

CYBER 70

Computer Systems

PRODUCT ANNOUNCEMENTS

CONTROL DATA
CORPORATION

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CYBER 70 Product Description

1.0 GENERAL

The Control Data CYBER 70 series is an advancement in data processing, offerings:

- New system cost-performance levels
- New system hardware elements
- New system architectural features, stressing -
 - Storage hierarchies
 - Distributed processing
 - Multi-processing and high-efficiency multi-programming
- New total computing services concepts - especially that of CYBERLINK, the unique facility for directing work to the CYBERNET Service Network

Each model of the series is composed of on-site computers and supports a link to Control Data's CYBERNET Service Network for additional processing. The CYBER 70 series offers many new features exploiting distributed processing concepts*, and is an extension of Control Data's 6000/7000 proven architecture.

CYBER 70 systems offer the following modularity features:

- Four distinct CPU's available, three of which can have dual CPU configurations
- A memory hierarchy using:
 - An instruction stack
 - Interleaved central memory
 - Extended core storage

* DISTRIBUTED PROCESSING: The allocation of each processing function to the system hardware element which can perform it most cost-effectively. In general, this results in "distributing" low level functions - like input/output - to small processors in a multi-processor system, reserving the powerful central processor for productive computation and complex or time-critical operations.

- Multiprocessing supported by up to 20 peripheral processing units and 24 I/O channels.
- A new high performance disk system
- Programmable peripheral controllers
- First of a new family of terminals and I/O stations
- Advanced software concepts to support CYBER 70 features.

The use of programmable controllers, peripheral processing units, and stations allow processing or control functions to be distributed to elements in the system where they can be accomplished most cost effectively.

The product line achieves new levels of reliability and availability.

Key factors in achieving these levels are the use of:

- Hardware error checking
- On-line diagnostics for maximum availability
- Automatic error logging to pinpoint maintenance actions
- Graceful degradation of software and hardware
- Off-line maintenance of peripherals
- Advanced error recovery procedures
- Functional redundancy of hardware elements

Control Data's CYBER 70 is the first in the industry to offer a method of integrating fixed and variable costs for computing capacity by using the link to the CYBERNET Service Network.

In the following sections the advantages of CYBER 70 hardware, software and total services will be described.

2.0 CYBER 70 HARDWARE ELEMENTS

The CYBER 70 series has seven software-compatible basic models to cover the range from basic medium-scale computing requirements, through the largest-scale needs of the CDC 7600 user. Section 2.1 describes these seven basic models. The remaining description in these sections focuses on the six lower models, since the CYBER 70 Model 76 is exactly the CDC 7600, and all 7600 hardware and software specifications apply.

Section 2.2 describes main and augmented core storage options (Central Memory, and Extended Core Storage).

Section 2.3 describes input/output in terms of PPU and data channel options, and the data paths available.

Section 2.4 describes new CPU instructions and other enhancements.

Section 2.5 describes new stations and subsystems, including new interactive and remote terminals, and the high-performance 844-2 Disk Storage Unit.

Configurator information is in Section 2.6.

2.1 Basic Models

The seven basic models of the CYBER 70 are summarized in Table 1.

Model numbering is of the form 7X - YZ

where X = 2, 3, 4 or 6 - the CPU model

Y = 1 or 2 - number of CPU's

Z = memory option designator; number of 16K modules
of main core for models 72, 73, 74 and main/
augmented core combination for Model 76.

Z	Model 72, 73, 74	Model 76	
	Central Memory	SCM	LCM
2	32,768	32,768	256,000
3	49,152	-	-
4	65,536	65,536	256,000
6	98,304	32,768	512,000
8	131,072	65,536	512,000

There are four different CPU's, differing in computation speed and structural detail. The 72-2Z, 73-2Z and 74-2Z are models with dual CPU's; in the model 74-2Z, one CPU is a 74 type and the other a 73 type. The lower six models' instruction sets are supersets of the 6000 series instruction set. The model 76 is the CDC 7600, with an instruction set which is upward compatible from that of the lower six.

The approximate relative speeds of the CYBER 70 models are indicated below, in millions-of-instructions per second (MIPS):

<u>Model</u>	<u>Single CPU</u>	<u>Dual CPU</u>
72	0.9	1.5
73	1.2	2.0
74	3.0	3.7
76	15.0	-

All seven models are source code compatible at the COMPASS assembly language level, and are similarly compatible at the compiler source code level except for certain efficiency features.

Table 1 emphasizes the hierarchic organization of storage in the CYBER 70 series. This is further illustrated in Table 2. The total system storage is utilized in various ways to apply each storage level's cost/performance characteristics, so as to maximize total system performance for a given storage configuration tailored to the processing and cost requirements.

In addition to the storage involved in the primary streams of instructions and data, the CYBER 70's distributed processing employs ancillary storage apart from the primary hierarchy in performing I/O, communications management and operating system functions. This ancillary storage is contained in the system's PPU's, and in the programmable stations and controllers of the 844 Disk Storage Unit and of the new Data Communications Subsystem. In comparing a CYBER 70 with other computer systems, the CYBER 70's ancillary storage should not be overlooked in describing its total storage resources. In most competitive systems, primary storage is required to serve the operating system functions distributed away from the CYBER 70's primary storage.

CYBER 70 MODEL NO.	NO. OF CPU'S	SELECTED CPU (1) FEATURES	NO. OF PPU'S	NO. OF DATA CHANNELS	MAIN CORE STORAGE		AUGMENTED CORE STORAGE		ROTATING MASS STORAGE DEVICES
					CYCLE TIME	SIZE OPTIONS	CYCLE TIME	SIZE OPTIONS	
1. 72-1Z	1	ILR C/M IM	10, 14, 17, or 20	12, 18, 21, or 24 (paired with PPU option)	1.0 μ s per 60-bit word. Rate up to 0.1 μ s . per 60-bit word through bank phasing.	32,768 49,152 65,536 98,304 or 131,037 (60-bit words)	3.2 μ s per 480-bit record plus parity. Rate up to 0.1 μ s per 60-bit word through bank phasing.	0 125,952 251,904 503,808 1,007,616 or 2,015,232 (60-bit words).	844 Disk Storage Unit
2. 72-2Z	2	CEJ/MEJ CMAP							
3. 73-1Z	1								
4. 73-2Z	2								
5. 74-1Z	1	IRL IM CEJ/MEJ CMAP							
6. 74-2Z		Instruc- tion Stack							
7. 76-YZ	1		6 to 13	7, 11, or 15	275 ns. per 60- bit words. Rate up . to 27.5 ns per 60-bit word through bank phasing.	32,768 or 65,536 (60-bit words)	1.76 μ s per 480-bit record, plus parity. Rate up to 27.5 ns per 60-bit record through bank phasing.	256,000 or 512,000 (60-bit words)	7638 Disk 844 Disk Storage Unit

(1) See Section 2.4 for descriptions of ILR (Interlock Register), C/M (Compare/Move, new character string instructions), IM (Integer Multiply instruction), CEJ/MEJ (monitor exchange jump instruction feature), and CMAP (Central Memory Access Priority feature).

TABLE 1. Summary of CYBER 70 Models

<u>LEVEL</u>	<u>STORAGE</u>	<u>FUNCTION</u>	<u>CYBER 70 MODELS</u>
1.	Instruction Stack - 60-Bit	Holds instructions to direct concurrent operations in the multiple arithmetic/logical functional units. Managed by hardware, fetching from main core storage.	76 (12-48 instructions) 74 (8-32 instructions)
2.	Operating Registers - 18- and 60-bit	Hold addresses, operands and increments (index quantities) to minimize main core storage references by CPU computing functional units. Managed by hardware, directed by software setting of address and index registers.	All (eight 60-bit and sixteen 18-bit registers per CPU)
3.	Main Core Storage - 60-bit	Holds instructions and data of executing programs, and some operating system elements. Transfers, by software, are to/from Augmented Core Storage, and (except Model 76) via PPU to/from mass storage and peripherals.	76 (275 ns. Small Core Memory, SCM) 74, 73, 72 (1.0 μ s. Central Memory, CM)
4.	Augmented Core Storage - 480-bit plus parity	Holds data for executing programs, programs scheduled for execution, data files and buffers, and many operating system elements. Transfers, by software, are to/from Main Core Storage, and via PPU to/from mass storage.	76 (1.76 μ s, Large Core Memory, LCM) 74, 73, 72 (optional; 3.2 μ s. Extended Core Storage, ECS)
5.	Rotating Mass Storage	Holds on-line resident data files, libraries of user and system software programs, and files being staged by the operating system between higher level storage and external devices.	All (See Table 1)
6.	Off-line storage	Disk packs, and conventional magnetic tape and unit record media and devices.	All

TABLE 2. Primary Storage Hierarchy of CYBER 70 Systems

2.2 CYBER 70 Core Storage - Models 72, 73, 74

CYBER 70 systems offer two types of core storage:

Central Memory (CM), and
Extended Core Storage (ECS) - recommended option

Central Memory provides a fast, random storage for executing programs and data, while the larger ECS is used for I/O buffering, containing large data arrays, and to support job-swapping and other operating system service functions. ECS is optional on all three models. The following describes the characteristics of CM and ECS. The storage size options for each are summarized in Tables 3 and 4.

- **CENTRAL MEMORY (CM)** - the CYBER 70 Central Memory is composed of banks of 4096 sixty-bit words of core storage. The complete cycle time for one bank is one microsecond (1^{μ} s). The banks are phased so that successive addresses are in different banks, to permit operation of CM at a much higher rate than the basic bank cycle time. The maximum transfer rate is one 60-bit word per 100 nanoseconds.

CM is available in sizes ranging from 32,768 words (eight banks) to 131,037 words (32 banks). (See Table 3). The large number of banks in CM minimizes memory access conflicts; therefore, CM is highly effective for fetching instructions and accessing random data items at very high rates.

There are three access paths to CM:

- CPU(s)/CM
- ECS/CM
- PPU(s)/CM

CM includes a control section which provides service to each of these access paths on a priority basis, queues access requests if necessary, and resolves any access conflicts.

- EXTENDED CORE STORAGE (ECS) - The optional ECS subsystem comprises the Extended Core Storage, its controller, and one or more Distributive Data Paths (DDP's) attached to I/O channels.

The CYBER 70 ECS is composed of banks of 125,952 sixty-bit words of core storage. Eight 60-bit words are contained in a 488-bit physical ECS word. Each 60-bit word has an associated parity bit in the ECS word. The complete cycle time for one bank of ECS is 3.2 microseconds per 488-bit ECS word.

In multiple bank ECS subsystems, banks are phased in a way such that consecutive eight-word records come from different banks. This phasing, combined with the wide (eight-word) access span make very fast transfers to or from ECS possible. After the initial access, ECS can transfer at a rate of one 60-bit word per 100 nanoseconds.

This gives a maximum rate of 600 million bits per second. This means that CM/ECS transfers can occur at up to the maximum transfer rate of Central Memory.¹

ECS is available in sizes ranging from 125,952 (one bank) to 2,015,232 words (16 banks). (See Table 4). The very fast transfer rates and short access time of ECS makes it ideal for use as a buffer between CM and rotating mass storage devices, as a high speed program swapping device, and for storage of large data arrays and of frequently used programs and system routines.

There are two access paths to ECS:

- CM/ECS
- I/O Channel/ECS via DDP

1. These maximum rates are attained in configurations with 65K or more of CM and 500K or more of ECS.

TABLE 3
CENTRAL MEMORY OPTIONS
Model 72, 73, 74

Option Designator (Z)	CM Size (60-bit Words)	Number of Banks
2	32,768	8
3	49,152	12
4	65,536	16
6	98,304	24
8	131,037	32

TABLE 4
EXTENDED CORE STORAGE OPTIONS
Model 72, 73, 74

ECS Size (60-bit Words)	Number of Banks
125,952	1
251,904	2
503,808	4
1,007,616	8
2,015,232	16

TABLE 5
PPU-I/O CHANNEL OPTIONS
Model 72, 73, 74

Number of PPUs	Number of I/O Channels
10	12
14	18
17	21
20	24

The ECS controller has four ports. CM is always attached to one of them. Another CYBER 70 system's CM may be connected to a second port, which permits configurations consisting of two CYBER 70 processors sharing (and communicating through) a common ECS subsystem.

The Distributive Data Path (DDP) provides a new path of data flow between ECS and the rest of the system. It allows fast PPU access to data in ECS via an I/O channel, and greatly reduces the data traffic through the central memory. This will reduce central memory conflicts and also reduce the overhead of the operating system. The DDP consists of a 480-bit buffer register attached to a channel. Options allow expanding a DDP to four registers. Each register connects to a standard input/output channel for maximum overlap of data transfer. All four registers share a single access to ECS. This arrangement allows up to four PPU's to transfer data to ECS at nearly the maximum data rate of the PPU's - a block transfer rate of approximately 43/μs. per 480-bit ECS word.

Two additional DDP's may be attached to ECS access ports in a single computer configuration.

In a multi-computer configuration, separate CYBER 70 systems can share ECS through both CM/ECS and I/O channel/ECS (via DDP) access paths.

Because ECS is such a key element in CYBER 70 systems, the integrity, reliability and maintainability of this subsystem have been stressed. These characteristics are attained by the following means:

- Parity Generation/Checking. There is one parity bit for each 60-bit word in ECS.
- Reserve Storage. Each bank of ECS has a reserve memory of 5K words. This assures that the full 125K words of a bank will be available even though the bank may develop some degraded locations. Exchanging a reserve increment of 1K requires only a minor maintenance action by the customer engineer.
- Half Memory Operation. In ECS subsystems which contain two, eight or 16 banks, either half of ECS can be operated in maintenance mode, leaving the other half available to the system. This permits the system to continue running uninterrupted while a portion of ECS is being maintained.
- Standard software provides for alternate means to continue processing should one or more components of the ECS subsystem become unavailable.

2.3 CYBER 70 Input/Output - Models 72, 73, 74

I/O for CYBER 70 processors is handled by a number of Peripheral Processing Units (PPUs). Each PPU has its own 4096 (12-bit) word core storage and working registers. The cycle time of this memory is one microsecond.

Each PPU may connect to any of the system's high-speed data channels. The number of channels present depends upon the PPU option selected. The number of channels for each PPU option is shown in Table 5. The width of a channel is 12 bits. Transfers over a channel can occur at a maximum rate of one 12-bit word per microsecond or twelve million bits/second.

