

IPL Systems 4400 Series

MANAGEMENT SUMMARY

Since IPL Systems introduced the 4400 Series in 1980, the plug-compatible family has grown to include six members. IPL is one of the front-runners in the IBM plug-compatible marketplace and has been successfully building PCMs for OEM use since 1977. The company's managers saw an opportunity for growth by selling directly to end users and announced the 4400 Series as their trump card. The company currently supports OEM agreements with Masstor in the U.S. along with Olivetti and other distributors in Europe, the Middle East, and the Far East. IPL also has signed a joint development agreement to design and build compatible CPUs with Mitsubishi Electric Corporation using advanced ECL large scale integration gate array technology.

The primary objective in designing an IBM plug-compatible system is to make it literally transparent to IBM operating systems, systems software, applications, and IBM and IBM-compatible peripherals. IPL set out to not only achieve this objective, but to develop a system that 1) provides fault-tolerant architecture in the PCM marketplace, 2) incorporates state-of-the-art technology, 3) is easily field-upgradable, 4) provides high reliability and maintainability, 5) offers substantially faster delivery times than the competition, and 6) provides better price/performance than the competition.

The company itself has been quite successful among its peers in the high technology community. IPL has about 400 systems installed and on order worldwide, of which over 120 have been sold directly to end users in the U.S. With its expertise in microcode emulation, the company has been able to successfully counter IBM's 4300 announcements with products of its own. ▸



Featuring six models with better price/performance than comparable IBM 4300 Series processors and a fault tolerant model, the IPL 4400 Series systems have from 1 to 16 megabytes of main memory, 3 to 10 channels, and are field-upgradable.

The IPL 4400 Series of plug-compatible mainframes includes six powerful systems with improved price/performance over their IBM 4300 Series counterparts. The systems require less floor space and power than the IBM products, and are all field upgradable to the next model.

MODELS: IPL 4436, 4443, 4445, 4446, 4460 and 4480.

CONFIGURATION: Main memory ranges from one to sixteen megabytes, and three to ten I/O channels are available.

COMPETITION: IBM 4341-10 through 4341-12; Cambex 1600 Series; Magnuson M80 Series; and NAS AS/3000 and AS/5000 Systems.

PRICES: Purchase prices range from \$125,080 for a one-megabyte 4436 to \$611,800 for a 16-megabyte 4480.

CHARACTERISTICS

MANUFACTURER: IPL Systems, Inc., 360 Second Avenue, Waltham, Massachusetts 02154. Telephone (617) 890-6620.

IPL Systems is a high technology company that was founded in 1973 to design and manufacture mid-range computer systems. The firm sells its products via OEM arrangements with such companies as Olivetti, Masstor, and international distributors. The company also markets its systems directly to end users under the IPL 4400 Series product name.

MODELS: IPL 4436, 4443, 4445, 4446, 4460 and 4480.

DATE ANNOUNCED: Models 4436, 4443, and 4446, October 1980; Model 4445, November 1981; Model 4460, October 1982; Model 4480, February 1983.

DATE OF FIRST DELIVERY: 4436, 4th Quarter 1980; 4443, 4th Quarter 1980; 4445, 3rd Quarter 1982; 4446, 3rd Quarter 1981; 4460, 2nd Quarter 1983; 4480, 3rd Quarter 1983.

NUMBER INSTALLED TO DATE: Approximately 400 worldwide, of which three-fourths are in the U.S. Over 120 systems have been sold directly to end users.

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent 1 alphanumeric character, 2 BCD digits, or 8 binary bits. Two consecutive bytes form a "halfword" of 16 bits, while 4 consecutive bytes form a 32-bit "word."

FIXED-POINT OPERANDS: Can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; 1 halfword (16 bits) or 1 word (32 bits) in binary mode. ▸

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▷ PROCESSORS AND MAIN MEMORY

The IPL 4400 Series consists of five single-processor models, the 4436, 4443, 4445, 4446, and 4460, and one dual-processor model, the 4480, that use microcoding extensively to emulate IBM System/370 and 4300 Series operating features. All models are composed of several distinct elements, such as the CPU, memory modules, input/output control units, and service processor, that are connected to a high-speed internal link, known as the ExpandaBus. All data transfers occur over the ExpandaBus, resulting in higher overall throughput. The ExpandaBus architecture actually is made up of three buses: the central data transfer bus, a main storage bus, and a control storage bus. The systems are field-upgradable, and typically require nothing more than changing a few plug-in modules in the system backplane.

Models 4460 and 4480 include a high-speed multiply-divide unit, a feature which improves performance. Also included with the 4460 and the 4480 is support of the Start I/O Fast Release function. The 4480 consists of two independent processing units which share main storage. The 4480 can be configured either in a multiprocessor complex, or as two uniprocessors. Main storage for the 4480 consists of 8, 12, or 16 one-megabyte modules which each have two ports. A spare one-megabyte module is also included which can be operator-configured in the place of a failing storage module without a system break.

The central processor in all models uses emitter-coupled logic (ECL) circuitry, which is acknowledged to be superior to transistor-to-transistor logic (TTL) technology in areas such as performance, heat dissipation, and energy requirements. ECL technology also affords greater component packaging densities, resulting in reduced floor space requirements. The CPU features a 50-nanosecond cycle time.

Main memory is implemented in 16K N-channel MOS RAM chips in models 4436, 4443, and 4445. In models 4446, 4460 and 4480, the company uses 64K-bit chip technology. All memory is error-correcting, and corrects all single-bit errors and detects most multiple-bit errors. Memory cycle time is 500 nanoseconds for both read and write operations. The entry-level 4436 has from one to eight megabytes of memory, expandable in two-megabyte increments. The intermediate 4443 and 4445 models have from two to eight megabytes, and models 4446, 4460 and the top-end 4480 can have from two to sixteen megabytes of memory. All models, except the 4436, also feature a buffer storage, or cache, for improving execution speeds. The 4443 has 8K bytes of cache. The 4445, 4446, 4460 and 4480 have 10K, 16K, 24K, and 48K bytes of cache, respectively. The system's operating features are implemented in microcode, which is contained in control storage. Models 4436, 4443, 4445, 4446 and 4460 are equipped with 64K bytes of control storage while model 4480 has 128K bytes.

IPL 4400 Series processors will operate with all IBM and IBM-compatible peripheral devices that are supported on System/370, 303X Series, and 4300 Series systems except ▷

▷ **FLOATING-POINT OPERANDS:** 1 word, consisting of 24-bit fraction and 7-bit hexadecimal exponent, in "short" format; 2 words, consisting of 56-bit fraction and 7-bit hexadecimal exponents, in "long" format; or 4 words in "extended precision" format.

INSTRUCTIONS: 2, 4 or 6 bytes in length, specifying 0, 1, or 2 memory addresses, respectively.

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

MAIN STORAGE

STORAGE TYPE: N-channel MOS RAM using 16K chips on Models 4436, 4443, 4445, and 4446. Models 4460 and 4480 employ 64K-bit chip technology.

CAPACITY: Model 4436, one to eight megabytes in two-megabyte increments; Models 4443 and 4445, two to eight megabytes in two-megabyte increments; Models 4446 and 4460, 2 to 16 megabytes in two-megabyte increments; and Model 4480, 8 to 16 megabytes in four-megabyte increments.

CYCLE TIME: For all 4400 Series models, 500 nanoseconds for both read and write operations.

CHECKING: All data paths between the central processor and main memory are parity-checked by byte. When data is stored, an error-correcting code is substituted for the parity bits. When the data is retrieved, single-bit errors are detected and corrected automatically, and most multiple-bit errors are detected and flagged for appropriate action.

STORAGE PROTECTION: The Store and Fetch Protection features, which guard against inadvertent overwriting and/or unauthorized reading of data in specified 2048-byte blocks of storage, are standard in all models.

CENTRAL PROCESSORS

The IPL 4400 Series processors are all designed to execute the IBM System/370 instruction set, as well as special control functions associated with the IBM 4300 Series. The CPUs are highly modular in construction, and are built around a high-speed internal bus, known as the ExpandaBus.

The processors are heavily microcoded, and have an internal cycle time of 50 nanoseconds. Extensive use of emitter-coupled logic (ECL) circuitry produces high internal speeds, while requiring less power and floor space, and generating less heat than comparable systems. The use of ECL permitted the company to design a computer system which processed less data in each cycle than other comparable mid-range systems, but nevertheless achieved the desired performance by executing cycles at a much higher rate. Processing less data per cycle requires the use of less logic circuitry, hence reducing manufacturing costs and improving reliability and serviceability.

