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THE IBM 3745 COMMUNICATION CONTROLLER - AN ARCHITECTURAL PERSPECTIVE

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Abstract

This publication contains information on the hardware components of the IBM 3745 Communication Controller. The document focuses on the innovations introduced with the IBM 3745 and how these architectural features enhance its performance and capacity.

This publication consists of presentation material with supporting textual information.

Preface

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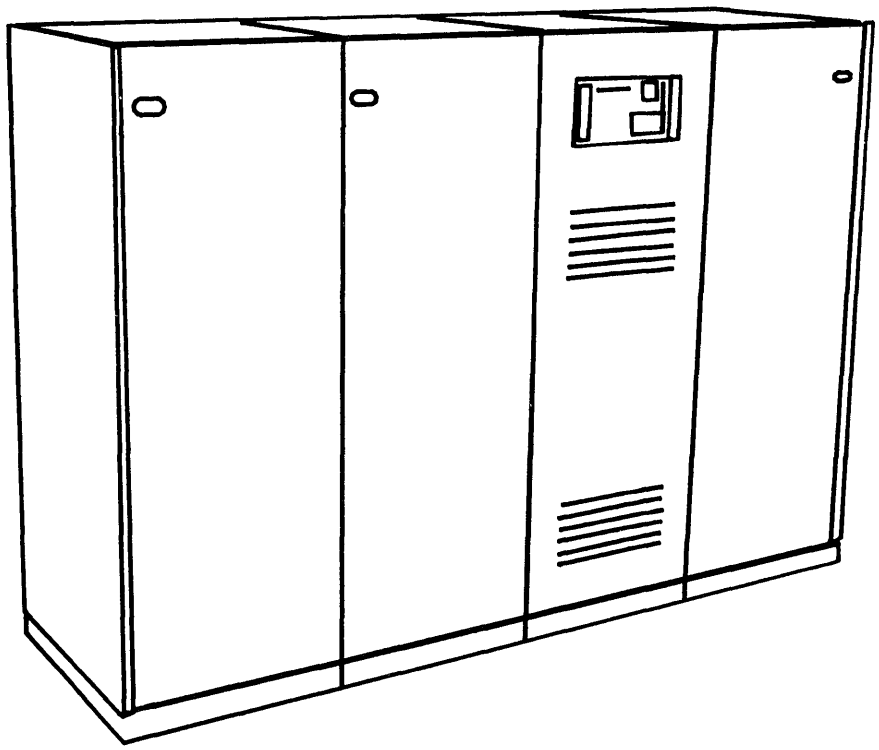
3745 Architecture

For more detailed information, the reader of this foil presentation should be also familiar with the following publication:

IBM 3745 Communication Controller Introduction - GA33-0092

Foil 1: Evolution

The 3745 is an evolutionary product based on the highly successful architecture of the IBM 3725. It has increased performance and availability characteristics that make it a leading edge communication controller.



An Evolutionary Product

Leading the Way Into the 90's

Foil 2: Significant Features

One of the most significant enhancements to the 3745 communication controller is the presence of one or two separate central control units. Each CCU operates independently running separate and distinct copies of the Network Control Program (NCP). A built-in bus switch capability allows the channel adapters and scanners associated with one CCU to be switched over to the other CCU. This ability to backup a CCU greatly enhances overall communication controller availability. The use of dual I/O buses on each CCU increases individual CCU throughput. Traffic volume between the CCU and the attached channel adapters/scanners is effectively twice that of a CCU with a single I/O bus.

Each CCU has either 4 or 8 megabytes of memory. Storage access time is matched to CCU speed by use of 16 kilobytes of high speed cache memory.

Attachment capacity of the IBM 3745, with one or two CCUs, has been designed to support up to 16 channel adapters, 16 T1 lines (8 active), 512 low to medium speed lines, and 8 token rings.

The Maintenance and Operator SubSystem introduced on the IBM 3725 has been improved to provide increased useability and maintenance capabilities on the 3745. A 45 megabyte hard disk provides quick NCP dump and load. Console options consist of either a remote or alternate console in addition to the local console.

The remote support facility concept introduced on the IBM 3720 has been extended to the 3745 and allows service personnel from an IBM hardware support facility to analyze problems and provide microcode fixes without having to be on site.

Power for the communication controller components is provided by a distributed power system. Individual power modules allow sections of the communication controller to be powered off for maintenance and change.

These features provide an improved level of communication controller performance and availability.

Significant Features

- 1 or 2 Central Control Units (CCU's)
  - Independent NCP Operation
  - Switching of Channel Adapter & Scanner Buses
  - Dual I/O Buses per CCU
- 4 or 8 Megabytes of Main Memory per CCU
  - 16 Kilobytes High Speed Cache Memory
- Maximum Attachment Capacity
  - 16 Channel Adapters
  - 16 T1 Lines
  - 512 Low/Medium Speed Lines
  - 8 Token-Rings
- Maintenance and Operator Subsystem
  - 45 Megabyte Hard Disk
  - Local/Remote/Alternate Console
- Remote Support Facility
- Distributed Power System

Improved Performance & Availability

Foil 3: Configurability Options

The multiple functions supported by the features reduces the need for constant controller upgrades and changes as the network itself changes. The IBM 3745 can be configured with one or two CCUs depending on the required level of performance and redundancy. The channel adapter has been designed to support data streaming in block multiplexer mode. The same channel adapter supports byte multiplexer, block multiplexer and selector channel attachment. A single communication scanner type supports S/S, BSC, and SDLC protocols. Line interface couplers are protocol insensitive and support multiple speeds.

The use of only 11 features codes for the 3745 simplifies configuration options. A reduced number of features result in fewer ordering errors for initial orders as well as reducing the complexity of machine upgrades.

Fewer features means more effective communication controller change and growth.

Configurability Options

- Features Provide Multiple Functions
  - Single or Dual CCU Performance/Availability
  - Channel Adapter Supports Data Streaming
  - Channel Adapter Attaches to Byte, Block or Selector Channel Data Transfer
  - Communication Scanner Supports S/S, BSC, and SDLC
  - Line Interface Couplers Support Multiple Speeds
- Eleven Feature Codes Simplifies Configuration Options
  - Reduces Configuration/Upgrade Time
  - Fewer Ordering Errors
  - Reduces Complexity of Machine Upgrades

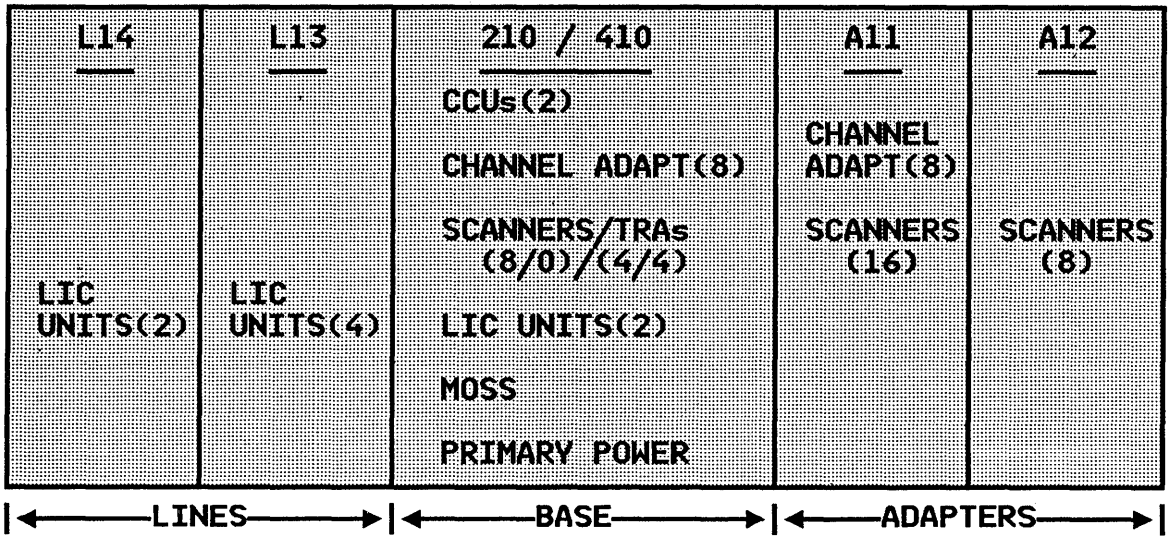
Effective Controller Change and Growth

Foil 4: Machine Types and Models

There are two machine types and six models. The communication controller base frame is the 3745 and has two models. Model 210 has one CCU. Model 410 has two CCUs. It is possible to field upgrade the 3745 Model 210 with one CCU to a 3745 Model 410 with two CCUs. The base frame of both models contains up to 8 channel adapters and a combination of scanners and token ring adapters. Up to 8 high or low speed scanners can be included in the base or the base can support up to 4 high or low speed scanners and up to 4 token ring adapters. The base also contains up to 2 LIC Units, the Maintenance and Operator Subsystem (MOSS), and primary power.

Machine type 3746 designates expansion frames and has four models. Model A11 is the first adapter expansion and can contain up to 8 additional channel adapters and up to 16 additional low speed scanners. Model A12 is the second adapter expansion and can be installed only if a Model A11 is installed. Model A12 contains up to 8 additional low speed scanners. The first line expansion, Model L13, can contain up to 4 additional LIC Units. Model L14, can be installed only if a Model L13 is installed, and can contain up to 2 additional LIC Units.

Machine Types and Models



Two Machine Types and Six Models

Frame	Type	Model
Base w/ Single CCU	3745	210
Base w/ Twin CCU	3745	410
First Adapter Expansion	3746	A11
Second Adapter Expansion	3746	A12
First Line Expansion	3746	L13
Second Line Expansion	3746	L14

Field Upgradable from 3745 Model 210 to Model 410

Foil 5: Innovations

Single or twin central control units drive scanners and channel adapters from buses which are connected through a bus switch. The bus switch is contained within a single module and is part of the logic that drives and receives commands and data from the buses. This new switching function allows a 3745 with twin CCUs to be reconfigured internally.

Two CCUs can be operated independently. Each CCU has a independent Network Control Program (NCP) running. In effect two communication controllers are running within the same frame. No NCP/CCU backup is available internally.

One CCU can be running with the second CCU dedicated to backup. If a failure in the primary NCP/CCU occurs the backup CCU can be activated and ACF/NCP loaded from hard disk.

Two NCPs can be running, each with additional scanner/channel adapter load capacity defined but not activated. If a failure occurs in either NCP/CCU, switching to and activation of the previously defined backup resource can recover critical lines quickly.

Reconfiguration bus switching can be accomplished either automatically or through external commands.

Both CCUs have two high speed I/O buses for increased throughput. Both buses effectively operate in parallel.

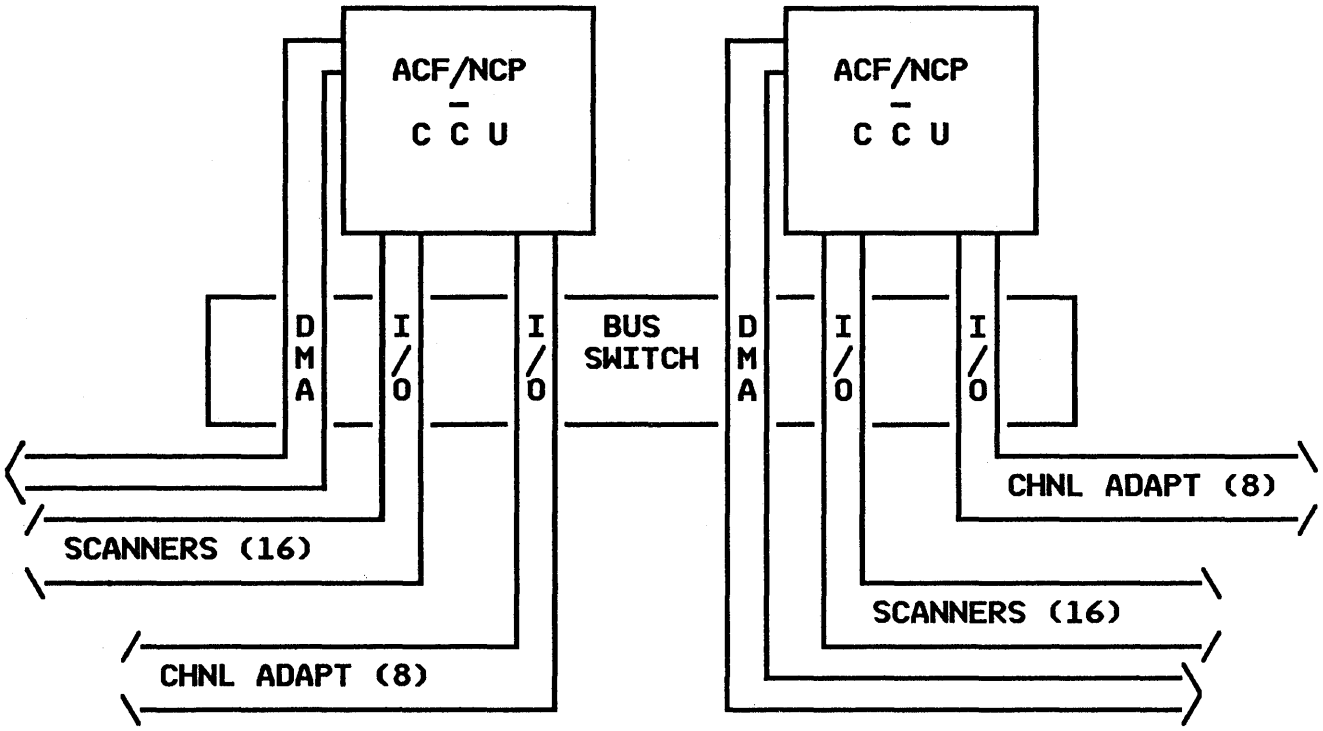
Data streaming is a new capability of the multi-function channel adapters that increases instantaneous message throughput and doubles the cable length between the host and the 3745.