PPU's are ideally suited for performing logical and control operations. In performing these functions, the PPU's must communicate with various devices:

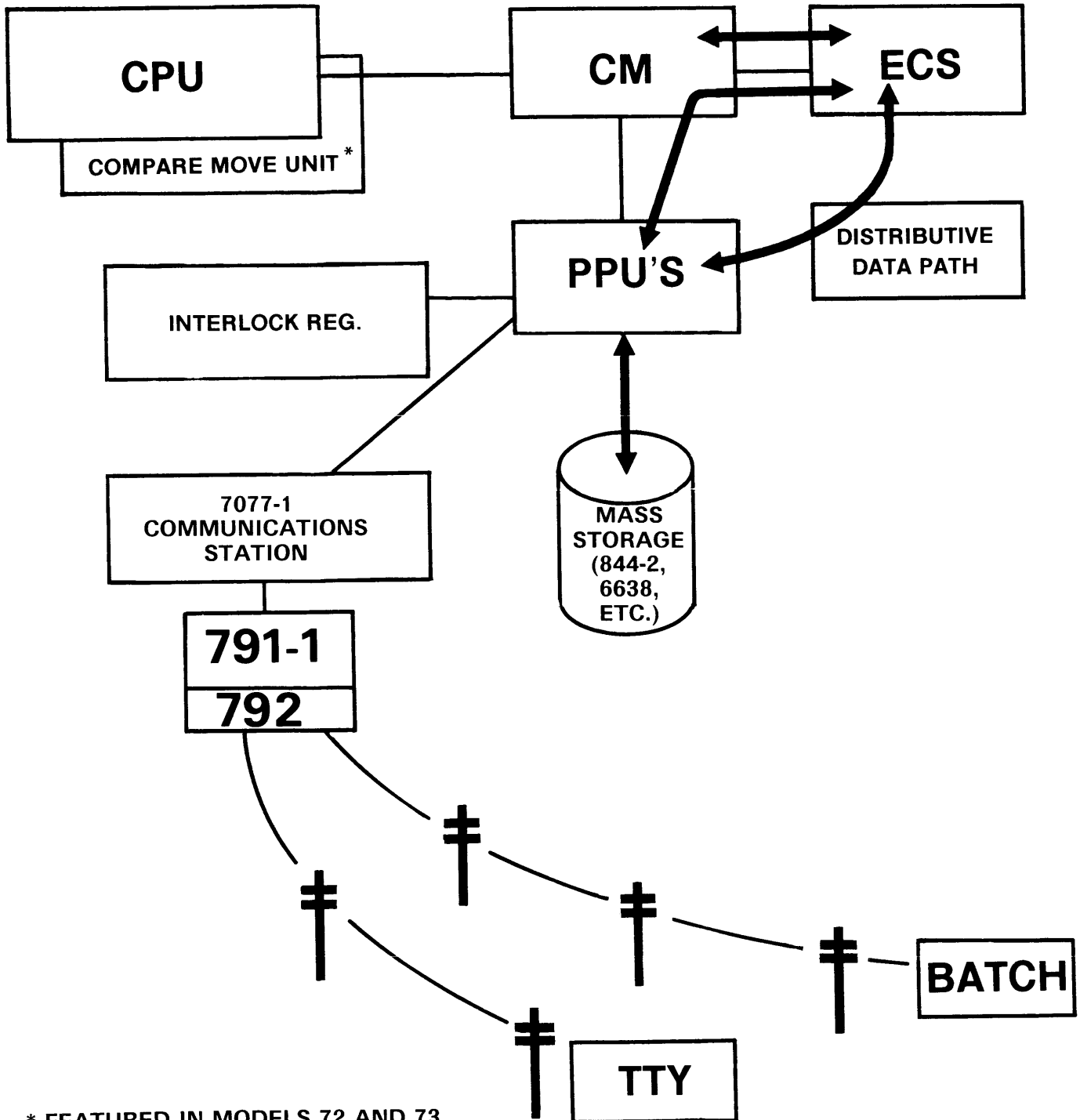
- For Control:
 - With the CPU for exchange control
 - With equipment controllers for I/O control
 - With the ECS subsystem for PPU/ECS transfers
 - With the Interlock Register (See Section 2.4) for inter-PPU coordination.

- Data Paths:
 - PPU/channel/equipment controllers
 /ECS (via the Distributive Data Path)
 /PPU
 - PPU/CM

Figure 1 shows a schematic example of CYBER 70 communications and control paths, and is a functional block diagram.

CYBER 70

MODEL 72, 73, 74



* FEATURED IN MODELS 72 AND 73

FIG. 1

2.4 CYBER 70 Enhancements - Models 72, 73, 74

Each of the CYBER 70 systems is upward compatible from the standard 6000 series, but each contains additional features as follows:

- Interlock Register (LR)
- Compare/Move (C/M) instructions - Models 72 and 73 only
- Integer Multiply (IM) instruction
- Monitor Exchange Jump (XJ, MXN, MAN) instructions
- Central Memory Access Priority (CMAP)
- Instruction Stack Operations - Model 74 only

Each of these features is briefly discussed below.

- The Interlock Register (ILR) is a 64-bit register (optional 128-bit register) which is accessed by PPU's through the interlock channel (15₈). Any PPU may function the ILR to perform the following operations on any bit in the ILR:

- Test
- Set
- Test and Set

The ILR is used to provide a hardware interlocking capability for I/O channel reservations, and various other software system interlocks and interprocessor communications. The advantages are lower system overhead, faster response to system requests and fewer CM access conflicts.

- Compare/Move instructions are provided on serial processing models of the CYBER 70 series (Models 72 and 73). Its function is to provide high speed operations on character strings. Four new instructions are implemented in the CMU:

- MOVE DIRECT, moves up to 127 6-bit bytes from one location to another in Central Memory. (The character string moved need not begin or end on a word boundary).
- MOVE INDIRECT, moves up to 8191 bytes. The instruction contains the address in CM of the word which contains the move parameters.
- COMPARE, performs an arithmetic comparison of two character strings in CM. The byte position of the first unequal byte pair is returned in register X0, with the sign of this count indicating high or low comparison.
- COMPARE COLLATED, compares two character strings via a table look-up. Register A0 contains the address of the table in CM used to provide the bytes collating sequence. The comparison is then carried out as above, except the collating bytes are used for comparison.
- The Integer Multiply instruction is an extension of the capability of the Double Precision Floating Multiply (42) instruction. When both operands contain a zero exponent (+ or -), the execution of this instruction will produce their integer product. This capability provides faster and more convenient short integer arithmetic. Integer Multiply is particularly advantageous for FORTRAN programs which have complex integer and/or indexing calculations.
- The Monitor Exchange Jump instructions (XJ, MXN, MAN) exchange the CPU depending upon the condition of the CP monitor flag. These features provide for flexible control of the CPU which facilitates its use for monitor functions. This is particularly advantageous in the optimum use of Extended Core Storage subsystems.

- The Central Memory Access Priority (CMAP) feature permits a designated PP preference over non-priority PPU's for Central Memory reads and writes. This feature also ensures that CM-ECS transfers are maintained at the maximum rates for the given configuration.
- The instruction stack of the CYBER 70 Model 74 operates like that of the CDC 6600. Faster execution is effected by fetching P+2 as well as P+1 when bringing instructions from CM to the instruction stack; by a new optimization of the reservation network for operating registers and functional units; and by faster execution of certain branch instructions.

2.5 Stations, Subsystems and Terminals

The system elements described in this section exemplify the "distributed processing" concept which is fundamental to the CYBER 70 Series. Peripheral equipment can be attached to the CYBER 70 models through stations, or directly through controllers and peripheral processors. The use of stations provides the following advantages:

- . Separation of peripheral equipment handling from computation, thus reducing the dedication of expensive mainfram resources for I/O management.
- . Distribution of peripheral equipment to operationally convenient clusters.
- . Distribution of access to the computer to remote and local stations.

2.5.1 The following section describes the new:

- . 7611-10 Service Station
- . 7054-7654/844-2 Disk Storage Unit and Controllers
- . CYBER 70/Models 72, 73, and 74 as stations to the Model 76
- . 7077-1 Communications Station
- . 791-1 Communications Subsystem
- . 733-10 High Speed Batch Station with its option 733-130 (50K bps data set adapter) for making it a remote High Speed Batch Terminal

7611-10 Service Station

The 7611-10 Service Station provides increased flexibility for the CYBER 70/76 in handling unit record and communication requirements. The 7611-10 consists of the following equipment:

- 1) Service Station Processor
- 2) Display
- 3) Entry Keyboard
- 4) Interface coupler for a MODEL 76 first level PPU
- 5) 8,192 bytes of 200 nanosecond 8-bit byte memory
- 6) 32,768 bytes of 1.1 microsecond 8-bit byte memory
- 7) 8 million bits of 8 millisecond average access microdrum storage (2 drums)
- 8) 3 full duplex I/O channels, of which 2 are available to the user.

Service Station Expansion 10263-1

Consists of:

- 1) 32,768 bytes of 1.1 microsecond memory
- 2) 8 million bits of microdrum storage
- 3) 3 full duplex I/O Channels

The basic station configuration can support up to 10 data streams. With the Service Station Expansion 10263-1, this increases to 20 data streams. A data stream is defined as a unit record device - a card reader, card punch or line printer.

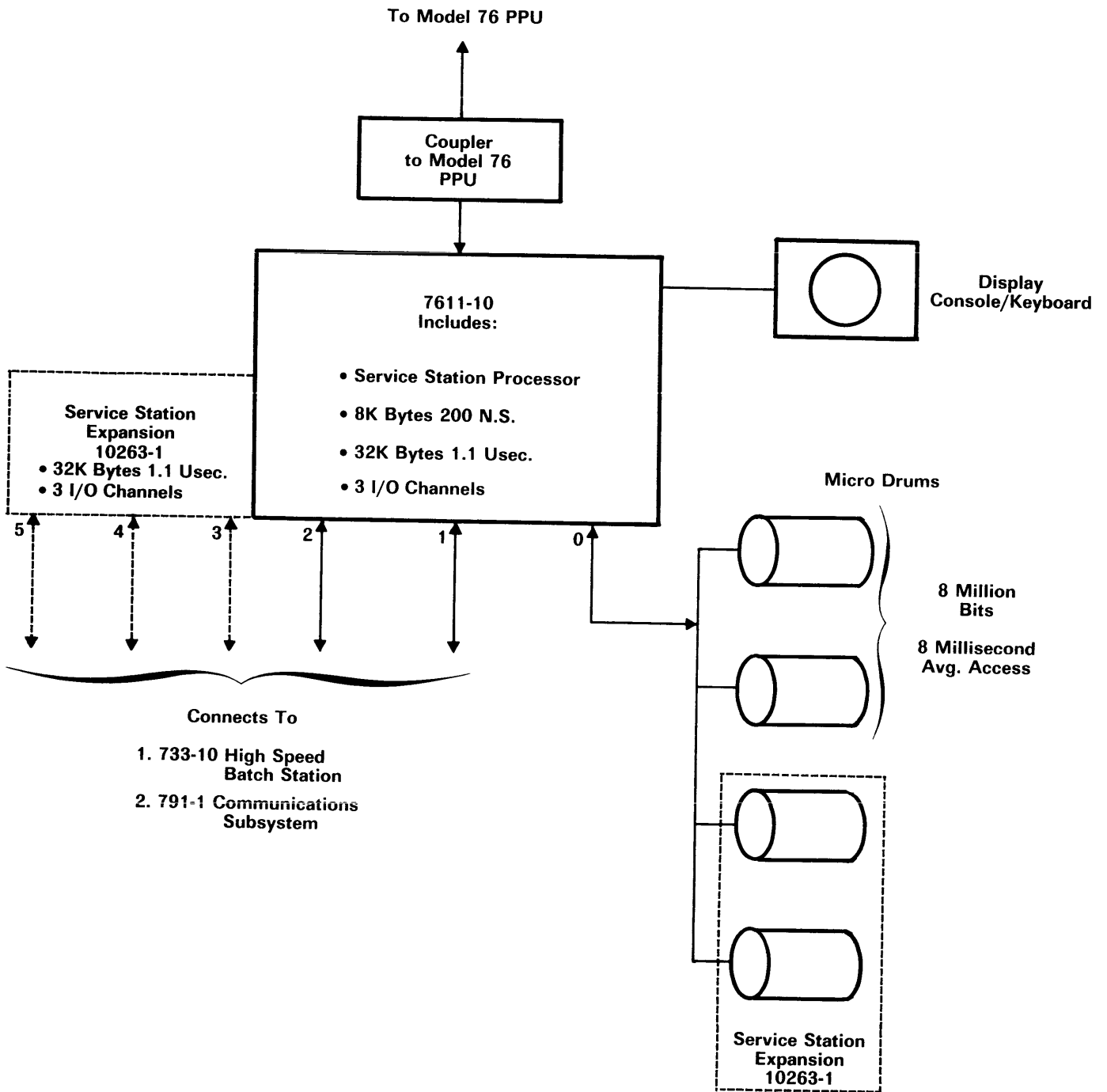
The following devices can be connected to the 7611-10's available I/O channels:

- 1) 733-10 High Speed Batch Station (H.S.B.S.) which provides the local unit record capability. With the addition of Option 733-130 (50K bps data set adapter) to the 733-10 HSBS, it now becomes a Remote High Speed Batch Terminal which can communicate to a 791-1 Communication Subsystem.

- 2) 791-1 Communications Subsystem provides a programmable communications multiplexer that can support up to 48 mixed full duplex lines with rates from 75 to 50,000 bits per second.

Both the 733-10 with its 733-130 option and 791-1 are explained in greater detail later in this section.

The 7611-10 replaces the Unit Record Communication Station defined in the 7600 Product Announcement and Corporate Pricing Manual which consists of the following equipment: 7641-1, 7642-1, 7643-1, 7653-1-2-3 and 10186. The 7611-10 (available First Quarter 1972), 733-10 and 791-1 will be supported under SCOPE 2.0, providing local and remote job entry similar to Export/Import.



- *Service Station Expansion 10263-1**
- 32K Bytes of 1.1 Usec. Memory
 - 8 Million bits of Micro Drum Storage (2 drums)
 - 3 Full Duplex I/O Channels

844-2 Disk Storage Unit Subsystem (DSU)

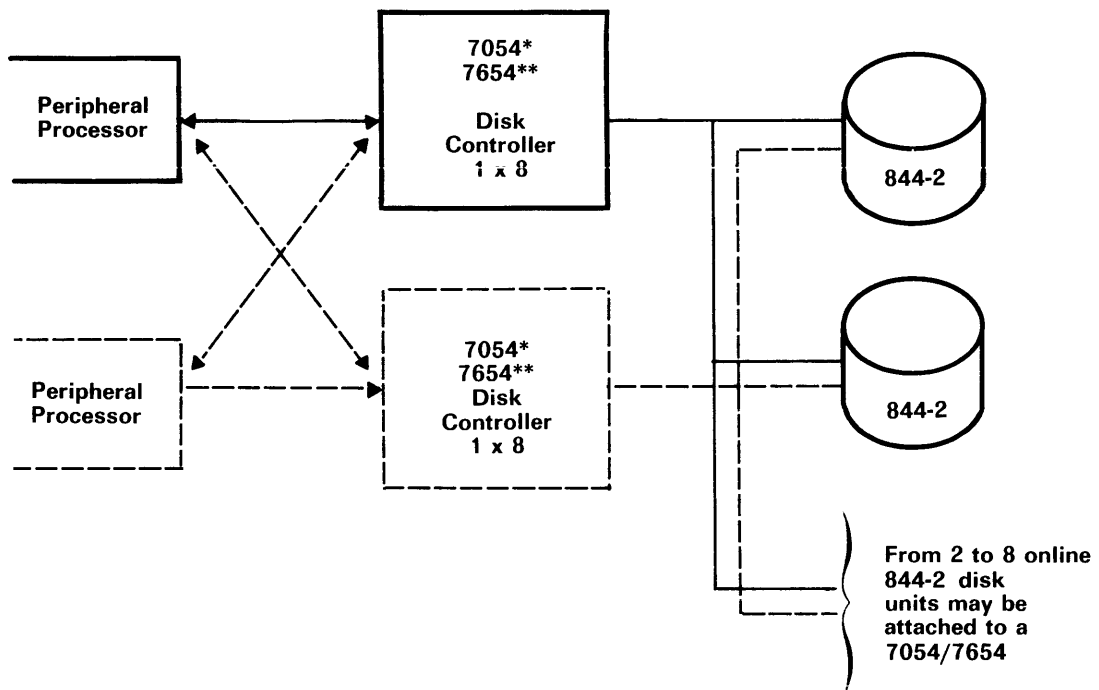
The 844-2 Disk Storage Unit and the 7054 and 7654 Controllers are CDC's latest announcements in high performance removable disk pack, large capacity random access storage devices. The 844-2 system has the following features:

- 1) 708 million bits per pack spindle
- 2) Transfer rate of 1.3 million bits/second
- 3) Average arm access time of 30 milliseconds
- 4) Average latency 8.3 milliseconds
- 5) Dual channel capabilities

The basic 844-2 is a single spindle with dual access capability. The minimum system contains two 844-2's (1.4 billion bits) and is upgradeable by single units to a maximum of eight 844-2's (5.7 billion bits).

The 7054 Disk Storage Controller is used when configuring 6000 Series and Model 72, 73 and 74 CYBER Systems. It will be supported under SCOPE 3.4.1. The 7654 Disk Storage Controller is used on the 7600 and Model 76 Systems. It will be supported under SCOPE 2.X. The 844-2 Disk Storage Unit and the 7654 Controller replace the MDD Station defined in the 7600 Product Announcement, which consists of the 7653-1 Mass Storage Controller and the 841 Disk Storage Unit.

