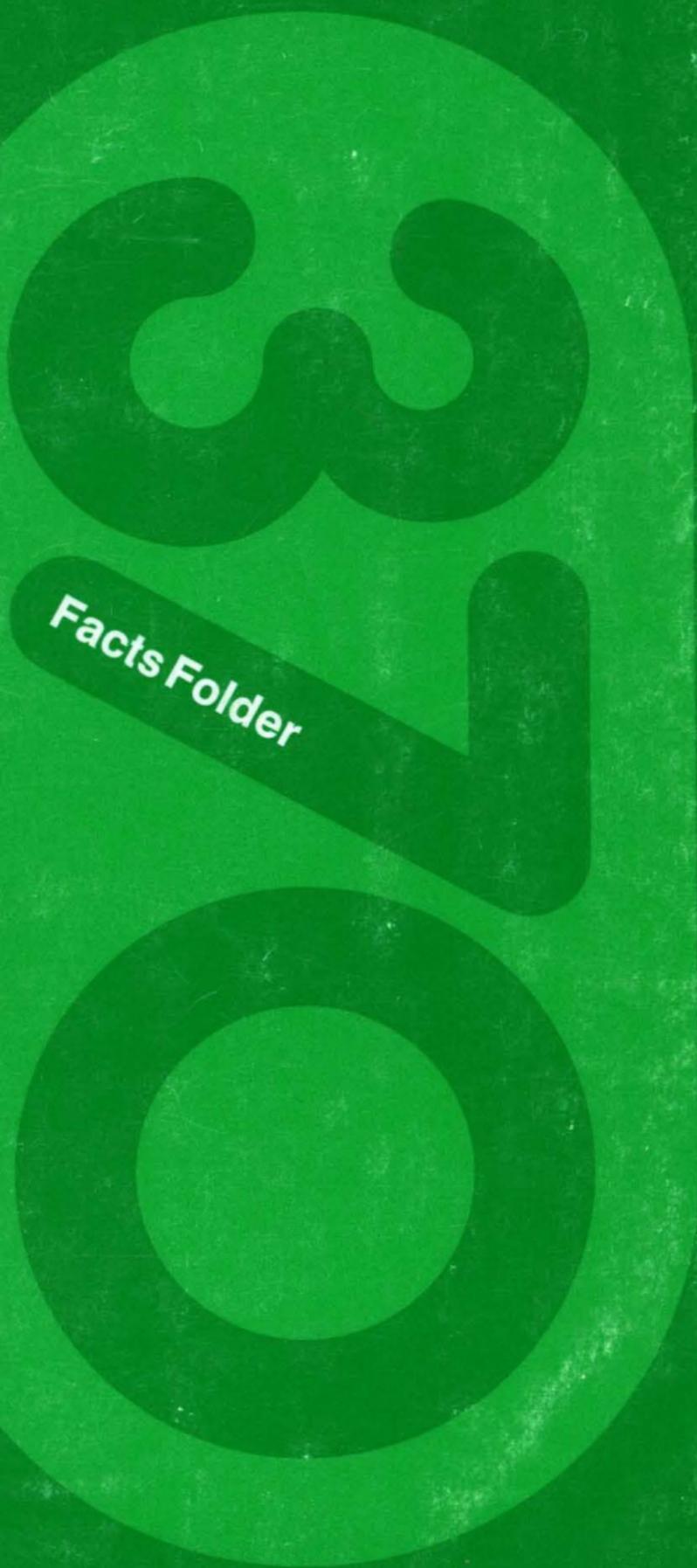


IBM

System/370 Model 135



Facts Folder



Model 135

System/370 Model 135 Facts Folder

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This facts folder describes the System/370 Model 135. Topics discussed include processing unit highlights, monolithic main and control storage, virtual storage, attachment of I/O devices, the devices themselves, and programming systems support. Reflecting the system's design, the brochure emphasizes reliability, availability, and serviceability.

This publication will be updated periodically to reflect system changes; however, the authoritative sources of system information are the system library publications for the Model 135, for its associated components and for its programming support. Consult your IBM representative for availability dates of various programming system functions and hardware components.

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**Description not included in this facts folder, but may be included in a system configuration.

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ABBREVIATIONS

bpibits per inch
bpsbits per second
cpicharacters per inch
cpm	. . .	.cards per minute
cps	. . .	.characters per second
ips	. . . .	.inches per second
KB	. . . .	.thousand bytes/second
KD	. . . .	.thousand digits
lpm	. . .	.lines per minute
MB	. . .	.megabytes (million bytes)
ms	. . . .	.milliseconds
usec	. . .	.microseconds
ns	. . . .	.nanoseconds

System/370 Model 135

System/370 is an extension of System/360 philosophy and architecture. The Model 135 is a microprogram-controlled system for intermediate workloads. Specifically the Model 135 is a growth system allowing users of System/360 Models 25 and 30 to extend computer applications to new areas while expediting existing workloads.

Particularly significant points are: (1) Extended System/370 architecture allows compatible growth from System/360 operating systems to a virtual storage environment using new System/370 operating systems. (2) Core storage is replaced by monolithic storage. (3) The Model 135 incorporates the I/O equipment for most of the System/370 line and supports most operating systems for the System/360 as well as most of the new operating systems for System/370.

In addition the Model 135 includes the following, which are explained later:

- Extended control mode of system operation, dynamic address translation, and channel indirect data addressing—features required for the implementation of virtual storage
- Integrated emulators under OS and DOS
- Standard OS/DOS Compatibility feature and optional OS/DOS emulator program
- Byte alignment
- Optional extended precision floating point
- A monitor feature to trace user-defined program events
- Interval timer of 3.33-ms (nominal) resolution
- Time-of-day clock with readout capability in 16-usec increments
- An optional CPU Timer and Clock Comparator with readout capability in 16-usec increments
- New instructions for System/370
- Block multiplexing
- Support of System/7 for sensor-based applications

Control and Processor (Main) Storage

The Model 135 uses monolithic storage for both processing and control storage. Control

storage is reloadable control storage (RCS) and is used primarily for microprogram residence. Manufacturing economies result from the reduction of the total amount of control storage required. Unused addresses are not available for processor storage. The amount of control storage is minimized because only the microcode required for a given system is resident. That is, the microcode is customized and supplied to the user on a disk, which is loaded from a dedicated console file. Particularly significant is the customer engineer's ability to load microdiagnostic code into control storage by changing the disk.

Functional capability is extended by the ability to more easily support different architectures in one system. Emulator microcode is quickly and easily loaded, as are special features, through the read-only console file.

Serviceability is increased because control storage is available for diagnostic residence and thus more extensive diagnostics can be provided without additional control storage. Further, design is simplified by a single-storage system with one storage-addressing design, a single set of sensing circuits, a common data flow design, etc.

Processor Storage

Model 135 storage is available as shown below.

CPU Model	Processor Storage
FE	98,304 bytes
GD	147,456 bytes
GF	196,608 bytes
DH	245,760 bytes

Larger main storage sizes available can contribute significantly to system performance--for example, by permitting the allocation of more main storage to language translators and sorts to improve their execution speed, and by permitting the execution of larger processing programs that reduce the necessity for overlay structures. Larger storage-level language translators and linkage editors provide more functions and execute faster. More and larger I/O buffers can

be used to speed up input/output operations and optimize use of direct access storage space. In most cases, more jobs can be executed concurrently in a multiprogramming environment.

Virtual Storage and Dynamic Address Translation

Even where large amounts of storage have been allocated in the early design of an application, processor storage requirements can exceed that provided. An application may be expanded by new functions or by an increased volume of transactions. Also, the number of batched jobs converted to online, terminal-oriented systems may grow.

In cases where additional programming effort to create additional job steps, or to develop a dynamic overlay structure, or to restructure terminal-based applications is not an acceptable alternative, a larger address space can be provided than contained in the real storage installed. (An address space is defined as a consecutive set of storage addresses that can be used for a program's instructions and data.) This requirement can be satisfied by providing an address space (called virtual storage) that is implemented using online direct access storage, dynamic address translation, and System Control Programming support (SCP). This approach also offers the advantage of supporting a larger address space for less cost than if larger processor storage were used, since direct access storage continues to be significantly less expensive per bit than processor storage. In addition, this approach offers functional capabilities that large processor storage alone cannot provide.

Virtual storage is an address space the maximum size of which is determined by the addressing scheme of the computing system in which it is implemented rather than by the actual number of processor storage locations present in the computing system. In System/370, for example, which uses a 24-bit binary address, a virtual storage as large as 16 MB can be supported. When virtual storage is implemented, the storage that can be directly accessed by the CPU, normally called processor or main storage, is referred to as real storage.

The dynamic address translation (DAT) facility is the mechanism that translates the virtual storage addresses contained in instructions into real storage addresses as each program instruction is executed. Address translation is accomplished in System/370 using a hardware-implemented table-lookup procedure (translation look-aside buffer) that accesses tables in real storage that are provided and maintained by the System Control Programming (SCP).

The SCP monitors the activity of the sections of executing programs and attempts to keep the most active sections of each program in real storage, leaving the least active sections on direct access storage except when they are needed for execution.

This division of a program into sections, the transfer of these sections to and from direct access and real storage, and the address translation necessary to accomplish this transfer are all handled entirely by the SCP.

Virtual Storage and DAT Terminology

Virtual storage is divided into fixed-length (either 2K or 4K), consecutively addressed sections called virtual storage *pages*. In general, virtual storage is allocated to problem programs in contiguous pages by the IBM-supplied operating systems that support virtual storage. Real storage, like virtual storage, is divided into fixed-length sections called *page frames*, each of which is the same size as the virtual storage page. Real storage page frames, unlike virtual storage pages, need not be contiguous.

The direct access storage used to contain virtual storage pages is called *external page storage*. As needed, the control program transfers instructions and data, by page, between external page storage and real storage. This process is called *demand paging*.

While most existing problem programs are pageable, some are not. A non-pageable program's addresses are identical to real storage addresses; to execute these programs sufficient contiguous real storage must be available to contain the entire program.

The following types of programs may not be pageable:

- Programs containing channel programs that are modified while active
 - Certain programs that use EXCP coding and/or contain I/O appendage routines
 - Programs that are highly time-dependent
- Specific restrictions vary among the virtual storage control programs.

Concurrent Virtual Machines

Virtual machine programming support (VM/370) extends the virtual storage concept to the total system. Each terminal user appears to have the complete functional capabilities of a dedicated System/370 at his disposal and can specify the configuration he requires: the number, type and I/O addresses of all device types to be used as well as up to 16 MB of storage. Multiple virtual machines may be running conversational, batch, or teleprocessing jobs at the same time on the same real computer.

For a discussion of this programming support, see "Virtual Machine Facility/370 (VM/370)".

Internal Performance

When measured against the same operating system and the same allocation of processor storage, the typical internal performance of the Model 135 exceeds that of the System/360 Model 30 by a multiple of 2 to 4.5 for commercial applications and a multiple of 3.5 to 7 for scientific applications.

Again when measured against the same operating system and allocation of processor storage, typical internal performance of the Model 135 exceeds that of the System/360 Model 25 by a multiple of 3.5 to 6.5 for commercial applications and a multiple of 5.5 to 16 for scientific applications.

Internal performance may not strictly relate to throughput when using different operating systems. These comparisons assume that the Model 135 is operating in basic control mode.

