Bull DPS 9000 Series

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Product Summary

Description
DPS 9000 Series computers are general-purpose, large-scale mainframes optimized for high-performance transaction processing. Like other Bull mainframes that operate under the GCOS 8 operating system, DPS 9000 systems are ASCII-oriented, word-oriented machines with 36-bit words.

Strengths
Throughput is high, especially for on-line transaction processing. The integrated vector processor can operate simultaneously with normal operations with minimal overall system degradation. All but the lowest model are fully duplicated, fault-tolerant systems. Higher density packaging and direct liquid cooling improve the DPS 9000 over the DPS 90 via faster processing, smaller footprint and power consumption, and quieter operation. The system can support a virtual address space of over 8000 gigabytes for software use.

Limitations
A job mix heavily weighted toward batch operations will be processed less efficiently than a job mix weighted toward on-line transaction processing.

Competition
IBM 3090 Series, including new J and JH models; largest models of Unisys A Series; Control Data 990; new Digital VAX 9000 systems.

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Price
$5,856,400 to $22,967,400 for central system.

GSA Schedule
Bull HN sells to the federal government only indirectly, via the HFSI Division of Honeywell, Inc.; contact HFSI.

Analysis

Product Strategy

Bull's top-of-the-line DPS 9000 Series, the successor to the DPS 90 Series, provides Bull's large-systems customers with an extended growth path. Bull's first major upgrade to large-scale mainframes took place in 1987, when the company (Honeywell Bull at the time) addressed the growing power needs of its DPS 8 users with the DPS 8000 Series. The upgrade path for GCOS 8-based systems has further benefited from the DPS 90 and DPS 9000 Series.

Models and Power Range

The DPS 9000 line consists of the Model 91, a single processor; the Model 92T, a fully redundant, two-processor system; the Model 93, a triple processor; and the Model 94, a quad processor. Main memory ranges from 128 megabytes to 1 gigabyte. These configurations support up to one megabyte of system-level cache in addition to local CPU cache. Up to four Input/Output Processors (IOPs) each support up to 64 physical channels and up to 256 logical channels.

When Bull announced the new series in November 1988, the vendor called these machines the most powerful general-purpose mainframes in the world, eclipsing the IBM 3090 S models and the Amdahl 5990 Series, then the acknowledged performance leaders. (IBM recently boosted 3090 performance with new J and JH models, so these comparisons are open to review.) Bull based its superiority claims on the machines' transaction processing capabilities. DPS 9000 processors can perform more than 1,000 transactions per second using the TP1 debit/credit benchmark. The overall range of the currently marketed GCOS 8 machines, from the entry-level DPS 8000/41 to the DPS 9000/94, provides a 56-fold increase in processing power (18 to 1,010 transactions per second).

Markets Served

The systems address traditional Bull markets and application areas: high-volume transaction processing, relational database management, and complex networking. To strengthen its service to these markets, the company has also made Oracle available for all its mainframe products including the DPS 90. Oracle, a relational database management system from Oracle Corporation, has become an industry-standard relational database.

In addition to database and transaction processing, the DPS 9000 Series includes an integrated vector processor for numeric-intensive applications. This capability helps customers implement image and graphics processing, modeling, and simulations.

Primary U.S. vertical markets for all GCOS 8-based systems are manufacturing, public sector segments, telecommunications, insurance, and retail. Generally, Groupe Bull's plan for strengthening Bull HN's profitability in the U.S. is to follow the strategy it claims succeeded in the United Kingdom and Italy: "a solutions approach to market demand and a reinforced reseller network." Part of the recent national advertising blitz has, in fact, been aimed at resellers. In addition, Bull HN is placing an increased emphasis on UNIX-based products.

Mass Storage and Data Management

Mass storage devices include triple-capacity storage units acquired from IBM. For customers implementing high-performance transaction processing applications, Bull offers its MSS8080 mass storage subsystem, calling it "the most economical choice"; the basic system sells for $78,900 and a secondary system for $49,300. Specific applications areas include airline reservation systems, order entry, and catalog sales. The MSS8080 can be configured in multiple modules, each of which features two actuators and holds up to 760 megabytes of data. A single MSS8080 cabinet can contain more than three gigabytes of storage. Additional cabinets can expand the capacity to a maximum of 24 gigabytes. The storage device can transfer data at up to 10 megabytes per second using a new, high-capacity data channel interface. Multiple data transfers are multiplexed in the interface to achieve this transfer rate.

Bull's Interel relational data management system includes a Structured Query Language (SQL)

Company Profile
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Exec. V.P. for U.S. Marketing, Sales, and Service: Gerald Vennard
Exec. V.P. for R&D: Dominic Chan
Exec. V.P. Strategy and Business Management: Ward McKenzie

Company Background:
Bull HN Information Systems has evolved as an international partnership. In 1962, Honeywell and NEC began a long-term technology agreement; Honeywell's relationship with Groupe Bull began in 1970. A 1987 buy-in by Groupe Bull made it an equal partner with Honeywell in a globe-encircling French-U.S.-Japanese partnership.

Beset by a major net loss in 1988, a series of layoffs, and successive reorganizations, Honeywell reduced its role in the company by selling shares to Groupe Bull at the end of 1988. Honeywell Bull was then renamed to reflect what is now its new majority owner, Groupe Bull. Groupe Bull's dominant interest has since increased to 69.4 percent.

The new U.S.-based organization is called Bull HN Information Systems, Inc., with HN briefly alluding to Honeywell and NEC's minority stakes in the partnership—now 15.6 percent and 15 percent, respectively.

Groupe Bull—strictly speaking, the holding company Compagnie des Machines Bull (CMB)—is 92 percent owned by the French national government. Only the remaining 8 percent is publicly traded on European stock exchanges.

Products of the combined companies range from CP8 Smart Cards to mainframes to large networks. Combined annual R&D investment of the partnership is 11.5 percent of total revenues (exceeding $600 million).

On October 2, 1989 Groupe Bull agreed to acquire Zenith Data Systems (the leading U.S. manufacturer of laptop computers) from Zenith Electronics Corporation.

Financials:
The U.S.-based Bull HN remains a sizable company with over 19,000 employees worldwide and operations in more than 28 countries. Bull HN's annual revenues—from the U.K., Italy, Asia, Australia, Mexico, Canada, as well as the U.S.—exceed $2 billion.

Groupe Bull overall has more than 45,000 employees and operations in more than 90 countries and over 11,000 employees in the U.S. With consolidated revenues exceeding $5.3 billion (1988), Groupe Bull is the leading European-based supplier of information systems.

After accounting for Groupe Bull's increased stake in Bull HN, consolidated 1988 net earnings of Groupe Bull were $51 million, almost 35 percent over 1987. These profits continue the steady growth of the prior three years of "renewed profitability" (averaging $34 million)—a dramatic recovery after several years of substantial net losses ($187 million in 1983-84).

Bull HN is not publicly traded, so quarterly earnings figures for 1989 are not available. 1988 annual revenues for Bull HN were $2.2 billion: 46 percent from North America, 31 percent from Italy, 17 percent from the U.K., and 6 percent from other countries.

Bull HN accounted for 41.6 percent of Groupe Bull's total worldwide revenues in 1988.

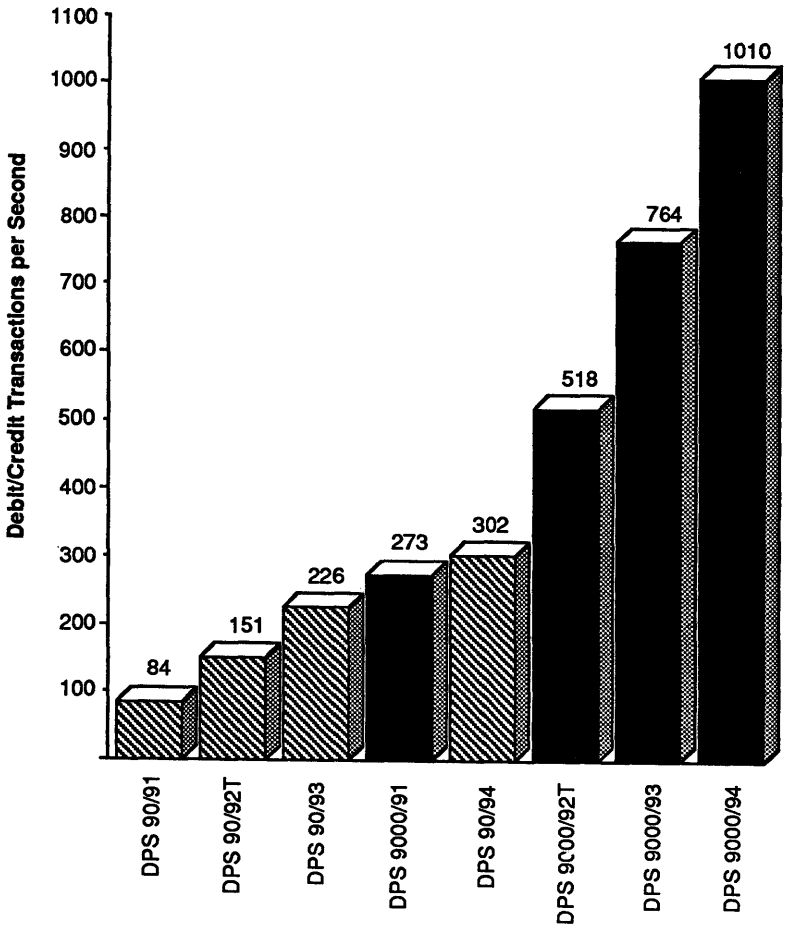
and its own data dictionary system. Interel's implementation of SQL is compatible with IBM's SQL/DS and DB2, Oracle from Oracle Corporation, Ingres from Relational Technology Inc., and the Teradata DBC/1012 database computer.

Bull has also repackaged a Teradata database machine under its own label as the Relational Data Base Computer (DBC), which may be implemented with all currently marketed GCOS 8 machines (DPS 8000 and up). The DBC package includes associated disk storage, channel exchanges, interfaces, and addressing expansions. A single DBC can serve multiple hosts.

Bull claims the Relational DBC is *necessary* for databases greater than 25 gigabytes in size, *compelling* for databases between 10 and 25 gigabytes, and *worth considering* for databases between 2 and 10 gigabytes. Software relational

Figure 1.
Bull DPS 90 and DPS 9000 Power Ranges

Debit/credit benchmark performance by model.
Courtesy of Bull HN Information Systems.



database management systems—Interel or Oracle—should suffice for databases smaller than two gigabytes.

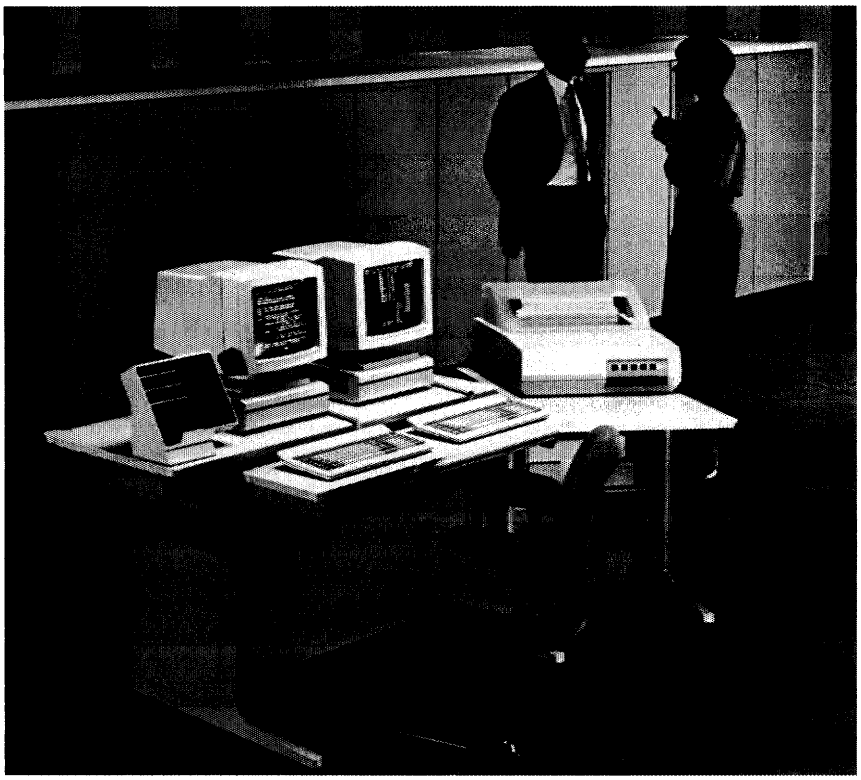
The DPS 9000 Series runs under Software Release 4000 of the GCOS 8 operating system used for all of the company's large-scale mainframe products. Release 4000 differs from Release 3000 only in that it identifies the DPS 9000 and its components to GCOS.