844-2/7054-7654

DISK STORAGE UNIT AND CONTROLLERS

*Model used with CYBER 70 Models 72, 73, & 74

**Model used with CYBER 70 Model 76

NOTE: Second PPU and controller is optional but recommended when used as a system disk.

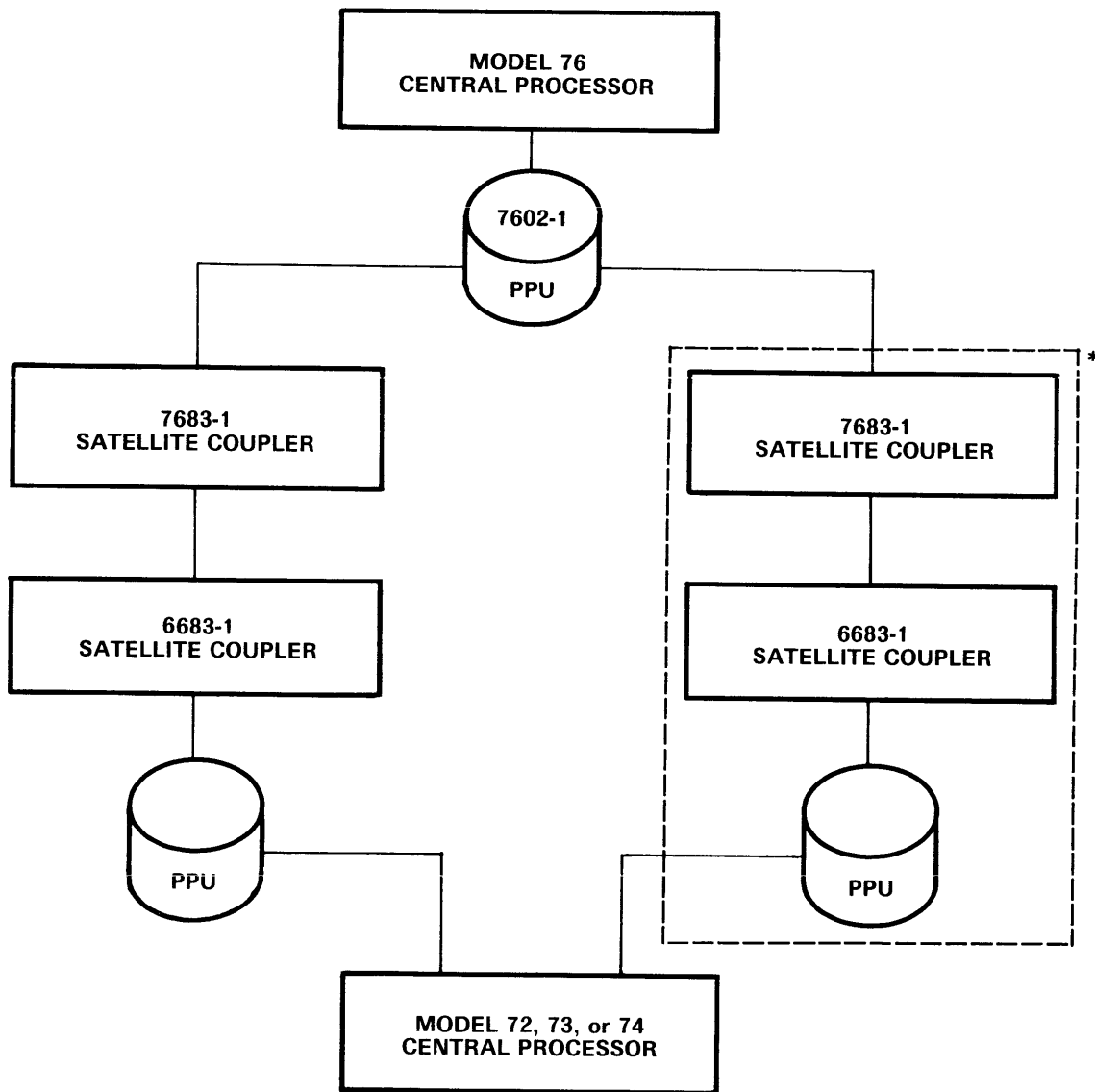
Models 72/73/74 as Station to Model 76

The CYBER 70 Models 72, 73, and 74 when connected to the Model 76 through a 6683/7683 Coupler can be used as a station providing the following capabilities:

- 1) Local and remote batch processing
- 2) Interactive processing including TTY, CRT, and graphics
- 3) Back-up computing power for the Model 76
- 4) Data management and communications functions through products such as SCOPE Indexed Sequential, MARS VI, INTERCOM IV, and Query/Update.

Scope 2.0 will fully support the CYBER Models 72, 73, and 74 as stations to the CYBER Model 76.

**CYBER MODEL 72, 73 or 74
AS A STATION TO A MODEL 76**



*Optional

7077-1 Communications Station

The 7077-1 Communications Station connected to a Model 72, 73 or 74 PPU can support up to three 791-1 Communications Subsystems, giving it the capability of handling up to 144 communication channels. It also provides 16,384 bytes of 1.1 microsecond core memory which is used for I/O buffers. As 791-1's are added, this memory must be expanded to handle the increased load. Using memory module 10262-1, 2, 3, options, this memory can be expanded up to a maximum of 65,536 bytes in increments of 16,384 bytes.

The 791-1 Communications Subsystem is a programmable unit which provides the capability of connecting multiple communication line of different types and speeds to a Model 72, 73, or 74 through a 7077-1 Communications Station, or to a Model 76 through a 7611-10 Service Station.

The 791-1 contains 8,192 bytes of core memory with a cycle time of 200 nanoseconds, a cyclic encoder unit, and control logic to support expansion up to 48 full duplex communication lines. The memory can be increased to a maximum of 16,384 bytes by addition of the 10274-1 Memory Module.

The 791-1 provides capability to connect up to 16 full duplex communication lines via the 792 communication adapters which are mounted in the 791-1. Line expansion is through the 8-line communication modules 791-2, 3, 4 and 5, which give an additional 32 full duplex lines that may be added to the basic 16 lines. Line speeds may vary from 75 to 50,000 bps and the transmission mode may be half- or full-duplex.

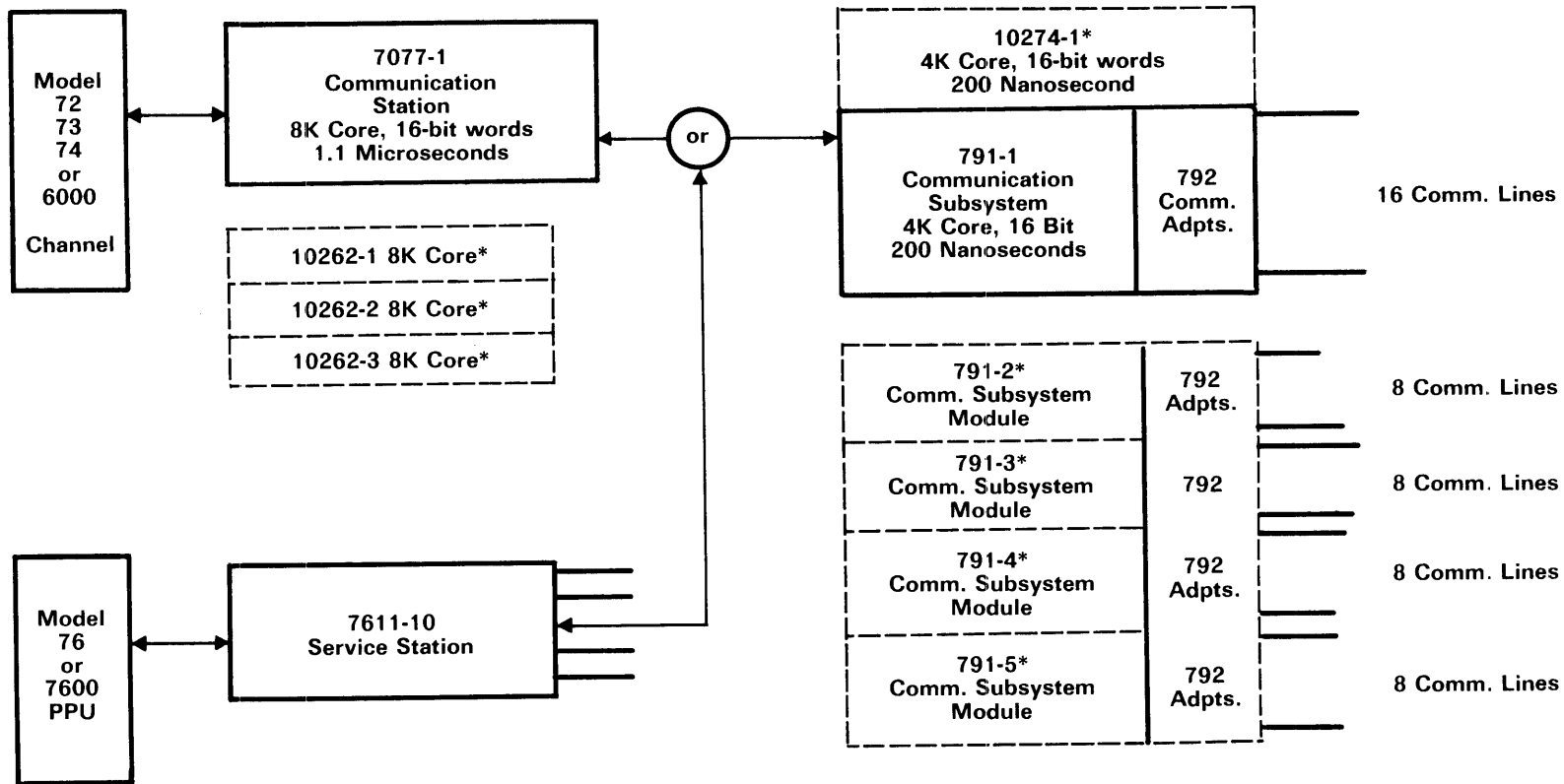
Although the 791-1 with its associated 791-2, 3, 4 and 5 modules can interface up to 48 communication lines, via the 792 Communication Adapters, the total number of lines that can be serviced is dependent upon the type and speed of the lines.

When the lines are of identical speed and type, the 791-1 supports up to:

4	-	50,000	full duplex bps lines
10	-	19,200	" " " "
16	-	9,600	" " " "
32	-	4,800	" " " "
48	-	2,400	" " " "

The 791-1 presents one interface to the 7077-1 communications station or the 7611-10 service station processor through which the data is sent to or received from the CYBER 70 Model. By performing these communications tasks, the 791-1 frees up the CYBER 70 PPU time and memory which can be applied to more productive processing. The modular design and flexibility offered by the 791-1 allows the user to begin with a small number of remote terminals and expand, in small economic increments, to encompass a large number and variety of terminals as may be required.

7077-1 COMMUNICATIONS STATION & 791-1 COMMUNICATIONS SUBSYSTEM



791 Capability
 4 — 50,000 FDX bps lines
 10 — 19,200 FDX bps lines
 16 — 9,600 FDX bps lines
 32 — 4,800 FDX bps lines
 48 — 2,400 FDX bps lines

Comm. Adapters
 792-1 = 75 to 1800 bps asynch.
 792-2 = 2000, 2400, 4800
 and 9600 bps asynch.
 792-3 = 19,200, 40,800,
 50,000 bps asynch.
 792-10 = Automatic Dialer Unit

*Optional hardware for increased
 capability and communication equipment support.

The 733-10 High Speed Batch Station

This station which is the first of a family of batch stations and terminals provides for flexible support of high speed unit record equipment. This programmable station, supplied with standard firmware, directly drives the peripheral equipment. The basic station consists of: 8192 bytes of 200 nanosecond memory, a microdrum for station system use, a 1200 LPM line printer, and a 1200 CPM card reader. The station can be expanded to support an additional four devices plus a Keyboard/Display (733-15X). The devices are shown below and can be configured in any combination, with a maximum device limitation of four line printers, two card readers, one card punch, and one data set adapter (used for terminal option only). The 733-15X Keyboard/Display option can be added to any terminal configuration.

733-110 - Line Printer (1200 LPM)

733-120 - Card Reader (1200 CPM)

733-101 - Punch (250 CPM)

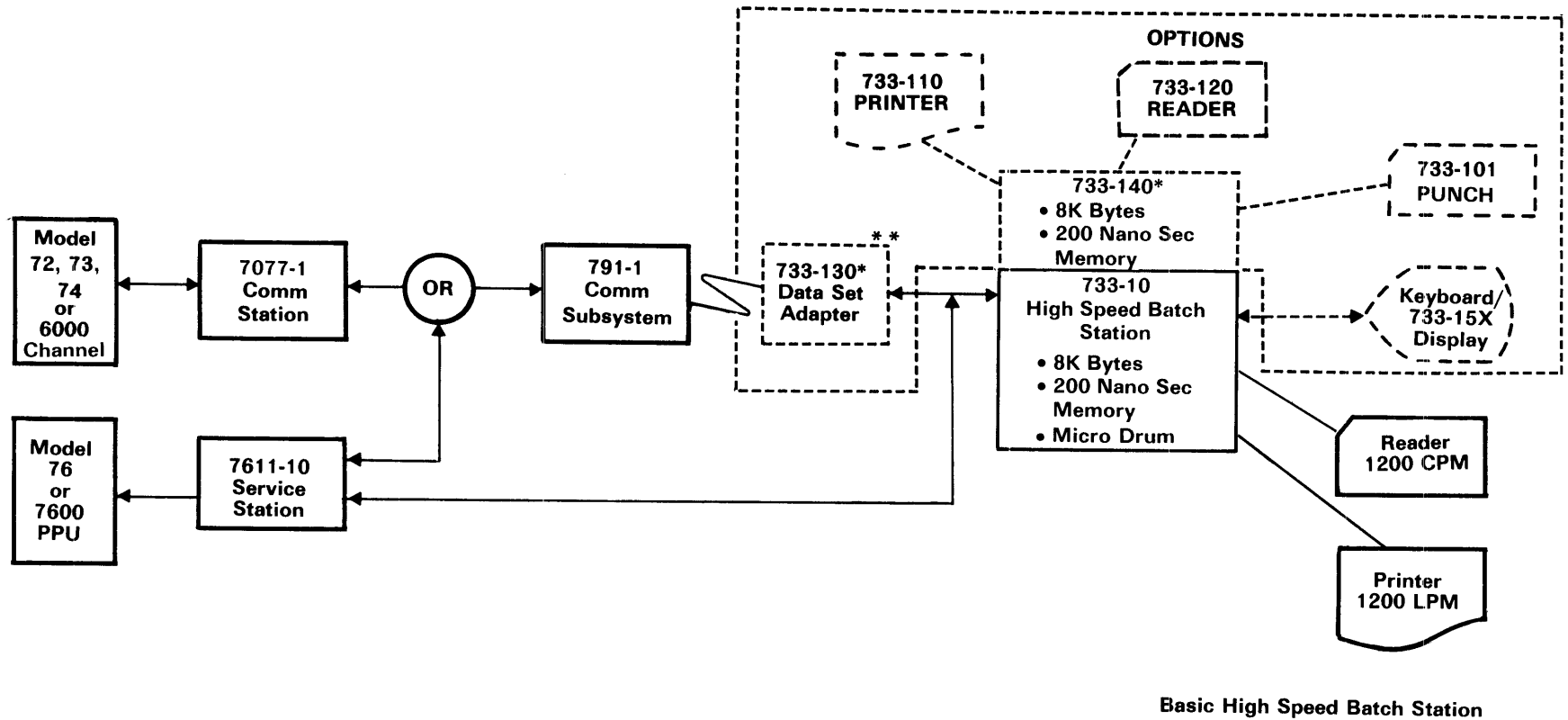
733-130 - Data Set Adapter

The High Speed Batch Station can drive simultaneously any four devices at full rated speed. If more than four devices are connected, degraded operation will result if all are running simultaneously.

With Option 733-130 Data Set Adapter (50,000 bps) the 733-10 becomes a High Speed Batch Terminal. A 733-15X Keyboard/Display is available in the terminal configuration.

The addition of options 733-101, 733-110 or 733-120 to the basic station, in any combination, requires the Memory Increment Option 733-140.

