as program loading, input/output control, and operator communications. In addition, most installations use an operating system, and ICL offers a choice of six. These range from the very basic Automatic Operator, usable on 8K card or paper tape systems, through five different versions of GEORGE (GEneral ORGanizational Environment). GEORGE 1 and 1S are straightforward, single-job-stream operating systems, and GEORGE 2 adds input and output spooling facilities. GEORGE 3, usable on 49K systems with disc storage, is a comparatively powerful system that offers multiple job streams, an integrated File Store data management system, remote job entry, and interactive programming facilities. GEORGE 4, designed specifically for 1904A through 1906S systems operating in the paging mode, offers essentially the same user facilities as the non-paged GEORGE 3 system.

For business applications, 1900 Series users generally choose to write their programs in COBOL, PLAN (the 1900 Series symbolic assembly language), or NICOL (an RPG-like system designed mainly to ease the transition from tabulating to computing). Scientific programmers can choose to work in FORTRAN, ALGOL, BASIC, or any of several less popular languages. The COBOL, FORTRAN, and ALGOL compilers and the PLAN assembler are all available in numerous versions designed for different hardware configurations. In addition, ICL offers conversational-mode compilers for FORTRAN and BASIC, as well as high-speed compile-and-run processors for FORTRAN and ALGOL.

More than 60 ICL-developed applications packages are now available to 1900 Series users. These programs span a broad range of applications, with particular emphasis upon data management, production control, operations research, statistics, civil engineering, electrical engineering, and numerical control.

up to 8.19 million 6-bit characters, and up to 8 drives (or 65.52 million characters) can be connected to a control unit. One read/write head serves each of the 10 recording surfaces and covers the 200 tracks it contains. Each track is divided into 8 sectors of 512 characters each. Average head movement time is 87.5 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 208,000 characters/second.

2813 EXCHANGEABLE DISC STORE (EDS 30): Provides large-capacity random-access storage for Models 1902A through 1906S on 11-disc packs which are physically interchangeable (but not format-compatible) with the IBM 2316 Disk Pack. Each 2813 transport unit accommodates one on-line pack holding up to 30.7 million 6-bit characters. An EDS 30 subsystem consists of a 2812/2 control unit and from one to nine on-line 2813 transports, providing a total storage capacity of up to 276 million characters. Each transport has a comb-type access mechanism that can read or write up to 151,552 characters (20 tracks) at each of its 203 positions. Each track is divided into 15 sectors of 512 characters each. Average head movement time is 60 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 416,000 characters/second. The 2812/2 control unit is an internally programmed controller that handles the queuing, initiation, control, and checking of all data transfer operations, buffers all data transfers between the EDS transports and main memory, performs automatic error checks during reading and writing, permits multiple simultaneous seek operations, and facilitates maintenance of the subsystem.

2815 EXCHANGEABLE DISC STORE (EDS 60): Provides large-capacity random-access storage for Models 1902A through 1906S on 11-disc packs which are physically interchangeable (but not format-compatible) with the IBM 2316 Disk Pack. The EDS 60 is a "double-density" version of the EDS 30 described above, with improved access times. Each 2815 transport accommodates one on-line pack holding up to 61.5 million characters. An EDS 60 subsystem consists of a 2812/3 control unit and from three to nine on-line 2815 transports, providing a total storage capacity of up to 553.5 million characters. There are 406 tracks on each of the 20 recording surfaces. Each track is divided into 15 sectors of 512 characters each. Average head movement time is 35 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 416,000 characters/second. The 2812/3 control unit performs the same programmed functions as the 2812/2 described above.

2821/1 TWIN EXCHANGEABLE DISC STORE (TEDS): Provides low-cost random-access storage for the Model 1901A, and for Models 1902A and 1902S when equipped with the Integrated TEDS Adapter. Each 2821/1 unit accommodates two on-line cartridges. Each cartridge consists of two discs and stores up to 1.6 million 6-bit characters. There are 200 tracks on each of the two recording surfaces, and each track holds 4000 characters. Average access time is 165 milliseconds, and data transfer rate is 208,000 characters/second. The Integrated TEDS Adapter accommodates up to four 2821/1 units, yielding a maximum on-line capacity of 12.8 million characters.

2851 DRUM STORAGE SYSTEM: Serves as a high-speed backing store for the automatic operating systems in Models 1904A through 1906S. As such, it cannot be directly addressed by user programs. A 2851 subsystem consists of a 2851/1 control unit and from one to eight

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COMPATIBILITY

Intrafamily compatibility was a principal design goal of the 1900 Series, and ICL has achieved this goal to a degree well beyond that of many competitive computer families. Minor differences in the input/output and control logic of the various processor models, as well as differences in their hardware instruction repertoires, are resolved by the software Executives. Thus, with only minor exceptions, users can count on full upward compatibility of programs, data, and job description commands throughout the 1900 Series. Moreover, it is practical, within reasonable limits, for a smaller 1900 Series system to serve as a backup machine for a larger one – an important consideration in underdeveloped countries where computers are relatively few and far between.