Processing Unit Features

- General upward compatibility with most System/360 architecture and programming

has been maintained through implementation of the basic control (BC) mode of system operation. A new extended control (EC) mode of operation is also provided. When the Model 135 operates in EC mode, the program status word (PSW) format and the layout of permanently assigned lower processor storage are altered to support additional system control and new functions (such as dynamic address translation); consequently the System Control Programming (SCP) designed for System/370 should be used. With some exceptions, existing user-written problem programs that operate under a System/360 operating system can operate under the new System/370 SCP designed as its successor.

- Dynamic address translation (DAT) hardware is standard. Operating only in EC mode, it provides translation of virtual storage addresses into real storage addresses during program execution.
- Channel indirect data addressing is a standard feature. Because an I/O buffer may be assigned to noncontiguous real storage areas, channel indirect data addressing is required to access a list of the real storage areas (page frames) assigned.
- Integrated emulators support the concurrent execution of System/370 programs with Model 20, and 1401/1440/1460 programs in a multiprogramming environment.
- An OS/DOS Compatibility feature is standard, and an OS/DOS emulator program is available. The combined emulator feature and companion program provide for the execution of a DOS supervisor and DOS programs under OS control.
- Byte (as opposed to word or doubleword) boundary alignment is permitted for the operands of nonprivileged instructions to reduce the need for padding bytes in records for the purpose of aligning fixed or floating point data.
- Extended precision floating point is available to provide precision of up to 28 hexadecimal digits, equal to up to 34 decimal digits.
- A monitor function is standard and can be used to trace user-defined program events for debugging or gathering statistics.

- System/370 general purpose instructions can be used to (1) reduce the need for multiple move instructions or move subroutines, (2) facilitate field padding, storage clearing, and record blocking and deblocking, and (3) improve decimal arithmetic performance.
- Other new instructions are implemented for dynamic address translation and for extended control mode.
- Operator console devices include a 15-cps console printer-keyboard, and an 85-cps console printer-keyboard for faster display.
- A lighted console panel Reference Display Window provides literal text as a decoding aid that describes such things as status of Integrated Communications Adapter (ICA) lines and modems, CPU and I/O checks, an alter/display mnemonics guide for the console printer-keyboard, a binary/hexadecimal conversion guide, as well as references for the customer engineer (external registers display and diagnostic reference display). A knob provides the operator with a choice of lines of information that designate the data required.

Control Storage Requirements

As discussed earlier under "Control and Processor (Main) Storage", reloadable control storage is housed in the 3135 Processing Unit along with main storage, arithmetic and logic circuits. Reloadable Control Storage is loaded from the console file. 24,576 bytes of control storage are standard; two additional increments of 12,288 bytes each are available, if required, to support special features.

Control storage requirements are determined by those features selected from the table below. The table specifies an exact number of bytes for each feature. The total amount for all the features selected determines whether or not the additional increments are required. In effect, control storage is simply "packed" until it reaches the capacity of a given increment, at which point another increment is added.

If the total from the table exceeds 24,576 but is not greater than 36,864, the first 12K control storage increment is required. If the total is greater than 36,864, the second 12K control

storage increment is also required. The total for all features ordered cannot exceed 49,152.

Control Storage Requirements

Basic Systems Microcode	15,482
Block Multiplexer Channel	1,568
Direct Control	50
Extended Precision Floating Point	676
Floating Point	1,200
64 Byte Multiplexer Subchannels	1,024
128 Byte Multiplexer Subchannels	2,048
256 Byte Multiplexer Subchannels	4,096
1401/1440/1460 Compatibility	3,492
Integrated Communications Adapter	2,100
Integrated File Adapter for 2319*	4,652
Integrated File Adapter for 3330*	10,192
Integrated Printer Adapter	1,300
Selector Channel**	1,584
Model 20 Compatibility	876
3210 Model 1 Adapter	1,494
3215 Model 1 Adapter	1,930
Synchronous Data Adapter Type II**	3,700
Terminal Adapter Type I Model II**	1,700
Terminal Adapter Type III**	2,100
CPU Timer and Clock Comparator	1,400

*IFA for 2319s and 3330s are mutually exclusive.

**The specified control storage is required once only: in the case of selector channels, for one or two channels; in the case of adapters, for any number of lines of one type adapter.

System Technology—Monolithics

The Model 135 uses monolithic system technology (MST) for *logic* circuitry. In addition, control and local storage *and processor storage* are implemented using monolithic technology instead of wired, discrete ferrite cores. With monolithic circuitry more storage capacity is compacted into a smaller space. The basic storage device is a silicon chip less than 1/8-inch square with more than 1400 components in 174 complete circuits, including 128 storage cells and 46 supporting circuits.

Reliability, Availability, Serviceability

High computer productivity is maintained because (1) retry of most failing instruction executions is handled automatically by the

hardware without programming assistance, (2) the use of error checking and correction (ECC) hardware, which is standard, automatically corrects all single-bit errors and detects all double-bit and some multiple-bit errors in main and control storage, and (3) extensive hardware and programming systems error recovery and repair features are provided.

The console file is used for loading and executing diagnostic routines and is a basic debugging tool for the system. These prewritten (read-only) disk devices are used primarily to load control storage with the customized microcode for a specified system. Normally only a single cartridge containing the system microcode will stay loaded. Only the customer engineer will need to mount or dismount cartridges to perform diagnostics or to reconfigure the system.

A service for both hardware and software reliability is RETAIN/370 (REmote Technical Assistance and Information Network), which is available to IBM rental and purchase customers with an IBM Maintenance Agreement for System/370. RETAIN/370 enables the on-site customer engineer to describe problem symptoms to Technical Support Center personnel for their analysis. Specialists can expedite problem identification and repair.

Program support personnel may also use RETAIN/370 facilities to diagnose program problems. The personnel need only supply the external symptoms of a particular program problem to obtain pertinent maintenance information. Time formerly spent in manually searching documentation for previously defined problems is eliminated. The time span from a problem's initial appearance until it is resolved for all users can be dramatically reduced.

Timers

Readout resolution of the timers is affected by the number and type of I/O operations being performed. New instructions control the system timing facilities and operate on bits 0 through 47 of the 51-bit timers.

An interval timer of 3.33 ms is provided to improve job accounting accuracy. A time-of-day

clock is included to provide time-of-day values in conjunction with available programming support.

A CPU Timer and Clock comparator are optional. The CPU Timer provides an interval timing capability equivalent to that of the interval timer but has a 16-usec readout capability, equal to that of the time-of-day clock. The Clock Comparator can be used to cause an interrupt when the time-of-day clock reaches a specified value. The CPU Timer and Clock Comparator provide higher resolution timing than the standard interval timer.

Channels

Model 135 can support significantly faster I/O devices than can Models 25 and 30. A byte multiplexer channel is standard. One or two high-speed selector channels can be installed. An Integrated Communications Adapter (ICA) is an optional feature. The Integrated File Adapter (IFA) optional feature can coexist on a system with the multiplexer and selector channel(s).

Model 135 channels are integrated. They share with the CPU the use of control storage, use of the CPU and processor storage data flow, and use of the CPU arithmetic logic unit. Integrated channels result in reduced space and power requirements, and in total system economies.

Selector Channels

One or two selector channels are available on a Model 135 and may be included with the Integrated File Adapter feature installed.

Selector channels on a Model 135 are functionally equivalent to System/360 selector channels but support significantly higher data rates than Models 25 and 30 channels.

Data is transferred between processor storage and the four-byte buffer in each channel, one or two bytes at a time, using cycle stealing. Single-byte transfers occur when the first or last byte of a data block is on an odd storage address. The maximum data rates that can be sustained by the first and second selector channels, respectively, are 1.3 MB and 1.2 MB. Maximum aggregate selector channel rate is 2.4

MB. This maximum data transfer activity, however, interferes with CPU and byte multiplexer channel activity.

With the Integrated File Adapter, non-IFA direct access devices should be attached to the higher-priority (for command chaining operations) selector channel, which is normally the first selector channel. With IFA-attached 2319s plus 3330 Disk Storage on the higher-priority selector channel, the lower-priority selector channel should be limited to devices with data rates not exceeding 144 KB. Selector channel priorities for command chaining may be reversed with the Channel Priority special feature. With the 3330 IFA, no other direct access devices may be attached to the system.

Block Multiplexer Mode

Block multiplexer mode of operation for all installed selector channels is a no-charge optional feature. This mode is designed to increase system throughput by increasing the amount of data entering and leaving the system in a given period of time (the effective data rate). A selector channel operating in block multiplexer mode can support interleaved, concurrent execution of multiple high-speed I/O operations, much as the byte multiplexer channel can be shared by multiple low-speed devices.

When Model 135 selector channels function in block multiplexer mode, the channel disconnects from the channel program during certain nondata transfer operations and becomes available for an I/O operation on another device so that data transfer operations are interleaved.

In selector mode, upon initiation of a command-chained program, the channel remains busy for the entire time the channel program is in operation, whether or not data is actually being transferred.

The channel indirect data addressing function is standard.

Rotational Position Sensing

This capability (standard on the 3330 Disk Storage) in conjunction with block multiplexer channel mode, can make channel operations

more efficient by permitting the channel to be disconnected and later reconnected just before the desired record is about to come under the read/write heads--that is, when the desired rotational position is reached. During the interval when the channel is disconnected, data records for other channel programs may be transmitted on the channel data path. In conjunction with multiple requesting, rotational position sensing permits better utilization of the control unit, devices, channel, and CPU. (Multiple requesting permits several I/O commands to be queued in the control unit.)

Byte Multiplexer Channel

The byte multiplexer channel is designed to operate primarily in byte-interleaved mode, permitting several slow-speed devices to operate concurrently, and can operate in burst mode, allowing one high-speed device at a time to function. However, burst mode operation of unbuffered devices is not recommended.

Sixteen subchannels are standard, and 64, 128, or 256 subchannels are available. The number of subchannels available is not related to the size of processor storage, but because control storage must be allocated when the system microcode is customized, the user must specify the number of subchannels.

Integrated File Adapter (IFA)

This optional feature provides the Model 135 with a means of directly attaching 2314 or 3330-type disk drives. Neither a selector channel nor a disk control unit is required. With this feature, although the disk drives do not connect to a standard I/O channel, they are programmed as if they did.

Combinations of models of 2319, 2312, and 2318 Disk Storage units can be connected via the adapter for configurations of three to eight natively attached disk drives. Coexisting with any of the above IFA configurations, standard control unit attachment of one to eight 2314 facilities can be attached to one selector channel.

Alternatively, a 3330 subsystem may be attached for a maximum of 16 IFA-attached drives.

Configurations are discussed in the 3330 description.

Integrated Printer Adapter (IPA)

This optional feature permits direct attachment to the Model 135 of one 1403 Printer, Model 2, 7, or N1, without the necessity of a 2821 Control Unit. The Universal Character Set feature can be optionally specified for 1403 Models 2 and N1.

Integrated Communications Adapter (ICA)

Integrated Communications Adapter (ICA) is an optional facility similar to that provided for System/360 Model 25. Both provide for the attachment of remote and local I/O devices operating through various user-owned or common-carrier facilities. ICA permits the attachment of up to eight teleprocessing lines to the Model 135 without the need for a separate communications control unit such as the 2701 Data Adapter Unit or 2702/2703 Transmission Control. Lines connected via the ICA are addressed and logically operate as if attached to the byte multiplexer channel via a 2701 Data Adapter Unit. Specific adapter types allow teleprocessing lines in various combinations of start/stop and binary synchronous communications lines.

