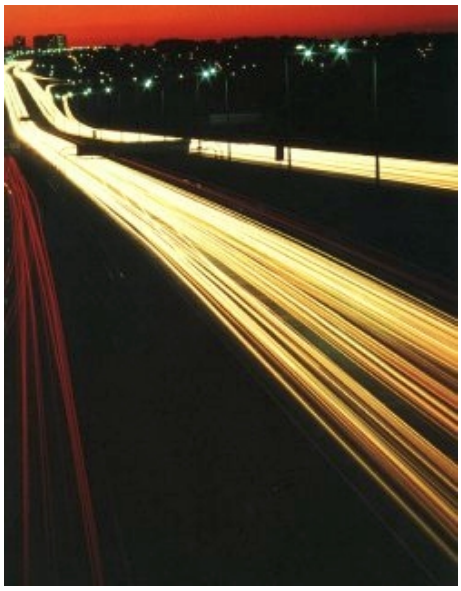
EXTENDED SYSTEM ARCHITECTURE, the platform for tomorrow



Fujitsu's Extended System Architecture (EXA) is the architecture that provides optimal performance on large, multiprogramming, multiprocessing computer systems: high-end M Series machines.

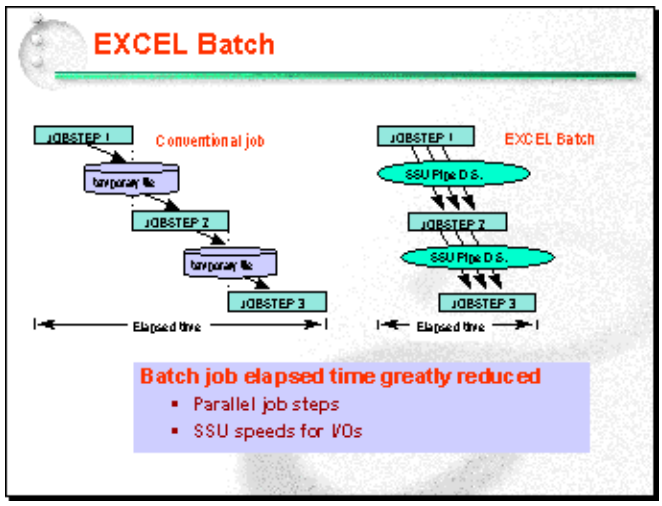
The improvements implemented in EXA greatly increase the capabilities of Fujitsu's powerful main- frames. EXA supports up to 2 gigabytes of high-speed system storage, as many as 256 channels, and over 4000 1/O devices This advanced technology increases speed of data throughput and significantly enhances I/O-related performance.

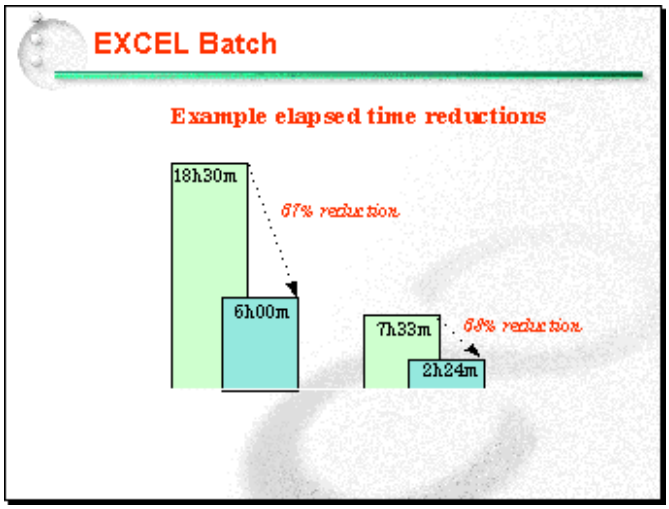
The new EXA architecture has been designed to meet the pressing needs for higher speed transaction processing, for more efficient relational databases, and for a high-speed virtual machine facility.