Software Development Aids

Pacbase: This applications generator, from CGI Systems Inc., uses a methodology based on computer-aided software engineering (CASE) to improve productivity in all phases of application development. Bull claims the product should reduce system maintenance costs and the time required for software maintenance and development. The product should also help companies reduce development backlogs and increase control of corporate data.

Pathvu and Retrofit: These tools, from Catalyst Inc., analyze and restructure existing Cobol programs, helping users to better maintain and enhance their software. Pathvu does the analysis and generates reports tailored to the needs of a software management team. It follows the logic patterns in a program's code; identifies "dead" code and logic flaws; and creates and maintains 43 separate statistics used to generate management, technical, and individual program reports.

Retrofit converts unstructured Cobol programs into structured Cobol. It unscrambles convoluted logic, corrects structural flaws, ensures consistency, and produces PERFORM-based programs that are functionally equivalent to the original program.



Bull's newest mainframe line, the DPS 9000 Series, is targeted for high-volume transaction processing and data management but can simultaneously execute numeric-intensive Fortran programs with its integrated vector processor. Shown is the Model 92T dual-processor configuration.

Magna 8: Bull has augmented Magna 8, its fourth-generation language offering, with transaction processing capabilities.

System Security

Bull has also introduced the System Security Manager (SSM) for GCOS 8 systems. (Contact the vendor on availability of SSM for specific GCOS 8 releases.) Applicable to both local and remote users, SSM offers a GCOS 8 installation flexible degrees of security, but with pervasive and tough enforcement. For example, the security manager can determine how many unsuccessful logon attempts constitute a security breach and how reports of security breaches for each user should be routed. Once a security breach occurs, SSM directs printed and audible alarms to the system console and a log record to the security terminal and a control file. It also terminates the work unit causing the breach, locks the offender's user profile, and prevents establishment of any new work units for that user until his/her profile has been unlocked.

In SSM, security levels can be applied to personal IDs, user IDs, processes, and files. Hierarchical security levels can be defined, along with nonhierarchical access categories and sets of categories. Thus, a user or process can be restricted both to a set of substantive categories and by security clearance level. User profiles are encrypted and can be managed centrally. The security manager can immediately lock a user out of the system.

Competitive Position

In the vendor's marketing formula, the GCOS 8 system family is a distinctive combination of advanced data management (including Bull's relational strategy), price/performance and efficiency (per benchmark testing), low five-year cost of ownership, multivendor compatibility/coexistence, and ease of growth. The DPS 9000 is particularly appealing based on a combination of high performance, simultaneous support for both regular and vector applications, and environmental (space/power/quietness) advantages.

The new System Security Manager is without direct competition on GCOS 8 platforms.

The machines compete directly against IBM 3090 S, J, and JH models; the Hitachi (NAS) AS/EX Series; and the Amdahl 5990 models, which have a top-speed performance of more than 105 million instructions per second (MIPS). Prior to the recent 3090 power boosts, Bull compared the DPS 9000 Model 91 with 3090 models through

400S and Model 92T with 3090 models through (and beyond) 600S. According to Bull's debit/credit benchmark tests (in 1988), DPS 9000 Models 93 and 94 dwarfed the competition.

Actually, Bull can supply more interesting figures, showing the relative performance of compared 3090 systems when the percentage job mix of transaction processing to batch is 75 to 25, 50 to 50, or 25 to 75.

In the Unisys lineup, Bull considers the DPS 9000 Model 91 a power match for Unisys 2200 computers through about Model 633, and of the A Series through about Model A17L. DPS 9000 Model 92T exceeds the power of the Unisys 2200 Model 644 and the A17N.

The new Digital VAX 9000 competes with IBM 3090 Series computers and, like the DPS 9000, is also optimized for on-line transaction processing. If correctly described as comparable in power to a 3090 Model 180S, a single-CPU Digital 9000 should be roughly competitive with Model 91 of both the DPS 90 and the DPS 9000 Series.

Bull's pricing structure includes a flat rate for each incremental memory increase, which tends to make larger memories prohibitively expensive. On the other hand, memory increments can be asymmetric (different CPUs can have different amounts of memory), which enables the installation to buy just the memory it needs. IBM has only recently permitted asymmetric memory growth in the 3090 Series.

Benchmarks

Bull markets DPS 9000 processors as general-purpose mainframes, but with particular emphasis on transaction processing—a long-standing interest of Bull from the days when on-line transaction processing was something of a niche market. This history has influenced Bull's comparison of its machines with those of other vendors that were geared primarily to batch processing.

The debit/credit benchmark provides double-entry bookkeeping for a customer account in a banking-like application. Each test transaction realistically involves both in-memory processing and several I/O functions: reading a 100-byte message from a terminal, rewriting the account, writing history, rewriting the teller, rewriting the branch, and sending a 200-byte message to the terminal. This nonproprietary benchmark is accepted by several vendors, although there is still room for debate about how a particular test was implemented.

In debit/credit benchmark testing under the GCOS 8 operating system, DPS 8000 Models 41 to 84 could process 18 to 100 transactions per second, respectively. ***NOTE:*** *Jobs using long floating-point operands would have substantially slower performance. Jobs using Binary Coded Decimal (BCD) encoding also exact a performance penalty.* By comparison, DPS 9000 machines can perform up to 1,010 transactions per second.

The overall range of the currently marketed GCOS 8 machines, from the entry-level DPS 8000/41 to the DPS 9000/94, allows a 56-fold increase in processing power (18 to 1,010 transactions per second).

Bull does not publish MIPS ratings, arguing correctly that they provide a poor comparative measure of realistic performance. Unfortunately no independent group has provided extensive cross-comparisons of competitive large-scale mainframe systems based on relatively realistic measures.

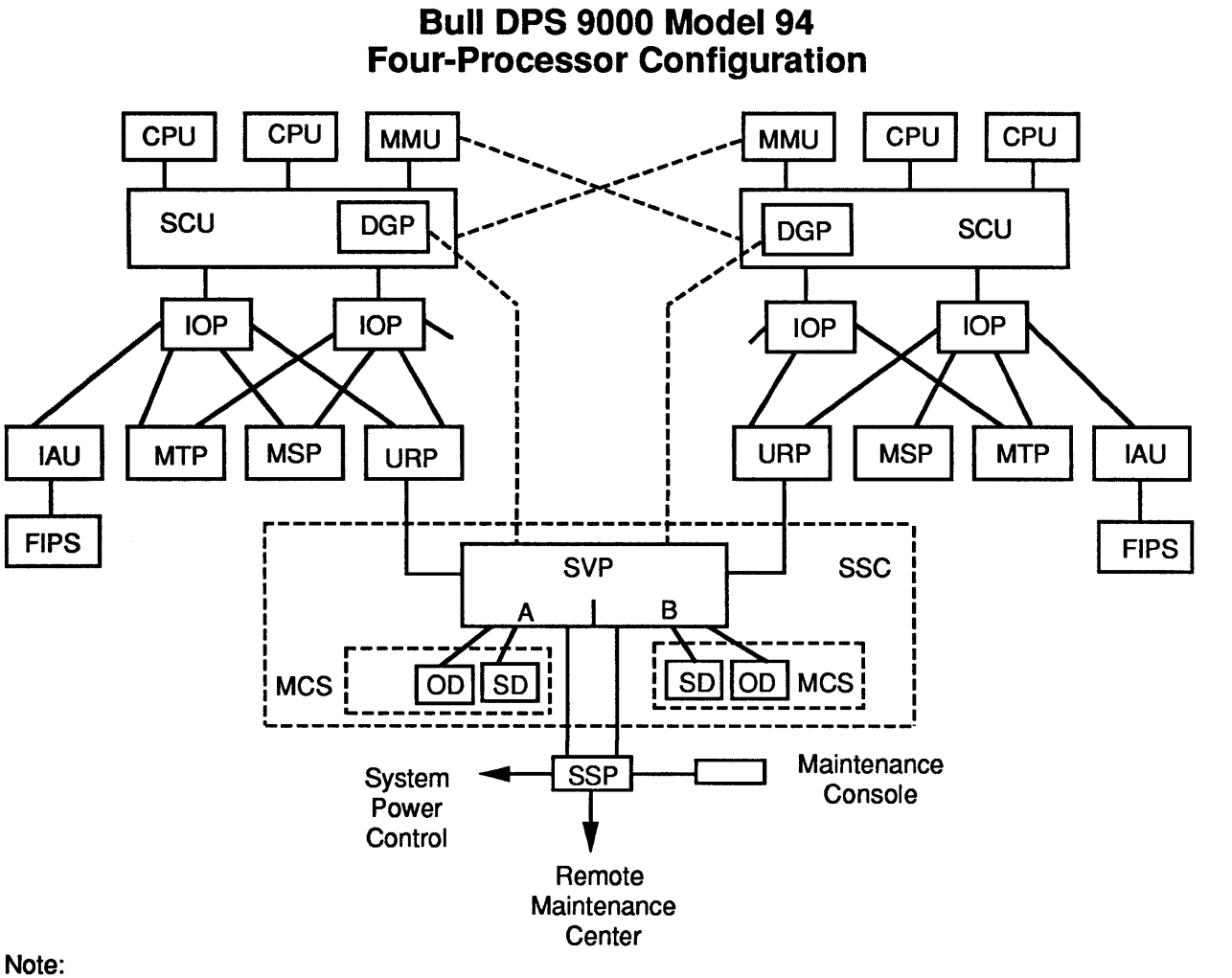
On the other hand, Bull has published LINPAC (full precision) figures for the DPS 9000's vector processor: 17.5 megaflops (millions of floating-point operations per second). The vector processor currently runs only Fortran programs. The planned GCOS 8 Release 5000 will expand the repertoire of vector instructions.

Relationship to Current Product Line

The new machines provide DPS 90 customers who need more performance with a long-awaited migration path. To date, the company has installed more than 200 DPS 90s, worldwide. In all likelihood, these existing DPS 90 accounts will be Bull's best DPS 9000 prospects. The availability of more powerful hardware will help maintain the company's existing base.

As would be expected, the DPS 9000 Series features more memory capacity and faster throughput than Bull's previous top-end model line, the DPS 90 Series. Memory capacity now reaches 1 gigabyte, compared to 256 megabytes for the DPS 90s. The new models use a system-level cache that speeds up memory accesses to the Main Memory Unit (MMU), a feature the DPS 90s do not have. Additionally, the new models use one-megabit memory chips to pack more memory capacity into a smaller space. The DPS 90s use 256-kilobit chips.

Figure 2.
Bull DPS 9000 Model 94 Four-Processor Configuration



Note:

The SCC shown is fully duplicated, as required for DPS 9000 Model 92T, DPS 9000 Model 93, and DPS 9000 Model 94 systems. A basic SCC configuration for a DPS 9000 Model 91 system includes one Master Console Station (with one operator display, one status display, and one serial printer) and a fully duplicated Service Processor (SVP).

CPU:	Central Processing Unit	URP:	DPS 9000 Unit Record Processor
MMU:	Main Memory Unit	FIPS:	FIPS-compliant Peripherals
SCU:	System Control Unit	SVP:	Service Processor
DGP:	Diagnostic Processor	MCS:	Master Console Station
IOP:	Input/Output Processor	SCC:	System Control Center
IAU:	Interface Adapter Unit	OD:	Operator Display
MTP:	Magnetic Tape Processor	SD:	Status Display
MSP:	Mass Storage Processor	SSP:	System Support Processor

Courtesy of Bull HN Information Systems.