The system architecture is modular, with the CPU, main memory, input/output channels, and console functioning as independent subsystems interconnected by the ExpandaBus. System expansion and upgrading is easily accomplished by removing/replacing the required boards from the system. Maintenance is also made simpler since faulty components can be replaced in the field, once the specific problem has been determined. All models, except the top-end 4480, can be field-upgraded to the next model, or any ▷

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Table 1. CHARACTERISTICS OF THE IPL 4400 SERIES PROCESSORS

	4436	4443	4445	4446	4460	4480
SYSTEM CHARACTERISTICS						
Relative performance level	0.60	1.00	1.25	1.50	1.65	2.70
Date announced	10/80	10/80	11/81	10/80	10/82	2/83
Date of first delivery	4th Quarter 1980	4th Quarter 1980	3rd Quarter 1982	3rd Quarter 1981	2nd Quarter 1983	3rd Quarter 1983
Virtual storage capability	Standard	Standard	Standard	Standard	Standard	Standard
Principal operating systems	DOS/VS, DOS/VSE, OS/VS1, SVS, MVS, MVS/SP, VM/370, VM/SP, SSX/VSE	MVS/SP, VM/SP				
Upgradable to	4443	4445	4446 & 4460	4460	4480	—
MAIN STORAGE						
Type	NMOS, (16K-bit)	NMOS, (16K-bit)	NMOS, (16K-bit)	NMOS, (16K-bit)	64K RAM	64K RAM
Cycle time, nanoseconds	500	500	500	500	500	500
Bytes fetched per cycle	8	8	8	8	8	8
Minimum capacity, bytes	1,024K	2,048K	2,048K	2,048K	2,048K	8,192K
Maximum capacity, bytes	8,192K	8,192K	8,192K	16,384K	16,384K	16,384K
Increment size, bytes	2,048K	2,048K	2,048K	2,048K	2,048K	4,096K
Error checking and correction	Standard	Standard	Standard	Standard	Standard	Standard
PROCESSOR						
Processor cycle time, nanoseconds	50	50	50	50	50	50
Control storage:						
Capacity, bytes	128K	128K	128K	128K	128K	256K
Access time, nanoseconds	20	20	20	20	20	20
Buffer (cache) storage:						
Capacity, bytes	—	8K	10K	16K	24K	48K
Access time, nanoseconds	—	100	100	100	100	100
I/O CHANNELS						
Number of channels:						
Standard	3	3	6	6	6	10
Maximum	6	6	6	6	6	10
Subchannels per channel (max.)	256	256	256	256	256	256
Maximum channel data rates:						
Block mode, bytes/second	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Byte mode, bytes/second	180,000	180,000	180,000	180,000	190,000	180,000
Maximum aggregate data rate, bytes/second	11,000,000	11,000,000	11,000,000	11,000,000	11,000,000	18,000,000

➤ those devices requiring direct control or integrated controllers and adapters. Each 4400 system has at least one byte multiplexer and two block multiplexer channels that conform to standard IBM interface definitions. Up to three additional block multiplexer channels can be added to all models. A channel set with one byte and four block multiplexer channels comes standard with each processor within the 4480. Byte multiplexer channels transfer data at 50K bytes per second in byte mode and 180K bytes per second in burst mode. Block multiplexer channels 1 and 2 can transfer data at up to 3 megabytes per second, and channels 3, 4, and 5 can transfer data at up to 2 megabytes per second. Data streaming, which is required with the high-performance IBM 3375 and 3380 (and equivalent) disk drives, is supported on channels 1 and 2.

The byte multiplexer channel can support up to 256 unshared subchannels, and each block multiplexer channel can support up to 256 subchannels.

SOFTWARE AND SUPPORT

Each model in the IPL 4400 Series, except the 4480 in a tightly-coupled multiprocessor mode, is fully compatible with the following IBM operating systems: DOS/VS, DOS/VSE, OS/VS1, OS/VS2 (MVS and SVS), MVS/SP, ➤

➤ model, if desired. Without a frame swap, only the 4460 is field-upgradable to the 4480.

The system's operational characteristics are provided by microcode, a reloadable control program that is loaded into the system at power-up. Microcoding has made it possible for IPL, as well as its competitors, to quickly emulate architectural and functional changes in 4300 Series processors.

IPL's processors are equipped with dynamic address translation (DAT) which allows programs to be written using up to 16 megabytes of virtual storage in page sizes of 4096 or 2048 bytes. The conversion of a virtual address to a real address is done by a translation process using a set associative memory called Translation Lookaside Buffer (TLB). The size of the TLB was increased eight times with the announcement of the 4460.

COMPATIBILITY: The IPL 4400 Series is compatible with the IBM System/370 and 4300 Series models with the following exceptions:

- Programs using machine-dependent data
- Programs that depend on features of I/O devices that are not implemented on the 4400 Series
- Programs that use main storage locations between address 128 and 736 (decimal) after a diagnostic logout to main storage ➤

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➤ VM/370, VM/SP, and SSX/VSE. The 4480, in a multiprocessor configuration is supported by VM/SP and MVS/SP. Extended Control Program Support (ECPS) for VS1, DOS/VSE, MVS, and VM/370 is standard in all models. ECPS: VM can operate concurrently with ECPS:VM/370 or ECPS:VS1 in all models. Additional enhancements are being planned during 1983, including support for Cross Memory Services for ECPS: MVS.

System support is provided on several levels, all of which are available to a user if a malfunction occurs. The service processor, a component of the 4400 system, isolates system problems and initiates recovery measures. Information provided by the service processor makes it easier for local service personnel to correct the problem. IPL has 13 sales/service offices in major cities nationwide. IPL's Worldwide Technical Support Center, located at the company's headquarters in Waltham, MA, can link up, when a customer activated security key is enabled, with the system via a telephone connection. An IPL engineer at Waltham can then operate the system remotely and run a series of diagnostic routines.

COMPETITIVE POSITION

If the objective of a PCM is to offer better price/performance than comparable IBM 4300 Series products, then the 4400 Series certainly fills the bill. The entry level 4436 is comparable in performance to the 4341-10, but costs about 11 percent less. The 4443, rated at about one million instructions per second (MIPS), according to IPL, is as fast as or faster than the 4341-1 for most applications and costs 14 percent less. The 4445, which was announced in November 1981, is 25 percent faster than the 4443, approximately 11 percent faster than IBM's 4341-11, and costs about 16 percent less than the 4341-11. The 4446 is rated at about 1.5 MIPS, is comparable in performance to the 4341-2, and costs about 17 percent less. The newer 4460 is rated equal to the IBM 4341-12 at 1.6 million instructions per second (MIPS); however, the price is 22 percent less than the 4341-12. The latest model announced by IPL, the 4480, is said to fill the gap between IBM's 4341-12 and the 308X Series; therefore, no comparisons can be made with respect to price and performance. The 4480, according to IPL, is said to compete with systems manufactured by Tandem and Stratus in regard to fault-tolerance; however, the 4480 is said to have a greater processing capacity than either the Tandem or Stratus machines, and has the advantage of IBM program compatibility.

ADVANTAGES AND RESTRICTIONS

Considering the fact that IPL markets the 4460 to compete with the IBM 4341-12, the 4460 not only sells for significantly less, it comes standard with 8K more bytes of cache memory than the 4341-12. IPL claims that 16K bytes are allocated for operand data and the other 8K bytes are used for instructions.

Concurrent operation of ECPS:MVS and ECPS:VM/370 on all IPL 4400 systems is an advantage to IPL users. IBM also makes this feature available on models 4341-2 and

➤ **PROCESSOR FEATURES:** The standard timing features of the System/370 architecture are included in all 4400 Series central processors. These include a CPU timer and a Clock Comparator; the latter provides a means for causing an interrupt when the standard Time-of-Day Clock reaches a program-specified value. Additional instructions are provided to set and store the Time-of-Day Clock, Clock Comparator, and CPU Timer.

Additional features of the System/370 found in the IPL processors include control registers, System/370 Commercial Instruction Set, byte-oriented operand, conditional swapping, dynamic address translation, microprogrammed instruction retry, double word buffer, interval timer, machine check handling, time-of-day clock, channel command retry, channel indirect addressing, console audible alarm, console file, advanced control program support, extended control mode, and program event recording. Control registers are used for operating system control of relocation, priority interruptions, program event recording, error recovery, and masking operations. A double-word buffer consists of a 64-bit area temporarily reserved for data used in performing an I/O operation. Each channel attached to the CPU has a fixed amount of channel buffer dedicated to its use.

The interval timer is a 32-bit decremental counter that is reduced by one several hundred times per second. The timer generates an interrupt when the contained value is decremented from a positive to a negative number. Machine check handling analyzes errors and attempts recovery by retrying the failed instruction if possible. If retry is unsuccessful, it attempts to correct the malfunction or to isolate the affected task. The time-of-day clock is incremented once every microsecond and provides a consistent measure of elapsed time suitable for the indication of date and time. Some channels have the capability to perform channel command retry, a channel and control-unit procedure that causes a command to be retried without requiring an I/O interruption. Channel Indirect Addressing (CIA) is a companion feature of dynamic address translation, providing data addresses for I/O operations. CIA permits a single channel command word to control the transmission of data that crosses noncontiguous pages in real main storage. If CIA is not indicated, then channel one level (direct) addressing is employed.

The console audible alarm is a device activated when predetermined events occur that require operator attention or intervention for system operation. The console file is the basic microprogram loading device for the system, containing a read-only file device. The media read by this device contains all the microcode for field engineering device diagnostics, basis system features, and any optional system features. The extended control mode (EC) is a mode in which all features of the System/370 computing system, including dynamic address translation, are operational. Program event recording is a hardware feature used to assist in debugging programs by detaching and recording program events.