ICA can coexist on a Model 135 with a 2701, 2702, 2703 or 3705 when these units are providing teleprocessing services on the byte multiplexer channel. The Integrated Communications Adapter also operates in a manner that combines the functions of a byte multiplexer channel and a communications control unit such as the 2701 or 2703.

Lines from a Model 135 Integrated Communications Adapter can connect to:

Terminal Adapter Type I, Model II

1050 Data Communication System

2711 Line Adapter Unit

2740 Communication Terminal (Models 1 and 2)

2741 Communication Terminal

2760 Optical Image Unit (via 2740-1)
System/7
Terminal Adapter Type III
2845 Display Control for 2265 Display
Stations
2848 Display Control (Models 1, 2, and 3) for
2260 Display Stations (Models 1 and 2)
Synchronous Data Adapter Type II
A System/360 or System/370 with a 2701
Data Adapter Unit, 2703 Transmission
Control or 3705 Communications Control
Unit
Another System/370 Model 135 with the
ICA and Synchronous Data Adapter Type II
feature
System/3 with the Binary Synchronous
Communications Adapter
Model 20 with the Binary Synchronous
Communications Adapter
Model 25 with the Integrated Communica-
tions Adapter and Synchronous Communi-
cations Adapter
1130 System with the Synchronous
Communications Adapter
1800 System with the Communications
Adapter
2770 Data Communication System
2780 Data Transmission Terminal
2790 Data Communication System (via
2715-2)
3270 Information Display System
3735 Programmable Buffered Terminal

3046 Power Unit

One 3046 is used with each 3135 Processing Unit to provide the 400-hertz power requirement.

Input/Output Equipment

In addition to I/O devices described in this facts folder, most devices that attach to a System/360 Model 25 or larger can be attached to the System/370 Model 135. The new System/370 System Control Programming may not, however, provide programming systems support for devices that would degrade system performance.

A numeric listing of attachable I/O follows the Contents and may serve as an index to this facts folder. Consult your IBM representative if questions arise regarding programming systems support of I/O or attachment of devices not listed.

Direct Access Storage

3330 Disk Storage, 3830 Storage Control, and 3330 IFA

Large-capacity, high-speed direct access storage utilizing 3336 Disk Packs. Each 3330 module houses two disk drives.

If full track records are used, each drive has a capacity of 100,018,000 bytes. Data rate is 806 KB.

Rotational position sensing with multiple requesting, inline diagnostics, and command retry by control unit and channel are standard. The 3330 subsystem incorporates error detection, correction, and logging features.

On the 3830 a program-controlled two-channel switch that may be attached to the same CPU or shared by different CPUs is optional. An additional two-channel switch on the 3830 Model 2 permits switching between four channels.

A 3330 subsystem may consist of a channel-attached 3830 Storage Control, Model 2, and one or two 3333 Disk Storage drive module(s), to each of which one, two, or three 3330 Disk Storage drive module(s) may be attached.

Using the 3330 Integrated File Adapter IFA, a subsystem may consist of the 3330 IFA and one or two 3333 Disk Storage drive module(s), and one, two, or three 3330 Disk Storage drive module(s), attached to each of the 3333s.

2319 Disk Storage

2319 Disk Storage consists of three disk drives (each with a maximum capacity of 29 MB) for a total of 87 MB per 2319. The disk drives in the 2319 are functionally and program-compatible with 2314-type disk storage drives. Interchangeable 2316 Disk Packs are used as the storage medium.

A 2319-A1 attaches directly to the Model 135 via the Integrated File Adapter. With the 2319-A1 as the first unit attached, a 2319-A2 may be attached as an additional unit connected to the IFA via the 2319-A1. The 2319-A1 and the 2319-A2 each consist of three disk drives, and to this six-drive combination either a 2312 (single drive) or 2318 (two-drive) Disk Storage Unit may be added.

An alternative to the attachment of the 2319-A2 to the 2319-A1 can be combinations of 2312, 2313 (four-drive), or 2318 units attached to the 2319-A1 so long as the total number of drives connected via the IFA does not exceed eight for any configuration.

Average access time is 60 ms; 25 is minimum and 130 is maximum. Data rate is 312 KB.

Whether or not the IFA is installed, 2314 A and B series DASF can be channel-attached (see 2314 below).

2314 Direct Access Storage Facility

Mechanically and electronically independent storage drives utilize removable and interchangeable 2316 Disk Packs. Facilities may be configured with one to nine independent disk drives (on a nine-drive facility the ninth is a spare). Each module can store up to 29,176,000 bytes on a disk pack, so that facilities may have from 29,176,000 to 233,408,000 bytes of online storage depending on the number of independent drives. Average access time is 60 ms. Data rate is 312 KB. A 2314 facility attaches to a selector channel. 2314-A drives without a control unit may also be attached via the IFA and 2319.

2311 Disk Storage Drive

The 2311 Disk Storage Drive can store up to 7,250,000 bytes on 1316 Disk Packs.

Average access time is 75 ms; maximum is 135 ms.

The reading/writing rate of up to 156,000 bytes/second permits efficient sequential and random access processing.

Up to eight 2311 Disk Storage Drives can be attached to the 2841 Storage Control for a total of 58 MB of online direct access storage.

2841 Storage Control

Control unit for 2302, 2303, 2311, and 2321. Attaches to a selector channel.

2844 Auxiliary Storage Control

Provides a second functionally identical control unit for the 2314 Storage Control, Model A1, and thus the ability to switch any of the eight 2314 A series DASD modules between the two control units under program control. The second path to the data permits two concurrent data transfer operations.

Magnetic Tape Equipment

3803/3420 Magnetic Tape Subsystem

Consists of 3803 Tape Control and a family of three 3420 Magnetic Tape Units. Recording format is 9-track, 1600-bpi, phase-encoded. Standard features include automatic tape threading, cartridge loading of 2400-foot reels, and a new automatic tape reel hub latch, all of which reduce setup time and minimize the possibility of tape damage. Optional features include dual density (1600/800 bpi), 7-track (556/800 bpi) capability, and tape switching combinations of up to 16 drives and 4 control units. With the two-channel switch feature on the 3803, a control unit can be accessed from either of two channels.

Characteristics	Model 3	Model 5	Model 7
Nominal data rate (KB)			
at 1600 bpi PE	120	200	320
at 800 bpi NRZI	60	100	160
at 556 bpi (7-track)	41.7	69.5	111.2
Recording density (bpi)	1600/ 800/556	1600/ 800/556	1600/ 800/556
Tape speed (ips)	75	125	200
Nominal interblock gap (inches)			
9-track	0.6	0.6	0.6
7-track	0.75	0.75	0.75
Nominal IBG/IRG time (ms)			
9-track	8.0	4.8	3.0
7-track	10.0	6.0	3.75
In-column rewind time (seconds) 2400 ft.	70	60	45
Nominal rewind and unload time (seconds)	76	66	51
Autothreading operation (seconds)*	10	10	7
Nominal read access time to data (ms)	4.0	2.9	2.0

*From initiation (using mounted supply reel) to "tape-drive ready"

3410/3411 Magnetic Tape Subsystem

A 3410/3411 subsystem consists of a primary drive (3411) to which multiple satellite tape units (3410) may be attached. Recording format is 9-track, 1600-bpi, phase-encoded. A dual density feature permits reading and writing 800-bpi NRZI tapes. A 7-track feature allows reading and writing 7-track tapes of 200-bpi, 556-bpi, or 800-bpi format.

Mechanical features are a new push-pull type of quick release latch for tapes, a simplified tape path for easier threading, and a single capstan drive.

While the 3803/3420 fulfills the requirements of systems for very high speed, the 3410/3411 is designed for systems or those parts of a configuration with lower speed requirements. The price for the 3410/3411 is correspondingly lower than that for the faster subsystem.

The 3410/3411 subsystem requires less floor space because of the integration of the control

unit with one of the tape units. Floor space requirements are also minimized because the cable-connected units can be placed at any angle up to 90 degrees in relation to each other.

Each 3411 Magnetic Tape Unit and Control contains a single tape unit, the subsystem's power supply, and control circuitry for 3410 Magnetic Tape Units with the same data rate, so that model numbers for 3411s and 3410s correspond. On System/370, the 3411 Model 1 will attach up to three additional units, 3410 Model 1s, for a maximum of 4 tape units. The 3411 Model 2 will attach up to 5 additional units, 3410 Model 2s, for a maximum of 6 tape units. The 3411 Model 3 will attach up to 5 additional units, 3410 Model 3s, for a maximum of 6 tape units.

Characteristics	Model 1	Model 2	Model 3
Nominal data rate (KB)			
at 1600 bpi	20	40	80
at 800 bpi	10	20	40
at 556 bpi	6.9	13.9	27.8
at 200 bpi	2.5	5	10
Tape speed (ips)	12.5	25	50
Recording density (bpi)	1600/800/ 556/200	1600/800/ 556/200	1600/800/ 556/200
Nominal access time (ms) to data	15	12	6.0
Nominal interblock gap (inches)	0.6	0.6	0.6
Max. reel size (inches)	10.5	10.5	10.5
Rewind time (min/reel)	3	3	2

2401 Magnetic Tape Unit

A single tape drive requiring connection to a control unit.

Model 1--30 KB at 800 bpi*

Model 2--60 KB at 800 bpi*

Model 3--90 KB at 800 bpi*

Model 4--60 KB at 1600 bpi

Model 5--120 KB at 1600 bpi

Model 6--180 KB at 1600 bpi

Model 8--Operates only in the seven-track format at 200, 556, or 800 bpi with data rates of 15, 14.7, or 60 KB.

***Can operate with seven- or nine-channel capabilities with appropriate special features.**

2415 Magnetic Tape Unit and Control

Each model has one single-channel tape control and multiple independently operating tape drives.

Model 1 has two 800-bpi, 15 KB tape drives.

Model 2 has four 800-bpi, 15 KB tape drives.

Model 3 has six 800-bpi, 15 KB tape drives.

Model 4 has two 1600-bpi, 30 KB tape drives*.

Model 5 has four 1600-bpi, 30 KB tape drives*.

Model 6 has six 1600-bpi, 30 KB tape drives*.

***Can operate at 800 bpi when equipped with an appropriate compatibility feature.**

Characteristics	Models 1-6
Tape speed (ips)	18.75
Nominal IRG time (ms)	32
Rewind time (minutes)	4
Rewind and unload (minutes)	4

2420 Magnetic Tape Unit

Recording format is 9-track, phase-encoded.

Model 5--160 KB at 1600 bpi (see chart below)

Model 7--320 KB at 1600 bpi (see chart below)

Characteristics	Model 5	Model 7
Nominal data rate (KB)	160	320
Density (bpi)	1,600	1,600
Tape speed (ips)	100	200
Nominal interblock gap (inches)	0.6	0.6
Nominal IBG/IRG time (ms)	6	3
Rewind time (minutes)	1.2	1.0
Rewind and unload (minutes)	1.3	1.1
Autothreading operation (seconds)*	10	7

***From initiation (using mounted supply reel) to "tape-drive ready"**

2803 Tape Control

Control unit for 2401. A single control unit controls up to eight tape drives. Eight control units can be connected to a selector channel.