Parallel Processing

The system-storage unit links a number of CPU's to provide high-speed communication in a system-storage-coupled multi-processor (SCMP) system. With exclusive control information in system-storage, the delays in database and other file access across systems is minimised.

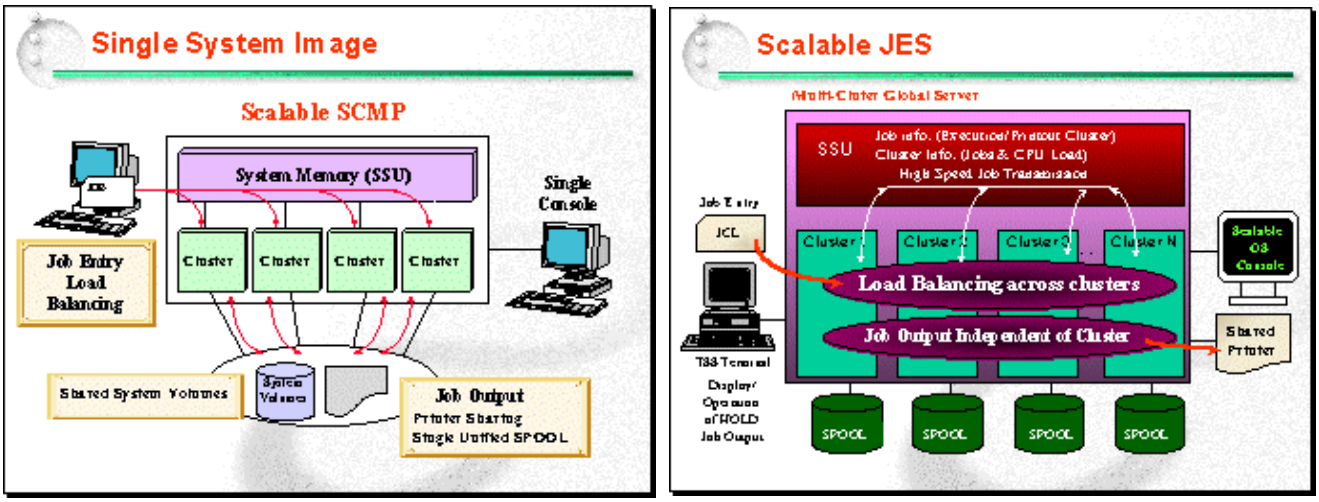
System storage also provides "pipe" facilities for files within and between batch jobs. This allows the steps of a job or two jobs to execute in parallel, with substantial reduction in the elapsed time.





Although a number of clusters may be running, each with its own main storage, CPUs and copy of the operating system, system operation can be carried out on a single system image. There need be no awareness for the operator of physical configuration. Activity in the system as a

whole may be balanced to carry out activity on whichever system has the available capacity, and the user needs no awareness of the existence of multiple clusters.



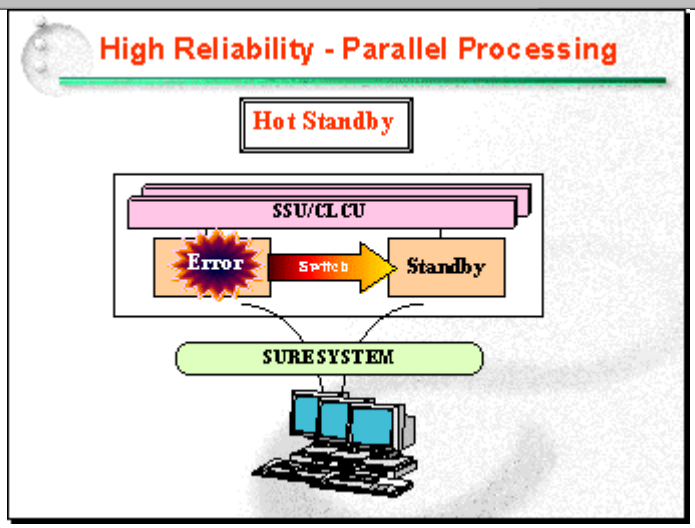
To avoid affecting the performance and responsiveness of online systems, it is still possible to administer separately, running batch work on separate clusters from online.