The DPS 9000 also features up to 64 physical channels per IOP or up to 256 physical channels for large configurations using four IOPs. The DPS 90 can be configured with up to 64 channels.

While high-density packaging makes the DPS 9000 more compact and faster than previous models, higher circuit densities lead to a need for liquid cooling. The DPS 9000 uses liquid cooling in its

CPUs and System Control Units (SCUs). The installation can select from two types of heat exchangers to remove the heat from the sealed system. By contrast, the DPS 90 (based on lower density versions of NEC mainframe circuitry) is entirely air cooled. While somewhat more complex, liquid cooling has the advantage of much quieter operation. (The vendor reports a 95 percent reduction in noise.)

DPS 88 and 90 users can upgrade to the DPS 9000 without converting applications, since all three product lines run under the same GCOS 8 operating system. Users migrating to the DPS 9000, however, will face a processor swap-out, since direct field upgrades are not possible.

Bull has no plans to port the CP-6 operating system to the DPS 9000. CP-6 currently runs on DPS 8 and DPS 90 systems and represents a small (if enthusiastic) part of the Bull user base.

Users can connect most existing Bull peripherals to the DPS 9000. Some of the newer peripherals include the double-density MSU3381/3383 disks, the triple-density MSU3391/3393 disks, and the CTS8504 Series Cartridge Tape Subsystem.

Compatibility

Although the overall performance range of the GCOS 8 product line has grown, limited compatibility with Bull's smaller systems remains an issue, as it is for IBM and some other vendors. GCOS 8 systems are ASCII-oriented, 36-bit word machines. By contrast, DPS 7000 Series computers are 32-bit word, byte-oriented, EBCDIC-based machines. Although GCOS 7 and 8 have some common file formats and can both support some new multiplatform packages such as Oracle, regular GCOS 7 applications cannot be easily migrated to the larger GCOS 8 machines; they require substantial code rewriting and recompilation.

For both competitive and internal compatibility reasons, therefore, Bull HN and its corporate predecessors have for years stressed cross-product consistencies to facilitate transaction processing applications, a major marketing cornerstone. Hence Bull's Distributed Systems Architecture (DSA) is an open architecture that supports peer-to-peer networks and conforms to ISO's Open Systems Interconnection (OSI) model for interconnecting equipment from other vendors.

Like IBM, Unisys, and most other vendors, Bull has been addressing hardware/software connectivity concerns. Bull announced its Integrated Information Architecture (IIA), a framework that lets mainframe, mini, or micro users access data at different computing levels within an organization. IIA was similar in concept to IBM's evolving three-level Systems Application Architecture (SAA). But Bull HN's Integrated Information Architecture (IIA) and Bull SA's Blue/Green architecture are now in the process of being merged, refined, and extended. The new architecture is due in 1990.

In conjunction with this trend toward interoperability, the Interel relational data management system is designed to facilitate end-user access to databases. Interel, using an SQL interface, can access both relational and nonrelational data structures.

The GCOS 8 operating system runs on all Bull large-scale mainframes, enabling applications written for one large machine to work with minimal or no modification on other Bull large-scale hardware running GCOS 8.

The Personal Computer Interconnect product lets PC users access mainframe data and download the data to the PC for incorporation into popular application packages, such as Lotus 1-2-3, dBASE III, MultiMate Advantage, and WordStar Professional. For even greater freedom to mix processing platforms, Bull now markets the Oracle relational database product family, which supports more than 80 platforms from a wide variety of vendors.

Bull's cross-platform (OS/2, UNIX, GCOS 6/HVS 6, GCOS 7, GCOS 8) activities focus on improved compatibility and integration both among its own product lines and with other vendors' lines—via Open Systems industry-standard products and by various interfaces. Since mid-1988 Bull has called its network OSI/DSA to stress its full implementation of the Open Systems Interconnection model, including inherent peer-to-peer communications. Customers, therefore, will not need to migrate applications to OSI software or operate separate proprietary and OSI networks.
NOTE: *The long-standing "OSF" in Bull's network products stands for Open Software Facility,* not *Open Systems Foundation.*

Decision Points

Given its integrated vector processor and with appropriate Bull or third-party software, the DPS 9000 provides effective support both for large-scale transaction/batch data processing and for numeric-intensive Fortran processing—with only minimal degradation if both types of processing are performed simultaneously. This dual character of the machine will appeal to businesses with a side or central interest in scientific or image processing, for example.

Installations that have unusually heavy batch processing requirements and low requirements for on-line transactions may find the DPS 9000 optimized the wrong way. (Recent IBM 3090 enhancements include hardware/software boosts specifically geared to getting more batch work done in the shrinking daily "batch processing window.")

The DPS 9000's reliability has been enhanced (over the DPS 90) at the electronics level as well as through improved diagnostics and faster recovery. Fully redundant configurations in Models 92T and up provide fault-tolerant operation.

Bull's comprehensive database strategy preserves the user's database investment. I-D-S/II can still be used for CODASYL-type databases, including on-line transaction processing. Users wanting to experiment with or migrate gradually to relational databases can use Bull's Interel software to perform SQL relational queries on existing databases—without duplicating or transforming those databases—while developing new databases that are actually relational. Bull expects Interel to provide long-term service to many installations that will indefinitely maintain both CODASYL and relational databases. Oracle is available for users needing distributed processing across multiple platforms or who already have Oracle on their PCs and want to extend that relational capability. Finally, for users with maximum performance requirements, Bull offers a fully integrated, Teradata-supplied database computer.

Cross-References

Hardware prices for the DPS 9000 are summarized at the end of this report. For GCOS 8 software prices, see the report on the Bull DPS 8000 Series (Page 70C-115JE-401).

Characteristics

Product Overview

Models

DPS 9000/91 single processor, DPS 9000/92T tandem system, DPS 9000/93 triple processor, and DPS 9000/94 four-processor system.

DPS 9000 models consist of a Central System Module (CSM), Input/Output Processor (IOP), System Control Center (SCC), System Support Processor (SSP), Unit Record Processor (URP), Power Supply Unit (PSU), Cooling Unit (CLU), and Interface Adapter Unit (IAU). The CSM consists of the CPU, System Control Unit (SCU), and Main Memory Unit (MMU).

The DPS 9000 Model 91 consists of one CPU, one SCU, one MMU with 128 megabytes of memory, one IOP without channels, one IAU without channels, one SCC cabinet, one SCC console, one SSP, one URP, and one channel pair. The model requires a PRU0908 or PRU1208 printer.

The DPS 9000 Model 92T consists of two CPUs, two SCUs, two MMUs with a total of 256 megabytes of memory, two IOPs without channels, two IAUs without channels, one SCC cabinet, two SCC consoles, one SSP, two DPS 9000 URPs, and two channel pairs. The model requires two PRU0908s or PRU1208s or one of each.

The DPS 9000 Model 93 consists of three CPUs, two SCUs, two MMUs with a total of 256 megabytes of memory, three IOPs without channels, three IAUs without channels, one SCC cabinet, two SCC consoles, one SSP, two DPS 9000 URPs, and two channel pairs. The model requires two PRU0908s or PRU1208s or one of each.

The DPS 9000 Model 94 consists of four CPUs, two SCUs, two MMUs with a total of 256 megabytes of memory, four IOPs without channels, four IAUs without channels, one SCC cabinet, two SCC consoles, one SSP, two DPS 9000 URPs, and two channel pairs. The model requires two PRU0908s or PRU1208s or one of each.

Data Formats

Basic Unit: Thirty-six-bit words.

Fixed-Point Operands: Binary fixed-point numbers are represented with 18-bit half-word, 36-bit single-word, and 72-bit double-precision operands.

Table 1. System Comparison

MODEL	DPS 9000/91	DPS 9000/92T	DPS 9000/93	DPS 9000/94
System Characteristics				
Date announced	Nov 1988	Nov 1988	Nov 1988	Nov 1988
Date first delivered	June 1989	NS	NS	NS
Field upgradable to	DPS 9000/92T	DPS 9000/93	DPS 9000/94	(Max. size)
Relative performance	1.0	1.9	2.8	3.7
Number of processors	1	2	3	4
Cycle time, nanoseconds	NS	NS	NS	NS
Word size, bits	36	36	36	36
Operating systems	GCOS 8	GCOS 8	GCOS 8	GCOS 8
Main Memory				
Type	1M-bit MOS	1M-bit MOS	1M-bit MOS	1M-bit MOS
Minimum capacity, bytes	128M	256M	256M	256M
Maximum capacity, bytes	512M	1024M	1024M	1024M
Increment size, bytes	128M	128M	128M	128M
Cycle time, nanoseconds	NS	NS	NS	NS
Buffer Storage				
Minimum capacity	128KB + 512KB	256KB + 1024KB	384KB + 1024KB	512KB + 1024KB
Maximum capacity	1024MB	1024MB	1024MB	1024MB
Increment size	128MB	128MB	128MB	128MB
Input/Output Control				
Number of channels:				
Byte multiplexer	NA	NA	NA	NA
Block multiplexer	NA	NA	NA	NA
Word	NA	NA	NA	NA
Other	Max. 64 per IOP	Max. 64 per IOP	Max. 64 per IOP	Max. 64 per IOP

NA—Not applicable.
NS—Not supplied by vendor.

Floating-Point Operands: In GCOS 8, operands may be represented as binary floating point (single precision, double precision, or mixed) with a range of $10 \pm^{38}$ and as hexadecimal floating point (single or double precision) with a maximum range of $10 \pm^{153}$.

Instructions: All basic instructions use one 36-bit word. The processor performs operations using 6-, 9-, 18-, 36-, and 72-bit operands. All single-word instructions use bits 0 through 17 for the address field, bits 18 through 27 for the OP code, bit 28 as the interrupt inhibit bit, bit 29 as the address register bit, and bits 30 through 35 as the instruction address modifier. Multiword instructions use bits 0 through 17 for various functions, bits 18 through 27 as the OP code, bit 28 as the interrupt inhibit bit, and bits 29 through 36 as the operand descriptor or modification field. Words two, three, and four contain the operand descriptor or indirect pointer for operands one, two, and three, respectively.

Internal Code: Nine-bit ASCII code is standard.

Main Storage

Main memory ranges from 128 or 256 megabytes (depending on model) to 1,024 megabytes. Memory interlacing improves performance by allowing simultaneous access to data. Memory uses automatic error detection and correction procedures. Memory can be expanded in increments of 128 megabytes. Memory for each System Control Unit can be expanded independently (asymmetrically).

Storage Type: Main memory uses one-megabit dynamic random access memory (DRAM) circuits.

Capacity: See Table 1.

Cycle Time: See Table 1.

Checking: Eight-bit code for single-error correction and double-error detection.

Reserved Storage: Not applicable. Associative memory and cache memory are included in the CPU.

Central Processors

The DPS 9000 Series, implemented with Current Mode Logic (CML) circuitry, uses a seven-stage pipeline architecture. CML is a variant of Emitter Coupled Logic semiconductor technology. A DPS 9000 CML gate array features 1,000 or 4,000 gates per chip. CML multichip carriers employ 42 chips each and 12 modules per multilayered board. A DPS 9000 CPU features 26 multichip modules. To cool the chip modules, Bull uses a self-contained water-cooling unit.

To enhance throughput, the DPS 9000 Series uses a multilevel cache architecture. The systems use

Table 2. Mass Storage

MODEL	MSU0500	MSU0501	MSU3380/ 82	MSU3381/ 83	MSU3391/ 93	MSS8080
Cabinets per subsystem	8-15	8-15	8	8	8	8
Disk packs/HDAs per cabinet	2	2	2	2	2	8
Capacity	626MB	1.1GB	2.52GB	5.04GB	7.56GB	1.03GB
Tracks/segments per drive unit	1,630 per surface	1,686 per surface	13,275	26,550	39,825	16,872
Average seek time, msec.	25	25	15	17	16	18
Average access time, msec.	33.3	33.3	23.3	25.3	24.3	26.3
Average rotational delay, msec.	8.3	8.3	8.3	8.3	8.3	8.3
Data transfer rate	1065K bps	1065K bps	3M bps	3M bps	3M bps	1.875M bps
Controller model	MSP0611/ 0612	MSP0611/ 0612	MSP3880/ 3884	MSP3882/ 3886	MSP3991/ 3992	Integrated (2)
Comments	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

cache memories at the CPU and system levels. Each CPU has a 128-kilobyte cache with a three-nanosecond access time. The DPS 9000 Series itself has a main memory capacity of up to one gigabyte using one-megabit chip technology.