A high performance transmission subsystem provides support for T1 transmission rates. Up to 8 concurrent T1 links can be active. A direct memory access bus bypasses the CCU for high speed data transfer. Transfer of control information between very high speed line adapters and memory occurs without significant utilization of CCU resource.

A serial link between the scanners and the LICs increases the configuration flexibility. The fixed positional relationship between scanners and LICs no longer exists.

The 3745 incorporates a fully distributed power system for increased availability. Shut-down of controller sections for maintenance and upgrade is now possible, without impacting the use of the remainder of the controller. This concurrent maintenance capability increases the overall availability of the 3745.

Innovations



- Single or Twin CCUs
  - Switchable for Reconfiguration
    - Twin CCUs - Dual Independent NCPs
    - Twin CCUs - Standby Dedicated CCU
    - Twin CCUs - Backup Available Resource
  - Dual High Speed I/O Buses per CCU
- Data Streaming Channel Adapters
- High Performance Transmission Subsystem Utilizing Direct Memory Access
- Serial Link Between Scanners and LICs
- Distributed Power System

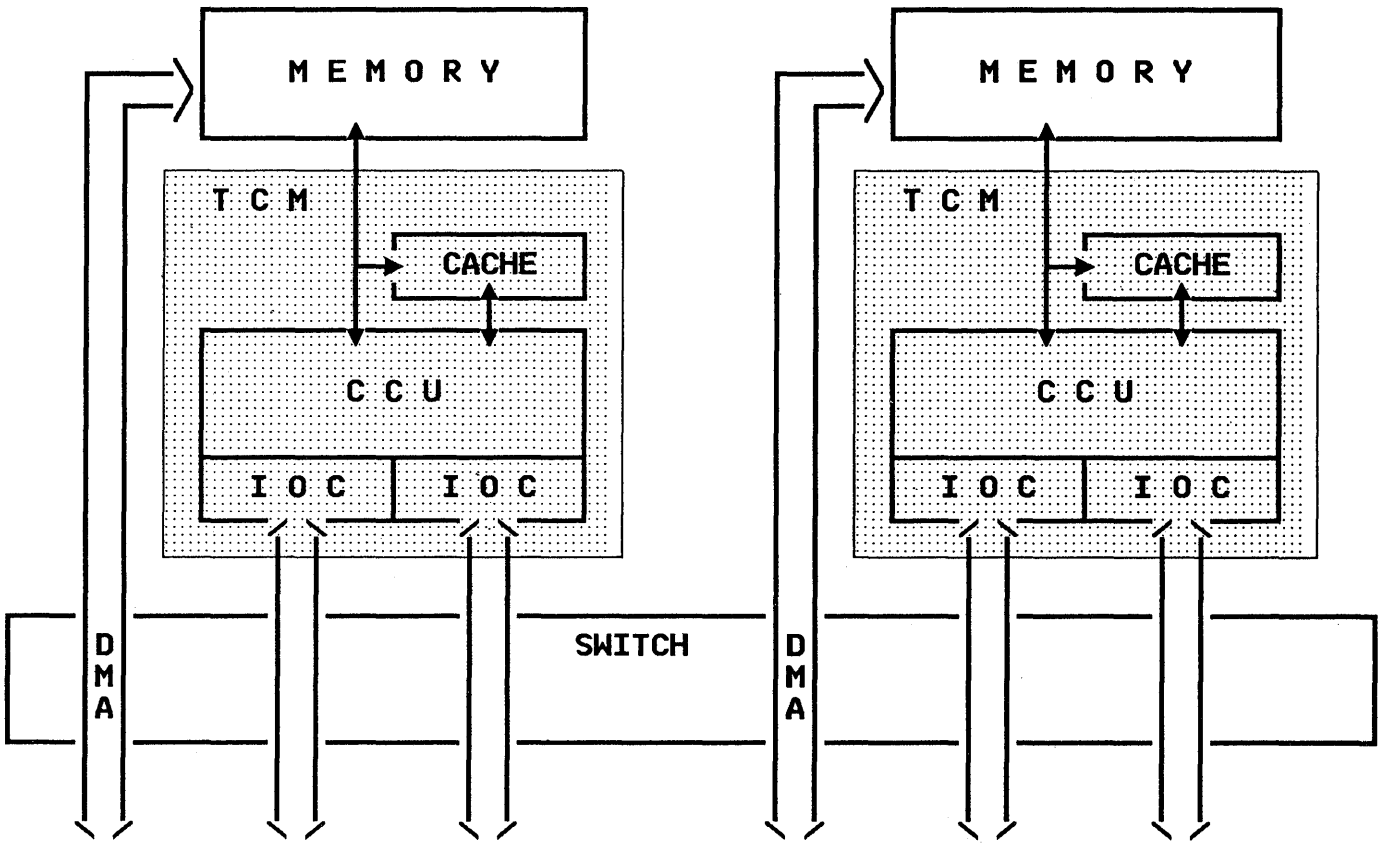
Foil 6: Proven Technology

The central control unit, the dual I/O bus control, and the cache memory of the 3745 utilize the extremely dense circuitry of the thermal conduction module. This TCM technology is the same as that used in the powerful 9370 host processor. The high density 1 megabit memory chips used for main memory are also used by the 9370 processor series.

The 3745 architecture is an extension of the 3725 architecture. As an evolutionary product, its architecture and its technology are proven performers.

The technological advantage is a denser, higher performance communication controller.

Proven Technology



- Thermal Conduction Module (TCM)
- Same Technology as 9370
  - Central Control Unit
  - 1 Megabit Main Memory Chips
- Architecture Evolved From 3720/3725

Denser - Higher Performance

Foil 7: Concepts and Structure

The IBM 3745 is architected using a concept of dual central control units. Each CCU has two I/O buses for attachment of scanners and channel adapters. A third bus, Direct Memory Access, supports very high speed line data transfer. This permits various performance/availability options and allows higher data transfer speeds.

The Control Subsystem consists of the central control units and the channel adapters. One or two central control units and up to 16 channel adapters are available to accommodate performance and host CPU attachment requirements. Up to 8 two processor switches are available permitting backup options or attachment to multiple hosts. The central control units execute the control program instructions. The main memory for each CCU is 4 or 8 megabytes in size.

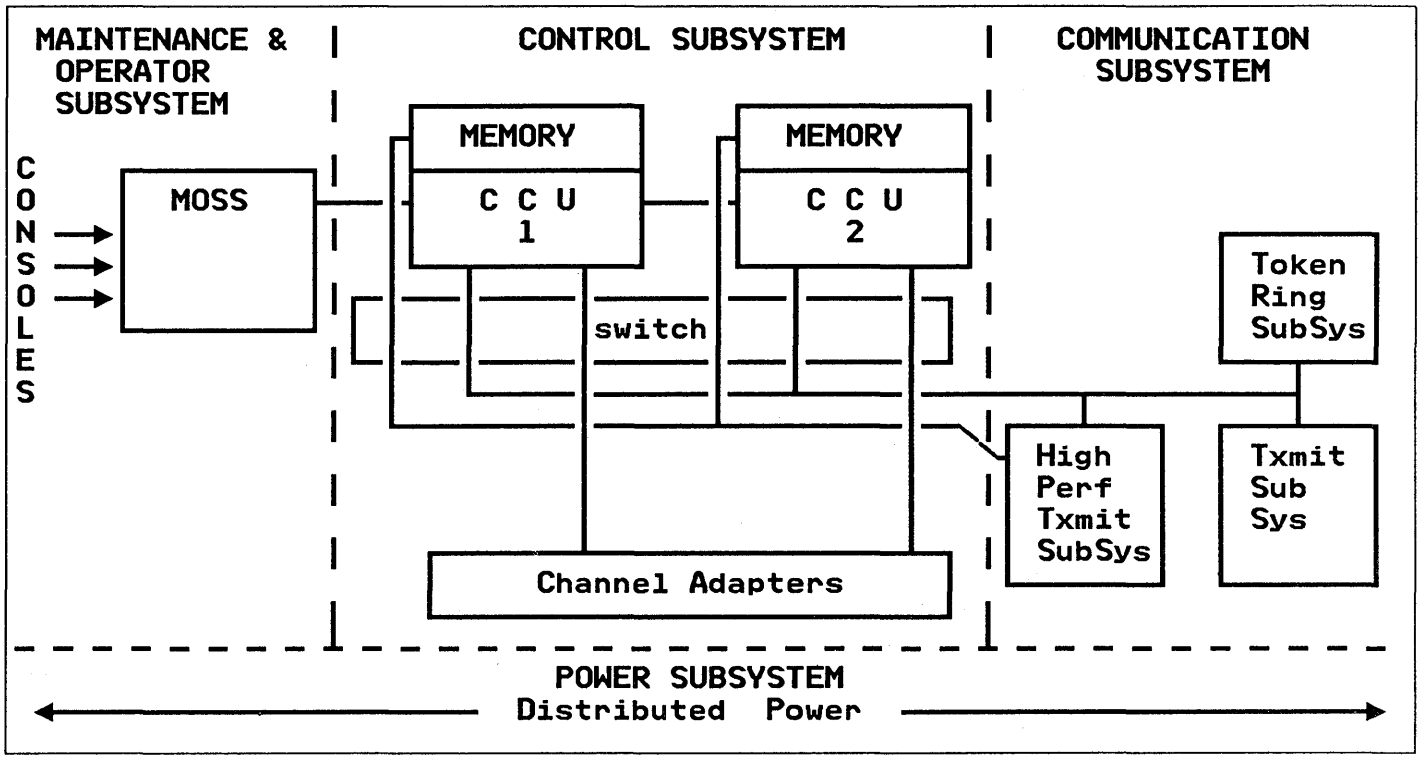
Communication Subsystem - This subsystem consists of the following subsystems.

> Transmission SubSystem (TSS) - Up to 32 microprocessor based communications scanners may be attached to the 3745. Each scanner is composed of a Communications Scanner Processor, a hardware Front End Scanner, and Line Interface Couplers. Line speeds from 50 BPS to 256 KBPS are supported.
>
> High Performance Transmission Subsystem (HPTSS) can have a maximum of eight very high speed line adapters. Each line adapter can connect up to two lines, only one being active at a time. Line speeds up to 1.544 megabits per second for T1 links in the US, Canada, and Japan, and up to 2.048 megabits per second for CEPT links in other countries.
>
> The Token-Ring Subsystem (TRSS) consists of the Token-Ring Driver and Token-Ring Interface Couplers (TIC). The TIC provides functions conforming with the IEEE 802.5 standard and allows full participation on an IBM Token-Ring network.

Maintenance and Operator Subsystem (MOSS) - An operator keyboard-display console combined with a microprocessor and dedicated storage add function that aids the 3745 operator and IBM service representative in operating the 3745, performing problem determination, running diagnostics and completing repair.

The Power Subsystem consists of modular DC power distribution under control of a centralized power system microprocessor. The power modules are distributed at a subsystem level throughout the 3745. The separate power design enables replacement of failed components without impacting the operation of other system components.

Concepts and Structure



- Control Subsystem
- Communication Subsystem
  - Transmission Subsystem (TSS)
  - High Performance Transmission Subsystem (HPTSS)
  - Token Ring Subsystem (TRSS)
- Maintenance and Operator Subsystem (MOSS)
- Distributed Power Subsystem

Foil 8: Central Control Unit

The central control unit of the 3745 utilizes the architecture proven with the 3725. The CCU has a fast (75 nanosecond) cycle speed that provides high throughput. The CCU supports a cycle steal mechanism for adapter initiated operation. Cycle steal avoids program overhead and CCU cycles by allowing hardware control of data cycles. The architecture also supports 54 instructions, and five program interrupt levels. Task processing on a priority basis provides appropriate levels of quick response to network program tasks.

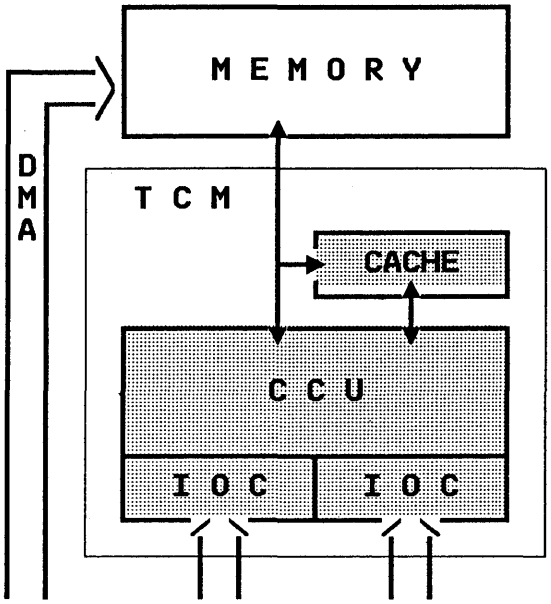
Two high speed I/O buses support parallel operation. Interleaving of bursts of command and data between the channel adapters and scanners of the two buses effectively doubles bus throughput. Both of these buses, as well as the Direct Memory Access bus, are switchable between the twin CCUs of the 3745. In a twin CCU configuration one I/O bus will connect scanners to the CCU and the other I/O bus will connect the CCU to channel adapters. In a single CCU configuration channel adapters and scanners can be mixed on both I/O buses. The Direct Memory Access bus bypasses the CCU.

Included within the TCM is 16 kilobytes of high speed cache memory. The cache memory operates at the speed of the CCU and moves blocks of instructions and data into and out of main memory. Overall memory speed is improved allowing the CCU to operate at its fast cycle speed.

The innovations to and the technology of the central control unit result in significant performance increases. The performance of the 3745 with a single CCU is approximately two times the performance of a 3725, which allows from 1.6 to 4.0 times more line attachments than the 3725. (Performance is a function of the specific NCP path length being executed). When the 3745 is configured with two CCUs and is supporting T1 links, T1 line attachment can reach 8.0 times that of a 3725.