Because of ICL's independent approach to its design, the 1900 Series offers no program compatibility, at the machine or assembly-language level, with any competitive computer system. ICL's implementations of the COBOL, FORTRAN, ALGOL, and BASIC languages, however, are in accordance with the established standards for these languages.

Data compatibility with the IBM System/370 and other current computer systems is also quite limited. The ICL systems use standard 80-column cards and industry-compatible 7- and 9-track magnetic tape formats, but the ICL disc packs use fixed-sector-length formats which are incompatible with those of other systems. Moreover, the 1900 Series uses 6-bit BCD characters and 24-bit words, whereas the current IBM systems use 8-bit EBCDIC characters and 32-bit words.

COMPETITIVE POSITION

In the scope and depth of its product line, the 1900 Series ranks as one of the world's most impressive computer families. With more than 2500 installations to date, it has achieved a popularity and acceptance far beyond that of any other computer family from a non-U.S. manufacturer. What's more, ICL has done a good job of prolonging the effective marketing life of the series by steadily upgrading its hardware and software facilities.

In price/performance, ease of use, and overall effectiveness, the 1900 Series still compares favorably with the offerings of IBM and other competitive manufacturers in most situations. But ICL is finding it difficult to attract many new users to the 1900 Series these days. Despite the many attractions of the mature, time-proven 1900 Series, prospective new users are understandably more likely to be drawn toward the comparatively new and technologically exciting systems offered by IBM and

2851/2 or 2851/4 drum storage units. Both drum units have a storage capacity of 2,097,152 characters and an average rotational delay (half-revolution time) of 6.3 milliseconds, and both record data in 128-word sectors. The 2851/2 records 4 bits in parallel, with 32 sectors in each band of 4 tracks; while the 2851/4 records in bit-serial mode, with 8 sectors in each track. Data transfer rates are 1,400,000 characters/second for the 2851/2 and 350,000 characters/second for the 2851/4.

INPUT/OUTPUT UNITS

7-TRACK MAGNETIC TAPE SYSTEMS: These systems read and write data on standard ½-inch tape in 7-track, industry-compatible formats. Three types are available, with the following tape speeds (in inches per second), recording densities (in bits per inch), and data transfer rates (in 6-bit characters per second):

Type 1971: 37.5 ips; 200 or 556 bpi; 7500 or 20,800 char/sec.

Type 1972: 75 ips; 200 or 556 bpi; 15,000 or 41,700 char/sec.

Type 1973: 75 ips; 200, 556, or 800 bpi; 15,000, 41,700, or 60,000 char/sec.

All three types are offered in clusters of two, four or six tape drives plus controller. Each row (or frame) of tape holds one 6-bit character plus parity bit. Data can be read only in the forward direction.

9-TRACK MAGNETIC TAPE SYSTEMS: These systems read and write data on standard ½-inch tape in 9-track, industry-compatible formats. Six types are available, with the following characteristics:

Type 2504: 37.5 ips; 1600 bpi, phase encoded; 80,000 char/sec.

Type 2505: 75 ips: 1600 bpi, phase encoded; 160,000 char/sec.

Type 2506: 37.5 ips; 800 bpi, NRZI; 40,000 char/sec.

Type 2507: 75 ips; 800 bpi, NRZI; 80,000 char/sec.

Type 2508: 37.5 ips; 1600 bpi, phase encoded; 80,000 char/sec.

Type 2509: 75 ips; 1600 bpi, phase encoded; 160,000 char/sec.

All six types are offered in clusters of two, three, or four tape drives plus controller. Each 24-bit word is recorded in 3 consecutive rows (or frames) of tape, with 8 data bits and 1 parity bit in each row. (Note that the data transfer rates are expressed in 6-bit characters rather than rows.) Data can be read in either the forward or reverse direction.

The recently announced Type 2508 and 2509 Magnetic Tape Systems provide two significant improvements over the earlier Type 2504 and 2505 systems: automatic loading (which permits 10-inch reels contained in special cartridges to be loaded in about 10 seconds) and vacuum-operated capstans. All four 1600-bpi models feature in-flight correction of single-bit errors.