In addition to CPU cache, DPS 9000 features a system-level cache which keeps recently accessed data in a high-access-speed location. System-level cache is located within the SCU between the CPU and main memory. The cache supports CPU and I/O processor buffering requirements and, along with the CPU cache, supports the pipeline architecture. A fully configured system has up to one megabyte of system cache.

The multistaged pipeline architecture permits a CPU to process up to seven different instructions simultaneously. A branch prediction system anticipates branching characteristics within code to keep the pipeline busy.

To augment numeric-intensive computing, DPS 9000 systems feature an integrated vector processor for handling repetitive, vector-type Fortran routines. Additionally, the vector processor can take advantage of an optional Kuck & Associates Fortran vectorizer, which automatically transforms program loops into appropriate vector instructions. The DPS 9000 processor features 63 vector mask instructions for vectorizing iterative loops that typify Fortran code.

A single Main Memory Unit (MMU) holds from 128 to 512 megabytes of memory. The unit consists of up to eight memory sections and a controller. Each MMU uses two-way interlacing. A fully configured system has two MMUs.

The System Control Center uses a Service Processor and a Master Console. The SCC supports system operation and error logging; it also provides a user interface to the system.

The System Support Processor handles maintenance, monitoring, and automatic error reporting. The SSP automatically reports hardware errors to the Technical Assistance Center. The unit includes a maintenance console separate from the Master Console.

The DPS 9000 Unit Record Processor connects the Service Processor to a system printer and to the IOP. This connection allows the Service Processor to generate hard copy error logs and load CPU, SCU, and IOP firmware.

The Input/Output Processor handles I/O operations between the MMU and peripheral subsystems. Up to two IOPs can be attached to a single System Control Unit (SCU). An IOP has a transfer rate of 96 megabytes per second. Each IOP supports up to 64 physical channels and up to 256 logical channels.

The Power Supply Unit supplies power to the Central System Module. The Cooling Unit supplies liquid coolant to the CPU and SCU to dissipate heat. It uses a liquid coolant reservoir, two pumps, power equipment and controller, and a controller interface for the SSP.

Relational DBC

To speed relational database processing, DPS 9000 systems can interface with Bull's *Relational DBC (Data Base Computer)* system. Manufactured by Teradata Corp., this fault-tolerant, fully redundant database machine can support databases ranging from 2 gigabytes to 1000 gigabytes on up to 32 disk storage units. The DBC can serve up to 16 large Bull systems at one time. It attaches to a central system via two or more FIPS I/O channels. Oracle and Bull's own Interel relational database software can be used with the DBC.

Mass Storage

Table 2 describes Bull disk storage units currently offered for the DPS 9000.

Input/Output Units

Table 3 describes Bull tape and printer products currently offered for the DPS 9000.

Terminals

Table 4 describes Bull terminals currently offered for the DPS 9000.

Communications

Datanet 8 Series front-end network processors handle communications functions for the DPS 9000 mainframes. The Datanet 8 Series includes the 8/10, 8/20,

Table 3. Input/Output Units

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed, Inches/Sec.	Transfer Rate, Bytes/Sec.
MTU0630	9	800/ 1600/ 6250	NRZI/ PE/ GCR	75 or 125	60-100K/120-200K/468.7-781.2K
MTU8205	9	800/ 1600	NRZI/ PE	125	100-200K
MTU8206	9	1600/ 6250	PE/ GCR	125	200-780K
MTU8208	9	1600/ 6250	PE/ GCR	200	320-1250K
CTS8500	18	37,871 bytes	AXP	79	3M

Printers	Printing Speed	Print Positions	Horizontal Spacing, Chars./Inch	Vertical Spacing, Lines/Inch	Form Size, Inches
PRU0903	900 lpm	136	10	6 or 8	4-to-19 width x 3-to-11 length
PRU1203	1,200 lpm	136	10	6 or 8	4-to-19 width x 3-to-11 length
PRU1600	1,375 lpm	136 or 160	10	6 or 8	4-to-22 width x 3-to-22 length

and 8/30, which operate within Bull's Distributed Systems Architecture (DSA), an open communications architecture.

The DPS 9000 Series accommodates distributed processing. To support connection to other vendors' equipment, the DPS 9000 conforms to all levels of the Open Systems Interconnection (OSI) standard.

Bull also has an OSF/SNA gateway product that enables DSA network users to communicate with IBM host computers employing IBM's Systems Network Architecture. (IBM 3270 terminal emulation is required.)

Datanet 8 Series network processors operate under the control of the Distributed Network Supervisor (DNS) software executive, which in turn operates under the GCOS 8 operating system. DNS also supports other Bull mainframe systems under GCOS 8 (and midrange systems under GCOS 7).

Features common to all network processors in the Datanet 8 Series include:

- Capability to interconnect systems using private networks that use High-level Data Link Control (HDLC) data communications links
- Capability to connect to PDNs; to VANs, using the CCITT X.25 interface; and to most types of standard digital or analog, leased, or switched data communications lines
- Capability to attach terminal devices
- System Control Facility for remote maintenance
- Console access for network management functions
- Integrated 5¼-inch diskette drive for executive software maintenance functions

Datanet 8 Series processors require a visual display console. Physical connections between Datanet 8 Series network processors and DPS 9000 central systems are made through Direct Interface Adapter (DIA) channels. Each network processor provides support for one to four connections to the DPS 9000.

Datanet 8/10 is a single-processor system that supports a maximum of 31 data communications lines. The basic system includes one megabyte of central memory expandable to a maximum of two megabytes and a 5¼-inch diskette drive for executive software support. A console visual display terminal is required, along with a receive-only console printer for each supporting site.

Three RS-232-C asynchronous data communications ports are included with each 8/10. Line interface module options accommodate line characteristics such as data transmission speed; asynchronous/ synchronous operation; and physical interfaces such as RS-232-C, V.35, and X.21.

The basic Datanet 8/20 configuration has a single processor with cache memory and one megabyte of

Table 4. Terminals

MODEL	BDS 5 Asynchronous	BDS 7 Synchronous
Display Parameters		
Max. chars./screen	2,000, 3,300	2,000, 3,300
Screen size (lines x chars.)	25 x 80/132	25 x 80/132
Symbol formation	7 x 10	7 x 10
Character phosphor	Green or amber	Green or amber
Total colors/no. simult. displayed	NA	NA
Keyboard Parameters		
Style	Low profile	Low profile
Character/code set	ASCII	ASCII
Detachable	Standard	Standard
Program function keys	16 standard	16 standard
Other Features		
Buffer capacity	3 pages	3 pages
Tilt/swivel	25°/90°	25°/90°
Graphics capability	NA	NA
Terminal Interface	RS-232-C; RS-422-A	RS-232-C; RS-422-A

NA—Not applicable.
NS—Not supplied by vendor.

central memory, all of which may be doubled for increased performance. Auxiliary hardware is similar to that for Datanet 8/10. Each Datanet 8/20 includes three RS-232-C asynchronous data communications ports. The basic system's 31 data communications ports can be expanded to 127 ports with power and line expansion module options.

The basic Datanet 8/30 is similar to the 8/20 but with two megabytes of central memory; again, the basic configuration can be doubled for increased performance. The basic system provides support for 159 data communications ports, expandable to 255 ports with a line expansion module option.

Datanet 8/10, 8/20, and 8/30 processors are fully upward compatible. These network processors can coexist with pre-DSA products to facilitate migration from earlier systems.

Line options common to all three Datanet models include:

- Multiline Communications Controller-16 (DCF8052). It accommodates up to four Communications Interface Adapters.
- RS-232-C Asynchronous/Character Synchronous Integrated Communications Interface Adapter (DCF8073). The adapter has four RS-232-C communications ports, includes four 50-foot cables (DCE to DTE) for device attachment, and has a maximum data transfer rate per port of 19.2K bps.
- RS-232-C Bit Synchronous HDLC Integrated Communications Interface Adapter (DCF8049). The adapter has two RS-232-C communications ports, includes two 50-foot cables (DCE to DTE) for device attachment, and has a maximum data transfer rate per port of 19.2K bps.
- Low/Medium Speed Asynchronous/Character Synchronous Communications Interface Adapter (DCF8053). This nonintegrated adapter requires a minimum of one line interface module. It will accommodate up to four line interface modules. Maximum data transmission rate per line interface module is 19.2K bps.

The following line interface modules are allowed with DCF8053:

- RS-232-C/V.24 Asynchronous/Character Synchronous Line Interface Module (DCF8055). This module has one RS-232-C/V.24 data communications port, includes one 50-foot cable (DCE to DTE) for device attachment, and has a maximum data transmission speed of 19.2K bps.
- MIL-188-C Asynchronous/Character Synchronous Line Interface Module (DCF8059). This module has one MIL-188-C data communications port, includes one 50-foot cable (DCE to DTE) for device attachment, and has a maximum transmission speed of 19.2K bps.
- Medium/High Speed Character Synchronous/Bit Synchronous Communications Interface Adapter (DCF8061). This nonintegrated adapter can support one medium-speed (to 19.2K bps) or one high-speed (to 64K bps) data communications line.

The following line interface modules are allowed with DCF8061. Each includes a 50-foot cable (DCE to DTE).

- RS-232-C/V.24 Bit Synchronous HDLC Line Interface Module (DCF8062). This module has one RS-232-C/V.24 data communications port and a maximum data transmission rate of 19.2K bps.
- X.21 Bit Synchronous HDLC Line Interface Module (DCF8064). This module has one X.21 data communications port and has a maximum data transmission rate of 64K bps.

- MIL-188-C Bit Synchronous HDLC/Character Synchronous Line Interface Module (DCF8067). This module has one X.21 data communications port and has a maximum data transmission rate of 64K bps.
- V.35 Bit Synchronous HDLC/Character Synchronous Line Interface Module (DCF8069). This module has one V.35 data communications port and has a maximum data transmission rate of 64K bps.
- Bell 301/303 Bit Synchronous/Character Synchronous Line Interface Module (DCF8071). This module has one Bell 301/303 data communications port and has a maximum data transmission rate of 64K bps.

System Software

GCOS 8 Software Release 3000 is the latest substantively new version of the company's primary operating system for large-scale mainframes; Release 4000 simply adds identifiers and drivers to enable GCOS 8 to recognize the DPS 9000's system components.

Introduced in 1979 with the DPS 8 systems as the *General Comprehensive Operating Supervisor*, GCOS is a product with roots dating back to the early 1960s. Bull's objective has been to keep the GCOS 8 operating system current through releases that capitalize on new technology while preserving the user's investment in software. GCOS 8 is a multiprocessing, multiprogramming, communications-oriented operating system that supports distributed systems requirements.

Bull's overall goal for distributed systems is the eventual linking of an organization's entire complex of physically separate data processing systems into a single logical network system regardless of physical boundaries. Bull's Integrated Information Architecture concept divides Bull systems into three different operating levels: the enterprise level at the top of a computing organization, the departmental level at the middle, and the workstation level at the bottom. Users can access information pertinent to an entire organization at the enterprise level. Departmental-level data serves the specialized needs of separate groups within an organization. Workstation-level processing meets the information needs of individuals. Each level can be interconnected in two or three tiers to meet specific user requirements.

Included in the new release is support for relational database management software, improved transaction processing, and high-capacity disk drives. Software Release 3000 also includes the Rapid Access Data System (RADS), a software disk cache feature for improving system response time, particularly within interactive environments.

Generally, applications written for GCOS 8 can run without modification on any Bull large system running GCOS 8. Migration from Release 2500 of GCOS 8 can be accomplished without recompiling application software.

GCOS 8 is a user-defined and user-oriented virtual operating system with multidimensional capabilities. GCOS 8 balances the use of system resources and provides multiple options for customizing the system for each user's needs. GCOS 8 can concurrently support a wide range of processing modes: batch processing, remote job entry (RJE), interactive remote job entry (IRJE), timesharing, transaction processing, direct program access, on-line test and diagnostics, on-line program test and development, and decision support for end users.

