

ICL 2900 Series

MANAGEMENT SUMMARY

The 2900 Series is a compatible, field-upgradable range of 5 mainframe computers: the 2953, 2957, 2958, 2966, and 2988. During 1984 the 2955, which was incompatible with the other systems, was withdrawn and a new entry-level model, the 2953, was launched.

All 2900 systems operate under the Virtual Machine Extended (VME) operating system. Most models can be extended from a single configuration to form a "dual" or "superdual" system providing greater fault tolerance and increasing power. CAFS-ISP (Content Addressable File Store—Information Search Processor), an intelligent disk subsystem which reduces data retrieval time, can be fitted to all 2900 systems. Networking facilities are provided to link other ICL products, as well as other manufacturers' machines, to the 2900.

The 2900 Series is the largest family of computers within ICL's "Network Product Line." Other members include Distributed Resource System (DRS), System 25 minicomputer, PERQ graphics workstation, and the ICL Personal Computer. The systems within the Network Product Line have common standards and can be networked together using ICL's IPA (Information Processing Architecture).

In order to provide flexible upgrade capability, ICL provides single, dual, and superdual versions of most 2900 systems. A single machine contains an Order Code Processor (OCP), which is the central processing unit, and handles internal functions such as program instructions and interrupt control, but not input/output. ICL employs separate I/O controllers within the 2900 Series.

A dual machine contains 2 OCPs, giving approximately 1.8 times the power of 1 OCP. This provides a low-cost performance upgrade to a single processor system, and resilience to an OCP failure. A dual system may be operated as a fault-tolerant machine consisting of 2 single systems if duplicate peripherals are purchased.



The ICL 2966 mainframe computers can be configured with single or dual processors having up to 32M bytes of store, each.

The 2900 Series is ICL's range of mainframe computers for medium to large users. The Series comprises 5 upgradable models. CAFS-ISP (Contents Addressable File Store—Information Search Processor) is available on all models and provides fast access to large amounts of data. The 2900 machines can be used as central DP systems, network nodes, or as distributed standalone systems.

MODELS: 2953, 2957, 2958, 2966, 2988.
CONFIGURATIONS: 4MB to 64MB main memory, up to 6 device control units for I/O, and from 1 to 4 Order Code Processors.
COMPETITION: IBM 4300, 303X, and 308X families, and comparable ranges from other manufacturers.
PRICE: From approximately £110,000 to over £1,000,000.

CHARACTERISTICS

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TABLE 1. SYSTEM CHARACTERISTICS

	2953
SYSTEM CHARACTERISTICS	
Date of introduction	October 1983
Date of first delivery	NA
Virtual storage capability	Standard
Number of central processors	1
Principal operating system	VME
Main Storage	
Storage type	MOS-64K
Read cycle—nanoseconds	750
Write cycle—nanoseconds	600
Partial write—nanoseconds	1200
Bytes fetched per cycle	8
Storage interleaving	No
Minimum capacity—bytes	4M
Maximum capacity—bytes (single)	8M
Dual systems	No
Superdual systems	No
Increment size—bytes	2M
Buffer Storage (slave stores)	
Cycle time—nanoseconds	80
Bytes fetched per cycle	4
Data slave capacity—bytes	16K
Processing unit	
Machine cycle time—nanoseconds	80
Processing unit features	
Floating point	Standard
Extended precision floating point	Standard
Decimal arithmetic	Standard
Fast multiply/divide unit	No
Realtime clock	Standard
Microprogrammed	Yes
Pipeline steps	2
Pipeline capacity instructions	2
Compatibility features	
ICL 1900 series emulation by microcode	Yes
ICL 2903, 2904 emulation by microcode	Yes
ICL System 4 emulation	No
Channels	
Store Control Units (SCU)	1
Device Control Units (DCU)	1 to 4
SCU to main store	16MB/s
Maximum total transfer rate	19.6MB/s
Power ratio	—

➤ Superduals are an extension of the dual concept and provide a higher level of automatic recovery. Each system component is duplicated and in the event of a failure, operation continues without the failed part. This is especially useful in systems with a large number of online users.

All models are available in single configuration; the 2957, 2959, and 2966 can additionally be configured in dual and superdual versions, and the 2988 is also available as a superdual system.

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➤ **DISTRIBUTORS:** ICL also has offices in the following countries: Barbados, Fiji, Ghana, Iraq, Jamaica, Kenya, Malawi, Malaysia, Mauritius, Mexico, Nigeria, Pakistan, Papua New Guinea, Saudi Arabia, Singapore, Sudan, Swa-

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▷ CAFS-ISP units can optionally be used with all 2900 systems. Data is retrieved by attributes and values rather than by location, and random access to the data is provided. CAFS-ISP will search unstructured data and can be used with a query language for simple text handling.