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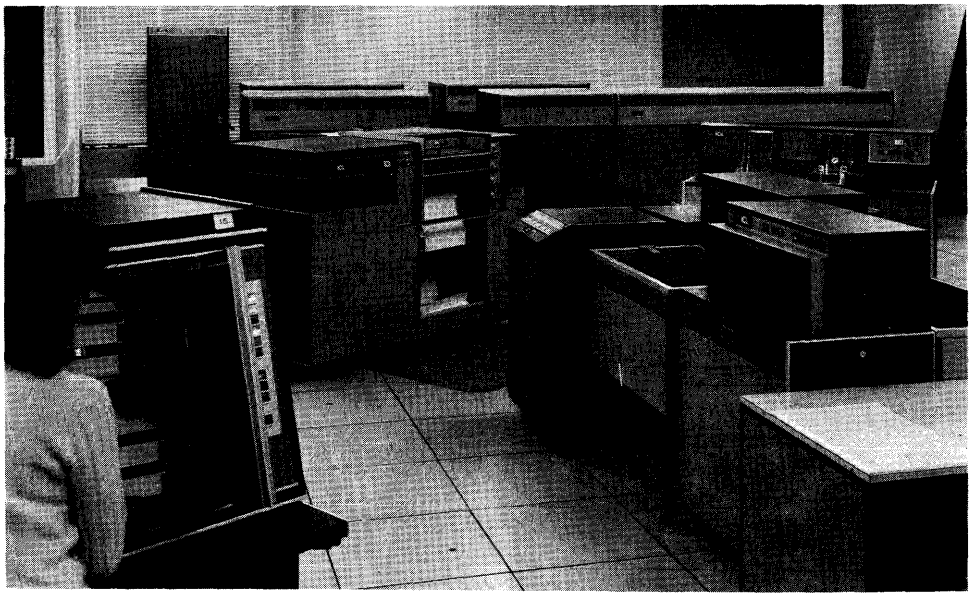

This photo shows part of a typical installation of the medium-large-scale 1904A system. From left to right are a high-speed card reader, line printer, 196K-word central processor (housed in the five cabinets at the rear), card reader, and paper tape equipment.

other manufacturers. Most of ICL's recent efforts have necessarily been devoted to preserving its large user base, and a high proportion of its recent sales have been to organizations that were already committed to using the 1900 Series.

In an all-out effort to reinforce its position in the marketplace, ICL recently replaced its top management, adopted a more marketing-oriented organizational structure, arranged a $35.5 million long-term loan from the UK Department of Trade and Industry to help finance its research and development program, and began seriously discussing the possibilities for cooperative agreements with other European or U.S. computer manufacturers. Meanwhile, ICL is reportedly developing a completely new line of medium-to-large-scale computers that will provide compatibility with IBM systems; but initial deliveries of these new models are likely to be at least two years away.

Regardless of ICL's future fortunes as a computer supplier, it is clear that the 1900 Series systems will continue to deliver effective performance in a broad range of applications for years to come. □

2101 CARD READER: Reads standard 80-column cards serially, on demand, at up to 1200 cpm in Type 2101/0 and 2000 cpm in Type 2101/2. Type 2101/0 can be used in any 1900 Series system, while Type 2101/2 can be used with all current models except the 1901A. Both versions include integrated control units. The 3000-card feed hopper and single 3000-card stacker can be loaded and unloaded while the reader is operating. Card data in the ICL 1004, 1300, 1500, 1900, or proposed ISO character code is translated into the 1900 Series internal code. The optional Card Image feature transfers the full card pattern into main memory.

2102 CARD READER: Reads standard 80-column cards serially at up to 300 cpm. Accepts the same codes as the 2101, above. The 1000-card feed hopper and single 1000-card stacker can be loaded and unloaded while the reader is operating.

2104 CARD READER: Reads standard 80-column cards serially at up to 600 cpm. Accepts the same codes as the 2101, above. The 1000-card feed hopper and single 1000-card stacker can be loaded and unloaded while the reader is operating.

2105/1 CARD READER: Connects only to the integrated card reader adapter of the 1901A central processor. Reads standard 80-column cards serially at up to 300 cpm.

2106/1 CARD READER: Connects only to the integrated card reader adapter of the 1901A central processor. Reads standard 80-column cards serially at up to 600 cpm.

1920/2 CARD PUNCH: Punches standard 80-column cards in row-by-row fashion at 100 cpm. Has an integrated control unit and 80-bit buffer. Translates data from the 6-bit internal code into the ICL 1900 card code. Performs a hole-count check upon punching accuracy. Has an 800-card input hopper and a 650-card stacker with an offset stacking facility for error cards.

2151 CARD PUNCH: Punches standard 80-column cards in row-by-row fashion at 300 cpm. Has an integrated control unit and a full 80-character buffer. Translates data from the 6-bit internal code into the ICL 1900 card code. Performs a hole-count check upon punching accuracy. Has a 1000-card input hopper and two 850-card stackers.

1915/2 PAPER TAPE READER: Reads 5, 6, 7, or 8-track paper tape at 300 char/sec., with or without parity checking. Automatically translates the 8-track ICL 1900 paper tape code (based on the ISO 7-bit code) into the 6-bit internal code. Handles other codes through program translation and/or through the optional Tape Image feature, which transfers an exact bit image of all 8 tracks to main memory.

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1916/2 PAPER TAPE READER: Reads 5, 6, 7, or 8-track tape at 1000 char/sec. Code-handling facilities are the same as those of the 1915/2, above.

1925 PAPER TAPE PUNCH: Punches 5, 6, 7, or 8-track tape at up to 110 char/sec. Automatically translates the 6-bit internal code into the 8-track ICL 1900 paper tape code (based on the ISO 7-track code). Handles other codes through program translation and/or through the optional Tape Image feature.

