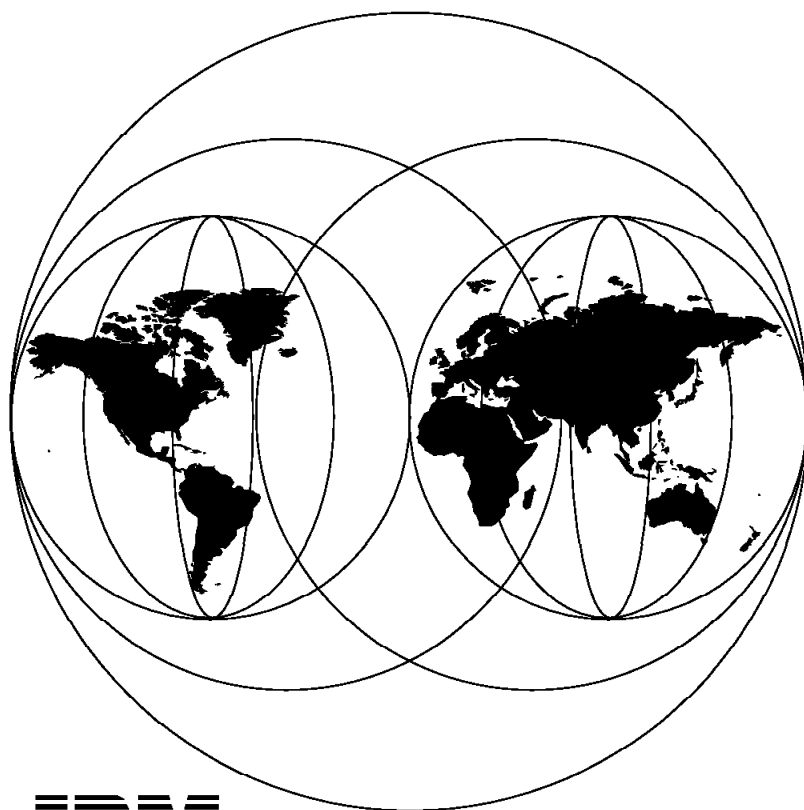# Enterprise Systems Connection (ESCON) Implementation Guide

July 1996

IBM

International Technical Support Organization
Poughkeepsie Center

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Enterprise Systems Connection (ESCON) Implementation Guide

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> **Take Note!**
>
> Before using this information and the product it supports, be sure to read the general information in Chapter 9, "Special Notices" on page 251.

First Edition (July 1996)

This edition applies to the Enterprise Systems Connection (ESCON) environment as announced on June 16, 1992.

This publication is classified ″IBM Confidential″ and therefore its use is confined to IBM employees. The intent is to provide insight into the capability of IBM products for IBM marketing representatives, systems engineers, and industry specialists.

> **Warning**
>
> This book is based on a pre-GA version of a product and may not apply when the product becomes generally available. It is recommended that, when the product becomes generally available, you destroy all copies of this version of the book that you have in your possession.

Contents

Preface

Enterprise Systems Connection (ESCON) is the most significant change to large systems I/O channel architecture in 25 years. This redbook describes ESCON architecture, and provides information on ESCON configuration planning, migration, and coexistence with conventional channel (OEMI) architecture.

The redbook discusses the limitations of OEMI architecture and illustrates how ESCON resolves them. Through the use of fiber optic technology and a radically different connection topology, and innovations such as ESCON Directors, ESCON Repeater/ Converter, and ESCON Manager, former limitations in processing speed, switching and reconfiguration, and distances of attachment are overcome.

In addition, this redbook refers to IBM control units, devices, and interconnection components, and describes how to define these to the I/O subsystems of S/390 processors.

This publication will be of significant value in helping configuration planners, system programmers and system operators understand, implement, and maintain configurations based on the ESCON architecture.

How This Redbook Is Organized

This redbook contains 267 pages. It is organized as follows:

- Chapter 1, "Introduction" summarizes the functional enhancements provided by Enterprise Systems Connection (ESCON).

- Chapter 2, "Terminology" helps to understand the terms of connection elements used for physical installation.

- Chapter 3, "System/370 Architecture and Implementation" was included to provide the reader with some basic understanding of the System/370 I/O interface.

- Chapter 4, "Fiber Optic Technology" provides background information on LED and laser fiber optic terms.

- Chapter 5, "ESCON I/O Architecture" describes the new I/O interface, based on fiber optics, the protocols being used, the addressing scheme, the dynamic switch capability, and the transmission of data, to provide an overall understanding of the data flow within the ESCON network.

- Chapter 6, "ESCON I/O Architecture Implementation" gives descriptions, configuration guidelines, and usage recommendations for those products, announced during September 1990, that support the ESCON I/O interface.

- Chapter 8, "ESCON Configuration Planning" helps to review the planning or installation process of the ESCON products.

The Team That Wrote This Redbook

This redbook was produced by a team of specialists from around the world working at the International Technical Support Organization Poughkeepsie Center.

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Comments Welcome

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Your comments are important to us!

Chapter 1. Introduction

The Enterprise Systems Connection (ESCON) is the most significant change to the I/O area of data processing since the original parallel Original Equipment Manufacturer Interface (OEMI) was introduced more than 25 years ago.

1.1 Overview

The following is a summary of ESCON announcements since September 5, 1990. Full details are found in the appropriate sections of this document and in the related publications listed in the Preface.

1.1.1.1 New ESA/390 and New I/O Interface

ESCON is an integral part of the Enterprise Systems Architecture/390 (ESA/390). ESCON replaces the previous /360 and /370 parallel OEMI with the ESCON I/O interface supporting new media, and providing new interface protocols. Replacing the previous bus-and-tag cables and their multiple data and control lines, ESCON provides bi-directional serial bit transmission, in which the communication protocol is implemented through sequences of special characters and through formatted frames of characters.

1.1.1.2 Fiber Optics

In contrast to the previous copper cables used in the parallel OEMI, ESCON utilizes fiber optic cables for data transmission. These cables are 100 times lighter than the old bus-and-tag cables, have substantially reduced bulk, have fewer pin connections (and are therefore more reliable), have less loss and distortion, and are free from signal skew.

1.1.1.3 Topology

ESCON introduces a new topology of control unit and channel attachment. ESCON control units and channels are attached in a switched point-to-point arrangement. The switching capabilities allow multiple connections between channels and control units without requiring permanent physical connections. The point-to-point connections allow physical changes to the I/O configuration concurrently with normal operations.

1.1.1.4 ESCON Directors

To implement the switching function of ESCON, a new class of devices was introduced. These devices, called directors, connect channels and control units only for the duration of an I/O operation. They are non-blocking, can switch millions of connections per second, and are the centerpiece of the ESCON topology. Apart from dynamic switching, the ESCON directors can also be used for static switching of "single user" control units among different system images.

1.1.1.5 ESCON Repeater/Converter

To allow ESCON to more easily access the common carrier trunk fiber network, the ESCON Repeater/Converter was introduced. This new device gives the common carrier the ability to monitor usage of the fiber link and also collect error statistics. These signal repeater/converters can also be used outside of the common carrier environment in place of ESCON directors where there is only a requirement for one or two fiber links to a destination.

1.1.1.6 ESCON Manager

To manage the new ESCON configuration, a new program product, the ESCON Manager, was introduced. The ESCON Manager provides an easy-to-use interface that can be automated. It offers protection from possible disruptive changes, offers integrity through safe switching, can manage multiple systems, and is available for both MVS/ESA and VM/ESA operating system platforms.

1.1.1.7 ESCON CTC

ESCON also introduces an effective and price competitive replacement for previous channel-to-channel hardware. With ESCON channels, a user can communicate at channel speed between processors without requiring extra hardware.

1.1.1.8 Distance

Extended distances of attachment are possible with ESCON. In appropriately configured systems, control units and processors are located up to 60 km from each other and still retain all the characteristics of control units and processors attached at much closer distances. This extended distance is exploited to provide new applications and solutions for problems of escalating real estate prices, securing remote I/O, disaster recovery, hot backup sites, and so on.

1.1.1.9 ESCON Capable Processors

A whole new processor family, the ES/9000, was announced with ESCON. All processors in this family, from the smallest to the largest, can support and exploit all the new facilities offered by ESCON. Some processor models of older families were either enhanced (ES/3090-9000 Model T) or retrofitted, such as the ES/3090 Model J, to use and support ESCON.

MVS/ESA, VM/ESA, VSE/ESA, TPF, and the ESA versions of ACF/VTAM and DFP provide the software support for an ESCON environment.

1.1.1.10 ESCON Control Units

Many control units have been announced with ESCON attachment support.
Some of the control units already available at ESCON announcement time can be upgraded to ESCON. These include:

- 3990 Models 2 and 3
- 3490
- 3172 Model 1

1.1.1.11 Converters

Two protocol converters were introduced to ease migration from the parallel OEMI to ESCON. They perform opposite functions, one converting parallel OEMI to ESCON protocol, the other doing the reverse. These converters are migration devices and cannot exploit the full functions of ESCON.

Chapter 2. Terminology

This section describes ESCON fiber optic terms.

Since fiber optic cabling is new to many users of IBM equipment, it is important to understand the terms that are used when cabling an ESCON environment. Figure 1 shows the placement of the elements in a fiber optic network. These elements are used to physically realize the connections in an ESCON environment and to reflect the considerations involved in logical planning for connectivity, availability and performance in order to develop the target configuration.

Refer also to Chapter 8, "ESCON Configuration Planning" on page 241.
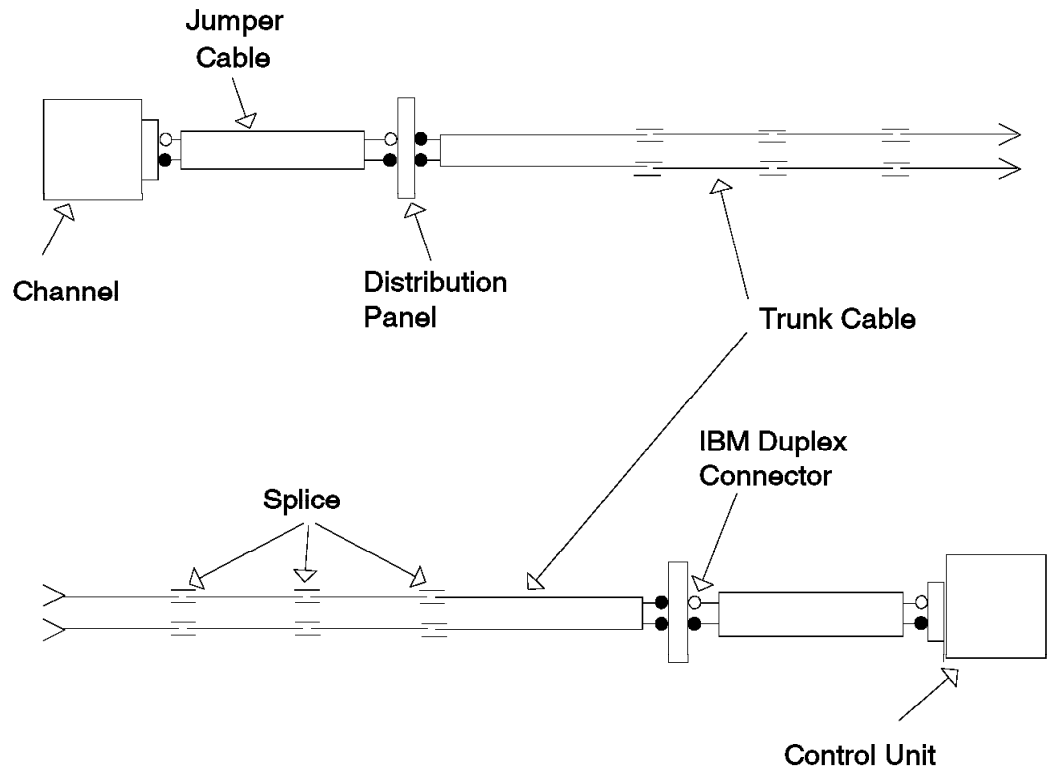
Figure 1. Fiber Optic Cable

2.1.1.1 Transmitter

Transmitters are not shown in Figure 1, but there is a transmitter in the channel, and one in the control unit. The transmitter converts electrical signals to light pulses, sent by a light emitting diode (LED) or a laser.

2.1.1.2 Jumper Cable

The jumper cable has the same function as the pair of cables that make up a parallel channel cable. There are two fibers, one to carry data in one direction, and the other to carry data in the opposite direction. It is important to note that a glass fiber cable is one-way. This is due to the way the fibers are connected to transmitters and receivers, not to any property of the fiber itself. Jumper cables are used, for example, to connect:

- Channel to control unit
- Channel to ESCC Model 1
- Channel to distribution panel
- Channel to ESCD
- ESCD to ESCD
- ESCD to control unit
- ESCD to ESCC

They may also be used to connect control units and distribution panels.

Jumper cables for IBM ESCON I/O devices, Directors, and Model-1 Converters are supplied by IBM in standard lengths up to 122 meters (400 feet) at *no charge*. The number of jumper cables supplied at no charge by IBM depends on the IBM ESCON device.

LED jumpers are orange and their duplex connectors are black. XDF jumpers are yellow and their duplex connectors are grey.

2.1.1.3 Distribution Panel

The distribution panel is a "junction box" that connects cables. It could be thought of as being similar to a patch panel to connect workstation terminals to terminal controllers. However, a distribution panel connects channels to control units and should not be treated like a patch panel. Disconnecting channel cables during operation could cause significant outages. A distribution panel simplifies reconfiguration and allows the addition of extra channels without disruptive re-cabling, as required with parallel copper channels.

2.1.1.4 Trunk Cable

A trunk cable is a single cable containing many optical fibers. The number of fibers in a trunk cable is usually a multiple of 12. Trunk cables are obtained from vendors in many sizes. A trunk cable with 144 working fibers, for example, is the equivalent of 72 bus and tag cables.

Trunk cable is used instead of multiple jumper cables when many connections are required between two locations, usually separated by significant distance.

The individual fibers in a trunk cable are terminated at the rear of a distribution panel. Jumper cables are used to attach ESCON devices to the front of the distribution panel.

IBM offers trunks manufactured by IBM business partners.

2.1.1.5 Splice

Fiber cables may be joined by splicing. Splicing is a complex task and should be performed only by a trained technician. Every splice causes light loss, and the number of splices may impact the length that the fiber can be.

In some countries, trunk cables can be ordered at a standard length of 50 meters, already spliced.

2.1.1.6 Connector

Fiber cables are connected to distribution panels, ESCDs, channels, control units, or converters with IBM duplex connectors. The IBM duplex connector terminates both optical fibers in the cable. It is keyed to ensure that the connector is inserted into the IBM ESCON device receptacle correctly.

Note: Many types of connectors are available including the ST, FC, FC/PC, Biconic, SMA, SC, and FDDI connectors. An IBM duplex connector is required for attachment to any IBM ESCON device.

2.1.1.7 Receiver

A receiver in the channel and the control unit detects the light pulses, demodulates them, and changes the optical signal to an electrical signal.

Chapter 3. System/370 Architecture and Implementation

This section provides you with some basic information on the System/370 I/O interface, also called S/370 Original Equipment Manufacturer's Information (OEMI) interface, parallel interface, or bus-and-tag interface. The information supplied helps you understand why IBM introduced ESCON to overcome the limitations and constraints of the architecture utilized for many years.

3.1 Introduction to the S/370 I/O Interface

The System/370 I/O interface is the communication link between a physical channel on a System/370 Central Electronic Complex (CEC) and an I/O control unit (CU). It is designed to work in S/370 mode or in ESA/390 mode. Its purpose is to:

- Send channel commands from the CEC to a CU

- Transfer data during read and write operations

- Receive status at the end of operations

- Receive sense information from control units

The S/370 I/O interface uses two cables, called bus-and-tag cables. A bus cable carries information (one byte each way), and a tag cable indicates the meaning of the information on the bus cable. Figure 2 on page 8 shows bus-and-tag cables connected sequentially to all the control units. This is often referred to as "daisy chaining." The last CU is equipped with terminator blocks. The architectural limit to the number of control units in the chain is 256, but the electrical power restricts it to a maximum of eight control units on a channel. With an IBM 3814 Switching Management System, more than eight control units can be connected to a channel, because the 3814 amplifies the signals on a channel interface.

Daisy chaining better utilizes a channel for slow control units, but a single failing control unit or a bad cable connection can influence other control units chained on the channel.

7
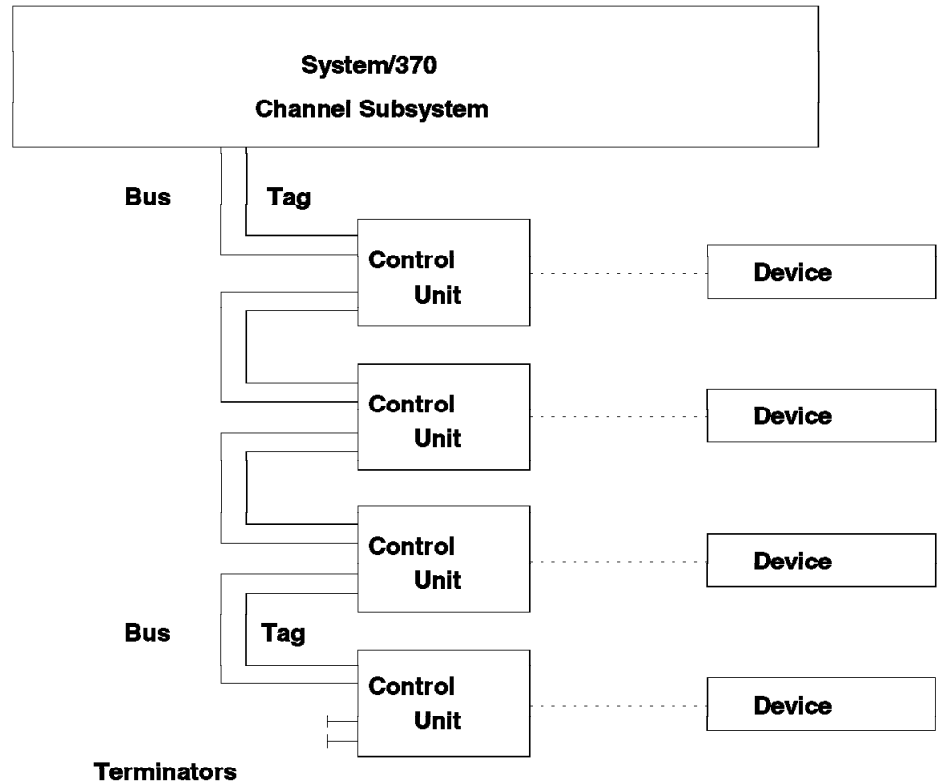
Figure 2. S/370 I/O Interface Cabling

3.1.1 Information Flow

An access method or application program builds a chain of channel command words (CCWs) and informs the operating system I/O Supervisor. The operating system updates the necessary control blocks and starts the I/O operation with an instruction. The instruction invokes the Channel Subsystem (CSS).

The CSS selects a path to the CU. Then it fetches a CCW from storage and sends the command to the CU. The CU executes the command, which can result in data being transferred, and presents an ending status to the CSS. CSS fetches the next CCW from storage, unless the end of the CCW chain has been reached. The channel program format and its execution is described in *Principles of Operation*, and the channel command codes in the CCWs are found in the corresponding reference books for the specific CU.

The channels in the CSS communicates with the CUs through the bus-and-tag cables. Each cable itself consists of a bundle of shielded copper coaxial cables with a grounded shield. Bus-and-tag cables end in connectors with 48 contacts (signal and ground). Each control unit connection on the channel interface has 192 contacts; therefore, the total number of contacts on the channel interface is the product of 192 times the number of control units plus 96 for the terminators. In our example in Figure 2, there are 864 pairs of contacts. The cables are heavy (1.5 kg per meter or 1 pound per foot per pair) and not very flexible, so customers must provide enough space in the raised floor, and the floor must support tons of cables in addition to the equipment. Close to the CEC the cables sometimes pile up, so they can hardly be removed when changes to the

configuration are required. When cables pile up, they often prevent air cooling from work efficiently.

The bus cable has a signal line for each bit value. A set of signal lines forming a byte is called Bus Out and carries information from the channel to the control unit (command codes, unit addresses, or data). Another set of signal lines forms another byte, called Bus In, and carries information from the control unit to the channel (status, sense, addresses, or data). The exact meaning of the transmitted bytes is determined by a signal on a tag signal line.

Electrical current is propagated in a cable at less than the speed of light, depending on the material used in the cable and in the CU. Since the resistance is not exactly the same in all signal lines, some bits are skewed with respect to other bits. The bottom of Figure 3 shows this effect. This effect reduces the maximum length of the cables to 122 meters or less even if special cables and special channel protocols are used.