All 2900 models are based on the same central processing unit and provide upgrading capabilities from the entry-level 2953 to the top end 2988. Model differences include main memory capacity, and peripheral capabilities. Main memory on the 2953 ranges from 4M bytes to 8M bytes. The 2957 and 2958 have a basic memory of 4M bytes, expandable to 16M for a 2957 and 32M bytes for a 2958 superdual version. Main memory on the 2966 and 2988 extends from 8M bytes to 64M bytes in the superdual configuration.

All five models support virtual memory and virtual machine processing; and use microcoded instructions. To optimize processing speed, pipelining techniques are applied throughout the range.

In order to provide software compatibility to customers of ICL's earlier 1900 and System 4 ranges, emulation capability is available on certain 2900 processors (see Table 1).

PERIPHERALS AND COMMUNICATIONS

A large variety of peripherals is available for the 2900, with the accent on medium- to large-capacity disk drives, and on flexibility in control. Apart from disk drives, ICL offers magnetic tape drives, printers, and card and paper tape devices.

A variety of terminals are offered and connections are provided to link other members of ICL's Network Product Line, including the DRS system, System 25, PERQ, and the ICL Personal Computer. Through IPA, terminals on these systems can access 2900 systems.

In order to control peripherals, ICL provides three control units termed DCU (Device Control Unit) 1, DCU 2, and DSC (Decision Support Controller). The DCU 1 is a general purpose controller, while the DCU 2 has been developed to handle a very large number of disks and magnetic tapes and may have one or two CAFS-ISP modules associated with it. The DSC is similar to the DCU 2, but additionally has a CAFS-ISP fitted as standard. Peripheral devices are connected via couplers to interface modules on the DCU 1, DCU 2, and DSC.

Communications couplers are available for DCU 1 which support a small 2900 network. A Network Processor System (NPS) provides communications facilities for large networks. An Open System Gateway product (OSG/2900) provides a gateway from 2900 systems into the OSLAN local area network.

The DCUs, DSC, communications couplers, NPS, and OSG/2900 can all be connected to ICL's Information Processing Architecture (IPA) for communication and networking purposes. IPA provides facilities for remote

▷ ziland, Tanzania, Trinidad, Uganda, United Arab Emirates, Zambia, and Zimbabwe.

MODELS: ICL 2953, 2957, 2958, 2966, and 2988. Obliques are used (e.g., 2958/35) with numbers to denote particular configurations.

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent one alphanumeric character, 2 BCD digits of 8 binary bits. The word of 32-bits is formed from four consecutive bytes.

FIXED POINT OPERANDS: 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode: one word (32 bits) or one double word (64-bits) in binary mode.

FLOATING POINT OPERANDS: A word consisting of a 24-bit (6 hex digit) fractional part plus a 7-bit hexadecimal exponent in long form or, in extended form, 4 words with 112-bit fractional part (28 hex digits) plus 7-bit hexadecimal exponent.

INSTRUCTIONS: 2 or 4 bytes in length. Most instructions are available in both forms. There also are three instruction formats. Primary format instructions are either computational or miscellaneous. Secondary format instructions are store-to-store instructions. Tertiary format instructions are conditional jump instructions.

INTERNAL CODE: EBCDIC (Extended Binary-Coded Decimal Interchange Code).

MAIN STORAGE

Main storage on the 2900 series consists of at least one Store Module. Each such module contains up to 16MB of 64K-chip memory in 2 or 8MB blocks.

STORAGE TYPE: 64K MOS chips.

CYCLE TIME: See Characteristics Table. High speed slave stores make effective speed of main memory much higher than the figures indicate.

CHECKING: All data paths between the central processor and main storage are parity checked by byte. When data is stored, an error-correcting code is substituted for the parity bits. (An 8-bit modified Hamming code is appended to each 8-byte doubleword of data.) When the data is retrieved, single-bit errors are detected and corrected automatically, and most multiple-bit errors are detected.

STORAGE PROTECTION: Each segment of virtual storage is protected by three codes: a 1-bit Execution Permission key, an 8-bit Read access key, and an 8-bit Write access key. Only code associated with an Execution Permission bit can be executed. When a store access is made, the contents of the Access Control Register (ACR) are compared with either the read or write key of the segment. Sixteen levels of privilege are used. Values of 0 to 9 are set by the system software and values 10 to 15 by the applications programs. Access is granted when the contents of the ACR are equal to, or less than, the key assigned to the segment.

RESERVED STORAGE: Each virtual machine is assigned a set of consecutive storage locations for use as a last-in, first-out stack of general purpose 32-bit registers. The hardware-coupled stack varies in size dynamically as the needs of the virtual machine change.

CENTRAL PROCESSORS

▷ The 2953, 2957, 2958, 2966, and 2988 encompass a wide range of power and processing facilities. They are all pipe-

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TABLE 2. MASS STORAGE

Subsystems	FDS 640	FDS 160	EDS 80
Cabinets per subsystem	Up to 63	Up to 30	Up to 30
Disk packs/HDA's per cabinet	1 HDA	2 HDAs	2 HDAs
Capacity, MB	651.2	160.1 per HDA	79.2 per HDA
Average access time, msec.	25	30	30
Average rotational delay, msec.	8.3	8.3	8.3
Data transfer rate MB/s	1.2	1.2	1.2
Controller model	DCU 1 DCU 2 DSC	DCU 1 DCU 2 DSC	DCU 1 DCU 2 DSC

HDA—Head Disk Assembly.