2601 & 2602 PAPER TAPE READER PUNCHES: Read 5, 6, 7, or 8-track tape at up to 250 or 1000 char/sec., respectively, and punch it at up to 110 char/sec. The reader and punch share a single I/O channel and can operate simultaneously by interleaving their data transfers to and from main memory. Code-handling facilities are the same as those of the 1915/2 and 1925, above.

1933 PRINTER: Prints up to 1100 lpm using the full set of 64 characters and up to 1350 lpm when a 48-character subset is used. Has a conventional drum-type printing mechanism, an integrated control unit, a full-line print buffer, and a dynamic stacker that restacks fanfold forms in their original folds. Available with either 120 or 160 print positions. Spacing is 10 characters/inch horizontally and 6 or 8 lines/inch vertically. Skipping speed is a maximum of 31 inches/second. Uses the ECMA "B" Size 1 type font. Accepts forms from 4 to 18 inches wide and up to 18 inches long.

2401 PRINTER: Prints up to 300 lpm using the full set of 64 characters. Has a conventional drum-type printing mechanism, 120 print positions, and an unbuffered control unit. Skipping speed is a maximum of 24 inches /second. Format and character set are the same as those of the 1933, above.

2402 PRINTER: Prints up to 600 lpm using the full set of 64 characters and up to 750 lpm when a 48-character subset is used. Has a conventional drum-type printing mechanism and an unbuffered control unit. Available with either 96 or 120 print positions. Skipping speed is a maximum of 31 inches/second. Format and character set are the same as those of the 1933, above.

2404 PRINTER: Connects only to the integrated printer adapter of the 1901A central processor. Prints up to 300 lpm, using 64 characters of the ECMA "B" Size 1 type font. Available with either 96 or 120 print positions.

2405 PRINTER: Connects only to the integrated printer adapter of the 1901A central processor. Prints up to 600 lpm, using 64 characters of the ECMA "B" Size 1 type font. Available with either 96 or 120 print positions.

1934 DIGITAL INCREMENTAL PLOTTERS: Produce X-Y plots on 120-foot rolls of paper, using a drum-type plotting mechanism. Six models (1934/1 through 1934/6) are available, offering a choice of step sizes (0.004, 0.005, or 0.01 inch), plotting speeds (200 or 300 steps/second), and plotting widths (11 inches on 12-inch paper or 29.5 inches on 31-inch paper).

UNIVERSAL DOCUMENT READER: Optically reads marks and/or characters from paper documents. Consists of a single feed hopper, a mark reading head and/or a character reading head, and 3, 6, 9, or 12 stackers (plus a reject tray and a "no destination" stacker). Handles documents in two size ranges: "small" documents from 4.75 to 8 inches in length by 3 to 6 inches in width, and "large" documents from 8 to 13 inches in length by 4 to 8.5 inches in width. Small and large documents are read at the rate of 300 and 150 documents/minute, respectively. The optical mark reading head can identify marks made by a pencil, imprinter, typewriter, or line printer; a matrix of up to 60 rows of 23 marking positions, plus a mandatory clock track, can be handled on a large document. The optical character reading head reads one line of characters printed in the ECMA "B" Size 1 type font at either 8 or 10 characters/inch; reading speed is 550 characters/second. When both heads are installed, marks and characters can be read simultaneously from the same documents.

COMMUNICATIONS EQUIPMENT

7900 SERIES COMMUNICATIONS SYSTEMS: A range of modules which can be combined to form multi-line communications control systems of either the character-buffering or message-buffering type. These modules include: (1) line termination units, which convert signals from the communications lines into the appropriate form; (2) line scanners, which assemble the bits received over the lines into characters; and (3) communications processors (used only in message-buffering systems), which utilize stored programs supplied by ICL to control the communications functions, store complete messages, deal with errors, and accumulate line performance statistics for maintenance purposes. The 7900 Series systems can be used with Models 1902A through 1906S.

In character-buffering systems, individual characters are transferred between the line scanner and the central processor, which is responsible for all line control and message buffering functions; because of the heavy load imposed upon the central processor, this type of system is suitable for only a limited number of lines. In message-buffering systems, complete messages (or blocks of messages) are transferred between the central processor and the communications processor. All control procedures are carried out by the dedicated control programs in the communications processor, thereby greatly reducing the communications load upon the central processor.

ICL's principal communications processor is the 7903, which includes 16K, 24K, or 32K 16-bit words of 1.1-microsecond core storage and an integrated paper tape reader. The 7903 accommodates up to four 7930/9 Scanner Selectors, and up to three line scanners can be connected to each Scanner Selector. The 7903 includes an interprocessor module that permits it to be connected to a 1900 Series central processor via a standard interface.

ICL also offers the less powerful 7901 Communications Processor, which includes 8K or 16K 24-bit words of 4-microsecond core storage. The 7901 has two multi-channel interfaces, each capable of accommodating a 7921 Scanner Selector and handling up to 64 lines. The 7901 can be equipped with a card or paper tape reader, and is connected to a 1900 Series central processor via the 7926 Interprocessor Buffer.