Fast database access

The SSU's high-capacity enables a large amount of frequently accessed data to remain resident in the SSU, which can be directly accessed by the CPU. With AIM/DB network and SymfoWARE relational databases located in the SSU, MSP-EX provides an environment for extremely fast transaction processing. The SSU can substitute for disk storage, providing an area for fast paging, swapping, and Virtual Input-Output (VIO). The large SSU capacity gives SORT and other MSP-EX functions a high- speed work area for temporary data sets. Of note is the EXCEL BATCH solution, based upon the Parallel Data Control Feature (PDCF) software product, which utilises the SSU to achieve significant reductions in batch processing elapsed time.

Failsafe systems

The EXA architecture and the System Storage Unit combine to give Fujitsu's most powerful computers a new, and unique to Fujitsu, form of multisystem coupling called the System Storage Coupled Multiprocessor (SCMP). The SSU can be shared by as many as eight systems. With SCMP, multiple system complexes can be configured as hot-standby systems with switchover times of seconds. With duplicated SSU, power supply, service processor and all control hardware, unprecedented levels of failsafe, fault-tolerant operation can be provided.



Advanced Virtual Machine/Extended
The Advanced Virtual Machine/Extended (AVM/EX) program product for Fujitsu's GlobalServer systems mainframes, combines with the Extended Virtual Machine (EVM) hardware facility to provide efficient support for the simultaneous use of as many as 14 guest operating systems, each with a minimum of impact on performance.

COMPATABILITY with existing investments and future developments

The architecture for the 1990s
Fujitsu's MSP-EX now offers advanced levels of support for international and industry standards. Applications developed for IBM's MVS environment can be ported to MSP-EX. Direct connection to other operating systems is possible. Current investments in programs and data have been protected, and the ability to use today's and tomorrow's most sophisticated applications has been improved. Cross-vendor compatibility Source code compatibility of high level languages, such as FORTRAN and COBOL, permits applications to be ported from IBM to Fujitsu environments. Support for SQL standards provides compatibility with other vendors' relational databases, including IBM's DB2.

Multiple system support
An AVM/EX-equipped system offers users superb adaptability and versatility with advanced migration and conversion capabilities. Applications developed for IBM MVS can be migrated to MSP-EX via AVM/ EX facilities.

'UXP/M is Fujitsu's implementalion of UNIX
'UNIX is a registered trademark of UNIX System Laboratories Inc.
'IBM is a registered Trademark and MVS is a trademark
of International Business Machines Corporation.

INFORMATION SYSTEMS PRODUCTS

The AIM environment for productivity
The Advanced Information Manager (AIM) provides a flexible online data processing

environment, capable of handling large-scale, high-performance information systems. Closely integrated with the MSP-EX operating system, AIM Version 20 utilizes the advances built into MSP-EX and expands the scope of this already versatile production environment.

Distributed processing
Expanded support for distributed processing and recognized standards is a major enhancement in AIM V20. The Open Systems Interconnection standard for Remote Database Access (OSI/RDA) allows user-transparent access to distributed data. AIM V20 supports a range of communications standards, including FNA and OSI, key components of distributed computing.

AIM facilitates distributed computing, both vertically and horizontally, by allowing the integration of workstations and mainframes from Fujitsu and other vendors. These AIM capabilities, the basis for cooperative processing, enable user applications to take advantage of the hardware/software strengths of each element in the distributed system.

High-volume, network database
Fujitsu's CODASYL network database, AIM/DB, provides for specialized applications that use extremely large databases, or that have high-traffic. AIM/DB offers high speed and high throughput to such applications.