Synchronous operation
Up to 122 meters (400')

Parallel data transfer
Up to 4.5 MB/sec

Tag Signal at Start

Tag Signal at 400'

TAG Cable

Channel

Control unit

Byte at Start

Byte at 400'

BUS Cable

Skew and attenuation
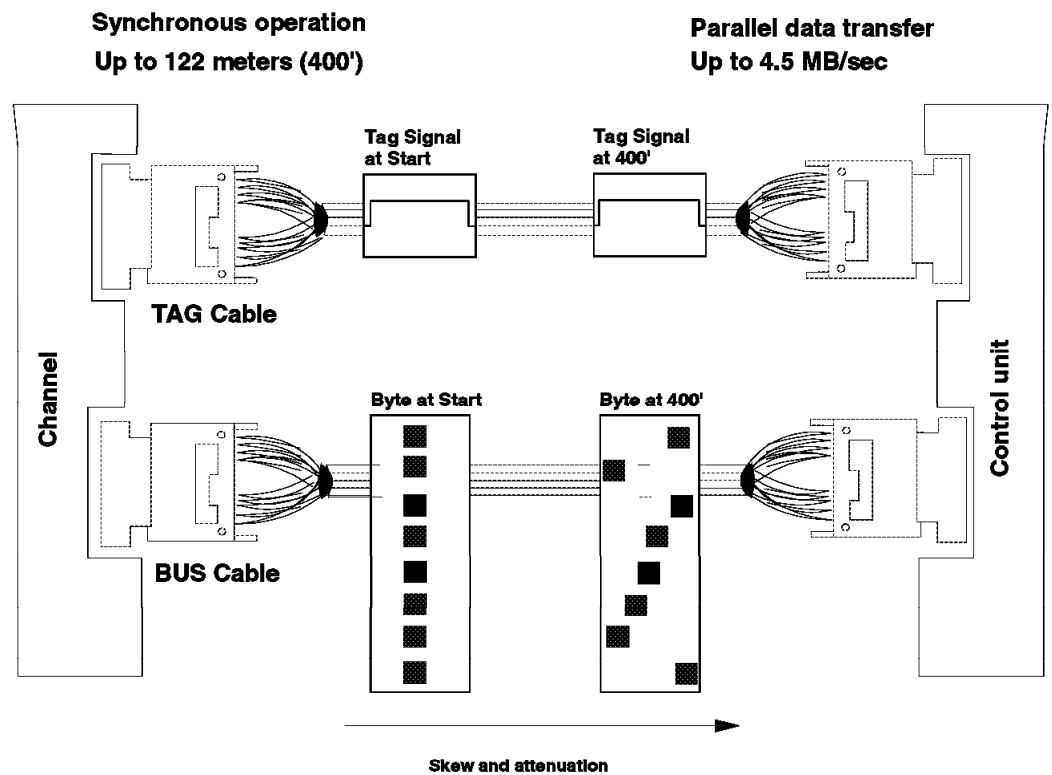
Figure 3. S/370 I/O Interface Signal Transmission

With the IBM 3044 Fiber Optic Channel Extender the length of a S/370 channel can be extended. The 3044 converts the signals into serial form and transmits them through a fiber optic cable. A second 3044 converts the optical signal back to a S/370 I/O interface bus-and-tag cable for attachment to control units. The data rate varies with the length of the fiber optic cable.

3.1.2 Types of Channels

There are two main types of channels, byte-multiplexor and block-multiplexor. Selector channels, which do not disconnect during an I/O operation, are no longer used and have been replaced by block-multiplexor channels.

Byte-multiplexor channels are used with slow, unbuffered devices to transfer a small amount of data. For each transfer, the CU must make a request to the channel in order to be reconnected. Typically, these CUs are unit record devices such as printers or optical readers, or teleprocessing CUs.

Block-multiplexor channels are used for devices that require a large amount of data at high speed, such as disk and tape devices. They may be disconnected after Channel End (CE) and later reconnected on a request from a CU. This process allows for a higher throughput and requires fewer SCP interrupts.

There are two protocols used for block-multiplexor channels, Direct-Coupled Interlock (DCI) and Data Streaming protocol.

The DCI protocol requires a response to a demand. There is a checking interlock between some tag signals. Figure 4 shows a write operation on a block-multiplexor channel using DCI protocol. At each "Service In" we wait for the corresponding "Service Out" to accept data.

Service In

Service
Out

Bus Out
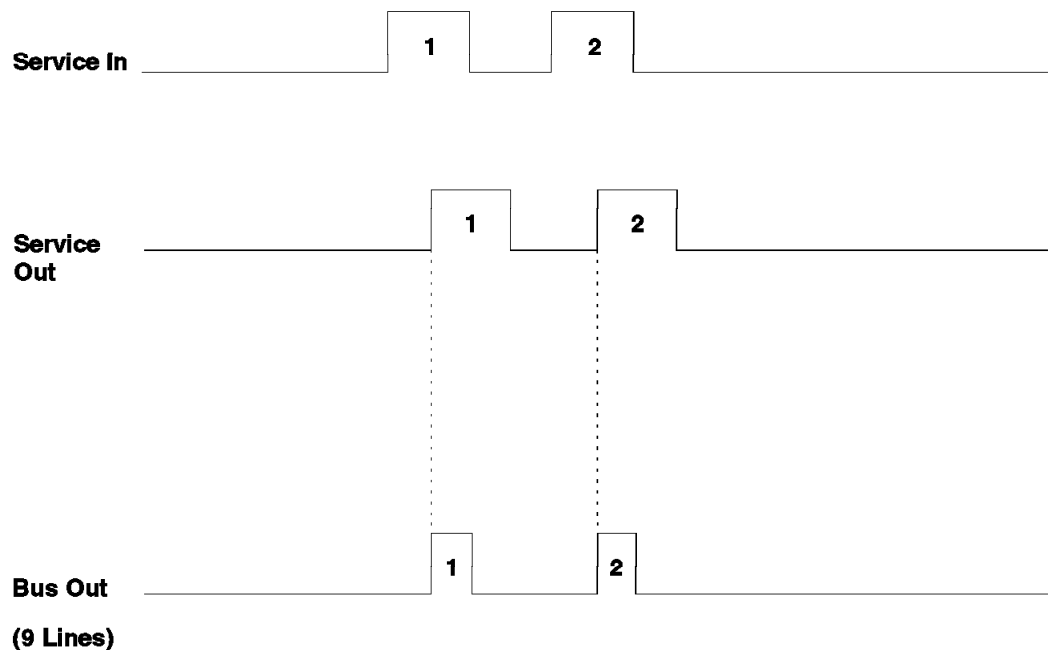
(9 Lines)

Figure 4. Direct-Coupled Interlock Protocol

The data streaming protocol does not require the demand response. It is called a non-interlocked transfer method. It removes some of the dependencies between the control data transfer lines. In other words, "Service In" and "Data In" are independent of "Service Out" and "Data Out." Data streaming provides

a higher data rate (up to 4.5 MB/sec). Figure 5 on page 11 shows a write operation on a block-multiplexer channel using data streaming protocol.
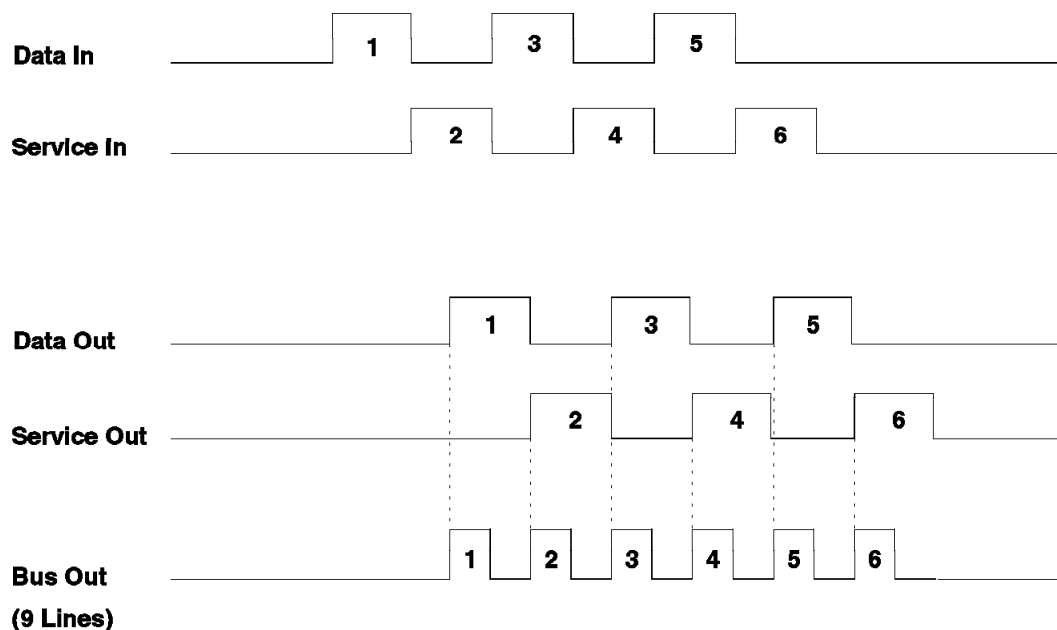
Figure 5. Data Streaming Protocol

3.2 Limitations

Traditional copper cables have physical limits and disadvantages:

- Small bandwidth restricts the data rate to 4.5 MB/sec.

- Multiple signal lines have to be used to transmit each byte. Different speeds of transmission on these lines cause skewing of a byte and limit the length of the cable.

- There are 192 pairs of contacts with each connection.

- Copper cables cannot be added to or removed from a running system. Dynamic changes of the channel configuration are not possible.

- The cables have a large diameter (29 mm each), requiring a high raised floor. They are not very flexible, are hard to install, and are even harder to remove from under a raised floor.

- The weight of one cable is 0.75 kg per meter (approximately 0.5 pounds per foot), so both bus-and-tag cables for a distance of 122 meters weigh more than 180 kg (or approximately 396 pounds for a pair of 400 foot cables).

- Copper cables have to be well-protected against electromagnetic interference from other cables and against radio frequency interference. Because of electrical radiation and the possibility of tapping into a copper

cable, security of copper cables is low. Signals between devices with different electrical ground potential can create disturbances.

- Copper is an expensive material.

Taking the above limitations into account, data communication with remote computer centers, allowing disaster recovery within seconds or minutes, is not possible with this architecture.

Chapter 4. Fiber Optic Technology

This chapter provides the reader with some basic principles of fiber optic technology and fiber optic communication. Also, the major advantages of optical fibers over copper cables are given. For a more thorough description of fiber optic technology you may want to look at an excellent publication titled, *Introduction to Fiber Optics for IBM Data Communications*.

In addition to fiber optic technology, this chapter refers to different architectures built on fiber optics. ESCON is one of these architectures, but the ESCON architecture is not discussed here, it is discussed in subsequent chapters of this book. As fiber optics based architectures are relatively new, they are evolving and changing, and this chapter can only give you a rough idea of what these architectures might be.

4.1 Optical Fiber Advantages

Optical fibers have several important advantages over traditional copper cables. Optical fibers are therefore increasingly being used to replace copper cables not only in communications systems, but in various other applications. The advantages include the following:

- Larger bandwidth

  A fiber optic cable can sustain a much higher data rate than a copper cable. Typical bandwidths are 500 MHz to 100 GHz over 1 km for different kinds of optical fibers.

- Physical characteristics

  A fiber optic cable is very flexible. It is small and light, and consequently it is much easier to install than a copper cable. Even though a fiber optic cable is very flexible, care should be taken not to bend the cable too sharply. The IBM 3044 Jumper Cable has a minimum bend radius of 48 mm (approximately 2 inches). It is also highly resistant to environmental conditions such as temperature, water, light, and radiation. There are many benefits when using fiber optic cables.

- No electromagnetic interference

  A signal transmitted in a fiber optic cable does not generate electromagnetic interference (EMI), does not have radiated electromagnetic susceptibility (RES), and is not affected by radio frequency interference (RFI). These problems have to be considered when a transmission uses copper cables.

- Low loss

  The light signal travelling in a fiber optic cable will lose its energy very slowly, usually at less than 1 dB/km.

- Small crosstalk and high security

  Since there is no electrical radiation from the fiber optic cables, they have a high degree of security when compared to copper cables. Although fiber optic cables are not easy to tap, it is possible. Security must be taken into consideration when "dark fibers" from telephone companies or other vendors providing network services are used. As the transmitted light is converted to electrical signals in repeaters, data may be exposed.

• No common ground

  The fiber optic cables use light, not electricity to transmit signals, so the signals are not affected by the electrical disturbances to ground. Also, when devices are not electrically connected there will be no ground loops, or currents, caused by differing electrical ground potential.

4.2 Optical Fibers

An optical fiber functions as a kind of waveguide for light. It is usually made of silica glass. The fiber itself has a central core and a surrounding cladding of slightly different glass material. These are protected by a plastic or nylon coating, sometimes called a buffer. The physical size of an optical fiber is determined by the diameter of the core and cladding, expressed in microns (um). One micron is a millionth (1/1,000,000) of a meter. A fiber optic cable having a core diameter of 62.5 um and a cladding of 125 um is designated as 62.5/125 um optical fiber. You can see an example of an optical fiber cable in Figure 6.
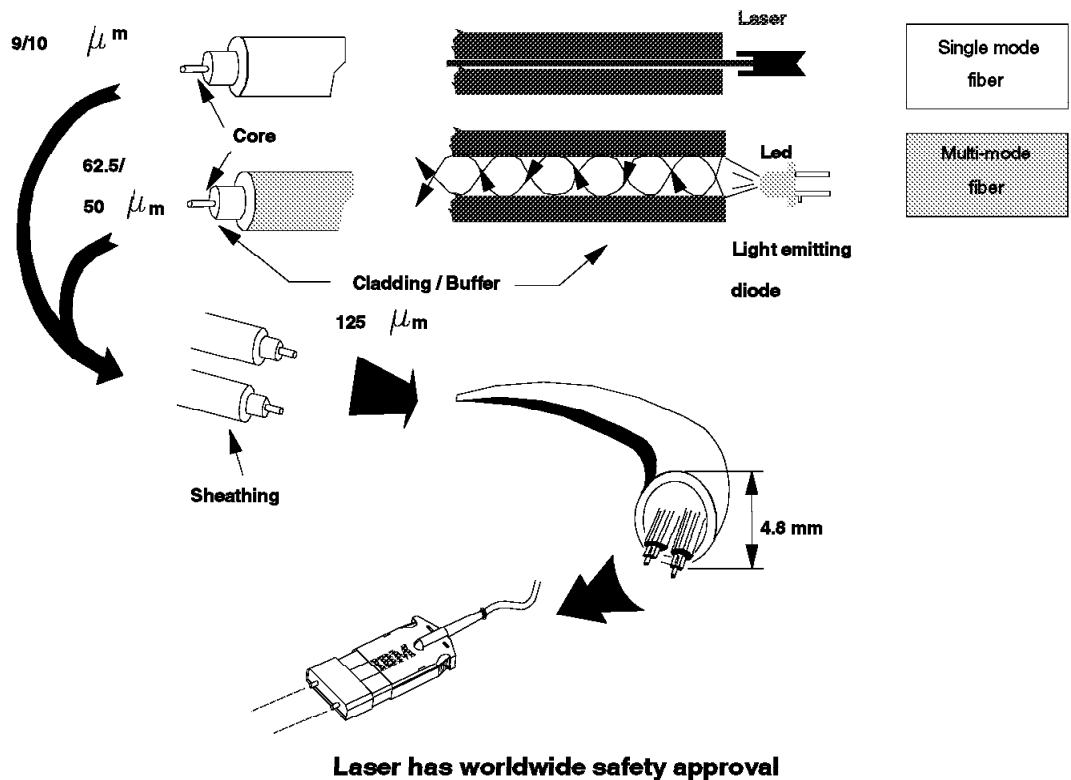
Figure 6. Fiber Optic Cable

The optical fibers are coated with several kinds of protective layers. The material and the thickness of these layers depend on the usage of the cable. An optical fiber cable normally contains a pair of fibers, or several pairs of fibers. The former is called a jumper cable and the latter a trunk cable. The outer diameter of a jumper cable is typically 4.8 mm, or 0.19 inch, while a trunk cable with 72 pairs of fibers measures about 12.5 mm, or half an inch in diameter. Optical fiber cables are manufactured for different environments and they should always be used within their design criteria.

4.3 Propagation of Light in an Optical Fiber

The light used for transmitting signals in fiber optic communication systems could be visible light or invisible light such as infrared or ultraviolet. However, only certain frequencies are suitable for use in optical fibers as the attenuation of the signal varies with the wavelength. The wavelengths of 850 nanometers (nm) and 1300 nm have the lowest attenuation, so these are the most commonly used wavelengths. The power of light used to transmit a signal in an optical fiber is relatively small; 10-50 milliwatts. Still, you should follow all the safety precautions when you work with devices transmitting light. As the light used is invisible, you may not know if the transmission is on. The light used may cause harm to human tissues and even blindness if aimed at an eye.

4.4 Bandwidth

Light travels in a vacuum at a speed of 300,000,000 meters per second. In glass, the speed is slower, 200,000,000 meters per second. However, the data transmission capacity is determined by the bandwidth used. The higher the bandwidth, the greater the amount of data carried through an optical fiber. Normally the bandwidths for optical fibers are given in MHz-km. A bandwidth of 500 MHz-km denotes that a 500 MHz signal can be transmitted over a 1 km distance. This is the typical bandwidth for multi-mode fibers. Bandwidths for single-mode fibers are in the GHz range, typically 100 GHz over a 1 km distance. Using lower frequencies we can send light signals, or pulses, over longer distances. The distance is limited due to dispersion, or scattering, of the signal so that the pulses cannot be separated from each others at the receiving end. There are several reasons for dispersion and we will discuss them later.

4.5 Transmission Modes

There are two transmission modes we can use to send light signals through an optical fiber: single-mode or multi-mode. The optical fibers used are called single-mode or multi-mode fibers. These optical fibers have different physical dimensions and light transmission characteristics.

The term 'mode' is related to the number and variety of wavelengths that may be propagated through the core of an optical fiber. In other words, it describes the propagation path of a light ray in the core of an optical fiber.

When the core has a comparatively large diameter, light rays enter the optical fiber at different angles compared to the central axis of the core. These light rays will reflect from the interface of the core and cladding and their paths in the core follow a zig-zag pattern. Light rays also enter the core parallel to the central axis of the core. These light rays will follow a straight path through the core. We have now light rays in different modes travelling in an optical fiber. This is called multi-mode transmission.

Small cores allow only the light rays almost parallel to the central axis of the core enter an optical fiber. So we have fewer modes travelling in the fiber. This is called single-mode transmission, where only one frequency of light, or one mode, is propagated.

4.5.1 Single-Mode Fiber

A single-mode fiber usually has a core diameter of 8 to 10 microns and a cladding diameter of 125 microns. The light source used for single-mode optical fibers is a *laser* (Light Amplification by Stimulated Emission of Radiation). A laser commonly used in communication systems is generated by a semiconductor laser diode (LD). Light generated by a laser diode is very coherent. The maximum distance for a single-mode optical fiber link is 20 km.

**STEP
INDEX**

**Cross
sectional
view**

**Index
profile**

**Input
pulse**

**Light
path**

**Output
pulse**
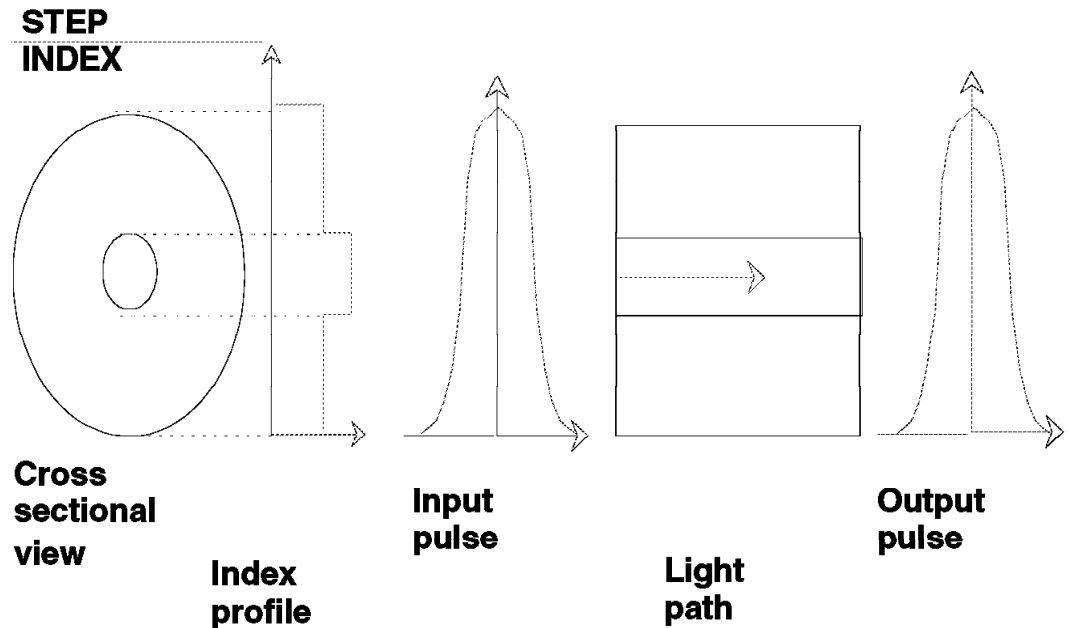
Figure 7. Single-Mode Fiber Profile

4.5.2 Multi-Mode Fiber

As described, multi-mode fibers carry several modes concurrently. The 62.5/125 or 50/125 um optical fiber cables are supported by IBM. A light emitting diode (LED) is usually the light source for multi-mode fibers. The maximum distance for a multi-mode optical fiber link is 3 km using a 62.5/125 um optical fiber.

Even though the distance achieved by multi-mode fibers is relatively short compared to that for single-mode fibers, multi-mode fibers have several advantages and therefore were selected for campus-wide communications in the ESCON architecture. For several years to come, the multi-mode fiber is the right choice, although further in the future single-mode fibers will be used more frequently. If you are planning an installation, you should consider installing both multi- and single-mode fiber cables even though the single-mode cables would have no use yet.

4.6 Refractive Index Profile

Beside transmission mode, another important term is refractive index profile. The refractive index profile describes the relationship between the index of the core and the cladding. There are two commonly used types of refractive index profiles:

4.6.1 Step Index

In a step-index fiber, the core has a uniform index, but there is an abrupt change in the refractive index between the core and the cladding.

4.6.2 Graded Index

In a graded-index fiber the core has a gradually decreasing refractive index from the center of the core outward to the cladding boundary. This causes the light rays propagated in a graded-index optical fiber to travel at almost the same speed even though they have different geometrical paths. The graded-index fibers are made by doping the glass material used to manufacture the fibers. Figure 7 and Figure 8 describe the step and graded indices of fiber optic cables.