Control Subsystem
Central Control Unit

Foil 8



- 3725 Architecture Extended
  - Increased Cycle Speed
  - Cycle Stealing Mechanism
  - 54 Instructions
  - Five Program Interrupt Levels
- Two High Speed Input/Output Buses For Parallel Operation
  - Switchable Between CCUs
  - Provides Scanner & Channel Adapter Attachment
- 16 Kilobyte Cache Memory
  - Improves Processor Throughput
  - Buffers Instructions and Data

Increased Performance

Foil 9: Memory/Memory Control

Main memory for each CCU is available in 4 or 8 Megabytes. Addressing of main memory is architected to 16 Megabytes. The use of high speed cache memory between main memory and the CCU increases the effective access speed. The 16 kilobyte cache is made of 1024 16 byte lines. Reads and writes between cache and main memory are done in 16 byte bursts.

The memory control contains powerful error correction code in order to provide higher data integrity (reliability). The correcting capability of the error correction code depends on the type of error, whether it is a hard error (memory bit stuck to 0 or 1), or a soft (transient) error. The following table relates the correction capability to the error type and also indicates whether the capability existed on the IBM 3725. The ability to correct all 'two hard' memory bit errors and half of the 'two hard and one soft' memory bit errors, is new with the 3745 and was not present in the 3725.

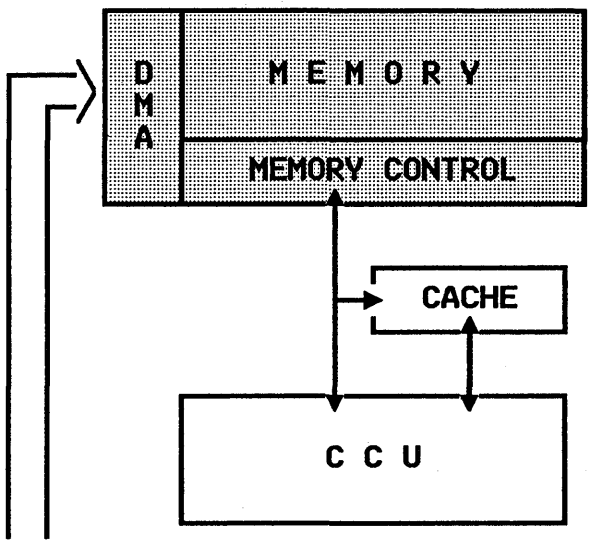
Type of Error	Coverage	Notes
One hard	100%	As in 3725
One soft	100%	As in 3725
One hard and one soft	100%	As in 3725
Two hard	100%	New Capability
Two hard and one soft	50%	New Capability

Direct Memory Access provides data transfer from one or more very high speed lines to CCU main memory. DMA bypasses the CCU and takes full advantage of the memory speed during data burst transfers from the very high speed line adapters.

The enhanced control and the buffered memory provide faster, more reliable access.

Control Subsystem
Memory/Memory Control

Foil 9



- Main Memory Available in 4 or 8 Megabytes
  - Addressing Architected to 16 Megabytes
  - Buffered by High Speed Cache
- Memory Control Ensures Data Transfer Integrity
  - Error Checking and Correction
  - Single Transient (Soft) Bit Error Correction
  - Double Permanent (Hard) Bit Error Correction
  - Triple Bit Error Detection/Correction
- Direct Memory Access
  - Operates in Parallel with CCU
  - Switchable Between CCUs
  - Supports 8 Very High Speed Line Adapters

Faster - More Reliable Access

Foil 10: Channel Adapter

Each channel adapter is equipped with a microprocessor. The channel adapters attach the CCU to the host data channels. Host channel support is byte-multiplexor, block-multiplexer (with data streaming), or selector channels. A two processor switch feature provides an additional channel interface to a channel adapter. Only one interface can be active at a time. The two interfaces can connect to the same or to different hosts. Each two processor switch feature requires two channel adapter positions.

The data streaming feature makes it possible to reach a high speed data rate for a host located up to 400 feet from the controller. Data transfer at an instantaneous speed of 2 million bytes per second reduces the channel occupancy time. Reduced channel occupancy allows more traffic to flow over the channel.

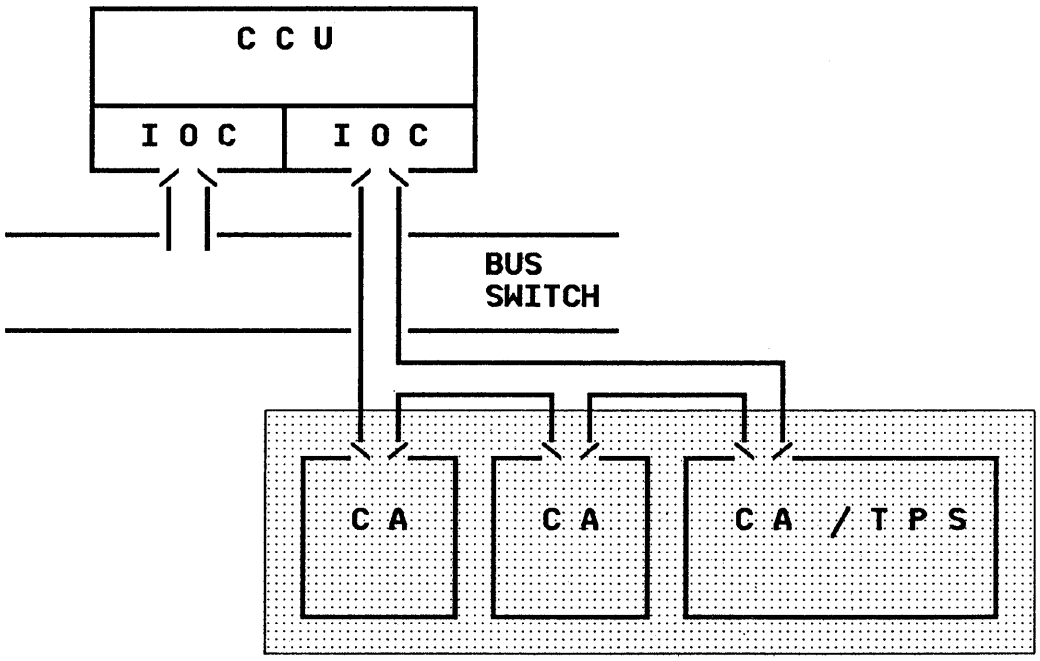
Channel adapter features and parameters are defined at installation time by the MOSS operator and saved on the MOSS hard disk. These definitions are used by MOSS at each initial program load to set the operating state of the channel adapter. No hardware jumpering is required.

Improved channel adapter maintenance is possible through new MOSS services. Individual channel adapters can be brought off-line and diagnostics run on them. Modular power-off allows pairs of channel adapters to be powered off for replacement. Enhanced tests display channel adapter and channel adapter interface status for all installed channel adapters. MOSS support for the channel adapters include subchannel address setting via MOSS instead of hardware jumpers, automatic channel monitoring, alert notification and power-on reset.

The channel adapters' increased capabilities enhance the attachment of the 3745 to one or multiple hosts.

Control Subsystem
Channel Adapter

Foil 10



- Byte, Block, & Selector Attachment Support
  - Optional Two Processor Switch Feature
  - 16 Channel Adapter Maximum
- Data Streaming Support
  - Instantaneous - 2 Megabytes per Second
  - Reduced Channel Occupancy
  - Cable Length - 400 Feet
- Feature & Parameter Initialization via MOSS
  - Subchannel Addresses Set by MOSS
- Improved Maintenance
  - Concurrent Diagnostics & Component Replacement
  - Enhanced Tests & Error Notification

Enhanced Host Attachment

Foil 11: Communication Scanner

The transmission subsystem can have up to 32 communication scanner processors (CSPs). Each communication scanner is composed of a CSP and a Front End Scanner-Low speed.

A new logical addressing technique selectively scans only the LICs with activated lines. When a LIC has its lines deactivated it is removed from the scanning sequence (except for X.21 lines). This increases the number of LICs that can be attached to the CSP. Because of this capability it is possible to exceed 100% line weight when configuring the 3745. Line weights must be considered when lines are activated as activated lines must not exceed 100%.

The logical addressing improves the flexibility of LIC attachment. LICs can be placed anywhere without regard to scan sequence or LIC weight. High speed LICs can come before or after low speed LICs and there can be open LIC positions.

There are reduced line weights for scanners operating with four LICs or less. Limiting the number of LIC positions scanned by a single scanner to four, allows a 32 byte transfer burst size to be used (in addition the the 16 and 64 byte transfer used with the 3725). Depending on line speed, scanner performance (reduced the line weights) is improved by up to 25%. (Refer to Foil 36 in the Appendix.)

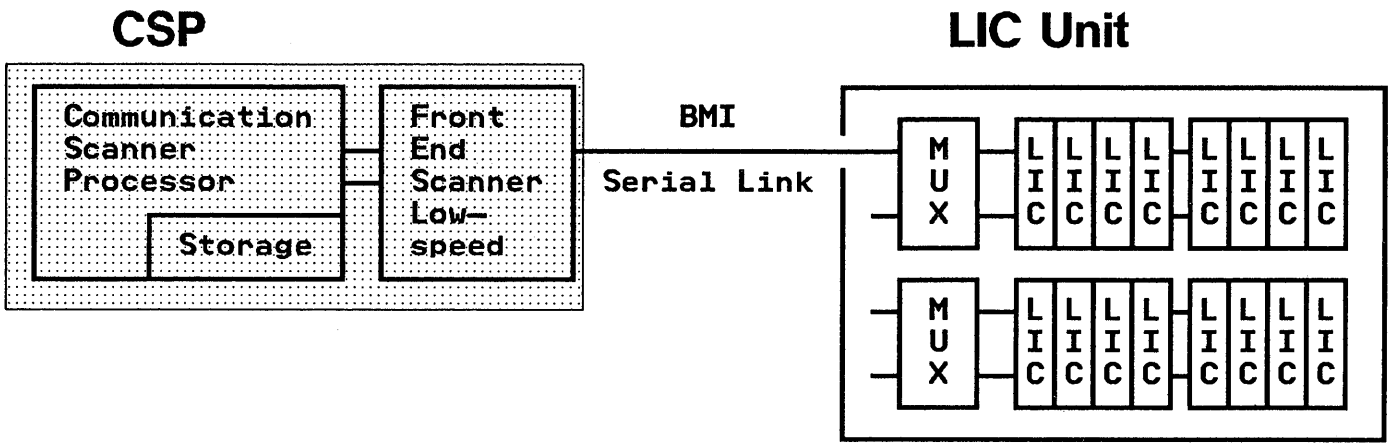
The 3745 uses a microprocessor based communication scanner. It supports multiple line protocols, provides character buffering, and cycle steal data transfer into main memory. The CSP also performs other repetitive operations such as ASCII/EBCDIC translation for BSC lines.

The serial Bit Multiplex Interface (BMI) link between the CSP and LICs provides greater flexibility in configuration change. The twisted pair interface eliminates the fixed positional relationship between scanner and LIC. The flexible nature of the BMI link allows the CSP and the connecting LICs to be in any of their positions within the 3745. The 3745 can have scanners and LICs independently added to support performance or connectivity requirements.

This design provides the most effective utilization of scanner resources.

Transmission Subsystem Communication Scanner

Foil 11



- Up to 32 Communication Scanner Processors
  - Logical Address Technique
    Selectively Scans Only LICs With Activated Lines
    - Increases LIC Attachment Capacity
    - Improves LIC Attachment Flexibility
  - Reduced Line Weights With 4 LICs per Scanner
- Microprocessor Based Scanners Support
  - Multiple Line Protocols
  - Character Buffering
  - Data Transfer to CCU Using Cycle Steal
  - ASCII / EBCDIC Translation for BSC Lines
- Bit Multiplex Interface - Serial Link Between CSP & LIC Unit

Effective Resource Utilization

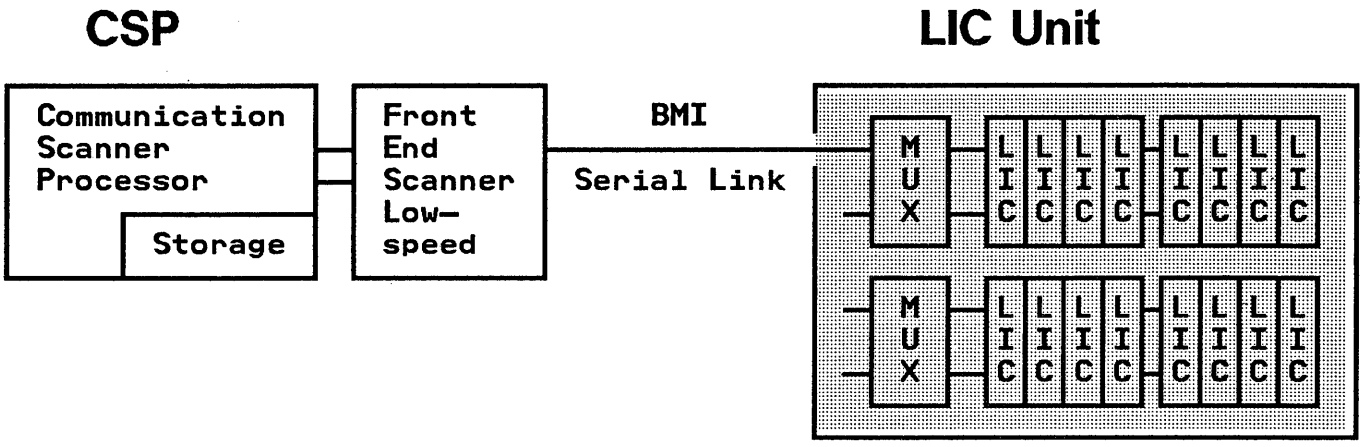
Foil 12: LIC Unit

The Line Interface Couplers are packaged into LIC Units. The IBM 3745 supports up to 8 LIC Units. Each LIC Unit contains 2 multiplexor (MUX) cards that interface either 4 or 8 LIC positions to the CSP. Depending on line weight, one or two scanners drive the 8 LIC positions associated with the multiplexor. The multiplexor directs the serial bit stream from the CSP to the appropriate LIC. The LIC Unit capacity is 16 LICs.

