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CONTROL DATA CORPORATION

CONTROL DATA®
MP-32
COMPUTER SYSTEMS

GENERAL INFORMATION MANUAL

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INTRODUCTION 1

GENERAL INFORMATION

The CONTROL DATA® MP-32 is a medium scale, solid state, general purpose digital computer system. Advanced design techniques in the field of microprogrammable architecture are used throughout the system to provide a flexible, extendable, compact, and high performance system for use in a variety of scientific, real-time, and data management applications. Modular packaging of the basic MP-32 facilitates expansion of the system components to accommodate increased application requirements. The primary advantages of the MP-32 for the system designer result from the building block philosophy that was fundamental in the MP-32 design. For a given application, the system designer can construct a compact array of memory coupled MP-32 processors, which optimally solves the data processing problem. MP-32 processors can be application tailored for specific digital algorithms by microprogramming techniques which allow significant system throughput rates.

The MP-32 can be utilized as a standalone system or as a high performance front-end subsystem to CONTROL DATA® Cyber 170, Cyber 70, and 6000 systems. Both of these computing environments are supported by a significant set of software products.

The MP-32 operating system is designated MPX. The MPX system is a multiprogramming, multitasking, multiprocessing system capable of the concurrent execution of user jobs in a single CPU environment and simultaneous execution of concurrent jobs in a multi-processor environment.

In a Cyber 170, Cyber 70, 6000 coupled environment, the MP-32 software is complemented by packages hosted on the large scale computer system. A coupler package allows the MP-32 input and output streams to be routed through the Cyber system. This allows a user to create and submit MP-32 jobs from any Cyber input/output device (terminal, RJE station, or local peripherals). Additionally, the coupler package supports the general exchange of data between user jobs executing in both the MP-32 and the Cyber. In a development environment, the coupler package allows MP-32 and Cyber software to be created/maintained from a single terminal set utilizing the extensive support software available on the large scale mainframe.

HARDWARE 2

CONFIGURATION

The MP-32 configurator is contained in Figure 2-1. An MP-32 system is constructed from two basic chassis, the Basic System Controller (BSC) chassis and the Multi-Port Memory (MPM). These chassis are identical in size. Up to three chassis may be mounted in an equipment cabinet. Peripheral controllers and adapters mount in the BSC chassis in prewired slots.