▷ terminal access, file transfer, and automatic message routing for Transaction Processing Systems.

Disk storage comprises two fixed drives and one exchangeable drive. Access to CAFS-ISP, which offers a powerful extension to the disk drives, is provided.

Disk capacities are 160M bytes and 651M bytes on fixed disks and 79M bytes on an exchangeable disk pack drive.

CAFS-ISP is designed to retrieve file information directly, rather than through a conventional string of related indices. It is designed to implement this procedure as a self-contained task, independent of the central processor. Its targeted market area includes personnel inquiries, telephone directory inquiries, analysis of reports of operating incidents or any field with a high incidence of queries.

ICL currently provides 4 ways of exploiting the search capabilities of CAFS-ISP:

- QueryMaster, an online general inquiry package;
- RCI, Relational CAFS Interface, which offers an efficient and simple tool for Cobol programmers;
- Programming Interface for expert programmers and software houses; and
- Pre-Selective Access Method (PSAM) which enables an existing program without recompilation to use CAFS-ISP to select records.

A number of magnetic tape drives, with transfer rates ranging from 60 kilobytes per second to 780 kilobytes per second is provided. All tapes are 9-track with many of them offering compressed recording capability together with features such as autoloading with tape cartridges.

Four line printers, with speeds ranging from 220 lines per minute with a 96-character set to 1440 lpm with a 48-character set, are available with the 2900 Series (see Table 2).

▶ line processors permitting the overlapping of up to 6 instructions. In addition, slave stores are used. Processing speed is also enhanced by the use of 17-layer printed circuit boards which provide matched interconnections and minimize pulse distortion. High-speed, low-power LSI circuits also contribute to the same end.

Optimization of these 2900 models is further supplemented by the use of modular units, each devoted to a specialist function—such as instruction processing or store access control. These and other units can work concurrently, thus benefitting throughput.

There is a very significant bonus from this modular approach: systems can be more closely matched to user requirements and reconfiguration is also easier. Each modular unit can be isolated for repair or maintenance without interrupting operation of the system as a whole.

All models are microprogrammed and use an integrated storage system, in which the main memory comprises one or more modules. Since these modules are constructed without access control circuits, resulting in their just being blocks of memory.

These microprogrammed processors are two-stage pipeline processors consisting on an instruction scheduler to fetch and decode instructions, and microcode processor to handle operands and arithmetic instructions.

Instruction scheduling time (the time taken to fetch instructions and data) is minimized by the application of block fetch techniques.

Microcoded processors can optimize frequently used code. On ICL systems a separate microcode exists for each operating system.

ICL calls the central processing units Order Code Processors to emphasize that the units do not deal with I/O but handle only program instructions, arithmetic, logic, data manipulation, and interrupts.

SLAVE STORES: To explain slave stores, it is necessary to examine the pipelining processes favored by ICL.

▶ The objective of pipelining and slave stores is to speed up the execution time of instructions. This is achieved by dividing the Order Code Processor (OCP) into three main units—the Instruction Scheduler, the Microcode Processor, and the Store Accessing Unit. ▶

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▷ ICL also markets a laser printer whose printing mechanism produces page printing rather than working on a line-by-line basis. The speed is equivalent to 21,000 lines per minute with 12 lines to the inch.

Two card readers are offered—one at 300 cards per minute and the other at 1,000 cards per minute. Both use photoelectric means of reading the cards' input.

SOFTWARE

Virtual Machine Environment (VME) is the operating system for ICL's 2900 Series. The system runs on all 2900 machines, including earlier models, and provides full program compatibility across the range. For users of earlier ICL 1900 and System 4 machines, emulation of object programs is provided under Direct Machine Environment (DME). Concurrent Machine Environment (CME) allows VME and DME to run side by side on the same processor.

VME consists of a base and a series of options which enhance throughput and control. VME is designed to handle mixed batch, teleprocessing, and interactive inputs. Since VME is file oriented, ICL states that it can be used to take a central part in networks, supporting large numbers of terminals.

The virtual machine concept used by VME is designed to reduce overhead. It also prevents each job from corrupting other jobs or the system software. When a job is loaded, the operating system determines which files, services, and facilities the job needs. The operating system checks its catalog to be sure the job hasn't made any unauthorized requests and then defines a system that exactly meets the job's needs. At runtime, any attempt by the job to use facilities not included in its virtual machine will trigger an interrupt and halt processing of the job until appropriate action is taken.

Although a job can share system and application software with other jobs, it links itself to this code in such a way that all parameters, addresses, and variable data are stored in the job's own stack of registers, making this information inaccessible to other jobs.