High-speed data access
In the AIM V20 environment, large transactional tasks are accelerated through sophisticated hard- ware cooperation. Fujitsu's System Storage Unit (SSU) performs data access at semiconductor speeds. With SSU, transfer rates for frequently accessed data can be increased by a factor of 100 compared with DASD.

Reliability
High-level integrity and fast recovery of databases and data files are features of AIM V20. Multisystem processing, with shared databases on shared DASD or in the SSU, ensures operational continuity. Nonstop processing is achievable with multiple system complexes in hot-standby configurations. Downtime associated with a processor failure is limited to seconds.

INTERACTIVE ENVIRONMENT for development

Benefits to end users and programmers
Fujitsu's Time Sharing System/Extensions TSS/E) builds upon the advantages of MSP-EX to provide more efficient access to, and use of, the resources needed for program development and system maintenance.

TSS/E maintains proven timesharing benefits including:

- Concurrent access to system resources for many terminal users
- Transparent user access from any terminal on the network
- A user-friendly interface and interactive format
- Improved responsiveness and productivity

Enhancements through TSS/E and associated products give users improved operational capabilities and raised productivity levels. The user interface can be customized to meet the needs of end users and experienced developers.

Associated products that enhance the performance of TSS/E include: the Integrated Data Communication Manager (IDCM), which simplifies the development of applications for, and their use by, workstations in a distributed environment; and the several Application Program environment (AP) products, which support interactive operations and facilitate menu and screen management.

High levels of security provided
Fujitsu's Resource Access Control Facility (RACF) protects operating systems, application programs, and databases. RACF meets the C2 level criteria in the "Trusted Computer System Evaluation Criteria" defined by the National Computer Security Center (NCSC), part of the US Department of Defense (DOD). The security features of RACF are in continuous development due to cooperative efforts between RACF users and Fujitsu designers. The standards of Class B1 will be met in the near future. RACF maintains control through the following procedures: A user-ID and a password identify and authenticate each user of the computer system; access to information and operations is allowed in accordance with the authorization levels specified for each user; RACF prevents users from obtaining other users' residual data (ie. data is physically overwritten when deleted by a user, rather than being left accessible on the disk drive as a 'residual' dataset); and it maintains detailed audit trails of security-relevant events.

GLOBAL NETWORKS and open communications

The EXA architecture and the MSP-EX operating system prooide Fujitsu 's powerful computers with network facilities capable of handling every high-volume, large-scale distributed processing. Conformance to OSI, CCITT, ANSI and SNA standards ensures high levels of connectivity. Expansive global networks, with trillions of connected computers and workstations, are possible. Facilities supported by the network enable efficient dissemination of information by voice, text and image throughout the organization and the world.

Wide range of protocols supported
Support for widely used protocols is provided with MSP-EX's enhanced Fujitsu Network Architecture, FNA5. TCP/IP, and Open Systems Interconnection (OSI) protocols open avenues to a wide range of industry-proven applications.

Peer-to-peer communications
FNA5 allows peer-to-peer communications in which data transfer is based upon international standards, which eliminate the need for translation software. FNA5 supports intelligent networks with functions that enable dynamic adaptation to changes in network topology.

Expandable, high-speed networks
The Extended and Open Networking Facility (EONF) is Fujitsu's array of software and hardware enhancements that enable FNA5 networking. EONF, based on OSI standards, supports both OSI and current FNA protocols on the same communication lines. With EONF's support for trillions of addresses through the Virtual Telecommunications Access Method-G (V/TAM-G) V30,

networks of virtually unlimited size are possible. Support for Integrated Services Digital Network (ISDN), which permits simultaneous transmission of digital voice, computer, and video signals over public telephone lines, is provided by EONF VTAM-G V30 also enables use of high-speed Fiber Distributed Data Interface (FDDI) LANs, which can communicate at 100 megabits per second. FDDI is an emerging ANSI/ISO standard for the use of fiber optics in networks.