Sixteen-drive addressing is available as a special feature. With an appropriate special feature, the Model 2 can also control 2420 Magnetic Tape Units.

2804 Tape Control

Control unit of the 2803 type that allows simultaneous read and write using two channels. Model 3 attaches only to a 2401 Model 8.

2816 Switching Unit

Unit to provide switching between 2803 Tape Controls, Model 2, and 2420 tape units, either alone or intermixed with any model combination (1-6) of 2400-series tape units.

Card Readers and Punches

3505 Card Reader

Model B1 reads up to 800 cpm.

Model B2 reads up to 1200 cpm.

Attaches to selector or multiplexer channel via the control unit contained within the 3505. When equipped with a 3525 adapter, the control unit provides the additional control unit hardware required for independent, fully buffered operation of one 3525 Card Punch. While only one control unit position of a channel is required, two subchannels and separate unit addresses are used. The 3505 and 3525 appear to the channel to be two logically and physically independent devices. (Many failures can be diagnosed and repaired on one unit while the other continues to operate.)

Standard features are a 3000-card-capacity file feed and one logical stacker consisting of two physical stackers, each with a 1750-card capacity. Cards are initially placed in the right stacker. A full right stacker causes an operator signal light to be activated and cards are then placed into the left stacker if it is ready. Reactivation of the right stacker is automatic after the left stacker is filled, if the cards have been removed and the operator has set the stacker ready switch to the on position.

The optional Selective Stacker feature permits cards to be directed under program control to a second logical stacker (third physical stacker).

Automatic feed retry is standard. If a card fails to feed on the first try, the 3505 makes three feed retries before indicating a misfeed.

Standard Card Image feature for the 3505 provides the same function that the Card Image of the Column Binary feature provides for other readers. Read Column Eliminate (RCE) can also be operative during column binary mode reading. Read Column Eliminate is a standard programmable feature that permits the 3505 to ignore card columns containing perforations that would normally cause a read check.

Optical Mark Reading (OMR) is a special feature that allows up to 40 marks per 80-column card to be read by the 3505. Both vertical mark fields and punched-hole fields can be read in one pass of a card. Vertical marks can be preprinted on cards in a nonreflective ink, or can be made with a No. 2 or equivalent pencil.

For the Model B2, an optional feature provides the operator with a means of adjusting the read feed to accommodate 51-column or 80-column cards. With this feature installed, the stacker capacity is permanently reduced to 1500 cards.

3525 Card Punch

Model P1 punches up to 100 cpm.

Model P2 punches up to 200 cpm.

Model P3 punches up to 300 cpm.

The 3525 attaches to a channel via the 3505 Card Reader. Only one 3525 can be attached to each 3505 and a 3525 adapter must be installed in the 3505 (see the 3505 above). The three models of the 3525 punch differ only in speed, and any 3525 model can be combined with either 3505 model.

Standard features are a 1200-card-capacity file hopper, two 1200-card-capacity stackers, automatic punch retry, and a dedicated error stacker.

Automatic punch retry (when combined read/punch operations are not being performed) is controlled by the control unit without program or operator intervention. When a punch error is detected, the control unit directs the erroneously punched card to the 200-card-capacity dedicated error stacker. Output data stored in the buffer is repunched into the next card.

Optional Card Read feature allows reading and punching in one pass. Read Column Eliminate (see the 3505 above) is standard on a 3525 with the read feature.

The Multiline Card Print special feature provides the punch with a print station between the post-punch wait station and the stacker. Printing may occur on any or all of 25 lines on each card under program control. A prerequisite is the 3525 Multiline Print Control feature on the 3505 Card Reader.

With the Multiline Card Print feature, throughput varies with the model, the number of lines printed, and the location of the lines. Some typical rates are:

Number of Lines	Line Position	Throughput Rate		
		P1	P2	P3
1	1	100	200	300
4	11-14	67	114	133
10	11-20	44	62	67
25	All	24	29	30

A Two-Line Card Print special feature is similar to the Multiline Card Print feature, but provides printing on lines 1 and 3 only (between the top edge of the card and punch row 12 for line 1, and between punch rows 12 and 11 for line 3).

2540 Card Read Punch

Reads up to 1000 cpm. Punches up to 300 cpm. Special features include Punch Feed Read Control and Column Binary.

2501 Card Reader

Model B1 reads 600 cpm.
Model B2 reads 1000 cpm.

2520 Card Read Punch

Reads and punches up to 500 cpm.

2821 Control Unit

Control and buffer storage for 2540 Card Read Punch and/or 1403 Printers.

Model 1 controls a 2540 Card Read Punch and one 1403 Printer.

Model 2 controls one 1403 Printer.

Model 3 controls two 1403 Printers, Model 2, 7, or N1, in any combination; with Third Printer Control feature, it controls three 1403 Printers.

Model 5 controls a 2540 Card Read Punch and two 1403 Printers, Model 2, 7, or N1, in any combination; with Third Printer Control feature, it controls three 1403 Printers.

Model 6 controls one 2540 Card Read Punch.

2596 Card Read Punch

A punched card input/output unit that uses 96-column cards, the 2596 provides 96-column-card data interchange between System/3 and System/370 or System/360.

Reads 500 cpm and will not overrun.

Punches 120 cpm and is fully buffered.

An optional feature provides interpreting at a print speed of 120 cpm. Interpreting will take place during the same pass as punching with no loss of card punching speed. Printing consists of three lines of 32 characters each.

The unit cannot read and punch (or read and punch/print) the same card on a single pass.

A channel-connected unit, the 2596 contains its own control unit. The number of 2596s that can be attached to a system depends on the number of system channel control unit positions available.

1442 Card Read Punch and Card Punch

These 80-column-card devices attach via the multiplexer channel. Model N1 reads 400 cpm and punches up to 160 columns/sec. Model N2 punches up to 160 columns/sec.

Printers

3211 Printer

132 print positions, 2000 lpm with standard 48-character set. Universal Character Set is standard. Larger character sets available as an option operate at lower speeds. Interchangeable train cartridge contains 432 graphics. The cartridge character arrangement is unrestricted (27-character minimum) and can be alphabetic, numeric, or special characters in any combination. When the character arrangement is optimized for specific printing loads, speeds of

up to 2500 lpm can be attained. A line with 150 print positions is optional and there is no decrease in speed with the longer line. A tapeless carriage feature controls forms spacing and skipping using a program-loaded forms control buffer contained within the control unit.

The 3211 attaches to a 3811 Control Unit, which controls only one 3211.

1403 Printer, Model N1

132 print positions, 1100 lpm (1400 lpm maximum with Universal Character Set feature). Type 1416 Interchangeable Train Cartridge required. Attaches directly to an Integrated Printer Adapter (optional) or via a 2821 Control Unit to a byte multiplexer subchannel. Optional: Universal Character Set feature.

1403 Printer, Model 2

132 print positions, 600 lpm (750 lpm maximum with Universal Character Set feature). Attaches directly to an Integrated Printer Adapter (optional) or via a 2821 Control Unit to a byte multiplexer subchannel. Optional: Auxiliary Ribbon Feeding, Interchangeable Chain Cartridge Adapter, Universal Character Set feature.

1403 Printer, Model 7

120 print positions, 600 lpm. Attaches via a 2821 Control Unit. Optional: Auxiliary Ribbon Feeding, Interchangeable Chain Cartridge Adapter.

Consoles

3215 Console Printer-Keyboard and 3210 Console Printer-Keyboard, Model 1

The 85-cps 3215 Console Printer-Keyboard is attached to the right-hand extension of the Model 135 console reading board for use as the operator console device.

Alternatively, the 3210 Console Printer-Keyboard with a print speed of 15 cps can be used. Both the 3215 and the 3210 are attached via integrated adapters. Both are functionally compatible and program compatible with each other and with the 1052.

Of benefit to operators and customer engineers is the alter/display mode of operation. This permits data to be placed in, or printed from:

- Processor storage

- General, floating point, and control registers

- The current PSW

- A storage protect key

- Control storage (display only)

Keyboards for both the 3210 and the 3215 are identical to that of the 1052, except for certain coding key changes that have been made for operator convenience.

Communication Terminals

3270 Information Display System

The 3270 Information Display System provides for the attachment of display terminals and printers to meet the user's needs for man-machine alphanumeric input/output.

A choice of control units provides for local or remote terminal groups. The 3271 Control Unit provides for remote terminal groups using binary synchronous transmission over a leased or privately owned communication network. The 3272 Control Unit provides for local terminal groups that are channel-connected (direct attachment). For standalone (single-remote) applications the 3275 Display Station does not require a control unit and uses the binary synchronous communications technique. Multidropping of the 3275 (interconnecting several stations via one communication line) and a 3271 Control Unit is possible.

Display stations are available in two models. Model 1 of either the 3277 or the 3275 displays up to 480 characters on the face of a cathode ray tube. Model 2 of either the 3277 or 3275 displays up to 1920 characters. Two print units are available for a choice of speed: the 3284 prints 40 cps; the 3286 prints 66 cps. Normally printer model numbers are selected according to the configuration, so that the display and printer have buffers of equal capacity. Model 1s are used in applications where printers are associated with the 480-character screen. Model 2s are used where printers are associated with

the larger 1920-character screen. Model 3s are used in standalone-remote applications.

Three basic types of keyboards are available: typewriter, data entry, and operator console. A data entry keyboard, for example, is of the keypunch variety and has numerics grouped in rows and columns. All keyboards work in conjunction with a display station to allow a display operator to compose, edit, and enter messages into the CPU. Each keyboard is movable with editing features such as typamatic cursor, tab, back tab, insert-delete, and erase (end of field, keyboard input data, entire screen).

Flexibility is further extended by a selector light pen that allows a display operator to identify portions of a system message for data entry.

Buffer storage in the display device permits simultaneous display image presentation and message composition from a keyboard at each display station.

An Operator Identification Card Reader is available for attachment to the 3270. The use of this device with the associated magnetically striped and encoded plastic ID cards provides controls over access to the system for user enforcement.

Buffering of displays and printers permits copying the data from a display for printing, or copying the data from one display at another display. In standalone-remote applications the data from a display may be copied by the printer because of buffer sharing.

The numerical listing below identifies IBM 3270 System series units:

3271 Control Unit, Model 1--for remote displays

3271 Control Unit, Model 2--for remote displays

3272 Control Unit, Model 1--for direct attachment to system channel

3272 Control Unit, Model 2--for direct attachment to system channel

3275 Display Station, Model 1--standalone-remote

3275 Display Station, Model 2--standalone-remote

3277 Display Station, Model 1--attaches to control unit

3277 Display Station, Model 2--attaches to control unit
3284 Printer, Model 1--40 cps
3284 Printer, Model 2--40 cps
3284 Printer, Model 3--40 cps (standalone)
3286 Printer, Model 1--66 cps
3286 Printer, Model 2--66 cps

Configurations:

Scattered terminals at remote locations are described below under the heading "Standalone-Remote". Local clusters (groups) of terminals are described under "Direct Attachment". The heading "Remote Clusters" is self-explanatory. There is a choice of screen sizes--480- or 1920-character displays--and of printer speeds--40 or 66 cps.

A display system may be designed to include both of the display station sizes and both speeds of printers. Each control unit can direct the operation of up to 32 attached display stations, 31 printers and one display, or a mixture in which the total number of display stations and printers does not exceed 32.