STEP INDEX:

GRADED INDEX:

Cross sectional view

Index profile

Input pulse

Light paths

Output pulse
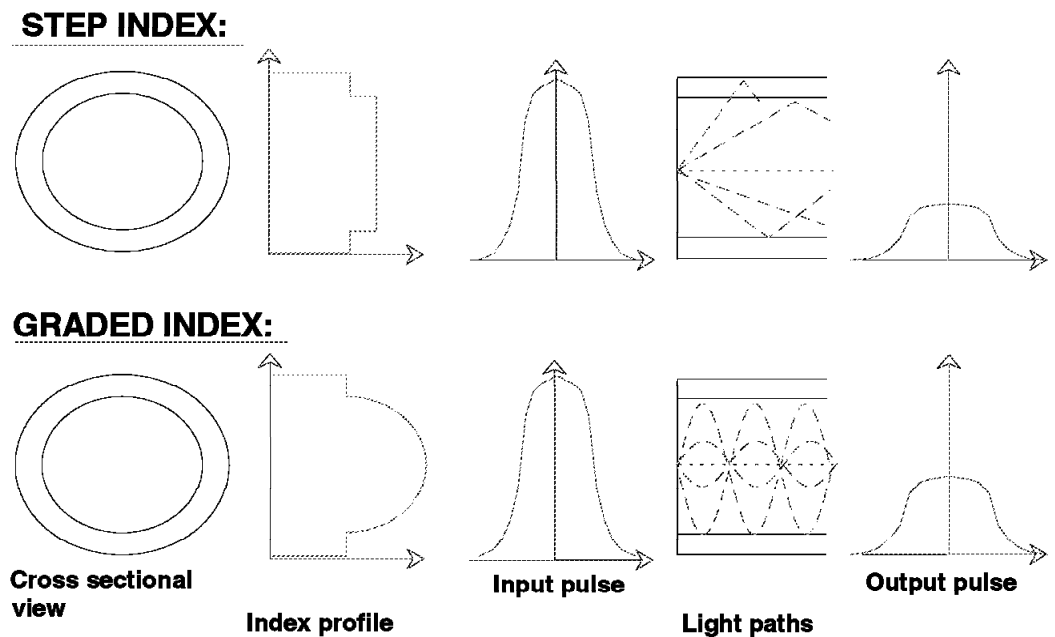
Figure 8. Multi-Mode Fiber Profiles

4.7 Dispersion

Light rays travelling parallel to the central axis of the core, called lower modes, will be faster than the rays reflecting from the interface of the core and the cladding. These reflected rays are called higher modes. If we have both lower and higher mode rays in a multi-mode optical fiber, the rays will arrive at slightly different times at the receiver. This is called mode delay, or modal dispersion. Modal dispersion may prevent differentiation of the incoming pulses in a receiver. Modal dispersion could significantly limit the useful distance of a multi-mode optical fiber. Using the graded index optical fibers for multi-mode transmission decreases the modal dispersion as both the higher and lower modes proceed at the same speed.

Dispersion is also caused by different wavelengths in the light signal transmitted into an optical fiber. The different wavelengths travel with different speed and so they can cause merging of the pulses. This is a common problem in single-mode fibers. It is best avoided using a light source of coherent light. The impurities in the material used for optical fibers can also cause dispersion, as lower modes may convert to higher modes.

4.8 Light Sources and Detectors

To make use of optical fibers, we have to convert the electrical pulses that electrical devices use to light pulses, and vice versa. This conversion is done using transmitters and receivers. Since we usually have a pair of fibers for a fiber optic link, each end of the link needs a transmitter and a receiver. Let us have a look what kind of devices are used:

4.8.1 Transmitters

A transmitter emits, or sends, light into an optical fiber. The light rays should all be of the same wavelength. Remember what we learned earlier about dispersion. The emitted light works as a carrier. For data transmission, we have to add the data in the carrier. We can do this by modulating the emitted light. As described later in this manual, data is transmitted through an optical fiber serially. So if data appears as parallel signals to our transmitter, it must first be converted to serial signals.

The devices used in transmitters can be LEDs or laser diodes. LEDs generate light that has a narrow range of wavelengths around the central wavelength. It is used for multi-mode fibers. An LED is a small and quite inexpensive component. Laser diodes are rather complicated devices and therefore usually more expensive than LEDs. Their advantages are the intensity and accuracy of the light. The light is more coherent than the light from a LED. Also, a light of high power can be generated. Laser devices are used with single-mode fibers.

4.8.2 Receivers

The light travelling through an optical fiber must be detected to convert it back to electrical signal. Detection is done by light sensitive devices called photodiodes. After being detected, the signal is amplified and usually digitized.

4.9 Fiber Optic Standards

In addition to the ESCON architecture, there are other standards based on fiber optics. This section provides information on some of the standards that are either available or being designed.

You may often hear the terms 'proprietary' and 'open systems' in conjunction with fiber optic standards. The proprietary systems cover architectures such as S/390 and ESCON. They are owned as the property of somebody, usually a company. Open systems are architectures that different vendors may use to produce products. These products can be used in an installation connected to products of any vendor, assuming that all the products meet the same standard.

4.9.1 Fiber Channel Standard

Fiber Channel Standard (FCS) is ANSI standard X3T9.3. This standard has not been finalized yet. It became available for the first public review late in 1992. The base for FCS is laser technology with a bandwidth of 1 GHz. It will be first utilized by NIC and scientific applications providing a high performance parallel interface (HIPPI). In the Fiber Channel Standard, switching is not architected; only the ends are defined. Switching in the network is based on the destination and source addresses. There may be several switches in a network. It may become possible to use FCS as a high speed backbone network. It may also be used as a general transfer vehicle for upper level protocols, such as TCP/IP, HIPPI, SBCC, and so on. These upper level protocols may be intermixed on a link.

4.9.2 Synchronous Optical Network (SONET)

SONET is a US standard for the internal operations of optical networks. It is closely related to a system called Synchronous Digital Hierarchy (SDH), which is a CCITT recommendation for the internal operations of optical networks.

SONET can mix packages, or frames, from different sources and carry them over a network. It uses a family of rates of 51.84 Mbit/sec. Using multiples of these rates, SONET is capable of reaching gigabit rates per second. Within SONET, several bandwidths can be transported simultaneously.

4.9.3 Integrated Services Digital Network (ISDN)

ISDN describes and specifies a digital user interface to a public communication network. It does not specify the internal operations of a network, but the interfaces to it and services it provides.

There are three generic types of ISDN:

- Narrowband ISDN can utilize 64 Kb/sec copper links primarily on a switched services basis.

- Wideband ISDN is a form of ISDN where a user is able to access a wider synchronous data channel utilizing several 64 Kb/sec copper links.

- Broadband ISDN is a cell based packet switching system. It does not offer synchronous links as narrow- and wideband ISDN, but an Asynchronous Transfer Mode (ATM) cell switching.

ISDN is already in use for carrying speech and data simultaneously over a channel. It is aimed at many applications, not only for computing, but consumer services at offices, homes, and other locations.

4.9.4 Asynchronous Transfer Mode (ATM)

ATM is a protocol which has been accepted as the basis for the broadband ISDN service. It is aimed at high speed cell switching systems. ATM is suitable for all types of traffic, including voice, data, image, and video. Information is transferred in cells that contain a header defining the route through a network. Each cell may contain data, or payload, of 48 bytes.

4.9.5 Fiber Distributed Date Interface (FDDI)

FDDI was developed by ANSI. It was originally proposed as a standard for fiber optical computer channels, but has become a generalized standard for operation of a LAN at 100 Mbit/sec. The FDDI standard was approved in 1991, and there are many FDDI devices available on the market.

FDDI is primarily intended for operation over optical fiber, but recently has been proposed for operation over standard copper wire (shielded twisted pair). Using multi-mode optical fiber, a FDDI ring may be up to 200 km in length with a maximum of 500 stations. Data transfer takes place in frames or packets. The maximum frame size is 4500 bytes and contains a header with the physical destination address of a FDDI station. The ring protocol of FDDI is conceptually similar to the token-ring LAN (IEEE 802.5), but differs significantly in detail.

FDDI was approved quite early, and so it has been implemented and accepted by many customers.

Chapter 5. ESCON I/O Architecture

This chapter describes the general concepts of the ESA/390 ESCON I/O interface. This discussion provides a foundation for understanding the function of the elements comprising the interface, their associated terminology, and their interrelationships. This is not a substitute for the appropriate reference documentation that can be found in *Enterprise Systems Architecture/390 ESCON I/O Interface*.

This chapter is divided into the following sections:

Overview A brief description of the ESCON I/O interface and its main elements are presented and described.

ESCON Director A detailed description of the ESCON Director function, port, and port states is presented.

Link Transmission and Reception

Addressing, data structures for exchange of information, link-level and device-level operations, logical paths, and I/O operations are presented.

5.1 Overview

The ESCON I/O interface has little or no impact on application and system software. The software areas affected are essentially limited to the I/O configuration process. Other areas, such as operations and configuration management, are heavily affected. Many new concepts, products, and terms are introduced.

Before getting into detailed information, let us describe and define some of the terms and concepts that you must know to understand the ESCON I/O interface. Some of the concepts are an evolution of the existing parallel interface as described in the OEMI specifications, while others are completely new. This section describes both.

5.1.1 Physical Elements

In general terms, the ESCON I/O interface consists of a set of rules defined by the ESA/390 architecture, physical and logical protocols, and media specifications, that allow the transfer of information between a control unit and an ESA/390 channel subsystem. From this point of view, the ESCON I/O interface accomplishes the same function as the previous parallel channel interface, and also provides for expanded connectivity, higher performance potential, lower supporting facilities costs, and some additional unique functions.

The connection between a control unit and an ESA/390 channel is still referred to as a channel path. You will see, however, that the physical implementation of this channel path differs dramatically from the parallel OEMI specifications. Figure 9 can be used throughout the discussion as a graphic description of all the channel path elements.

```
ESA/390          CPU A          ESA/390          CPU B
Channel Subsystem               Channel Subsystem

CH CH CH                                       CH CH CH
01  02  03                                     01  02  03
```
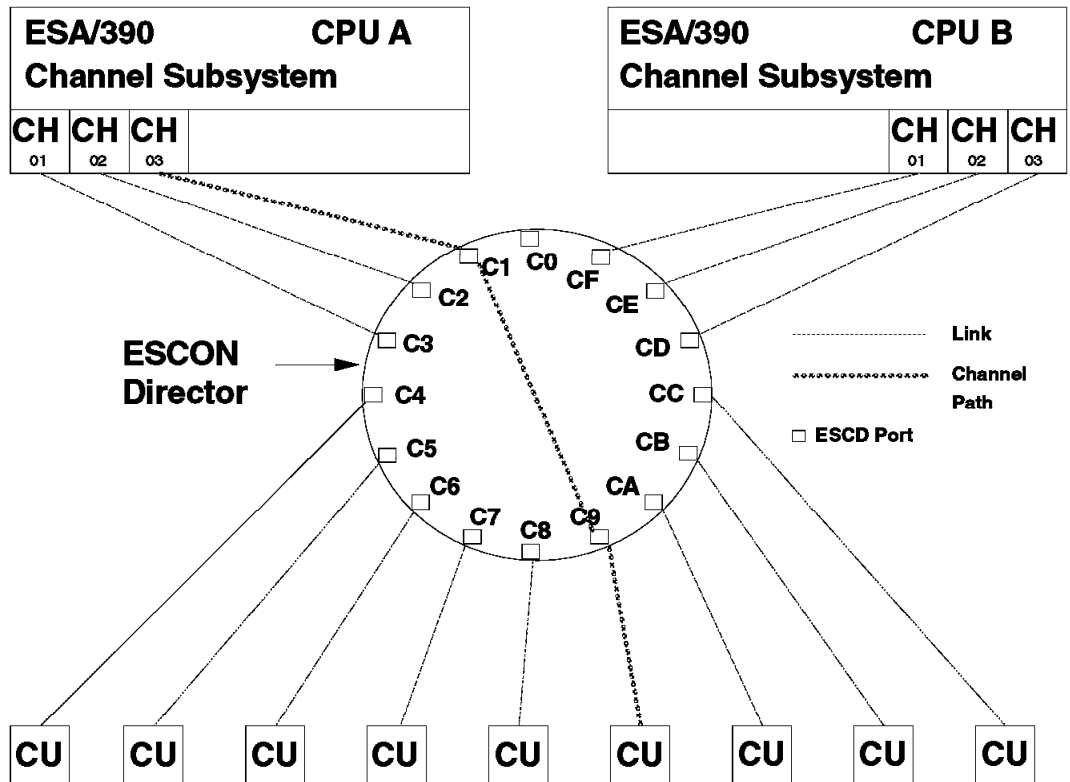
Figure 9. Links, Ports and Channel Paths

5.1.1.1 Channel

A channel executes commands presented by the standard ESA/390 I/O instruction set, and it manages its associated link interface to control bit transmission and reception. In simple terms, the channel on a write command retrieves data from central storage, encodes it, and packages it into frames before sending it on the link. On a read command, the channel performs the opposite operation.

5.1.1.2 Link

The transmission medium for the ESCON I/O interface is a fiber optic cable. Physically, it is a pair of optical fibers that provide two dedicated unidirectional serial bit transmission lines. There are no parallel transmissions, or "tag" lines. Information in a single optical fiber flows, bit by bit, always in the same direction. At any link interface, one optical fiber is used to receive data while the other is used to transmit data. The link is used to attach and interconnect all other elements of the ESCON I/O interface. See Figure 10 for an example of an IBM jumper cable with duplex connectors that can be used as the link medium.

Please note that although there are dedicated fibers for reception and transmission in a single link, full duplex capabilities are not exploited for data transfer. As we will see, the ESCON I/O protocol specifies that for normal I/O operations, frames flow serially in both directions, but basically in a request/response fashion; data and data requests might overlap.
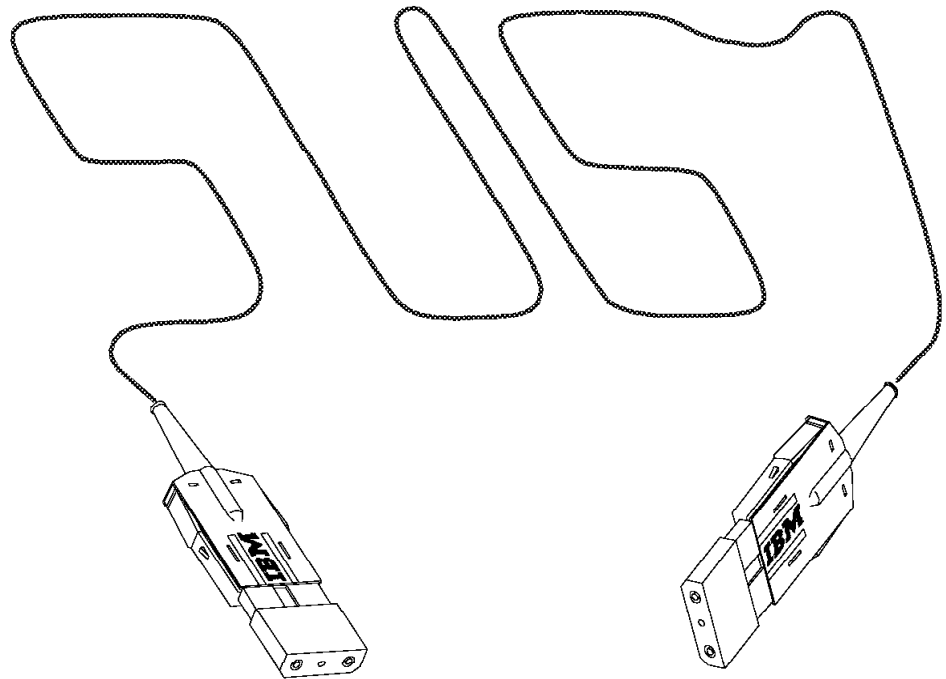
Figure 10. Jumper Cable with Duplex Connectors

5.1.1.3 Link-Level Facility

The link-level facility performs link-level protocols and functions, such as initialization, offline processing, and error recovery, and manages logical paths and the attached link, including transmitter and receiver.

5.1.1.4 ESCON Director

The ESCON Director (ESCD) and its dynamic switching capability is the ″hub″ of the ESCON topology (Figure 9).

A link connects to an ESCON Director through a port. The number of ports available for connecting external links is implementation-dependent but can never exceed 254.

The ESCON Director, under user control, routes transmissions from one port to any other port in the same ESCON Director, and provides data and command exchange for multiple channels and control units.

IBM has announced four ESCD models to provide dynamic switch function:

- ESCON Director Model 1
- ESCON Director Model 2
- ESCON Director Model 3
- ESCON Director Model 4

They implement less than the architected maximum number of ports. They are non-blocking, in the sense that there are enough internal paths that all ports can

communicate simultaneously. Signals travel from one port to another, converting from optical signals to electrical and back to optical. This allows for some ″elasticity″ in the bit stream (source and destination ports do not have to be locked at exactly the same time) and for repowering the optical signal, balancing for any losses at interfaces or on the fiber cables themselves. ESCON Director Model 1 and ESCON Director Model 2 are described in detail in 6.3, "IBM 9032 and 9033 ESCON Directors" on page 85.

5.1.1.5 Control Unit

The control unit receives commands from the channel, receives data from and transmits data into the channel, and controls execution of commands and data transfer at associated devices. The control unit attaches to one or multiple links through link interfaces.

The ESCON I/O interface does not allow multiple control units (or control unit link interfaces) to reside on the same link. A control unit, however, can contain multiple images with dedicated or shared physical control unit facilities. The ESCON I/O interface provides for addressing these multiple images.

However, multiple control units can still be configured to the same channel through an ESCON Director.

5.1.2 Data Transmission and Encoding, Protocols, and Logical Paths

All information transmitted over the ESCON I/O interface must be encoded into a 10-bit transmission code according to the ESCON I/O encoding rules. Codification ensures data integrity, provides special control characters, and provides a way of synchronizing transmitter and receiver.

5.1.2.1 Encoding

When a channel retrieves data from or stores data into central storage, it does so in binary format in groups of 8 bits (not including any parity bit). This data is usually coded in EBCDIC, although, as far as the channel is concerned, the coding is irrelevant.

The ESCON I/O interface specifies that the channel must encode the characters it sends on a link. The same encoding must be done by the control units. There are several reasons why this is done, some of which are beyond the scope of this document, but let us just say for the moment that, besides error detection and balancing of ones and zeros, encoding can provide a way of defining special characters that cannot normally occur in the data to be transmitted. To make this possible, an encoded character must contain more than 8 bits (as all 8-bit combinations are possible prior to encoding). These extra characters can then be used for special functions and cannot be confused with normal characters.

The ESCON I/O interface defines a 10-bit character code. The 8-bit characters are converted to 10-bit characters through an algorithm that tries to maximize the change of states in a link (from zero to one and back to zero) while maintaining an equal number of ones and zeros over time. This makes link synchronization and error detection easier to achieve.

5.1.2.2 Link-Level and Device-Level Frames

Apart from encoding, characters are packaged into frames with a specified format. The ESCON I/O interface defines two types of frames, one to control the link and associated elements, and another to control device operations. The former are called link-level frames, and the latter device-level frames. For instance, sending a SEEK command to a 3390 device requires device-level frames, while reporting a port-busy condition in an ESCON Director involves exchanging link-level frames.

5.1.2.3 Logical Paths

Device-level operations can occur only after specific resources have been established at the channel and control unit level and related to one another. This relationship between a channel and a control unit image that designates the physical path to be used for device-level communication between both link-level facilities is called a logical path. The logical path is established through a link-level procedure, and is usually accomplished at initialization. Due to physical constraints, the maximum number of logical paths that a control unit can concurrently support is model dependent. An ESCON channel can currently support a maximum of 120 logical paths.

The ESCON I/O interface addressing limits are greater than the current implementations provide for. Refer to Chapter 6, "ESCON I/O Architecture Implementation" on page 41 for information on the current values for the ESCON control units.

Note the difference between a channel path and a logical path. A channel path is the collection of elements (links, ports, ESCD connections) that provide a physical path for the information to flow. A logical path is a representation of a communication path between the channel subsystem and the control unit, including all the addressing information required to establish a connection.

5.2 ESCON Director

The ESCON Director temporarily connects ports for transmission. The connection can remain in effect while several frames are exchanged between the ports. As discussed below, the connection is made (and broken) on request from a frame sent by either a control unit or a channel. The switching function of the ESCON Director provides a way of connecting multiple channels and control units without requiring permanent connections. The ESCON Director also provides a control unit function that can be used to control port connectivity. Ports can be dedicated, prohibited from communicating to other ports, or blocked from communicating.

The control unit function is model dependent, and in the case of the announced ESCON Directors, can be invoked either by the ESCON Director console, or by the control unit port, which is a reserved port internal to the ESCON Director. The ESCON Manager program product can be used to interface with the control unit port and provide the user with a high-level, not-implementation-specific, easy-to-use interface.

5.2.1 Link Address

A link address is associated with each ESCD port number by a mapping scheme. Data arriving at an ESCD port carries a link address that the switching function of the ESCON Director uses to determine the outbound port to "send" the data to. This data is (before encoding) one byte long (8 bits), and so can specify a maximum of 256 values. Two of these values (X′00′ and X′FF′) are reserved and have special meanings.

Several conditions at the destination port can prevent the data from being successfully delivered. If delivery is unsuccessful, the data is discarded and the transmitting link interface informed. Link-level frames are used for this purpose. Some of the conditions that can prevent a successful connection include port busy and port offline.

If a port has a dedicated connection to another port, the address included in the transmitted data is not checked and the data is passed through to the destination port. If a frame must travel through two ESCON Directors, only one can establish a dynamic connection.

5.2.2 Port States

Ports in an ESCON Director can be in several states, namely:

Inactive   A port can accept or initiate a connect request.

Busy   The port cannot accept a connect request. The port enters this state due to internal functions, such as error logging.

Connection   The port enters this state as a result of a valid connection request. In this state the port cannot accept further connection requests.

Static   A port enters this state when assigned a dedicated connection with another port by the controlling function of the ESCON Director.

Offline   A port is in this state when it is receiving or transmitting an offline sequence. This state can be caused by:

- Issuing a BLOCK command
- Performing diagnoses (wrap test)

Link failure   This is usually the result of a "loss of light" at the receiver end of the port.

5.3 Link Transmission and Reception

This section describes more specifically how information is structured and how addressing is implemented in the ESCON I/O interface.

5.3.1 Sequences and Frames

There are two main format types in the ESCON I/O architecture:

- Sequences

- Frames

A sequence is a set of characters in a predefined order used to signal specific states or transitions to states at the link facility or ESCD port. A sequence always starts with the same control character which is a 10-bit character that cannot occur normally in the application data to be transmitted. For instance, when an ESCD port enters the offline state, it starts transmitting the "offline" sequence on the link.