On the CYBER Models 72, 73 and 74, the 733-10 requires options 733-130 and 733-15X, and connects through the 7077-1/791-1 Communications Station. On the Model 76, the 733-10 connects directly to a channel of the 7611-10 Service Station when used in a local environment, and can be used in a remote environment by addition of Option 733-130 and 733-15X.



*Option 733-140 (8K bytes of 200 nonosecond memory) must be added to the station if it is to support more than 2 peripheral devices.

**Optional 733-130 (50K bps data set adapter) must be used when the 733-10 High Speed Batch Station is used as a High Speed Batch Terminal.

2.5.2 Terminals

The following section describes the new 711 CRT Display, 712 Keyboard/Printer, and 713 Conversational Display Terminals available on the CYBER 70 Series. Note that this section is dealing only with the new terminals, and that all existing terminals supported by the 6000 Series Systems will be supported by the CDC CYBER 70 Series Systems. Included in this capability is support of other manufacturer's terminals. Reference should be made to the proper 6000 documents to obtain the descriptions for the 6000-supported terminals.

711 CRT Display Terminal

This terminal connected to a Model 72, 73, or 74 through a 6671 Communication Station in a 200 UT mode, is one of a family of low cost, stand-alone remote terminals, designed for communication with a CPU in a conversational mode over telephone lines.

This common-carrier compatibility of the 711 Terminal and its freedom from space-consuming external control units makes interactive computer-communication easy to install wherever there is a telephone outlet.

An electronically silent, standard typewriter keyboard is combined with an adding machine numerical key cluster to make the unit familiar to clerical personnel. No extensive operator training is necessary.

The sharp, easy-to-read video screen elicits operator enthusiasm and high performance levels. And a touch of a control button transmits to or retrieves from the computer upwards of 640 characters of alphanumeric data at a time.

712 Keyboard/Printer Terminal

This terminal connected to a Model 72, 73, or 74 through a 6671 Communication Station in a 200 UT mode, is one of a family of low-cost, stand-alone remote terminals, designed for communication with a CPU in a conversational mode, via telephone lines. This common-carrier compatibility feature, plus complete freedom from space-consuming external control units, makes interactive computer-communication easy to install wherever telephone facilities are available.

An electronically silent, standard typewriter keyboard is combined with an adding machine numerical key cluster to simplify operation and eliminate the need of extensive operator training.

The basic 712 Printer Terminal (30 characters per second) consists of a keyboard, an impact printer, built-in controller and interface modem. Controller circuits accommodate interaction with up to 16 additional input/output units, such as keyboard/displays and magnetic tape stations. The 712 is fully ANSI-compatible, both in control and character code.

The 713 Conversational Display

This display, connected to a Model 72, 73, or 74, through the 7077-1/791 Communications Station, replaces teletypewriter remote terminals on either leased or dial telephone lines with a fast, quiet, all electronic keyboard and CRT unit. For the expert it means 300 baud for more responsive interaction with the CPU. For operators it means easy, clank-free operation suitable to quiet, efficient office areas.

Memory sizes of 640 or 1280 characters, a fully electronic keyboard and a non-impact printer hardcopy option complement the 713's use as an interactive terminal. User personnel may take advantage of ASCII upper and lower case characters, a high-speed numeric entry cluster, 80 character lines, and inverse video (black on white) display selection.

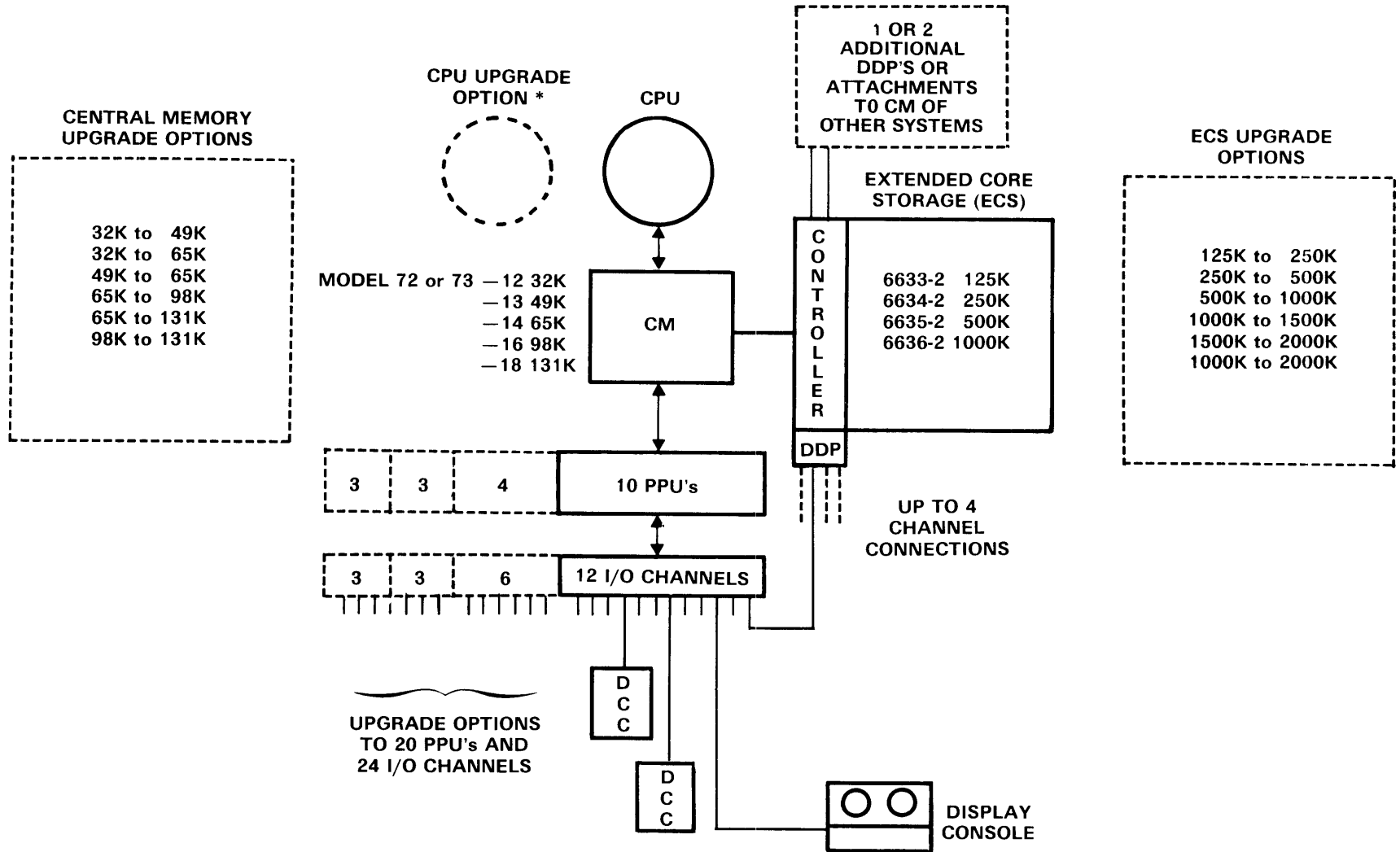
This low-cost approach to high reliability interactive data entry and retrieval stands alone with its own built-in controller, memory, and interface. It's ready for immediate use with any modem. The operator can then transmit to the CPU on either a character by character, echo-plex basis or in half duplex mode, permitting pre-transmission correction and proofreading of each entire entry onto the video screen.

Preliminary Hardware Configurators*

CYBER 70 HARDWARE CONFIGURATORS

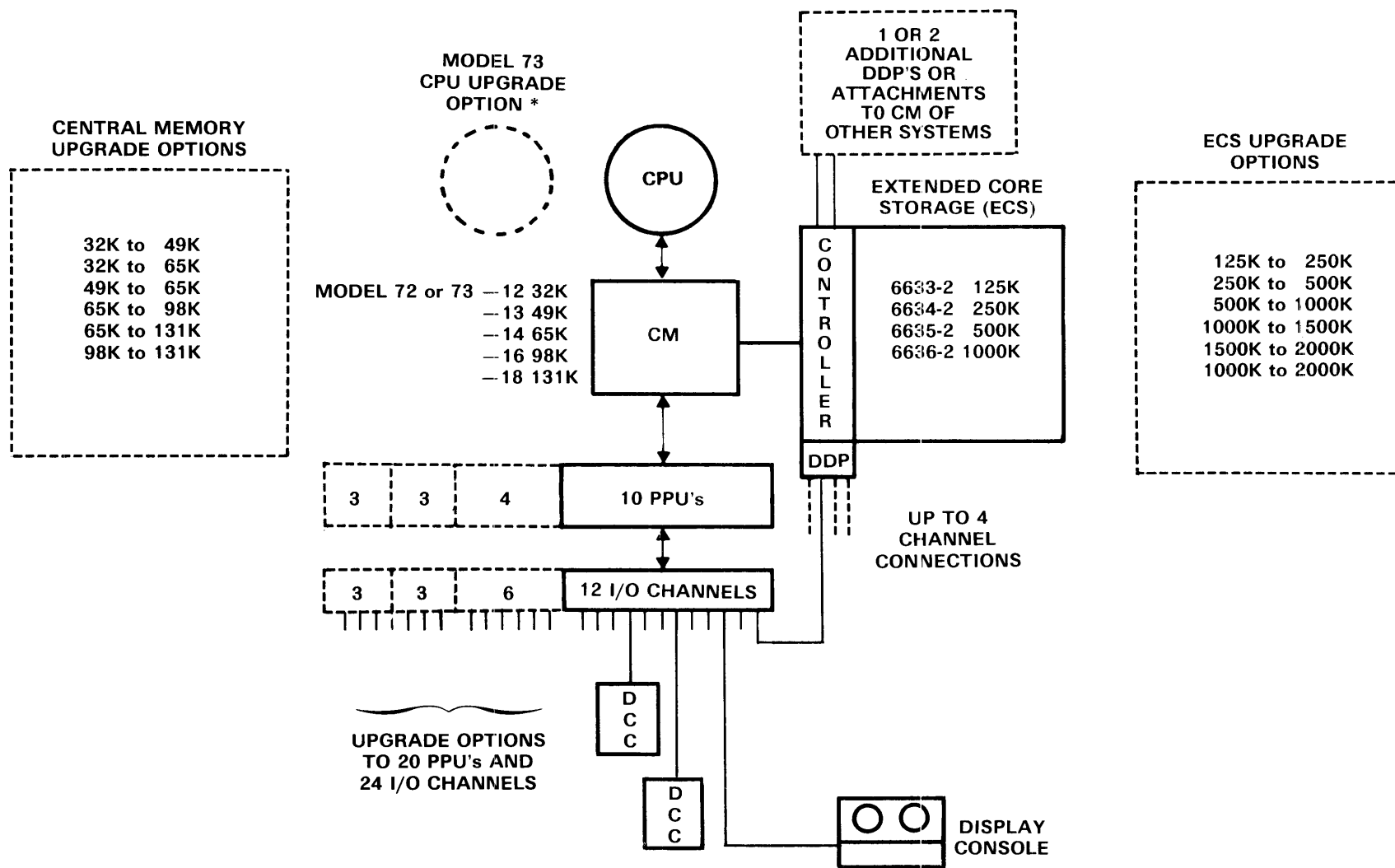
This section includes the configurators which will indicate how the Central Processors, Peripherals, Mass Storage Subsystems, Communication Subsystem, Stations, and Terminals described earlier interface to the CYBER 70 Series Models.

CYBER 70 MODEL 72 AND 73 CONFIGURATOR



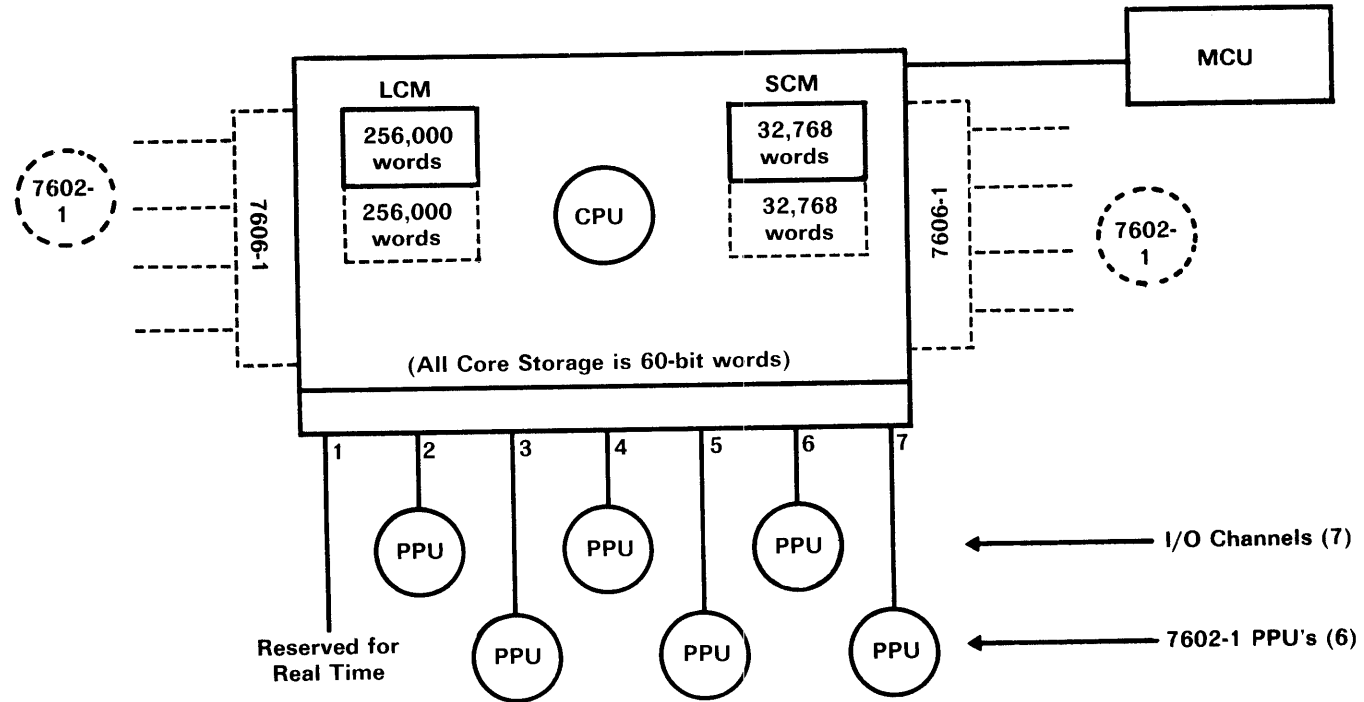
DDC — Data channel converters to allow 3000 series peripherals to interface the CYBER 70 Series
*** Minimum of 65K central memory with two CPU's**

CYBER 70 MODEL 74 CONFIGURATOR



DDC — Data channel converters to allow 3000 series peripherals to interface the CYBER 70 Series
 * Minimum of 65K central memory with two CPU's

CYBER 70 MODEL 76 CONFIGURATOR



Memory Options
7608-1
 256,000 LCM
 (Total of 512,000 LCM
 per 76 YZ)
7609-1
 32K SCM
 (Total of 65K SCM
 per 76 YZ)