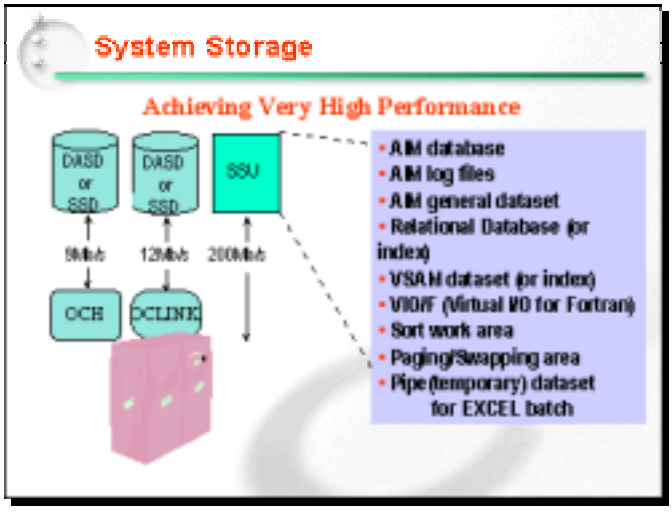
Integrated communication interface
Fujitsu's Integrated Data Communication Manager (IDCM) integrates the communication interfaces of the AIM, TSS and Distributed System Manager (DSM) environments and allows users to develop applications that are independent of network architecture. IDCM interacts with VTAM-G V30 to create a unified communication interface for users of workstations.

COMPONENTS optimized for performance

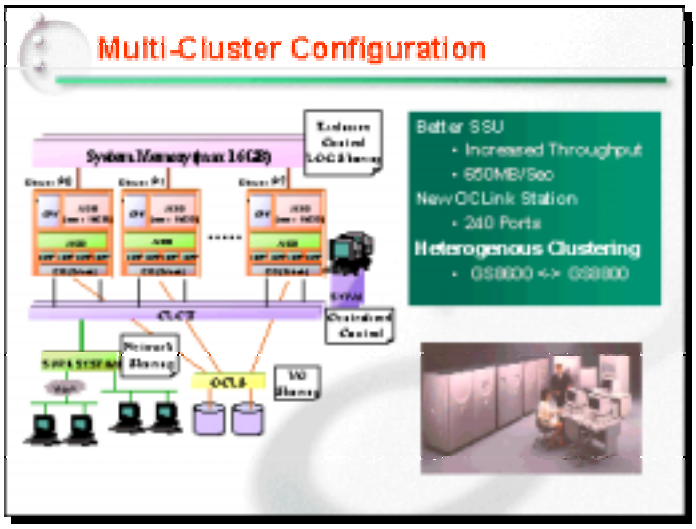
The major new components of Fujitsu 's EXA architecture and of the MSP-EX operating system cooperate to deliver significant benefits to Fujitsu S top-performing mainframes. EXA has been designed around the concept of using a mainframe as a GlobalServer Fujitsu 's GlobalServer incorporates the functions of a high-speed process server a data server; a network server; and of systems management.

High-throughput process server
The elements of EXA that combine to allow quick access and high throughput of system data include:

- The System Storage Unit (SSU), a new level of semiconductor storage, which facilitates high-speed, high-volume transaction processing. The SSU has an extremely fast data-transfer rate of up to 500 megabytes per second, and a capacity of up to 8 gigabytes. It is directly accessible from the CPU and enables data sharing and communication among systems. As many as four systems can be connected. The 47-bit addressing capability of the SSU allows a maxi- mum logical space of 128 terabytes.



- A multi-cluster configuration allows a number of MSP-EX systems to share System Storage. These systems can share files, including database and log files, in the very-fast access System Storage area. Such a multi-cluster system also allows the use of SSU features to configure a hot-standby system, which is capable of switching processing from a failed system to a working system in a matter of seconds.