The 7900 Series includes four basic types of line scanners:

- A "universal" scanner with CCITT interfaces for up to 16 communications lines, for both synchronous and asynchronous devices operating at 50, 75, 100, 150, 200, 300, 600, 1200, 2400, 3600, or 4800 bits/second.

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- A "universal" scanner with CCITT interface for up to 16 communications lines, for both synchronous and asynchronous devices operating at 110 bits/second, and at up to 4800 bits/second when used with self-clocking modems.

- A telegraph-only scanner for up to 63 teletypewriter terminals communicating asynchronously at 50, 75, 100, 150, or 500 bits/second.

- A telegraph-only scanner for up to 63 teletypewriter terminals communicating asynchronously at 100 bits/second; designed for large in-house teletypewriter systems and for the UK Post Office Datel 100 Service.

7010 TELEPHONE DATA TERMINAL: Connects a single modem and associated telephone line to a 1900 Series central processor via a standard I/O channel. Can be used to connect a remote batch terminal (e.g., the ICL 7020) to a 1900 Series computer or to interconnect two 1900 Series computers via a communications link. Provides character and block-parity checking and generates appropriate transmission control characters. Available in three models with transmission speeds of 600/1200, 2400, and 4800 bits/second.

7070 TELEPHONE/TELEGRAPH LINE TERMINAL: Connects a single teletypewriter, operating over either a telephone or telegraph line, to a 1900 Series central processor via a standard I/O channel. Transmission is asynchronous, at a maximum speed of 10 characters/second.

7210/1 LOCAL INTERPROCESSOR BUFFER: Links two neighboring 1900 Series central processors by interconnecting two standard I/O channels, one on each processor. Data is transferred at a maximum rate of approximately 100,000 characters/second. The stored programs in each processor can regard the other processor as a peripheral unit.

7020 COMMUNICATIONS TERMINAL: A remote batch terminal designed to transmit and receive data at 600 or 1200 bits/second (Type 7010/3), 2400 bits/second (Type 7010/5), or 4800 bits/second (Type 7010/7). Peripheral interfaces permit connection of any of the following I/O devices: 7021 Line Printer (600 lpm, 120 or 132 print positions), 7022 Card Reader (320 cpm), 7023 Teletypewriter (10 cps, KSR or ASR), 7024 Paper Tape Reader (500 cps), 7025 Paper Tape Punch (110 cps), and 7028 Paper Tape Reader/Punch (110 cps). The 7020 can be connected to a 1900 Series computer via an appropriate 7010 Telephone Data Terminal or 7900 Series Communications System.

7071 TELETYPEWRITER: A modified Teletype Model 33 terminal, usable for remote or local interrogation of files and other communications functions. Available in both KSR (keyboard send/receive) and ASR (automatic send/receive) models and for both friction-feed and sprocket-feed forms. Can be connected directly to a 1900 Series I/O channel, or remotely via a 7070 Line Terminal or a 7900 Series Communications System.

7072 TELETYPEWRITER: A modified Teletype Model 35 terminal. Available in the same choice of models as the 7071, all with essentially the same functional capabilities. The 7072 is a "heavy-duty" model and is recommended for applications in which its usage will exceed three hours per day.

TERMIPRINTER: A modified GE TermiNet 300 teletypewriter, capable of transmitting and printing data at switch-selectable speeds of 10, 20, or 30 characters/second. Prints by means of a molded polyurethane belt containing two complete sets of print characters on the tips of flexible fingers; the belt rotates continuously between a bank of print hammers and an inked ribbon. The basic KSR model includes a standard typewriter keyboard and offers a choice of either 75 or 118 print positions and either friction or sprocket feed. For ASR operation, a paper tape reader and punch (or reader only) can be added. Receive-only (RO) models are also available, with 118 print positions and either friction or sprocket feed. ISO coding is used, and there are 96 printable characters, including both upper and lower case alphabetics.

7181 VISUAL DISPLAY UNIT: Provides local or remote displays of alphanumeric data. Consists of a CRT display, buffer store, character generator, and typewriter-style keyboard. An optional keyboard extension, consisting of a block of numeric keys, can be used to enter either numeric data or special function codes. The CRT screen displays up to 2000 characters, in 25 lines of 80 characters each, in a viewing area 10.4 inches wide by 6.9 inches high. The character set consists of 92 symbols, including both upper and lower case alphabetics. Editing operations include character insert and delete, line insert and delete, erase, tabulate, and computer-controlled message formatting. For hard copies of displayed data, a teletypewriter (receive-only or automatic send/receive) or Termiprinter (receive-only) can be connected to the display unit.

For local use, the 7181/4 Visual Display Unit is connected to a 1900 Series computer via a 7180/1 Control Unit. The 7180/1 has 16 channels, and each channel can be connected either directly to a display unit, or indirectly via a 7180/7 Expansion Unit. Each 7180/7 can accommodate 15 display units, enabling a single 7180/1 to control up to 240 display units. Each display is linked to the control unit by a cable up to 5000 feet in length (or 10,000 feet when an Expansion Unit is interposed). Data is transferred at up to 1 million bits/second.