With the announcement of Model 4480, IPL introduced the concept of non-stop computing to the IBM compatible world. The 4480 consists of two completely independent processing units sharing a partitioned, dual ported main storage. Each processing unit has its own instruction execution unit, control storage, channel set cache buffers, storage control unit, service processor, operator console, and power supplies. When operating in a tightly coupled, dual processor configuration, a simplified image of the system is presented to the user in terms of peripherals, input and output queues, and system control. In contrast, the system may also be configured as two separate uniprocessor systems, providing continuous availability of a production system on one of

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➤ 4341-12; however, IBM charges an additional \$26,000 for this option. IPL systems also feature concurrent operation of ECPS:VS1 and ECPS:VM/370 which is not offered at all on any IBM 4300.

While IBM does not offer a non-stop system, IPL offers the new model 4480, which is termed the "Continuous Compatible Computer." The company says that this system can "survive the vast majority of hardware failures and continue to function even while the failing component is being identified and replaced."

A typical installation of an IPL system is said to take an average of four hours because the mainframes are delivered in one frame that doesn't have to be bolted together.

Another big advantage of the 4400 Series, aside from the obvious price/performance advantage, is its rapid delivery. Typically a user can have a system delivered within 30 days ARO.

While the 4480 employs the tightly-coupled approach to continuous, non-stop processing, one possible drawback that should be considered is that shared main storage can be a single failure point for both processors. IPL claims that this potential problem is minimized through the use of dual port independent access to each storage module and the unique partitioning of main storage into one-megabyte module field replaceable units.

USER REACTION

In the 1983 User Ratings of Computer Systems survey, we received 12 responses from IPL 4400 Series users. All of the installations had one system installed. Four of the systems were purchased; the rest were leased from IPL. Three users had converted from an IBM System/360, and two had converted from the IBM 4341. The companies were in the following businesses: three service bureaus, and one each in education, engineering, government, insurance, manufacturing, media, and retail. The companies displayed a wide range of applications, such as traditional accounting/billing, and such specialized ones as mathematics and statistics.

Each system had several local terminals, and most had, or planned to have, remote terminals. Main memory ranged from one to eight megabytes; the majority had from two to four megabytes. A wide number of operating systems were in use, such as DOS/VS, DOS/VSE, MVS, VM/SP, VM/CMS, OS/VS1 and OS/MVT and products from other software vendors: DOS/MVT/VSE from Software Pursuits, and EDOS/VS from Nixdorf. Nine users were running Cobol, two were running Assembler, and one was running Fortran. Plans for 1983 included more memory, peripherals, system software, and new applications. Almost all had plans to add more data communications to their installation.

The users had very positive comments about their 4400 systems, and little or no negative remarks. We asked the users to rate their systems in several distinct categories as ➤

➤ the microprocessors while software or hardware maintenance is running on the other.

Main storage receives power independently of the two processing units. It contains 8, 12, or 16 one-megabyte modules, each with two ports, and an active spare one-megabyte module. Either port can fail without affecting the other port and any storage module can fail without affecting the others. In the event of a storage module failure, the active spare module can be brought on-line without waiting for the field engineer.

CONTROL STORAGE: All 4400 Series processor operations are controlled by microprograms that reside in high-speed control storage. The standard control storage capacity is 64K bytes in models 4436, 4443, 4445, 4446, and 4460 and 128K bytes in model 4480. Control storage can be increased to 128K bytes or 256K (4480) if required. This is sufficient to hold the microcode required for the System/370 Universal Instruction Set and all of the standard software assist features. The microprograms are loaded into control storage by means of a diskette unit called the Console File.

REGISTERS: Models 4436 through 4460 have sixteen 32-bit general-purpose registers and eight 64-bit registers. Model 4480 has 2 X sixteen bit general-purpose and 2 X eight 64-bit floating point registers. These registers can be used for indexing, base addressing, and as accumulators.

INSTRUCTION REPERTOIRE: The System/370 Universal Instruction Set is standard in all 4400 Series processors.

OPERATIONAL MODES: The Extended Control (EC) and Extended Control Program Support (ECPS) features are standard on the 4400 Series processors. As a result, all models can operate in any of the following modes: Basic Control (for System/360 programs), Extended Control (for programs that require dynamic address translation), ECPS:VS1 (which uses microcoding to improve system performance under the VS1 operating system), ECPS:VM/370 (which provides improved system performance under VM/370), ECPS:VSE mode, which uses microcoding to reduce overhead and improve system throughput under DOS/VSE, and ECPS:MVS, which provides improved performance when operating under MVS. In addition, all three announced releases of MVS/SP can operate in native mode, or concurrently with ECPS:VM.

PERFORMANCE: IPL rates its 4400 Series models in terms of relative performance compared to comparable IBM 4300 Series models. Using figures supplied by IPL, here's how IPL and IBM processors measure up:

Manufacturer	Model	Relative Performance
IPL	4480	2.70
IBM	—	—
IPL	4460	1.65
IBM	4341-12	1.65
IPL	4446	1.50
IBM	4341-2	1.50
IPL	4445	1.25
IBM	4341-11	1.13
IPL	4443	1.00
IBM	4341-1	1.00
IPL	4436	0.60
IBM	4341-10	0.60

A high-speed multiply-divide unit, which improves performance, was included with the announcement of the 4460 and the 4480. These systems also include support of the Start ➤

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▷ being either Excellent, Good, Fair, or Poor. We've compiled the ratings in the following chart.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	9	3	0	0	3.75
Reliability of mainframe	8	3	0	0	3.73
Reliability of peripherals	3	5	0	0	3.38
Maintenance service:					
Responsiveness	7	3	1	0	3.55
Effectiveness	6	5	0	0	3.55
Technical support:					
Trouble-shooting	5	4	1	0	3.40
Education	3	4	3	0	3.00
Documentation	3	4	3	0	3.00
Manufacturers software:					
Operating system	0	4	0	0	3.00
Compiler & assemblers	0	3	0	0	3.00
Application programs	0	3	0	0	3.00
Ease of programming	1	4	0	0	3.20
Ease of conversion	2	2	0	0	3.50
Overall satisfaction	2	6	1	0	3.11

*Weighted Average on a scale of 4.0 for Excellent.

These ratings indicate a high level of satisfaction with IPL and the IPL systems. It should be pointed out that the high figures in the areas of service are based on a relatively small number of systems installed within a service area, thus affording the IPL user almost exclusive access to local service technicians. It will be interesting to see if IPL can continue to maintain this level of service satisfaction as it installs more systems. Datapro cautions the reader when looking at ratings on "Reliability of peripherals," and the three categories under "Manufacturer's software." These items reflect system components not provided by IPL, but nonetheless are critical to overall system performance.

Datapro talked with two IPL users to find out just how well their systems performed. We first called a 4443 IPL user in the entertainment industry who had converted from an IBM 370. The system currently runs under EDOS/VS and they are planning to add two more megabytes of main memory along with additional channels to accommodate more peripherals within the next year. The company spokesman said that this was the "simplest" conversion he had seen in 14 years. He said that IPL ran diagnostic testing on Friday afternoon and had the system installed in "no more than 30 minutes" on Saturday morning. This installation has experienced only one system failure in 20 months. Since the IPL field service engineer makes periodic visits and finds very limited problems, the users at this installation refer to him as the "Maytag repairman." Overall, the company spokesman had nothing but praise for the 4443 system.

Another user, this one in the retail/wholesale business on the west coast, had converted from an IBM 360 to an IPL 4443. The Director of Information Services for the company said that the conversion went so smoothly that IPL "rolled it in, plugged it in, and it came up running." The installation took 45 to 50 minutes and when the amount of "core was doubled" (a 2-megabyte upgrade), that took only 45 minutes. This spokesman said that they have experienced "only one system outage in 1½ years." This 4443 runs under the DOS/MVT/VSE operating system and ▷

▶ I/O Fast Release function which avoids having the CPU wait for peripheral devices to respond to start I/O commands.

BUFFER STORAGE: Each 4400 Series model, except the 4436, has a cache buffer to provide improved system throughput. The buffer stores selected areas of main storage that might be used next by the CPU. If the requested data is contained in the cache, the CPU request can be handled rapidly. The 4443 has 8K bytes of cache, the 4445 has 10K bytes, the 4446 has 16K bytes, the 4460 has up to 24K bytes, and the 4480 can have up to 48K bytes. The 4460 has 16K bytes of operand cache memory when using 4K-byte pages in addition to the 8K-byte instruction cache.

CONSOLE: A system console is supplied with all of the 4400 Series central processor models. It consists of a control panel, keyboard, CRT display, the Console File (a pair of diskette drives used to load the 4400 microcode and system diagnostics into control storage), and an optional console printer. The system console can operate in either of two modes, as selected during the initial microprogram load (IMPL) procedure.