In addition to the system software, ICL offers development tools including the 4th generation Applications Master, a system generator for online databases. Integrated database management software based on IDMS and ICL's Data Dictionary includes query and report facilities supported by CAFS-ISP.

A wide range of applications software is available from ICL and third-party suppliers for financial accounting and business planning, retail and manufacturing, and office systems packages such as electronic mail, private viewdata, and diary systems.

COMPETITIVE POSITION

The major competition to the 2900 Series comes from IBM with the 4300, 303X, and 308X Series.

▶ The idea behind this division is to enable as much overlap as possible to take place between these three units. If overlapping within a unit can also take place, so much the better.

Dealing with these three units in turn: the Instruction Scheduler forms the first part of the pipeline. Its job is mainly to fetch instructions from storage and decode them—i.e., break them down into their component parts, such as operands, registers used, and address.

Operands are passed to the second unit, the Microcode Processor, which breaks the operands down further and executes them in part. It also performs arithmetic and other operations. Overlap between the first two units frequently occurs, so that when an instruction is being decoded by the Instruction Scheduler, the second unit, the Microcode Processor, is completing the processing of the previous instruction.

The third unit, the Store Accessing Unit, provides the interface between the OCP and the main store. To optimize the accesses to store, the Store Accessing Unit has two fast-access slave stores—the Data Slave and the Current Page Registers.

The Data Slave consists of 64 cells, arranged in pairs. Each cell pair can hold up to 32 bytes of data and 32 bytes of addressing information—the object being to “slave” any two 16-byte areas in virtual storage fulfilling certain conditions. Since virtual memory is large and the slave memory small, a statistical process is applied with an algorithm so that new information is always placed in the cell with the least-recently used coded address. The coded address itself is worked out using a so-called “hashing” algorithm, whereby virtual storage is partially mapped on to the slave storage by using selected bits of the virtual storage address. To prevent errors, information left in a cell, after slaving some other part of virtual storage, is marked invalid.

The Current Page Register Slave also comprises 64-cells with each cell containing 32 bytes of data. Each cell can contain a virtual address and the corresponding real address in main store. The associative addresses are formed in a similar way to that used in the Data Slave and by applying a comparable optimizing “hashing” algorithm. To avoid accessing difficulties, this Current Page Register Slave storage is updated whenever its cells do not hold the virtual-to-real address translation required for the current main store access.

REGISTERS: An effectively unlimited number of 32-bit general purpose registers is available to users in the stack assigned to each virtual machine.

ADDRESSING: Only the stack and certain hardware registers can be addressed directly. All virtual addresses must be translated. A 64-bit Descriptor Register (DR) is used to expedite the handling of arrays and strings and the passing of control between tasks. There are 7 types of descriptors, each comprised of 32 bits of control information and a 32-bit address.

The virtual address of an item identifies its location by segment, by page within the segment, and by its displacement from the beginning of the page. When the address translation hardware is asked for the real address of the item, it first makes a parallel search of the Current Segment and Page Registers which hold information on items currently in either the slave store or in main memory. If the address is not in these registers, the translation hardware then searches the Segment and Page Tables to find the item's location on disk.

INSTRUCTION REPERTOIRE: The order code includes 113 instructions for fixed point, floating point, and decimal ▶

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TABLE 3. INPUT/OUTPUT UNITS

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed Inches/Sec.	Transfer Rate, Bytes/Sec.
GTS2 310	9	6250	GCR	50	310
	9	1600	PE	50	80
	9	800	NRZI	50	40
GTS2 470	9	6250	GCR	75	470
	9	1600	PE	75	120
	9	800	NRZI	75	60
GTS2 780	9	6250	GCR	125	780
	9	1600	PE	125	200
	9	800	NRZI	125	100
MTS 61	9	1600	PE	37.5	60
Printers	Printing Speed	Print Positions	Horizontal Spacing, Chars./Inch	Vertical Spacing, Lines/Inch	Form Size, Inches
LP 360	360 (48)	132	10	6 or 8	4 to 16.75 wide 8 to 14 long
	300 (64)				
LP 720	220 (96)	132	10	6 or 8	4 to 16.75 wide 8 to 14 long
	720 (48)				
	600 (64)				
LP 1130	440 (96)	132	10	6 or 8	4 to 16.75 wide 8 to 14 long
	1130 (48)				
	900 (64)				
LP 1440	600 (96)	132	10	6 or 8	4 to 16.75 wide 8 to 14 long
	1440 (48)				
	1200 (64)				
LPS 14	829 (96) max 21000	136/163/	10/12/15	6/8/12	max 16 wide
Laser Printer		204			3 to 14 long
Punched Card Equipment	Columns	Speed Cards/Min.	Input Hopper Capacity	Output Stacker Capacity	Options
CP 60	80	60	NA	NA	NA
CR 300	80	300	1000	1000	Card Image Mode
CR 1000	80	1000	1000	1000	Card Image Mode

NA—Not available.