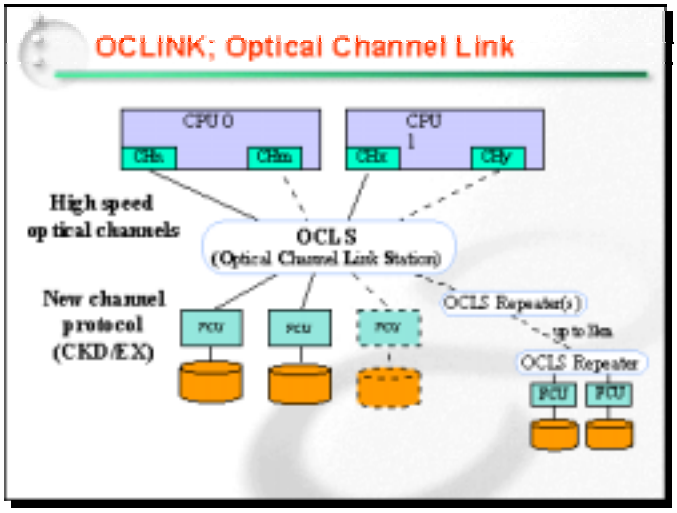


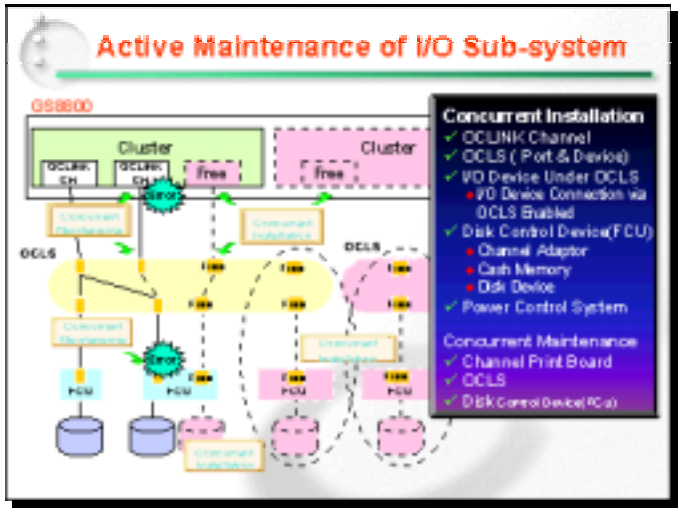
- The Extended Virtual Machine Facility (EVM), an EXA firm- ware feature, which incorporates the control instructions for many of the functions vital to efficient virtual computing. These instructions, formerly simulated by software, control I/O operations as well as communications between multi- processor CPUs. EVM, available for Fujitsu's M-760, M-780 and M-1800 mainframes, provides for significant reduction in system overheads.

- The Advanced Virtual Machine/Extended (AVM/EX) facility, the software product that combines with EVM to give Fujitsu's high-end machines the ability to run up to 14 operating systems simultaneously and with high performance. Both Fujitsu and IBM operating systems can run under AVM/EX, with a minimum of impact on performance. AVM/EX supports shared CPUs, up to 256 shared channels, and flexible use of the SSU.

- The Extended Channel Facility (ECF), which enables I/O requests to be completed via any free path connected to that channel. This dynamic path reconnection considerably increases channel load capacity. ECF is a firmware facility which resides in the channel subsystem and thereby reduces CPU overhead. ECF extends the number of available channels to 256, and the number of connectable I/O devices to over 4000.

- The use of faster optical channels has improved I/O transfer rates and throughput. OCLINK (Optical Channel LINK) channels, together with the new CKD/EX channel protocol, further improve data throughput and reliability. They provide higher speed channel transfer (12-19MB/sec); fewer channels required with much higher channel throughput and loading (50-70% busy possible); continuous operation in the event of failure; active maintenance while links in use; and remote peripherals - up to 9Km distance from the central site.