Frames are the main vehicle for transferring information over the ESCON I/O interface. Frames always start with a delimiter (an ordered set of characters) that signal the start of a frame. Until the end-of-frame delimiter is received, the frame has a specified format based on its type. The length of a frame is variable.

5.3.2 Synchronization

When a link interface first starts transmitting, it does so by continuously sending the idle character on the link. This is a control character that cannot occur within the body of a frame. On the receiving end, a link interface detects incoming bit transitions and phase locks onto them. The description of bit synchronization is outside the scope of this document. Bit synchronization however, is not enough to recognize characters. On a parallel interface, characters are recognized because each bit comprising the character has a dedicated line. On an ESCON interface, how does a link interface achieve character synchronization and recognition? The answer is in the encoding algorithm. The transmission code is formed in such a way that it is possible to retrieve character synchronization out of the data once bit synchronization is achieved. In other words, clocking is retrieved from the data. Let us explain how this is possible.

As stated before, the idle character is a unique configuration of bits that cannot occur in a normal transmission. When trying to achieve synchronization, a port looks at the incoming bit stream and tries to identify the idle character. Once this is done, and a predetermined number of idle characters are received without interruption, the port achieves character synchronization. The idle character is a unique combination of bits even when shifted, so it is impossible to mistake its reception. Remember that the encoding algorithm encodes 8 bits into 10 and so not all the possible 1024 combinations are used as data or control characters, even if some data codes use more than one 10-bit code. Refer to *ESA/390 ESCON I/O Interface* for information on encoding. Loss of synchronization is easily detected, as a bit shift usually generates invalid character codes.

Note also, that unless it is not operational, a link facility never stops transmitting. Indeed, were it possible to see the light pulses travelling through the fibers (it is not, because the jacket of the fiber optic cable is opaque, and the frequency used lies in the infrared spectrum, making it invisible), the fiber optic cabling of a computer room would produce a light show of pulsating signals flowing in and out of the ESCON Director in a star formation. If data is not actively transmitted over the link, the link-level facility or the ESCD port is continuously transmitting

the idle character. This guarantees that synchronization is maintained and does not have to be reacquired each time a frame requires transmission.

5.3.3 Link-Level Addressing

The link addressing discussed in the previous section does not fully describe the addressing capabilities of the ESCON I/O interface. In the ESCON I/O interface, the address is made up of the following elements:

- Link value associated with the ESCD port number

- Host logical address

- Control unit images

- Devices

The first three elements, when specified together, constitute a full link address, which uniquely identifies the recipient of a frame as seen from the ESCON I/O interface. The second element, host logical address, is used only for shared channels (EMIF) in the LPAR mode. From the host logical address, the channel subsystem determines which of the LPARs sharing the channel this frame is intended for. For more information about EMIF, see 6.2, "ESCON Multiple Image Facility" on page 74. The fourth element, the device, is used when communication is to or from a device and is in addition to the full link address.

In summary, the full link address determines the recipient of the frame, while the device address is used by the recipient to either select a device in the case of a control unit or to associate a frame with a subchannel (the representation in the ESA/390 channel subsystem of a device) in the case of a channel.

Note also that all frames have two full link addresses. One specifies the destination address and another the source address. In the example depicted in Figure 11 on page 29, a control unit is sending a frame to an ESA/390 channel through an ESCON Director. The link header, the frame field containing, among other things the full link addresses, specifies that the final destination of the frame is port C1 and the source port is C9. These correspond to the ESCD ports to which the channel and the control unit are attached.

ESA/390 CPU A
Channel Subsystem
CH 01 | CH 02 | CH 03

ESA/390 CPU B
Channel Subsystem
CH 01 | CH 02 | CH 03

C1

C9

CU CU CU CU CU CU CU CU CU

A Frame

| Link Header | Information Field | Link Trailer |

SOF	Dest. Addr.			Source Addr.			Link
	Link Address:		Log. Addr:	Link Address:		Log. Addr:	**Cntl.**
	C1		**0**	**0**	**C9**	**0**	**0**

Link Header
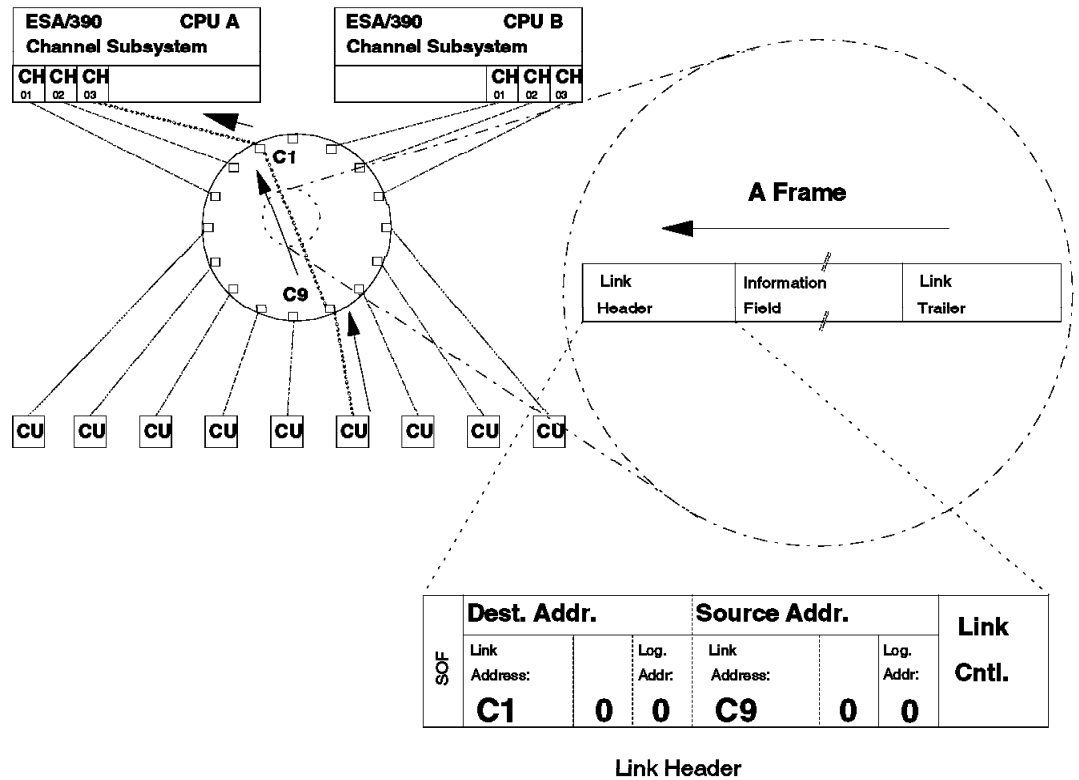
Figure 11. ESCON I/O Interface Addressing

The ESCD port was discussed in the previous section. The control unit image, however, is a new concept. The ESCON I/O interface allows physical control units to define multiple images that can be addressed separately. These control unit images can control a shared or independent set of devices. The control unit image shares the link-level facility with all other control unit images, and can, depending on model implementation, share other physical control unit resources.

A control unit image can be considered to operate independently from all other control unit images. Namely, each can establish communication with its own channels. In Figure 12 on page 30, channel 03 in CPU A is sending a frame to the control unit linked to port C9 of the ESCON Director and specifying control unit image 5 as the final recipient of the frame. The switching function of the ESCON Director uses the port address of the destination full link address to make the connection, and the physical control unit uses the logical address of the same full link address to select the appropriate control unit image to process the frame.

Device addressing is further discussed in 5.3.3.2, "Device-Level Frames" on page 32.
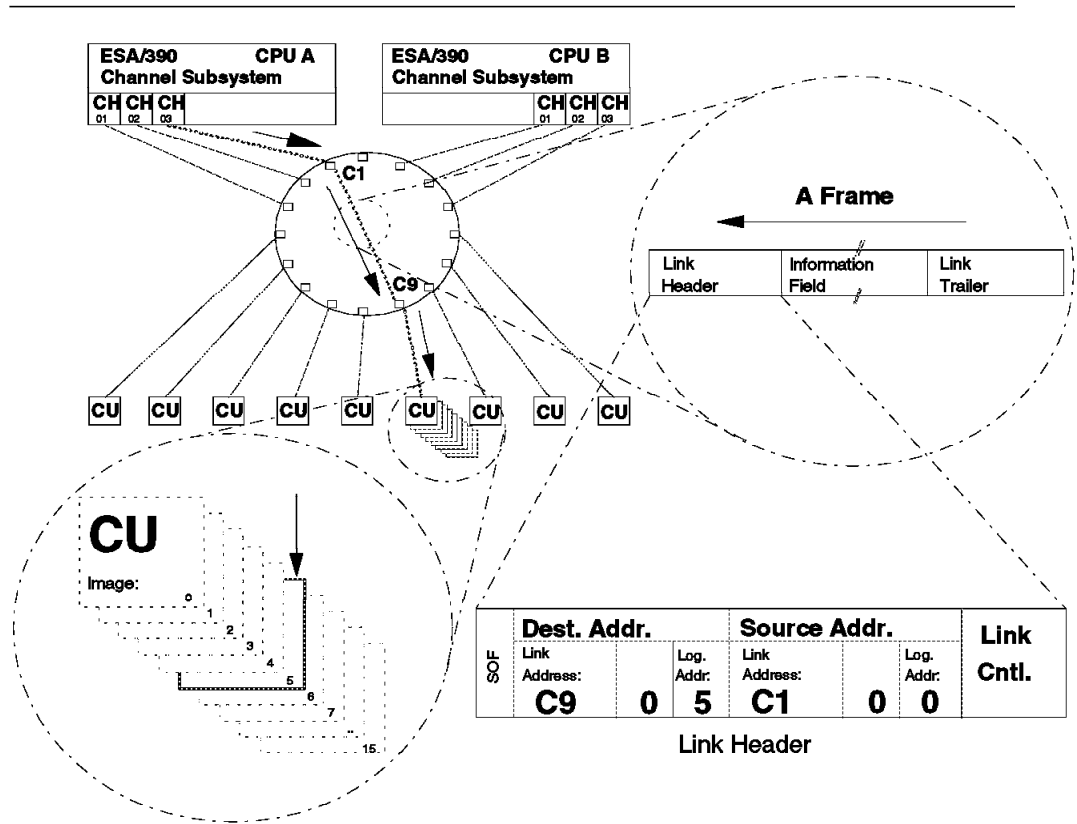
Figure 12. ESCON I/O Interface Addressing - CU Images

5.3.3.1 Frame Format

There are two types of frames:

Link-Level Frames Frames used to manage links and their operation.

Device-Level Frames Frames associated with device operations, such as control, status presentation, and data transfer.

All frames have the same main structure, shown in Figure 11 on page 29. All frames contain:

- A link header of fixed length (7 characters, including the delimiters).

- An information field of variable length (maximum 1028 characters for device-level frames).

- A link trailer of fixed length (5 characters, including the EOF delimiter).

The frames are enclosed by two sets of special characters, the start-of-frame delimiter (two characters) and the end-of-frame delimiter (three characters). There are two types of each delimiter. The start-of-frame (SOF) delimiter can be:

- Connect
- Passive

A connect SOF delimiter establishes a connection to the ESCD port specified in the destination address field. If the destination port is not in the inactive state, the requested connection will be denied and the receiving port will reply with a port-busy frame. A passive SOF presumes that a connection has already been

established. If a connection has not been established, a connection error is generated upon frame reception.

The end-of-frame (EOF) delimiter can be:

- Disconnect
- Passive

Once a connection between ports has been established, it remains in effect until either an error is recognized that prevents the connection from being kept, or a frame is received (on either end), that contains a disconnect EOF. The involved ports will revert to an inactive state. A passive EOF does not break a connection.

The format of the link-header and the link-trailer are common to both device-level and link-level frames.

Link Header: Except for the SOF delimiter, the link-header contains three subfields:

- Destination address (full link address)
- Source address (full link address)
- Link control field

Full link addresses have the format:

Link Address	Reserved	Logical Address
Byte 0		Byte 1
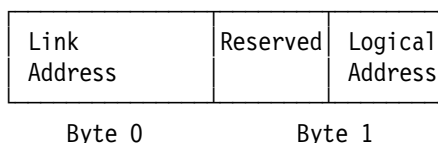
Byte 0 contains the destination link address when the channel path includes one dynamic connection. The first four bits of byte 1 are reserved and must contain zeros. The last four bits of byte 1 contain either the host logical address or the control unit image number. The former is used for channel sharing in LPAR mode and the latter for control units supporting multiple control unit images. If neither of the previous features are used, then the field contains zeroes.

The link control field has the following format (before encoding):

```
xxxxx00y
```
01234567
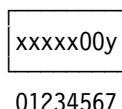
Bit 7 (y) specifies the type of frame; 1 indicates a link-level frame, and 0 indicates a device-level frame. If y = 1, bits 0 to 4 (xxxxx) specify the link-level function to be executed; otherwise, they are all zeros.

Link-Trailer: Except for the end-of-frame delimiter, the link-trailer contains a 2-byte cyclic redundancy-check (CRC). This field is used by channels and control units to ensure data integrity. For a full discussion of the algorithms used to generate the CRC field, please refer to *ESA/390 ESCON I/O Interface*.

Link-Level Information Field: The information field of link-level frames has a variable length (from 0 to 104 bytes) that depends on the function requested by the link-control field. For instance, on a port-reject frame, the information field holds the reason code as to why a frame was rejected. The information field of a link-level-acknowledgment frame (ACK) has a length of zero; there is no information field for this frame type.

The device-level information field has a more complex format and is discussed in the following section.

5.3.3.2 Device-Level Frames

Beyond link-level addressing information, device-level frames may contain:

- Information to address individual devices
- Commands, flags, and status
- Data

All this data, if specified, is contained in the information field. So, although the main base structure of link-level and device-level frames is the same, the actual contents and format of the information fields differ. Figure 13 contains the layout of the information field for a device-level frame.
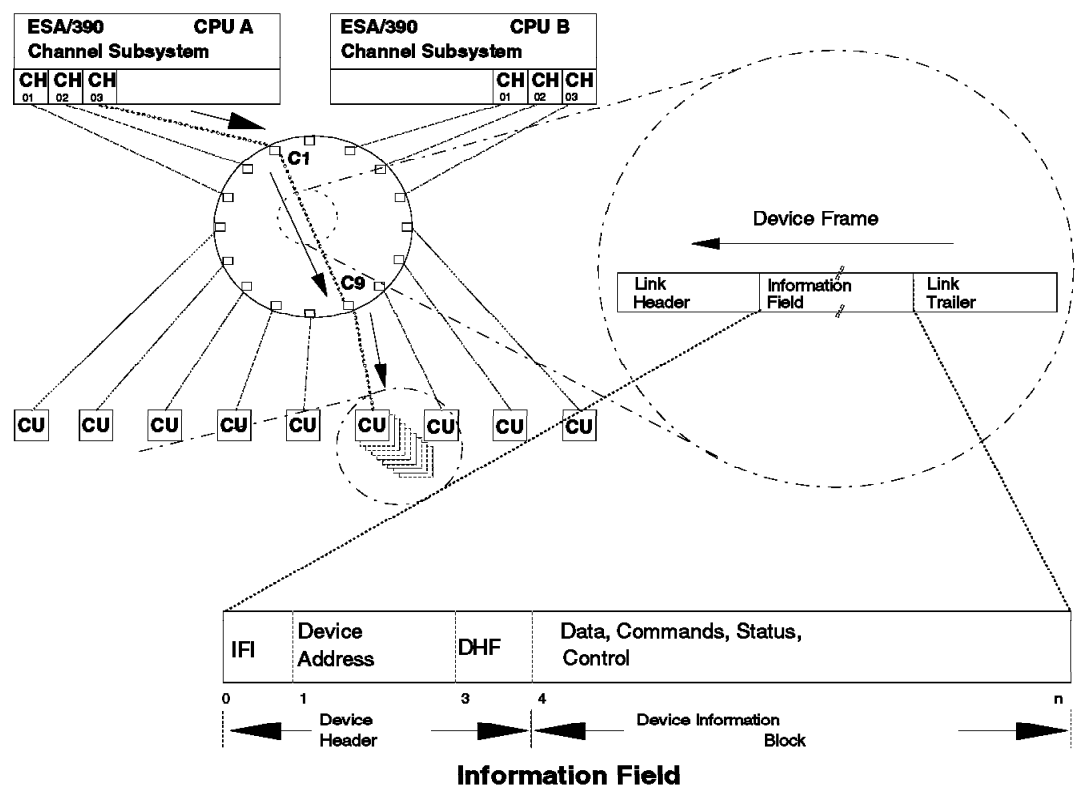
Figure 13. Device-Level Frame Information Field

The information field in a device-level frame has the following subfields:

- Device header, containing:
  - Information field identifier (IFI)
  - Device address
  - Device-header flag (DHF)
- Device information block (DIB)

The IFI contains an 8-bit field specifying the device-level frame type, whether a specific device is associated with this frame, and whether supplemental status is present on a status frame. The device-level frame type can be:

- Data
- Command

- Status
- Control

If the IFI determines that this frame does not contain a specific address (for instance, when addressing a control unit), the address field is not used.

The device address field is a 16-bit field used to address specific devices. Bits 0 to 7 are not used and must be set to zeros.

The device header flag bits control execution of an I/O operation. Some of the protocols that can be invoked by these bits include:

- Disconnection notification
- Frame chaining
- Data requests

The DIB format depends on the device-level frame type (Figure 14):

- For a data frame, the DIB contains data.

- For a command frame, the DIB contains the command, the data count, and the command flags.

- For a status frame, the DIB contains status and may contain supplemental status, depending on the IFI specification.

- For a control frame, the DIB contains the control function and parameters.

Note that although the length of the device-level frames is variable, there is no field specifying its length. The length of any frame is determined by the occurrence of the EOF delimiter in the character stream.

Data

```
          ┌─────┬─────┬─────┬─────────────────//────────────┐
          │     │Dev. │     │                               │
          │ IFI │Addr.│ DHF │            Data               │
          │     │     │     │                 ──────//───────┤
          └─────┴─────┴─────┴───────────────────────────────┘
            0     1     3    4                               n
```

Command

```
          ┌─────┬─────┬─────┬─────┬─────┬───────┐
          │     │Dev. │     │ Cmd │     │       │
          │ IFI │Addr.│ DHF │ Flg │ CMD │ Count │
          │     │     │     │     │     │       │
          └─────┴─────┴─────┴─────┴─────┴───────┘
            0     1     3     4     5     6     7
```

Status

```
          ┌─────┬─────┬─────┬─────┬─────┬────────┐
          │     │Dev. │     │ Sta │     │ Status │
          │ IFI │Addr.│ DHF │ Flg │ STA │ Param. │
          │     │     │     │     │     │        │
          └─────┴─────┴─────┴─────┴─────┴────────┘
            0     1     3     4     5     6     7
```
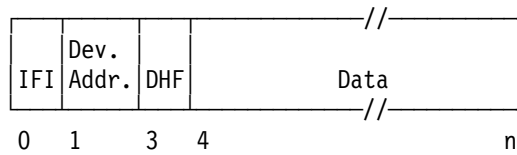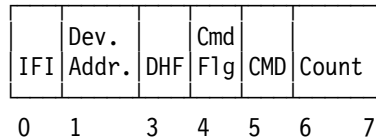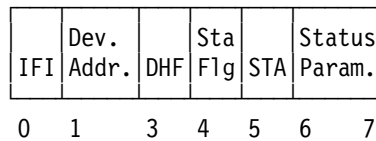
Status with Supplemental Status

```
          ┌─────┬─────┬─────┬─────┬─────┬────────┬────────────//──────┐
          │     │Dev. │     │ Sta │     │ Status │Supplement.         │
          │ IFI │Addr.│ DHF │ Flg │ STA │ Param. │Status              │
          │     │     │     │     │     │        │         ───//──────┤
          └─────┴─────┴─────┴─────┴─────┴────────┴────────────────────┘
            0     1     3     4     5     6        8                   n
```

Device—Level Control

```
          ┌─────┬─────┬─────┬─────┬───────────┐
          │     │Dev. │     │ Ctl │ Control   │
          │ IFI │Addr.│ DHF │ Fun │ Parameter │
          │     │     │     │     │           │
          └─────┴─────┴─────┴─────┴───────────┘
            0     1     3     4     5         7
```
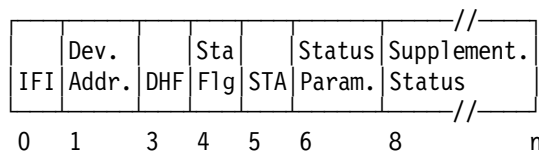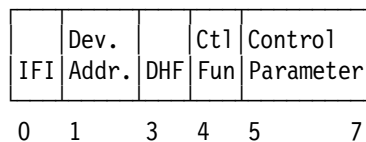
Figure 14. Device Information Block (DIB) Formats

5.3.4 Logical Paths and I/O Operations

As stated before, part of the design criteria for the ESCON I/O interface was an absence, or at least minimization, of required modifications to control programs and applications. This being the case, who actually addresses and manages the protocol of the ESCON I/O interface? Certainly, control units must have the required hardware and logic to manage, interpret, and execute commands received at the interface. On the processor side, however, it is the ESA/390 channel subsystem, based on configuration information provided by the user (usually through the IOCP program), that does all the addressing and protocol management to support the I/O operations initiated by the software. These I/O operations are executed as described below.

Before an I/O operation can be initiated by a channel on a device, the channel must establish a logical path to the control unit. While establishing this logical path, the channel determines whether the control unit has the resources to accept the logical path, and informs the control unit of the pacing and DIB sizes the channel can handle.

Logical paths are usually established at initialization, but if EMIF is used in LPAR mode, logical paths are established at partition activation or later. Requests to establish logical paths are based on information contained in the IOCDS.

Note that when providing the ESA/390 channel subsystem with I/O configuration information, the user specifies only the link addresses associated with the ESCD ports to which the control unit interfaces are attached. The user cannot specify link addresses for channels. During initialization, and before establishing logical paths, the channel acquires its own link address (ALA) by executing a specific link-level procedure. After being identified, the channel can establish the logical paths to all control unit interfaces as defined in the IOCDS, as long as the number of logical paths a control unit provides are not exhausted.