➤ **ADVANTAGES AND RESTRICTIONS**

The 2900 Series provides a wide range of processing power. A 10-fold increase in power is available between the entry-level 2953 model and the top-end superdual 2988. All models can be field upgraded and use the VME operating system. ICL designed the 2900 as a multiprocessing system, and its I/O architecture has been supplemented with the CAFS-ISP option which will search unstructured data. Additionally, the fact that all the models are available in dual or superdual configurations enables a user to upgrade a 2900 system to include a higher level of fault tolerance when required.

USER REACTION

The 1983 Datapro Survey of British Users of Computer Systems brought responses from 165 ICL 2900 users with 312 installations. The returns were divided into the following machine categories: 2946 & 2955; 2950 & 2956; 2960; ➤

➤ arithmetic, for handling character strings, for performing logical operations, and for manipulating information contained in the stack and in the stack registers. There are 43 arithmetic instructions, 14 store-to-store instructions, 3 conditional jump instructions, and 51 miscellaneous instructions.

PHYSICAL SPECIFICATIONS

The main cabinet of models 2953, 2957, 2958, and 2966, which contains an Order Code Processor (OCP), a System Control Unit (SCU), a Device Control Unit (DCU), a Decision Support Controller (DSC) or a second DCU, and main memory, measures 170.5 by 202 by 79 cm³ (height by width by depth), and weighs approximately 1110 kg.

The main cabinet in a 2988 system contains the same modules as in the less powerful models, but is larger, measuring 170 by 268 by 79 cm³ and weighing 1480 kg.

CONFIGURATION RULES

All models are available in single configurations, all except the 2953 and 2988 are available as dual machines, and the ➤

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▶ 2966; and 2966-based. The 2966 and 2966-based groups are the most relevant, as they include current systems. There were 154 installations of 2966 models with an average life of 18 months, and 40 installations of 2966-based systems with an average life of 16 months. Models 2946, 2950, 2955, 2956, and 2960 are no longer actively marketed, but user responses for these machines are included as they provide useful information on the 2900 line.

Major applications areas for all models included accounting/billing, payroll/personnel, order processing/inventory control, and purchasing. Communications monitors were used on approximately 75 percent of the systems, and integrated word processing functions on 15 percent.

In response to the question "Did the system do what you expected it to do", fifty-four 2966 users said "Yes", 3 said "No", and 10 were undecided; seventeen 2966-based users said "Yes", 1 said "No", and 4 were undecided.

To the question "Would you recommend the system to another user?", the following answers were given: forty-five 2966 users would recommend the system, 3 would not, and 19 were undecided; and fourteen 2966-based users said "Yes", 2 said "No", and 6 were undecided.

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

	2966	2966- based	2950 & 2955	2950 & 2956	2960
Ease of Operation	3.00	2.82	2.62	3.04	2.97
Reliability of Mainframe	2.94	2.96	3.22	3.27	2.66
Reliability of Peripherals	2.74	2.85	2.81	2.73	2.48
Maintenance Service					
Responsiveness	2.89	2.75	2.70	2.77	2.97
Effectiveness	2.69	2.88	2.56	2.56	2.41
Technical Support					
Troubleshooting	2.29	2.19	2.11	2.04	2.03
Education	2.39	2.52	2.52	2.48	2.37
Documentation	2.28	2.19	2.22	2.04	2.45
Manufacturer's Software					
Operating System	3.09	2.78	2.70	3.19	3.09
Compilers & Assemblers	2.97	2.93	2.88	2.84	2.97
Applications Programs	2.43	2.44	2.60	2.41	2.35
Ease of Programming	2.72	2.73	2.69	2.92	2.52
Ease of Conversion	2.61	2.52	2.52	2.32	2.65
Overall Satisfaction	2.83	2.81	2.81	2.76	2.56

*Weighted averages on a scale of 4 for Excellent, 3 for Good, 2 for Fair, and 1 for Poor. □

▶ 2957, 2958, 2966, and 2988 can additionally be configured as superdual systems, the difference between the dual and superdual system being that OCPs and DCUs are not cross-connected in superdual machines. Each single system comprises 1 Order Control Processor (OCP), 1 System Control Unit (SCU), 1 or 2 System Control Processors (SCPs), main memory, and a number of Device Control Units (DCUs) and Decision Support Controllers (DSCs). Dual and superdual versions contain 2 OCPs, 2 SCUs, and 2 SCPs, in addition to main memory, and DCUs and DSCs.

The 2953 entry model comprises a minimum of 4MB main memory and a single DCU; this can be extended to include 8MB main memory and 3 more DCUs or DSCs.

The basic 2957 single model contains, in addition to OCPs, SCUs, and SCPs, 4MB of main memory, and a DCU. This can be upgraded to 8MB of main memory, and 3 DSCs or additional DCUs. In the dual and superdual configurations, main memory can be extended from 8MB to 16MB.