Standalone-Remote

A 3275 Display Station, Model 1 (480 characters), or a 3275 Display Station, Model 2 (1920 characters), does not require a control unit, and each configuration may include a 3284 Printer, Model 3 (40 cps).

*Direct Attachment (local)**

For 480-character displays, a 3272 Control Unit, Model 1, and a 3277 Display Station with keyboard, Model 1, are prerequisites. 3284 Printers, Model 1 (40 cps), or 3286 Printers, Model 1 (66 cps), may be included.

For 1920-character displays, a 3272 Control Unit, Model 2, and a 3277 Display Station with keyboard, Model 2, are prerequisites. 3284 Printers, Model 2 (40 cps), or 3286 Printers, Model 2 (66 cps), may be included.

*Remote Clusters**

For 480-character displays, a 3271 Control Unit, Model 1, and a 3277 Display Station with keyboard, Model 1, are prerequisites. 3284 Printers, Model 1 (40 cps), or 3286 Printers, Model 1 (66 cps), may be included.

For 1920-character displays, a 3271 Control Unit, Model 2, and a 3277 Display Station with keyboard, Model 2, are prerequisites. 3284 Printers, Model 2 (40 cps), or 3286 Printers, Model 2 (66 cps), may be included.

*In either direct attachment or remote cluster configurations, additional display stations, Model 1 or 2, and either 3284 or 3286 Printers, Model 1 or 2, may be intermixed when attached to the Model 2 of the 3271 or 3272 Control Unit, but the programming must not attempt the reading of 1920 characters into a 480-character buffer.

3780 Data Communications Terminal

The 3780 Data Communications Terminal is a combination card reader, line printer, and control unit that reads up to 600 cpm, transmits and receives at speeds up to 7,200 bps, and prints up to 425 lpm. The terminal uses binary synchronous communications (BSC) over common-carrier facilities for communications with other BSC terminals and with a System/360 or System/370 equipped with a 2701, 2703, or 3705. The 3780 can share common-carrier leased and private line switched communications facilities with other BSC terminals, and can transmit in half-duplex mode at a choice of speeds depending on the modem attached. Two 512-character buffers, space compression/expansion, and horizontal format control are provided. Either EBCDIC or ASCII must be specified as the code for transmission and reception.

3735 Programmable Buffered Terminal

An operator-oriented terminal designed for intermediate- to high-speed batch transmission of data, entered under terminal program control. Operation is normally offline and transmissions are batched. During offline operation the terminal has the ability to automatically re-create previously keyed documents, right-justify, center-type, perform arithmetic operations, and provide operator guidance and error detection functions normally associated only with a terminal online to a central computer.

Primary application is source document creation with either local playback or batched

transmission or both. The 3735 consists of a control unit and an associated printer-keyboard. Local playback from the SELECTRIC II® printer is at 15.5 cps. The programmable control unit houses a fixed disk facility, logic circuits, and a binary synchronous communications adapter (up to 4800 bps). Other standard features are a 62.8K area of disk storage for user data or programs, a 45.2K area containing an IBM-written terminal control program, IBM-developed diagnostics, auto answer, switched network operation, and both vertical and longitudinal redundancy checking on internal transfer operations.

An optional feature is an additional output matrix printer with a print capability of 66 cps. This printer, a 3286 Model 3, extends the ability of the 3735 to meet a wider range of printing requirements. EBCDIC is standard but ASCII Character Set A or B may be specified in lieu of EBCDIC provided the 3735 is equipped with the appropriate printer attachment.

Other optional features are user storage expansion up to 146.4K bytes in increments of 41.8K multipoint operation, synchronous clock, keylock, Operator Identification Card Reader, a 5496 Data Recorder attachment, and a 1200-bps integrated modem.

The 5496 is a key entry unit for the creation as well as verification of 96-column cards. The 5496 Data Recorder, when connected to a 3735 Programmable Buffered Terminal attachment, becomes an input/output device for reading and punching of 96-column cards.

The 1200-bps integrated modem replaces an external modem and is available in both leased line and switched network versions. In the latter version it is equipped to automatically answer incoming calls.

2922 Programmable Terminal

The 2922 Programmable Terminal can be used for remote job entry, for making inquiries into a computer's data base, and for teleprocessing applications that require extensive printouts at locations distant from a central computer. The terminal includes a printer, a punched card reader, and a controller. Rated speed of the

printer is 500 lpm; of the reader, 500 cpm. Actual reading and printing speeds are determined by the transmission code and character set, and communications facility. Transmission is at 2400, 4800, or 7200 bps. The 2922 employs the System/360 Model 20 instruction set and 8K bytes of storage for processing. The terminal system uses binary synchronous communications over common-carrier facilities for communication with a System/360 or a System/370 equipped with a 2701, 2703, or 3705.

Options are a 2152 Printer-Keyboard, Model 1, and Full Transparency Text Mode. The latter provides the capability of transmitting or receiving 8-bit binary data. (Without the transparency option, the terminal can transmit or receive EBCDIC or ASCII codes.)

2740 Communication Terminal

Designed for online data entry and inquiry to a System/370 Model 135 via the Integrated Communications Adapter, 2701 Data Adapter Unit, 2702 Transmission Control, 2703 Transmission Control, or 3705 Communications Controller. Operates using point-to-point or multidrop communications facilities.

Model 1 is unbuffered and transmits at 14.8 cps over switched or leased network facilities.

Model 2 is buffered and transmits up to 66.7 cps over leased network facilities to the ICA or over switched facilities to the 2701, 2702, or 2703.

With buffering, data transmission can occur from one multidropped terminal while other operators are keying data. Buffering also permits visual verification before transmission.

2741 Communication Terminal

Designed for point-to-point operation over switched or leased network facilities with a data processing system connected through the 3705 Communications Controller, or the 2701 Data Adapter Unit, or the 2702 or 2703 Transmission Control.

2760 Optical Image Unit

The 2760/2740 provides for data entry in conversational mode using a light probe in contact with an image display screen. The right half of this divided 9' x 14' screen displays data as illustrations (color or black and white) or words, phrases, and sentences as projected from a cartridge-contained filmstrip. An individual cartridge contains up to 128 images. The left half of the screen contains response points that can be labeled by an overlay. The operator selects items or operations displayed in words and/or pictures on the screen of the optical image unit. By touching a sense probe to the segment of the screen where pertinent information appears, he causes selected data to be transmitted to the computer. The filmstrip can be moved to any frame under program control.

The need for keyboard and card punching skills is eliminated and the operator does not require special computer or programming knowledge. Data is transmitted via the 2740 in the form of coordinates representing the location of one of the 240 response positions on the screen. These coordinates are decoded in the processor program. Coding of transactions and items is done by the system designers.

The 2760 requires linkage to a 2740 Communication Terminal, Model 1. The 2740 can be used to print hard copy transmitted from the computer or to enter information into the computer via the keyboard.

2770 Data Communication System

A multimedia terminal system designed to use a variety of input and output devices such as printers, punched cards (80-column and 96-column), paper tape, magnetic tape cartridges, alphameric visual display, or magnetic character reading.

The 2770 is particularly suited for batch processing and inquiry-type use. The system transmits data over common-carrier public switched networks and leased or private voice-grade communication lines. The 2772 Control Unit is the basic component of the system. It handles either EBCDIC or ASCII,

transmitting at rates up to 4800 bps using binary synchronous communications or at rates up to 7200 bps when communicating with a 3780 Data Communications Terminal.

When operating offline, any input unit can send data to any output unit attached to the 2772. When operating online, output units can be selected under computer control.

2780 Data Transmission Terminal

Designed to use the binary synchronous communications (BSC) technique, terminals are available in four models to permit configurations of printers and/or card read punches to fit user requirements. Transmission rates are 2000, 2400, or 4800 bps over appropriate common-carrier leased or public-switched voice-grade channels or equivalent privately owned facilities. Permissible codes are 6-bit Transcode, EBCDIC, ASCII, or, with the transparency feature, any 8-bit combination.

With the Synchronous Clock special feature, any model can transmit or receive over appropriate facilities at 1200 bps. Rated speeds are maximum. Actual terminal throughput is limited not only by transmission rates above, but by other application-oriented factors such as number of characters in record, code set, etc.

Any model equipped with the optional Terminal Identification feature will automatically transmit a contiguous two-character terminal identification code to the CPU. Available only for 2780 terminals operating on public telephone switched networks, the feature allows the CPU under stored program control to determine a legitimate 2780 BSC terminal user and distinguish between types of compatible BSC machines and their associated I/O configurations and features.

Specific models may be equipped with the optional Dual Communications Interface, which allows the 2780 to be switched manually between two communication facilities for greater flexibility in system design and improved availability.

2790 Data Communication System

An inplant data collection and production monitoring system consisting of a control unit

(either System/7, 2715 Transmission Control Unit, or 1800 Data Acquisition and Control System) and two-wire loop-connected Area Stations (2791 and 2793), which can serve as controllers for various combinations of 2795, 2796, and 2797 Data Entry Units, 2798 Guidance Display Unit, 1053 Printer, and 1035 Badge Reader.

2260 Display Station

A visual I/O system used to display alphameric information. Stations provide rapid man-machine communication by direct cable connection to a selector or multiplexer channel of the data processing system via a 2848 Display Control.

Up to 960 characters can be displayed in 12 lines of 80 characters each on a 3' x 9' area on the face of a CRT. All information is buffered and regenerated to provide a steady display.

Under operator or program control, information is written on a cleared display or added to an existing display on the face of the tube.

The 2260 Display Station is available in two models. Model 1 displays up to 960 characters and is for operation with a 2848 Display Control, Model 3. Model 2 displays up to 240 or 480 characters depending upon the 2848 model used.

2848 Display Control

A control unit to provide either a local or remote communication path between 2260 Display Stations and the data processing system channel interface. Remote transmission over leased, private voice-grade lines may be to a System/360 or /370 via a 2701 Data Adapter Unit or 3705 Communications Controller or ICA. (The 3705 supports the 2260 in emulation mode only.)

Direct data transfer to and from the data processing system is performed at 2560 cps.

Character generator, buffer storage, and timing and logic control are standard features.

Model 1 permits the connection of a maximum of 24 displays of 240 characters in 6 rows of 40 characters each.

Model 2 permits the connection of a maximum of 16 displays of 480 characters in 12 rows of 40 characters each.

Model 3 permits the connection of a maximum of 8 displays of 960 characters in 12 rows of 80 characters each.

Model 21 permits the connection of a maximum of 24 local displays of 240 characters in volume data entry applications. Additional CPU commands permit signaling the operator that the program has detected an error in the input data.

Model 22 permits the connection of a maximum of 16 local displays of 480 characters in volume data entry applications. Additional CPU commands permit signaling the operator that the program has detected an error in the input data.

2265 Display Station

For a single display terminal in a remote location, the 2265, along with the prerequisite IBM 2845 Display Control, is program-compatible with, and similar in function to, the 2260/2848 display system. Used for displaying data either as output from System/370 or as a result of operator keying, the 2265/2845 utilizes voice-grade data channels. Transmission can be at 1200 or 2400 bps over common-carrier leased or private line voice-grade data channels.

Up to 960 characters formed by a stroke generation technique can be displayed. One of two formats may be ordered: 15 rows, 64 characters per row; or 12 rows, 80 characters per row.

Up to sixteen 2265/2845s may be attached to the same communication line.

Optional keyboard can be cable-connected to the display.