Control units go through the same ALA procedure. Information about the ALAs and the established logical paths is kept in the channels and control units. This enables the channel and the control unit to identify the sender of a frame by inspecting the source full link address included in the frame link-header.

In Figure 15, channel 02 in CPU B has acquired its own link address and established logical paths with the control units connected to the ports with C5 and C9. The control unit in port with C9 has acquired its own link address and established logical paths with the channels attached to the ports with C1, C2, and CE.
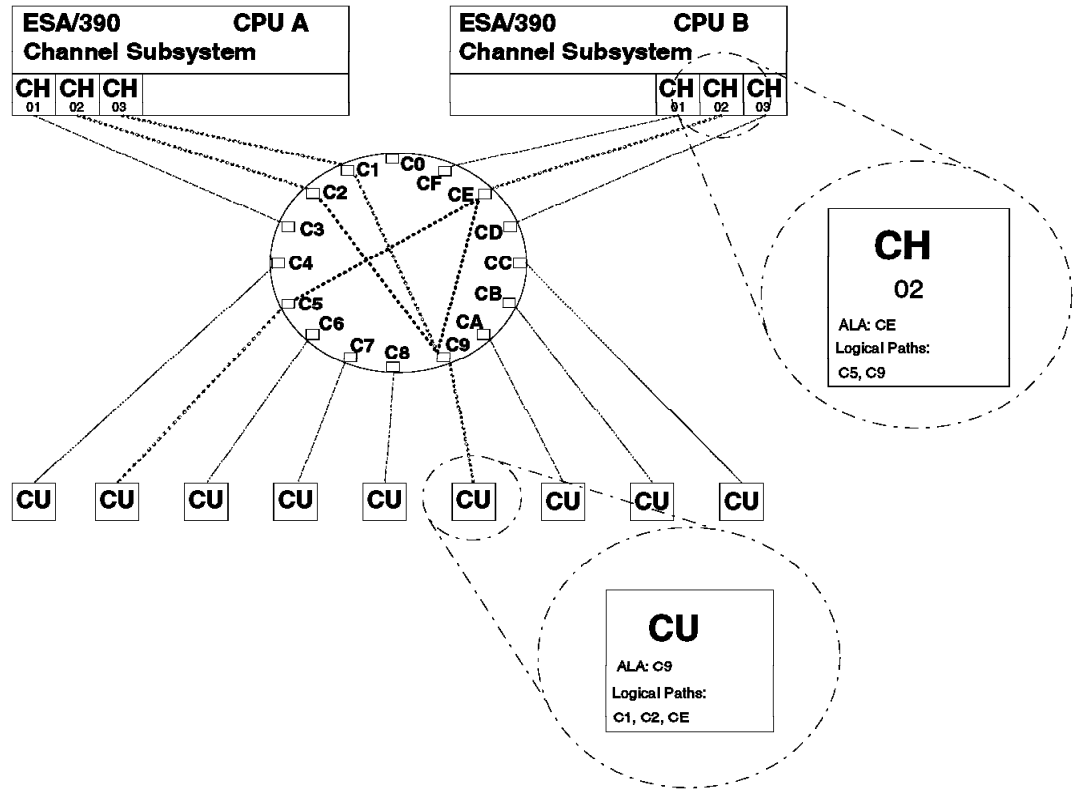
Figure 15. Logical Paths

5.3.4.1 I/O Execution

Based on all the information supplied in the IOCDS, and all the information obtained during initialization, the ESA/390 channel subsystem can execute a Start Subchannel (SSCH) instruction. Using this information and the subchannel number specified in the SSCH, the channel subsystem identifies the device, the possible access paths, and their associated link addresses. The actual frames and number of frames generated are dependent on the CCWs associated with the SSCH, and the maximum DIB size supported by the channel and control unit.

Usually, there are multiple frames per CCW, which explains why distance has a noticeable effect on performance. (To execute a single I/O at a control unit located 9 km away from the processor complex, the aggregate distance all frames have to travel might be hundreds of kilometers). A typical exchange of frames for a single read CCW has the format shown in Figure 16.

Each of the frames of the conversation is implemented by a command, control, or status device-level frame. Several data frames may be required to satisfy a read (or write) data request. Depending on the capacity of the control unit or channel to receive multiple frames, the transmission of data may be temporary halted, only to be restarted by a further data request from the channel or control unit.

```
      Channel          Frame          Control Unit

                     (Read)
      Command        ───────────────────▶

                        (Command response)
                     ◀─────────────────── Control

                 (Accept Command response)
      Control        ───────────────────▶

                     ◀─────────────────── Data
                     ◀─────────────────── Data
                     ◀─────────────────── Data
                     ◀─────────────────── Data
                     ◀─────────────────── Data

                          (CE, DE)
                     ◀─────────────────── Status

                 (Accept status)
      Control        ───────────────────▶

                       (Device ACK)
                     ◀─────────────────── Control
```
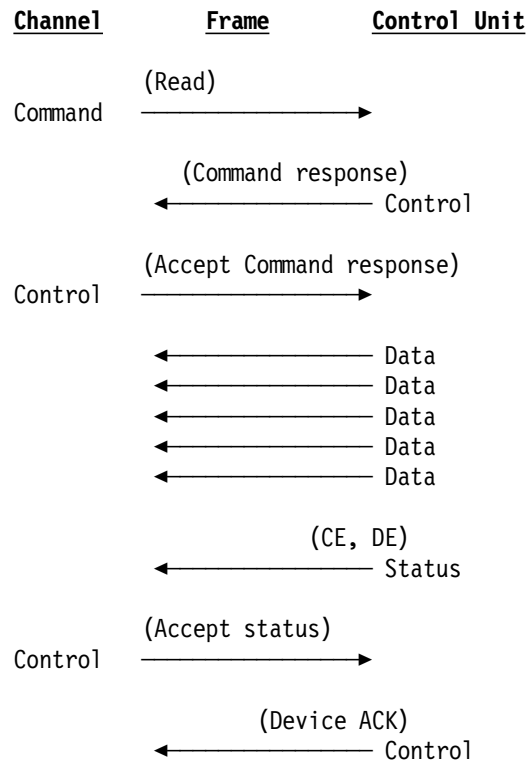
Figure 16. Frame Exchange for One Read CCW

In summary, the management of the links that form a channel path is hidden from the host operating system. From the software point of view, I/O operations are carried out as they previously were. New conditions, such as port-busy, are handled by the ESA/390 channel subsystem without host software intervention, thus maintaining a high level of compatibility with software written for the OEMI parallel interface.

5.3.5 Maximum versus Effective Data Rate

The signalling rate for the ESCON I/O interface is 200 Mbit/sec (M = 1048576). Thus, a bit is generated every 5 ns and sent on the link. Recall that links never stop and are always transmitting at least the idle character. Does this mean that the useful transfer rate is 20 MB/sec?

Before we discuss effective data transfer rate, let us make an important distinction: *the discussion in this section applies only to data transfer rate and not to I/O subsystem performance*. I/O subsystem performance is dependent on several factors, of which effective transfer rate is only one, and very often a minor one.

Many devices attach to control units with ESCON I/O interfaces. Although all these control units can transmit and receive characters at the specified signalling rate (200 Mbit/sec), the devices that they control usually do not handle that transfer rate. It is possible to match link and device speed through buffering in the control unit, but buffering requirements, or even the internal processing rate within the control unit, may be such that this is not enough. A control unit may have to pace what it receives so that it can have enough time to "do away

with" the data it receives. It may need time to manage buffer space, to move data from the link buffers to device buffers, or to allocate space from a centrally located cache. Pacing the data sent on the links is hence another way of matching speed and successfully transferring data.

The ESCON I/O architecture provides a standard link-level protocol to set the number of pairs of idle characters sent between device-level data frames, reducing the effective rate of data transfer. Figure 17 shows the links connecting two ESA/390 channels to two types of control units: a display controller and a DASD controller. Assuming the DASD controller can accept data at a higher rate than the display controller, we have shown fewer idle characters between frames for the DASD controller than the display controller. The data rate for the DASD controller will thus be higher than the data rate for the display controller, although the signalling rate is the same for both links.
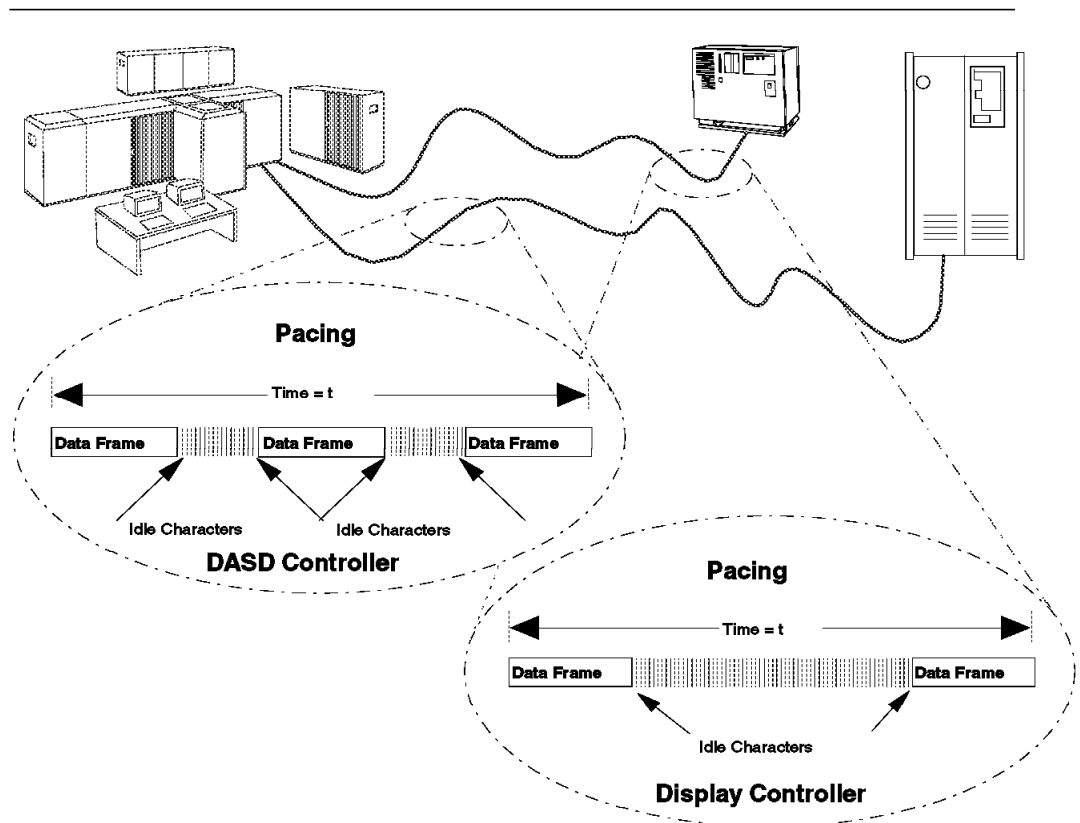
Figure 17. Pacing the Data Transmission

Pacing is not the only factor contributing to the achievable data transfer rate. As discussed in 5.3.4.1, "I/O Execution" on page 36, a single I/O operation (such as writing a record to a DASD) requires the exchange of several frames between the ends of the links comprising the channel path. For instance, a control unit receiving a device-level command frame usually responds with a device-level command response frame. The I/O operation then proceeds as shown in Figure 16. This exchange of frames between the ends of the links is typical when an I/O operation is executed. The internal processing time of a control unit (or of a channel) to a frame, *cannot* be ignored when estimating effective data transfer rate. Examine the hypothetical conversation illustrated in Figure 18.
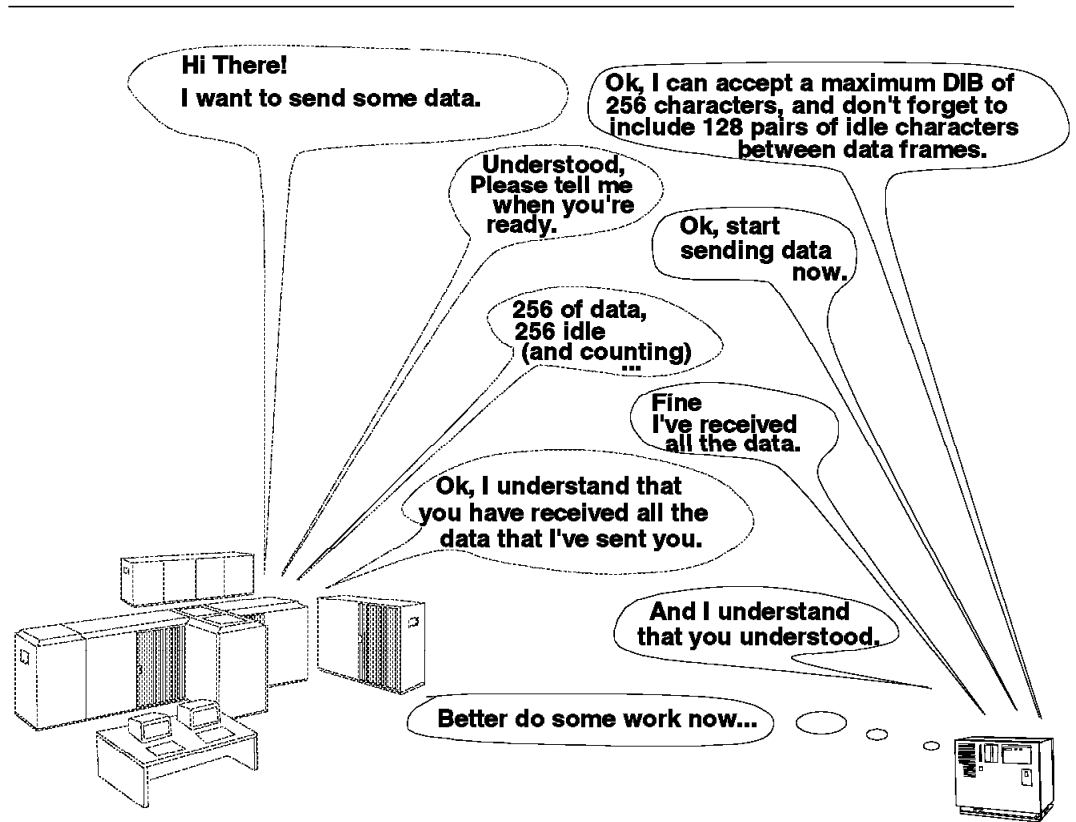
Figure 18. Hypothetical Conversation between a Control Unit and a Channel

As you can see, only part of the conversation was actually involved in data transfer. Furthermore, not only did the rest of the conversation take time, but also both the control unit and the channel had to decode each other's frames, and that took time as well. For instance, after receiving the first channel request ("I have data to send you"), the control unit might take, say 100 microseconds to decode the request and put on the link its "Ok, I can accept...". If you recall the basic signalling rate of the ESCON I/O interface, in 100 microseconds we can transmit 2000 characters, capacity that we have just wasted. All these partial timings have to be totalled and the result divided into the original amount of data transferred to arrive at the effective data transfer rate.

The conclusion, then, is that 20 MB/sec is the instantaneous data transfer within a *single* data frame. If frame overhead is factored, the rate drops to:

$$n \; / \; (OH + n) \; x \; 20$$

where n is the quantity of data and OH is the header and trailer. The effective data transfer rate is always lower and is dependent on the channel and the control unit capacity to service, identify, and respond to incoming frames, especially how extensively the control unit depends on data request pacing as shown in Figure 17.

5.3.6 Effect of Distance on Data Rate

As mentioned earlier and shown in Figure 16 on page 37, there are several frames flowing between the ends of a path to complete an I/O operation. Even though the ESCON architecture has, to a great extent, simplified the channel protocol, some request and response frames are still sent over the path in addition to the data frames. The time it takes for these frames to travel from one end to another and back (the turn-around time) has a significant effect on the data rate. Figure 19 shows an estimate of how the effective data rate decreases as the path length increases.

Notice that we can transfer data at about the same rate on an ESCON channel over a distance of 60 kilometers, as on a parallel channel over 122 meters. As discussed earlier, there are several other factors in addition to distance that have a significant effect on the data rate. The maximum data rate of an ESCON channel is 18.6 MB/sec, and the channel can maintain that speed up to a distance of 8 kilometers. At a distance of 9 km, we can still drive the channel at a rate of 17.6 MB/sec. If we increase the distance, or the length of the channel, up to 23 km, we can still gain a transfer rate of 9 MB/sec. However, keep in mind that not all control units are capable of utilizing that transfer rate.
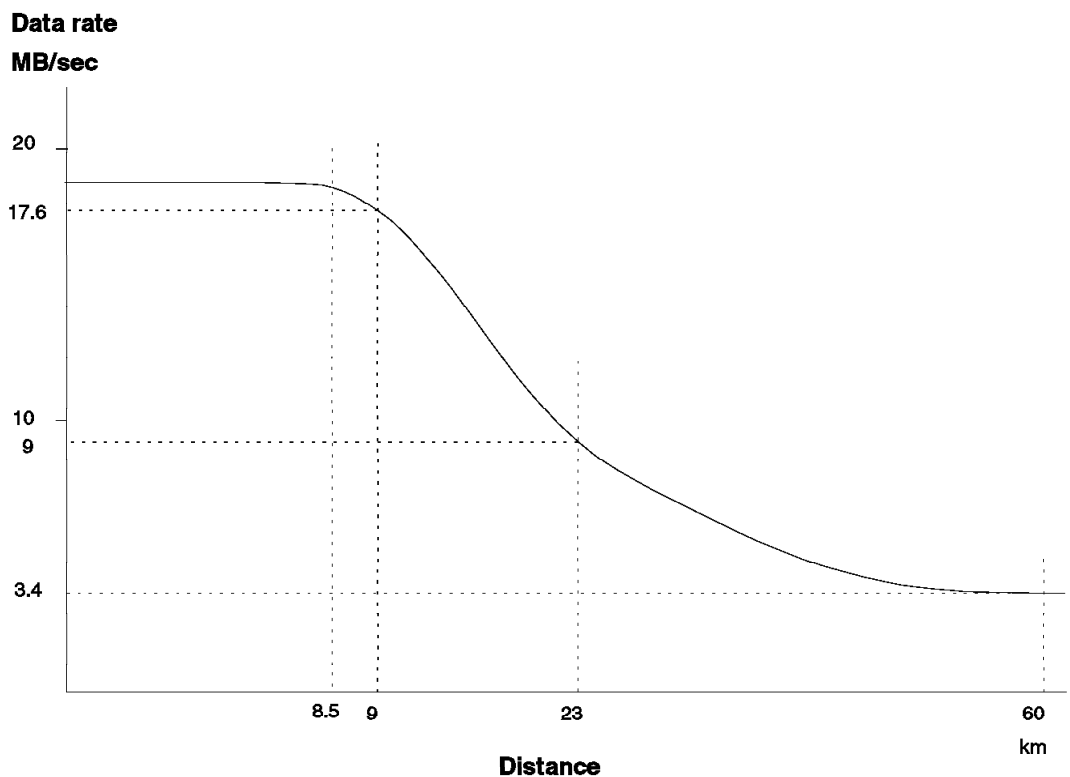
Figure 19. Data Rate Compared to Distance (not drawn to scale)

Chapter 6. ESCON I/O Architecture Implementation

This chapter describes how the ESCON I/O architecture is implemented in IBM's current product line.

Among others, the following types of products are designed to support the ESCON I/O architecture:

- Channels
- EMIF in LPAR mode
- Channel-to-channel (CTC) connections
- Directors
- Converters
- Storage Products
- Magnetic Tape Subsystems
- Teleprocessing Products

6.1 ESCON Channels

When the ES/390 architecture was announced, a new processor range to support the ESCON I/O interface, the ES/9000, was also announced. Some processor models of the ES/3090 family were also enhanced at that time to utilize the ESCON architecture. Today all current IBM S/390 processors support the ESCON I/O interface.

ESCON channels (also referred to as ESCON LED channels) always use multi-mode optic fiber cable with a LED light source. The maximum single link distance (without repeating) is up to 2 km (using 50 um fiber) or 3 km (using 62.5 um fiber).

Previously, an ESCON XDF channel feature was offered for some processors. For completeness, it is mentioned in some of the feature lists in this chapter, but it is not available any more. It was withdrawn from marketing on May 30, 1995.

ESCON channels can attach control units or channels in the following ways:

- Directly

  Control unit and channel must permit use of ESCON channels in native mode.

- Through an IBM 9034 ESCON Converter

  The IBM 9034 permits you to attach an ESCON LED channel to a parallel interface control unit or to a channel. For additional information on the IBM 9034 ESCON Converter, see 6.14, "IBM 9034 ESCON Converter Model 1" on page 194.

- Through one or two ESCON Directors (IBM 9032 or 9033)

Using two ESCON Directors or multiple an IBM 9036 ESCON Remote Channel Extenders, intermediate XDF links may be created.

6.1.1 ESCON Capable Host Processors

The following processors can have ESCON channels:

- ES/3090 Model J, including:

    Models 180J, 200J, 280J, 300J, 380J, 400J, 500J, and 600J

- ES/3090-9000T Models, including:

    Models 150T, 170T, 180T, 250T, and 280T

- ES/9000 air-cooled rack-mounted models (IBM 9221)

- ES/9000 air-cooled frame-mounted models (IBM 9121)

- ES/9000 water-cooled models (IBM 9021)

- S/390 Parallel (Transaction/Enterprise) Servers (IBM 9672)

The signalling rate for the ESCON I/O interface is 200 MB/sec. The maximum data rate on different processors depends on the data transfer capability of the channel subsystem on the processor.

The maximum data rate of ESCON channels in today's processors is 17 MB/sec. This includes the following processor types:

- IBM S/390 parallel Servers 9672 models E,P, and R

- IBM ES/9000 9021, 520 and 711 based models

The maximum data rate of ESCON channels in previous processors was 10 MB/sec.

6.1.2 Host Processor Mode of Operation

At IML time the operator can select one of three modes of operation:

- S/370 mode - In this mode, ESCON channels cannot be used.

- ESA/390 mode - In this mode, ESCON channels can be used if the required software levels are installed. For information about the required software levels, see 6.1.3, "ESCON Channel Software."