For remote use, the 7181/2 Visual Display Unit is connected to a 1900 Series computer via a suitable communications link. Data can be transmitted to or from the 7181/2 at up to 4800 bits/second. Up to 24 display units can share a single modem and leased line through the use of a Line-Sharing Adapter. Each adapter has 8 channels, and one or two 8-channel expansion modules can be added to accommodate 16 or 24 terminals.

SOFTWARE

ICL distinguishes between Executives, which must be used in every 1900 Series installation, and operating systems, whose use is optional in all models except the large-scale 1906A and 1906S.

EXECUTIVE: This basic software system complements the 1900 Series hardware by performing the following principal functions:

1. Interpretation and execution of the operator's commands to the system, which are entered via the console typewriter or prepunched cards or paper tape.

2. Provision to the operator of information about the system's status and any irregular conditions.

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3. Control of all data transfers to and from peripheral devices, including error checking and recovery.

4. Implementation of "Extracodes" (i.e., standard subroutines that are executed whenever certain machine instructions are encountered in a program). Extracodes are used for input/output and control operations, as well as for certain arithmetic instructions in the smaller 1900 Series processors.

5. Loading, initiation, and termination of programs.

6. Allocation of peripheral devices to specific programs.

7. Control of multiprogramming (i.e., allocation of the central processor's time among two or more operational programs and prevention of interference between the programs).

One or more versions of the Executive are available for each of the 1900 Series central processors. The smaller versions lack facilities for multiprogramming. Main memory requirements for the Executive naturally vary with the complexity of the system and its configuration.

AUTOMATIC OPERATOR: This basic operating system complements the Executive in the smaller 1900 Series processors, Models 1901A through 1903S. It enables a series of programs to be successively loaded and executed with a minimum of operator intervention; there are no facilities for multiprogramming or for the use of program libraries on magnetic tape or disc. The minimum configuration for use of the Automatic Operator is an 8K central processor, one card or paper tape reader, and one output device. Certain control statements used by the Automatic Operator are not compatible with those used by the GEORGE operating systems.

GEORGE 1: This single-stream operating system can be used by installation with at least 16K words of main memory, either magnetic tape or disc storage, a card or paper tape reader, and a line printer. GEORGE 1 is an overlaid system that can reside on either magnetic tape or disc. Using job description commands on punched cards or paper tape, GEORGE 1 can successively load and execute a series of programs contained in a magnetic tape or disc library. It can also produce memory dumps, edit source programs and data files on magnetic tape, and perform other useful utility functions. Complete or partial job descriptions that are used repeatedly can be defined, named, and filed as "macros" to save operating time. GEORGE 1 has no multiprogramming facilities, but multiprogramming processors with sufficient main memory and peripheral equipment can use two or more copies of GEORGE 1 to run multiple job streams in parallel.

GEORGE 1S: This subset of the GEORGE 1 operating system can be used by installations with as little as 8K words of main memory, one disc drive (EDS or TEDS), a card or paper tape reader, and a line printer. GEORGE 1S is issued as an integral part of the overlaid single-programming Executive for Models 1901A through 1903S and requires no additional main memory while a job is being run. It performs essentially the same functions as GEORGE 1, above. Job descriptions written for GEORGE 1S can be submitted without change to the GEORGE 1 and 2 operating systems.

GEORGE 2: This extension of the GEORGE 1 operating system adds capabilities for "spooling" of input and output data in Models 1902A and above. An input stream of job descriptions, programs, and/or data can be transcribed from punched cards or paper tape to magnetic tape or disc, and output data can be transcribed from magnetic tape or disc to a printer. Although user programs are still executed in single-stream fashion, the disc-to-disc or tape-to-tape mode of operation made possible by the input/output spooling generally yields improved throughput. GEORGE 2 requires at least 24K words of main memory and occupies three program slots in the central processor.

GEORGE 3: This comparatively powerful multi-stream operating system can be used by Model 1902S through 1906S processors with at least 49K words of main memory. Also required are 500,000 words of direct-access (disc or drum) backing storage, 4 magnetic tape drives, card or paper tape reader, line printer, console typewriter, program timer, and real-time clock. GEORGE 3 complements the multiprogramming Executive by providing the following principal facilities:

1. Job schedulers which enable the system to process a number of jobs simultaneously in both on-line and background modes. The high-level scheduler analyzes the overall job mix and determines the proportion of computer time to be allocated to each job. The low-level scheduler then allocates a time slot to each job and controls the switching from job to job.

2. A comprehensive job description language, which can be submitted to the processor via punched cards, paper tape, or a console typewriter. Complete or partial job descriptions can be defined as "macros" and filed on disc.

3. Spooling of input and output data on disc files or magnetic tape (called "off-lining" in ICL parlance).

4. A File Store data management system, which organizes the user's data files into a tree-structured hierarchy. Users need to concern themselves only with the contents of their files; GEORGE 3 will store them on discs or magnetic tape, maintain multi-level directories, retrieve specified records for processing, safeguard the files against unauthorized access, and periodically dump them onto magnetic tape so they can be reconstituted at any time.