With the appropriate special feature, an optional 1053 Printer, Model 4, may be attached to the 2845 Display Control.

2845 Display Control

The 2845 Display Control functions as a remote terminal control communicating via a 2701 Data Adapter Unit, 3705 Communications

Controller (emulation mode only) or ICA to a System/370. Program compatibility permits multidropping on the same communication line with the 2260/2848.

Optional Features:

Destructive Cursor causes deletion of the data contained in any character position through which the cursor passes.

1053 Adapter permits the attachment of a Model 4 printer.

Line Addressing permits selection of display starting line location for incoming data under computer control.

Tab feature permits high-speed cursor movement between "tab stops" under keyboard control.

Paper Tape

2671 Paper Tape Reader

Attaches via a multiplexer channel and a 2822 Paper Tape Reader Control.

Reads strips or rolls of 5-, 6-, 7-, or 8-track codes at speeds up to 1000 cps from 11/16", 7/8" or 1" chad tape.

Optional spooling facilities provide for center roll or reel feeding and rewinding. With these features installed, feeding and rewinding of paper tape rolls is a minimum of 500 cps. Strip reading can be accomplished at 1000 cps.

2822 Paper Tape Reader Control

Control unit for attaching a 2671 Paper Tape Reader.

1017 Paper Tape Reader

Reads 5-, 6-, 7-, or 8-track tape at 120 cps. Tape width is 7/8", 11/16", or 1".

Model 1 reads strips only.

Model 2 reads strips or rolls.

1018 Paper Tape Punch

Direct output punching of 5-, 6-, 7-, or 8-track tape at 120 cps.

2826 Paper Tape Control

Control unit for attaching 1017 and 1018 paper tape units.

Controls up to two 1017s plus up to two 1018s.

Optical Readers

3881 Optical Mark Reader

Reads machine-printed and/or hand-marked data from documents ranging in size from 3'' x 3'' to 9'' x 12''. Model 1 operates online, reading data into a System/370 at a rate of 4000 (8 1/2'' x 11'') to 6000 (3'' x 3'') documents/hour.

Model 2 operates offline with output to a 3410 Magnetic Tape Unit, Model 1, at a rate of 3700 (8 1/2'' x 11'') to 5700 (3'' x 3'') documents.

On a 9'' x 12'' document up to 2480 marking positions are provided. Format control sheets load format control information into the 3881 and permit reading up to six different formats on the same run.

Basic storage is 435 bytes. An Expanded Storage feature provides an additional 512 bytes for situations where the total number of fields and characters processed exceeds the number of positions available with the basic 435-byte storage.

An optional BCD (Binary Coded Decimal) Read feature permits processing turnaround document applications.

Checking capabilities and two output stackers allow detection of marking errors and segregation of documents with errors. An optional Serial Numbering feature permits printing consecutive numbers on documents being processed.

1287 Optical Reader

Provides for reading of printed numeric digits, alphabetic characters, and special symbols into a System/370. Multiline data to be read may be positioned horizontally or oriented at a 90-degree angle to the normal document top. With the Numeric Handwriting feature, any model can also read handprinted numeric digits and certain alphabetic characters.

Other features include rescan, character display with online correction, and format flexibility under program control.

Model 1 reads multiple lines of numeric machine-printed or handprinted data from cut-form paper or card documents.

Model 2, in addition to performing the functions of Model 1, can read data from continuous rolls of paper (journal tapes).

Model 3 is identical to Model 1, with the added capability of reading the alphameric ANSCS OCR-A (American National Standards Institute Character Set for Optical Character Recognition, Size A) character set.

Model 4 is identical to Model 2, with the added capability of reading alphameric ANSCS OCR-A.

Model 5 reads multiple lines of numeric handprinting from cut-form paper or card documents as the basic reading function. The machine-printed OCR font feature is available to provide reading capability for numeric ANSCS OCR-A, IBM 1428, and Farrington 7B fonts.

Cut-form documents are from 2.25" x 3" to 5.91" x 9", with a maximum scanning area of 4" x 8.75". Throughput varies with size of document and with type and number of characters and fields being read.

Alphameric typing, machine printing, handprinting, and marking can be intermixed on the same document.

Up to eight 1287s can be attached to a system, in any combination of models. Each 1287 contains its own control unit and requires a channel control unit position.

An optional Serial Numbering feature permits sequential numbering of documents as they are processed to facilitate manual retrieval.

1288 Optical Page Reader

An online unit that optically reads ANSCS OCR-A printed alphabetic and numeric characters and specified symbols. Document sizes may vary from 3" x 6.5" to 9" x 14".

When equipped with the Numeric Handwriting special feature, the 1288 can also read numeric digits and certain alphabetic characters.

When equipped with the Optical Mark Reading special feature, it can read marks that have either

been made by hand or machine-printed onto documents.

An optional Serial Numbering feature permits sequential numbering of documents as they are processed to facilitate manual retrieval.

Magnetic Character Readers

1419 and 1255 Magnetic Character Readers

Read magnetically inscribed data from card and paper documents into the System/370. Maximum rate of the 1419 is 1600 documents/minute.

The 1255 reads up to 500 or 750 documents/minute depending on the model.

Pocket selection may be controlled either by the reader or by the system program.

Fixed field length and readability checks provide a technique for controlling accuracy.

May be used for both online and offline sorting.

Tape Cartridge Reader

2495 Tape Cartridge Reader

An online unit that reads tape cartridges inscribed on the IBM 50 Magnetic Data Inscriber or the IBM Magnetic Tape SELECTRIC® Typewriter (MTST). Hopper holds up to 12 cartridges. Performs automatic load, read, rewind, and unload without operator intervention at approximately one cartridge per minute under control of a utility program. Reads data at 900 cps and checks parity.

Audio Response Units

7770 Audio Response Unit

Provides convenient access to a System/370 from IBM 2721 Portable Audio Terminals, IBM 1001 Data Transmission Terminals, and pushbutton-type telephone sets. The 7770 receives data via voice-grade lines from a terminal and transmits it to the processing unit under program control. The processing unit then processes the data and composes a coded response message, which is transmitted back to the 7770. The response message is a sequence

of coded characters, one character for each audio word address. The 7770 interprets the response message, selects the desired words in proper sequence from a prerecorded vocabulary, and transmits the audio response back to the terminal.

The basic 7770 Audio Response Unit has four communication lines and 32 words of vocabulary. Additional lines are available in increments of four, up to a total of 48. The vocabulary is expandable to 128 words.

2721 Portable Audio Terminal

Any standard telephone handset placed in the cradle of the 2721 provides coupling so that the 2721 becomes a computer terminal. The 2721 is designed for use with the IBM 7770 Audio Response Unit, Model 3, for data entry or query through the 2721's keyboard. An earphone and a speaker are provided for the spoken answer. The computer system can be programmed to repeat input for verification and to guide the user through a transaction.

2730 Transaction Validation Terminal

The 2730 reads magnetically encoded information on 2 1/8" x 3 3/8" (credit card size) plastic cards with a magnetic stripe on the back. This information, along with data entered via the 2730 12-key keyboard, is transmitted over a telephone line to a System/370 equipped with a 7770 Audio Response Unit and 2968 Receiver-Terminal Control Unit.

The 2730 is acoustically connected to a telephone handset mouthpiece. The earphone of the handset is used to receive spoken responses from the computer.

Graphics System

2250 Display Unit

The basic console contains a direct-view 21-inch cathode ray tube providing a 12" x 12" display area, an associated power supply, and digital and analog circuitry. Alphameric information is drawn on the tube face by positioning the cathode ray tube (CRT) electron beam under program control. The images are

constructed by displaying a series of dots in the desired pattern, or the CRT may draw straight lines between any two points of a 1024 x 1024 matrix.

A total of 3848 characters can be displayed simultaneously in 52 lines with 74 characters per line. To relieve the computer that feeds the display of plotting characters, a character generator is available. Using this generator, two sizes may be specified for each character.

For manual input there is a choice of three units: a standard typewriter keyboard, a programmed function keyboard, and a light pen.

The Model 3 is for multiple display units. Multiplexing logic provides the ability to time-share a number of consoles on one computer without operator delay.

2840 Display Control, Model 2

Control unit that provides common circuits for multiple 2250 Display Units. The unit includes 32,768 bytes of core buffer and a character generator.

Sensor-Based System

System/7

System/7 is a sensor-based system that communicates with System/370 in a multisystem configuration for the solution of plant automation, process control, laboratory automation, and data acquisition applications. System/7 is interrupt-driven, providing direct hardware branching for processing on four interrupt levels with 16 sublevels each to service a total of 64 identifiable interrupting sources. For each of the four interrupt levels there are seven index registers, one accumulator, and one instruction address register backup.

Monolithic storage cycle time is approximately 400 ns.

System/7 may communicate over switched or leased lines at a rate of 134.5 kbps or over leased lines at a rate of 600 bps. The System/7 may be connected to a 3705 Communications Controller, 2701 Data Adapter Unit, 2702 or 2703 Transmission Control, or the 135 ICA.

The *System/7 Facts Folder* (G520-2389) provides a concise summary of highlights. A *Guide to the IBM System/7* (GC20-1736) is well indexed and provides ready access to detailed information, including a glossary and a list of related publications.

Communication Control

3705 Communications Controller

The 3705 Communications Controller is a teleprocessing system component that functions as an interface between the channels of a data processing system and communications facilities.

Telecommunications systems are characterized by a variety of terminal devices and of communications facilities. Terminal device types include start-stop, binary synchronous, and remote display controls/display stations. Each terminal device type may vary in terms of the codes it will accept and the transmission speed at which it is capable of sending or receiving. The most significant differences between communications facilities result from the fact that they may be switched or leased, duplex or half-duplex, point-to-point or multipoint, and that they may be telegraph, voice-grade or wideband channels.

The 3705 attaches to the System/370 and provides the hardware necessary for attachment of terminals via data communications equipment over common-carrier or user-owned communications facilities.

The 3705 combines the capabilities of a transmission control unit (such as the IBM 2703) with many of the teleprocessing functions formerly performed by the host CPU. These former CPU functions include, but are not limited to, line control, polling, addressing, code translation, and error recovery.

Each model of the 3705 houses a central control unit, a control panel, and from 16K (Model A1) to 240K (Model D8) of core storage. The 3705 also accommodates Channel Adapters, Communications Scanners, Line Interface Bases and Line Sets, with the maximum for each model as follows:

- "A" Models accommodate 1 Channel Adapter, 1 Communication Scanner, up to 4 Line Interface Bases, and up to 32 Line Sets.
- "B" Models accommodate up to 2 Channel Adapters, up to 2 Communication Scanners, up to 10 Line Interface Bases, and up to 80 Line Sets.
- "C" Models accommodate up to 2 Channel Adapters, up to 3 Communication Scanners, up to 16 Line Interface Bases, and up to 128 Line Sets.
- "D" Models accommodate up to 2 Channel Adapters, up to 4 Communication Scanners, up to 22 Line Interface Bases, and up to 176 Line Sets.

These Line Sets are either the interface to external modems, include the modem function, or use a teletype interface. Line Sets that include the modem function or use a teletype interface attach directly to the communication line. In any case, Line Sets (depending on type) can attach either one or two communication lines, giving the 3705 a maximum line attachment capability of 352 lines.

Feature Selection

Features are selected to fulfill teleprocessing system requirements, and their combination with the 3705 constitutes a TP component.