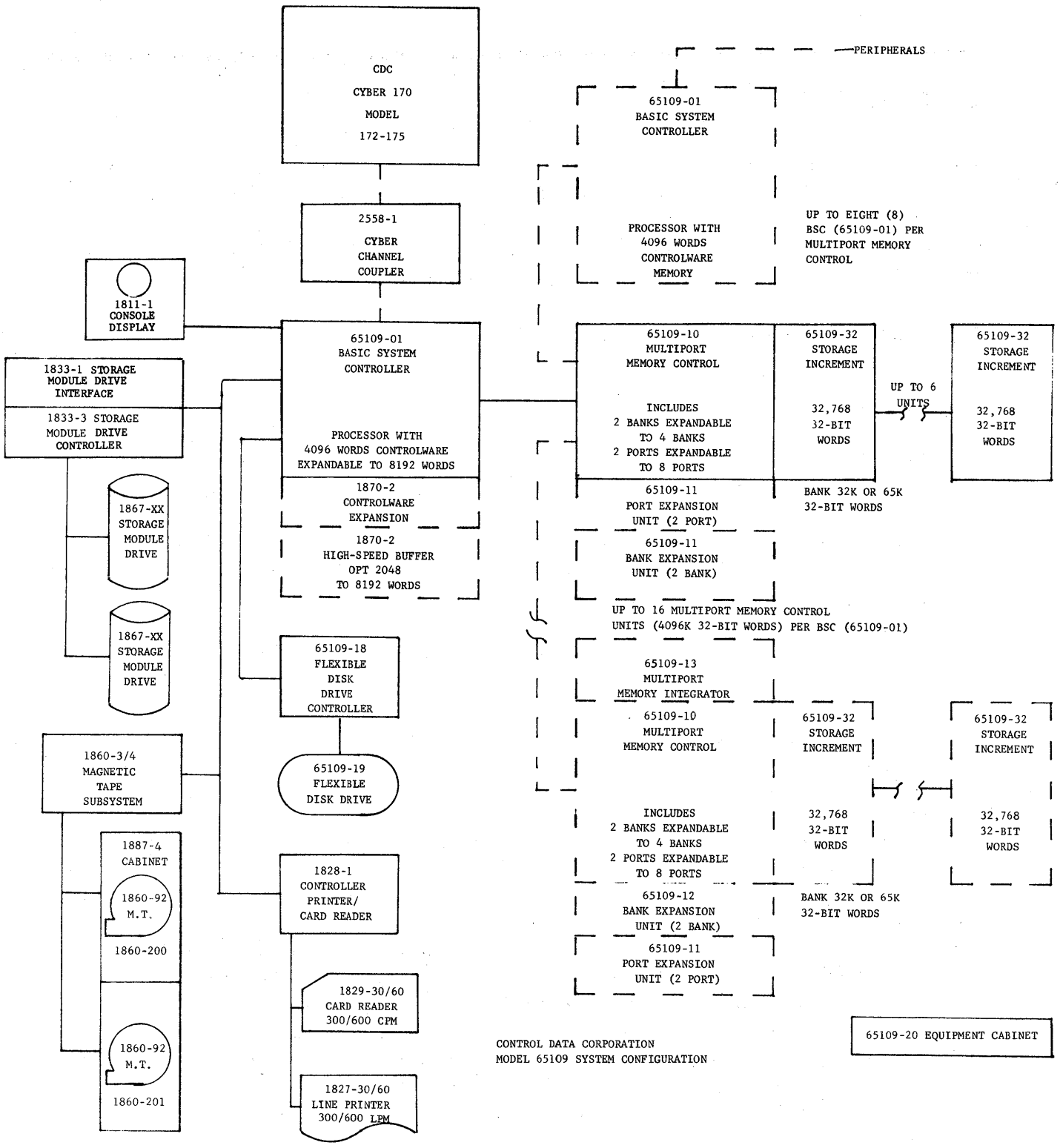
FEATURE SUMMARY

MP-32 Processor (Basic System Controller)

- Full 32-bit processor with both ones and twos complement arithmetic.
- Standard read/write micromemory of 4,096 instructions expandable to 8,192 instructions.
- Standard 32-bit × 32-word and 32-bit × 256-word register files.
- Optional 32-bit × 2048-word register file with address auto-increment control. Expandable to 32-bit × 8192 words.
- Real-time clock with millisecond increment and 32-bit counter.
- Memory management unit addressing 4 million words of memory. Full memory protect and access control logic.

MP-32 Multi-Port Memory

- Standard two port memory expandable to eight ports per chassis in increments of two ports.
- High bandwidth capacity of 26.6 million bytes/sec. per memory chassis.
- Up to sixteen memory chassis may be coupled for a 4,096K 32-bit word memory capacity.
- Address and data parity.
- Maintenance features that provide the capability of Manual Bank Lockout, Port Isolation and Chassis Address Selection for isolating and reconfiguring memory for maintenance.
- Test Mode Selection for data and address echo checking.
- Programmed Port Lock/Unlock capability with automatic unlock on timeout. This locks a port to a bank to assure data integrity in a multiprocessor environment for flag word communication protocol.



CONTROL DATA CORPORATION
MODEL 65109 SYSTEM CONFIGURATION

EMULATOR PACKAGE

The MP-32 provides a general purpose computer capability with a basic firmware emulation package. This package utilizes the wealth of hardware resources to present a state of the art 32-bit computer architecture to the programmer. This "macro level" architecture was utilized by CONTROL DATA® to develop the MPX operating system and support products. This architecture utilizes a subset of the MP-32 hardware allowing user expansion by the creation of application tailored microprograms. General features of the computer are:

- 32-bit twos complement single precision arithmetic and 64-bit twos complement double precision arithmetic.
- Eight sets of register files, 32 registers per set. The register files are further divided into a monitor state set and seven program state sets.
- Each of the eight machine states has a dedicated page map register set for rapid context switching.
- 32-bit single precision and 64-bit double precision floating point arithmetic.
- Bit, byte, half word, full word, and double word addressing modes.
- Extendable instruction set with the ability to define different instruction sets for each state.
- Features to allow expansion to multi-processor systems.
- Fully vectored interrupt system with up to twenty user defined real time interrupts.

MPX SYSTEM

The MPX system is a multiprogramming, multiprocessing system capable of the concurrent execution of multiple user jobs in a single CPU environment and simultaneous execution of concurrent jobs in a multiprocessor environment.

The MPX operating system consists of various software components which provide the user with the ability to conveniently define, control, and execute (via control statements from a standard input unit) an entity called a job. A job consists of the sequential or concurrent execution of one or more tasks. A task may be classified as a user task, a system task, or a library task. A user task is created by loading and linking one or more relocatable binary modules from the job input stream or from a user-specified unit (tape, or file). A library task is created by loading and linking one or more binary modules from the system library (LIB). Binary modules are produced by either the FORTRAN compiler or the COMPASS assembler. A system task is a function in the MPX operating system that is either called directly by a monitor call from a user or library task. Figure 3-1 provides an overview of the MPX System flow.