- LPAR mode - If ESA/390 mode is selected for a partition, ESCON channels are supported; if S/370 mode is selected, ESCON channels cannot be used.

6.1.3 ESCON Channel Software

ESCON channels can be used in the software environments described in Table 1 through Table 5. The tables show the minimum operating system software levels required, and for these software levels additional PTFs are probably necessary. All versions and releases of software higher than those shown support the ESCON I/O interface.

6.1.3.1 MVS Environment

Table 1. MVS SCP	
SCP	**Comment**
MVS/SP 3.1.0e	(1), (2)
MVS/SP 3.1.3	(1), (2)
MVS/ESA SP 4.1.0	(1)
MVS/ESA SP 4.2.0	(1)
MVS/ESA SP 4.2.2	(1)
MVS/ESA SP 4.3.0	(1)
Note:	
1. If an ESCON Director is installed, ESCON Director feature is required.	
2. ESCON support feature required.	

6.1.3.2 VM Environment

Table 2. VM SCP	
SCP	**Comment**
VM/ESA 1.1.0	ESA feature required
VM/ESA 1.1.1	
VM/ESA 1.2.0	

6.1.3.3 AIX Environment

Table 3. AIX/ESA SCP	
SCP	**Comment**
AIX/ESA 2.1	

6.1.3.4 VSE Environment

Table 4. VSE SCP	
SCP	**Comment**
VSE/ESA 1.1	Support TYPE=CVC mode only
VSE/ESA 1.2	Support TYPE=CNC mode
VSE/ESA 1.3	
Note: VSE/ESA does not support the ESCON Director	

6.1.3.5 TPF Environment

Table 5. TPF SCP	
SCP	**Comment**
TPF 3.1	See SECOM for PTF information

6.1.3.6 EREP

Level	Comment
Table 6. EREP	
Level	**Comment**
EREP 3.4.2	Minimum level (1)
EREP 3.5	Link incident recording + 3490E support
Note:	
1. PTF for APAR IR91836 is required for link incident recording and 3490E support	

6.1.3.7 IOCP

Level	Comment
Table 7. IOCP	
Level	**Comment**
IXPIOCP 2.0	
IXPIOCP 2.1	VSE/SP 4.1.3 and VSE/ESA 1.1. only.
IXPIOCP 2.2	All 520-based models require this release or later.
IXPIOCP 2.3	Supports 9121 MP Models 490, 570, and 610.
IXPIOCP 2.4	Any parallel channel can be defined as a byte multiplexer on a 9121 processor.
IXPIOCP 2.5	Required on non-EMIF capable processors for ESCON CTC communication with shared ESCON channels on EMIF capable processors.
IZPIOCP 1.1	Permits definition of shared channels in LPAR mode.

6.1.4 ESCON Channels Operating in Conversion Mode

The conversion mode feature consists of Licensed Internal Code (LIC) that is loaded during POR time in those channels that are defined by IOCP as CHPIDs TYPE=CVC. The feature allows an installation to connect an IBM 9034 ESCON Converter Model 1 to a fiber optic channel. The 9034 converts the fiber optic protocol to parallel standard I/O protocol (OEMI). For more information on the 9034, refer to 6.14, "IBM 9034 ESCON Converter Model 1" on page 194.

6.1.5 ESCON Channels on ES/3090J and ES/3090-9000T Processors

The IBM ES/3090 Model J and ES/3090-9000T can be installed with the following channels:

- Parallel channel
- ESCON LED channels

The ESCON LED channels can be added to the parallel channel configuration, but in some cases it is necessary to first remove one or more parallel channel groups.

As ESCON channels are installed, they are assigned the CHPID addresses shown in Table 8 through Table 11 by the corresponding processor ESCON row.

Parallel channels are assigned the low-end CHPID addresses; Table 8 through Table 11 provide these addresses in the corresponding processor parallel row.

As mentioned before, addresses may overlap, so parallel channels will have to be removed.

6.1.5.1 Expansion / Extension Frames

The ESCON LED channels are installed in extension frames 05/15 that require expansion frames 29/39 for cable management. Thus, for processors with:

- More than 48 parallel channels installed per side
- A vector installed
- A third processor per side installed

expansion frame 29 has already been installed as a prerequisite for extension frame 05. Otherwise, expansion frame 29 has to be ordered together with expansion frame 05, which holds the first ESCON LED channel increment on the A-side of the processor complex. Where applicable, another extension/expansion frame set (frames 15/39) must be ordered for the B-side.

6.1.5.2 CHPID Numbering

Table 8 through Table 11 give an overview of the address ranges used by the standard and optional channel groups for the different processors, both for parallel channels and for ESCON LED channels. If an address range for ESCON LED channels overlaps an address range for the installed parallel channels, then the group of parallel channels belonging to that address range must be physically removed.

The left column of these tables lists the processor involved. The next columns show the standard address range and the optional channel groups that can be installed, they are marked as 'Standard' or with the group number. As you can see, the ES/3090-9000T Model 150T has a minimum of 16 parallel channels installed, in the address range of 00 to 0F.

For instance, Table 10 shows that the ES/3090-9000T Model 150T can have up to 32 channels in a parallel-only configuration. In a parallel/ESCON mixed configuration, the ES/3090-9000T Model 150T can have up to 64 channels, up to 32 parallel and up to 32 ESCON LED channels.

Table 8 (Page 1 of 2). CHPID Numbering on ES/3090J Models (Side A)									
Processor		**Channel Groups / Address Ranges**							
		00-0F	**10-17**	**18-1F**	**20-27**	**28-2F**	**30-37**	**38 3B**	**3C 3F**
180J	Parallel	Standard	1	2					
	ESCON				4		3	2	1
200J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
280J	Parallel	Standard	1	2					
	ESCON				4		3	2	1
300J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
380J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1

Table 8 (Page 2 of 2). CHPID Numbering on ES/3090J Models (Side A)

Processor		Channel Groups / Address Ranges							
		00-0F	10-17	18-1F	20-27	28-2F	30-37	38 3B	3C 3F
400J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
500J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
600J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1

Table 9. CHPID Numbering on ES/3090J Models (Side B)

Processor		Channel Groups / Address Ranges							
		40-4F	50-57	58-5F	60-67	68-6F	70-77	78 7B	7C 7F
280J	Parallel	Standard	1	2					
	ESCON				4		3	2	1
380J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
400J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
500J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1
600J	Parallel	Standard	Standard		1	2	3		
	ESCON				4		3	2	1

Table 10. CHPID Numbering on ES/3090-9000T Models (Side A)

Processor		Channel Groups / Address Ranges						
		00-0F	10-17	18-1F	20-2F	30-37	38 3B	3C 3F
150T	Parallel	Standard	1	2				
	ESCON				4	3	2	1
170T	Parallel	Standard	1	2				
	ESCON				4	3	2	1
180T	Parallel	Standard	1	2				
	ESCON				4	3	2	1
250T	Parallel	Standard	1	2				
	ESCON				4	3	2	1
280T	Parallel	Standard	1	2				
	ESCON				4	3	2	1

Table 11. CHPID Numbering on ES/3090-9000T Models (Side B)								
Processor Model		**Channel Groups / Address Ranges**						
		40-4F	**50-57**	**58-5F**	**60-6F**	**70-77**	**78 7B**	**7C 7F**
250T	Parallel	Standard	1	2				
	ESCON				4	3	2	1
280T	Parallel	Standard	1	2				
	ESCON				4	3	2	1

Be aware that for parallel channel groups, the CHPID numbers have to be in ascending order. For ESCON LED channels, the numbers have to be in descending order, starting with the highest possible address supported by the processor. You cannot mix both parallel and ESCON CHPID numbers within the same increment. In other words, the CHPID numbering for a specific channel group must be all parallel or all ESCON. If there is an address overlap, the corresponding parallel channel groups must be removed before the ESCON channel group(s) can be installed.

6.1.5.3 Adding ESCON LED Channels

Assume a 3090 Model 200J is configured with 64 parallel channels. The CHPID numbering is as follows:

1. First standard range: 00-1F

2. First optional channel group: 20-27

3. Second optional channel group: 28-2F

4. Third optional channel group: 30-3F

Now, we want to add the first ESCON LED channel group.

In Table 8, we look in the ESCON row of the 3090 Model 200J and at the right we find CHPID range 3C-3F. However, this address range is already used for some of the parallel channels.

As you can see in Table 8, the ESCON CHPID range 3C-3F overlaps the parallel CHPID range 30-3F.

Within the same column there is no intermixing possible between parallel and ESCON CHPID numbering. In other words, the CHPID numbers 30-3F must be all ESCON or all parallel. So, before we can add the first ESCON LED channel group, the third parallel channel group must be removed. This means that we lose 16 parallel channels, and we add four ESCON LED channels, for a net loss of 12 channels. Therefore, two additional ESCON LED channel group increments would have to be installed to provide an equivalent number of channels.

Let us now add the second ESCON LED channel group.

In Table 8 we look in the ESCON row of the 3090 Model 200J and the next ESCON CHPID range to the left is 38-3B. As this range was removed when we added the first ESCON LED channel group, there is no address overlap, so we do not have to remove any of the parallel channels.

A third ESCON LED channel group is to be installed.

In Table 8 we look in the ESCON row of the 3090 Model 200J and the next ESCON CHPID range to the left is 30-37. This range has already been removed, and there is no address overlap, so we do not have to remove any of the parallel channels.

Assume now that we need another group of ESCON LED channels, so we want to install the next group of 16 ESCON LED channels.

In Table 8 we look in the ESCON row of the 3090 Model 200J, and the next ESCON CHPID range to the left is 20-2F. However, this address range is already used for the first and the second optional parallel channel groups.

As you can see in Table 8, the ESCON CHPID range 20-2F overlaps the parallel CHPID ranges 20-27 and 28-2F.

So, before we can add the fourth ESCON LED channel group, the first and the second optional parallel channel group must be removed. In this case, there is no loss of channels; in fact, we have created an equal configuration of 32 ESCON LED and 32 parallel channels.

6.1.5.4 Impact on Existing Parallel Channels

If one or more parallel channel groups must be removed, it may be necessary to re-cable control unit interfaces other than those that are being replaced by the ESCON LED channels. The following migration options are available for control units on the channels being replaced.

- Attach control units to other non-ESCON channels.

  If other parallel channels are available, the control units may be moved to the other parallel paths. Of course, the IOCDS must be updated to reflect the new hardware configuration.

- Connect control units through ESCON LED channels operating in conversion mode.

  Parallel channels may be replaced with ESCON LED channels configured to operate in conversion mode. This allows the installation of ESCON cabling, ESCON Directors, and ESCON channel hardware, while continuing operation with parallel control units. If this option is chosen, the 9034 must be installed, and the IOCDS must be changed to reflect TYPE=CVC for the CHPID.

6.1.6 ESCON Channels on IBM 9221 Processors

This section describes the configuration and address ranges of the parallel and ESCON channels for the IBM 9221 processors. For more detailed information, refer to *ES/9000 Models 120, 130, 150, 170, and 200 SE Guide*.

The 9221 processor can be configured with an integrated I/O bus attachment and two types of channel, which follow:

- Parallel channel
- ESCON LED channel

Previously, there was also an ESCON XDF channel feature. It was withdrawn from marketing on May 30, 1995.

The maximum channel combination for an IBM 9221 processor is as follows:

- For Models 120, 130, and 150:
    - A maximum of 12 Parallel/ESCON channels
- For Models 170 and 200:
    - A maximum of 18 Parallel/ESCON channels (with integrated I/O bus)
    - A maximum of 24 Parallel/ESCON channels (without integrated I/O bus)

6.1.6.1 Channel Adapter Card and Channel Cards

An IBM 9221 is configured with two types of channel adapter cards and two types of channel cards. The channel card attaches to the channel adapter.

The following two channel adapter cards with feature codes identify the card slot position in the central electronic complex (CEC).

- 2-channel-driver adapter card (feature code # 6104, 6106)
    - #6104 - 1st channel adapter in card slot # 5 of the CEC
    - #6106 - 2nd channel adapter in card slot # 4 of the CEC
- 4-channel-driver adapter card (feature code # 6105, 6100)
    - #6105 - 1st channel adapter in card slot # 5 of the CEC
    - #6100 - 2nd channel adapter in card slot # 4 of the CEC

Each channel-driver on the adapter card may connect to a parallel or ESCON LED channel card.

These two channel cards are:

- 1-channel attachment card

    This card contains one CHPID.

    - Parallel channel card (Feature Code # 6101)
    - ESCON LED channel card (Feature Code # 6111)
- 3-channel attachment card

    This card contains three CHPIDs.

    - Parallel channel card (Feature Code # 6103)
    - ESCON LED channel card (Feature Code # 6113)
    - ESCON XDF channel card (Feature Code # 6114, withdrawn from marketing)

The channel cards can be attached to the same channel adapter card.

6.1.6.2 CHPID Numbering

This section provides CHPID numbering for 9221 processors.

Figure 20 shows the CHPIDs associated with each channel card slot. There are three CHPIDs assigned to each card slot. If a 3-channel attachment card (for example, # 6113) is installed, it uses all three CHPIDs assigned to that card slot. If a 1-channel attachment card (for example, # 6111) is installed, it uses the lowest CHPID assigned.

For example, if feature code # 6113 is installed in card slot 11 and # 6111 is installed in card slot 12. The CHPID numbering is as follows:

- CHPID 20, 21 and 22 are associated with # 6113

- CHPID 23 is associated with # 6111

  CHPID 24 and 25 are not used.

IBM 9221 Processor Rear View

	20	23	26	29	2C	2F	32	35
	21	24	27	2A	2D	30	33	36
	22	25	28	2B	2E	31	34	37
10	11	12	13	14	15	16	17	18

Card Slots
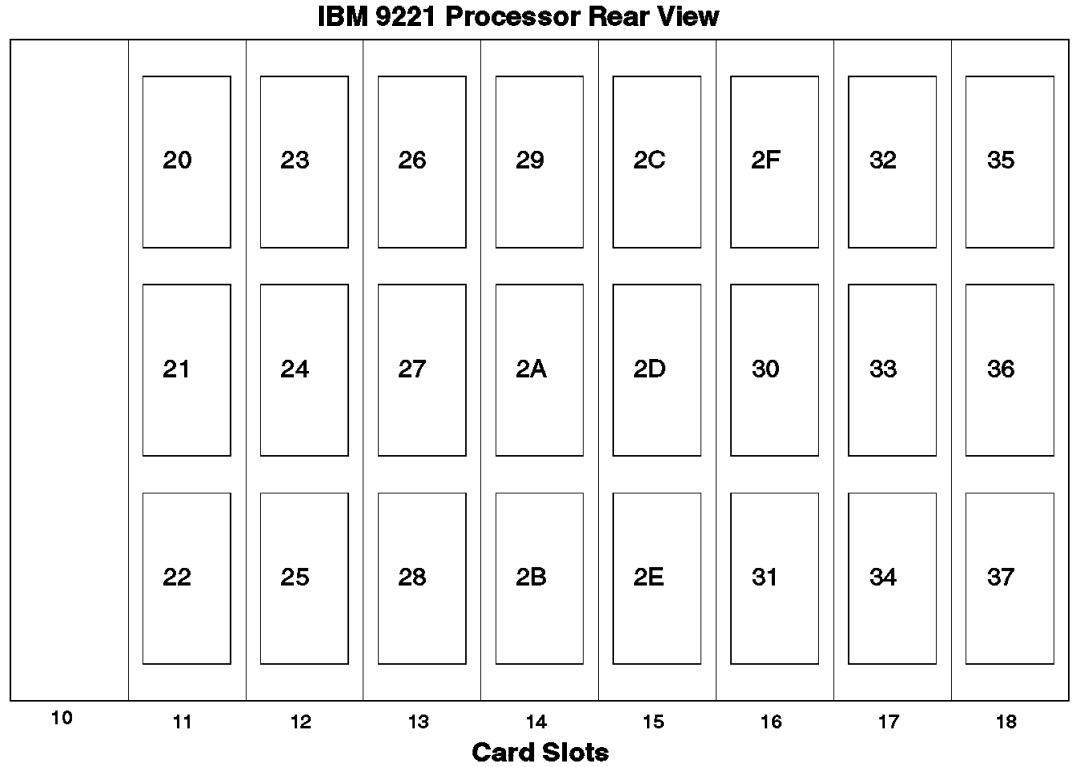
Figure 20. 9221 CHPID Assignment

6.1.7 ESCON Channels on IBM 9121 Processors

This section describes the configuration and address ranges of the parallel and ESCON channels for the air cooled frame machines. For more detailed information, refer to *Enhanced ES/9000 Air-Cooled Frame Processors Announcement Presentation Guide* or *ES/9000 Air-Cooled Frame Models SE Guide.*

The 9121 processor may be installed with two types of channels, as follows:

- Parallel

- ESCON LED

Previously, there was also an ESCON XDF channel feature. It was withdrawn from marketing on May 30, 1995.

The channel increment number is a group of four channels.

ESCON LED channels can be installed on any channel board with ESCON capability in multiples of four (channel increment number).

When processors are upgraded to have ESCON channels installed, one or more parallel channel groups may have to be removed. As ESCON channels are installed, they are assigned CHPID addresses, as described in 6.1.7.2, "CHPID Numbering" on page 54. As mentioned before, address overlap may occur, so parallel channels may have to be removed.

6.1.7.1 Frames and Channel Boards

The IBM 9121 is configured with two types of frames:

- Base frame
- Expansion frame (optional)

Each frame can hold a maximum of two channel boards per side. The 320-based 9121 models can have a maximum of 48 channels installed per side. The 511-based 9121 models can have a maximum of 64 channels installed per side. There are two types of channel boards:

- Parallel/ESCON combination channel board

  This board can contain up to 12 parallel and four ESCON channels.

- ESCON-only channel board

  This board can contain up to 16 ESCON channels.

A maximum of four channel boards per side can be installed in 9121 models, as follows:

Base Frame

- Board 1

  - Can have the following channel combinations:

    Parallel only (up to 12 parallel)
    Parallel/ESCON combinations (up to 12 parallel and four ESCON)
    ESCON-only (up to 16 ESCON)

  - CHPID numbers are 00-0B (parallel) and 1C-1F (ESCON).

  - For an ESCON-only board, CHPID numbers are 00-0B, and 1C-1F.

- Board 2

  - Can have the following channel combinations:

    Parallel only (up to 12 parallel)
    Parallel/ESCON combinations (up to 12 parallel and four ESCON)
    ESCON-only (up to 16 ESCON)

  - CHPID numbers are 0C-17 (parallel) and 18-1B (ESCON).

  - For an ESCON-only board, CHPID numbers are 0C-1B.

Expansion frame

- Board 3

  - Can have the following channel combinations:

    Parallel only (up to 12 parallel)
    Parallel/ESCON combinations (up to 12 parallel and four ESCON)
    ESCON-only (up to 16 ESCON)

  - CHPID numbers are 20-2B (parallel) and 2C-2F (ESCON).

- For an ESCON-only board, CHPID numbers are 20-2F.

- Board 4 for 320-based and non-MP 511-based models with 48 or fewer channels

  - Can hold only up to three parallel channel groups, consisting of four channels each.

  - Up to 12 parallel channels, but without the ESCON channels.

  - The CHPID numbers are 2C-2F, 18-1B, and 1C-1F (parallel only).

- Board 4 for 511-based MP models or more than 48 channels

  - Can have the following channel combinations:

    Parallel only (up to 12 parallel)
    Parallel/ESCON combinations (up to 12 parallel and four ESCON)
    ESCON-only (up to 16 ESCON)

  - CHPID numbers are 30-3B (parallel) and 3C-3F (ESCON).

  - For an ESCON-only board, CHPID numbers are 30-3F.

Figure 21 shows the base frame with board 1 and board 2 installed, and the expansion frame with board 3 and board 4 installed for one side of a 320-based 9121.

The upper part of the figure shows a configuration with 48 total channels, four sets of 12 parallel channels installed on board 1 and board 2 in the base frame, and on board 3 and board 4 in the expansion frame.

The middle part of the figure shows a configuration with 48 total channels, 24 parallel channels and 8 ESCON channels installed on board 1 and board 2 in the base frame, and 16 ESCON channels on board 3 in the expansion frame. Because the maximum number of channels allowed for a 320-based 9121 is installed in boards one through three, board 4 may not contain channels.

The lower part of the figure shows a configuration with the maximum possible of 44 ESCON channels installed. On the base frame a maximum of 28 ESCON channels can be installed, (16 ESCON channels on board 1 and 12 ESCON channels on board 2), and 16 ESCON channels on board 3 in the expansion frame. Because the maximum number of channels allowed for a 320-based 9121 is installed in boards one through three, board 4 may not contain channels.

On the 320-based 9121 models, channel board 4 does not contain any ESCON channels.