5. Multiple on-line programming (MOP) facilities, which permit multiple remote teletypewriters to be used as on-line interactive terminals. Each teletypewriter user has all the relevant facilities of the system at his disposal; he can use the standard command language, access the central File Store, and enter, edit, compile, and execute programs. The resulting output can be transmitted back to the teletypewriter and/or printed by the central computer.

6. Remote job entry and control facilities, which permit jobs to be entered from remote locations via ICL 7020 Communications Terminals or suitably equipped 1901A computers. These jobs are run in the same way as other background work, and their output can either be returned to the

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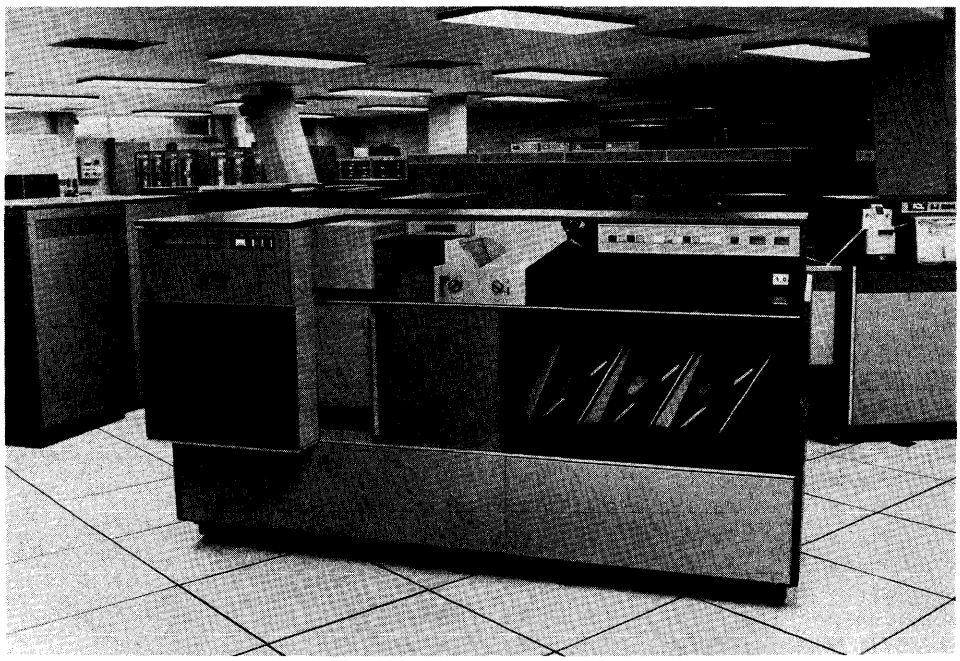

ICL's Universal Document Reader can be fitted with an optical mark and/or character reading head and from 3 to 12 stackers. Shown here is a 3-stacker model equipped for character reading.

originating terminal or written on central-site peripheral devices.

7. Accounting and budgeting facilities, which aid in analyzing and controlling the system's utilization. Monitoring information, including details of each job's progress, is accumulated in a central file. ICL provides a basic log analysis program, and the user can add others to suit his particular needs. Budgets can be allocated to individual users to control their use of the system's resources, and can be checked each time a job is initiated.

GEORGE 4: This extension of GEORGE 3 is the standard operating system for Model 1904A, 1904S, 1906A, and 1906S processors operating in the paging mode. It offers essentially the same user facilities as GEORGE 3, but all are adapted to operate in a paging environment. The principal changes are in the scheduling and space-allocation routines, and an added "page-turning" routine controls the swapping of pages between main memory and the required 2851 Drum Storage System. GEORGE 4 automatically divides all object programs into 1024-word blocks and "maps" them into the pages of main memory and the backing drum. Programs and job descriptions written for execution under GEORGE 3 can be run without change under GEORGE 4.

1900 DRIVER: This is a set of standard routines designed to handle the functions which are common to on-line data communications systems and to control the progress of each message through the system. The 1900 Driver accepts incoming messages, initiates processing by the appropriate user-written application routines (or "beads"), monitors transfers to and from disc or tape files, and passes outgoing messages to the communications network. A set of program testing aids permits individual beads or groups of beads to be tested independently of the communications equipment. The 1900 Driver can be used on 1900 Series processors that have at least 16K words of main memory and use an overlaid multiprogramming Executive.

MINIMOP: This "multiple on-line programming" system controls the simultaneous operation of up to nine remote teletypewriters used as on-line interactive terminals. Background batch jobs can be run concurrently with the interactive programs under the control of either GEORGE 2 or the Executive.