Maintainability is improved. The LIC Unit is a user access area. Customers may replace and change LICs. A spare LIC Type 1 and Type 3 are provided with the 3745 to allow user replacement of failed LICs. Hot pluggability for on line upgrade and replacement is supported.

The LIC Unit increases line configuration flexibility.

Transmission Subsystem
LIC Unit



- Up to 8 LIC Units per 3745
  - Each LIC Unit Contains 2 'MUX' Cards to:
    - Interface to One or Two Scanners via Bit Multiplex Interface
    - Control Serial Bit Stream
  - Capacity for 16 LICs per LIC Unit
- Improved Maintainability
  - User Access Area for Replacement & Change
  - Modular Power Off for On Line Upgrades & Repair
  - Spare LIC Type 1 & 3 Provided with Machine

Increased Flexibility

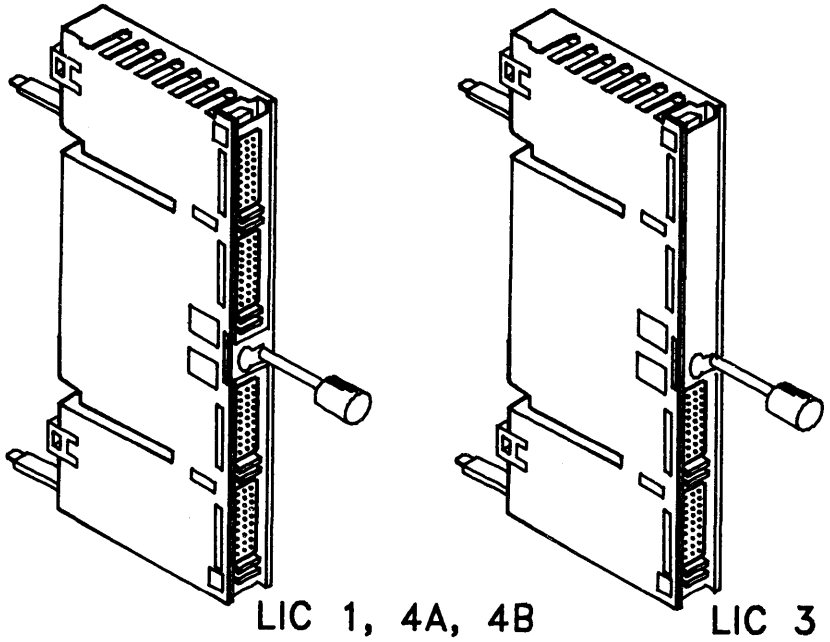
Foil 13: Line Interface Couplers

The line interface couplers (LICs) on the 3745 have been designed to accept snap on cables. This allows quick cable attachment of the telecommunication lines. Telecommunication lines from remote locations interface to the LIC through modems and Digital Service Units. Local telecommunication lines can be directly attached to the 3745. All LICs contain an internal clock function that eliminates the need for external clocking. The speed is software selectable at various speeds up to 245,760 bits per second.

Four types of LICs are available for connecting the widely used interfaces - V.24/RS 232C, V.25/RS 366A, V.35, and X.21. In the US these interfaces are supplied by LIC Type 1 and LIC Type 3. Different LIC types can be plugged into the same LIC Unit.

Hot pluggability allows plugging and unplugging of LICs when the 3745 is in operation. A specially designed cassette protects the electronics from damage.

The new LICs simplify line attachment allowing customer access for easier growth and change.



- Snap On Cable External Interface
  - Modems and DSUs
  - Direct Attached Local Terminals
    - On Card Internal Clock Function
    - Software Selectable Up To 245,760 BPS
- Supports V.24, V.25, V.35, and X.21 Interfaces
- Hot Pluggability for On Line Change - Protective Cassette

Simplified Line Attachment

Foil 14: High Speed Scanner

Up to 8 very high speed scanners can be supported within the base frame of the 3745. Each high speed scanner consists of a CSP, and a Front End Scanner High speed with Direct Memory Access. The high speed scanner accepts a clear channel (without channel and subchannel TDM framing) at speeds up to 1.544 megabits per second for T1 and up to 2.048 megabits per second for CEPT. The high speed scanner is used for inter-network-node support of high speed lines. This connection must be SDLC, full duplex, point-to-point, leased line traffic.

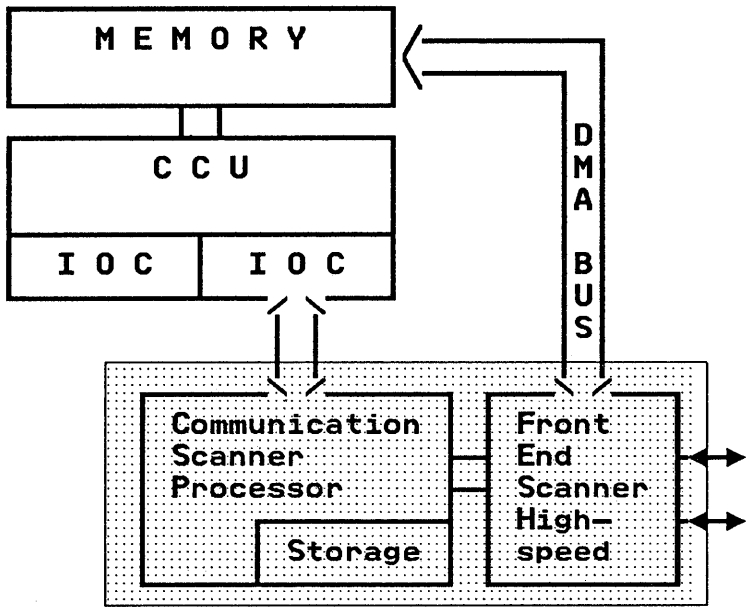
The interface choices provided for the two ports on the Front End Scanner-High speed are: V.35 and X.21. The interfaces choices are identified, via specify code, at the time of order. Only one interface may be activated at a time. The customer selects any combination of these interfaces. ACF/NCP specifies which interface is to be activated.

The scanner can provide clocking for direct attachment to another 3745. attached to it. In this mode the very high speed scanner can provide clocking at 245.7 kilobits per second, at 1.474 megabits per second and at 1.843 megabits per second. The direct attach speed is set by ACF/NCP.

With the very high speed scanner the 3745 provides very effective T1 line support.

High Performance Transmission Subsystem
High Speed Scanner

Foil 14



- Up to 8 Very High Speed Data Channels
  - Clear Channel - No Channel/Subchannel TDM Framing
    - 1.544 MBPS Bandwidth: T1
    - 2.048 MBPS Bandwidth: CEPT
  - Supports INN
    SDLC, Full Duplex, Point to Point, Leased
- Supports V.35 & X.21 Interfaces
  - Two Interfaces per Adapter (1 Active)
- Direct Attachment Support
  - 245.7 KBPS/1.474 MBPS/1.843 MBPS

Multiple T1 Support

Foil 15: Scanner Function

The scanner has been designed to minimize NCP and microcode impacts. A different microcode is loaded into the CSP depending on whether a FESH or FESL is installed. The microcode in the CSP knows whether a Front End Scanner-High speed (FESH) or a Front End Scanner-Low speed (FESL) is installed.

The scanner setup and control is done via the I/O bus. NCP and MOSS commands are passed over the I/O bus. Microcode loads are also sent via the I/O bus.

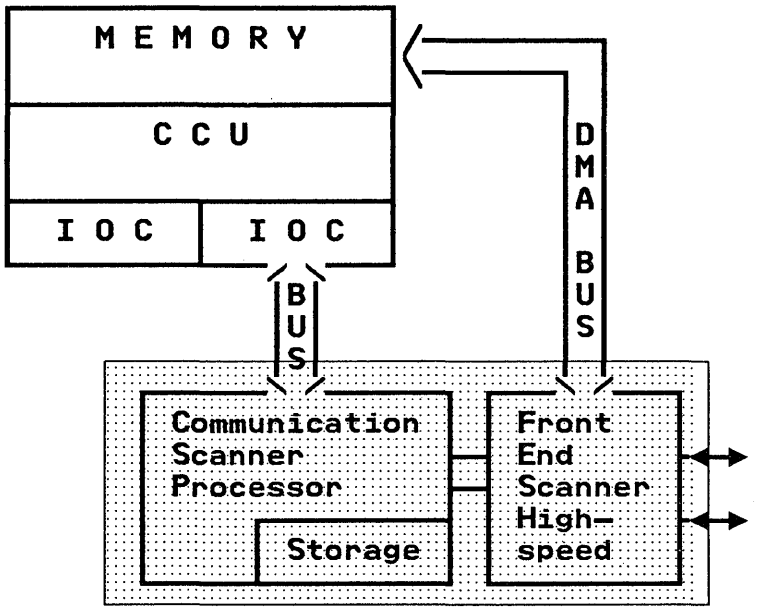
The direct memory access bus between the FESH and CCU memory allows direct data transfer in bursts of up to 64 bytes. Burst size is set by MOSS and may vary from scanner to scanner. The DMA bus is also used for parameter/status exchange between NCP and the very high speed scanners. High speed, efficient transfer is accomplished without use of CCU cycles.

The functions of the high-speed (FESH) hardware are similar to the functions of the FESL. Data link control functions deal at a bit and byte level with data link control. DMA bus management deals with the protocol and management of data across the DMA bus. Digital Service Unit interface management is identical to modem interface management in the FESL.

The high performance transmission subsystem is an innovative approach to high speed line support. The scanner has been designed to minimize both ACF/NCP and microcode tasks.

High Performance Transmission Subsystem Scanner Function

Foil 15



- New Scanner (CSP) Microcode
- Adapter Setup & Control via I/O Bus
  - NCP & MOSS Commands
  - Initial Scanner Microcode Load & Re-IML
- Direct Memory Access (DMA) of Up to 64 Byte Bursts
  - Data Between the Line & Main Memory
  - Parameter/Status Between NCP & Adapters
- Front End Scanner High-speed Functions
  - Data Link Control Functions
  - DMA Bus Management
  - Digital Service Unit (DSU) Management

Innovative High Speed Support

Foil 16: Token Ring Adapter

The token ring subsystem consists of up to 4 token ring adapters which reside in the 3745 base. The token ring adapter consists of a token ring driver and one or two Token Ring Interface Couplers (TICs). The interface to the ring and the external equipment is through the Token Ring Interface Coupler.

The Token-Ring Driver handles the operations between the CCU and one or two Token-Ring Interface Couplers. The IOC Bus Interface allows communication between the Token Ring Adapter (TRA) and the control program (NCP) or between TRA and MOSS. The actual data transfer between main memory and the TIC's is performed using an Adapter Initiated Operation called cycle steal. Cycle steal is a hardware implementation of data/command transfer. With cycle steal transfer of data/commands between the token ring driver and CCU memory occurs without utilizing CCU cycles. This increases communication controller throughput.

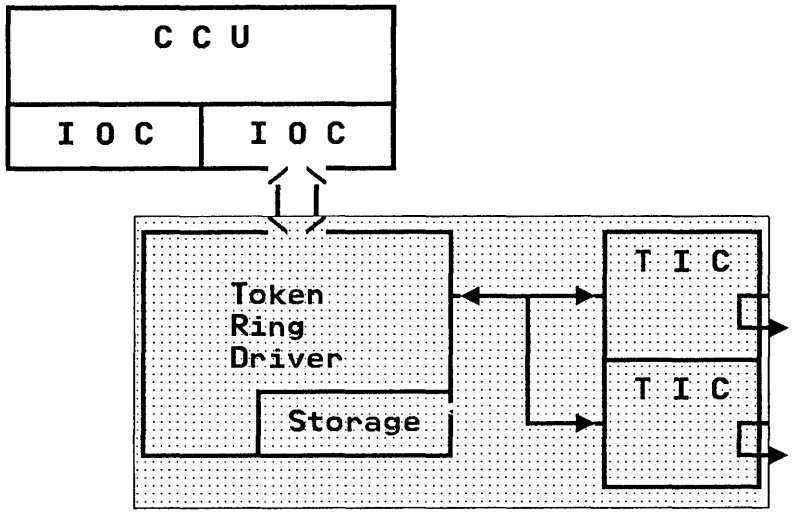
The Token-Ring Interface Coupler (TIC) provides one attachment to an IBM Token-Ring Network. It contains a microprocessor operating under control of resident microcode. The coupler transmits and receives at a speed of 4 million bits per second using protocols conforming with IEEE 802.5 and ECMA 89 standards. However the throughput of the 3745 depends on transaction characteristics, network control program path length and 3745 CCU utilization.

Token ring devices can be predefined to the system, allowing terminals to be added or deleted non-disruptively and without having to sysgen a new NCP load module.

The token ring adapter allows full function token ring participation.

Token Ring Subsystem
Token Ring Adapter

Foil 16



- Up to 4 Token Ring Adapters (8 TICs) per 3745
- Each Token Ring Adapter Has a Token Ring Driver Which:
  - Adapts 1 or 2 Token Ring Interface Couplers (TICs) to the I/O Bus
  - Buffers Data During Data Transfer Between Main Memory and Token Ring
- Microprocessor Based Token Ring Interface Coupler
  - Provides Connection to IBM Token Ring
  - Performs Message Assembly/Disassembly
- Token Ring Devices Can be Added/Deleted Non-disruptively

Full Function Token Ring Participation

Foil 17: Distributed Functions

The 3745 power subsystem accepts three phase 50/60 Hertz AC input and generates all the regulated DC outputs required by the various subsystems. The primary power box, located in the base frame, implements the protection needed to turn off the power supply when a fault condition is detected and to tolerate all power line impairments in accordance to IBM standards.