Enhanced data server

MSP-EX's data server capabilities are derived from integrated components that enable high-speed network and relational database processing, and improved distributed computing. The major data server products include:

- The Relational Database II (RDB II), Fujitsu's second generation relational database, which conforms to SQL and RDA international standards. RDB II takes advantage of EXA enhancements to provide significant improvements in response time and throughput. RDB II is the base for both decision-support and transaction processing systems in the 1990s.
- The Advanced Information Manager V20 (AIM V20), a pro- gram product that supports very large-scale and high-traffic information processing tasks in the transaction-processing environment. AIM supports distributed processing, both horizontally between mainframes and vertically between the mainframe and workstations. Standard communication protocols enable AIM to operate in multi-vendor environments. AIM conforms to OSI international standards, which allow operations in a variety of environments.
- The AIM/DB network database, which offers high- performance in ultra large-scale transaction processing environments. When resident in the SSU, the database has extremely fast accessibility. EXA's advanced hot- standby facilities ensure high availability for AIM/DB.
- The Advanced Information Manager Bridge (AIM/BRIDGE), which allows major ISV's software developed under IBM's CICS environment to run in Fujitsu's AIM environment.
- The Integrated Data Communication Manager (IDCM), which integrates the communication interfaces of the AIM, Time Sharing System (TSS), and Distributed System Manager (DSM) environments.
- The Strategic Interactive Information System (STRACT), an application designed to unify database access by providing one set of commands for access to various databases including RDB II, AIM/DB, VSAM, and SAM. STRACT also offers services for database processing including graph and report creation, and time-series forecasting.
- MANASYS, the latest enhancement to Fujitsu's fourth generation language, used with the AIM online relational and network databases, as well as with AIM's transaction processing subsystem. MANASYS implements a programmer workbench facility that provides options for two new products: MANAGEN, an automatic application generator, and MANAREF a cross reference and impact analysis tool.

- The Application Development And Management facilities/ Information Resource Dictionary (ADAM/IRD), a program product for managing resources in the application development environment. ADAM/IRD coordinates use of information related to data items, records, screens, reports, and programs, stored in the ADAM/IRD dictionary. The developer can easily catalogue, update, delete, and retrieve such information from the dictionary.

High-capacity network server

Fujitsu's Networking Architecture, FNA5, offers major enhancements to MSP-EX networks. MSP-EX network facilities greatly increase MSP connectivity and expand support for remote systems. Among the most significant of the new network products are:

- The TCP/IP Support Program (TISP), which supports the TCP/IP protocol under MSP This support allows interconnection of MSP and UNIX environments. With TISP, the MSP host is able to act as a server for file storage, mail systems, file transfer, and applications for connected UNIX-based systems.
- The FNA Loose Coupling Facility (FLCF), which enables connection to IBM's SNA networks. FLCF forms a gateway on the stable, physical unit type 2 interface, and is thus independent of the version and level of IBM software.
- The Virtual Telecommunications Access Method-G V30 (VTAM-G V30), which adopts the OSI standard network address method and greatly expands the number of connectable computers and workstations. VTAM-G V30, in cooperation with FLCF and TISP, links directly to IBM's SNA, and to UNIX systems.

Advanced system management

MSP-EX provides for the integration of security and of system management facilities. This sophisticated integration increases both the security and the efficiency levels available to the computer system. The system management products include:

- The Resource Access Control Facility (RACF), which provides improved security for systems programs, application programs, and databases. RACF currently meets the standards of Class C2 and it is intended to meet the standards of Class B1.
- The Archives Service Program (ARCS), which includes functions that backup, restore, copy, and migrate data on DASD volumes.
- The Automatic Data Migration Facility (ADF), which manages use of secondary storage, such as DASD and cartridge tape libraries.
- The Library Support Program (LIBSP), which enables automatic control of the operations of optical disk storage libraries and of cartridge tape libraries.
- The Advanced Printing Subsystem (APS), which offers a single system interface for message and forms processing within batch, time-sharing, and AIM environments.
- The Disk Space Control Facility (DSCF), which works with RACF to control the disk space available to individual users or groups. DSCF also restricts access to specified disks.
- Various other MSP-EX facilities, which provide for integrated network monitoring and management, and for dynamic updates of host, network, and workstation environments.