GCOS 8 also has file protection and file sharing, testing and diagnostics, communications, data management facilities, language processors, diagnostic and system protection facilities, and various system utilities. Batch, timesharing, transaction processing, and other activities can be individually tailored and dynamically varied throughout the day.

GCOS 8 is a flexible operating system that features hardware transparency; the user has no need to know the particular architecture of the system, its hardware, I/O devices, or processor types. All processors can access all of memory and execute any program. GCOS 8 can address up to 1024 megabytes of real memory and can use the entire real memory for all dimensions. Up to 477 user programs can execute concurrently. It provides high throughput by efficient and rapid scheduling of all activities, which reduces operator intervention; peripherals are allocated before memory so that operator or mechanical delays do not interfere with processing.

GCOS 8 memory management is flexible. The system architecture with GCOS 8 provides dynamic memory management, descriptor-controlled access, and shared access to both data and procedures. Each of these functions is based on a hardware-protected memory segment. The memory segment is defined by a segment descriptor that contains the logical address of the beginning of the segment, the size of the segment, and the permissions that control its use.

Dynamic memory management permits programmers to develop software as if there were an unlimited logical memory. The available physical memory depends on the system configuration and the work load.

GCOS 8 controls the physical organization of up to 512 work spaces of up to 4 million pages of virtual storage each, with each page consisting of 4096 bytes. Up to 477 separate working spaces (out of 512) are available for user processes.

Any available page of main memory can be used for any page-sized block of logical memory. Although pages may be located anywhere in memory, they can be accessed as if they were physically contiguous. Segment descriptors and page table words translate the virtual address to a main memory address.

Programs, including the GCOS operating system itself, are protected by a domain structure. A domain is a set of noncontiguous segments in one or more working spaces. Domains put boundaries around certain parts of the operating system, protecting them from unauthorized access. The programmer and site administrator decide which segments will be available to a subprogram.

(The CPU itself operates in three modes: slave, master, and privileged master. For general user applications, slave mode limits user access to memory and furnishes a restricted instruction set. Privileged master mode lets users access certain memory domains but protects them against alteration while also protecting the GCOS 8 operating system from corruption.)

Other operating system security features include logon controls, file access controls, control of on-line user transaction access to applications, and control of database access down to the field (data item) level. The operating system will abort an activity if an illegal operation is attempted.

System access to a GCOS host begins with the GCOS 8 network interface module (DNET/ROUT), which routes terminal access to the requested subsystem. Logon procedures vary greatly among subsystems, but all require user identification and password. Each subsystem has a master user defined for administrative purposes. The master user console is typically a terminal connected via the front-end network processor.

Programming Languages

Language processors available for use under GCOS 8 are Ada, APL, Basic, C, Cobol-68, Cobol-74, Cobol-85, Compiler "B," Fortran-66, Fortran-77, GMAP, GPSS, Lisp, Pascal, PL/1, RPG II, and Simscript.

Database Management

Bull's Interel (integrated relational) data management system also provides relational access (in query mode only) to nonrelational UFAS files and DM-IV databases. Interel accomplishes this without restructuring data files or programs. Included with Interel is an integrated and extensible data dictionary system called the IRDS.

All Bull systems also support the Oracle relational database management system. While Interel has high-performance characteristics, Oracle excels in support of distributed processing across multiple hosts and across hosts from multiple vendors.

Bull also continues to offer Data Management-IV (DM-IV), its network-model database management and transaction processing system.

Data Management

Data management on Bull large systems is handled through Interel with IRDS and through DM-IV with I-D-S/II.

Interel: This data management product includes Bull's version of the Structured Query Language (SQL) and Bull's Information Resource Dictionary System (IRDS), both of which conform to ANSI standards. Interel's SQL is compatible with IBM's SQL/DS and DB2, Oracle from Oracle Corporation, Ingres from Relational Technology Inc., and the Teradata DBC/1012 database computer.

The Interel SQL uses English-like commands to create, update, or delete tables and to authorize access for system users. Interel automatically creates table definition and database table space, establishes the necessary controlling information, and deposits this information in the IRDS central dictionary.

Interel accesses stored data through its Data Manager. Using this component, full relational files can be added to existing nonrelational models, and information can be merged through SQL. Users, therefore, have a seamless interface from third-generation database technologies to newer fourth-generation technologies; they can migrate to relational database functions without duplicating information through copy management.

Data Management-IV (DM-IV): DM-IV is Bull's CODASYL network-model database management and transaction processing system. DM-IV's database management component, the Integrated Data Store/II (I-D-S/II), administers the creation of the physical and logical structures of the database and controls the creation of the application-specific views of that database used in processing. It then serves as the interface between the database and the various DM-IV processors. I-D-S/II is fully integrated with Bull's Cobol-74 compiler, and user interfaces are also implemented for Fortran.

DM-IV contains the following facilities to handle database management, transaction processing, querying, and report processing, in addition to providing batch and interactive database capabilities.

Data Dictionary/Directory System (DD/DS): DM-IV's dictionary/directory provides a comprehensive set of software modules that can implement a centralized data dictionary/directory. Data is entered into the dictionary database via batch or interactive operations. The DD/DS supports up to 19 entity types including fields, records, files, programs, procedures, jobs, schemas, and reports. It also supports multiple versions and status of each entity type, alias names, narrative, and attributes unique to the entity type.

Several report generation facilities are available to the DD/DS user. The reporting system extracts information from the data dictionary and presents it to the user in various formats. Included is an extensive cross-reference reporting capability for all entity type occurrences and an Impact Analysis Report which analyzes and reports the effect of change to an entity type occurrence. A complete set of utilities assists in maintenance of the data dictionary system and its database.

File Management Supervisor (FMS): This DM-IV subsystem provides powerful file management capabilities, including multilevel user catalogs, file sharing, and access control. The system employs a hierarchical (tree structured) design. A System Master Catalog lists the various user Master Catalogs, and each user may, in turn, define one or more levels of subcatalogs. Users may permit general sharing of their files or specify individual users who may have access to them on either a read/write or read-only basis. Password access control can be imposed at any or all levels of the file structure. Security is also provided by the optional logging of file

access attempts and by a timesharing command that allows a user to encrypt his or her files.

Unified File Access System (UFAS): This DM-IV subsystem provides automatic management for file processing, including record location and automatic blocking and deblocking. File organizations supported include sequential, relative, indexed, and integrated files. UFAS also includes facilities for error checking and initiation of error processing as defined by ANSI Cobol-74 and file integrity protection for normal and abort processing.

Common Files Facility (CFF): This DM-IV facility controls the sharing of user program and data files between GCOS III and GCOS 8 as well as between GCOS 8 hosts without requiring manual partitioning of data or mass storage devices. The CFF allows different systems using GCOS 8 to share files on a single common group of disk drives.

CFF allows up to four computer systems to share common disk drives. Concurrent access to files is controlled by lock bytes in the mass storage processor that supervises disk drive operation. Locking occurs at the single file level, which ensures that only one computer system in the cluster can update a file at one time. CFF clusters can also exist within communications networks based on Bull's DSA.

Data Communications Software

Distributed Network Supervisor (DNS): This supervisor was written specifically for the Datanet 8 Processor and is part of a set of communication software products based on Bull's Distributed Systems Architecture (DSA). DNS supports up to four host connections, enabling one Datanet 8 to serve multiple hosts.

DNS operates in the Datanet 8 in conjunction with a GCOS 8-based host to provide support for transaction processing, distributed transaction processing, distributed terminal concentration, timesharing, remote job entry, direct program access, and networks made up of DPS 90, DPS 9000, DPS 88, DPS 8000, DPS 8, DPS 7, DPS 7000, and DPS 6 (or Level 6) hosts in any combination. DNS supports private networks and Public Data Networks (PDNs) and Value Added Networks (VANs), including X.25 packet switched and X.21 circuit switched networks. DNS supports a variety of Bull terminals.

Functions that can be distributed throughout the systems comprising a DSA network include network monitoring, cross-network software loading, dumping, data logging for statistics, billing and maintenance, in-line tests, and software generation.

Network Processing Supervisor: This supervisor supports five types of remote processing in any combination: remote job entry (RJE), transaction processing, timesharing, message switching, and direct program access. Four standard interfaces for remote computers support RJE: remote computer interface, remote network processor multimessage interface, BSC interface, and HDLC interface.

A combination of the Datanet Front-end Network Processor and the NPS software control the information network. The network can range in size from several terminals to a comprehensive, distributed information network with multiple host processing facilities.

NPS supports a variety of remote terminals, computers, and communications facilities from Bull and other vendors. NPS can also be customized to support additional terminal types and network protocols, journalizing of message traffic, restart/recovery capability, supervisory control through one or more Network Control Supervisory Stations, statistical recording and reporting, and control of line/terminal parameters.

Remote Terminal Supervisor II (GRTS-II): This supervisor provides controls for five types of remote processing: remote job entry, transaction processing, timesharing, message concentration, and direct program access. RJE supports the same standard interfaces as NPS. Programming subsystems supported under timesharing are the same as for NPS. GRTS-II does not support the direct program access communications-queued (DAC-queued) mode provided in NPS, nor does it support any host interface which makes use of the DAC-queued method.

GRTS-II includes a *Communication On-Line Test System (COLTS)* and support for remote terminals and devices with speeds from 75 to 56,000 bps. GRTS-II may coexist with NPS or DNS, each residing and executing in a different network processor. Host-to-host file transmission is supported through the Data Link System.

Transaction Processor 8 (TP8): Bull's transaction processing product, TP8 is particularly suited to heavy transaction processing work loads and contains features that make it compatible with all earlier GCOS transaction processing products, including DM-IV/TP, TPE II, TDS, and TPE. This compatibility helps preserve a user's information investment while offering increased performance and functionality.

TP8 provides an on-line, realtime system and, through DSA session control, interfaces with a logical network that is independent of the network's physical topology. TP8 is a native-mode transaction processor designed to use the features of both GCOS 8 and DSA. TP8 supports both DSA and pre-DSA networks. System resources can be partitioned to a logical application level.

Several major services traditionally associated with transaction processing executives—integrity control, memory management, buffer management, and journalization—are integrated into the shared software layer of GCOS 8. The various environments of GCOS8/TP8 as well as batch and other transaction processors use these services. As a part of shared systems service software, TP8 can help reduce memory requirements

because only one copy of the executive software is necessary for all native users.

TP8 can also take better advantage of multiple central processors, allowing parallel execution of application routines. Applications can be implemented through routines and programs written in several languages including Cobol 74 or Fortran. While in execution, each routine or program is processed independently and can access the range of facilities available in GCOS 8.

The DM-IV Transaction Processor (TP) is the older Bull product currently in wide use with GCOS 8 systems. DM-IV/TP provides the facility for rapid, efficient, on-line database processing. It is especially effective in applications where the end user has little or no knowledge of the operating system or storage structure, or of data processing in general. Its internal design is optimized for high-volume transaction processing where extremely fast response and fast, automatic restart/recovery are required. The TP system includes both on-line software components for processing the actual transaction and a variety of support software products for program testing, library updating, and TP system generation. Within DM-IV/TP, there are five major functional components: Transaction Manager, Database Manager, Integrity Manager, Message Manager, and Executive Manager.

Supporting tools for both TP8 and DM-IV/TP include the Transaction Application Test System (TATS) and Transaction Screen Management System (TSM). TATS is a software tool that provides an interactive timesharing environment for writing, compiling, testing, and debugging Transaction Processing Routines (TPRs) using a DM-IV (I-D-S/II) database. TATS also provides a TPR program skeleton generator, and forms mode support is currently provided for the TP8 or DM-IV/TP Forms Option (TPFO). The TATS package can also interactively verify database updates and integrate completed TPRs into the production system.

TSM is a set of tools designed to enhance the development of application programs in a TP8 or DM-IV/TP environment. This system enables the developer to design, develop, test, and implement screen formats for application systems. Little or no knowledge of the communications network or the TP8 or DM-IV/TP operating environment is required.