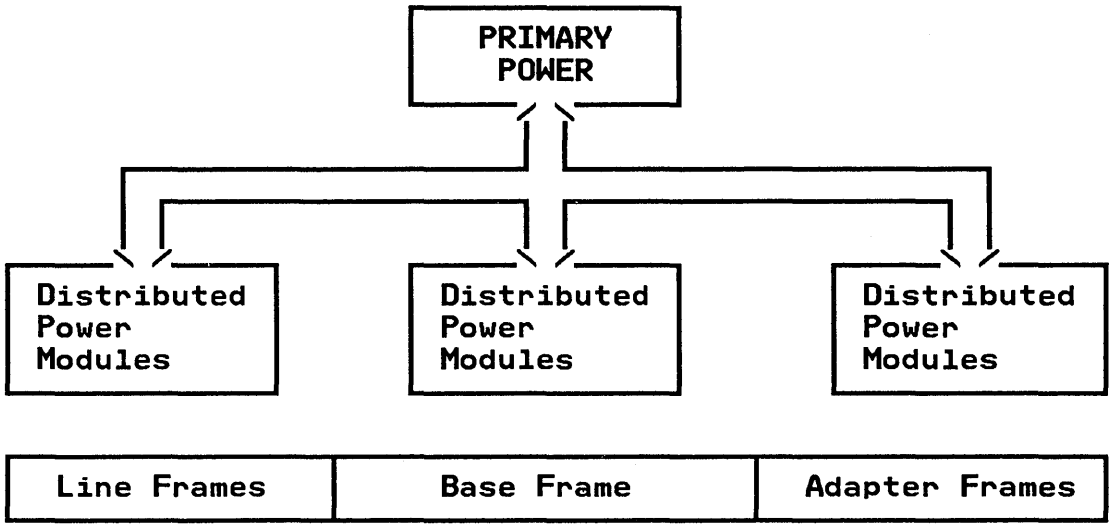
A microprocessor, located within the power adapter card that interfaces with MOSS, manages the entire power subsystem. Power fault recognition, automatic power restart after AC main power failure, scheduled power on, and remote power off, are some of the enhanced power subsystem functions.

Distributed power modules throughout the 3745 allow concurrent component repair. Each power module can be independently powered off and/or reset. Local power off allows subsystems to be repaired without affecting the entire controller.

The power subsystem increases communication controller availability.

Power Subsystem Distributed Functions

Foil 17



- Primary Power Functions in Base
  - Input Power Fault Tolerance
  - Power Off & Distribution
- Microprocessor Controlled Subsystem
  - Fault Recognition
  - Automatic Power Restart
  - Scheduled Power On
  - Remote Power Off
- Distributed Power Modules Throughout Controller
  - One Power Module per Adapter Pair
  - Allows Concurrent Component Repair
  - Independent Power Off / Reset

Increased Controller Availability

Foil 18: Structure

The Maintenance and Operator Subsystem (MOSS) continuously monitors the status of the communication controller. Abnormal conditions are analyzed and reported via alarms to the 3745 console(s) and alerts to the network control console. MOSS has its own microprocessor with 1 megabytes of memory.

Multiple adapters in the components of the communication controller allow MOSS to monitor the status of the CCUs, control the DMA and I/O bus switching, and enable and disable channel adapters.

A console adapter allows the 3745 to be controlled from a local console (located within 16 feet) or an alternate console (located within 400 feet) or a remote console connected via a 1200 BPS modem to the controller. Only one console may be active at a time. If the remote support facility is used, it will allow communication between the MOSS and the IBM RETAIN system, providing remote service assistance. The RETAIN terminal can be used as an operator console as well as for transferring microcode patches to MOSS if required. (A modem for the RSF application is provided with the 3745).

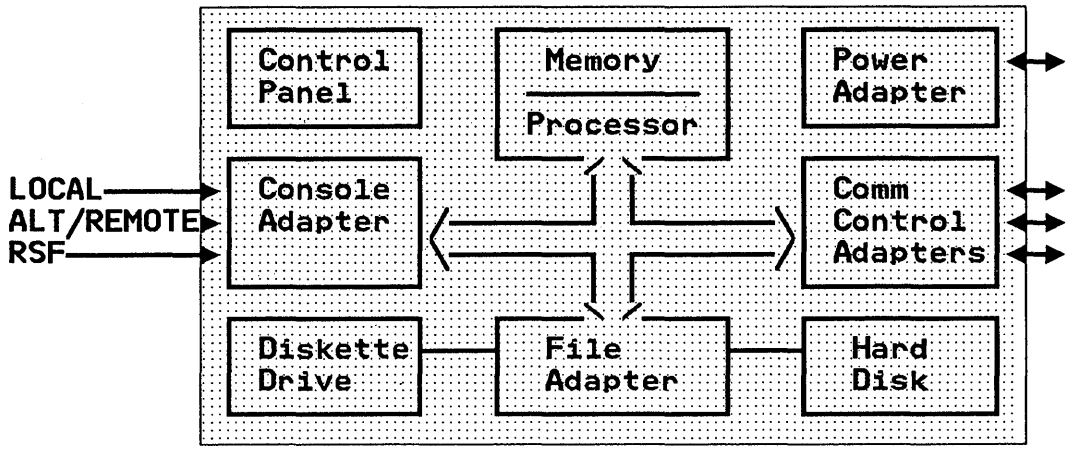
A file adapter provides MOSS storage control. A 45 megabyte hard disk in addition to a 1.2 megabyte diskette drive provides extensive capacity for file and data storage.

A distributed power control adapter with a dedicated microprocessor monitors 3745 power.

MOSS interfaces to the control panel indicators and switches. These provide an alternate method for controlling the primary power subsystem, activating MOSS functions, and for operator notification.

Maintenance and Operator Subsystem Structure

Foil 18



- Microprocessor With 1 Megabyte Memory
- Communication Controller Adapters
  - Monitor CCU Status
  - Control the DMA & I/O Bus Switching
  - Enable/Disable Channel Adapters
- Console Adapters For Control From:
  - Local
  - Alternate or Remote
  - Remote Support Facility
- File Adapter For MOSS Storage Control
  - 1.2 Megabyte Diskette
  - 45 Megabyte Hard Disk
- Distributed Power Control Adapter
- Control Panel Interface

Foil 19: Functions

The initialization of the controller includes MOSS initial microprogram load (IML), scanner IML, and channel adapter and control program load. Initialization can be invoked automatically during power-on/restart or after hard CCU stop. Initialization can also occur at the request of the host or the operator. Customization sets attributes of the channel adapters, transmission subsystem, and high speed transmission system (eg. type, burst transfer size).

Configuration management allows display and update of various machine parameters. The Configuration Data File stores information defining the setup of the 3745 hardware. The Line Interface Display displays line parameters.

MOSS will automatically take a dump of the controller memory and re-IPL the CCU after a CCU has an unrecoverable program error. The 3745 operator may also request a CCU memory dump and CCU re-IPL. When a CCU IPL and dump occurs, if the option is selected, there is an automatic dump of the controller storage to hard disk and a reloading of the control program from hard disk. The network operator can request the saved dump to be transferred to the host. The operator also has the capability to erase the dump from the hard disk.

Bus switching enables all line and channel adapters to be switched from one CCU to the other CCU for twin configurations in standby and backup mode. This function is performed automatically in case of a CCU hardware failure. It can also be initiated by the operator.

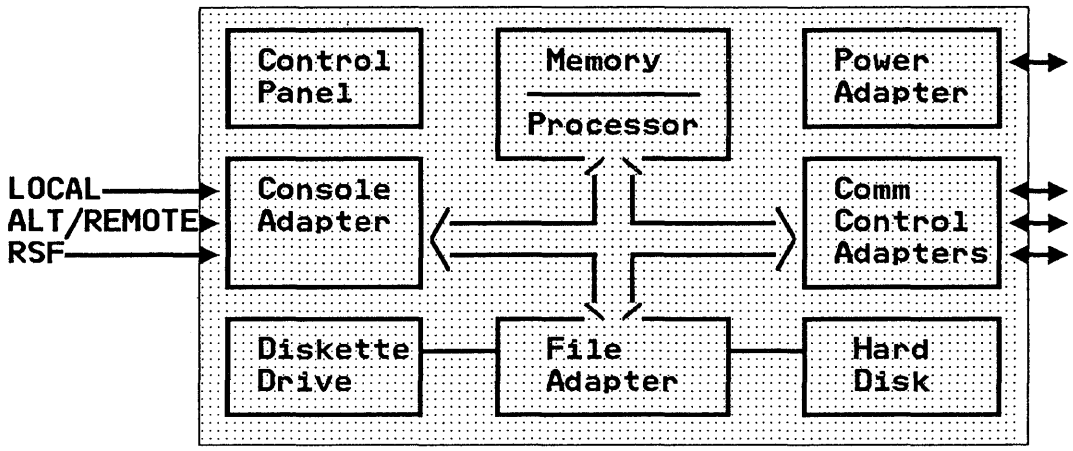
Error handling in the 3745 includes extensive recovery and retry for intermittent failures. On detection of a failure, pertinent information is logged and a retry/recovery attempt is invoked. Retries allow the controller to recover from intermittent hardware and transmission failures. In most cases, the controller remains available to the rest of the network while the retries are being executed.

Controller errors are detected by the NCP or by MOSS. When a box event is detected in a component of the controller, pertinent information is collected by NCP or MOSS. MOSS formats this information into a box event record (BER), stores it on disk, analyzes the event record, and sends an alarm to the controller console and an alert to the host. Alert messages contain generic information formatted by NetView.

MOSS manages the controller for increased availability.

Maintenance and Operator Subsystem Functions

Foil 19



- 3745 Initialization & Customization
- Configuration Management
- Automatic CCU IPL & Dump
- I/O & DMA Bus Switching
- Retry and Recovery Operations
- Problem Determination
- Supports Concurrent Maintenance
- System Notification of Failures

Controller Management for Availability

Foil 20: Automatic/Maintenance Functions

Many of the functions performed by the maintenance and operator subsystem are automatic. Continuous monitoring of the 3745 controller allows MOSS to recognize and recover from error conditions without affecting operation. The network operator will be advised of the intervention of MOSS in preventing a problem from affecting operation.

- MOSS monitors the controller status and generates a message when a problem occurs. These messages are sent to the 3745 console as an alarm and to the network operator as an alert.
- The message resulting from the 'event' that occurred within the controller is analyzed and stored for later retrieval.
- Failed components within the controller that MOSS can not restart are isolated from the rest of the controller and shut down.
- The controller can be restarted automatically after a primary power failure or the 3745 can have a scheduled 'power on' based on time of day.
- MOSS controls the switching of scanners and channel adapters associated with a CCU to the other CCU. This switching to fallback CCU resource (dedicated CCU or CCU with additional capacity) can be automatically initiated by a CCU 'hard check'.
- CCU dump and re-IPL occur after CCU 'hard check'.
- MOSS will dump the contents of a scanner or of itself after a 'hard check' and then reload the microcode.
- Token-ring interface couplers and channel adapters will have their contents dumped after a 'hard check'.

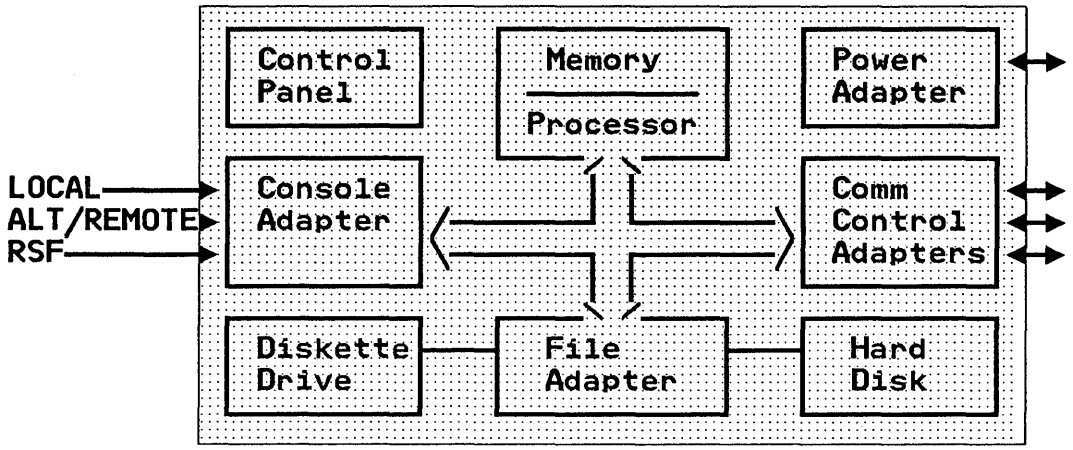
In cases where maintenance is required, MOSS will isolate the failure and notify the network operator. MOSS will also perform tests and other diagnostic procedures.

- Diagnostics are executed either; concurrently with the 3745 controlling the network, on-line with part of the 3745 controlling the network, or with the 3745 off-line not performing any network control. The type of diagnostic execution is dependent on the severity of the controller problem.
- An Internal Scanner Interface Trace (ISIT) provides valuable information on the traffic of troublesome lines. An ISIT can also be requested from the host.
- The remote support facility allows trained specialists to perform diagnostics remotely and to provide microcode fixes via phone lines.

The maintenance and operator subsystem increases the 3745 tolerance to faults.