- Display mode, in which the CRT and keyboard appear to the operating system as an IBM 3277 Model 2 Display Station with keyboard. This mode requires the Device Independent Display Operator Console Support (DI-DOCS) software or its equivalent. If the optional console printer is included, it requires the Multiple Console Support (MCS) software or its equivalent and must be addressed separately as an IBM Console Printer.
- Printer-keyboard mode, in which the CRT, keyboard, and optional console printer appear to the operating system as an IBM 3215 Console Printer-Keyboard. This mode is supported by DOS, DOS/VS, OS, OS/VS, and VM/370.

The system console also contains the Service Processor, a microprocessor for diagnostic functions and a remote data link facility that provides on-line communications with a remote console, such as the one at IPL's Worldwide Technical Support Center at its Waltham headquarters. The data link enables personnel at the Support Center to operate the user's system remotely in order to diagnose both hardware and software problems.

The CRT(s) associated with the console can be located up to 30 feet from the CPU. IPL supports up to three additional CRTs and printers at the console on model 4460 and up to six additional CRTs and printers on model 4480. IPL also supports IBM 3278 2A, 3279 2C and compatible terminals on models 4460 and 4480.

PHYSICAL SPECIFICATIONS: All 4400 Series processors are housed in the same cabinet, which can contain the maximum 16 megabytes of memory. The 4400 typically requires about one-third less floor space than an IBM 4341, when equipped with the standard system console. Listed below are the dimensions and power requirements of the basic 4400 Series models, including the console.

Dimensions:

- Width, in (cm)—31.5 (80)
- Depth, in (cm)—63 (160)
- Height, in (cm)—60 (153)
- Weight, lb (kg)—2000 (907)

Power requirements:

- Voltage—208V ± 10%
- Phases—3
- Frequency, Hz—60 ± 0.5

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▷ many different application programs are being used that were written by in-house personnel. The user is "very happy with the box" because it is very reliable; it just "sits there and runs." □

▶ Heat dissipation, BTU/hr—10,000 for the 4436 through 4460 and 17,000 BTU/hr for the 4480

Environmental requirements for all models are as follows: operating temperature range—60 to 90 degrees F. (15 to 32 degrees C.); relative humidity range—20 to 80 percent.

INPUT/OUTPUT CONTROL

The IPL 4400 systems support one byte multiplexer channel and up to five block multiplexer channels. The basic 4400 system is supplied with a byte multiplexer channel and two block multiplexer channels, which can be increased up to five block multiplexer channels.

Each byte multiplexer channel has 256 unshared subchannels and can address up to 256 devices. Similarly, each block multiplexer channel can have up to 256 subchannels. Unit control words (UCWs) can be dynamically assigned from a pool of 432 unshared and 16 shared UCWs.

The maximum byte multiplexer channel data rate is 50,000 bytes per second in normal operating mode and 180,000 bytes per second in burst mode. Any block multiplexer activity reduces the byte multiplexer data rate.

Block multiplexer channels 1 and 2 have a maximum data rate of 3.0 million bytes per second (Data Streaming), and block multiplexer channels 3-5 have a maximum rate of 2.0 million bytes per second. The aggregate data rate for all block multiplexer channels in a 4436, 4443, 4445, 4446, or 4460 system is 11 million bytes per second. For model 4480, the aggregate block multiplexer data rate is 18 million bytes per second. Block multiplexer channels can operate as selector channels where they control one operation at a time.

A unique double-word buffer that provides greater levels of throughput is included with each block multiplexer channel.

Each of the processors within the 4480 comes equipped with its own independent channel set with one byte multiplexer channel and four block multiplexer channels. These dual independent channel sets allow for one of the processors to be taken off-line and used to isolate and repair a failing path while the system continues to run as a uniprocessor.

SIMULTANEOUS OPERATIONS: Concurrently with computing, a 4400 Series processor can control a maximum of one high-speed I/O data transfer operation on each block multiplexer channel and one low-speed I/O data transfer operation on each subchannel of each byte multiplexer channel, subject to the maximum channel and aggregate data rates specified above. Alternatively, a byte multiplexer channel can operate in burst mode and handle a single high-speed I/O operation instead of multiple low-speed operations.

CONFIGURATION RULES

IPL 4400 systems can be configured in essentially the same manner as IBM System/370 and 4300 Series computer systems, except that no integrated peripheral controllers are available for the IPL computers.

PERIPHERAL EQUIPMENT

The IPL 4400 can utilize all IBM System/370 and 4300 Series input/output and mass storage subsystems, except those that require integrated controllers or adapters, as well as the plug-compatible counterparts of these IBM subsystems offered by other vendors. Detailed coverage of many of these peripherals can be found in Volume 2 of DATAPRO 70.

SOFTWARE

All of the current 4400 Series computer systems, except the 4480 in a tightly-coupled configuration, fully support the following IBM operating systems: DOS/VSE, DOS/VSE, OS/VSE, OS/VSE (SVS and MVS), VM/370, and SSX/VSE. Detailed descriptions of these operating systems can be found in Reports 70C-491-06 (IBM 303X Series) and 70C-491-08 (IBM 4300 Series). Extended Control Program Support (ECPS) for VSE, DOS/VSE, MVS, and VM/370 is standard in all models. Concurrent operation of ECPS:VM and ECPS:VSE or ECPS:MVS is also standard in all models. To increase the performance of MVS/SP Release 3 running on its systems, IPL plans to include a Cross Memory Services (Dual Address Space) enhancement to ECPS:MVS.

When Model 4480 is operated in a tightly coupled, multiprocessor complex, it is supported by OS/MVS 3.8, OS/MVS SP 1.1 or higher, or VM/SP Release 1 or higher. When it is run as two uniprocessors, it is supported by all operating systems supported on Model 4460.

PRICING

IPL 4400 Series systems are available on a direct purchase basis, or two-, three-, four-, and five-year third-party leases. Two-year lease prices are provided in this report. For additional lease prices, contact IPL. The cost for a system upgrade is listed in this report.

Since Model 4480 is considered a single processing complex, only a single license fee is needed for each IBM licensed program whether the 4480 is operated as a tightly coupled dual processor or as two separate uniprocessor systems.

SUPPORT: IPL provides three levels of hardware support for 4400 Series users. The systems all include a Service Processor, which identifies and logs all system problems. The next level is local hardware and software support, located in IPL branch offices around the country. The third level, IPL's Worldwide Technical Support Center, located in Waltham, MA, can be contacted, and a communications link established, to isolate and correct a system malfunction. All three levels are made available to the user in the event of a system problem.

Software support is provided in two different arrangements. Plan I supports OS/VSE Release 7, VM/370 Release 6, MVS Release 3.8, and DOS/VSE Release 34 as part of the monthly maintenance costs. IPL will diagnose SCP (System Control Program) problems and provide the appropriate fixes, where needed. Plan II provides one or two days per month of System Engineer time for a wide variety of SCP requirements, and supports the above SCPs plus DOS/VSE Release 2 or 3 with Advanced Functions, VM/SP, and MVS/SP.

With the June 1981 announcement by IBM of its intention to provide System Installation Productivity Options (SIPOs) for non-IBM users, the way was cleared for IPL and other plug-compatible vendors to function as a user's agent ▶

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in dealing with IBM for specific SCP and other licensed IBM program products.

and SCPs for one shift per day, five days per week. Full maintenance coverage for 24 hours per day, seven days per week is available. Maintenance is included in the monthly rental and lease figures.

The minimum monthly maintenance charges, as shown in the following price list, include support for both hardware