The 2958 single system offers 4MB of main memory, extendable to 16MB, while the dual and superdual configurations provide between 8MB and 32MB. DCU and DSC limits are as for the 2957.

The single 2966 model contains 8MB to 16MB of main memory and a maximum of 4 DCUs, or a single DCU and 3 DSCs. In the dual and superdual versions, main memory extends from 16MB to 64MB, and up to 6 DCUs can be supported.

The top-end model, the 2988, contains a duplex OCP in both the single and superdual configurations. The single system provides between 8MB and 16MB of main memory, and up to 4 DCUs; 3 DCUs can be replaced by DSCs. The superdual 2988 offers main memory capacity of 16MB to 64MB, and between 2 and 6 DCUs.

COMPATIBILITY: VME software is compatible across all the 2900 models. For users of ICL's earlier 1900 and System 4 computers which have different order codes, an emulation facility allows the existing programs to run unchanged. Various conversion tools are available for customers wishing to convert programs or data to VME formats.

Emulation is provided in the form of microcoded operating system packages, with the microcode resident in the OCPs. The 2953, 2957, 2958, and 2966 can run both ordinary 2900 series programs and emulation programs simultaneously by using Concurrent Machine Environment (CME). This allows two operating systems to be run together—Direct Machine Environment (DME) for the old machines and Virtual Machines Environment (VME) for the 2900 series. CME is available in various forms to cater for differing combinations of old and new machine software.

INPUT/OUTPUT CONTROL

DEVICE CONTROL UNIT 1 (DCU 1): This is a microprocessor-controlled general purpose controller which is available on all five members of the series. It can be configured to a user's specific peripheral and communications needs. Connection of devices to the DCU 1 is effected through specialized couplers which support: up to 16 fixed (FDS) or exchangeable (EDS) disk drives and/or up to 7 serial devices such as magnetic tape drives and printers, together with up to 15 communications lines via two Synchronous Multi-Line Communications Couplers (SMLCCs).

DEVICE CONTROL UNIT 2 (DCU2): The DCU2 has a very high throughput rate (4 megabytes/second) and can support up to 32 disk drives—giving, for example, well over 20 gigabytes of FDS 640. Connections are also provided for line printers, card readers, magnetic tape units, and the CAFS-ISP units.

DECISION SUPPORT CONTROLLER (DSC): This is like DCU2, but additionally contains the CAFS-ISP unit within it.

MASS STORAGE: See Table 2.

INPUT/OUTPUT UNITS: See Table 3. ▶

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► COMMUNICATIONS CONTROL

SYNCHRONOUS MULTI-LINE COMMUNICATIONS COUPLER (SMLCC): The SMLCC is designed for small- to medium-extent communication requirements. A maximum of two SMLCCs can be fitted to a DCU1 and these can have up to 15 lines attached with a maximum line speed of 9600 bits per second (bps). ICL's XBM protocol is supported. Adapters are available for other protocols, including, currently, X.25 and asynchronous working. One SMLCC is included in each 2900 system.

An IBM 2780/3780 protocol converter is available, as is the ICL Bulletin Link Unit (BLU) for use with the Bulletin private viewdata system.

NETWORK PROCESSOR SYSTEM (NPS): A communications processor provides a range of networking facilities. Up to four 2900 systems can be connected together. The basic cabinet contains the main processor, main memory, dual diskette drives, up to 4 high speed local mainframe interfaces, and network interfaces for a maximum of 24 communications lines. A video console is provided for system control. The addition of 4 expansion cabinets provides a total of 256 communications lines.

The Network Processor's operating system (NP-OS) is loaded from one of the host mainframes, and provides the environment to control the user's network and to route messages and data between devices. Protocols supported are ICL's XBM, asynchronous, and X.25.

INFORMATION PROCESSING ARCHITECTURE (IPA): Corresponding to IBM's SNA, IPA offers a wide range of facilities for distributed computing and for networking most of the ICL product range. These facilities include the ability to transfer jobs, program code and bulk output from one system to another, distribution of TP applications between a number of cooperating systems, and access to a remote service through a user's local system. IPA will be the reference point for future ICL communications and networking products in both hardware and software areas.

OPEN SYSTEMS GATEWAY (OSG/2900): This allows 2900 mainframes to connect into the OSLAN local area network. OSG/2900 can be interfaced to a DCU or DSC. All IPA facilities can be used on the link with OSLAN, allowing file transfers and applications interworking.

OPERATING SYSTEM

All 2900 systems run under the VME (Virtual Machine Environment) operating system which offers facilities for the provision and control of a powerful mixed-mode computing service to end users with differing needs.

VME offers a number of methods of working which may be used in any combination:

- Multiple Access Computing (MAC)
- Transaction Processing (TP)
- Local Batch
- Remote Job Entry (RJE).

MAC enables users to have immediate interactive access to the system using local or remote terminals. It includes HELP, screen editing, and program development facilities.