Multi-Tasking

MPX provides a multi-tasking capability which enables tasks to call and establish other tasks. A task may call and wait for completion of its callee or multiprogram with it. Tasks maintain lists for callers, but a task may call with reject so that it is not threaded if the called task is busy. Each task is assigned a state during its execution which implies a corresponding set of page and operating registers. Tasks within a job share I/O units and buffers. A task running under MPX exists in several stages. These stages are defined as follows:

(1) READY	The task is threaded by priority in the CPU ready list. It is candidate for control of the CPU.
(2) WAIT	The task is threaded by priority against a resource other than the CPU (e.g., an I/O unit, system task, system table, another task, etc.)
(3) RUNNING	The task currently has control of the CPU.
(4) TERMINATED	The task has completed execution and has returned to its caller.

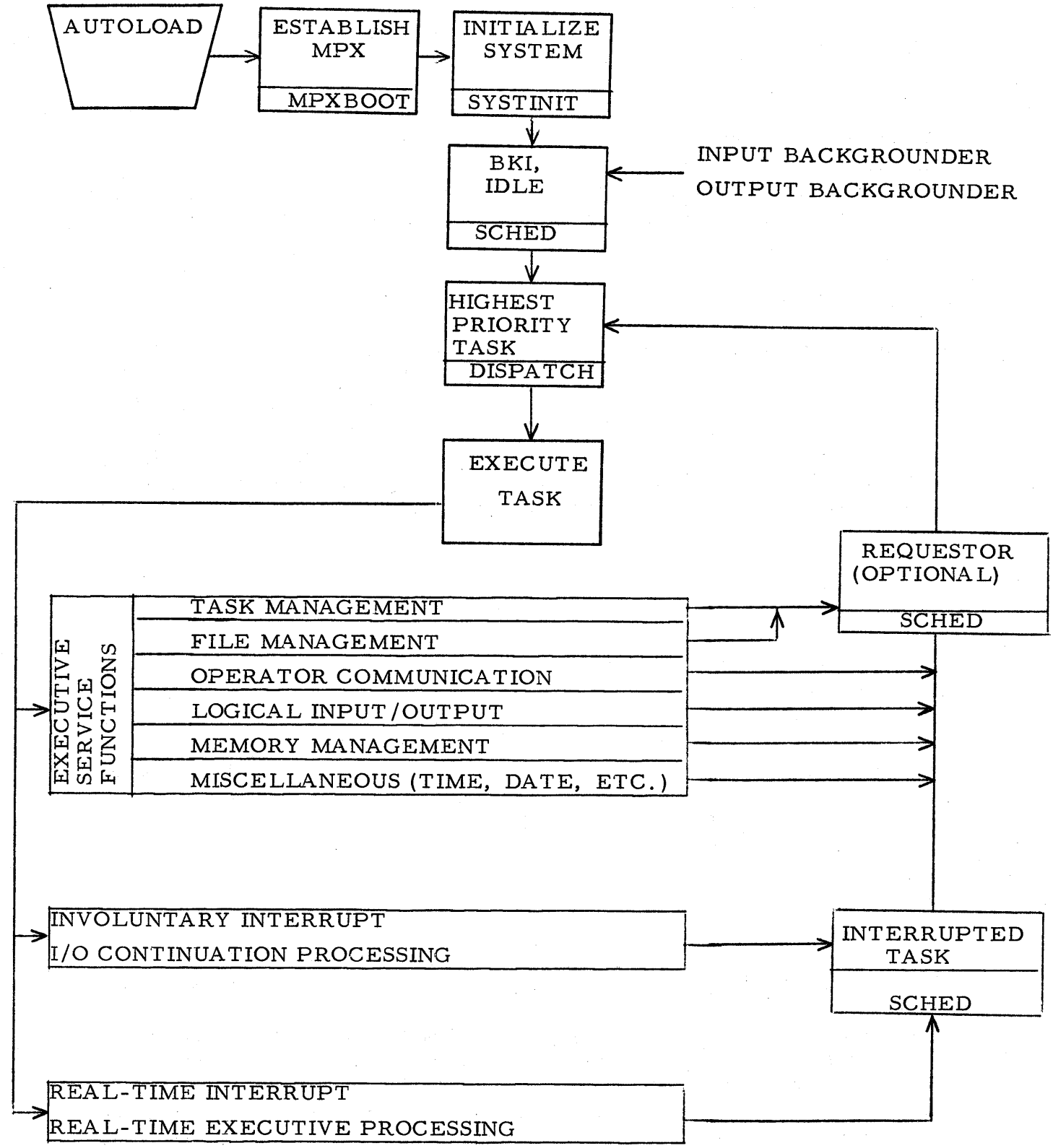


FIGURE 3-1. MPX System Flow

A task in the ready stage can only go to running. A task in wait must go to ready before running. The running task can voluntarily go to wait or terminated and involuntarily go to ready if a higher priority task becomes ready. A terminated task may be released or simply go dormant.