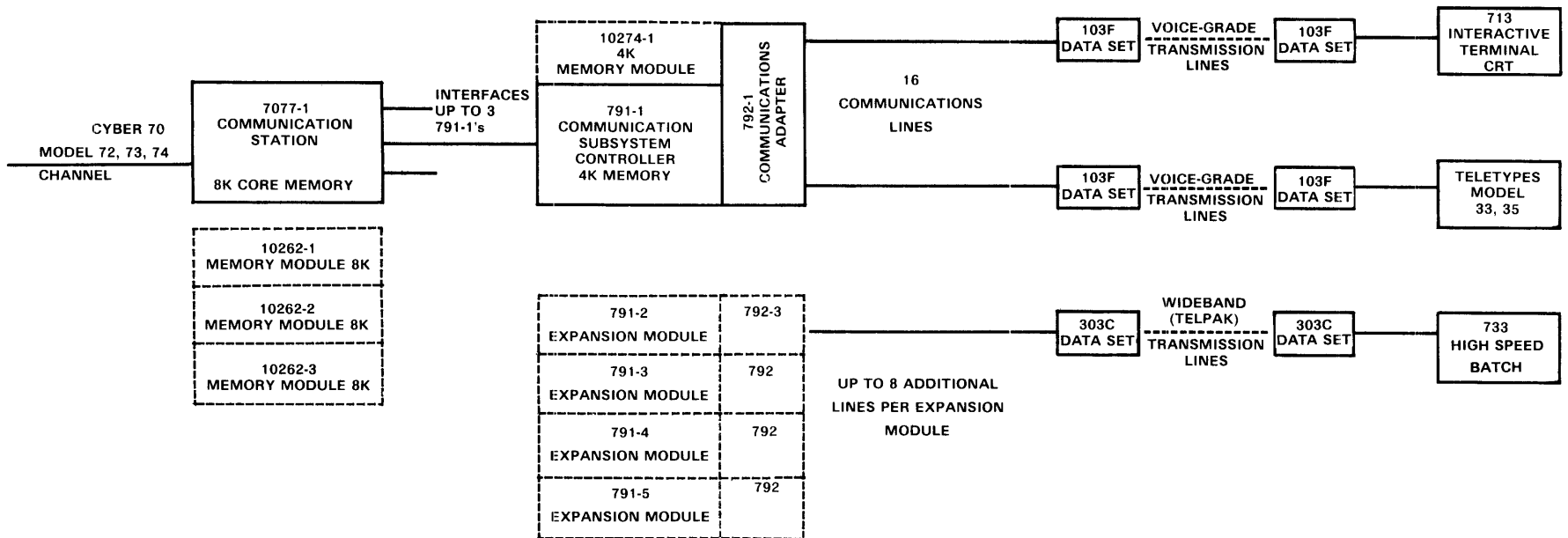
Mainframes
 76-12 (32K SCM / 256,000 LCM)
 76-14 (65K SCM / 256,000 LCM)
 76-16 (32K SCM / 512,000 LCM)
 76-18 (65K SCM / 512,000 LCM)

Each Mainframe Includes:
 • CPU
 • 7 I/O Channels
 • 6 Peripheral Processors Units (PPU)
 • Maintenance Control Unit (MCU)
 which includes:
 Card Reader
 CRT Display

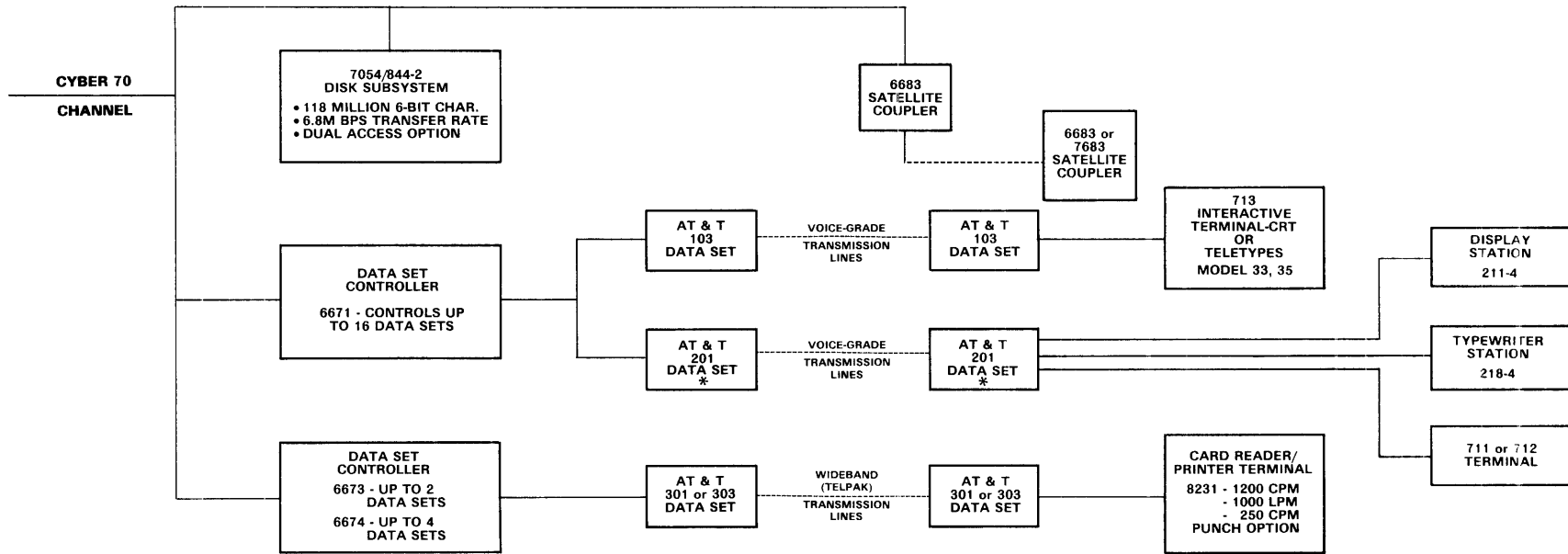
I/O Options
7606-1
 4 additional I/O
 Channels
 (Total of 15
 channels per 76 YZ)
7602-1
 PPU
 (Total of 13 PPU's
 per 76 YZ), 1 per
 I/O Channel)

*Dotted lines indicate options

CYBER 70 SERIES/MODEL 72, 73, 74 COMMUNICATIONS SUBSYSTEM CONFIGURATOR

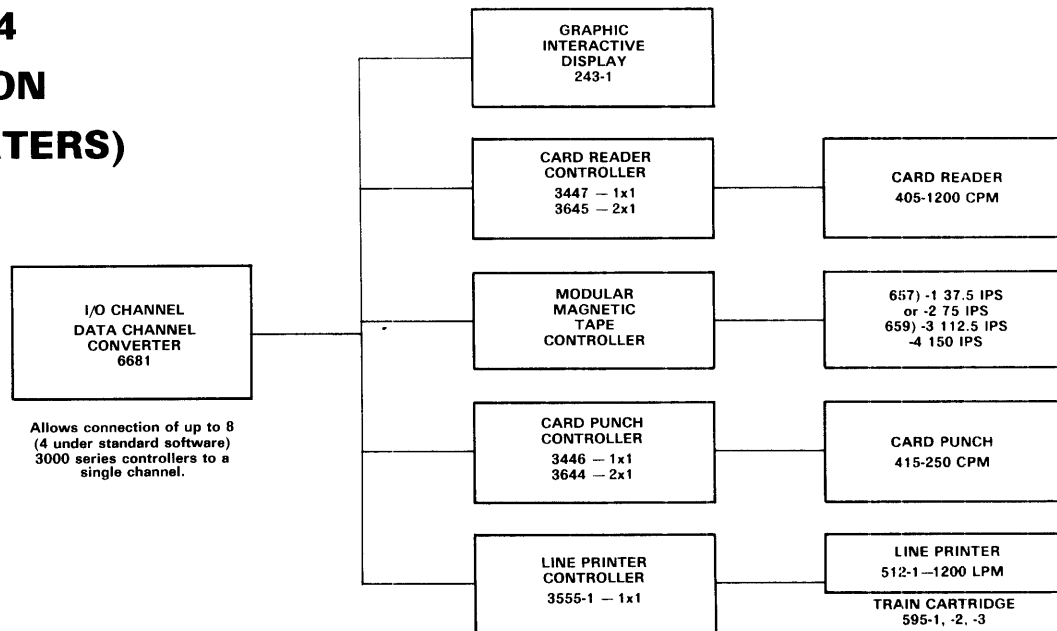


CYBER 70 MODEL 72, 73, 74 STANDARD PERIPHERAL CONFIGURATION



* NOTE: may be changed to some other data set in the future

CYBER 70 MODEL 72, 73, 74 PERIPHERAL CONFIGURATION (VIA DATA CHANNEL CONVERTERS)



NOTE: NxM indication for peripheral controller is used to show that the controller may be driven from N channels and will drive up to M peripheral products. The N channels time-share the controller except for the Magnetic tape controllers which may be accessed simultaneously by each of the N channels.

Allows connection of up to 8 (4 under standard software) 3000 series controllers to a single channel.

CONTROL DATA CYBER 70 SERIES/MODEL 76 STATION (WITH PERIPHERALS)CONFIGURATOR

This section gives the station configuration guidelines in table format for ready reference. These guidelines embody the hardware and software rules for station support.

I/O Function	Station(s) Support	Number of 7602-1 PPU's per Station	Peripheral Units Supported by Station
System Mass Storage	7654/844-2 7638 (One of these required per system)	1 Required (2 Recommended) 2 Required	Not Applicable
Unit Record Communications Equipment	*7611-10 Service Station (A maximum of 1 7611-10 per 7602-1)	1 Required	733-10 High Speed Batch Station and following options: 733-110 (1200 LPM Printer 733-120 (1200 CPM Reader 733-101 (250 CPM Punch 791-1 Communications Subsystem to which 733-10's can be connected.
On-Line/ Staged	7618-1 (1 X 8 controller)	1 Required	65X Tape Units
Magnetic Tape	7628-1 (2 X 8 controller)	2 Required	65X Tape Units

*Up to five (5) 733-10 High Speed Batch Stations can be supported local to the 7611-10 and up to four (4) 733-10's remotely per 791-1 communications subsystem. However, the basic 7611-10 can support up to only 10 peripheral devices no matter how many 733-10's are used. With the 10623-1 Option, up to 20 peripheral devices can be supported per 7611-10.

- 2 -

I/O Function	Station(s) Support	Number of 7602-1 PPU's per Station	Peripheral Units Supported by Station
Multi-Functional - Unit Record - Magnetic Tape - Mass Storage - Communications	CYBER 70 Series/ Models 72, 73, or 74 6000 Series Computer 7611-1	1 Required 1 Required 1 Required	All standard product stations and their associated peripherals and terminals. All standard product supported 6000 peripheral equipment 407 Card Reader 417 Card Punch 517 Train Printer (2 maximum per 7611-1) 607 Tapes (4 maximum per 7611-1)
Magnetic Tape Staged	7611-2 Magnetic Tape Station (A maximum of 1 7611-2 per 7602-1)	1 Required	7629-1 - 1 x 8 Tape Controller 7629-1 - 2 x 8 Tape Controller Sixteen (16) Tape Units maximum
Removable Disk Storage	7654/844-2 Station	1 Required	7654- Disk Storage Control 1 - 7654 can support up to 8 844-2's

3.0 CYBER 70 SOFTWARE

The CYBER 70 series will be supported from the outset by SCOPE and KRONOS operating systems and their extensive software product sets. More than seven years of CDC development and user experience have matured this software; and the new hardware and architectural features of the CYBER 70 further extend the levels of performance of the predecessor 6000 systems.

This section outlines major software releases applicable to the CYBER series; points out the primary objectives of that software; and describes some anticipated future software development.

3.1 SOFTWARE PLANS

The CYBER 70 series will be supported with the following choice of standard operating systems:

KRONOS	2.0	-	1Q71	-	Models 72, 73, 74
*SCOPE	2.0	-	3Q71	-	Model 76
SCOPE	3.4	-	3Q71	-	Models 72, 73, 74
SCOPE	3.4.1	-	2Q72	-	Models 72, 73, 74

The indicated dates are for standard off-the-shelf availability, after full-scale product testing. Other software packages to support new terminal equipment will be released in accordance with schedules to be announced.

Except where a software feature is dependent on a CYBER 70 series hardware feature, these operating systems will also support current 6000/7000 series computers.

SCOPE 3.4.1 will more fully exploit the CYBER 70 hardware than does SCOPE 3.4. Developmental versions of SCOPE 3.4.1 will be used for CYBER 70 demonstrations and benchmarking June - December 1971, and a

* SCOPE 2.0 for the 7600 is documented elsewhere, so it and its product set will not be described here.

complete system will be pre-releasable with initial system deliveries in December 1971. Therefore, SCOPE 3.4 is described here only to point up those features which are important to the CYBER 70 series, and to emphasize the sound, evolutionary nature of CYBER 70 software.

The SCOPE software product set likewise will be available on both the CYBER 70 and 6000 series. The CYBER 70's new CPU instructions offer many opportunities for significant performance gains. The most important of these will be reflected in the SCOPE 3.4 product set, with assembly-time options to indicate the presence or absence of the special instructions.

To illustrate, COBOL 4.0 use the compare/move instructions is expected to yield throughput improvements of about 60% on many COBOL production jobs. The amount of improvement is highly job-dependent. Estimates are based on the following preliminary timing data for the more typical COBOL operations on short alphanumeric data items. For longer data items, the new instructions provide even greater improvements.

COBOL Operation	C/M*	Item Size (Chars)		Time (μ s)		Ratio of Times
		A	B	6400	CYBER 73	
IF A > B	CC	3	3	55.0	14.9	3.7
IF A < B	CC	3	3	57.5	16.3	3.5
IF A = B	CU	3	3	15.0	11.5	1.3
MOVE A TO B	MD	3	3	10.1	2.4	4.2
MOVE A TO B	MD	5	5	9.8	2.5	3.9
MOVE A TO B	MD	4	10	11.8	2.4	4.9
MOVE A TO B	MD	10	4	10.1	2.4	4.2
MOVE A TO B	MD	210	210	117.6	11.1	10.6
MOVE A (I) TO B(I)	MI	21	21	162.6	133.9	1.2

* Compare/move instruction employed on the CYBER 73. CC - Compare Collated; CU - Compare Uncollated; MD - Move Direct; MI - Move Indirect

3.2 CYBER 70 Software Strategy

The major considerations which guide software support of the CYBER 70 series are as follows:

1. Evolution from 6000 Software

This provides the theme of "software maturity - field-tested" as a sales tool, and assures availability of rich software support with the first delivered CYBER 70's.

2. User compatibility upward

CYBER 70 jobs are transportable between comparable configurations of Models 72, 73 and 74 with no changes to control cards or program source decks. When a user upgrades from a CYBER 70 Model 72, 73 or 74 (using SCOPE 3.4 or later) to a Model 76 (using SCOPE 2.0 or later), at most minor changes are required.

3. Effective use of CYBER 70 storage organization and access paths

Operating system development will exploit the typical CYBER 70's storage hierarchy (main core, augmented core, mass storage) to give large work load capacity on a low-priced system with relatively small main core memory. The mechanisms for achieving this include:

- a) Job scheduling and swapping which enable high (70-90%) CPU utilization over a wide range of applications, even for small CM configurations;
- b) Locating many system programs and tables in ECS to conserve CM while still allowing fast access from PPU's via the DDP;
- c) Using the DDP access path for buffering mass storage I/O through ECS.

The objectives in marketing terms:

- a) Lower priced initial configurations, because small CM with auxiliary ECS can meet the workload requirements for which competitors must bid more of their higher-priced memory;
- b) Low priced storage upgrades, in combinations of CM and ECS, which compete favorably with the IBM 370's low incremental cost-per-bit.

4. Capitalize on other CYBER 70 hardware features

Performance and feature advantages of the series lie in the interlock register, the new CPU instructions and features, the 844 Disk Storage Unit, and the series of new terminals and communications equipment. For example, the interlock register, new XJ/MXN/MAN instructions and CMAP feature contribute to minimizing system overhead. The Compare/Move instructions speed up typical COBOL and SORT/MERGE jobs by large percentages, while the Integer Multiply instruction can offer great gains in such applications as processing multi-dimensional arrays in FORTRAN.

5. System reliability, recovery and availability

The basic CYBER 70 philosophy is one of fail-soft, through these lines of defense:

- CDC hardware has a general reputation in the industry for built-in and maintained reliability. But even the soundest hardware can fail. So -
- Advanced diagnostic techniques - including dynamic error-logging, and periodic automatic on-line diagnostic programs - serve to reduce the probability that a hardware failure will be undetected until it is experienced by a user program.

- Hardware/software safeguards are provided throughout the system to detect and attempt recovery from transient failures - without imposing unreasonable costs to the user for either hardware logic or software overhead. Knowing the most vulnerable hardware elements and failure types, and knowing what to do about them, are a heritage from seven years' experience with the successful 6000 series systems.
- Even during emergency maintenance periods the system can continue to do work. Automatically, or at worst by simple operator procedures (deadstarting), it can accommodate to make best use of the hardware resources still available.