All Parallel

Base Frame		Expansion Frame		
12 P	12 P	12 P	12 P	**48 P**
0 E	0 E	0 E	N/A	**0 E**
Board 1	**Board 2**	**Board 3**	**Board 4**	**48 Total**

Mixed Parallel and ESCON

Base Frame		Expansion Frame		
12 P	12 P	16 E	N/A	**24 P**
4 E	4 E			**24 E**
Board 1	**Board 2**	**Board 3**	**Board 4**	**48 Total**

All ESCON

Base Frame		Expansion Frame		
16 E	12 E	16 E	N/A	**0 P**
				44 E
Board 1	**Board 2**	**Board 3**	**Board 4**	**44 Total**
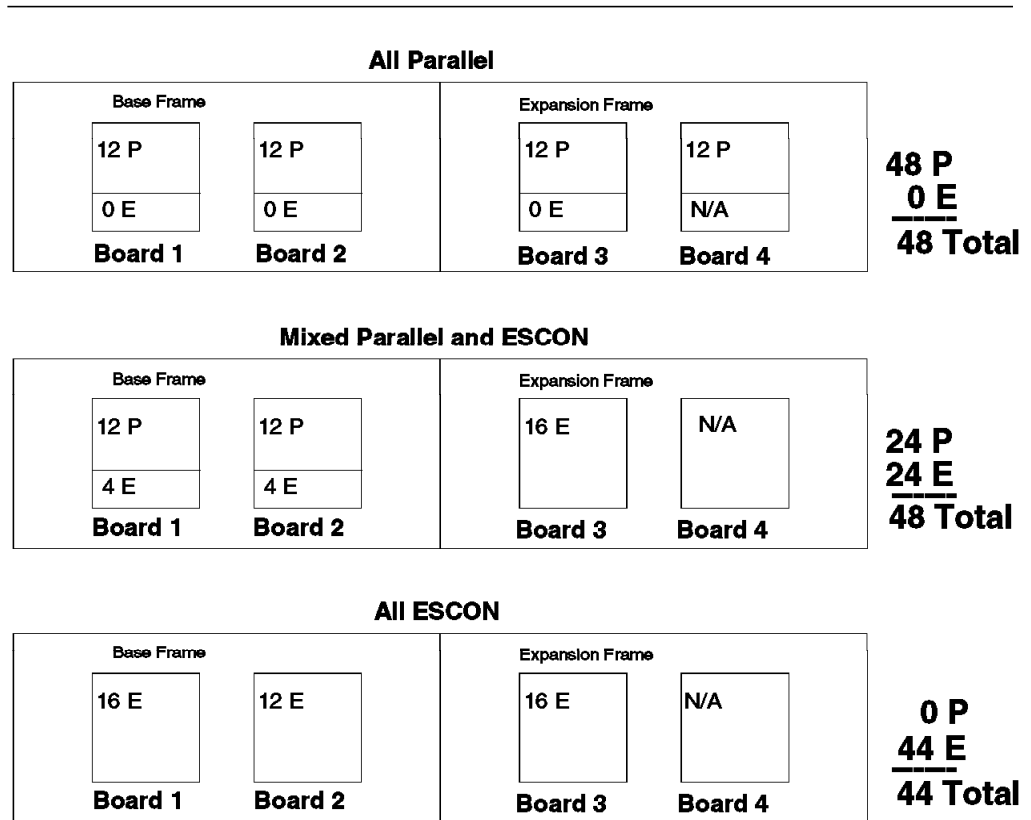
Figure 21. 320-based 9121 Channel Combination Example (Per Side)

Figure 22 shows the base frame with board 1 and board 2 installed, and the expansion frame with board 3 and board 4 installed for one side of a 320-based 9121.

The upper part of the figure shows a configuration with 64 total channels: four sets of 12 parallel channels installed on board 1 and board 2 in the base frame and on board 3 and board 4 in the expansion frame, and four sets of 4 ESCON channels installed on board 1 and board 2 in the base frame and on board 3 and board 4 in the expansion frame.

The middle part of the figure shows a configuration with 64 total channels, 12 parallel channels and 20 ESCON channels installed on board 1 and board 2 in the base frame, and 12 parallel channels and 20 ESCON channels installed on board 3 and board 4 in the expansion frame.

The lower part of the figure shows a configuration with 64 total channels, 32 ESCON channels installed on board 1 and board 2 in the base frame, and 32 ESCON channels installed on board 3 and board 4 in the expansion frame.

On the 511-based 9121 models, channel board 4 may contain either parallel and ESCON channels or all ESCON channels.

All Parallel + ESCON

Base Frame

12 P	12 P
4 E	4 E
Board 1	Board 2

Expansion Frame

12 P	12 P
4 E	4 E
Board 3	Board 4

48 P
16 E
64 Total

Mixed Parallel and ESCON

Base Frame

12 P	16 E
4 E	
Board 1	Board 2

Expansion Frame

12 P	16 E
4 E	
Board 3	Board 4

24 P
40 E
64 Total

All ESCON

Base Frame

16 E	16 E
Board 1	Board 2

Expansion Frame

16 E	16 E
Board 3	Board 4

0 P
64 E
64 Total
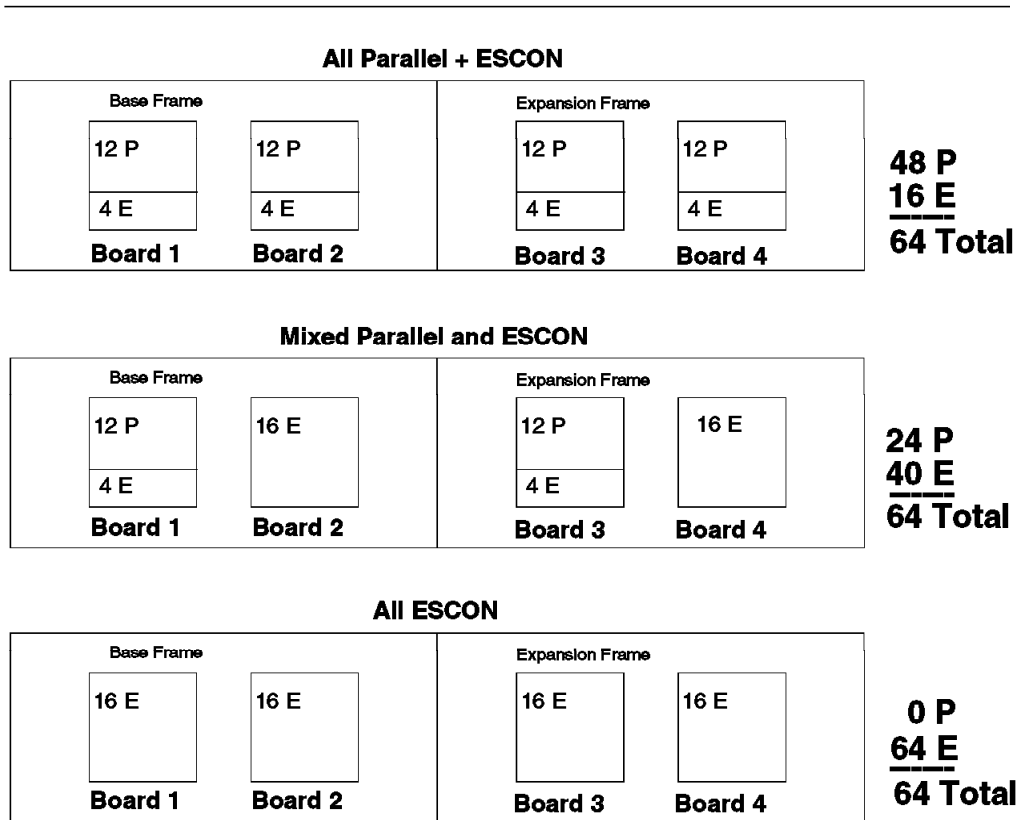
Figure 22. 511-based 9121 Channel Combination Example (Per Side)

6.1.7.2 CHPID Numbering
This section provides CHPID numbering for 9121 processors. The tables show combinations with CHPIDs and feature codes.

The feature code determines how the address ranges of the corresponding board will be taken by the parallel and the ESCON channels.

The three sets of four channels on a parallel board are installed in ascending address order. However, the installation of the four channel sets on an ESCON-only channel board starts with the highest address.

6.1.7.3 Channel Board 1: Entry Channel Board
CHPIDs for board 1 (entry channel boards) are summarized in Table 12, and the minimum channel configurations are indicated by underlined feature codes.

Table 12. CHPID Numbering for Channel Board 1 (Entry Channel Board)

Entry Channel Board	Channel Group Position	Channel type	Uni, Dyadic, and MP Side A				MP Side B	
			CHPID Range	FCs for 180 and 190	FCs for 210	FCs for 260 - 742 and MP side A	CHPID Range	FCs for Side B
Entry Parallel	1	P	00-03		*standard*		40-43	*standard*
	2	P	04-07		3550	*standard*	44-47	*standard*
	3	P	08-0B		3500	*3555*	48-4B	*4555*
	4	E	1C-1F		3x00		5C-5F	4x00
Entry Mixed	1	P	00-03		*standard*		40-43	*standard*
	2	P	04-07		3551	*standard*	44-47	*standard*
	3	P	08-0B		3500		48-4B	4500
	4	E	1C-1F		*3x55*		5C-5F	*4x55*
Entry ESCON #3605 (#4605 on Side B)	1	E	00-03		3x54		40-43	4x54
	2	E	04-07		3x52	*3x53*	44-47	*4x53*
	3	E	08-0B		*3x51*		48-4B	*4x51*
	4	E	1C-1F		*3x55*		5C-5F	*4x55*

Note: When used, x=7 for ESCON LED channels and x=8 for ESCON XDF channels

6.1.7.4 Channel Board 2

Table 13 summarizes the CHPID numbering for the channel board 2. Feature codes 3704/3804 (and 4704/4804 on Side B of MPs) cannot be installed when there are 16 ESCON channels installed on the entry channel board.

Table 13. CHPID Numbering for Channel Board 2

Optional Base Frame Channel Board	Channel Group Position	Channel type	Uni, Dyadic, and MP Side A				MP Side B	
			CHPID Range	FCs for 180 and 190	FCs for 210	FCs for 260 - 742 and MP Side A	CHPID Range	FCs for Side B
Parallel #3400 (#4400 on Side B)	1	P	0C-0F		3501		4C-4F	4501
	2	P	10-13		3502		50-53	4502
	3	P	14-17		3503		54-57	4503
	4	E	18-1B		3x01		58-5B	4x01
ESCON #3600 (#4600 on Side B)	1	E	0C-0F		3x04		4C-4F	4x04
	2	E	10-13		3x03		50-53	4x03
	3	E	14-17		3x02		54-57	4x02
	4	E	18-1B		3x01		58-5B	4x01

Note: When used, x=7 for ESCON LED channels and x=8 for ESCON XDF channels

6.1.7.5 Channel Board 3

When installed (on Models 210 and above), the expansion frame can support channel boards 3 and 4. The corresponding feature codes for the first optional expansion frame channel board are given in Table 14.

Table 14. CHPID Numbering for Channel Board 3								
First Optional Expansion Frame Channel Board	**Channel Group Position**	**Channel type**	**Uni, Dyadic, and MP Side A**				**MP Side B**	
			CHPID Range	**FCs for 180 and 190**	**FCs for 210**	**FCs for 260 - 742 and MP Side A**	**CHPID Range**	**FCs for Side B**
Parallel #3401 (#4401 on Side B)	1	P	20-23	N/A	3504		60-63	4504
	2	P	24-27	N/A	3505		64-68	4505
	3	P	28-2B	N/A	3506		68-6B	4506
	4	E	2C-2F	N/A	3x05		6C-6F	4x05
ESCON #3601 (#4601 on Side B)	1	E	20-23	N/A	3x08		60-63	4x08
	2	E	24-27	N/A	3x07		64-67	4x07
	3	E	28-2B	N/A	3x06		68-6B	4x06
	4	E	2C-2F	N/A	3x05		6C-6F	4x05
Note: When used, x=7 for ESCON LED channels and x=8 for ESCON XDF channels								

6.1.7.6 Channel Board 4 - Version 1

On 320-based 9121 models and non-MP 511-based models with 48 or fewer channels, channel board 4 can support up to three parallel channel groups. The CHPID numbering is summarized in Table 15.

Table 15. CHPID Numbering for Channel Board 4 - Version 1								
Second Optional Expansion Frame Channel Board	**Channel Group Position**	**Channel type**	**Uni, Dyadic, and MP Side A**				**MP Side B**	
			CHPID Range	**FCs for 180 and 190**	**FCs for 210**	**FCs for 260 - 742 and MP Side A**	**CHPID Range**	**FCs for Side B**
Parallel #3402 (#4402 on Side B)	1	P	2C-2F	N/A	3507		6C-6F	4507
	2	P	18-1B	N/A	3508		58-5B	4508
	3	P	1C-1F	N/A	3509		5C-5F	4509

6.1.7.7 Channel Board 4 - Version 2

On MP 511-based models with more than 48 channels channel board 4 can support either the 12 parallel channels and 4 ESCON channels board or the 16 ESCON channels channel board. The CHPID Numbering is summarized in Table 16.

Table 16. CHPID Numbering for Channel Board 4 - Version 2								
Second Optional Expansion Frame Channel Board	**Channel Group Position**	**Channel type**	**Uni, Dyadic, and MP Side A**				**MP Side B**	
			CHPID Range	**FCs for 180 and 190**	**FCs for 210**	**FCs for 260 - 742 and MP Side A**	**CHPID Range**	**FCs for Side B**
Parallel #3412 (#4412 on Side B)	1	P	30-33	N/A	3510		70-73	4510
	2	P	34-37	N/A	3511		74-78	4511
	3	P	38-3B	N/A	3512		78-7B	4512
	4	E	3C-3F	N/A	3x09		7C-7F	4x09
ESCON #3602 (#4602 on Side B)	1	E	30-33	N/A	3x12		70-73	4x12
	2	E	34-37	N/A	3x11		74-77	4x11
	3	E	38-3B	N/A	3x10		78-7B	4x10
	4	E	3C-3F	N/A	3x09		7C-7F	4x09
Note: When used, x=7 for ESCON LED channels and x=8 for ESCON XDF channels								

6.1.7.8 Adding ESCON Channels

Assume a Model 440 is configured with 36 parallel channels. The CHPID numbering is as follows:

- Entry Parallel range: 00-0B

- First optional channel group: 0C-0F

- Second optional channel group: 10-13

- Third optional channel group: 14-17

- Fourth optional channel group: 20-23

- Fifth optional channel group: 24-27

- Sixth optional channel group: 28-2B

Now, we want to add the first ESCON channel group.

In Table 12 we find in the entry parallel channel type 'E' CHPID range 1C-1F. As we do not use this range for the installed parallel channels, there is no address overlap, so we do not have to remove any of the parallel channel groups. As shown, this first ESCON channel group will be installed on board 1.

Let us now add the second ESCON channel group.

The next ESCON CHPID range in the channel board type parallel and channel type 'E' of Table 13 is 18-1B. As shown, this ESCON channel group will be installed in board 2.

The next ESCON channel group will be installed.

The next ESCON CHPID range is 2C-2F. As shown, this ESCON channel group will fit in board 3.

We need another group of ESCON channels, so we want to install the next group of four channels.

There is no additional entry for ESCON channels in the current configuration. The next address range will be 28-2B, as follows from Table 14. However, the address range 20-2B is already used for some of the parallel channels.

Within this address range, no intermixing is possible between parallel and ESCON CHPID numbering. In other words, the CHPIDs assigned to addresses 20-2B must be all ESCON or all parallel channels.

So, before we can add the fourth ESCON channel group, the fourth, fifth, and sixth parallel channel groups must be removed. This means that we lose 12 parallel channels, and we add four ESCON channels, for a net loss of eight channels. Two additional ESCON channel group increments would have to be installed to provide an equivalent number of channels.

6.1.7.9 Impact on Existing Parallel Channels

If one or more parallel channel groups must be removed, it may be necessary to re-cable control unit interfaces other than those that are being replaced by the ESCON channels. The following migration options are available for control units on those channels being replaced:

- Attach the control unit to other non-ESCON channels.

  If other parallel channels are available, the control units may be moved to the other parallel paths. Of course, the IOCDS must be updated to reflect the new hardware configuration.

- Connect the control units through ESCON channels operating in conversion mode.

  Parallel channels may be replaced with ESCON channels configured to operate in conversion mode. This allows the installation of ESCON cabling, ESCDs, and ESCON channel hardware, while continuing operation with parallel control units. If this option is chosen, the 9034 must be installed, and the IOCDS must be changed to reflect TYPE=CVC for the CHPID.

6.1.8 ESCON Channels on IBM 9021 Processors

ESCON channels can be added to a parallel channel configuration, but in some cases it is necessary to first remove one or more parallel channel groups.

The 9021 processor can be configured with two types of channels, as follows:

- Parallel
- ESCON LED

Previously, there was also an ESCON XDF channel feature. It was withdrawn from marketing on May 30, 1995.

ESCON LED channels can be installed on the processor in channel increment numbers.

The channel increment number for 9021 processors is as follows:

- For the 340-based models:
  - Parallel channel increment: 16
  - ESCON channel increment: 8 (first and second), 16 (third and later)
- For the 520 and 711-based models:
  - Parallel channel increment: 16

– ESCON channel increment: 16

As ESCON channels are installed, they are assigned the CHPID addresses shown in Table 17 through Table 23. Parallel channels are assigned the low-end CHPID addresses. As mentioned before, address overlap may occur, so parallel channels may have to be removed. This section gives information on address overlap for processors that have ESCON support.

6.1.8.1 CHPID Numbering on 9021 340-based Models

Table 17 and Table 18 give an overview of the address ranges for parallel channels and for ESCON channels on 9021 340-based models. If an address range for ESCON channels overlaps an address range for the installed parallel channels, then the group of parallel channels belonging to that address range must be physically removed.

Table 17. CHPID Numbering on 340-based Models (SIDE A)						
Processor		**Channel Groups / Address Ranges**				
		00-0F	10-1F	20-2F	30-37	38-3F
330	Parallel	Standard	1			
	ESCON			3	2	1
340	Parallel	Standard	1			
	ESCON			3	2	1
500	Parallel	Standard	Standard	1	2	
	ESCON			3	2	1
580	Parallel	Standard	Standard	1	2	
	ESCON			3	2	1
620	Parallel	Standard	Standard	1	2	
	ESCON			3	2	1
720	Parallel	Standard	Standard	1	2	
	ESCON			3	2	1

Table 18. CHPID Numbering on 340-based Models (SIDE B)						
Processor		**Channel Groups / Address Ranges**				
		40-4F	50-5F	60-6F	70-77	78-7F
620	Parallel	Standard	Standard	1	2	
	ESCON			3	2	1
720	Parallel	Standard	Standard	1	2	
	ESCON			3	2	1

In the left column of Table 17, for Side A, and of Table 18, for Side B, you can find the processor model involved. The next columns show the installation sequence for the standard and the optional channel groups for both parallel and ESCON channels. The address ranges printed as ′Standard′ indicate the addresses of the minimum number of channels installed. For example, the ES/9000 Model 720 has a standard configuration of 32 parallel channels in the address range of 00 to 1F (Side A).

The CHPID numbers of the optional parallel channel groups are in ascending order. However, if ESCON channels have to be installed, the CHPID addresses are assigned in descending order starting with the highest possible address supported by the processor.

You cannot mix both parallel and ESCON CHPID numbers within the same increment. If the addresses overlap, the corresponding parallel channel groups have to be removed before the ESCON channel group(s) can be installed.

6.1.8.2 CHPID Numbering on 9021 520 and 711 Based Models

Table 19 through Table 23 show an overview of the address ranges for parallel channels and for ESCON channels on 9021 520-based and 711-based models. The CHPID numbering for 520-based and 711-based models follows two different numbering sequences, depending on the number of channels installed on the processor complex:

• With 64 or fewer channels installed.

    See Table 19, Table 20, and Table 21.

• With more than 64 channels installed.

    See Table 19, Table 22, and Table 23.

    The CHPID numbering for parallel channels on processors with more than 64 channels installed is the same as that for processors with 64 or fewer channels installed.

Table 19 shows CHPID numbering for parallel channels.

Table 19. Parallel CHPID Numbering on 520-and 711-based Models			
Increment Number	**Number of Installed Parallel Channels**	**Side A Valid Parallel CHPID Range**	**Side B Valid Parallel CHPID Range**
1	16	00-0F	80-8F
2	32	00-1F	80-9F
3	48	00-2F	80-AF

Table 20 shows CHPID numbering for ESCON channels with 64 or fewer channels installed.

Table 20. ESCON CHPID on 520-and 711-based Models, 64 or Fewer Channels Per Side			
Increment Number	**Number of Installed ESCON Channels**	**Side A Valid ESCON CHPID Range**	**Side B Valid ESCON CHPID Range**
1	16	30-3F	B0-BF
2	32	20-3F	A0-BF
3	48	10-3F	90-BF
4	64	00-3F	80-BF

Table 21 shows combinations of channel increment with CHPID numbering. The increment number represents a group of 16 channels.

Channel Type	Side A	00-0F	10-1F	20-2F	30-3F	40-4F	50-5F	60-6F	70-7F
	Side B	80-8F	90-9F	A0-AF	B0-BF	C0-CF	D0-DF	E0-EF	F0-FF
Parallel		1	2	3					
ESCON		4	3	2	1				

Table 21. Channel Increment on 520-and 711-based Models,. 64 or Fewer Channels per Side

Table 22 shows CHPID numbering for ESCON channels with more than 64 channels installed.

Table 22. ESCON CHPID on 520-and 711-based Models,. More than 64 Channels per Side

Increment Number	Number of Installed ESCON Channels	Side A Valid ESCON CHPID Range	Side B Valid ESCON CHPID Range
1	16	30-3F	B0-BF
2	32	30-4F	B0-CF
3	48	30-5F	B0-DF
4	64	30-6F	B0-EF
5	80	30-7F	B0-FF
6	96	20-7F	A0-FF
7	112	10-7F	90-FF
8	128	00-7F	80-FF

Table 23 shows combinations of channel increment with CHPID numbering. The increment number represents a group of 16 channels.

Channel Type	Side A	00-0F	10-1F	20-2F	30-3F	40-4F	50-5F	60-6F	70-7F
	Side B	80-8F	90-9F	A0-AF	B0-BF	C0-CF	D0-DF	E0-EF	F0-FF
Parallel		1	2	3					
ESCON		8	7	6	1	2	3	4	5

Table 23. Channel Increment on 520-and 711-based Models,. More than 64 Channels per Side

You cannot mix both parallel and ESCON CHPID numbers within the same increment. If the addresses overlap, the corresponding parallel channel groups have to be removed before the ESCON channel group(s) can be installed.

6.1.8.3 Adding ESCON Channels

Assume an ES/9000 Model 740 is configured with 48 parallel channels and 16 ESCON channels, a total of 64 channels. The CHPID numbering is as follows:

- Parallel channels: 00-2F

- ESCON channels: 30-3F

Now, we want to add another 16 ESCON channels.

We look at the Table 22, because adding 16 ESCON channels exceeds the total of 64 channels per side. The CHPID numbering is as follows:

- Parallel channels: 00-2F (No change)

- ESCON channels: 30-4F

6.1.8.4 Impact on Existing Parallel Channels

If one or more parallel channel groups must be removed, it may be necessary to move control units other than those that are being replaced by the ESCON channels. The following migration options are available for control units on those channels being replaced:

- Attach control unit to other non-ESCON channels.