List Processing

MPX uses the concept of list processing. The lists are comprised of threaded task control tables (TCT's). Each TCT in a list has a forward and backward pointer word. The forward pointer word in the last TCT in a list is set to zero. Thus, if the top (first entry) of a list has a zero pointer word, the list is empty. In addition to threaded lists of TCT's, MPX maintains lists of internal tables, such as empty or full threads. List processing saves time as well as memory since no tables are actually moved.

Priorities

Control of resources under MPX is on a priority basis. All lists are ordered by priority. Priority ranges from 255 (highest) to 0 (lowest). Priorities in the range 240 - 255 and 0 - 9 are reserved for real-time and system tasks. A job may execute at several priorities. The *TASK card is provided to establish task priorities externally. Internally, the task call executive function is used. The *RJOB card, when used in place of the normal *JOB card, allows usage of the reserved priorities.

Interrupts

Interrupts are used by MPX to facilitate task switching and to continue I/O processing. Associated with each interrupt is a return word giving the machine status associated with the executing task. This return word is used to put the interrupted task back into execution. All I/O interrupts are enabled during program state execution and disabled in monitor state. Real-time and console interrupts are enabled during most of monitor state execution. Only list processing, console processing, and real-time executive processing execute with real-time interrupts disabled. When monitor state is interrupted by a real-time interrupt, the monitor state return is saved in a special cell. Special arithmetic fault interrupts may be selected by a user, with control passing to the user-supplied address. Internal

interrupts including memory reject, memory parity, page faults, and illegal instruction result in job termination if a user has control or system abort if a system task is in execution. These internal interrupts along with the power failure interrupt are never disabled.

Organization

The MPX system is logically divided into two entities; Exec and Job/Task monitor.

The EXEC is resident in its own state and has its own field length. Most monitor services are provided by EXEC.

The Job/Task monitor is mapped into each job's field length and provides job sequence control, program loading, and job termination. There is one copy of Job Monitor to service all jobs in the system and it is mapped into each user's field length each time a Job Monitor function is required (re-entrant).

PRODUCT SET

The product set members are compatible for all version of the MPX system. All product set members reside on the system's library. In addition to the product set members discussed in this section, there is a comprehensive library of cross assemblers and simulators hosted on the CONTROL DATA® Cyber series of computers. The following sections delineate the self-hosted products of MPX.

- COMPASS

  COMPASS is a macro assembler that translates programmer symbolic language into machine instructions.

- ANSI FORTRAN COMPILER

  MP60 FORTRAN translates FORTRAN source statements into machine instructions. In addition, the standard CONTROL DATA® enhancements are provided (ENCODE, DECODE, BUFFERIN, BUFFEROUT).

  A set of mathematical and logical functions are provided in the systems library to support user program generation.

- COSY

  MP60 COSY is a program used to maintain and update source language program libraries.

- PRELIB

  MP60 PRELIB is a multipurpose task for the maintenance and update of the MPX library.

- UTILITY

  The MPX utility package contains I/O transfer routines for all standard MP60 peripherals.

- FMP

  The FMP program is a file maintenance package of comprehensive mass storage utilities.

- COPYL

  COPYL is a package for user object library maintenance.

CYBER HOSTED SOFTWARE

Cyber Coupled Communication Package

The Cyber Communication Package provides a channel communication capability between large scale Cyber 170, Cyber 70, 6000 computers and the MP-32/MPX System. The Cyber Coupled Software features FORTRAN callable subroutines which allow the user to establish communication and to control data movement between the two systems. The MPX system supports the communication as a logical unit equipment following standard Read/Write protocol.

Package Features:

- Binary mode transfers bit stream (data packed into 60-bit word format). Word mode transfers (32 bits of data per 60-bit Cyber word).

- Character mode transfers
  8-bit ASCII to 6-bit display code.
  8-bit ASCII to 12-bit display code.
  8-bit ASCII to 8 of 12-bit ASCII.

- Input/Output Data Spooling

- Multiple Job Communication.
  Multiple Cyber jobs can communicate with multiple MPX jobs.

MASS/MPSIM

The Micro Assembler (MASS) is a Cyber hosted microassembler operating under the control of CONTROL DATA® NOS or NOS/BE operating systems. MASS provides the mnemonic language necessary for writing microprograms. It translates symbolic source program instructions into machine instructions, listings, and object output. Input consists of one or more source programs containing symbols, pseudo instructions, constants and mnemonic instructions. MASS is control card callable with parameters for controlling input and output file designations. Object output can be directed for transmission to an attached MP-32 or to an object file for card disposition.

The Micro Processor Simulator (MPSIM) is a Cyber hosted simulator operating under the control of CONTROL DATA® NOS or NOS/BE operating systems. MPSIM provides a capability for the verification of user generated microcode using interactive communications techniques. MPSIM allows user control of register displays, memory breakpoints, dumps, etc. Input consists of a program file and a series of user directed interactive commands.

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