Maintenance and Operator Subsystem Automatic/Maintenance Functions

Foil 20



- Automatic Functions
  - Alarm & Alert - Generation/Notification
  - Box Event Record - Analysis/Storage
  - Failed Component - Isolation/Shut Down
  - Controller Power On - Scheduled/Restart
  - I/O BUS Switching to 'Fallback' CCU Resource
  - CCU Dump & Re-IPL
  - Scanner & MOSS Dump/Re-IML
  - Token-Ring Interface Coupler Dump
  - Channel Adapter Dump
- Maintenance Functions
  - Diagnostic Execution - Concurrent/On-Line/Off-Line
  - Internal Scanner Interface Trace
  - Remote Support Facility (RSF)

Increased Fault Tolerance

Foil 21: Operator Functions

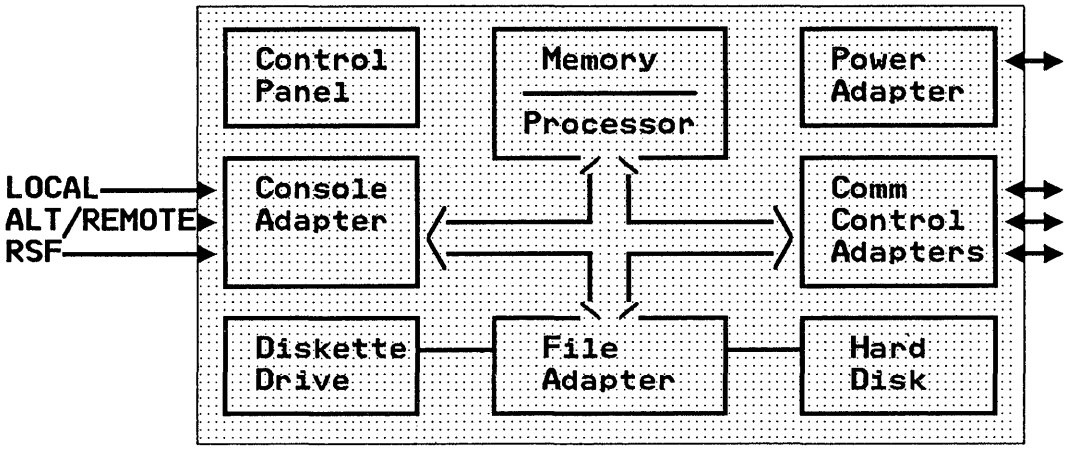
Many MOSS functions are provided for the benefit of the operator. These functions allow display of controller status, internal machine reconfiguration, and execution of diagnostics.

- Data concerning the configuration of the 3745 and its attached lines are stored as data files in the 3745 memory. MOSS allows the 3745 operator and the maintenance service operator to display and/or update these files.
- The operator manages the time and date of the clock contained within the 3745. Scheduled power-on utilizes the time/date information.
- The event log is a history of controller 'events' captured by MOSS. Display of this log is an effective controller and network diagnostic aid.
- CCU switching can be done by the 3745 operator. The scanners and channel adapters associated with one CCU can be switched to the other CCU via operator command.
- Either CCU can have the associated ACF/NCP program reloaded via an operator command from MOSS.
- Scanners and MOSS can have their microcode reloaded via MOSS command.
- MOSS can be used to change the data path of a particular line into the 3745 from one set of hardware to another. This port swap is transparent to ACF/NCP and is a quick way to circumvent 3745 LIC or scanner failure.
- The operator has the ability to display the interface of lines, scanners, token-rings, or channels on the MOSS console. This built in interface monitor function aids network/controller problem determination.
- The 3745 operator can execute 3745 on-line diagnostics. This provides the operator with a level of fault determination for suspected problems.

A wide range of MOSS functions are provided to the customer.

Maintenance and Operator Subsystem Operator Functions

Foil 21



- Configuration Data File Display/Update
- Time and Date Management - Scheduled Power-On
- Event Log Display
- CCU Switching
- CCU IPL
- Scanner/MOSS IML
- Port Swap
- Interface Display - Line/ Scanner/ Token-Ring/ Channel
- Execute On Line Diagnostics

Wide Range of Customer Function

Foil 22: Availability Features

The 3745 utilizes enhanced TCM and VLSI technology to provide inherent reliability. The 3745 provides increased availability through redundancy and quick diagnosis and repair.

Fast circumvention of failure is provided by dual central control units. With twin CCUs and a single CCU/NCP failure, the 3745 can activate backup resources in the other CCU. Channel adapters and scanners can be switched between CCUs as required. Port swapping allows rerouting around failed LICs and scanners to spare resources within the same CCU. ACF/NCP modules can be transferred non-disruptively to the 3745 hard disk. The hard disk on the controller allows quick dumps of storage and quick program reloads. MOSS has the ability to dump the memory of and re-IML a failed scanner or itself. Improved error correction suppresses multiple bit memory errors.

Fast diagnosis and reporting of failure is supported by the 3745. Centralized service access to the controller via the Remote Support Facility allows failure analysis and microcode loads to be performed remotely. Remote access to the 3745 MOSS console is available to the customer via the remote/alternate console conneetion. Improved memory error detection logic identifies multiple temporary and permanent memory errors. Constant power monitoring alerts the operator concerning input power/power distribution problems. MOSS provides improved analysis of controller event records and sends more explicit messages (events and alarms) to the 3745 operator. Improved internal trace and test capability provides better definition of line/controller conditions to enhance failure diagnosis.

Repair of the 3745 controller causes less disruption. Customer participation enables the customer to quickly exchange a failing Line Interface Coupler. The network impact of failure of a subsystem within the 3745 is minimized by the isolation and controlled shutdown of that failed subsystem. Improved memory error correcting logic suppresses more temporary and permanent memory errors and prevents them from impacting controller operation. Concurrent diagnosis and analysis of errors allows controller maintenance to be accomplished without affecting operating subsystems within the 3745. In addition, the Line Interface Couplers can be removed and replugged with power on allowing replacement (and change) without disruption to other parts of the controller.

The 3745 has been designed to provide increased availability.

Availability Features

- Fast Circumvention of Failure
  - Dual Central Control Units
    - Fall Back CCU Resource
    - Adapter/Scanner Switching to Active CCU
  - Port Swapping
  - Non-Disruptive Control Program Transfer
  - IPL/Dump from/to Hard Disk
  - Automatic Scanner & MOSS Dump/Re-IML
  - Improved Error Correction
- Fast Diagnosis & Notification of Failure
  - Remote Support Facility
  - Remote Access to MOSS
  - Power Monitoring
  - Improved Error Detection
  - Improved Error Analysis & Reporting
  - Improved Internal Trace & Test
- Less Repair Disruption
  - Customer Participation
  - Controlled Shutdown
  - Concurrent Maintenance
  - Hot Pluggable LICs

Designed for Availability

Foil 23: A Design to Meet New Challenges

The 3745 is an evolutionary product based on the proven architecture of the 3725. The use of faster technologies, dual I/O buses, and cache memory improves the 3745 performance. In addition, the second CCU doubles the 3745 CCU processing power and allows increased data throughput. The improved performance allows enhanced connectivity. The 3745 can support up to 512 communication lines and 8 T1 links. The 3745 is designed for higher availability. Dual CCUs, concurrent maintenance, and hot pluggability ensure the higher controller and network availability.

The 3745 was designed to meet the challenges of your (customer's) network needs.

A Design To Meet New Challenges

Evolutionary

Improved Performance

Enhanced Connectivity

Higher Network Availability

Meeting Your Communications Network Needs

3745 Bus Switching for Back-up and Recovery

One of the more significant features of the 3745 is the enhanced backup and recovery capability. Both automatic and manual capabilities exist that quickly and thoroughly recover from CCU and ACF/NCP disruptions. This capability exists within the base frame of the 3745 when it has two CCUs installed. Previously, a second communications controller plus an external method of switching, such as a matrix switch, would have been required. The cost, floor space and management of this approach discouraged many such implementations.

This section examines the variety of recovery techniques that bus switching provides and discusses the benefits of each recovery mode.

Foil 24: 3745 Bus Switching

Single or twin central control units drive scanners and channel adapters via buses which are connected through a bus switch. The bus switch is contained within a single module and is part of the logic that drives and receives commands and data from the buses.

Four modes of operation are available, two of which provide backup capability.

One CCU can be running an ACF/NCP. All buses are connected to the CCU. No fall-back mode is possible.

Two CCUs can be operated independently in twin-in-dual mode. Each CCU has an independent Network Control Program (NCP) active. In effect two communication controllers are running within the same frame. No NCP/CCU fall-back mode is available.

One CCU can be running with the second standby CCU dedicated to backup. If disruption of the primary NCP/CCU occurs the standby CCU can be invoked.

Twin ACF/NCPs can be running, each with additional scanner/channel adapter load capacity defined but not activated. If a disruption occurs in either NCP/CCU, switching to and activation of the previously defined backup resource can recover critical lines quickly.

The switching operation can be initiated by MOSS automatically based on specific disruptions. Switching can also be manually done via operator selection from the Maintenance and Operator Subsystem.

Network considerations influence the selection of the 3745 operating modes. Selection based on availability and performance requirements are discussed.

3745 Bus Switching

- 3745 Configurations
  - Single CCU
  - Twin CCU
- Modes of Operation
  - Non-fallback Modes
    - Single: One CCU, One NCP
    - Twin-in-Dual: Two CCUs, Two Active NCPs
  - Fall-back Modes
    - Twin-in-Standby: Two CCUs, One Inactive
    - Twin-in-Backup: Two CCUs, Two Active NCPs
- Automatic Control of Bus Switching
- Manual Control of Bus Switching
- Mode Selection Considerations

Foil 25: 3745 Configuration - Model 210

The 3745 Model 210 consists of a single Central Control Unit (CCU), main memory, two Input/Output buses and one Direct Memory Access (DMA) bus. These three buses run from the CCU to the bus switch.

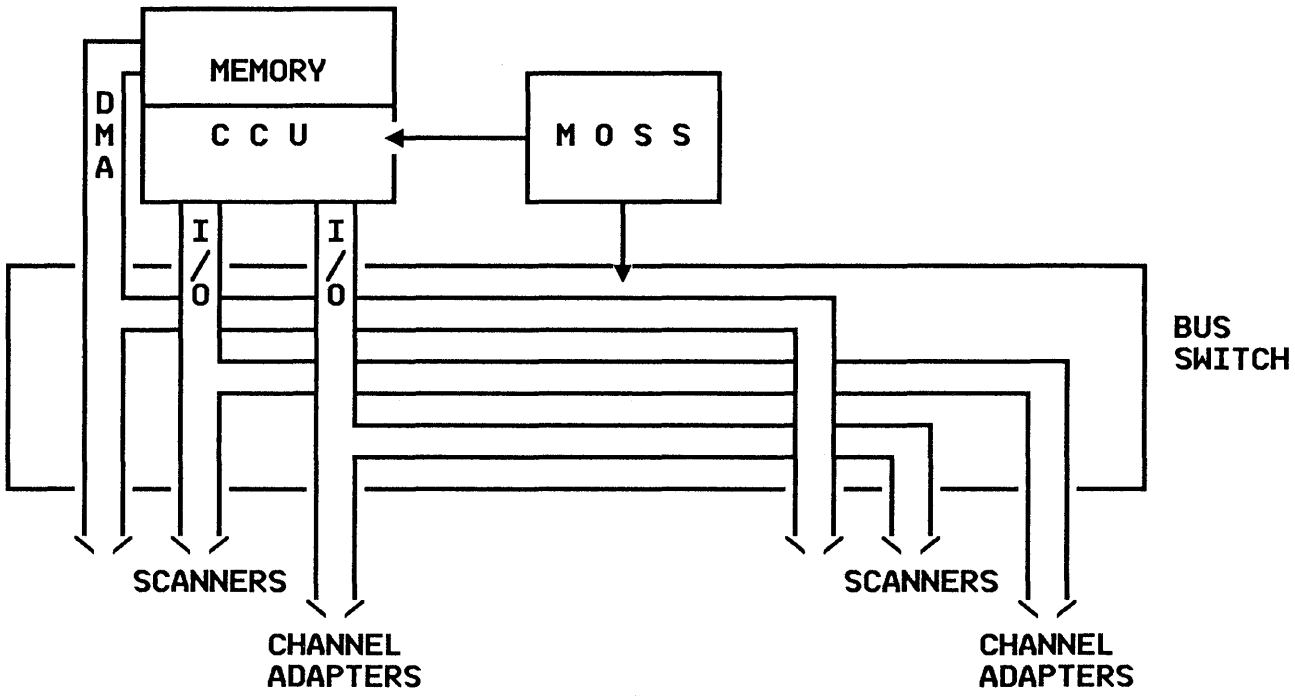
Within the bus switch the buses normally associated with the second CCU are connected to the buses of the single CCU to allow the single CCU to drive all six buses. The channel adapter bus associated with the 'first' CCU is connected to the scanner bus associated with the 'second' CCU. The scanner bus of the 'first' CCU is paired with the channel adapter bus of the 'second' CCU in the same manner. The two DMA buses are connected together.

The bus switch is present in the single CCU configuration, but is inoperative as a recovery switching mechanism, since there is no other CCU to switch to.

The connection capacity of this single CCU 3745 is: 512 lines, 16 channel adapter, 8 very high speed lines (T-1), and 8 IBM token rings.