The VME Transaction Processing Management System (TPMS) provides direct connection between the terminal user and applications software. TPMS supports multiple applications within one service while VME will support

multiple TP services if required. Data and message security and recovery features are available within TPMS. TPMS provides facilities to interface to ICL's IDMS database system, using high-level languages.

Batch facilities are controlled from an operator's workstation which can be local or remote. Remote job entry provides a means of submitting batch work from a remote location and receiving output back if required.

The DME (Direct Machine Environment) operating system which permits emulation of earlier ICL products such as the 1900 and System 4 machines can run concurrently with VME under CME (Concurrent Machine Environment). CME is optionally available with the 2900 Series.

LANGUAGES

Algol, APL, Basic, Cobol, Fortran, Pascal, and RPG II compilers are available.

BASIC: The Basic interpreter follows the informal standards set by Dartmouth Basic and by the National Computing Centre and incorporates a number of capabilities not included in earlier ICL versions of the language.

COBOL: This compiler follows the guidelines used in developing American National Standard (ANS) Cobol-74 and offers capabilities equal to the highest level of all ANS modules except Report Writer and Communications, which are not implemented. Instead, Report Master can be used for preparing reports, and the ACCEPT and DISPLAY verbs can be used to provide transaction processing facilities. ICL has added a number of extensions to the standard, including floating-point arithmetic, and has removed a number of restrictions.

FORTRAN: This compiler is based on American National Standard (ANS) Fortran, and includes, among its enhancements, facilities for handling direct-access files. ICL also offers an Optimizing Fortran Compiler (OFC) that produces more efficient code but requires longer compilation times.

PASCAL: The Pascal compiler is fully compatible with ISO standards, and conforms to the Jensen and Wirth compiler.

DATABASE MANAGEMENT

ICL offers an integrated set of products based around the Data Dictionary System (DDS), which is a complete system for the documentation of all aspects of applications development.

IDMS (Integrated Database Management System): A Codasyl implementation. An enhanced version, IDMSX, is available for high-throughput systems that require advanced recovery facilities.

ReportMaster: Aids in the generation of reports and extraction of information from files.

QueryMaster: An online enquiry facility which can utilize the power of CAFS-ISP to speed up inquiries.

PDS (Personal Data System): Enables non-DP staff to maintain their own data files, and includes data manipulation and enquiry facilities. Both PDS and QueryMaster use the same language which gives a relational view of the data.

RCI (Relational CAFS Interface): This makes available to Cobol programs a relational interface to IDMS data and other files. CAFS-ISP is used to provide fast access.

APPLICATIONS PROGRAMS: ICL offers a variety of packages under VME for many areas, including accounting, ►

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► business, central and local government, information processing, manufacturing industries, and management sciences. Brief descriptions of some programs are given below.

BACSTER (Bankers Automated Clearing Services Transfer Exchange Routines): For accounting, payroll, and personnel.

BUDGET 29: Budgeting program which gives management and variance accounts, and includes individual company and account structures.

FINAPL: A financial modelling package under APL.

PROSPER STAR: A table-based financial modelling package.

DILIS: Direct labour management package for local government. One version provides accounting, management, and database facilities, while the second offers repair and maintenance scheduling.

HMIS: Housing management system for local government housing, which includes management of rentals and repairs.

LAFIS: Financial package including ledgers, analysis, budgeting, and statistical functions.

PLANAPS: Planning Application System which generates minutes, reports, and letters.

SOCSIS: On-line Social Services System which holds records and offers assessment features.

UHBS: Unified Housing Benefit System which automates handling of the UK Housing Benefits legislation.

BULLETIN: ICL's private viewdata system. In addition to the normal facility of access to data by TV sets, a "window" facility is available which enables Bulletin inquiries to access data in a normal VME filestore or IDMS database. **BULLETIN** can also be used from standard ICL terminals. Messaging facilities are provided.

COMMITTEE MINUTES: Offers storage and retrieval of meeting minutes and reports.

EXECUTIVE ACTION: An office system designed to help managers in day-to-day work. It includes an electronic filing system, diary, mail, and telephone directory facilities.

STATUS: A system for storing large files of text and retrieving selective information from these files.

OMAC 29: A group of packages for online manufacturing, which includes a database, materials requirement, and multiple site/stock planning systems.

PLANNED MAINTENANCE: Repair and maintenance scheduling.

ICL ADVISER: A program that offers specialized techniques for understanding regulations or procedures. **ICL ADVISER** is able to handle a range of situations including those requiring links to TP systems and databases.

PACKAGE X: A system for the analysis and management of numerical data.

PERT: A management system for the planning and control of projects.

REVEAL: An advanced planning, forecasting, and analysis system for managers and professionals. It provides a multi-dimensional analysis environment with a relational data-

base and interactive color interface with graphics. The package may be linked directly to conventional applications and databases.

Application Master: A 4th generation system generator for online database systems.

Quickbuild: A fast application development environment aimed at departmental applications.