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>3-Year Lease</u>
PROCESSORS				
	Model 4436 Processor; includes CPU with 50-nanosecond cycle time, 500-nano- second main memory, one byte multiplexer and two block multiplexer channels, 64K bytes of control storage, and system console			
4436-1	1,024,000 bytes of memory	\$125,080	\$485	\$4,130
4436-2	2,048,000 bytes of memory	135,080	510	4,390
4436-4	4,096,000 bytes of memory	151,080	565	4,910
	Model 4443 Processor; includes CPU with 50-nanosecond cycle time, 500-nano- second main memory, one byte multiplexer and two block multiplexer channels, 8K bytes high-speed buffer storage, 64K bytes of control storage, and system console			
4443-2	2,048,000 bytes of memory	180,144	605	5,855
4443-4	4,096,000 bytes of memory	196,144	660	6,375
4443-6	6,144,000 bytes of memory	212,144	715	6,895
4443-8	8,192,000 bytes of memory	228,144	770	7,415
	Model 4445 Processor; includes CPU with 50-nanosecond cycle time, 500-nano- second main memory, one byte multiplexer and five block multiplexer channels, 8K bytes high-speed buffer storage, 64K bytes of control storage, and system console			
4445-2	2,048,000 bytes of memory	206,700	780	6,718
4445-4	4,096,000 bytes of memory	222,700	835	7,238
4445-8	8,192,000 bytes of memory	254,700	945	8,278
	Model 4446 Processor; includes CPU with 50-nanosecond cycle time, 500-nano- second main memory, one byte multiplexer and five block multiplexer channels, 16K bytes high-speed buffer storage, 64K bytes of control storage, and system console			
4446-2	2,048,000 bytes of memory	282,808	880	9,191
4446-4	4,096,000 bytes of memory	298,808	935	9,711
4446-8	8,192,000 bytes of memory	330,808	1,045	10,751
4446-12	12,288,000 bytes of memory	362,808	1,155	11,791
4446-16	16,384,000 bytes of memory	394,808	1,265	12,831
	Model 4460 Processor; includes CPU with 50-nanosecond cycle time, 500-nano- second main memory, one byte multiplexer and five block multiplexer channels, 16K byte or 24K byte high-speed buffer storage, 64K bytes of control storage, and system console			
4460-2	2,048,000 bytes of memory	295,800	960	9,614
4460-4	4,096,000 bytes of memory	311,800	1,015	10,134
4460-8	8,192,000 bytes of memory	343,800	1,125	11,174
4460-12	12,228,000 bytes of memory	375,800	1,235	12,214
4460-16	16,384,000 bytes of memory	407,800	1,345	13,254
	Model 4480 Processor Complex; includes two tightly-coupled CPUs, each with 50-nano- second cycle time, 500-nanosecond dual ported main memory, one byte multiplexer and four block multiplexer channels, 24K byte high-speed buffer storage, 64K bytes of control storage, and system console			
4480-8	8,192,000 bytes of memory plus 1,096,000 bytes active spare memory	547,800	1,765	18,255
4480-12	12,288,000 bytes of memory plus 1,096,000 bytes active spare memory	579,800	1,875	19,355
4480-16	16,384,000 bytes of memory plus 1,096,000 bytes active spare memory	611,800	1,985	20,460
SYSTEM OPTIONS				
1602	2,048,000 byte memory increment	20,000	55.00	****
1701	Hardware upgrade kit for over four megabytes of memory	7,785	16.50	****
1702	Power Sequence Extension (16 control units)	1,805	6.50	****
1801	Console Printer	5,250	60.50	****
1805	Additional 3278 CRT keyboard	3,515	60.50	****
1806	3279 2C CRT keyboard	5,535	60.50	****
1901	System upgrade; from 4436 to 4443	45,064	95.00	****
1902	System upgrade; from 4443 to 4445	38,916	175.00	****
1903	System upgrade; from 4445 to 4446	76,108	100.00	****
1904	System upgrade; from 4446 to 4460	42,992	80.00	****
1905	System upgrade; from 4460 to 4480	212,000	640.00	****
1950	Channel to Channel Adapter	22,500	30.00	605
2001	Third and fourth block multiplexer channels	11,760	11.00	275
2002	Fifth block multiplexer channel	5,880	5.50	135

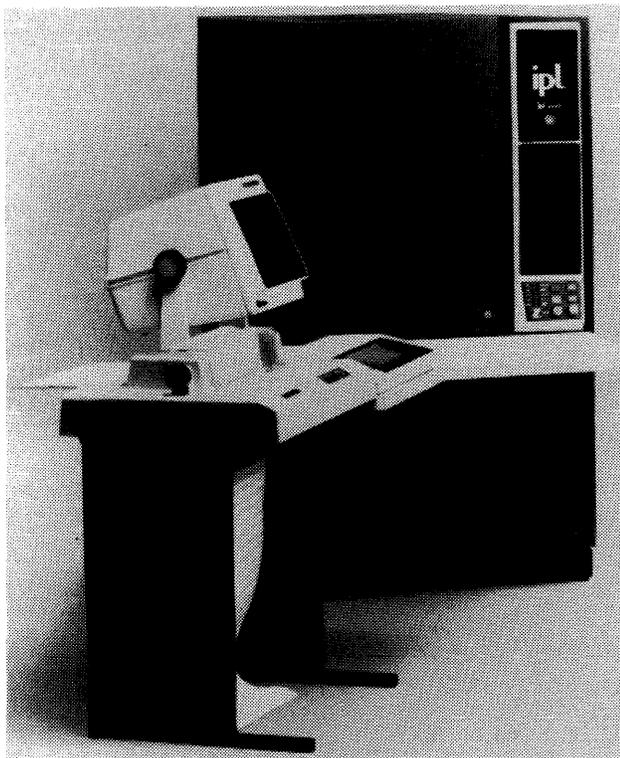
IPL Systems 4400 Series

MANAGEMENT SUMMARY

The plug-compatible mainframe (PCM) marketplace, which a few years ago was struggling for recognition in an IBM-dominated world, is alive and well, with IPL Systems one of its front-runners. IPL had been successfully building PCMs for OEM use since 1977, and the company currently supports OEM agreements with Control Data in the U.S. and Olivetti in Europe. However, the company's managers saw an opportunity for greater revenues by selling directly to end users, and, in October, 1980, announced the 4400 Series as their trump card.

The primary objective in designing an IBM plug-compatible system is to make it literally transparent to IBM operating systems, systems software, applications, and IBM and IBM-compatible peripherals. IPL set out to not only achieve this objective, but to develop a system that 1) incorporates state-of-the-art technology, 2) is easily field-upgradeable, 3) provides high reliability and maintainability, 4) offers substantially faster delivery times than the competition, and 5) provides better price/performance than the competition.

The company itself has been quite successful among its peers in the high technology community. IPL has about ➤



Featuring four models with better price/performance than comparable IBM 4300 Series processors, the IPL 4400 Series systems have from one to sixteen megabytes of main memory, three to six channels, and are field-upgradeable.

The IPL 4400 Series of plug-compatible mainframes includes four powerful systems with improved price/performance over their IBM 4300 Series counterparts. The systems require less floor space and power than the IBM products, and are all field upgradeable.

MODELS: IPL 4436, 4443, 4445, and 4446.

CONFIGURATION: Main memory ranges from one to sixteen megabytes, and three to six I/O channels are available.

COMPETITION: IBM 4331-2 through 4341-2; Cambex 1600 Series; Magnuson M80 Series, Nanodata QMX 6300 Series; and NAS AS/3000 and AS/5000 Systems.

PRICES: Purchase prices range from \$140,000 for a one-megabyte 4436 to \$509,765 for a 16-megabyte 4446.

CHARACTERISTICS

MANUFACTURER: IPL Systems, Inc., 360 Second Avenue, Waltham, Massachusetts 02154. Telephone (617) 890-6620.

IPL Systems is a high technology company that was founded in 1973 to design and manufacture mid-range computer systems. Originally the firm sold its products via OEM arrangements with such companies as Control Data and Olivetti. While it still maintains these OEM relationships, the company now markets its systems directly to end users under the IPL 4400 Series product name.

MODELS: IPL 4436, 4443, 4445, and 4446.

DATE ANNOUNCED: Models 4436, 4443, and 4446, October 1980; Model 4445, November 1981. The October date corresponds to IPL's entry into the end-user marketplace.

DATE OF FIRST DELIVERY: 4436, 4th Quarter 1980; 4443, 4th Quarter 1980; 4445, 3rd Quarter 1982; 4446, August 1981.

NUMBER INSTALLED TO DATE: Approximately 300 worldwide, of which three-fourths are in the U.S. Over 70 systems have been sold directly to end users.

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent 1 alphanumeric character, 2 BCD digits, or 8 binary bits. Two consecutive bytes form a "halfword" of 16 bits, while 4 consecutive bytes form a 32-bit "word."

FIXED-POINT OPERANDS: Can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; 1 halfword (16 bits) or 1 word (32 bits) in binary mode.

FLOATING-POINT OPERANDS: 1 word, consisting of 24-bit fraction and 7-bit hexadecimal exponent, in "short" format; 2 words, consisting of 56-bit fraction and 7-bit ➤

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➤ 300 systems installed and on order worldwide, of which over 70 have been sold directly to end users in the U.S. With its expertise in microcode emulation, the company has been able to successfully counter IBM's 4300 announcements with products of its own. The firm, which went public April, 1981, has recorded 18 consecutive profitable quarters over the last four years, a notable achievement in a volatile industry.

PROCESSORS AND MAIN MEMORY

The IPL 4400 Series consists of four single-processor models, the 4436, 4443, 4445, and 4446, that use microcoding extensively to emulate IBM System/370 and 4300 Series operating features. All models are comprised of several distinct elements, such as the CPU, memory modules, input/output control units, and service processor, that are connected to a high-speed internal link, known as the ExpandaBus™. All data transfers occur over the ExpandaBus, resulting in higher overall throughput. The ExpandaBus architecture actually is made up of three buses; the central data transfer bus, a main storage bus, and a control storage bus. The systems are field-upgradeable, and typically require nothing more than changing a few plug-in modules in the system backplane.

The central processor in all models uses emitter-coupled logic (ECL) circuitry, which is acknowledged to be superior to transistor-to-transistor logic (TTL) technology in areas such as performance, heat dissipation, and energy requirements. ECL technology also affords greater component packaging densities, resulting in reduced floor space requirements. The CPU features a 50-nanosecond cycle time.