Communication Line Attachment features are combinations of Line Interface Base (LIB) types and Line Set types. There are four different types of LIBs to accommodate the various types of line terminations. Depending upon the type, these LIBs will house from one to eight Line Sets each. From one to sixteen communications lines can be attached to each LIB via the Line Sets. The basic 3705 can house up to four LIBs, allowing up to 64 lines to be attached ($16 \text{ lines/LIB} \times 4 \text{ LIBs/3705} = 64$), and with expansion modules up to 22 LIBs can be accommodated so that 352 lines can be attached. The communication line, terminal, or external automatic calling unit determines the appropriate Line Interface Base and Line Set. These Line Sets can satisfy the attachment requirements of start/stop or synchronous communication lines, single current telegraph lines, external automatic calling units, and

directly coupled start/stop or synchronous terminals.

A Channel Adapter Type 1 supports communication with a System/370 byte multiplexer channel. All such communications are accomplished via four-byte transfers, with deselection and reselection occurring between each transfer.

A Channel Adapter Type 2 supports communication with a System/370 byte multiplexer, block multiplexer, or selector channel at data transfer rates of up to 376 KB. Data transfer is accomplished with a two-byte "burst" standard on the byte multiplexer channel and a multibyte "burst" standard on the block multiplexer and selector channels.

A Two-Channel Switch feature permits attachment of either Type 1 or Type 2 Channel Adapters to two system channels, and each channel adapter can be manually switched between two CPU channels. Two channel adapters with a two-channel switch on each will allow attachment to four CPUs. The Channel Adapter so equipped will, however, be enabled for operation on one channel at a time. Selection of the channel that is to be operable is by means of a manual switch on the control panel.

A Communication Scanner Type 1 interfaces between the Communication Line Attachment features and the central controller. 3705 interrupt facilities allow the program to perform character assembly and disassembly, and allow for program control of line control, control character recognition, code translation, and error recovery functions.

A Communication Scanner Type 2 interfaces between the Communication Line Attachment features and the central controller. This feature assembles and disassembles characters automatically, provides character buffering for each line, and allows for program control of line control, control character recognition, code translation, and error recovery functions.

An Internal Clock option provides clocking signals where the external modem does not.

A 1200-bps integrated modem that replaces an external modem is an optional feature available in both leased line and switched network versions. In the latter version it is equipped to automatical-

ly answer incoming calls, and can be equipped to automatically dial outgoing calls.

The 3705 can communicate in both asynchronous and synchronous mode with teleprocessing equipment that includes, but is not limited to, the following terminals which are supported by the Network Control Program, discussed below:

1050 Data Communication System

1130 Computing System

1800 Data Acquisition and Control System

2740 Communication Terminal

2741 Communication Terminal

2770 Data Communication System

2780 Data Transmission Terminal

2790 Data Communication System

3270 Information Display System

3735 Programmable Buffered Terminal

System/3 with a Binary Synchronous
Communications Adapter

System/7

System/360 Model 20 with a Binary

Synchronous Communications Adapter

System/360 Model 25 with an Integrated
Communications Adapter

System/370 Model 135 with an Integrated
Communications Adapter

System/360 or System/370 via an attached
2701, 2703, or 3705

Terminals supported by an emulator program include 1030, 2760, 2845/2265, 2848/2260, and 3670.

The 3705 operates under the direction of the IBM Network Control Program (NCP), which, in turn, interfaces to the CPU's telecommunications access method (TCAM). The Network Control Program is made up of functional modules, each performing a specific telecommunications control task. Functions can be selected simply by coding a series of macro instructions with the easy-to-use Network Control Program macro language. Minimum core storage requirement for the 3705 operating with the Network Control Program is 48K.

Another operational aid is the System Support Programs (SSP), an OS function that performs housekeeping for the Network Control Program. The System Support Programs include loader, dump, and generator. The 3705 can also operate as a 2701, 2702, or 2703 with an emulator

program on any System/360 or System/370 using OS or DOS.

The 3705 is available in 20 models. The core storage requirement and maximum number of communication lines are listed below for each model:

- A1, 16K, 64 lines
- A2, 48K, 64 lines
- B1, 16K, 160 lines
- B2, 48K, 160 lines
- B3, 80K, 160 lines
- B4, 112K, 160 lines
- C1, 16K, 256 lines
- C2, 48K, 256 lines
- C3, 80K, 256 lines
- C4, 112K, 256 lines
- C5, 144K, 256 lines
- C6, 176K, 256 lines
- D1, 16K, 352 lines
- D2, 48K, 352 lines
- D3, 80K, 352 lines
- D4, 112K, 352 lines
- D5, 144K, 352 lines
- D6, 176K, 352 lines
- D7, 208K, 352 lines
- D8, 240K, 352 lines

2701 Data Adapter Unit

The 2701 provides for the attachment of remote and local I/O terminals operating through data communications equipment via user-owned or common-carrier facilities. It attaches either to a selector or multiplexer channel, and provides for attachment of four start/stop communication lines, two synchronous communication lines, or four parallel data acquisition devices.

Specific adapters enable the 2701 to communicate over appropriate communication lines with another System/370, a System/360, System/7, and a variety of IBM and other terminals. With a Synchronous Data Adapter Type II the 2701 can operate in the binary synchronous communications mode and attain speeds up to 230,400 bps. Other adapters are available to enable the 2701 to function in various data acquisition modes.

With appropriate attachments the 2701 operates in half-duplex mode over common-

carrier switched telephone and common-carrier 150-bps Teletypewriter Exchange (TWX) networks, common-carrier leased private line telegraph service, common-carrier wideband service, and privately owned communication facilities.

A 1200-bps integrated modem that replaces an external modem is an optional feature available in both leased line and switched network versions. In the latter version it is equipped to automatically answer incoming calls, and can be equipped to dial outgoing calls.

2702 Transmission Control

The 2702 Transmission Control provides for the online attachment of various asynchronous I/O terminals through data communications equipment via private or commercial common-carrier transmission facilities to the IBM System/360 or System/370. It attaches to the byte multiplexer channel of models so equipped or to the 2870 Multiplexer Channel of models with this optional unit. The basic 2702 provides for the attachment of up to 15 half-duplex communication lines simultaneously operating at speeds up to 180 bps. Higher-speed lines (600 bps) may be connected to the 2702 by choosing the Speed Extension feature to allow the higher speed on all 15 lines. The line attachment capability of the 2702 can be increased up to 31 half-duplex communication lines via the 31 Line Expansion feature.

Specific adapters enable the 2702 to communicate over appropriate communication lines with IBM 1030, 1050, 1060, 2740, and 2741 terminals, IBM 1070 Process Communication System, System/7, and other terminals.

Data transmission is serial by bit. The 2702 performs the function of serializing data bytes from the system processor for transmission to the data terminal and assembling incoming serial data into bytes for transfer to processor storage.

With appropriate attachments the 2702 operates over common-carrier switched telephone and 150 bps Teletypewriter Exchange (TWX) networks, common-carrier leased private line voice-grade data and telegraph services, and privately owned communications facilities.

2703 Transmission Control

Regulates the data flow between System/370 and communication terminals connected to data communications equipment by private or common-carrier transmission facilities.

Permits attachment of up to 176 lines for simultaneous transmission of data to the central computer.

Permits up to seven different line speeds and up to five different transmission codes, or combinations of these.

Permits attachment of binary synchronous devices using ASCII, EBCDIC, or 6-bit Transcode.

2711 Line Adapter Unit

Provides for installation of IBM line adapters to permit attached 2702 and/or 2703 Transmission Control units to communicate with IBM terminals equipped with IBM line adapters.

The Model 135 Integrated Communications Adapter may also use an IBM 2711 Line Adapter Unit to connect to the appropriate IBM line adapter. The IBM Line Adapter must be the 4647 for four-wire operation.

Adapters modulate and demodulate signals over communication facilities much like common-carrier-provided data sets that would otherwise be required for these functions.

Three types of IBM line adapters can be installed to provide for (1) limited distance (eight-mile) communication, (2) communication over privately owned or leased common-carrier facilities, and/or (3) simultaneous sharing of a voice-grade line by up to four low-speed terminal lines.

Each low-speed line may be operated either point to point or multipoint.

Four IBM line adapters may be attached for each Line Set feature on the 2711.

Up to seven special feature line modules, capable of handling four lines each, may be added to the basic 2711 Line Adapter Unit. The unit will accommodate a maximum of 32 IBM line adapters in any mix.

3872 and 3875 Modems

Modems are *MO*dulation-*DE*Modulation devices whose primary functions are to produce

analog signals from the data that is to be transmitted over a communications facility and, at the receiving end, to convert the modulated signals back into the original data code.

Both the 3872 and 3875 may be specified in a wide variety of configurations such as point-to-point, multipoint, and switched networks. Both are available worldwide for use with international nonswitched networks -- switched networks can be utilized in the U.S.A. and in Canada. Major contributors to high teleprocessing systems availability are built-in test functions and the backup capability of transmitting at half speed. Where switched facilities can be used, they may be used for backup in the event of leased-line failure. The built-in test functions are operator accessible. The controls and indicators on the 3872/3875 front panel allow an operator to select the speed of operation, make required line equalization adjustments, and perform local and end-to-end testing for rapid problem isolation. The modems connect to the business machine-supplied interconnecting cable. Modem transmit and receive clocking signals are provided, and must be used by, the business machine.

The basic modem, without features, is used at the control station in a centralized multipoint network. Appropriate features are added to the basic modem for tributary use.

Automatic answering of incoming calls, as well as automatic equalization, is provided with the switched network feature on the 3872.

Automatic answering is available for the 3875 with the switched network backup feature. Both the 3872 and the 3875 offer feature selection to meet the user's specific data transmission requirements.

Primary differences between the two modems are that the 3875 is capable of operation at 7200 bps over C2 conditioned voice-grade channels, with backup mode at 3600 (over its regular conditioned voice-grade channel or on the public switched network), or at 1800 bps on the public switched network, while the 3872 using C1 conditioned communications facilities operates at 2400 or 1200 bps. Operation over the public switched network can be at the full 2400 bps.

The switched network may be the primary or the backup facility for the 3872.

A secondary difference is that the 3875 uses digital echo modulation techniques that reduce the bandwidth required for data transmission (minimizing susceptibility to line impairment associated with the side portions of voice-grade facilities). In contrast, the 3872 uses differential phase shift key modulation techniques.

The third level of differences between the 3872 and the 3875 is in the features offered that are not common to the two modems.

3875 Features:

1. Alternate Voice feature permits signaling and voice communication between modems in different locations over the same leased facility used for data transmission.
2. Fanout feature allows attachment of up to three business machines at one location. Only one of the machines may be actively using the interface at one time.

3872 Features:

1. The Second Modem feature allows combinations of two 3872 point-to-point, multipoint, or switched network modems to be housed in the same modem cabinet.
2. Automatic Call Originate provides dialing of telephone numbers under CPU control without the need for a separate automatic calling unit.
3. Automatic Equalization on the switched network automatically equalizes the telephone channel each time a connection is made. This equalization is required only once prior to the transmission of the first message in each direction. The time for equalization is less than one second in each direction.

Programming Systems Support

Programming systems support for the System/370 includes:

- Multiprogramming facilities to provide the potential for additional applications for the system
- Batch processing combined with teleprocessing applications such as remote inquiry,

message switching, data collection, or management information systems

- Integrated emulation--that is, concurrent execution of native mode and emulation on one system

System Control Programming (SCP) provides the primary support for the System/370.