COBOL: ICL offers a range of compilers for the standard COBOL language, including a Compact COBOL system that implements a restricted subset of the language and runs on the smaller 1900 Series processors. Main memory requirements for compilation are 5888 words for Compact COBOL and at least 10,240 words for COBOL. Also required are a card or paper tape reader, line printer, and either 4 magnetic tape drives or 1 disc unit. Features of the larger COBOL compilers include mass storage statements, sorting, COBOL Library facilities, batch compilation, and the ability to compile COBOL programs as separate segments which can later be consolidated into larger object programs or incorporated into programs written in other languages. Typical compilation speeds range from about 50 lines/minute for an 8K magnetic tape system with both source and object programs on slow I/O devices to about 1000 lines/minute for a 32K system with all files on disc. ICL also offers Decision Table Preprocessors that enable users to express complex problems in a straightforward tabular form, which is automatically translated into a COBOL source program and then compiled.

FORTRAN: ICL offers a wide range of compilers for three distinct levels of the FORTRAN language. ANS Basic FORTRAN compilers are available for systems with as little as 4K words of main memory and either card, paper tape, magnetic tape, or disc I/O. Full ANS FORTRAN compilers are available for 16K systems with the same four I/O media. The more powerful 1900 Extended FORTRAN language requires at least a 32K disc system for compilation; larger systems can use special compilers designed to minimize either the object-program execution time (Optimizing FORTRAN) or the compilation and testing time (FLAIR). FORCON is a conversational version of FORTRAN designed for on-line use via remote

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teletypewriters; it runs under the control of GEORGE 3 or 4.

BASIC: ICL's implementation of the BASIC language is a conversational system designed for use in an on-line programming environment under the GEORGE 3 operating system. The BASIC system features an interactive source-language analyzer and editor, program-file maintenance facilities, an "instant calculation" facility, and extensive diagnostic aids. The language is compatible with most other implementations of BASIC.

ALGOL: ICL offers numerous compilers for two distinct levels of the ALGOL language. Basic ALGOL compilers are available for systems with as little as 4K words of main memory and either card, paper tape, magnetic tape, or disc I/O. The more powerful ALGOL 60 language requires at least a 16K system with disc, magnetic tape, or paper tape I/O. BABS (Basic ALGOL Batch System) is a fast, in-core compiler designed to process batches of small programs in educational or research environments.

NICOL: This simplified commercial programming language is essentially a report program generator. Designed primarily for use on the 1901A, to ease the transition from tabulating to computing, it can also be used on the larger 1900 Series computers. In its simplest form, NICOL is based upon a cycle in which a record is read from an input file, processing is carried out, and one or more output records are produced. Input and output file definitions are written separately from the processing specifications.

PLAN: This is the basic symbolic assembly language for all models of the 1900 Series. It enables the programmer to exert firm control over all the hardware facilities, yet it is comparatively easy to use because of the underlying architectural simplicity of the 1900 Series architecture. Several versions of the PLAN assembler are available, for 4K card or paper tape systems, 8K magnetic tape or disc systems, and 32K magnetic tape or disc systems. The larger versions include comprehensive macro-instruction facilities.

UTILITY ROUTINES: ICL offers an appropriate complement of sort/merge, data transcription, diagnostic, and other utility routines for the 1900 Series. PATSY (Program Automatic Testing System) is designed to simplify batched compilation and testing of programs written in PLAN, COBOL, or NICOL.

APPLICATION PROGRAMS: ICL currently offers more than 60 applications packages spanning a wide range of business, engineering, and scientific functions. Of particular significance is NIMMS (1900 Integrated Modular Management System), a comprehensive data management system oriented toward industrial requirements planning, shop scheduling, stock control, and factory cost control. NIMMS can be used on a 32K disc system. As an offshoot of NIMMS, ICL now offers a generalized Data Base Management Software (DBMS) system. Other noteworthy programs for the 1900 Series, together with their minimum main memory requirements, include:

Data Management Software – 16K
FIND-2 (information retrieval and reporting) – 8K
SCAN (inventory analysis and control) – 8K
PERT – 8K
PEWTER (simplified PERT) – 8K
PROMPT (production control system) – 16K
PROP (financial planning system) – 8K
PROSPER (financial model-building) – 16K
COMPAY 1D (payroll) – 8K
SHREAD (share registration) – 16K
Linear Programming – 8K
Vehicle Scheduling – 16K
CSL, Mark 2 (simulation language) – 16K
SIMON (simulation language) – 16K
Scientific Subroutines – 8K
Statistical Analysis – 8K
Survey Analysis – 8K
Cut and Fill – 16K
Traverse Computation – 8K
Continuous Beam Analysis – 16K
Pipe Stressing – 16K
AC Load Flow – 16K
AC Network Reduction – 16K
Transient Stability – 16K
DC Network Analysis – 16K
Furness Traffic Prediction – 8K
Fluid Distribution Network Analysis – 16K
X2F Numerical Control System – 8K
MILMAP (numerical control) – 16K
Profiledata (numerical control) – 16K

PRICING

ICL declined to provide any official price data on the 1900 Series equipment. Note, however, that approximate mainframe and system prices are listed in the table on page 70C-533-01c. ICL is currently marketing the 1900 Series on a "bundled" basis. There is no additional charge for ICL software except to commercial service bureaus. ■