3745 Configuration
Model 210

Foil 25



- Single CCU Mode of Operation
- All Buses Driven By One CCU
- Bus Switch Present But Switching Not Applicable
- Connection Capacity: 512 Lines, 16 Channel Adapters, 8 Active T1 Links, 8 Token Rings

Foil 26: 3745 Configuration - Model 410

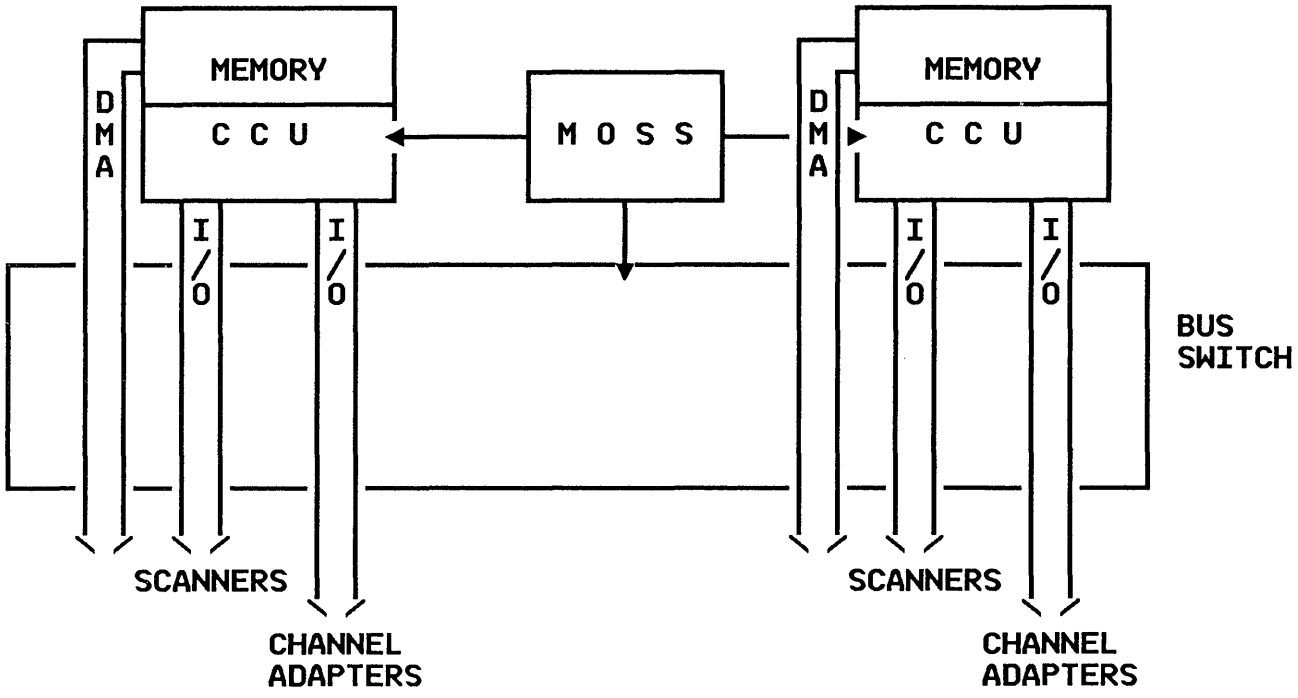
The 3745 Model 410 has twin CCUs operating within the same base frame. Each CCU drives one channel adapter and one scanner bus pair instead of two as with the single CCU 3745. Each CCU operates independently, running its own unique ACF/NCP. (Both CCUs do not have to be operating. One can be inactive for whatever reason.)

Bus switching capability exists between the channel adapters and scanners of the CCUs. If invoked, the buses would be connected in the same manner as for the single CCU 3745. This bus switching enables configuration flexibility and internal backup options.

The connection capacity of this twin CCU 3745 is the same as a single CCU 3745. That is: 512 lines, 16 channel adapter, 8 very high speed lines (T-1), and 8 IBM token rings.

3745 Configuration
Model 410

Foil 26



- Each CCU
  - Operates Independently
  - Executes a Unique NCP
- BUS Switching Capability Between CCUs
- Connection Capacity: 512 Lines, 16 Channel Adapters, 8 Active T1 Links, 8 Token Rings

Foil 27: Modes Of Operation - Single CCU

The first operational mode is the simplest and the one used by the other IBM communication controllers. The 'normal operation' mode shown is a single CCU operating with its ACF/NCP. This 3745 mode of operation is utilized where no fall-back capability is required or where external matrix switching is already in place to provide controller recovery.

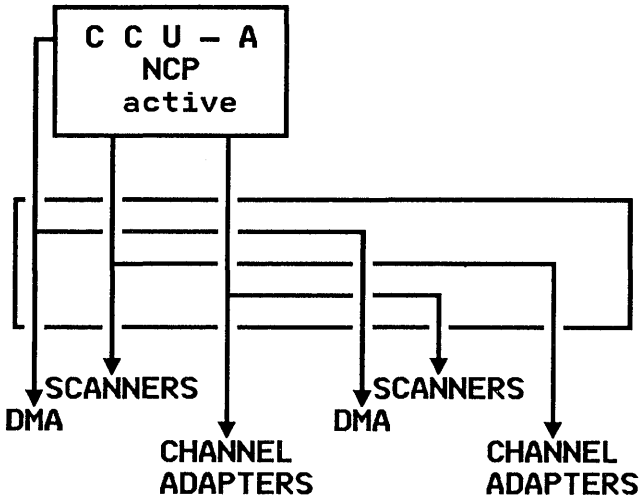
All six buses are driven by the single CCU, to which are connected all the scanner and channel adapters.

In this mode no bus switching capability exists. The single mode of operation is defined through the MOSS console and resides in the Configuration Data File. ACF/NCP checks this file on each IPL to insure that only the predefined mode is permitted.

There is no fall-back configuration possible. In the event of a CCU hard error, power loss, or ACF/NCP failure, the adapters are inoperative.

Modes of Operation
Single CCU

NORMAL OPERATION



FALL–BACK OPERATION

N O N E

- Single CCU Installed With NCP
- All Six Buses Connected and Active
- No Capability for Bus Switching
- No Fall-back Operation Possible

Foil 28: Modes Of Operation - Twin-in-Dual

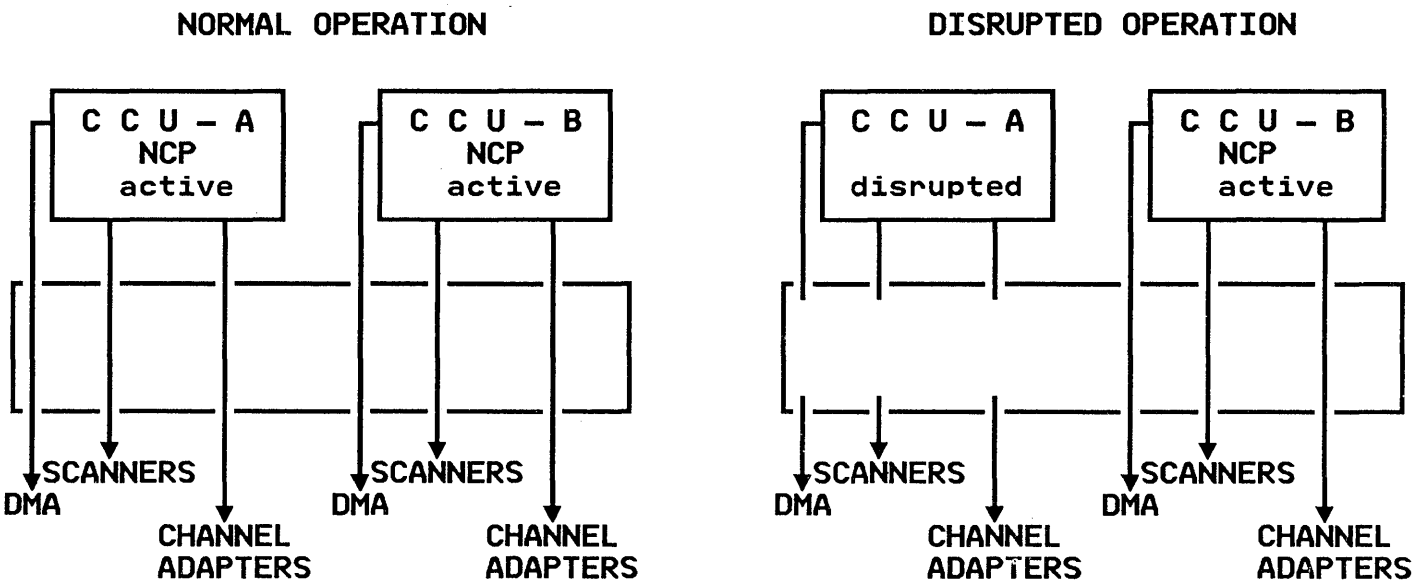
This twin-in-dual mode has twin CCUs running two distinct ACF/NCPs. Each CCU has an ACF/NCP and associated attachments handling a unique subarea network. This mode provides twice the throughput capability of that of a single CCU configuration.

This mode cannot provide for any backup capability. The loss of either CCU means that its associated subarea node is lost.

The 'disrupted operation' diagram shows CCU-A (as an example) in a not-operable state. Only the half of the network associated with CCU-A is lost. CCU-B continues to operate while the diagnosis and repair of CCU-A is being done.

Recovery of the disrupted CCU does not impact the operation of the active CCU. The networks are totally independent of each other

Modes of Operation
Twin-in-Dual



- Each CCU Runs a Distinct NCP and Manages Separate Subareas - NCP Load Modules
- Backup and Recovery Not a Part of Planned Operation
- Disruption of Either CCU Impacts Only Part of the Network
- CCU Recovery Does Not Impact Active CCU

Foil 29: Modes Of Operation - Twin-in-Standby

This mode provides an easy to use fall-back capability built into the 3745. In normal operation' the unused CCU (as an example CCU-B) is 'standing by' to assume operation in the event the running CCU (CCU-A) or its ACF/NCP is disrupted.

All buses in the 3745 are connected to the active CCU in the same manner as if they were in a single CCU 3745. The ability to do bus switching between CCUs provides protection from CCU disruptions that in the past required a second communications controller.

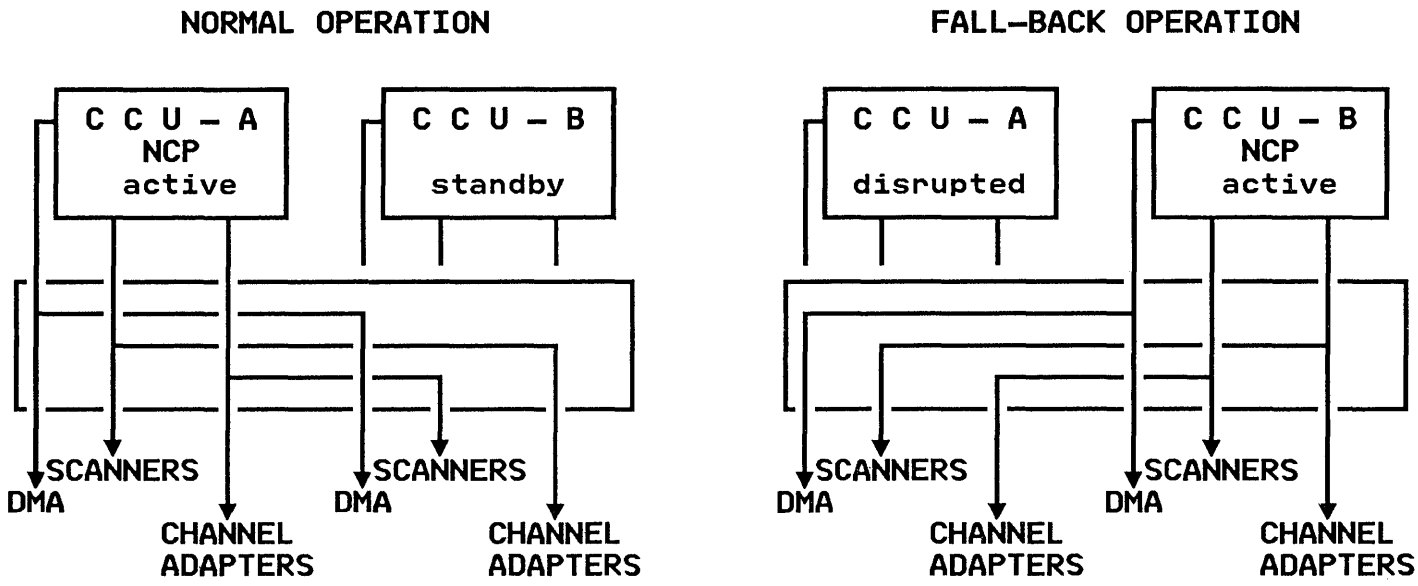
If the active CCU or its associated ACF/NCP is disrupted, the switching process is automatic. MOSS initiates the bus switching to attach the channel adapters and scanners to the standby CCU. Once the switch over is accomplished MOSS automatically loads the ACF/NCP module from hard disk into the CCU. The network operator can then reactivate lost links and nodes. After repair, no actions are necessary as the repaired CCU becomes the standby unit.

Under 'fall-back operation', once the buses are switched and the ACF/NCP is loaded and activated, the operator is informed to reactive lost links and nodes. This last step could be done by automatically via a user written NetView CLIST.

There are situations where operations or the service personnel would like to manually initiate the switching process. The MOSS main menu provides the ability to accomplish this. The MOSS console operator uses the 'FBK' (fall-back) panel to switch the entire configuration to the not-running CCU.

Modes of Operation
Twin-in-Standby

Foil 29



- Two CCUs But Only One Activated
- All Buses Attached to One CCU
- After Disruption of Active CCU, MOSS Provides:
  - Auto-Switch of Buses
  - Auto-Load of NCP Into Standby CCU
- Automatic Reactivation of Network via NetView Clist
- Fall-back Can be Initiated by MOSS Operator

Foil 30: Modes Of Operation - Twin-in-Backup

In 'normal operation' the configuration is similar to the twin-in-dual operation mode. Both CCUs are running their own ACF/NCP controlling their own sub-area network. This mode permits the full throughput capability of twin CCUs to be utilized while still providing for some partial backup.

What is different is that each ACF/NCP module has already included a selected portion (or all) of the network definitions of the other ACF/NCP. The ACF/NCP in CCU-B therefore has the definitions to permit some or all of the adapter connections of CCU-A and vice versa.

If a disruption occurs in one of the CCUs (as an example CCU-A), MOSS automatically will switch the buses from the disrupted CCU and connect them to the still operating CCU (CCU-B). Once all buses are switched to to the active CCU, the switched resources can now be activated from ACF/NCP by the operator.