The ECS subsystem illustrates these graceful degradation principles as follows:

<u>PROBLEM</u>	<u>ACTION</u>
1. Transient ECS parity.	Hardware detects. Software seeks recovery. Occurrences automatically logged to guide CE.
2. Persistent ECS parity.	CE switches in some of reserve 5K words per ECS bank.
3. Persistent parity and all of reserve in use.	On multi-bank systems, CE can shut down half of ECS for maintenance. Operator deadstarts. He can, but need not, reallocate ECS for best usage of the half available.
4. DDP requires maintenance.	Operator deadstarts a system variant which buffers PPU/ECS transfers through CM. ECS still used by system.

PROBLEMACTION

5. ECS completely unavailable.

Operator deadstarts to a system for a no-ECS configuration. Production continues.

6. New user features

While this software already has evolved to provide extensive services and user options, some new ones will continue to be added. (See Sections 3.3.2, 3.3.3, 3.3.4, 3.4 and 3.5).

7. Product set performance improvements

Major enhancements in the SCOPE product set - for both features and performance - will have been completed with the release of SCOPE 3.4. Some additional development is anticipated to achieve even better performance, especially on CYBER 70 configurations characterized by small CM and auxiliary ECS.

8. Users blend of systems and services

A unique capability allows a CYBER 70 configuration to be tied into the world's largest network of super-computer systems. This network, CDC's own CYBERNET, will offer capacity for overflow processing, and growth. CYBERNET will also provide larger configurations for special requirements. And finally CYBERNET offers applications and professional support for the applications. The package which links the on-site computer with the CYBERNET is called CYBERLINK.

3.3 Operating System Developments - Models 72, 73, and 74

The evolution of CYBER 70 operating system is indicated in this timetable:

	1970		1971				1972				
	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	
SCOPE 3.3	F										
SCOPE 3.4					F						
SCOPE 3.4.1				D	B	P		F			Models 72,73,74
KRONOS 2.0			F								
SCOPE 2.0			D		F						Model 76

F - Field release, fully product tested

P - Pre-release; all features, but not warranted

B - Benchmark; most features and performance gains

D - Demonstration; some features

The rest of this section outlines the base operating systems for the CYBER 70 Models 72, 73 and 74, stressing those features of special importance to the CYBER 70. Both SCOPE 3 and KRONOS also support current 6000 Series systems. SCOPE 3.4 is described in Section 3.3.1, and KRONOS 2.0 in Section 3.3.4.

SCOPE 3.4.1 is planned as the first operating system version to exploit all hardware features of the CYBER 70. SCOPE 3.4.1 is described in Section 3.3.2.

Sections 3.3.3 and 3.3.5 outline possible future development based on SCOPE 3.4.1 and KRONOS 2.0, respectively. These represent design possibilities only, and are presented to indicate future potential of the CYBER 70 series. These lines of development have not been planned or authorized, and are not CDC commitments.

Section 3.4 describes other CYBER 70 software products.

3.3.1 SCOPE 3.4

SCOPE 3.4 introduces several changes in SCOPE 3 system organization which will have significant impact on performance and dynamics. Principal among these are an Integrated Scheduler, ECS Extensions, and a new Loader and library organization. In addition to further broadening the CDC 6000's competence to handle a variety of workloads, these software features are the basis for adapting SCOPE to the new architectural features of the CYBER 70.

Other SCOPE 3.4 features include:

- 6000 Record Manager (6RM 1.0), and its extension modules for the SCOPE Advanced Access Methods: SCOPE Indexed Sequential (SIS 2.0) and SCOPE Direct Access (SDA 1.0)
- Error detection and recovery features
- Permanent File extensions
- Time-critical capabilities
- Tape scheduling
- Removable disk pack features
- CYBER 70 Model 72, 73 or 74 as a station to a Model 76; or 6000 as station to 7600
- Support of configurations with 7-20 PPU's
- Miscellaneous: 3-15 control points: order codes for non-stop mass storage I/O; system status codes to tell the number of 7/9-track tapes and of allocatable devices/units available; deadstart from 9-track tape.

Major features are described further below. In addition, SCOPE 3.4 will utilize the XJ, MXN and MAN instructions and the CMAP feature on systems having them.

INTEGRATED SCHEDULER

This reorganizes all job scheduling and resource allocation in a newly unified way. Jobs from all sources - batch, remote, and interactive - are queued according to five classes. Each of the five queues is managed according to installation parameters for each class governing initial priority and its aging rate, maximum priority, time quantum length given when the job is swapped into a control point, and quantum priority (the job class priority when it is at a control point, contending for CPU use).

Control points are released for use by another job by swapping out a total job whenever possible, after it has exhausted its time quantum. This frees the control point for another job, and means that, for all practical purposes, an unlimited number of jobs can be in process. Jobs which have ECS or non-allocatable equipment assigned are rolled out rather than swapped, this releases the job's CM field length, but not the control point.

Swapping is performed to a designated fast swap device (normally to ECS, if present). If space is unavailable, the system will swap to an allocatable mass storage device, selected to be most responsive on the basis of its access characteristics and current activity. For example, in an ECS system, swapping normally is to the ECS paged system area - taking about 2.5 - 10.5 msec. (depending on number of ECS banks) for a large job of 50K_g field length. If insufficient ECS pages are available, the swapping will revert to disk. Depending on the disk, this takes (ignoring stack request and channel queueing) about 425 msec. (6638), 1210 msec. (841), or 466 msec. (844). During the swap to disk, the CPU is free for other work, although the CM is not.

Operator controls are provided for dynamically adjusting system scheduling to the current flow of work.

The most important system effect of this new scheduling technique will be to maintain high CPU utilization for even small CM configurations. This means that less CM is required to process a given typical workload over a given time period, especially if the CM is augmented by ECS as most CYBER 70's should be.

ECS EXTENSIONS

ECS serves several functions:

- Residence for system library programs which otherwise would occupy higher-cost CM, or slower rotating mass storage.
- Buffering of sequential I/O between mass storage and CM, to permit reduction of rotating mass storage accesses, and can allow smaller CM buffer sizes without a throughput sacrifice.
- Primary swap device for the system scheduler.
- Residence for selected small files (at installation's option).
- Under user program control, a bulk direct access device for any application benefited by rapid random access, such as processing large matrices.

Under SCOPE 3.4, ECS is partitioned into two areas: that reserved for user direct access, and a paged system area dynamically allocated to satisfy demands for the first four functions listed above. Other controlling parameters are page size (from 1 to 511 units, where a unit is 64 60-bit words), default I/O buffer size, and maximum ECS resident library area.

An ECS buffer for a sequential mass storage file is established by a REQUEST card parameter. Pages are allocated and deallocated as each write/read from GM is performed, so that on the average only half the nominal ECS buffer size is allocated. Buffer overflow and underflow are sensed by the system to initiate necessary mass storage I/O.

Use of ECS as a swap device also utilizes dynamic allocation/deallocation of pages. Swapping is described above, under INTEGRATED SCHEDULER.

System programs can be moved to or removed from ECS residence by use of the EDITLIB utility while the system continues running. This encourages, for example, moving a FORTRAN compiler to ECS before starting a batch of FORTRAN runs.

LOADER and Library Reorganization

Existing loaders will be replaced in SCOPE 3.4 with a single loader containing a basic relocatable load processor and an expanded, versatile overlay processor.

This new loader will maintain all of the existing features of the SCOPE 3.3 CP and PP loaders, except segmentation (which new overlay capabilities replace). In addition the following features will be added:

- . Reorganization of the system library to provide multiple directories and libraries.
- . Selection by control card or directive of alternate system libraries or user libraries to satisfy externals.
- . Selective load of programs from a file.
- . Ability to load from a GM or an ECS file
- . Presetting of core.

- . Saving of core image of the loaded program.
- . Capability of not satisfying selected externals.
- . Expanded user call capability.
- . Multiple entry points to overlays, and overlay generation from multiple source files.
- . Support of an extended binary table format to allow for the relocating of off-set, variable-length address fields and for the loading and relocating of common blocks in ECS.
- . Overlay structures up to 4095 total depth and width.
- . Ability for a central processor program to obtain the highest word address of all overlays loaded such that dynamic buffer allocation and memory management can be done.
- . Ability to obtain the address of the entry point of a routine.

RECORD MANAGER (RM 1.0)

This is a unified logical I/O package. It provides object time I/O control and block and record formatting facilities for programs generated through FORTRAN 4.0, RUN 3.0, COMPASS 3.0, COBOL 4.0, SORT/MERGE 4.0, FORM 1.0 and QUERY/UPDATE 1.0.

Four blocking methods and eight record types are provided for sequential files. A FILE control card permits user choice and over-riding of the default block/record types employed by each compiler. This feature permits file interchange between programs generated by different products.

6RM is user-level compatible with the equivalent 7000 Data Manager of SCOPE 2.0, the CYBER 70 Model 76 operating system.

COBOL and SORT/MERGE will achieve I/O speed-ups by their use of 6RM.

SCOPE Advanced Access Methods (SIS 2.0 and SDA 1.0)

These packages are extension modules of 6RM for processing indexed sequential and direct access files.

SIS 2.0 best serves files which must be accessed both sequentially, and also randomly by key. It has some internal improvements to SIS 1.0, first released with SCOPE 3.3.

SDA 1.0 provides facilities for random file processing, using a hashing technique to access records by key.

ERROR DETECTION AND RECOVERY

Although all the following features are not exclusive to the 3.4 version of SCOPE, their listing serves as a review, and as an indication of the emphasis on system availability as a software improvement guideline.

Highly sophisticated tape unit diagnostic programs and tape read/write error recovery techniques have been implemented.

Additional error status information is returned to CP programs when I/O operations terminate abnormally.

Major stress is placed in SCOPE on the need to detect error-prone hardware before it can affect users. The Customer Engineer has two diagnostic systems available to him. The off-line maintenance system permits simultaneous testing of all peripheral devices, the CPU, CM, PPU's and peripheral memories. This system is normally used during preventive maintenance periods. The SCOPE on-line diagnostics provide testing and monitoring capabilities during customer operation.

The off-line maintenance system is designed to provide maximum comprehensive testing with minimum intervention. To accomplish this, a service routine monitors all PP's which are executing diagnostics, and maintains an error history for dumping to an output device. A combination of pre-set test lists and comprehensive keyboard controls provides a great deal of automatic testing.

The on-line diagnostic features are designed into the SCOPE operating system. These features include:

1. Deadstart Diagnostic Sequencer - Allows the operator the option of running a set of quick-look sequenced diagnostics each time the system is dead-started.
2. SCOPE Resident Diagnostic Programs - Permits testing of various subsystems without disrupting the system. These diagnostics are loaded and executed on demand and provide tests of memory, functional units, PPU and channels and peripheral equipment. For example, the 6638 Disk may be tested without destroying the system or permanent files.
3. Automatic Program Sequencer - Allows the rerunning of diagnostic jobs at regular pre-selected time intervals. Control cards determine the frequency of execution. For example, a job can be set up to run a central processor diagnostic every ten minutes. If malfunctions occur, they are detected immediately, and a message is entered in the dayfile. Thus, potential malfunctions may be detected before appearing as the result of user job failure.

4. Engineering File - Provides a means of logging system hardware malfunctions detected by SCOPE. Failures are recorded via entries from sequencer diagnostics, I/O devices, and peripheral and central processor programs. An analyzer program processes the data which has been collected in the Engineering File to give sorted lists and statistical tables of error data. This information is used by maintenance personnel in scheduling preventive maintenance actions on various parts of the system.

The off-line maintenance system with its comprehensive testing capability, combined with the SCOPE on-line diagnostics and the diagnostic monitoring and reporting capability, all allow continuous checking of system performance. The aim of these tools is: increased user confidence, increased system availability, and increased system reliability.

PERMANENT FILE EXTENSIONS

Among the added capabilities for managing permanent files are:

- Faster utilities, with extended capabilities to perform:
 - Selective dumping, loading, and auditing
 - Archiving to tape, and retrieval on demand
 - Transferring files from one mass storage device to another
- Sharing of a file among programs requiring simultaneous multi-read/single write or rewrite access.

TAPE SCHEDULING

Features are provided which assist an operator in readying tapes, and which avoid use of system resources until tape preparation is completed.

STATION TO CYBER 70 Model 76 or 7600

This feature permits configuring a CYBER 70 or 6000 as a station to the more powerful Model 76 or 7600 systems, forwarding designated jobs to the larger computer for processing. The station computer's batch stand-alone power is not reduced until the station relationship is established by operator action. The station computer can provide full communication services for the configuration.

REMOVABLE DISK PACK FEATURES

A pack may be designated as a System pack or a User pack. System packs are treated as allocatable devices, which remain mounted between deadstarts. Any permanent files on them are available under control of the permanent file subsystem. User packs are removable without interrupting other operations. They are classed as non-allocatable devices, and SCOPE processing is similar to that of magnetic tapes.

3.3.2 SCOPE 3.4.1

SCOPE 3.4.1 will utilize two of the CYBER 70's major architectural features - the Interlock Register and the Distributive Data Path. In addition, it will provide:

- 844 Disk Storage Unit support
- Processing of 8-bit ASCII and EBCDIC data
- CYBERLINK
- Additional features for removable disk packs

INTERLOCK REGISTER

The system's primary utilization of this new feature will be in interlocking access by PPU's to channels and system table pseudo-channels. The effects of this are: a) Faster response to a system PP program's request for a channel or pseudo-channel; b) Reduction in work for SCOPE monitor; and c) Reduction in CM accesses by PPU's, and consequent increase in system potential workload before CM conflicts can become a system-saturation factor.

DISTRIBUTIVE DATA PATH, PPU-TO-ECS

This CYBER 70 feature permits transfers of data and programs across an I/O channel between ECS and a PPU, without involvement of the CPU and a CM buffer.

SCOPE 3.4.1 will use this feature in two principal ways:

- 1) To load system PP programs from ECS residence; and
- 2) To perform I/O from mass storage, through the PPU to either a CM buffer (as under previous SCOPE versions) or directly to an ECS buffer.

(SCOPE 3.4 provides for ECS I/O buffering of mass storage, but must employ associated CM buffers and CPU activity to load/empty the ECS buffers).

Other applications of the DDP also are being evaluated. Examples: PPU access to system tables maintained in ECS rather than CM; and staging of job-swapping through ECS to mass storage.

The overall impact of the DDP is to reduce the amount of CM needed to perform a given workload with a given amount of ECS, by effectively supporting the substitution of (low-cost) ECS for (high-cost) CM in a system configuration.

844 DSU

This multiple disk pack device offers price/performance, reliability and expandability characteristics which favor it as a CYBER 70 system's primary or only rotating mass storage. SCOPE 3.4.1 will support the 844 and its associated programmable buffer controller, offering at least the usage features of the 841 Multiple Disk Drive, and the performance and storage capacity improvements which the 844 offer.

EIGHT-BIT DATA PROCESSING

SCOPE 3.4.1 will have facilities to meet those data processing requirements which call for interchange via magnetic tape of data encoded in 8-bit-per-character formats, or for processing strings of 8-bit characters (e.g., upper and lower case text).

A set of object-time subroutines are available to COBOL and FORTRAN programmers (using CALL/ENTER statements), along with easy-to-follow standard conventions for handling 8-bit encoded data.

These will enable users to perform the following functions:

- 1) Read/write nine-track magnetic tape files, with optional data item conversion to/from CDC numeric and alphanumeric (Display) codes, ASCII-6 and -8 codes, and IBM-supported numeric and EBCDIC codes. (Many IBM 360/370 file formats also can be read/written). Extended

character set codes on cards can be read/punched.

- 2) Within a program, move and compare strings of 8-bit characters; and convert 8-bit encoded data to/from 6-bit encoded alphanumeric or numeric data items for further processing (e.g., arithmetic operations).
- 3) Print 8-bit encoded data on a 512 printer equipped with a suitable graphic print train, allowing hard copy output of upper and lower case alphabetic and special symbols.