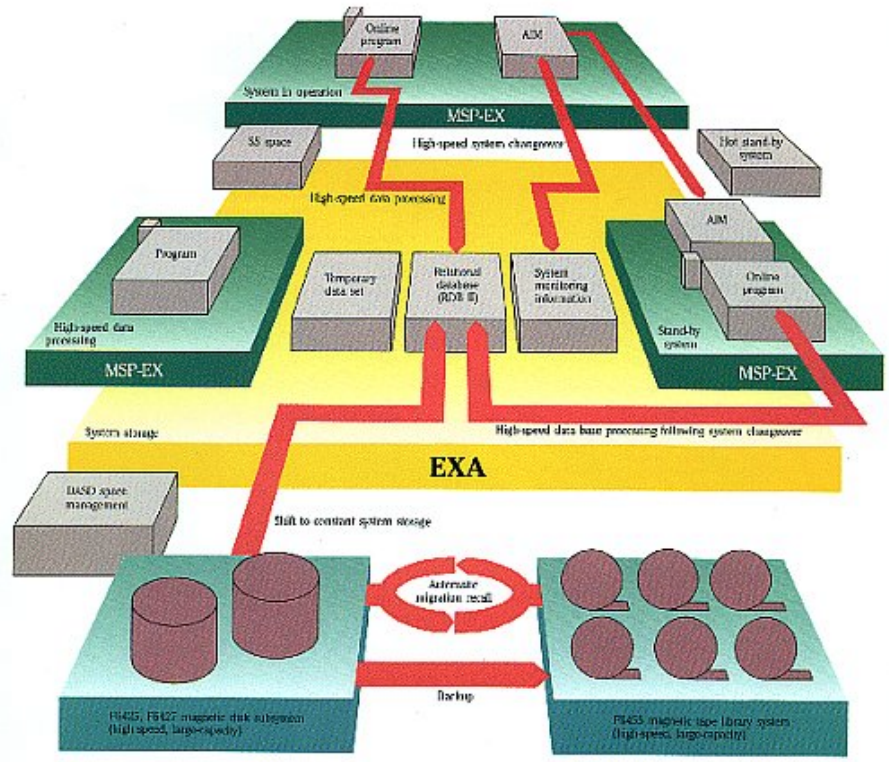
Efficient systems software

The systems software for MSP-EX enables dramatic improvement in system efficiency. The enhanced systems programs include:

- The SORT function, which has been enhanced to take advantage of EXA's high-speed SSU and 31-bit addressing capabilities. High-level languages, such as COBOL 85, can call SORT from the extended area. Efficient use of the extended area provides significant reductions in I/O operations.
- TSS/E, an extension to MSP's Time Sharing System, which provides users with better facilities. Improvements have been made to logon procedures, space management, data set retrieval, and command processing. The enhanced functions include syntax customization.
- The Virtual Directory Facility (VDF), which allows the directory section of a partitioned data set to reside in virtual storage VDF substantially increases the speed of directory reads and also decreases the number of I/O operations.

Wide range of applications and languages

Fujitsu's MSP-EX operating system supports a huge range of applications and advanced versions of the major programming languages, including COBOL 85, FORTRAN 77, PL/I, and C among others. MSP-EX's high degree of compatibility with the IBM MVS environment allows use of a large number of proven products. Some applications and programming languages are available in a range of the world's languages: English, Japanese, Korean, Taiwan Chinese, and Chinese.



Automated functions of MSP-EX facilitate hot-standby systems via system storage