Personal Computer Interconnect (PCI): PCI is a personal computer program for host access. PCI executes as an application layer on MS-DOS-based personal computers. The product supports Bull MicroSystem PC (AP and XP), IBM PC/AT/XT, and true IBM compatibles. PCI allows PC users to access host-based data and to transfer data to a PC and provides a state-of-the-art user interface. Users can operate a mouse or trackball to point at pop-up menus and icons representing file drawers, folders, and applications. All operations can also be controlled from the keyboard. Windows allow the user to manage several operations, such as spreadsheets, host query, and data conversion, at one time.

Features supported under PCI include auto logon, window manager, graphics controller, VIP terminal emulation, file transfer, script processing, and optional encryption and decryption of files. PCI can work with Lotus 1-2-3, dBASE III Plus, Multimate Advantage, WordStar Professional, ChartMaster, Spreadsheet Auditor, GEM, Bridge, and One Shot.

TimeSharing System (TSS): In connection with a Datanet front-end processor, TSS provides timesharing computing services to multiple users at remote terminals. System resources allocated to timesharing can be dynamically varied under operator control. The timesharing executive, operating as a subexecutive under GCOS 8, suballocates storage and dispatches the processor to the programs of individual timesharing users. Timesharing on GCOS 8 uses the GCOS 8 memory architecture to permit any desired amount of system memory to be allocated to timesharing. A single copy of TSS can support up to 600 users, assuming sufficient memory, I/O, and communications facilities. In multiple-processor systems, the timesharing users' programs can simultaneously use as many processors as necessary. A separately priced Multicopy Support Option allows from two to four copies of the timesharing executive to run on one GCOS 8 system, thereby increasing the number of users that can be supported.

GCOS timesharing users have a choice of six major programming languages: Cobol-74, Extended Basic, Pascal, TimeSharing Fortran-66, Fortran-77, and APL. Timesharing users can communicate directly with batch-mode facilities, permitting such activities as the development and testing of programs, data entry, control of batch program execution, and manipulation of results from remote terminals.

I-D-S/II provides the ability to interactively update and retrieve information from an I-D-S/II database. Access is a conversational file management system for creating, deleting, and maintaining catalogs and files and for assigning passwords and accessing criteria. The FDUMP facility can be used for inspection and maintenance of permanent files. The LODT routine permits execution of experimental user subsystems, including trace analysis and debugging of user programs from remote terminals. The TimeSharing Activity Report monitors the accumulated use of the timesharing system resources.

Program Development

Bull offers a number of products for program development. Among the newest are Pacbase, an applications generator from CGI Systems Inc., and Pathvu and Retrofit, two program analysis and structuring tools from Catalyst.

Pacbase: This product uses a methodology based on computer-aided software engineering (CASE) to improve productivity in all phases of application development. The company claims the product should reduce system maintenance costs and the time required for software maintenance and development. The product

should also help reduce development backlogs and help companies better control corporate data.

Pathvu and Retrofit: These tools analyze and restructure existing Cobol programs, helping programmers maintain and enhance software. Pathvu does the analysis and generates reports tailored to the needs of a software management team. It follows the logic patterns in a program code; identifies "dead" code and logic flaws; and creates and maintains 43 separate statistics which are used to generate management, technical, and individual program reports.

Retrofit converts unstructured Cobol into PERFORM-based structured Cobol. It unscrambles convoluted logic, corrects structural flaws, ensures consistency, and produces restructured programs that are functionally equivalent to the original program.

Other program development tools include the *Text Executive Processor (TEX)*, DM-IV Procedural Language Processor (PLP), the Transaction Application Test System (TATS), the Transaction Screen Management System (TSM), the DM-IV Query and Reporting Processor (QRP), and the Personal Computing Facility (PCF).

Text Executive Editor (TEX): With this editor users can create, format, maintain, and print text. TEX is an interpretive language that integrates the capabilities of the Text Editor with text processing, providing additional verbs and subroutine calls. The optional DM-IV Procedural Language Processor (PLP) is an extension of QRP which provides a high-level, procedure-oriented language for use by application and system programmers. When using the QRP end-user facilities, the user need not be concerned with the database structure or access methods.

Syntax Directed Editor (SDE): SDE is a productivity tool that helps create or modify Cobol-74 programs. SDE reduces the amount of code that a programmer must enter and immediately checks for format and syntax errors.

System-80: This programming aid helps reduce the time and effort devoted to coding, maintenance, and documentation normally associated with Cobol program development. It interacts with the programmer to acquire needed information about files, fields, screen formats, and validations and edits.

Softool: This set of software tools facilitates cost-effective management, development, and maintenance of application software. The Softool Development Environment Product Set offered by Bull consists of the Cobol Programming Environment (Cobol-74) and the Change and Configuration Control.

Simscript: This simulation-oriented language permits the translation of complex mathematical and logical models into meaningful simulation sequences. It is an event-oriented language with a timing routine that allows the analysis of activities in a controlled sequence in simulated time.

General-Purpose Simulator System (GPSS): GPSS is a simplified, simulation-oriented language that establishes mathematical models in order to provide results for further analysis.

General Macro Assembler Program (GMAP): GMAP enables the programmer to code either in an open-ended macro language or directly in machine-oriented symbolic instructions.

Debug Support System (DSS): DSS supports batch or on-line debugging of user programs and can trace programs, display memory contents, and modify memory locations. Object-level debug can be performed with any language. Cobol-85, Cobol-74, Fortran-77, and PL/1 support symbolic debug.

Utilities

System utilities include a Sort/Merge Facility, the File Generation Facility, FMS Utilities, Visual Information Display for Efficient Operation, Comprehensive System Utilities Facility, System Utility 8, General Loader, Bulk Media Conversion, and Source and Object Library Editor.

Application Software

Bull offers application programs that address finance, management sciences, manufacturing, health care, and banking. It also offers productivity tools. Bull groups its application programs into several overlapping "environments": end-user computing, (software) production, information management, communications and networking, administrative tools, and support applications.

Infoedge: A key software family in the end-user computing category is *Infoedge*, introduced with GCOS 8 SR3000. Serving experienced data processing professionals, technical end users, and non-data processing professionals, Infoedge includes a spreadsheet, a forms generator, and access to the relational database (Interel) data dictionary. Infoedge enables users to create and maintain forms with variable text and results fields; it also supports data storage and retrieval functions, math and logic functions, editing and graphics, and an on-line help facility.

Infoedge decision-support facilities include Infoedge-Graph and Infoedge-Financial Planner for financial modeling and business planning. Infoedge query facilities include Example Query, an end-user request facility; and Reporter, a facility for formatting data obtained from Example Query and SQL into report form. Workstation facilities include Infoedge-Mail, a distributed electronic message facility; and Infoedge-Meetings, a facility that permits authorized users to attend "meetings" through a terminal device.

Magna 8: Magna 8 is Bull's fourth-generation language; it also provides transaction processing capabilities.

Operating Environment

Installation Requirements

Motor generator and water-cooling equipment are required. The installation provides its own uninterruptible power system.

Configuration Rules

Table 1 indicates certain minimum and maximum bounds for main memory, number of channels, etc.

Figure 2 depicts the logical configuration for the top-of-the-line Model 94 quad processor, illustrating the redundancy required for fault-tolerant operation.

Measurements

Following are dimensions of DPS 9000 central system components:

Component	Width (in.)	Height (in.)	Depth (in.)	Weight (lb.)
Central System (CPU + SCU + MMU)	72.8	61.4	35.4	3,997
Power Supply Unit	35.4	61.4	35.4	NA
Input/Output Processor	65.0	61.4	35.4	1,872
Cooling Unit (liquid cooling)	55.1	61.4	31.5	1,698
Cooling Unit (optional air cool)	90.6	61.4	31.5	2,138
System Control Center (cabinet)	31.5	52.6	29.9	794
System Support Processor	31.5	39.4	29.9	496
Interface Adapter Unit	58.6	73.0	32.5	1,495
DPS 9000 Unit Record Processor	31.5	52.6	29.9	573

Temperature, Altitude, and Humidity Ranges

Following are the vendor's environmental specifications for the DPS 9000:

Temperature Range	
Normal Operating:	68° to 78° F (20° to 26° C)
Relative Humidity Range	
(noncondensing)	40% to 60%
Heat Output (Btu/hr.), approx.	
Central System Module:	18.5 to air 33.1 to liquid
Input/Output Processor:	33.1
Liquid-Cooling Unit	4.7
Air-Cooling Unit	47.2
Sys. Control Ctr. Cabinet	2.1
System Support Processor	1.2
Interface Adapter Unit	15.9
DPS 9000 Unit Record Processor	5.3
Power Consumption (kVA)	
Central System Module:	11.24
Input/Output Processor:	10.76
Liquid-Cooling Unit	1.5
Air-Cooling Unit	2.7
Sys. Control Ctr. Cabinet	0.99
System Support Processor	0.35
Interface Adapter Unit	5.0
DPS 9000 Unit Record Processor	1.72

Pricing

DPS 9000 equipment is available for purchase or for rental under a one-year or four-year lease. This report concludes with a basic DPS 9000 equipment price list; see the Cross-References paragraph at the end of the Analysis section for references to software prices.

Support

Bull offers several maintenance plans falling under basic hardware maintenance, extended maintenance coverage, and premium services. Basic monthly hardware maintenance provides contracted on-call remedial maintenance service during the Principal Period of Maintenance (PPM). PPM covers a period between 8 a.m. and 6 p.m., Monday through Friday, excluding holidays. Basic service includes toll-free access to the National Response Center, 24 hours per day, 7 days per week, and remote mainframe maintenance access. Other features include the services of specialist personnel from the Technical Assistance Center, Customer Service Engineer visits when necessary, and remedial and preventive maintenance services.

Extended Maintenance service provides coverage for hours outside the PPM. Under this coverage plan, the user pays an additional charge that is a fixed percentage of the base maintenance fee. The percentage varies by day and number of extended hours beyond the regular maintenance period. Customers requesting service outside the PPM will be billed at published contract-customer hourly rates. The current rate is $159 per hour for all times Monday through Sunday. Customers without a maintenance contract will be billed at a time and materials rate of $185 per hour for a minimum of four hours.

Premium service provides maintenance coverage on a 24-hour, 7-day-per-week basis. Coverage includes guaranteed response time credits, preventive maintenance, equipment installation, field change order installation, and equipment malfunction protection credits.

System engineering falls into one of five billable support categories, as described in the following table. Field engineering managers are responsible for the degree of skill required to perform the job.

	Hourly Rates* ($)	Monthly Rates ($)
Principal or senior technical consultant	138	19,174
Project supervisor or technical consultant	112	15,653
Technical specialist	100	14,088
Systems analyst/senior programmer	85	11,739
Programmer	59	8,218

**Minimum four-hour charge, plus local/state taxes.*

Hourly charges are for a four-hour minimum. The monthly rates do not include supplies.

GCOS 8 is delivered as two separate products. The Basic System is licensed at no separate charge to customers who acquired their central systems from Bull and for a separate license fee to customers who acquired their central systems from sources other than Bull. The GCOS Executive is separately licensed for the same tiered fee to all customers regardless of how they acquired their central system. All other facilities, such as job management, file systems, conversion aids, language processors, utilities, applications packages, communications software, system maintenance, and system performance analysis are separately priced.

The Bull TotalCare Software Services program provides users with a variety of standard and customized software support services ranging from onetime installation of operating system software to ongoing site management. Ongoing support is part of Basic and Expanded Services. Basic Support gives users access to Bull's National Response Center through a toll-free number 24 hours per day, 7 days per week. A software specialist at a Bull Technical Assistance Center then tries to solve the problem. Expanded Service features on-site support in addition to on-line diagnostic facilities. Customized programs include start-up services, system techniques for on-site management, supplemental services, and system services. TotalCare charges include some fixed pricing based on the amount of software a company uses. Other charges are quoted individually, depending on the site and specific needs.

Education

Education services include standard courses, advanced professional training, multimedia self-instruction courses permitting customers to self-train as often as needed, site surveys to determine educational requirements, on-site classes, and clustered on-site classes to accommodate a group of users from an area.

Typical Configurations

Sample configurations for the DPS 9000 Series are shown below. Detailed equipment and selected software prices follow these configurations.