CYBERLINK

This feature permits CYBER 70 jobs to be transmitted to CYBERNET for processing. It provides an advantageous way to handle computing work on an exception basis. CYBER 70 system costs can be traded off between costs of CM and other resources, against CYBERLINK fixed costs and the CYBERNET variable costs, to yield the CDC customer a most economical computing service. CYBERLINK also answers the problem of a user who has a highly variable data processing workload.

The user's CYBER 70 serves as a CYBERNET station. By control card indication or operator action, a job is directed by wide-band or voice-grade communications facilities to CYBERNET, whose full hardware and software resources then are available for executing the job. Data files may be transmitted with the job, or may be maintained within CYBERNET. The job output is returned to the originating CYBER 70 for further processing, local output, or forwarding to a terminal.

REMOVABLE DISK PACKS

This feature is in addition to the SCOPE 3.4 facilities for System permanent packs (non-removable without system interruption; may hold cataloged permanent files) and User removable packs (removable; no

permanent files; processed similar to magnetic tapes). The new feature is for User permanent packs. Any permanent files on them are cataloged and served by the facilities of the SCOPE permanent file subsystem. Multi-pack files may be processed without all packs' being mounted; only the first pack and one being processed are required.

3.3.3 SCOPE 3.4.X Development

CDC plans for SCOPE development beyond version 3.4.1 have not yet been finalized. To provide further insight into the CYBER 70's potential, however, some potential development areas listed below.

MASS STORAGE IMPROVEMENTS

Additional error recovery techniques will be implemented. Improved 844 Disk Storage Unit software and buffer controller firmware is anticipated, both to achieve better performance and to exploit the device's unique reliability features. A technique employing two PPU's to read/write disks in full-track recording mode will improve I/O which can benefit significantly from maximum transfer rates (e.g., buffering through ECS, program swapping to disk, and loading large programs from disk). Improved dual access support will provide for treating a dual access 821/841/844 as a single logical device having alternate access paths, rather than as two logical devices. Mass storage pre-allocation will permit greater user control over the physical residence of files, an important feature for tuning application systems using large on-line data bases.

DEADSTART RECOVERY

Enhancements will permit even greater facility to salvage jobs which were partially completed when the need arose to re-deadstart the system.

SCHEDULER IMPROVEMENTS

These are aimed at further reducing the overhead for swapping jobs.

Among the possibilities: negate the need for any CM storage moves preparatory to swapping; in an ECS system, stage all swapping to disk through ECS, rather than treating disk as the overflow device for a large ECS swap area; and use of full-tracked disk for faster swapping transfers.

MULTI-COMPUTER ECS USAGE

This will support use of ECS for system communications among multiple computers, in addition to its shared use as a storage device. The multi-computer system will share INPUT/OUTPUT queues, and all permanent files.

3.3.4 KRONOS 2.0

KRONOS 2.0 is a KRONOS 1.0-compatible system that incorporates extended capabilities. Some of the most notable performance improvements are in the area of batch and remote throughput rate, teletype terminal response time and mass storage input/output.

KRONOS 1.0 has already demonstrated its ability to handle 384 remote teletypes and up to sixteen 200 User Terminals. KRONOS 2.0 permits up to 512 simultaneous teletype users, and provides an even faster response time than KRONOS 1.0. It also has a full complement of local and remote batch facilities, and hardware diagnostics programs to monitor all segments of the system.

Operating system response time to requests for system resources has been reduced through the use of a CPU monitor program, which may process requests from PPU programs or from CPU programs. KRONOS 2.0 and its product set exploit the central exchange jump and monitor exchange jump instructions if present. For example, the CPU relocatable loader, COMPASS assembler, and FORTRAN and COBOL object time I/O all use central exchange jumps to make I/O requests to the system.

Job scheduling and swapping has been improved by such techniques as "swap interleaving" whereby the field length of a job being swapped out is released in small parcels so that a job waiting for CM space can be swapped in as soon as possible. In addition, many system utility programs have CM space scheduled on the amount of space they need, up to the field length requested by the user. Another improvement in job swapping in KRONOS 2.0 is that all jobs are swapped out - including those using non-allocatable equipment. Thus, the control point and FMT space being used by a job is always freed when it is swapped out.

KRONOS 2.0 utilizes ECS when available. It is available as an allocatable device for the storage of user data files and as a very fast swapping device. When ECS swap space is exhausted, jobs will be swapped to other available mass storage until there is again space available in ECS. This permits KRONOS to accommodate large numbers of simultaneous users, even when it is not possible to swap all of them to ECS.

Program loading and relocation is greatly speeded by using a CPU loader. The loader has the capability to satisfy external program references from user libraries. Library generation and maintenance programs are also provided.

KRONOS 2.0 also provides a job control language that allows a flexible method of altering the sequence of control card processing using "IF" tests and "GOTO" statements. The job control process also allows "procedure" files to be constructed so that a single control card may be expanded into a series of cards by using this procedure file and substituting variable arguments.

The job accounting package has been improved and expanded for KRONOS 2.0.

Under KRONOS 2.0, an absolute CPU program may have multiple entry points. This reduces the time needed for loading and eliminates the need for relocating program text.

File recovery after gross system failure has been enhanced with the incorporation of a "system sector" for each mass storage file. This system sector allows non-permanent files to be recovered even though critical CM tables have been altered.

A capability to submit batch jobs from a teletype has been included in KRONOS 2.0. Job decks may be created, edited and submitted to the batch subsystem from a remote teletype.

Because of sophisticated job scheduling methods and capability for up to 24 control points, KRONOS 2.0 can be expected to support an indefinitely large number of simultaneously active jobs.

Permanent file capabilities have been expanded to permit large, direct access files in addition to the indirect access permanent files under KRONOS 1.0. These files may be randomly accessed and "multi-user read" is provided. The permanent file security system has been improved, and the permanent file utilities have been redesigned in order to achieve

significant reductions in the time required to load and dump. Dumps may be selective according to such things as:

- user number
- files created, modified or accessed after a specified date
- all direct files
- all indirect files
- files on a certain device

Permanent file archive tapes are maintained in 7600 logical format to reduce required tape space. Several reports may be generated that describe the characteristics and/or contents of the permanent file subsystem or archives.

KRONOS 2.0 configures itself at deadstart to either enable or suppress use of the central exchange jump, monitor exchange jump, and hardware configurations of 7 to 20 PPU's. Any of these PPU's, with the exception of 0-2, may be logically "turned off" at deadstart if a hardware malfunction is known.

3.3.5 KRONOS 2.X Development

As for SCOPE 3.4.X, CDC plans for future KRONOS development have not yet been finalized. Potential developments, however, are as follows:

- An improved text editor.
- A command library capability which will permit users to execute a pre-defined set of TTY commands contained in a pre-stored file.
- Support of removable disk packs, including:
 - . Pack labeling
 - . Pack scheduling
- Improved usage of ECS for storing system tables, user files and job swapping.

- Use of 6000 Record Manager (6RM) to support SCOPE 3.4 product set.

Additional hardware to be supported includes:

- 6671 remote concentrator capabilities
- 65X magnetic tape drives
- A subset of the new terminal family.

ECS USAGE

The major emphasis in KRONOS 2.X will be to make even more effective use of ECS than KRONOS 2.0 does. This will be done by utilizing portions of ECS to store operating system routines that are heavily accessed. In addition, improvements will be made in scheduling in order to insure that the jobs that are swapped to ECS are those whose swapping activity rates justify it.

CYBER 70 architecture will influence KRONOS 2.X development. The distributive Data Path (DDP) may be used for the above stated purposes, and for I/O blocking to RMS, PPU program loading from ECS, or accessing system tables in ECS.

KRONOS may use ECS in one or more of the following ways:

a) Data files

Files which require rapid random access may reside in ECS.

b) Operating system storage

Any of the operating system programs which are currently disk resident may be stored in ECS.

c) Job swapping

Since jobs are swapped to disk using the standard system file format, ECS may be used as a swapping device.

d) System table storage

Some system tables may be ECS resident, thereby freeing valuable CM space.

e) I/O buffering to rotating mass storage

Greatly improved RMS utilization may be realized using this method.

REMOVABLE DISK PACKS

All files on a "removable pack" will be permanent files, and will abide by permanent file capabilities and restrictions. To access files on these packs a specific request for a disk pack is required. Upon receipt of a request for a disk pack, the user's program will be rolled out until such time as the operator has mounted the appropriate pack and notified the system of his action.

INTERLOCK REGISTER

The CYBER 70 Interlock Register provides an opportunity to further upgrade system performance. Some indicated uses are:

- Reserve I/O and pseudo channels via the ILR. This reduces CM accesses and eliminates the need for software channel scheduling.
- Indicate to "idling" PPU's the presence of a request in their input registers. This reduces CM accesses and decreases PPU response time to these requests.
- Indicate to the monitor that a PPU has a request for monitor service in its output register. This reduces CM accesses and decreases monitor response time.

KRONOS 2.X will utilize the XJ, MXN, MAN, and CMAP features to optimize system performance.

3.4 SOFTWARE PRODUCT SETS - Models 72, 73, 74

CYBER 70 Models 72, 73 and 74 will use the identical software products available on the CDC 6000. Installation-time assembly options will account for any hardware differences.

The following table relates major CDC-supported software products to the CYBER 70 operating systems under which they will be available. The products are grouped as follows:

I. Assembler and Compilers

- ALGOL
- BASIC
- COBOL
- COMPASS
- FORTRAN (RUN)
- FORTRAN Extended
- Interactive FORTRAN
- JOVIAL

II. Service Software

A. Data Management

- DDL/DML, Data Definition Language/Data Manipulation Language
- FORM, File Organizer and Record Manager
- MARS VI
- QUERY/UPDATE
- SORT/MERGE

B. Mathematical Programming

- OPHELIE II
- OPHELIE MIXED

C. Simulation

- SIMSCRIPT
- SIMJLA

D. Interactive Graphics

- IGS, Interactive Graphics System

E. Project planning/control

- PERT/TIME

F. Machine Tool Programming

- APT

G. Seismic Data Processor

III. Communications Software

- KRONOS (communications)
- INTERCOM
- 1700 IMPORT High-Speed
- 1700 MSOS IMPORT High-Speed
- 8231 IMPORT High-Speed

The table notes major improvements made between versions of software. CDC plans cannot be announced yet for all software products for the CYBER 70. The table shows this by the following code:

- X - Product is now available or committed
- D - Development project has been authorized, but is subject to re-planning
- P - Only initial plans have been approved.
- C - The product is expected to carry forward without change under later operating system versions, assuming initial development of both the product and the operating system version.

I. CYBER 70 ASSEMBLER and COMPILERS

OPERATING SYSTEM					SOFTWARE PRODUCT	NOTES
3.4	SCOPE		KRONOS			
	3.4.1	3.4.X	2.0	2.5		
X					ALGOL 3.0	Interactive execution under INTERCOM. Direct access to ECS. Linkage to subroutines coded in other languages. Improved code optimization. Debugging and error recovery aids.
D	C	C		C	ALGOL 4.0	Interface to 6000 Record Manager (6RM) for object-time I/O
X	X	C	X	C	BASIC 2.0	
				P	EXPANDED BASIC 1.0	Language extensions beyond Dartmouth BASIC, including: formatted output; complex number capability; string variables; expanded subroutine/function capabilities; extensive trace/debug aids; incremental compilation.
			X		COBOL 3.0	
X	X	C		C	COBOL 4.0	Significant object-time speed-ups. Additional features to achieve full ANSI compatibility. Exploits new compare/move and integer multiply instructions. 6RM interface for more efficient sequential and random I/O, added flexibility in file definition, and processing of indexed sequential (SIS) and direct access (SDA) files. Smaller core requirements, both compile- and object-time.

I. CYBER 70 ASSEMBLER and COMPILERS

OPERATING SYSTEM			SOFTWARE PRODUCT		NOTES
3.4	<u>SCOPE</u> 3.4.1	3.4.X	<u>KRONOS</u> 2.0	2.5	
		P			COBOL 4.X Interface to DDL/DML for data base applications
			X		COMPASS 2.0 Assembles source 2-3 times faster than COMPASS 1.1. Supports all 6000, 7000 and CYBER 70 hardware instructions except compare/move, and permits test assembly on any of these computers of code intended for any other. More than 25 new pseudo-instructions, offering important new capabilities. Added programmer convenience features, including additional diagnostic aids and a symbol cross-reference listing.
X	X	C		C	COMPASS 3.0 Supports new compare/move instructions. Assembly-time use of 6RM for I/O. Extensions for object program formatting.
X			X		FORTRAN (RUN) 2.3
X	X	C		C	FORTRAN (RUN) 3.0 Expected performance gains: 100% in compilation rate; -25% in execution CPU time; 15% in execution throughput. Compile-to-core feature. 6RM for object-time I/O. Exploits new integer multiply instruction. Under KRONOS 2.X, facilities for debugging programs symbolically through a terminal. Common library with FORTRAN Extended 4.0.

I. CYBER 70 ASSEMBLER and COMPILERS

OPERATING SYSTEM				SOFTWARE PRODUCT		NOTES
3.4	<u>SCOPE</u> 3.4.1	3.4.X	<u>KRONOS</u> 2.0 2.5			
			X			FORTRAN Extended 3.0
X	X			C		FORTRAN Extended 4.0 Compilation speed-ups of more than 100% if COMPASS 3.0 employed as final pass assembler. 6RM for object-time I/O. Exploits new integer multiply instruction. Common library with FORTRAN (RUN) 3.0.
		D		C		FORTRAN Extended 4.X Speed-up of formatted I/O. Free-format I/O feature. Interface to DDL/DML for data base applications.
			X			Interactive FOR- TRAN (TSRUN) 1.0 Replaced by RUN 3.0 for KRONOS 2.X.
		D				DDL/DML 1.0 See notes under Service Software (Data Management).