System Control Programming is fundamental to the operation and maintenance of the system and is available to users of IBM equipment without additional charge. System Control Programming provides the functional support for varying operational environments, such as batch mode for jobs entered locally or remotely, or time sharing of resources during the concurrent execution of other programs, and is directly involved with the management of available system resources. It supports configurations that differ in terms of processing units, storage, and devices. It controls the various input/output devices and the execution of programs.

Additionally, it includes functions needed to maintain and diagnose the elements of an IBM data processing system.

System Control Programming components include:

Supervisor

Job Management

System Service

Data Management Facilities

System Generation/Installation Facilities

Diagnostic and Maintenance Facilities

Language Facilities for System Modification

System Control Programming (SCP) Support

System/370 System Control Programming operates on the System/370 in Extended Control (EC) mode only and provides virtual storage support using the dynamic address translation facility. System Control Programming provides extensions to IBM's earlier operating systems as follows:

Disk Operating System/Virtual Storage

(DOS/VS) extends DOS Version 4

Operating System/Virtual Storage 1 (OS/VS1)

extends OS MFT

Operating System/Virtual Storage 2 (OS/VS2)

extends OS MVT for Models 145 and above

Virtual Machine Facility/370 (VM/370) extends Control Program 67/Cambridge Monitor System (CP-67/CMS), a program for the System/360 Model 67.

All of these SCPs except OS/VS2 support the Model 135 and offer a number of new features, the most important of which is support of virtual storage. Virtual storage is designed with the potential:

- For possible improvement in improved programmer productivity through a reduced need to be concerned with real storage constraints.
- For easier application development, where real storage size is a constraint, through greater flexibility in the design of applications, ability to use open-ended, straightforward application design, eased application growth and maintenance of operational programs, and ability to implement large applications.
- To make available to terminal-based programs the real storage required during periods of peak terminal activity. During periods of relatively low terminal activity the system can make available to batched jobs any real storage not used by terminal-based programs.
- For greater operational flexibility in such areas as program testing, system scheduling, and system backup.

The hardware and concept of virtual storage are discussed in this facts folder under the heading "Virtual Storage and Dynamic Address Translation".

Disk Operating System/Virtual Storage (DOS/VS)

DOS/VS supports many new features, the most significant of which are:

- Support of a single virtual storage of up to 16 MB with pages of 2K bytes. The minimum Model 135 processor storage size (96K) is sufficient for operation of DOS/VS.
- Increase in the number of problem program partitions from three to five.
- Ability to specify the dispatching priority of a partition at system generation time and alter it at IPL time and during system operation.

- A relocating loader, allowing programs to be loaded and executed in any partition and with any size supervisor.
- POWER, a facility that permits printing, punching, and card reading at high speed concurrently with and independent of other processing - an optional component of DOS/VS.
- System operation simplified by permitting sets of job control cards to be stored and cataloged on direct access storage. At execution time only one control card is needed to call a stored procedure and thus cause the execution of the job steps specified in the procedure.
- A new data management access method, virtual storage access method (VSAM), offering increased functional capability with ISAM program compatibility. VSAM introduces a new data format that provides increased data stability for use in data base environments. Data portability between OS/VS and DOS/VS systems also now becomes possible with VSAM data sets. A compatibility interface permits most programs written for ISAM data sets to access VSAM data sets without recompilation. VSAM also offers the potential for performance improvements relative to ISAM in virtual storage systems. Routines to convert ISAM data to VSAM data are provided. In addition, DOS/VS supports all DOS Version 4 access methods.

Emulator Programs

DOS/VS supports the same emulator functions on the Model 135 as the previous versions: 1401/1440/1460 and System/360 Model 20 emulation. These two integrated emulators use hardware compatibility features. The 1401/1440/1460 emulator is control card and disk pack compatible with the System/360 emulator CS/30. The Model 20 emulator includes utilities to convert Model 20 sequential, indexed sequential, and direct disk data files in Model 20 emulated format into disk data files in System/370 mode. The reverse operation is also provided.

Processing Programs

A new assembler which supports all the new System/370 instructions, a linkage editor, a

librarian, system utilities, and diagnostic aids such as OLTEP are all part of DOS/VS. Program Products, Type I and II programs, and user programs must be added to the system after the SCP has been generated.

Compatibility with Earlier Versions of DOS

In general, after re-link editing because of a larger supervisor, object programs that operate under DOS Version 3 or 4 will operate with DOS/VS (assuming the same I/O configuration) with some exceptions (for example, those using machine-dependent data). Note that DOS/VS does not support the 2311 Disk Storage Drive as a SYSRES device as do earlier versions.

Operating System/Virtual Storage 1 (OS/VS1)

OS/VS1 (referred to as VS1 in this discussion) is a functional extension of OS MFT and offers major new features, the most significant of which are:

- Support of a partitioned single virtual storage of up to 16 MB with pages of 2K. Up to 15 user program partitions and 37 system task partitions can be defined depending on the virtual and real storage available. A system with 160K bytes of available real storage is sufficient for all VS1 standard features but may use only a few, if any, optional features. A system with 144K bytes is subject to restrictions. In general, function and advantages can be restricted by the amount of real storage available. Therefore, many users may find that a processor storage size of 240K is most effective for VS1 on the Model 135.
- Improved management of peripheral I/O operations, provided by the new Job Entry Subsystem (JES), a performance-oriented replacement for readers and writers. JES, a standard feature in VS1, contains many features of the HASP program now used optionally with MFT. Moreover, JES supports any number of readers and writers, subject only to the availability of system resources, in contrast to OS/MFT, which supports 3 readers and 36 writers.
- Improved remote job entry to be provided by the new Remote Entry Services facility (RES). Because RES is a logical and functional extension of JES, jobs can be submitted to a

VS1 system remotely or locally using the same job control statements and commands. (RES is not available at initial release of VS1.)

- Job scheduling improvements that reduce contention for the job queue and make small partition scheduling more efficient.
- Other operational improvements accrue because of virtual storage. Examples are the management of real storage by the control program rather than the operator and scheduling personnel, and the eased handling of high-priority jobs because of less storage fragmentation.
- A new data management access method, virtual storage access method (VSAM), to offer increased functional capability with ISAM program compatibility. VSAM introduces a new data format that provides increased data stability for use in data base environments. Data portability between OS/VS and DOS/VS systems also now becomes possible with VSAM data sets. A compatibility interface permits most programs written for ISAM data sets to access VSAM data sets without recompilation or link-editing. VSAM also offers the potential for performance improvements relative to ISAM in virtual storage systems. Routines to convert ISAM data to VSAM data are provided. (VSAM is not available at initial release of VS1.)

Processing Programs

A system assembler which supports all the new System/370 instructions, a linkage editor, and the same utilities (with some modifications) as those provided by OS MFT are standard components of VS1, as are recovery management programs such as OLTEP and the Service Aids. VS1 also provides the same integrated emulator advantages as OS MFT. Program Products, Type I and II programs, and user programs to be used with VS1 must be added to the system after VS1 has been generated.

Transition to VS1

OS MFT programs and data will operate without change under VS1 with few exceptions (for example, programs sensitive to the PSW format). DOS Version 3 and 4 users can make the transition to VS1 with the OS DOS emulator.

MFT features not supported in VS1 are TESTRAN, Remote Job Entry (replaced by RES), Graphic Job Processor, Satellite Graphic Job Processor, Storage Hierarchy Support (obviated by virtual storage), and QTAM (replaced by TCAM).

Virtual Machine Facility/370 (VM/370)

VM/370 contains two major components:

1. The control program (CP), which manages the real resources of a System/370, including CPU time, to create and control multiple concurrent virtual machines. Each user appears to have access to the complete functional capabilities of a System/370, including virtual storage of 8K to 16 MB, and can specify the physical configuration and either the Conversational Monitor System (CMS), the other major component of VM/370, or one of the operating systems listed below. I/O devices which are part of a virtual machine's configuration normally require real device equivalents, except for (1) unit record devices, which CP can simulate using disk, and (2) virtual 2311 Disk Storage Drives, which CP can map onto a 2314 or 2319 disk. Up to two "full" 2311's may be mapped onto a 2314 or 2319 disk in this manner.
2. CMS, which operates under the overall direction of the CP and provides a general purpose, conversational capability suitable for problem solving, program development, and general conversational work. It includes commands for program compilation and execution, file and utility manipulation, and control and debugging. Compilers for such languages as COBOL, FORTRAN, and BASIC can be used with CMS.

VM/370 provides:

- The ability for the user to select from various versions and levels of IBM operating systems including DOS, DOS/VS, OS/360 (PCP, MFT, MVT), OS/VS1, OS/VS2, and PS44 to run in his virtual machine, subject to the following major restrictions:

No machine or program timing dependencies exist.

No use is made of the DIAGNOSE instruction for machine control, or of the READ DIRECT or WRITE DIRECT instruction.

No channel program is changed by the CPU or the channel during the interval between execution of the START I/O instructions and the channel end interrupt except that performed by the OS indexed sequential access method (ISAM).

No DOS emulation is permitted. VM/370 users may, however, run DOS and one or more of the OS systems concurrently in virtual machine mode.

- The ability to subdivide physical disk packs into logical "minidisks", each of which consists of a user-determined number of contiguous cylinders and each of which can be part of a different virtual machine. The use of minidisks expands the number of different users that can have concurrent access to direct access storage devices, and expands the number of operating systems that may be utilized. The system provides disk "password" protection to prevent unauthorized access to users' disks, and "read only" disk protection to prevent accidental destruction and/or to allow shared reading of disk files.
- Complete device address independence for all operating systems that run under control of VM/370.
- Backup facilities for other System/360 or System/370 systems having equivalent devices but differing I/O addresses and storage sizes.
- Potential for increased programmer productivity by (1) enabling tests to directly follow compilations, and (2) permitting hands-on debugging from the user's terminal (user information stored in a CP table defines the console functions permitted to a particular user). In addition, CMS commands simplify the creation and maintenance of source programs, reduce job control language statement preparation, and provide additional debugging tools.
- A high degree of system security, isolation, and integrity of each user's operating system, programs, and data, thus protecting a user's virtual machine from access or alteration by

another user. This permits system generation, maintenance, and testing, as well as program testing, concurrent with other work.

- Recovery Management Support and other additional facilities that supplement the reliability, availability, and serviceability characteristics of System/370 architecture.

Configuration Requirements

VM/370 requires a minimum of 240K bytes of real storage. The CPU Timer and Clock Comparator feature is required for operation of VM/370.

Languages

A system assembler is provided for installation and maintenance. The assembler can be used with CMS as can a number of Program Product compilers, such as OS Full ANS COBOL Version 4 Compiler, OS PL/I Optimizing Compiler, Code and Go FORTRAN IV (G1) Compiler, OS FORTRAN IV (H Extended) Compiler, and FORTRAN Interactive Debug. See your IBM representative for a complete list of these Program Products and their scheduled availability. These and other processing programs can be run under the control of an appropriate operating system in virtual machine mode under VM/370, subject to the same restrictions listed earlier.

Type I Support

Although primary support for the Model 135 is provided by the virtual storage System Control Programming DOS/VS, OS/VS1, and VM/370, the Type I programs DOS and OS MFT continue to be available. The Type I programs operate in Basic Control (BC) mode only.

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