Small Configuration:	
DPS 9000/91: Central System Complex includes 1 CPU, 1 system control unit, 1 main memory unit with 128MB of memory, 1 input/output processor without channels, 1 interface adapter unit without channels, 1 system control cabinet, 1 SCC console containing two displays, 1 printer, 1 console table, 1 printer stand, 1 System Support Processor, 1 DPS 9000 Unit Record Processor, and 1 channel pair	$5,856,000
One MSP3880 Mass Storage Processor	62,850
One MSU3380 Head of String Mass Storage Unit	82,800
Three MSU3382 Mass Storage Slave Units	177,000
One MTS8206 Magnetic Tape Subsystem	45,000
Seven MTU8206 tape units; 125 ips, 1600/6250 bpi	129,500
One MTF8200 1 x 8 switch	No charge
One URP8602 Embedded Unit Record Processor	4,500
Two PRU908 high-speed belt printers	69,950
Total Purchase Price:	$6,427,600

Large Configuration:	
DPS 9000/94 quad processor: 2 Central System Complexes each with 1 CPU, 1 system control unit, 1 main memory unit with 128MB of memory; 2 additional CPUs; plus 4 input/output processors without channels, 4 interface adapter units without channels, 1 system control cabinet, 2 SCC consoles each with two displays, 1 printer, 1 console table, 1 printer stand, 1 System Support Processor, 2 DPS 9000 Unit Record Processors, and 2 channel pairs.	$22,967,400
Additional 128M of Main Memory	640,000
200 BDS 5 Terminals	199,000

Two MSP3992 Mass Storage Processors, four-path	260,000
Four MSU3391 Head of String Mass Storage Units	512,000
Twelve MSU3393 Mass Storage Slave Units	1,266,000
Two MTS8206 Magnetic Tape Subsystems	90,000
Fourteen MTU8206 tape units; 125 ips, 1600/6250 bpi	259,000
Two CTS8500 Cartridge Tape Subsystems	193,540
Six CTU8500 tape units; 79 ips, 38K bytes/in.	239,040
One MTF8201 2 x 8 switch	6,130
One URP8602 Embedded Unit Record Processor	4,500
Two PRU908 high-speed belt printers	69,950
One 1600 high-speed belt printer	64,940
Total Purchase Price:	$26,771,500

Equipment Prices

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
PROCESSORS					
CPS8511	DPS 9000/91 Central System: Includes I Central System Module (CSM) containing 1 Central Processing Unit (CPU), 1 System Control Unit (SCU), and 1 Main Memory Unit (MMU) with 128MB of memory; 1 Input/Output Processor (IOP) without channels; 1 interface Adapter Unit (IAU) without channels; 1 System Control Center (SCC) cabinet; 1 SCC console containing 2 displays, 1 printer, 1 console table, and 1 printer stand; 1 System Support Processor (SSP); 1 DPS 9000 Unit Record Processor; and 1 channel pair. Requires printer (PRU0908 or PRU1208).	5,856,400	9,761	406,795	302,731
CPS8513	DPS 9000/92T Central System: Includes 2 Central System Modules (CSMs), each containing 1 Central Processing Unit (CPU), 1 System Control Unit (SCU), and 1 Main Memory Unit (MMU) with 128MB of memory; 2 Input/Output Processors (IOPs) without channels; 2 Interface Adapter Units (IAUs) without channels; 1 System Control Center (SCC) cabinet; 2 SCC consoles, each containing 2 displays, 1 printer, 1 console table, and 1 printer stand; 1 System Support Processor (SSP); 2 DPS 9000 Unit Record Processors (URPs); and 2 channel pairs. Requires 2 printers (PRU0908s, PRU1208s, or combination).	11,248,400	18,747	781,332	581,457
CPS8516	DPS 9000/93 Central System: Includes 2 Central System Modules (CSMs), each containing 1 Central Processing Unit (CPU), 1 System Control Unit (SCU), and 1 Main Memory Unit (MMU) with 128MB of memory; 1 additional CPU; 3 Input/Out put Processors (IOPs) without channels; 3 Interface Adapter Units (IAUs) with out channels; 1 System Control Center (SCC) cabinet; 2 SCC consoles, each containing 2 displays, 1 printer, 1 console table, and 1 printer stand; 1 System Support Processor (SSP); 2 DPS 9000 Unit Record Processors (URPs); and 2 channel pairs. Requires 2 printers (PRU0908s, PRU1208s, or combination).	17,117,200	28,529	1,188,989	884,829

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor.

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
CPS8518	DPS 9000/94 Central System: Includes 2 Central System Modules (CSMs), each containing 1 Central Processing Unit (CPU), 1 System Control Unit (SCU), and 1 Main Memory Unit (MMU) with 128MB of memory; 2 additional CPUs; 4 Input/Output Processors (IOPs) without channels; 4 Interface Adapter Units (IAUs) without channels; 1 System Control Center (SCC) cabinet; 2 SCC consoles, each containing 2 displays, 1 printer, 1 console table, and 1 printer stand; 1 System Support Processor (SSP); 2 DPS 9000 Unit Record Processors (URPs); and 2 channel pairs. Requires 2 printers (PRU0908s, PRU1208s, or combination).	22,967,400	38,279	1,595,354	1,187,240
	System Upgrades:				
CPK8511	DPS 9000/91 to DPS 9000/92T	5,692,000	9,487	395,553	294,160
CPK8512	DPS 9000/91 with additional IOP to DPS 9000/92T	4,792,000	7,987	333,009	247,649
CPK8517	DPS 9000/92T to DPS 9000/93	6,168,800	10,281	428,687	318,801
CPK8518	DPS 9000/92T with additional IOP to DPS 9000/93	5,268,800	8,781	366,143	272,289
CPK8519	DPS 9000/93 to DPS 9000/94	6,150,200	10,250	427,394	317,840
CPK8520	DPS 9000/93 with additional IOP to DPS 9000/94	5,250,200	8,750	364,851	271,328
	DPS 9000 Extensions:				
CMM8501	Additional 128 megabytes of memory; maximum of 3 for Model 91, maximum of 6 for Models 92T, 93, and 94	640,000	1,067	44,455	33,083
MXU8502	Additional IOP	900,000	1,500	62,515	46,523
CSU8501	Additional System Console	19,500	32	1,354	1,008
CSU8502	Remote System Console	21,500	36	1,493	1,111
CSF8601	Optional 23-inch Large Screen Monitor for System Console	2,358	16	157	135
CSF8602	Optional Ceiling Mount for CSF8601	195	NA	NA	NA
	Required Power and Cooling Equipment:				
Misc. IDs	Several devices required. Shown here: total of prices for chilled water or air cooling unit (either @ $200,000); motor generator with remote control ($42,000); power conditioning system ($55,000); and Static Invertor ($4,000). *Customer provides own Uninterruptible Power Supply.*	301,000	750	17,819	13,269
	Interface Adapter Unit (IAU) Options:				
MXU8510	Additional IAU	56,000	150	3,889	2,894
MXU8521	IAU Channel Expansion	3,000	10	208	155
MXU8523	IAU Power Expansion	56,000	150	3,889	2,894
MXU8527	IAU Power Sequencer for Channels 1-7	56,000	150	3,889	2,894
MXU8528	IAU Power Sequencer for Channels 8-14	56,000	150	3,889	2,894
	DPS 9000 Attachment Features:				
MXF8513	High-Speed Channel Pair	16,000	27	1,111	827
MXF8514	Page Processing Connection Feature	8,000	13	500	372
MXF8515	Low-Speed Channel Pair	16,000	27	1,111	827
MXF8516	Data Streaming Pair	16,000	27	1,111	827
MXF8524	General Purpose Adapter (GPA) for Mass Storage Processor	19,750	33	1,371	1,020
MXF8525	GPA for Magnetic Tape Processor	19,750	33	1,371	1,020
DCE8511	Network Processor Feature	8,000	13	555	413
RELATIONAL DATA BASE COMPUTERS					
CPS8001	Relational DBC for DPS 9000	365,000	1,125	24,350	18,250
HE8016	Required service package for Relational DBC; onetime charge for 12 months, nonrenewable	81,000	NA	NA	NA
HIP8001	Host Interface Processor (Other options also available.)	53,300	170	3,550	2,665

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor.

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
MASS STORAGE					
MSP3882	3880 Mass Storage Subsystem includes mass storage processor; two-channel, FIPS-compliant system supports up to two MSU3380/81s and six MSU3382/83s	62,850	200	3,740	3,185
MSP3886	3880 Mass Storage Subsystem includes mass storage processor; four-channel, FIPS-compliant system supports up to two MSU3380/81s and six MSU3382/83s	74,700	224	4,435	3,785
MSP0611	Freestanding Single-Channel Mass Storage Processor	50,000	165	1,828	1,507
MSP0612	Freestanding Dual Channel Mass Storage Processor	64,375	227	2,133	1,761
MSK0612	Upgrade Kit, MSP0611 to an MSP0612	23,000	82	861	711
PSS8001	Capacitor Ridethrough Option for MSP0611, 0612	3,120	17	124	104
MSP3991	Mass Storage Processor, two-channel, two-path; includes two storage directors, each with one Primary General Disk Channel Connection to DPS 8000	70,000	210	4,667	3,500
MSF3991	Two additional Switched General Disk Channel Connections for MSP3991	15,000	24	1,000	750
MSP3992	Mass Storage Processor, four-channel, four-path; includes four storage directors, each with one Primary General Disk Channel Connection to DPS 8000	130,000	420	8,667	6,500
MSK3390	Upgrade kit from MSU3390 to MSU3391	59,900	NC	3,993	2,995
MSK3392	Upgrade kit from MSU3392 to MSU3393	59,900	NC	3,993	2,995
MSK8082	Upgrade kit from MSF8080 to MSS8080	29,600	98	1,850	1,480
MSK3991	Upgrade from MSP3991 to MSP3992	60,000	210	4,000	3,000
MSF3992	Four additional Switched General Disk Channel Connections for MSP3992	30,000	48	2,000	1,500
Mass Storage Units:					
MSU3380	Head of String Mass Storage Unit; includes four actuators	82,000	295	4,065	3,460
MSU3381	Mass Storage Unit; head-of-string double-capacity system provides 3.697 gigabytes of formatted capacity	113,000	295	6,035	5,525
MSU3382	Mass Storage Slave Unit; includes four actuators	59,000	215	2,950	2,515
MSU3383	Mass Storage Unit, secondary double-capacity system; up to three may be added to each MSU3380/3381	90,000	215	4,845	4,420
MSU3390	Head of String Mass Storage Unit; includes two string controllers, two HDAs, and four actuators; provides 1.848 gigabytes of formatted capacity at 512K words/sector	81,700	257	5,447	4,085
MSU3391	Head of String Mass Storage Unit; includes two string controllers, two HDAs, and four actuators; provides 5.369 gigabytes of formatted capacity at 512K words/sector	128,000	275	8,533	6,400
MSU3392	Mass Storage Slave Unit; includes two additional HDAs and four actuators; provides 1.848 gigabytes; up to three may be added to each MSU 3390	59,300	165	3,953	2,965
MSU3393	Mass Storage Slave Unit; includes two additional HDAs and four actuators; provides 5.369 gigabytes; up to three may be added to each MSU 3390	105,500	165	7,033	5,275
MSU0500	Dual Fixed Disk Mass Storage Unit, 626 megabytes of capacity	38,850	238	1,412	1,180
MSU0501	Dual Fixed Disk Mass Storage Unit; 1101 megabytes of capacity	43,850	273	1,777	1,482
MSK0501	Upgrade kit; MSU0500 to MSU0501	5,000	31	361	297
MSF0011	Dual Access Feature for MSU0501/0500	4,140	27	163	136
MSA1141	Unit Addressing for up to two MSU05XX Units for MSP0611/0612	3,500	22	220	181
MSA1143	Dual Addressing for up to two MSU05XX Units	4,500	24	216	178
MSF0500	Spare Head Disk Assembly for MSU0500	12,340	NA	NA	NA
MSF0501	Spare Head Disk Assembly for MSU0501	15,808	NA	NA	NA
MSF1142	Unit expansion for configuring additional MSU05XX devices (max 7) to MSP0612	4,000	NA	125	NA
MSF1143	Nonsimultaneous (Switched) Datanet Channel for MSP0611/0612	8,237	21	284	234
MSF1150	Second Nonsimultaneous (Switched) Datanet Channel for MSP0611/0612	8,237	19	283	233

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor.