Main memory is implemented in 16K N-channel MOS RAM chips, and the company is planning to use 64K NMOS RAM later in 1982. All memory is error-correcting, and corrects all single-bit errors and detects most multiple-bit errors. Memory cycle time is 500 nanoseconds for both read and write operations. The entry-level 4436 has from one to eight megabytes of memory, expandable in one- or two-megabyte increments. The intermediate 4443 and 4445 models have from two to eight megabytes, and the top-end 4446 can have from two to sixteen megabytes of memory. The three larger models also feature a buffer storage, or cache, for improving execution speeds. The 4443 and 4445 have 8K bytes of cache, and the 4446 has 16K bytes of cache. The system's operating features are implemented in microcode, which is contained in control storage. All 4400 Series models have 16K words of control storage which can be increased to 32K words if required.

IPL 4400 Series processors will operate with all IBM and IBM-compatible peripheral devices that are supported on System/370, 303X Series, and 4300 Series systems except those devices requiring direct control or integrated controllers and adapters. Each 4400 system has one byte multiplexer and two block multiplexer channels that ➤

➤ hexadecimal exponents, in "long" format; or 4 words in "extended precision" format.

INSTRUCTIONS: 2, 4 or 6 bytes in length, specifying 0, 1, or 2 memory addresses, respectively.

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

MAIN STORAGE

STORAGE TYPE: N-channel MOS RAM currently using 16K chips. Use of 64K RAM will occur during 1982.

CAPACITY: Model 4436, one to eight megabytes in one- and two-megabyte increments; Models 4443 and 4445, two to eight megabytes in two-megabyte increments; and Model 4446, two to sixteen megabytes in two-megabyte increments.

CYCLE TIME: For all 4400 Series models, 500 nanoseconds for both read and write operations.

CHECKING: All data paths between the central processor and main memory are parity-checked by byte. When data is stored, an error-correcting code is substituted for the parity bits. When the data is retrieved, single-bit errors are detected and corrected automatically, and most multiple-bit errors are detected and flagged for appropriate action.

STORAGE PROTECTION: The Store and Fetch Protection features, which guard against inadvertent overwriting and/or unauthorized reading of data in specified 2048-byte blocks of storage, are standard in all models.

CENTRAL PROCESSORS

The IPL 4400 Series processors are all designed to execute the IBM System/370 instruction set, as well as special control functions associated with the IBM 4300 Series. The CPUs are highly modular in construction, and are built around a high-speed internal bus, known as the ExpandaBus™.

The processors are heavily microcoded, and have an internal cycle time of 50 nanoseconds. Extensive use of emitter-coupled logic (ECL) circuitry produces high internal speeds, while requiring less power and floor space, and generating less heat than comparable systems. The use of ECL permitted the company to design a computer system which processed less data in each cycle than other comparable mid-range systems, but nevertheless achieved the desired performance by executing cycles at a much higher rate. Processing less data per cycle requires the use of less logic circuitry, hence reducing manufacturing costs and improving reliability and serviceability.

The system architecture is modular, with the CPU, main memory, input/output channels, and console functioning as independent subsystems interconnected by the ExpandaBus. System expansion and upgrading is easily accomplished by removing/replacing the required boards from the system. Maintenance is also made simpler since faulty components can be replaced in the field, once the specific problem has been determined. All models, except the top-end 4446, can be field-upgraded to the next model, or any model, if desired.

The system's operational characteristics are provided by microcode, a reloadable control program that is loaded into the system at power-up. Microcoding has made it possible for IPL, as well as its competitors, to quickly emulate architectural and functional changes in 4300 Series processors.

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CHARACTERISTICS OF THE IPL 4400 SERIES PROCESSORS

	4436	4443	4445	4446
SYSTEM CHARACTERISTICS				
Relative performance level	0.60	1.00	1.25	1.60
Date announced	10.80	10/80	11/81	10/80
Date of first delivery	4th Quarter 1980	4th Quarter 1980	3rd Quarter 1982	3rd Quarter 1981
Virtual storage capability	Standard	Standard	Standard	Standard
Principal operating systems	DOS/VS, DOS/VSE, OS/VS1, SVS, MVS, MVS/SP, VM/370, VM/SP	DOS/VS, DOS/VSE, OS/VS1, SVS, MVS, MVS/SP, VM/370, VM/SP	DOS/VS, DOS/VSE, OS/VS1, SVS, MVS, MVS/SP, VM/370, VM/SP	DOS/VS, DOS/VSE, OS/VS1 SVS, MVS, MVS/SP, VM/370, VM/SP
Upgradable to	4443	4445	4446	—
MAIN STORAGE				
Type	NMOS (16K-bit)	NMOS (16K-bit)	NMOS (16K-bit)	NMOS (16K-bit)
Cycle time, nanoseconds	500	500	500	500
Bytes fetched per cycle	8	8	8	8
Minimum capacity, bytes	1,024K	2,048K	2,048K	2,048K
Maximum capacity, bytes	8,192K	8,192K	8,192K	16,384K
Increment size, bytes	1,024K or 2,048K	2,048K	2,048K	2,048K
Error checking and correction	Standard	Standard	Standard	Standard
PROCESSOR				
Processor cycle time, nanoseconds	50	50	50	50
Control storage:				
Capacity, bytes	128K	128K	128K	128K
Cycle time, nanoseconds	20	20	20	20
Buffer (cache) storage:				
Capacity, bytes	—	8K	8K	16K
Cycle time, nanoseconds	—	100	100	100
I/O CHANNELS				
Number of channels:				
Standard	3	3	3	3
Maximum	6	6	6	6
Subchannels per channel (max.)	256	256	256	256
Maximum channel data rates:				
Block mode, bytes/second	3,000,000	3,000,000	3,000,000	3,000,000
Byte mode, bytes/second	180,000	180,000	180,000	180,000
Maximum aggregate data rate, bytes/second	11,000,000	11,000,000	11,000,000	11,000,000

➤ conform to standard IBM interface definitions. Up to three additional block multiplexer channels can be added to all models. Byte multiplexer channels transfer data at 50K bytes per second in byte mode and 180K bytes per second in burst mode. Block multiplexer channels 1 and 2 can transfer data at up to 3 megabytes per second, and channels 3, 4, and 5 can transfer data at up to 2 megabytes per second. Data streaming, which is required with the high-performance IBM 3375 and 3380 (and equivalent) disk drives, is supported on channels 1 and 2. The byte multiplexer channel can support up to 256 unshared subchannels, and each block multiplexer channel can support up to 256 subchannels.

SOFTWARE AND SUPPORT

Each model in the IPL 4400 Series is fully compatible with the following IBM operating systems: DOS/VS, DOS/VSE, OS/VS1, OS/VS2 (MVS and SVS), MVS/SP, VM/370, and VM/SP. Extended Control Program Support (ECPS) for VS1, VSE, MVS, and VM/370 is standard in all models. ECPS: MVS and ECPS: VM can operate concurrently in all models. ➤

➤ **COMPATIBILITY:** The IPL 4400 Series is compatible with the IBM System/370 and 4300 Series models with the following exceptions:

- Programs using machine-dependent data
- Programs using the ASCII bit (PSW bit 12)
- Programs that depend on features of I/O devices that are not implemented on the 4400 Series
- Programs that use main storage locations between address 128 and 736 (decimal) after a diagnostic logout to main storage

PROCESSOR FEATURES: The standard timing features of the System/370 architecture are included in all 4400 Series central processors. These include a CPU timer and a Clock Comparator; the latter provides a means for causing an interrupt when the standard Time-of-Day Clock reaches a program-specified value. Additional instructions are provided to set and store the Time-of-Day Clock, Clock Comparator, and CPU Timer.

Additional features of the System/370 found in the IPL processors include control registers, System/370 Commercial Instruction Set, byte-oriented operand, conditional swapping, dynamic address translation, microprogrammed instruction retry, double word buffer, interval timer, machine check handling, time-of-day clock, channel command retry, channel indirect addressing, console audible ➤

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➤ Additional enhancements are planned for 1982, including support for Cross Memory Services for ECPS: MVS.

System support is provided on several levels, all of which are available to a user if a malfunction occurs. The service processor, a component of the 4400 system, isolates system problems and initiates recovery measures. Information provided by the service processor makes it easier for local service personnel to correct the problem. IPL has 13 sales/service offices in major cities nationwide. IPL's Worldwide Tech Control Center, located at the company's headquarters in Waltham, MA, can link up with the system via a telephone connection. An IPL engineer at Waltham can then enter the system remotely and run a series of diagnostic routines.

COMPETITIVE POSITION

If the objective of a PCM is to offer better price/performance than comparable IBM 4300 Series products, then the 4400 Series certainly fills the bill. The entry-level 4436 is 50 percent faster than the 4331-2, yet costs about the same. It is also comparable in performance to the newer 4341-10, but costs about 15 percent less. The 4443, rated at about one million instructions per second (MIPS), according to IPL, is as fast as or faster than the 4341-1 for most applications and costs 20 percent less. The 4445, which was announced November, 1981, is 25 percent faster than the 4443, approximately 11 percent faster than IBM's new 4341-11, and costs about 18 percent less than the 4341-11. The top-end 4446 is rated at about 1.6 MIPS, is about 7 percent faster than the 4341-2, and costs about 20 percent less. A big selling point for the 4400 Series, aside from the obvious price/performance advantage, is its rapid delivery. Typically a user can have a system delivered within 30 days ARO.