II. CYBER 70 SERVICE SOFTWARE

OPERATING SYSTEM			SOFTWARE PRODUCT		NOTES
3.4	SCOPE 3.4.1	3.4.X	2.0	KRONOS 2.5	
		D			<p>A. DATA MANAGEMENT</p> <p>DDL/DML 1.0 CODASYL Data Definition Language for standard description of complex data bases, and Data Manipulation Language for processing such data using a host procedural language (e.g., COBOL, FORTRAN) or the non-procedural QUERY/UPDATE.</p>
X	X	C		C	<p>FORM 1.0 A file- and record-processing utility, invoked by control card or from a COMPASS, COBOL or FORTRAN program. Processes any sequential, indexed sequential or direct access file describable to 6RM; also can convert commonly used IBM 360/370 sequential files, and record/item formats, to and from 6RM file/record/item formats. Capabilities include: file duplication; record extraction according to qualification criteria met by data items; record reformatting for printing, punching or subsequent processing.</p>
P	C	C			<p>MARS VI 2.0 Improved performance, especially for batch data base maintenance. Supports partially inverted data structure, as well as fully inverted.</p>

II. CYBER 70 SERVICE SOFTWARE (continued)

OPERATING SYSTEM					SOFTWARE PRODUCT	NOTES
3.4	SCOPE 3.4.1	3.4.X	KRONOS 2.0 2.5			
X	C	C		C	QUERY/UPDATE 1.0	Provides a simple language for updating and retrieving from established 6RM files - sequential, indexed sequential or direct access. Data is accessed by symbolic name, freeing the user from the need to know details of file organization, record format or data item characteristics.
	D	C			QUERY/UPDATE 2.0	Expanded report generation and data manipulation facilities. By use of DDL/DML 1.0, permits maintenance of and retrieval from complex structured data bases.
			X		SORT/MERGE 3.0	
X	X	C		C	SORT/MERGE 4.0	Expected performance improvements: 100% better CPU utilization for both tape and disk variants; 100% faster throughput for the disk variant.
X	X	C			B. MATHEMATICAL PROGRAMMING OPHELIE II 1.1	
X	X	C			OPHELIE MIXED 1.1	

II. CYBER 70 SERVICE SOFTWARE (continued)

OPERATING SYSTEM			SOFTWARE PRODUCT		NOTES
3.4	SCOPE 3.4.1	3.4.X	2.0	KRONOS 2.5	
X	X	C	X	C	C. SIMULATION SIMSCRIPT 2.0
X	X	C	X	C	SIMULA 1.0
X	X	C			D. INTERACTIVE GRAPHICS IGS 2.0 Interactive Graphics System functions are supported under INTERCOM 4.0 and subsequent versions
X	X	C	X	C	E. PROJECT PLANNING/CONTROL PERT/TIME 1.2
X	X	C	X	C	F. MACHINE TOOL PROGRAMMING APT 2.2

III. CYBER 70 COMMUNICATIONS SOFTWARE

OPERATING SYSTEM		SOFTWARE PRODUCT	NOTES
3.4	SCOPE 3.4.1	3.4.X	KRONOS 2.0 2.5
			<p>GENERAL: 1) KRONOS provides low-speed communications services as an operating system feature; high speed communications packages may be added by QSS. SCOPE communication processing is by the INTERCOM package, with standard IMPORT software available for various terminals.</p> <p>2) Detailed plans will be announced for both INTERCOM and KRONOS support of new terminals and communications controllers.</p>
			<p>X</p> <p>KRONOS 2.0 Terminal types supported: <u>with 6671/6 controllers -</u> 200 UT (BCD and ASCII), TTY's and any TTY-compatible terminal, including new 713-10 Interactive (TTY). Incorporates a text editor and file management features to support interactive programming.</p>
			<p>P</p> <p>KRONOS 2.X Additional terminal types supported: <u>with new 7077-1 and 791-1 - 711-10 Interactive (CRT), and</u> 712-10 Interactive (PRT). Incorporates 6RM to enable support of same latest version software products as SCOPE.</p>

III. CYBER 70 COMMUNICATIONS SOFTWARE (continued)

OPERATING SYSTEM		SOFTWARE PRODUCT	NOTES
3.4	<u>SCOPE</u> 3.4.1	3.4.X	<u>KRONOS</u> 2.0 2.5
X	D		<p>INTERCOM 4.0, including add-on facilities provided as available after initial release</p> <p>Terminal types supported:</p> <p><u>With 6671/3/4/6 controllers</u> - 200 UT (BCD and ASCII), 1700, station, 8231, TTY's, 274 graphics console.</p> <p><u>With 6671 controller</u> - 711-10 Interactive (CRT), 712-10 Interactive (PRT), 713-10 Interactive (TTY)</p> <p><u>With new 7077-1 and 791-1</u> - 733-10 High Speed Batch.</p> <p>Incorporates the many performance and feature improvements of INTERCOM 3.0 (released 1Q71 under SCOPE 3.3), including: text editor and other features for interactive programming; an interface to enable writing of programs which can process multiple terminal users in a serially-re-entrant manner. Incorporates the Interactive Graphics System (IGS); and, for efficiency and conservation of GM and PPU's, has an integrated Common Communication Interface replacing previous EXPORT HS 1.0 and INTERCOM 3.0 functions.</p>

III. CYBER 70 COMMUNICATIONS SOFTWARE (continued)

3.4	OPERATING SYSTEM		KRONOS		SOFTWARE PRODUCT	NOTES
	3.4.1	3.4.X	2.0	2.5		
	P	P			INTERCOM 4.X	Additional terminal types supported - <u>With 7077-1 and 791-1 -</u> 71X-10 Interactive (CRT, PRT and TTY)
X	C	C			1700 IMPORT H.S. 1.0	
X	C	C			1700 MSOS IMPORT H.S. 1.0	
X	C	C			8231 IMPORT 1.0	

4.0 CYBER-SERVICES

CYBERPAK, CYBERLINK, and CYBERNET are unique services in the field of computer marketing, and yet are logical extensions of Control Data's own use of its hardware products. These marketing concepts are vertical expansions of Control Data's business. That is, they are devised to meet the needs of a customer or prospect. Just as Control Data found it necessary to allocate a sizable portion of its funds to obtain computer services, your prospects and customers will make similar investments even though they still lease or operate their own CDC equipment. CYBER-SERVICES is Control Data's response to these user needs. It includes CDC's complete and versatile computer service repertoire. CYBERNET is Control Data's nationwide computer network; CYBERPAK is its unique marketing plan; CYBERLINK is its flexible approach to combine both hardware and services.

4.1 CYBERLINK

CYBERLINK is a new concept never offered before to an EDP system customer. Control Data can capitalize on this approach since the competition cannot offer computer services. It can mean one vendor for your customer's entire data processing needs. By proper use of CYBERLINK, you can help him significantly control his fixed costs. The concept is simple; it works like this:

Frequently an EDP system is configured for a "worst-case-load" situation. He may have an occasional or periodic need that requires more compute capacity than that required for his daily routines. Alternatively, he probably has several jobs which require exceptional amounts of certain resources, such as core memory, scratch file disk space, or magnetic tape drives. Rather than letting these occasional requirements dictate his configuration,

suggest that he use CYBERLINK to tap into Control Data's own computer utility -- the CYBERNET network. To quote an independent research firm, CYBERNET is "... unquestionably the most advanced service center network in existence and has a great potential for additional growth ..."* CYBERLINK is a method of linking a user's own system into the CYBERNET network. With CYBERLINK, you can now offer an almost unlimited reserve capacity.

CYBERLINK customer benefits include:

Overflow processing capacity which allows you to choose a blend of fixed and variable costs for your customer. He can minimize his fixed-cost commitment and still have the reserve processing capacity. Every prospect is concerned with having adequate capacity to rely on. When your prospect gets behind he needs that extra capacity in-house; and he would like to know that there is more extra capacity down-the-street. Our competition offers this security through system density; and now we can too. No matter how small the configuration, nor how far to the nearest CYBER 70, CYBERLINK can couple your on-site CYBER 70 into the CYBERNET. You can minimize the configuration and still meet the capacity requirement.

Processing of oversize jobs which allows you to trim the configuration and still be able to meet requirements to process oversize jobs via the CYBERNET. The CYBERNET operates SCOPE and KRONOS operating systems and current versions of all standard subsystems so that your customer can, for example, elect to perform large COBOL compilations on the CYBERNET computers. Then the binary

* A.D. Little's report on "The Computer Industry, 1969-1974", June, 1969

form can be transmitted back to execute the program on his own computer. The capability to handle oversize jobs with CYBERLINK can mean either a minimum configuration or improved cost performance. Cost performance can be improved dramatically, 60% in some cases, by use of ECS. CYBERLINK can really help here by allowing you to cut the central memory requirement in half, saving anywhere from \$8,000 - \$20,000 per month which might better be reinvested in CYBERLINK and ECS. ECS can improve cost performance as mentioned earlier, and CYBERLINK will allow you to handle the large core jobs without large core on-site.

Reserve growth capacity which means no need to carry a burden of excess capacity for "futures". No longer is it necessary to increase capacity in quantum cost steps either. By controlling the fixed costs at a "parity" level, your customers' growth can be completely variable cost - when he is ready for an increased capital investment he can do so; but until the time is right, his growth opportunities can be delayed to defer additional fixed costs. Surprisingly this will encourage add-ons in most cases. Actual work loads vary, and on a nearly loaded system the peak requirements often exceed the capacity. When this happens, the user typically forces the peaks into the valleys by postponing work or resisting additional new work until he is forced to upgrade. CYBERLINK can avoid this crisis by allowing the customer to overflow his capacity gracefully - new systems get written and programmers are attracted to the convenience of large core on the CYBERNET. As a result of this convenience, the customer gets more work done and before long, finds it's time for system add-ons.

Added value - which means a great deal more than just extra capacity. CYBERNET offers professional problem solving support through an ever growing number of powerful software tools. The applications software library has been developed by recognized experts in many varied industries and includes:

<u>Industry</u>	<u>Key Applications</u>
● Petro-chemical	OPHELIE
● Atomic/Nuclear	STARDYNE/EASE
● Hospital Administration	SHARP
● Electrical Power Generation	EUNAS
● Demographic Research	CENSTAT
● Fund Management	NTRDA
● Banking/Finance	DEMAND DEPOSIT

Applications software and staff consultants combine to offer an applications capability without equal.

A Micro-look at CYBERLINK

Let's look more closely at what this link really is

On your CYBER 70 system a CYBERLINK consists of all the necessary software, hardware, and communications equipment to tie or link your computer system to the CYBERNET plus a full 20% discount on all CYBERNET processing.

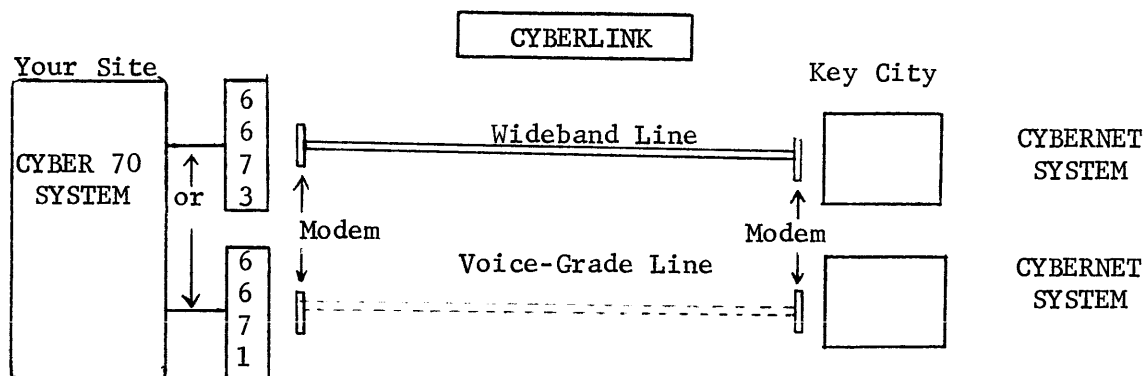
Specifically, when the link is to be wideband, 40,800-bits per seconds, CYBERLINK means a 6673 communications controller. The required software modules, the necessary 303 modems, and the first 25 miles of wideband communications lines are also included. There are seven key cities across the United States where CYBERNET computers are located:

- Palo Alto/San Francisco
- Los Angeles
- Houston

- Minneapolis/St. Paul
- Boston
- New York
- Washington D.C.

Of course, if your customer requires wideband and is more than 25 miles from any of the key cities, the necessary additional wideband mileage can be purchased from AT&T, but CDC will still pay for the first 25 miles.

For lower volumes the CYBERLINK means a 6671 communications controller, a CDC provided voice-grade line to the nearest key city, the required software modules, and the necessary 201 A/B modems.



4.2 CYBERPAK

- Have you ever wanted to sell 1/4 of a CDC 7600 -- a 6600 for \$9,000?
- Did you ever need a variable amount of computer power to satisfy your customer's seasonal or occasional loading conditions?
- Are some of your prospects in the capital equipment squeeze?
- Know any customer who would like someone else to manage their computer facility?
- Do your customers really need processing scattered throughout the country in their own facilities?

These questions can be answered by CYBERPAK; and here is what this means:

4.2.1 6600 CYBERPAK

6600 CYBERPAK offers a fractional portion of a CDC[®] 6600 Computer System available under a standard lease arrangement. Each CYBERPAK customer can lease a fraction of a 6600 system, ranging in size from 1/40 of a system up to one complete 6600 system.

The lease price includes complete operation of the computer, maintenance equipment, facility management, availability of CYBERNET applications programs. The customer can access the 6600 through any of several terminals, including such systems as the CDC MARC-IV (wideband 8231) terminal, the CDC MARC-II (i.e., UT200), IBM 360 models, and Univac 9200's. Since there are no restrictions on terminal locations, the customer may purchase some fraction of a 6600 which is made up of several smaller fractions scattered throughout the United States (or even worldwide). In other words, the purchased fraction is not limited to use at one particular facility.

The 6600 CYBERPAK configuration is shown below:

<u>Quantity</u>	<u>Product Number</u>	<u>Description</u>
1	6613	Central Computer
1	6638	Disk System
2	6612	Console Display
1 or 2	6674	Data Set Controller
1 or 2	6671	Data Set Controller
3 or 4	6681	Data Channel Converter
1	3624	Magnetic Tape Controller
8 to 16	607	Tape Drives
1 to 3	8231	Card Reader/Printer Terminal
1	3234	Disk Controller
4 to 8	854 or 841	Disk Drive

The computer system operates under the most recent version of the Control Data SCOPE Operating System with several CYBERNET extras.

Customers may lease a portion of the system, including the operation and management of the facility.

Each user shares the computing resources with other users in a multi-programming environment.

The user pays only for the resources he employs, and then only to the extent they are used.

4.2.2 CYBER 70 MODEL 76 CYBERPAK

The Model 76 CYBERPAK works exactly like 6600 CYBERPAK. The first CDC Model 76 will be installed when the first one quarter of a Model 76 is sold (anticipated to be in the Twin Cities during early 1972). Consequently, this plan provides an excellent opportunity to eliminate some of the concern and uncertainty which a user may have about leasing a full CDC CYBER 70 Model 76. Start your prospect out on a one-year 1/4 CYBERPAK.

4.2.3 6400 KRONOS CYBERPAK

This conversational time-sharing service differs from the remote-batch CYBERPAK as the customer buys a fixed quantity of lines or ports with unlimited access -- just as if he had his own machine. However, instead of a small, slow, CPU and on-line storage, the user has a 10-port CYBERPAK which provides the speed and power of a CDC 6000 system.

Significantly, a prospect in the data services business can resell large-scale conversational time-sharing for a small, fixed cost expense and still have temporary overflow capacity on demand. He can devote his efforts to marketing time-sharing (instead of operations) and his investments to applications development (instead of excess capacity).

The university that now finds each department independently purchasing conversational time-sharing can reduce its costs significantly and also bring these services under closer control of the DP manager. This "cost and control" strategy can effectively be applied to other businesses as well as the university sector.

Expenditure for outside conversational time-sharing is often surprising when it is totaled. A KRONOS CYBERPAK can cut these costs in half with a commitment well below current expenditures. The advantages of obtaining this service from one vendor include:

- sharing of programs
- sharing of files
- mutual understanding of the common system
- greater leverage to get things done

4.3 CYBERNET Applications Library and Support

Customers who maintain their own programs may store these packages at a single CYBERNET Center, at multiple centers, or on his own system. In addition, CYBERNET Centers maintain a broad range of specific applications programs that can be used by any customer. Analysts can also train customers to use these packages and help them set up individual computer runs. The following packages represent a sampling of these sophisticated applications programs:

APT--A system which generates numerical instructions that guide numerically controlled machine tool production.

CENSTAT--A program which analyzes 1970 U.S. Census summary tapes and produces detailed reports based on census statistics.

EAC/EASE--An advanced program that performs elastic analysis for structural engineering applications.

LOADFLOW--A program for studying the performance of electrical power systems.

MRI/STARDYNE--A series of programs for analysis of linear elastic structural models.

NAR/SYSCAP--A program for analysis of electrical and electronic circuits.

NETFLOW II--A program which solves most network problems, especially those involving transportation of goods and services.

OPHELIE II--A system for solving large-scale mathematical programming problems.

OPTIMA--A mathematical programming system for solving large-scale linear programming problems.

PDQ/LP--An extremely fast linear programming system for small-to-medium-sized problems.

QUESTAIRE II--A general questionnaire analysis system which manipulates, describes, and displays data.

SYSTEM 2000TM--A general-purpose data management system which can be operated in batch or interactive modes.

3.0 FUTURE ANNOUNCEMENTS

Among other possible subjects for future CYBER 70 announcements are the following:

1. File processing station, continuing the philosophy of distributed computing to define a dedicated processor for mass storage device management, file management, and some record management functions.
2. Additional communications and terminal equipment and software.
3. CODASYL Data Definition Language/Data Manipulation Language (DDL/DML).
4. CYBER 70 Model 76 Software
 - SCOPE 2.X
 - Communications Software
 - Added features and packages for data management, upward compatible from Models 72, 73, 74
5. CYBER 70 Models 72, 73, 74 Software
 - SCOPE 3.4.X
 - KRONOS 2.X
 - INTERCOM 4.X
 - FORTRAN Extended 4.X
 - COBOL 4.X
 - QUERY/UPDATE 2.0
6. PL/I
7. APL
8. Compare/move instructions for CYBER 70 Model 76

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