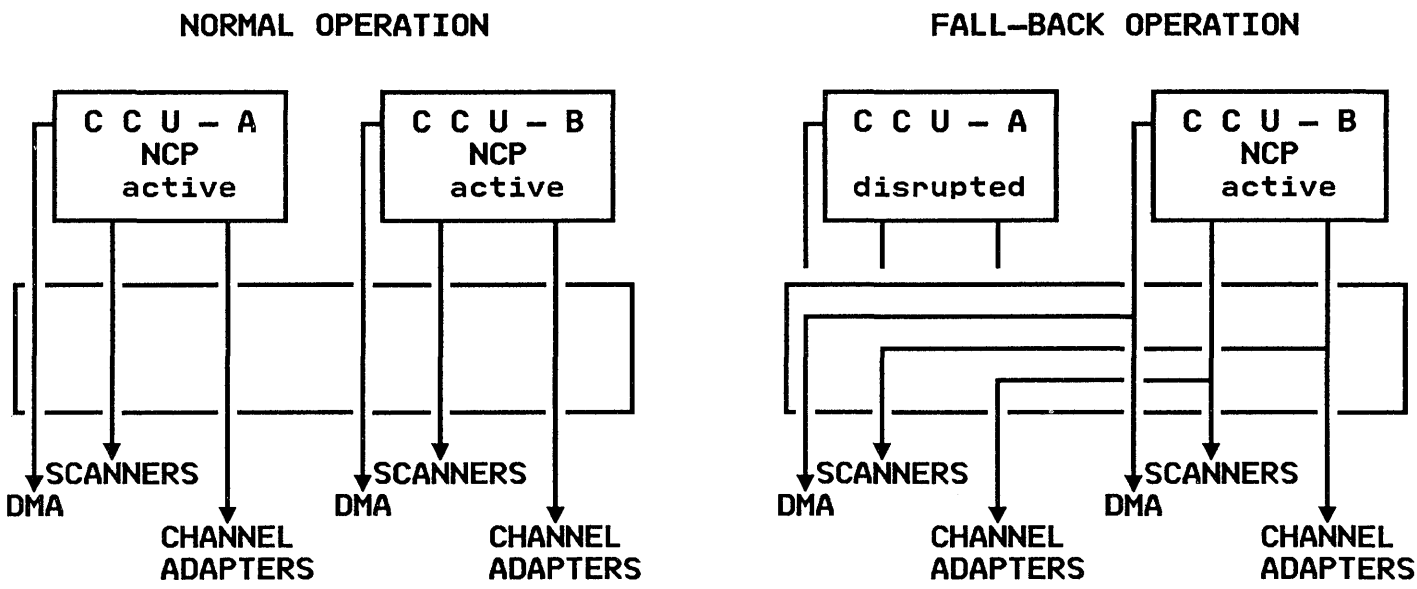
Under 'fall-back operation', once the buses are switched, the operator is informed to reactive lost links and nodes. This last step could be done by automatically via a user written NetView CLIST.

Since all VTAM and ACF/NCP definitions are already in place, all the operator must do is activate the links as required. The 'twin-in-backup' mode of operation provides the fastest recovery of critical lines of any operational mode.

Connection of the buses from the disrupted CCU to the active CCU is non-disruptive to the sessions of the active CCU.

Modes of Operation
Twin-in-Backup

Foil 30



- Two CCUs With Distinct ACF/NCPs
- Each ACF/NCP Defines Resources to be Backed-Up
- If One CCU Disrupted:
  - MOSS Provides Auto-Switch of Buses to Active NCP
  - NCP Initializes Buses and Adapters
- NetView Clist Can be Used for Network Reactivation
- Provides Fastest Recovery of Any Configuration
- No Interruption to Network On Active CCU

Foil 31: Automatic Control - Fall-Back

The two operational modes that have the capability to 'fall-back', recover from the loss of a CCU, are the twin-in-standby and twin-in-backup modes.

The actual recovery process is done automatically by MOSS based on the occurrence of any one of 27 detectable CCU or memory hard errors. Six of these errors deal with an ACF/NCP failure, such as program check. The general process consists of three steps. The first; clear the bus of any pending commands so new switching commands can be issued. The second; disconnect the buses from the inactive CCU and await confirmation that the process is successful. The third; connect the buses to the active CCU and await confirmation. If the mode of operation was twin-in-standby, the ACF/NCP would also be loaded into the standby CCU at this step.

MOSS takes these steps automatically based on the Configuration Data File profile. This file is defined by the user and includes the operational mode of the 3745. This file is defined at installation time and can be changed at any time by the operator.

These enhanced recovery options provide powerful backup capabilities that result in faster backup and recovery than can be achieved with many external communication controller backup techniques.

Automatic Control Fall-Back

- Standby and Backup Modes Allow Fall-back Recovery

- This Fall-back Operation Is Triggered Automatically by MOSS When:
  - A CCU Hard Check Occurs
  - Memory Failure Occurs

- The User Defines the Operational Mode of the 3745 via Configuration Data File

Provides Faster Backup and Recovery

Foil 32: Manual Control - Standby and Backup Modes

There are occasions when manual control of the bus switching process is required. For instance, when testing the operability of new ACF/NCP definitions or when verifying the 'fall-back' capability. The process is very simple.

From the MOSS main menu panel the operator selects the item labeled 'FBK', meaning fall-back. The screen content is shown at the top of this foil.

If the lines are still operational the MOSS operator enters a '1' to send a message to the network operator asking for deactivation of all links. When completed, the MOSS operator will receive a message from the network operator.

The MOSS operator then enters a '2' to request bus switching. The operator will be asked to confirm the request. After confirmation, MOSS will perform the bus switching and return an 'Operation Successful' message.

MOSS menu design insures ease of use for manual control of the standby and backup modes.

MOSS SCREEN WHEN IN STANDBY OR BACKUP MODE

```
CUSTOMER ID      3745 - XXXX          S/N

- SELECT THE FALL-BACK PHASE (1, 2)  ===>

1 = REQUEST NETWORK OPERATOR TO DEACTIVATE LINES (IF NECESSARY)

2 = PERFORM FALL-BACK
```

1. Operator Selects 'FBK' Item on MOSS Main Menu

2. MOSS Operator Enters a '1' To Request Network Operator to Deactivate Any Active Resources. Optional Step.

3. MOSS Operator Enter a '2' to Perform the Fall-back Operation Which Completes All Necessary Steps. (After Selection Confirmation)

Menu Design Insures Ease of Use

Foil 33: Manual Control - Switch-Back

The return to normal operation status from the fall-back position of the 'twin-in-backup' mode, is done by a MOSS operator function.

From the MOSS main menu the operator selects the item labeled 'SBK', meaning switch-back. The content of the resulting screen is shown at the top of the foil.

If lines are still operational on the buses to be switched back to the repaired CCU, a '1' is selected to ask the network operator to deactivate the links.

The MOSS operator then enters a '2' to request switch-back. The operator will be asked to confirm the request. After confirmation, MOSS will perform the switch back.

The ACF/NCP giving up control of these buses has a role in this operation. It determines if any activity is present on the buses. If there is none, ACF/NCP will let MOSS continue the transfer. If there is activity, ACF/NCP will let the operator know of the activity and let the operator make the choice of forcing the bus switch even though links are still active.

After the buses are successfully switched, MOSS initiates the load of the ACF/NCP from disk. A 'switch successful' message is displayed and the network can be activated.

MOSS SWITCH-BACK MENU

```
CUSTOMER ID      3745 - XXXX          S/N

- SELECT THE SWITCH-BACK PHASE (1, 2)  ===>

1 = REQUEST NETWORK OPERATOR TO DEACTIVATE LINES (IF NECESSARY)

2 = PERFORM SWITCH-BACK
```

1. Operator Selects 'SBK' from MOSS Main Menu

2. MOSS Operator Enters a '1' To Request Network Operator to Deactivate Any Active Resources. Optional Step.

3. MOSS Operator Enter a '2' to Perform the Switch-back Operation (After Selection Confirmation)

   - NCP Software Assists in BUS Detachment

     Conditional Detachment

     Forced Detachment

   - Receiving CCU IPLed and Resources Activated

Foil 34: Mode Selection Considerations

Modes of 3745 operation should be chosen based on of the functions provided and network requirements. Some links are critical and must be backed up, while others are less important and do not justify the expense and effort of backup.

In deciding which mode of operation to utilize, the first decision is whether CCU/NCP backup and recovery is necessary. If fall-back is not necessary, the selection of a single or twin CCU 3745, will be based on performance requirements.

The single CCU will run ACF/NCP and control one subarea with throughput and attachment capability approximately twice that of a 3725.

The dual CCU choice will permit network division between two subareas and provide approximately a four-fold increase in throughput over a 3725.

If backup and recovery is desired then twin CCUs are required. The decision between the 'twin-in-standby' or the 'twin-in-backup' modes of operation is based on the fallback throughput required.

The 'twin-in-standby' mode permits full network backup for the disrupted CCU or ACF/NCP. During normal and fall-back operation, the connection and throughput capability is the same as a single CCU 3745.

The 'twin-in-backup' generally provides for limited backup support as only selected lines will be activated by the receiving CCU which continues to operate during the recovery process. During normal operation, the connection and throughput is that of twin CCUs, while the fall-back throughput is that of a single CCU.

Mode Selection Considerations

The Selection of a Specific Mode Depends on Network Needs for Backup Capability

- **Single Mode**

  One Node Where High Availability is Not a Requirement

- **Twin-in-Dual**

  Two Nodes Where High Performance Is Required and Higher Availability Is Not

- **Twin-in-Standby**

  One Node Where Total Recovery Is Required

- **Twin-in-Backup**

  Two Nodes Where Performance and Recovery Are Required

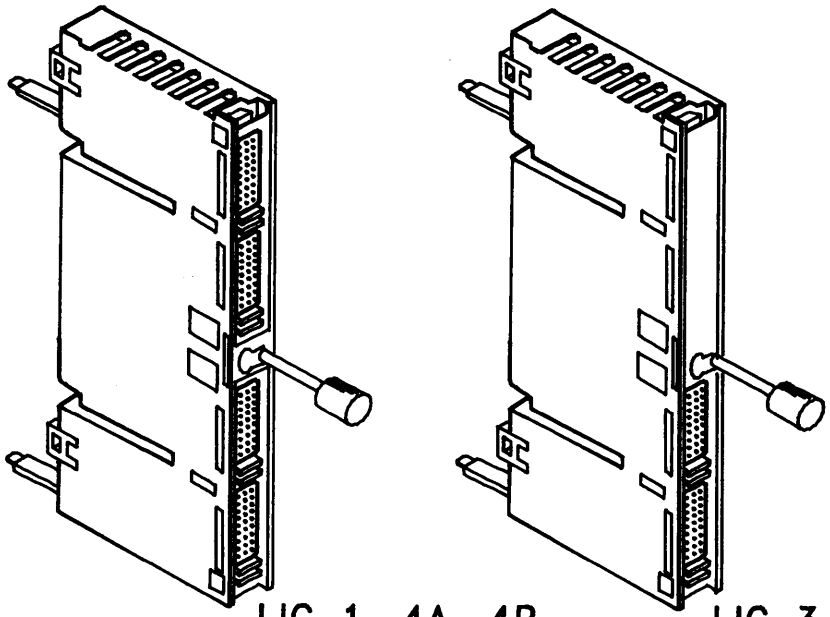
Appendix A. Line Interface Couplers

The 3745 Line Interface Couplers (LICs) utilize a line weight concept. A summary of data on LICs used domestically is provided for reference.

Foil 35: LIC Types

There are four Line Interface Coupler types available. LIC type 1 and LIC type 3 are commonly used domestically. The chart shows the maximum transmission speed of the LIC types.

Appendix
LIC Types



LIC Type	Interface	Transmission Speed (KBPS)	Lines/ LIC	Mode	Protocol
1	V.24 RS-232 V.25 RS-366	19.2	4	HDX FDX	S/S BSC SDLC
3	V.35	256.0	1	HDX FDX	BSC SDLC
4A	X.21	9.6	4	HDX FDX	SDLC
4B	X.21	256.0	1	HDX FDX	SDLC

Foil 36: LIC Types ...

LIC type 1 has reduced line weights when there are four or less LICs per scanner. With the limit of 4 LICs per scanner the line weights in the left column apply. When there are more than four LICs per scanner, the line weights in the right column apply. If the limit of 4 LICs per scanner is exceeded, the higher line weights, those in the right column, apply to all the LICs on the scanner (LICs 1 - 8).

Appendix
LIC Types ...

LIC Type 1

Protocol	Line Speed (BPS)	LIC LIMIT 4		LICS: 1 - 8	
		Line Weight	Max Lines	Line Weight	Max Lines
SDLC FDX	19200	10	10	12.5	8
	9600	5	16	6.2	16
	4800	2.5	16	3.1	32
SDLC HDX, BSC EBCDIC	19200	5.6	16	6.2	16
	9600	2.8	16	3.1	32
	4800	1.4	16	1.6	32
BSC ASCII	19200	7.9	12	9.5	10
	9600	4.0	16	4.8	20
	4800	2.0	16	2.4	32
Start/Stop (10 bit)	19200	44.7	2	44.7	2
	4800	11.2	8	11.2	8
	1200	2.8	16	2.8	32

LIC Type 3

Protocol	Line Speed (BPS)	Line Weight	Max LICs (Lines)
SDLC FDX	256000	100	1
	128000	50	2
	64000	25	4
	32000	12.5	8
SDLC HDX, BSC EBCDIC	256000	63.2	1
	128000	31.6	3
	64000	15.8	4
	32000	7.9	8
BSC ASCII	256000	84.2	1
	128000	42.1	2
	64000	21	4
	32000	10.5	8

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