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
MSF8030	Primary Disk Channel Connection Feature for MSP8021/22/23; each connection feature provides one IOP channel, cables, and associated interface logic in the mass storage processor	6,000	10	360	305
MSF8031	Switched Disk Channel Connection Feature for MSP8021/22/23; each connection feature provides one IOP channel, cables, and associated interface logic in the mass storage processor	4,850	8	290	245
MSF3882	Upgrade from MSP3882 to MSP3886; upgrade kit includes two switched general disk channel connections to the IOP	11,850	24	780	685
	Mass Storage Exchange Features:				
MXF8636	Channel Exchange Feature for MSP3880	18,350	NA	NA	NA
MXF8638	Channel Exchange Feature for MSP3884	36,700	NA	NA	NA
MAGNETIC TAPE SUBSYSTEMS					
CTS8500	Cartridge Tape Subsystem including one single-channel tape processor and one two-drive CTU8500 cartridge tape unit (CTU); supports up to four CTUs	96,770	706	6,048	4,839
CTU8500	Cartridge Tape Unit with two drives, using standard 18-track cartridges with 200MB nominal capacity	39,840	271	2,490	1,992
CTF8501	Cartridge Loader for CTU8500 (supports both drives); supports automatic or programmable loading/unloading	8,225	41	514	411
CTF8500	Crossbar 2 x 16 option connects two Cartridge Tape Subsystems and allows each to access the other's cartridge tape units	8,000	NA	NA	NA
CTF8502	Nonsimultaneous Channel Connection provides one extra channel connection	7,500	22	468	375
MTS8205	Magnetic Tape Subsystem; includes tape processor, one MTU8205 tape unit, and one IOP channel	48,000	410	2,913	2,516
MTS8225	Magnetic Tape Subsystem; FIPS-compliant, 125 inches per second (ips), 800/1600 bits per inch (bpi) supports up to eight tape devices and requires either MTF8200 or MTF8201	48,000	410	2,913	2,516
MTS8226	Magnetic Tape Subsystem; FIPS-compliant, 125 ips, 1600/6250 bpi supports up to eight tape devices and requires either MTF8200 or MTF8201	45,000	410	2,774	2,395
MTS8228	Magnetic Tape Subsystem; FIPS-compliant, 200 ips, 1600/6250 bpi supports up to eight tape devices and requires either MTF8200 or MTF8201	47,000	515	2,876	2,484
MTP0611	Magnetic Tape Processor for MTU0610/0630; supports up to eight tape units	29,400	239	1,093	918
MTF8030	Primary Tape Channel Connection Feature for MTP8021/8022/8023; each connection feature provides one IOP channel, cables, and associated interface logic in the magnetic tape processor	5,000	9	300	225
MTF8031	Switched Tape Channel Connection Feature for MTP8021/8022/8023	4,850	8	290	245
MTF8209	Switched General Tape Channel Connection for MTS8225/26/28	8,000	12	421	364
MTF8201	Magnetic Tape Subsystem 2 x 8 Switch	6,130	14	323	279
Magnetic Tape Units:					
MTU8205	Magnetic Tape Unit; 125 ips, 800/1600 bpi	19,050	240	1,038	897
MTU8206	Magnetic Tape Unit; 125 ips, 1600/6250 bpi	18,500	240	1,061	916
MTU8208	Magnetic Tape Unit; 200 ips, 1600/6250 bpi	21,000	342	1,163	1,005
MTU0630	Magnetic Tape Unit	14,815	202	604	516
Features for the MTU0630:					
MTF0634	75 ips, PE/NRZI feature, 800/1600 bpi	4,725	189	297	268
MTF0635	75 ips, PE/GCR feature, 1600/6250 bpi	7,110	162	351	309
MTF0636	125 ips, PE/NRZI feature, 800/1600 bpi	9,805	213	472	410
MTF0637	125 ips, PE/GCR feature, 1600/6250 bpi	10,330	186	470	408

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor.

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
MTK0630	Performance upgrade MTF0634 to MTF0635	2,385	26	76	61
MTK0631	Performance upgrade MTF0636 to MTF0637	1,700	34	57	47
MTK0632	Performance upgrade MTF0634 to MTF0636	5,080	26	176	146
MTK0633	Performance upgrade MTF0635 to MTF0637	3,220	26	121	101
MTK0634	High Altitude Adapter	240	NA	8	6
	Magnetic Tape Channel Exchange Features:				
MXF8616	Channel Exchange Feature for MTP0610; each exchange feature provides one IOP channel connection to connect tape processor that was previously attached to a Level 66 or DPS 8 system to a DPS 8000 system	5,000	NA	NA	NA
MXF8618	Channel Exchange Feature for MTP0611 Magnetic Tape Processor; provides one IOP channel connection to connect existing processor previously attached to a Level 66 or DPS 8 to a DPS 8000 system	5,000	NA	NA	NA
MXF8620	Channel Exchange Feature for MTF8012/8013/8016/8017 channel connections; provides one IOP channel connection to attach existing systems previously connected to a Level 66 or DPS 8 to a DPS 8000 system	5,000	NA	NA	NA
MXF8634	Channel Exchange Feature for MTS8205/8206/8208 and MTF8202; provides one IOP channel connection to attach existing system previously attached to a DPS 8 to a DPS 8000 system	9,175	NA	NA	NA
LINE PRINTERS					
PRU0903	High-speed belt printer; 900 lpm	34,975	498	2,097	1,752
PRU1203	High-speed belt printer; 1,200 lpm	38,275	553	2,375	1,955
PRU1600	High-speed belt printer; 1,600 lpm, 136 print positions	64,940	639	2,953	2,515
PRK0903	Upgrade PRU903 to PRU1203	5,000	59	304	229
PRK0907	Exchange of PDSI to DAI interface for 0903.1203; includes control panel	3,000	NA	NA	NA
PRU1600 Options:					
PRB0500	63-character OCR-B Print Belt	2,460	122	186	171
PRB0524	63 character OCR A/B Print Belt	2,460	122	186	171
PRB0532	63-character Puerto Rico Print Belt	2,460	127	186	171
PRB0549	63-character OCR-A Alphanumeric Print Belt	2,460	122	186	171
PRB0600	94-character ASCII Belt; upper-/lowercase	2,567	122	191	173
PRF0022	24 additional print positions; 136 to 160	2,610	22	113	94
UNIT RECORD PROCESSORS					
URP8600	Embedded Unit Record Processor; supports up to two CRU0501/1050, PCU0120/0121, or CCU0401 card units	4,500	8	300	225
URP8601	Embedded Unit Record Processor; supports up to two PRU0903/0901/1201/1203 printers	4,500	8	300	225
URP8602	Embedded Unit Record Processor; supports up to two PRU1200/1600 printers	4,500	8	300	225
PUNCH CARD EQUIPMENT					
CRU0501	Card Reader (500 cpm); requires URA0056	19,500	148	694	578
TERMINALS					
BDS 5	Asynchronous display terminal	995	6	NS	NS
BDS 7	Synchronous display terminal	1,200	8	NS	NS
DATANET 8 SERIES NETWORK PROCESSORS AND OPTIONS					
DCU8110	Datanet 8/10 Network Processor system with 1MB of memory expandable to 2MB; supports a maximum of 31 data communications ports and includes 3 RS-232-C/V.24 asynchronous/character synchronous ports	23,900	130	1,195	795

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor.

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
DCU8120	Datanet 8/20 Network Processor system with cache memory, 1MB of memory expandable to 2MB. System is upgradable to dual-processor system with dual-cache memory; supports 31 data communications ports extendable to 127 ports, and includes 3 RS-232-C/V.24 asynchronous/char. synchronous ports	38,000	215	1,900	1,275
DCU8130	Datanet 8/30 Network Processor system with cache memory and 2MB of memory expandable to 4MB. System is upgradable to dual-processor system with dual- cache memory; supports 159 data comm. ports expandable to 255 ports, and includes 3 RS-232-C/V.24 asynchronous/char. synchronous ports	80,000	350	4,000	2,675
DATANET OPTIONS					
	Options for the Datanet 8/10 Only:				
DCM8110	One-megabyte Memory Expansion Module	7,000	50	350	230
	Options for Datanet 8/20 Only:				
DCP8120	Extended Performance Option; includes second processor and associated cache memory	14,000	115	700	475
DCM8120	One-megabyte Memory Expansion Module	7,000	50	350	235
DCE8121	First Line Expansion Module; provides support for up to 32 additional data communications ports (max. 63 ports per DATANET 8/20)	2,500	5	125	85
DCE8122	Second Line Expansion Module; provides support for up to 64 additional data communications ports (max. 127 ports per DATANET 8/20); requires DCM8120 and DCE8121	5,000	10	250	170
	Options for Datanet 8/30 Only:				
DCP8130	Extended Performance Option; includes second processor and associated cache memory	27,000	220	1,350	900
DCM8130	Two-megabyte Memory Expansion Module	14,000	100	700	470
DCE8131	Line Expansion Module; provides support for up to 96 additional data communications ports (max. 255 ports per Datanet 8/30); requires DCM8130	7,500	15	375	250
	Options for Datanet 8/10, 8/20, and 8/30:				
DCF8002	Video Display Terminal Console, 24-by-80 character screen; one required for each Datanet 8/10, 8/20, or 8/30	795	20	40	30
DCF8003	Hard Copy Console Receive Only Printer (100 cps); one required for each system that uses Datanet 8, 8/10, 8/20, or 8/30 Network Processors	1,195	22	60	40
DCF8052	Multiline Communications Controller-16 (MLC-16) accommodates up to four Communications Interface Adapters; maximum of 16 data communications ports per MLC-16	2,700	15	135	90
	Low- and Medium-Speed Options:				
DCF8073	RS-232-C Asynchronous/Character Synchronous Integrated Communications Interface Adapter with four RS-232-C/V.24 data communications ports; includes four 50-ft. cables. Maximum port speed is 19.2K bps	2,000	16	100	70
DCF8049	RS-232-C Bit Synchronous HDLC Integrated Communications Interface Adapter with two RS-232-C/V.24 data communications ports; includes two 50-ft. cables. Maximum port speed is 19.2K bps	3,200	26	160	110
DCF8053	Low- and Medium-Speed Asynchronous/Character Synchronous Communications Interface Adapter; accommodates up to four Line Interface Module Connections; any combination of DCF8055, DCF8057, and DCF8059 is allowed	1,000	7	50	35

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor.

		Purch. Price ($)	Monthly Maint. ($)	1-Year Lease ($)	4-Year Lease ($)
	Medium- and High-Speed Options:				
DCF8061	Medium- and High-Speed Character Synchronous or Bit Synchronous Communications Interface Adapter accommodates one Line Interface Module Connection (DCF8062, DCF8063, DCF8064, DCF8065, DCF8067, DCF8069, or DCF8071)	2,200	16	110	75
NETWORK PROCESSOR CHANNEL CONNECTIONS					
DCE8020	Datanet 8 Network Processor Channel Connection Feature; each connection feature provides one IOP channel, cables, and associated interface in Datanet 8/10	8,000	72	346	295
DCE8119	Datanet 8/10, 8/20, 8/30 Network Processor Channel Connection Feature; provides one IOP channel, cables, and associated interface in the Datanet systems	8,000	72	346	295
	Network Processor Channel Exchange Features:				
MXF8628	Channel Exchange Feature for Datanet 8 and PPS	3,500	NA	NA	NA
MXF8641	Channel Exchange Feature for Datanet 8/10, 8/20, and 8/30	3,500	NA	NA	NA
	Hyperchannel Connections:				
MXF8640	DPS 8000 Series Hyperchannel Connection Feature A161	14,000	111	1,111	745
MXF8632	DPS 8000 System Channel Exchange Feature for connecting existing A161 Hyperchannel Subsystem previously attached to a Level 66 or DPS 8 to an IOP	5,300	NA	NA	NA
MXF8639	Power Sequence for FIPS channel/subsystem	3,200	5	200	149

NA—Not applicable.
NC—No separate charge.
NS—Information not supplied by vendor. ■