USER REACTION

In the early returns of Datapro's 1982 User Ratings of Computer Systems survey, we received six responses from IPL 4400 Series users. We telephoned two additional users from a list supplied by IPL, for a total of eight installations. All except one had one system installed; the other user had two systems in place. Only one 4400 was purchased; the rest were leased, mostly from IPL. Five users converted from an IBM System/360, two upgraded from System/370s, and one originally used a time-sharing service. The companies were in the following businesses: three service bureaus, two in marketing research, and one each in facilities management, amusements, and insurance. The companies displayed a wide range of applications, such as traditional financial/payroll/personnel, and such specialized ones as mathematics and statistics.

Each system had several local terminals, and most had, or planned to have, remote terminals. Main memory ranged from one to four megabytes; the majority had four megabytes. A wide number of operating systems were in use, such as DOS/VS, DOS/VSE, MVS, VM/SP, and

➤ alarm, console file, advanced control program support, extended control mode, and program event recording. Control registers are used for operating system control of relocation, priority interruptions, program event recording, error recovery, and masking operations. A double-word buffer consists of a 64-bit area temporarily reserved for data used in performing an I/O operation. Each channel attached to the CPU has a fixed amount of channel buffer dedicated to its use.

The interval timer is a 32-bit decremental counter that is reduced by one several hundred times per second. The timer generates an interrupt when the contained value is decremented from a positive to a negative number. Machine check handling analyzes errors and attempts recovery by retrying the failed instruction if possible. If retry is unsuccessful, it attempts to correct the malfunction or to isolate the affected task. The time-of-day clock is incremented once every microsecond and provides a consistent measure of elapsed time suitable for the indication of date and time. Some channels have the capability to perform channel command retry, a channel and control-unit procedure that causes a command to be retried without requiring an I/O interruption. Channel Indirect Addressing (CIA) is a companion feature of dynamic address translation, providing data addresses for I/O operations. CIA permits a single channel command word to control the transmission of data that crosses noncontiguous pages in real main storage. If CIA is not indicated, then channel one-level (direct) addressing is employed.

The console audible alarm is a device activated when predetermined events occur that require operator attention or intervention for system operation. The console file is the basic microprogram loading device for the system, containing a read-only file device. The media read by this device contains all the microcode for field engineering device diagnostics, basis system features, and any optional system features. The extended control mode (EC) is a mode in which all features of the System/370 computing system, including dynamic address translation, are operational. Program event recording is a hardware feature used to assist in debugging programs by detaching and recording program events.

CONTROL STORAGE: All 4400 Series processor operations are controlled by microprograms that reside in high-speed control storage. The standard control storage capacity is 16K words in all current models, and is sufficient to hold the microcode required for the System/370 Universal Instruction Set and all of the standard software assist features. Control storage can be increased to 32K words if required. The microprograms are loaded into control storage by means of a diskette unit called the Console File.

REGISTERS: Each of the 4400 Series processors has sixteen 32-bit general-purpose registers, which can be used for indexing, base addressing, and as accumulators, plus eight 64-bit floating-point registers.

INSTRUCTION REPERTOIRE: The System/370 Universal Instruction Set is standard in all 4400 Series processors.

OPERATIONAL MODES: The Extended Control (EC) and Extended Control Program Support (ECPS) features are standard on the 4400 Series processors. As a result, all models can operate in any of the following modes: Basic Control (for System/360 programs), Extended Control (for programs that require dynamic address translation), ECPS: VS1 (which uses microcoding to improve system performance under the VS1 operating system), ECPS: VM/370 (which provides improved system performance under VM/370), ECPS: VSE mode, which uses microcoding to

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▷ products from other software vendors: DOS/MVT/VSE from Software Pursuits, and EDOS/VS from Nixdorf. Just about everybody was running Cobol, with one exception who was using SAS, from SAS Institute. Plans for 1982 included more memory, peripherals, system software, and new applications. A few were planning to upgrade their system to the next performance level. Most all had plans to add more data communications to their installation.

The users had very positive comments about their 4400 systems, and little or no negative remarks. Typically, any negatives were peripheral-related, rather than with the CPU. We asked the users to rate their systems in several distinct categories as being either Excellent, Good, Fair, or Poor. We've compiled the ratings in the following chart.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	7	1	0	0	3.88
Reliability of mainframe	8	0	0	0	4.00
Reliability of peripherals	0	4	0	1	2.60
Maintenance service:					
Responsiveness	7	1	0	0	3.88
Effectiveness	7	1	0	0	3.88
Technical support:					
Trouble-shooting	5	3	0	0	3.63
Education	3	3	0	1	2.75
Documentation	0	7	0	1	2.75
Manufacturer's software:					
Operating system	0	2	1	0	2.67
Compilers & assemblers	0	3	0	0	3.00
Applications programs	0	3	0	0	3.00
Ease of programming	3	2	0	0	3.60
Ease of conversion	6	2	0	0	3.75
Overall satisfaction	6	2	0	0	3.75

*Weighted Average based on 4.00 for Excellent.

These ratings indicate a high level of satisfaction IPL users have for their systems, and IPL. It should be pointed out that the high figures in the areas of service are based on a relatively small number of systems installed within a service area, thus affording the IPL user almost exclusive access to local service technicians. It will be interesting to see if IPL can continue to maintain this level of service satisfaction as it installs more systems. Datapro cautions the reader when looking at ratings on "Reliability of peripherals", and the three categories under "Manufacturer's software." These items reflect system components not provided by IPL, but nonetheless are critical to overall system performance.

Datapro talked with several IPL users to find out just how well their systems performed. We first called on a service bureau in New England who has "absolutely no complaints" about their 4436. It presently runs under DOS/VSE, and they are planning to add VM in the near future, as well as more applications and terminals. The DP manager told us his system is "very fast," and has had only about 3 hours of down time since its installation in August, 1981. He's already saved at least \$20,000 over installing a 4300, and feels the 4400 has "all kinds of system growth potential." IPL service is "good," and he now has the remote diagnostics feature installed. ▷

▶ reduce overhead and improve system throughput under DOS/VSE, and ECPS: MVS, which provides improved performance when operating under MVS. In addition, all three announced releases of MVS/SP can operate in native mode, or concurrently with ECPS: VM.

PERFORMANCE: IPL rates its 4400 Series models in terms of relative performance compared to comparable IBM 4300 Series models. Using figures supplied by IPL, here's how IPL and IBM processors measure up:

Manufacturer	Model	Performance
IPL	4446	1.60
IBM	4341-2	1.49
IPL	4445	1.25
IBM	4341-11	1.13
IPL	4443	0.95
IBM	4341-1	0.90
IPL	4436	0.60
IBM	4331-2	0.40

BUFFER STORAGE: Each 4400 Series model, except the 4436, has a cache buffer to provide improved system throughput. The buffer stores selected areas of main storage that might be used next by the CPU. If the requested data is contained in the cache, the CPU request can be handled rapidly. The 4443 and 4445 have 8K bytes of cache, and the 4446 has 16K bytes.

CONSOLE: A system console is supplied with all of the 4400 Series central processor models. It consists of a control panel, keyboard, CRT display, the Console File (a pair of diskette drives used to load the 4400 microcode and system diagnostics into control storage), and an optional console printer. The system console can operate in either of two modes, as selected during the initial microprogram load (IMPL) procedure.

- Display mode, in which the CRT and keyboard appear to the operating system as an IBM 3277 Model 2 Display Station with keyboard. This mode requires the Device-Independent Display Operator Console Support (DIDOCS) software or its equivalent. If the optional console printer is included, it requires the Multiple Console Support (MCS) software or its equivalent and must be addressed separately as an IBM Console Printer.
- Printer-keyboard mode, in which the CRT, keyboard, and optional console printer appear to the operating system as an IBM 3215 Console Printer-Keyboards. This mode is supported by DOS, DOS/VS, OS, OS/VS, and VM/370.

The system console also contains the Service Processor, a microprocessor for diagnostic functions and a remote data link facility that provides on-line communications with a remote console, such as the one at IPL's Worldwide Tech Control Center at its Waltham headquarters. The data link enables personnel at the Tech Center to operate the user's system remotely in order to diagnose problems.

The CRT associated with the console can be located up to 30 feet from the CPU. In the third quarter of 1982, IPL plans to support up to three additional CRTs or printers at the console, as well as IBM 3278 2A, 3279 2C, and compatible terminals.

PHYSICAL SPECIFICATIONS: All 4400 Series processors are housed in the same cabinet, which can contain the maximum 16 megabytes of memory. The 4400 typically requires about one-third less floor space than an IBM 4341, when equipped with the standard system console. Listed below are the dimensions and power requirements of the basic 4400 Series models, including the console. ▶

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▷ The manager of another service bureau, this time on the west coast, told us he considered an IBM 4341 to replace his System/360 Model 50, but lost interest when he found out about delivery schedules. At the time, Magnuson only had its M80/32 available, and it was too slow for his needs. IPL had "a better deal," and he subsequently installed a two-megabyte 4443. The conversion from the 360 to the 4443 took only an hour. The system is "rock solid," and gives his company "99.9+ percent uptime." Although he was disappointed that IPL has not yet worked with him to evaluate additional system options for his installation, as he claimed IPL said they would, he had nothing but praise for the system.