Program Master: An integrated package for Cobol program development. It incorporates advanced split-screen facilities such as showing if the source line is in error and supplying diagnostics for ease of debugging.

STRUCTURES: Enables the structural engineer to perform analyses of skeletal structures for member and restraint reaction, forces and moments, together with joint, linear, and rotational displacements.

GINO: A suite of programs containing routines which produce graphics charts and 2-D and 3-D drawings.

A wide range of third-party software is also available, covering applications for accounting, banks, central and local government, information processing, management sciences, manufacturing industries, and retail and distribution.

Packages are also supplied by ICL and third parties to run under the DME operating system.

SERVICE/SUPPORT

DIAGNOSTICS: ICL's service and support strategy is based upon Service Desks and the Remote Support Centre. Automatic Diagnosis and Error Management System (ADEMS) is the onsite software component of this support strategy and runs under VME. Within the ADEMS framework, ICL provides analytical tools and diagnostic aids, maintenance and media control facilities, control of online test software, and an incident management system with up-to-date information about all incidents under investigation.

ADEMS maintains its own online database containing details of all system-detected events, as well as the observed incidents reported to it by operations staff. This aids in the local or remote management of problem resolution and preventative maintenance.

ICL maintains centrally a Maintenance Database which holds details of all known problems and corrections available. Information from this database is used by ICL Support Centers and customers.

MAINTENANCE: For purchased or leased systems the minimum period of maintenance is 8 consecutive hours between 8 a.m. and 6 p.m. Monday to Friday. Charges outside this period vary according to specific configurations. Hours of service may vary from country to country.

EDUCATION: Courses, which must be paid for separately by the user, cover systems appreciation, programming, and operations. Training for all levels of management is also available. In some cases, training may be carried out on customer premises. Video and cassette training modules for onsite or home use can be obtained from ICL.

DOCUMENTATION: A comprehensive range of documentation is available to cover all products within the 2900 Series. Some manuals are supplied with products, but generally documentation is purchased separately. ►

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► PRICING

The ICL 2900 Series systems are marketed on an unbundled basis. All software is subject to a license fee, normally

charged on a quarterly basis but sometimes on a capital basis either instead of or in combination with monthly charges. Hardware is available for purchase or lease. Maintenance charges are not included.

EQUIPMENT PRICES

	Purchase Price (£)	Quarterly Hire (5 yr.) (£)	Quarterly Maint. (£)
ICL 2953 VME ENTRY LEVEL			
Processor, 4MB main memory, Device Control Unit (DCU), Operating station, Peripheral couplers with Synchronous Multiline Comms. Coupler for 7 lines 3 x FDS 160 fixed disks of 160MB each: 2 x EDS 80 exchangeable disk of 80MB: LP 360 printer	112,427	Not possible	2,783
Basic systems software license including VME, Cobol, DDS	2,403/qtr.	—	—
ICL 2957/VME SYSTEM			
Processor, 4MB main memory, 1 x DCU 1, 1 x DSC, 1 x SMLCC for 7 lines, 2 x MDSS fixed/exchangeable disk drives with 80MB on exchangeable disk and 160MB fixed disk, one MT60 magnetic tape, one LP 360 lpm line printer	224,719	14,658	3,538
Basic systems software license, including VME, Cobol, DDS	2,403/qtr.	—	—
ICL 2958 VME SYSTEM			
Processor, 4MB main memory, 1 x DCU 1, 1 x DSC, operating station, peripheral couplers with a Synchronous Multiline Comms. Coupler for 7 lines 2 x FDS 160 160MB fixed disk drives, 2 x EDS 80 80MB exchangeable disk drives, 2 x FDS 640 640MB fixed disk drives, 2 x GTS 310 magnetic tape drives, 1 x LP 720 printer	362,285	23,628	4,873
Basic systems software license	3,195/qtr.	—	—
ICL 2966 VME SYSTEM			
Processor, 8MB main memory, 1 x DCU 1, 1 x DSC, operating station, peripheral couplers and Synchronous Multiline Comms. Coupler for 15 lines, 2 x FDS 160 160MB fixed disk drives, 2 x EDS 80 80MB exchangeable disk drives, 4 x FDS 640 640MB fixed disk drives, 2x GTS 470 470KB/sec. magnetic tape drives, LP 1130 printer	558,958	36,462	5,841
Basic systems software license	4,782/qtr.	—	—
ICL 2988 VME SYSTEM			
Two processors (duplex), 8MB main memory, 1 x DCU 1, 2 x DSC, operating station, peripheral couplers and Synchronous Multiline Comms. Couplers for 15 lines, 2 x FDS 160 160MB fixed disk drives, 2 x EDS 80 exchangeable disk drives, 6 x FDS 640 640MB fixed disk drives, 2 x GTS 780 780KB/sec. magnetic tape drives, 1 x LP 1130 printer	814,368	53,124	7,534
Basic systems software license	6,207/qtr.	—	—