In the midwest we contacted the DP manager of a market research firm that needed more power than its 370/155 was providing. His operations required substantial floating-point computational power, and he felt that IBM "couldn't deliver." Not contacting any other PCMs except IPL, he installed a 4443 only to find it too had difficulty handling his f-p requirements. Working closely with IPL, he has resolved his problem and has a larger 4446 on the way. He was very impressed with IPL's cooperation during this time.

Another user, this one an amusement organization in the southwest, had a similar floating-point problem which the DP manager told us IPL handled in "a very up-front" manner. The conversion from a 370/145 to a two-megabyte 4443 was "the easiest I've ever seen." He had a 4341 on order, but changed his mind because he felt the 4341 was too big, and was reluctant to order a 4331, since he would have to change out systems after outgrowing the 4331. He has realized some important savings, particularly since he doesn't need to work any overtime in his shop now. He felt IPL's service was "excellent," and has had virtually no problems with his 4443.□

► Dimensions:

Width, in (cm) 31.5 (80)
Depth, in (cm) 63 (160)
Height, in (cm) 60 (153)
Weight, lb (kg) 2,000 (907)

Power requirements:

Voltage—208V ± 10%
Phases—3
Frequency, Hz—60 ± 0.5

Heat dissipation, BTU/hr—10,000

Environmental requirements for all models are as follows: operating temperature range—60 to 90 degrees F. (15 to 32 degrees C.); relative humidity range—20 to 80 percent.

INPUT/OUTPUT CONTROL

The IPL 4400 systems support one byte multiplexer channel and up to five block multiplexer channels. The basic 4400 system is supplied with a byte multiplexer channel and two block multiplexer channels, which can be increased up to five block multiplexer channels.

Each byte multiplexer channel has 256 unshared subchannels and can address up to 256 devices. Similarly, each block multiplexer channel can have up to 256 subchannels. Unit control words (UCWs) can be dynamically assigned from a pool of 432 unshared and 16 shared UCWs.

The maximum byte multiplexer channel data rate is 50,000 bytes per second in normal operating mode and 180,000 bytes per second in burst mode. Any block multiplexer activity reduces the byte multiplexer data rate.

Block multiplexer channels 1 and 2 have a maximum data rate of 3.0 million bytes per second (Data Streaming), and block multiplexer channels 3-5 have a maximum rate of 2.0 million bytes per second. The aggregate data rate for all block multiplexer channels in a system is 11 million bytes per second. Block multiplexer channels can operate as selector channels where they control one operation at a time.

A unique double-word buffer that provides greater levels of throughput is included with each block multiplexer channel.

SIMULTANEOUS OPERATIONS: Concurrently with computing, a 4400 Series processor can control a maximum of one high-speed I/O data transfer operation on each block multiplexer channel and one low-speed I/O data transfer operation on each subchannel of each byte multiplexer channel, subject to the maximum channel and aggregate data rates specified above. Alternatively, a byte multiplexer channel can operate in burst mode and handle a single high-speed I/O operation instead of multiple low-speed operations.

CONFIGURATION RULES

IPL 4400 systems can be configured in essentially the same manner as IBM System/370 and 4300 Series computer systems, except that no integrated peripheral controllers are available for the IPL computers.

PERIPHERAL EQUIPMENT

The IPL 4400 can utilize all IBM System/370 and 4300 Series input/output and mass storage subsystems, except those that require integrated controllers or adapters, as well as the plug-compatible counterparts of these IBM subsystems offered by other vendors. Detailed coverage of many of these peripherals can be found in Volume 2 of DATAPRO 70.

SOFTWARE

All of the current 4400 Series computer systems fully support the following IBM operating systems: DOS/VS, DOS/VSE, OS/VS1, OS/VS2 (SVS and MVS), and VM/370. Detailed descriptions of these operating systems can be found in Reports 70C-491-06 (IBM 303X Series) and 70C-491-08 (IBM 4300 Series), Extended Control Program Support (ECPS) for VS1, DOS/VSE, MVS, and VM/370 is standard in all models. Concurrent operation of ECPS: VM and ECPS: MVS is also standard in all models. To increase the performance of MVS/SP Release 3 running on its systems, IPL plans to include Cross Memory Services (Dual Address Space) in a fourth quarter 1982 enhancement to ECPS: MVS.

PRICING

IPL 4400 Series systems are available on a direct purchase basis, or two-, three-, four-, and five-year third-party leases. Two-year lease prices are provided in this report. For additional lease prices, contact IPL. The cost for a system upgrade is equal to the difference in purchase or lease price between the two models. ▶

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► **SUPPORT:** IPL provides three levels of hardware support for 4400 Series users. The systems all include a Service Processor, which identifies and logs all system problems. The next level is local hardware and software support, located in IPL branch offices around the country. The third level, IPL's Worldwide Tech Control Center, located in Waltham, MA, can be contacted, and a communications link established, to isolate and correct a system malfunction. All three levels are made available to the user in the event of a system problem.

Software support is provided in two different arrangements. Plan I supports OS/VS1 Release 7, VM/370 Release 6, MVS Release 3.8, and DOS/VS Release 34 as part of the monthly maintenance costs. IPL will diagnose SCP (System Control Program) problems and provide the appropriate fixes, where needed. Plan II provides one or two days per

month of System Engineer time for a wide variety of SCP requirements, and supports the above SCPs plus DOS/VSE Release 2 or 3 with Advanced Functions, VM/SP, and MVS/SP.

With the June 1981 announcement by IBM of its intention to provide System Installation Productivity Options (SIPOs) for non-IBM users, the way was cleared for IPL and other plug-compatible vendors to function as a user's agent in dealing with IBM for specific SCP and other licensed IBM program products.

The minimum monthly maintenance charges, as shown in the following price list, include support for both hardware and SCPs for one shift per day, five days per week. Full maintenance coverage for 24 hours per day, seven days per week is available. Maintenance is included in the monthly rental and lease Figures.

EQUIPMENT PRICES

PROCESSORS

Model 4436 Processor; includes CPU with 50-nanosecond cycle time, 500-nanosecond main memory, one byte multiplexer and two block multiplexer channels, 16K words of control storage, and system console

		<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>3-Year Lease</u>
4436-1	1,024K bytes of memory	\$140,000	\$485	\$4,885
4436-2	2,048K bytes of memory	155,700	510	5,280
4436-3	3,072K bytes of memory	171,400	540	5,680
4436-4	4,096K bytes of memory	187,100	565	6,075
4436-8	8,192K bytes of memory	249,900	665	7,480

Model 4443 Processor; includes CPU with 50-nanosecond cycle time, 500-nanosecond main memory, one byte multiplexer and two block multiplexer channels, 8K bytes high-speed buffer storage, 16K words of control storage, and system console

4443-2	2,048K bytes of memory	182,765	605	6,695
4443-4	4,096K bytes of memory	214,165	660	7,490
4443-6	6,144K bytes of memory	245,565	715	8,285
4443-8	8,192K bytes of memory	276,965	770	9,080

Model 4445 Processor; includes CPU with 50-nanosecond cycle time, 500-nanosecond main memory, one byte multiplexer and two block multiplexer channels, 8K bytes high-speed buffer storage, 16K words of control storage, and system console

4445-2	2,048K bytes of memory	228,335	780	7,795
4445-4	4,096K bytes of memory	259,735	835	8,590
4445-8	8,192K bytes of memory	322,535	945	10,180

Model 4446 Processor; includes CPU with 50-nanosecond cycle time, 500-nanosecond main memory, one byte multiplexer and two block multiplexer channels, 16K bytes high-speed buffer storage, 16K words of control storage, and system console

4446-2	2,048K bytes of memory	289,965	880	9,855
4446-4	4,096K bytes of memory	321,365	935	10,650
4446-8	8,192K bytes of memory	384,165	1,045	12,240
4446-12	12,288K bytes of memory	446,965	1,155	13,830
4446-16	16,384K bytes of memory	509,765	1,265	15,420

SYSTEM OPTIONS

1701	Memory Upgrade for systems with four megabytes and up; applied only once beyond four megabytes	7,785	16.50	190
1901	System upgrade; from 4436 to 4443	42,000	Std. chg.**	1,470***
1902	System upgrade; from 4443 to 4445	43,915	Std. chg.**	1,710***
1903	System upgrade; from 4445 to 4446	76,130	Std. chg.**	2,660***
2001	Third and fourth block multiplexer channels	11,760	11.00	275
2002	Fifth block multiplexer channel	5,880	5.50	135
	1,024K-byte memory increment	15,700	25	395
	2,048K-byte increment	31,400	55	795

*Monthly lease price includes maintenance.

**Maintenance charge is standard rate for upgraded system, and apply to system following completion of upgrade.

***Minimum remaining contract term must be 24 months.