  If other parallel channels are available, the control units may be moved to the other parallel paths. Of course, the IOCDS must be updated to reflect the new hardware configuration.

- Connect the control units through ESCON channels operating in conversion mode.

  Parallel channels may be replaced with ESCON channels configured to operate in conversion mode. This allows the installation of ESCON cabling, ESCDs, and ESCON channel hardware, while continuing operation with parallel control units. If this option is chosen, the 9034 must be installed, and the IOCDS must be changed to reflect TYPE=CVC for the CHPID.

6.1.9 ESCON Channels on 9672 Processors

The following ESCON channel cards are available on the 9672 E, P, and R models. Data transfer rate for ESCON channels is 17MB/sec.

- ESCON channel feature #6113, three ESCON channels. (Feature valid for all E, P, and R1 models, but only R2 and R3 models upgraded from an R1 model; new R2 and R3 models have #2313).

- ESCON channel feature #2313, three ESCON channels on new model R2 and R3. (An EC, available since October 31, 1995, has increased the number of ESCON channels provided by this feature to four).

The feature numbers for parallel channel cards are shown below for completeness. Data transfer rate for parallel channels is 4.5MB/sec.

- Parallel channel feature #6103, three parallel channels. (Feature valid for all E, P, and R1 models, as well as R2 and R3 models upgraded from an R1 model; new R2 and R3 models have #2303).

- Parallel channel feature #2303, three parallel channels on new models R2 and R3.

Feature codes for OSA-1, OSA-2, and coupling links (TYPE=CFS) are not covered in this guide.

6.1.9.1 ESCON Multiple Image Facility

ESCON, parallel and OSA channels, and coupling links are supported on 9672 processors.

For use by an ESA operating system, an ESCON channel can be configured as:

- TYPE=CNC to attach to ESCON control units

- TYPE=CTC to support basic or extended mode CTC connection

- TYPE=CVC to attach through a 9034 ESCON converter to block mode parallel control units

- TYPE=CBY to attach through a 9034 ESCON converter to byte mode parallel control units

When configured as TYPE=CNC or TYPE=CTC, an ESCON channel may be shared among multiple ESA/390 mode LPARs through EMIF, or may be dedicated to a single ESA LPAR, or may be defined as reconfigurable. When configured as TYPE=CVC or TYPE=CBY, an ESCON channel cannot be shared but may be defined as dedicated to a single ESA/390 LPAR or as reconfigurable between LPARs.

6.1.9.2 Channel Hardware Configuration

Channel cards are installed on 9672 models to optimize channel subsystem performance and minimize the impact of component failure. Refer to the *Placement Report* and the CHPID Report produced by the IBM configuration tool CFSYSTEM when configuring a new 9672, an MES to a 9672, or a model upgrade to a 9672, in order to determine the resulting CHPID numbers and types for the channels, coupling links, and OSA channels configured. The configuration options for the 9672 are so varied that it is not possible to provide tables for them in this guide.

Obtain and print the CFSYSTEM configurator *Placement Report* which shows the placement of channel cards in the 9672 processor cage and, if applicable, expansion cages. The card location information shown in this report is the best way to determine which channel path identifiers (CHPIDs) are present in the CPC and which type of channel (ESCON, coupling link, OSA, or parallel) each is. This knowledge is required to do HCD or IOCP definitions for the CPC.

Please see Figure 23 on page 64, a sample Placement Report for a 9672 Model R83 ordered with:

- 1,024 MB storage
- 6 parallel channels
- 24 ESCON channels
- 4 1 km coupling links on two ISC adapters
- 1 OSA-2 FDDI Channel
- 3 OSA-1 Channels:
  - 1 Ethernet feature
  - 1 Token-ring feature
  - 1 FDDI feature

The report shows a line diagram of the machine viewed from the rear. The machine resides in two frames with a processor cage, feature #0030, in the top (EIA position 18 to 34) of the "A" frame, and a channel expansion cage, feature #2020, in the bottom (EIA position 1 to 17) of the "A" frame. There are also a power sequence control feature #6201 for 16 parallel control units in the bottom of the "A" frame with the channel expansion cage, and an OSA-1 cage, feature #5100, in the bottom (EIA position 1 to 17) of the "Z" frame. The report shows the front and rear card slots in each cage labeled with the feature code of the card (for example #2313, ESCON channel) that occupies the slot. Note that some cards occupy two slots; for example, a double IBB card, feature #2327, occupies slots 12 and 13 in the channel expansion cage.

The CHPID Report for the same 9672 Model R83 is presented in Figure 24 on page 65. This report shows the type, CHPID number and location of each channel in the machine. In addition, it shows the IBB, channel driver card (CHA SLOT), and channel card (I/O SLOT) for each channel. This hardware information should be used when planning the I/O configuration to select control unit paths, so as to minimize the impact of a component failure or concurrent maintenance action.

```
9672-R83 NEWNONE9A              Placement Report             July 26, 1995
      FRAME A                   1       FRAME Z                         1

EIA+--------------------------------+  +--------------------------------+
35 |                                |  |                                |
34 |                                |  |                                |
33 |                                |  |                                |
32 |--------------------------------|  |                                |
31 |        0030                    |  |                                |
30 |                                |  |                                |
29 |                                |  |                                |
28 |                                |  |                                |
27 |                                |  |                                |
26 |D * D|   |   |   |   |   |U|     |  |                                |
25 |C * C|   |   |   |   |   |P| SLOTS|  |                                |
24 |  *  |2 *|2 *|2 *|2 *|6|C| 01-13 |  |                                |
23 |R * R|2 *|2 *|2 *|2 *|1|   |     |  |                                |
22 |E * E|5 *|5 *|5 *|5 *|5|   |     |  |                                |
21 |G * G|6 *|6 *|6 *|6 *|2|   |     |  |                                |
20 |                                |  |                                |
19 |     |   |   |   |   |   |   |   |  |                                |
18 |--------------------------------|  |                                |
17 |--------------------------------|  |--------------------------------|
16 |     6201                       |  |        5100                    |
15 |--------------------------------|  |                                |
14 |        2020                    |  |                                |
13 |                                |  |                                |
12 |           SLOTS 01-17          |  |                                |
11 ||D|D *|0|2|0|2|2|0|2|5|2 *|0|0|0|0||  |                                |
10 ||C|C *|0|3|0|3|3|0|3|2|3 *|0|0|0|0||  |                                |
09 ||A|A *|1|1|1|1|1|1|1|0|2 *|1|1|1|1||  |1|C|                          |
08 || |  *|8|7|4|3|3|8|3|2|7 *|2|2|2|2||  |6|B|            SLOTS|
07 |--------------------------------|  |V|L|5 *|5 *|5|5|5|5|5|N| 01-12 |
06 |U|0|2|0|0|0|2|5|2|2|2|0|0|0|0|0|0|  | | |0 *|0 *|0|0|0|0|0|/|       |
05 |P|0|3|0|0|0|3|0|3|3|3|0|0|0|0|0|0|  |C|C|0 *|0 *|0|0|0|0|0|A|       |
04 |C|1|1|1|1|1|0|0|0|1|1|1|1|1|1|1|1|  |A|0|5 *|2 *|3|7|7|7|7|         |
03 | |4|3|2|2|8|3|1|3|3|3|8|2|2|2|2|2|  |R|N|                          |
02 |           SLOTS 35-18          |  |D|N|   |   | | | | | | |       |
01 +--------------------------------+  +--------------------------------+
```

Figure 23. Sample CFSYSTEM 9672-R83 Configurator Placement Report

```
9672-R83 NEWNONE9A                CHPID REPORT               July 26, 1995
IBB - CHA SLOT - CAGE LOCATION  - I/O SLOT -      CHPID/TYPE
 1 -     30    - FRAME A BOTTOM -    7     - 40/E  41/E  42/E  43/E
 1 -          - FRAME A BOTTOM -    6     - 44/C1 45/C1
 1 -          - FRAME A BOTTOM -    34    - 48/C1 49/C1
 1 -      4   - FRAME A BOTTOM -    33    - 4C/E  4D/E  4E/E  4F/E
 2 -     24   - FRAME A BOTTOM -    11    - 80/2F
 2 -     24   - FRAME A BOTTOM -    10    - 84/E  85/E  86/E  87/E
 2 -      9   - FRAME A BOTTOM -    29    - 88/P  89/P  8A/P
 2 -      9   - FRAME A BOTTOM -    28    - 8C/OE 8D/OT 8E/OF
 2 -      9   - FRAME A BOTTOM -    27    - 90/P  91/P  92/P
 2 -     24   - FRAME A BOTTOM -    26    - 94/E  95/E  96/E  97/E
 2 -     24   - FRAME A BOTTOM -    25    - 98/E  99/E  9A/E  9B/E
 2 -      9   - FRAME A BOTTOM -    8     - 9C/E  9D/E  9E/E  9F/E




    LEGEND FOR TYPE VALUES IN CHPID/TYPE COLUMN:


    C1 - 1KM COUPLING LINK - #0014->#0007
    C3 - 3KM COUPLING LINK - #0014->#0008
    C0 - NO COUPLING LINK  - #0014->
    E  - ESCON (LED, 3KM)  - #2313 OR #6113
    X  - ESCON (XDF, 20KM) - #6114
    P  - PARALLEL - #2303 OR #6103
    OE - OSA1 ETHERNET     - #5001->#5005
    OF - OSA1 FDDI         - #5001->#5003
    OT - OSA1 TOKEN RING   - #5001->#5002
    OO - NO OSA1 CARD      - #5001->
    2E - OSA2 EN/TR        - #5201
    2F - OSA2 FDDI         - #5202
```

Figure 24. Sample CFSYSTEM 9672-R83 Configurator CHPID Report

See Figure 25 on page 67, a sample Placement Report for a 9672 Model R41
ordered with:

- 1,024 MB storage
- 6 parallel channels
- 24 ESCON channels
- 4 1 km coupling links on two ISC adapters
- 3 OSA-1 Channels:
  - 1 Ethernet feature
  - 1 Token-ring feature
  - 1 FDDI feature

The report shows a line diagram of the machine viewed from the rear. The
machine resides in two frames with a processor cage, feature #0010, in the top
(EIA position 18 to 34) of the ″A″ frame, and an OSA-1 cage, feature #5000, in the
bottom (EIA position 1 to 17) of the ″A″ frame. There are also a channel
expansion cage, feature #1000, in the top (EIA position 18 to 34) of the ″Z″
expansion frame, and a parallel channel tailgate, feature #6109, with control unit
power sequence control feature #6102 for 32 control units, in the bottom of the
″Z″ expansion frame. The report shows the front and rear card slots in each
cage, labeled with the feature code of the card (for example #6113, ESCON
channel) that occupies the slot. Note that some cards occupy two slots, such as

the processor card, feature #0004 (4 CPs) in processor cage slots 03 and 04. Slots not labeled contain standard cards which are the same in all CPC configurations.

The placement of channel cards determines the channel path identifiers (CHPIDs) as shown in Table 24. In the table, PRC and EXP mean Processor Cage and Expansion Cage. In addition, the placement of OSA-1 features within the OSA-1 cage from left to right (from slot 03 to slot 11) determines the assignment of OSA-1 feature type to OSA-1 channel identifier from low to high.

Table 24. 9672-R R83 CHPIDs for Coupling Link, Channel, and OSA-1 Cards				
Cage Type	**Slot**	**Coupling Link IDs**	**Channel IDs**	**OSA IDs**
PRC #0010	26	Unused	20 - 22	Unused
PRC #0010	25	Unused	23 - 25	Unused
PRC #0010	24	Unused	26 - 28	Unused
PRC #0010	23	Unused	29 - 2B	29 - 2B
PRC #0010	22	Unused	2C - 2E	2C - 2E
PRC #0010	21	Unused	2F - 31	2F - 31
PRC #0010	20	12, 13	Unused	Unused
PRC #0010	19	16, 17	32 - 34	Unused
PRC #0010	18	10, 11	Unused	Unused
PRC #0010	17	14, 15	35 - 37	Unused
EXP #1000	26	Unused	60 - 62	Unused
EXP #1000	25	Unused	63 - 65	Unused
EXP #1000	24	Unused	66 - 68	Unused
EXP #1000	23	Unused	69 - 6B	69 - 6B
EXP #1000	22	Unused	6C - 6E	6C - 6E
EXP #1000	21	Unused	6F - 71	6F - 71
EXP #1000	20	52, 53	Unused	Unused
EXP #1000	19	56, 57	72 - 74	Unused
EXP #1000	18	50, 51	Unused	Unused
EXP #1000	17	54, 55	75 - 77	Unused
EXP #2000	19	5E, 5F	60 - 62	Unused
EXP #2000	18	5C, 5D	63 - 65	Unused
EXP #2000	16	5A, 5B	66 - 68	Unused
EXP #2000	11	58, 59	69 - 6B	Unused
EXP #2000	17	56, 57	6C - 6E	Unused
EXP #2000	12	54, 55	6F - 71	Unused
EXP #2000	09	52, 53	72 - 74	Unused
EXP #2000	15	50, 51	75 - 77	Unused

```
9672-R41 NEWNONE9A              Placement Report              July 27, 1995
      FRAME A                        0    FRAME Z                       0
      S/N NEWNONE9A                       S/N NEWNONE9A
EIA+--------------------------------+   +--------------------------------+
35 |                                |   |                                |
34 |--------------------------------   |--------------------------------|
33 |         0010   #1              |   |         1000   #1              |
32 |                                |   |                                |
31 |  |  |  |0|  |0|* 0|* 0|* 0|    |   |  |  |  |0|  |0|0|0|0|0|0|       |
30 |  |  |  |0|  |0|* 5|* 0|* 5| FRONT|  |  |  |0|  |0|0|0|0|0|0| FRONT   |
29 |  |  |  |1|  |1|* 1|* 0|* 1| SLOTS|  |  |  |1|  |1|1|1|1|1|1| SLOTS   |
28 |  |  |  |7|  |7|* 2|* 4|* 2| 13-01|  |  |  |2|  |7|2|2|2|2|2| 13-01   |
27 |  |  |  | |  | |*  |*  |*  |    |   |  |  |  | |  | | | | | | |        |
26 |  |  |  | |  | |*  |*  |*  |    |   |  |  |  | |  | | | | | | |        |
25 |------------------------        |   |------------------------        |
24 |  |6|6|0|6|0|6|6|5|6|6|6|       |   |  |0|0|0|0|0|0|0|0|0|6|6|6|      |
23 |  |1|1|0|1|0|1|1|0|1|1|1|       |   |  |0|0|0|0|0|0|0|0|0|1|1|1|      |
22 |  |5|1|1|1|1|1|1|0|1|1|1| REAR  |   |  |1|1|1|1|1|1|1|1|1|1|0|0| REAR |
21 |  |2|3|4|3|2|3|3|1|3|3|3| SLOTS |   |  |2|2|2|4|2|2|2|2|2|3|3|3| SLOTS|
20 |  | | | | | | | | | | | | 14-26 |   |  | | | | | | | | | | | | 14-26 |
19 |  | | | | | | | | | | | |       |   |  | | | | | | | | | | | |       |
18 |--------------------------------|   |--------------------------------|
17 |--------------------------------   |                                |
16 |         5000   #1              |   |                                |
15 |                                |   |                                |
14 |                                |   |                                |
13 |                                |   |--------------------------------|
12 |                                |   |         6102                   |
11 |                                |   |                                |
10 |                                |   |--------------------------------|
09 |1|C|                            |   |--------------------------------|
08 |6|B|                            |   |         6109                   |
07 |V|L|5|*|5|*|5|5|5|5|5|N| SLOTS  |   |                                |
06 | | |0|*|0|*|0|0|0|0|0|/| 01-12  |   |                                |
05 |C|C|0|*|0|*|0|0|0|0|0|A|        |   |--------------------------------|
04 |A|O|5|*|2|*|3|7|7|7|7| |        |   |                                |
03 |R|N|                            |   |                                |
02 |D|N|                            |   |                                |
01 +--------------------------------+   +--------------------------------+
```

Figure 25. Sample CFSYSTEM 9672-R41 Configurator Placement Report

Table 25 interprets the configuration in the sample Placement Report shown in
Figure 25.

Table 25 (Page 1 of 2). Placement Report Channel Configuration				
Cage	**Slot**	**Feature**	**Card Type**	**CHPIDs**
Processor	26	#6113	ESCON	20 - 22
Processor	25	#6113	ESCON	23 - 25
Processor	24	#6113	ESCON	26 - 28
Processor	23	#5001	OSA Extender	29 - 2B
Note: Based on the placement of the OSA-1 features in the OSA-1 cage: CHID 29 is Ethernet, CHID 2A is token-ring, and CHID 2B is FDDI.				

Table 25 (Page 2 of 2). Placement Report Channel Configuration				
Cage	Slot	Feature	Card Type	CHPIDs
Processor	22	#6113	ESCON	2C - 2E
Processor	21	#6113	ESCON	2F - 31
Processor	20	#0012	Airflow	None
Processor	19	#6113	ESCON	32 - 34
Processor	18	#0014	ISC Adapter	10 - 11
Processor	17	#6113	ESCON	35 - 37
Expansion	26	#6103	Parallel	60 - 62
Expansion	25	#6103	Parallel	63 - 65
Expansion	24	#6113	ESCON	66 - 68
Note: Without OSA-1 channels in the configuration, the ESCON channel card in slot 24 of the expansion cage would have been placed in a lower CHID position than the parallel cards. In effect, it was relocated here as if by MES by the OSA-1 channels.				
Expansion	23	#0012	Airflow	None
Expansion	22	#0012	Airflow	None
Expansion	21	#0012	Airflow	None
Expansion	20	#0012	Airflow	None
Expansion	19	#0012	Airflow	None
Expansion	18	#0014	ISC Adapter	50 - 51
Expansion	17	#0012	Airflow	None

Each 9672 CPC must have a minimum of one channel card, which may be of any type except OSA. ESCON and parallel channel cards are installed and assigned the available CHPID numbers remaining after the CHPID numbers for OSA channels and coupling link channels are determined. A 9672 is built with these channel cards installed in the following order from low to high CHPID number:

- All ESCON channels cards, feature code #6113
- All Parallel channels cards, feature code #6103

6.1.9.3 IZPIOCP Version 1 Release 4

IZPIOCP V1.4 is required to define an S/390 9672 Parallel Enterprise Server Model R2 or R3. It also supports, and is the recommended IOCP level, for use on the S/390 9674 Coupling Facility Model C01, the S/390 9672 Parallel Enterprise Server Model R1, and S/390 9672 Parallel Transaction Server.

6.1.9.4 HCD Support for the 9672 Parallel Enterprise Server

Support for defining a 9672 Parallel Enterprise Server Model 2 or Model 3 requires maintenance for HCD new function, APAR OW12830. The following PTFs provide this service:

- UW90179 and UW90180 for HCD Release 5.2, MVS/ESA V5.2 (all levels)

- UW90176 and UW90177 for HCD Release 5.1, MVS/ESA V5.1

- UW90176 and UW90177 for HCD Release 5.1, MVS/ESA V4.3 with the HCD Usability Feature (feature 5890 or 5891 or 5892)

- UW90155 for HCD Release 3, MVS/ESA V4.3

- UW90155 for HCD Release 3, MVS/ESA V4.2.2 with EMIF feature

- UW90152 for HCD Release 2, MVS/ESA V4.2.2

- UW90152 for HCD Release 2, MVS/ESA V4.2.0

6.1.9.5 HCD Support for ESCON TYPE=CBY Channel

The byte multiplexer mode for 3745, 3725, and 3270 devices, attached to a 9034-1 converter, requires specific HCD support:

- HCD Release 5 or higher OR

- HCD Release 5.1 with PTFs UW90027, UW90028, UW90014, maintenance for new function APARs OW03355 and OW02431 (R5.1 is included in MVS/ESA V4.3 Usability Feature)

6.1.9.6 ESCON Channel Cables

ESCON jumper cables are NOT provided with 9672 ESCON channel features. Planning the required jumper cable configuration, ordering jumper cables, and making arrangements to have them delivered and installed prior to the 9672 installation is a customer responsibility. Planning and making arrangements to have a fiber optic trunk system installed, if needed, is also a customer responsibility.

6.1.10 IOCP Definitions for Channel Hardware

This section defines only the new keywords for the CHPID statement. The new keywords for the CNTLUNIT statement will be discussed in the following sections, where IOCP examples will be given for ESCON architecture implementation.

6.1.10.1 IOCP Definitions for Channel Paths

ESCON channels operate in three modes, which are specified in the IOCP input as three channel path types. The CHPID statement has four new TYPE keywords to distinguish among these modes, as follows:

- TYPE=CNC

  A channel path with this keyword is an ESCON channel path. The ESCON architecture protocol is used by all control units and devices on this path.

- TYPE=CVC

  A channel path with this keyword is an ESCON channel path that attaches to an IBM 9034 ESCON Converter Model 1.

- TYPE=CTC

  A channel path with this keyword is an ESCON channel path that permits channel-to-channel communications.

- TYPE=CBY

  A channel path with this keyword is an ESCON channel path that permits 3745, 3725, and 3720 devices to operate in byte multiplexor mode when attached to a 9034 converter model 1. This support is only available on 9021 711-based models, 9121 511-based models and 9672 E, P, and R models. The SEC levels required for these processors, and relevant 9034 serial number information, are summarized below:

  - 9021 711-based requires SEC 236420.

  - 9121 511-based requires SEC C35954.

– 9672 E, P, and R requires EC D57262.

– 9034 Serial Number 41 53345 and above is at the correct level.

– 9034 Serial number below 41 53345 requires logic card P/N F8047.

Of course, the previous types of parallel channel modes are still provided through the keywords:

- TYPE=BY

  A channel path with this keyword is a parallel channel path working in byte-multiplexer mode.

- TYPE=BL

  A channel path with this keyword is a parallel channel path working in block multiplexer mode.

6.1.10.2 IOCP Definitions for ESCON Directors

Only fiber optic cables can be connected to an ESCON Director. An ESCON Director can make the following connections:

- Dynamic

  – ESCON channel to ESCON control unit

  – ESCON channel to ESCON CTC

  – ESCON control unit to ESCON channel

  – ESCON CTC to ESCON channel

  – Parallel channel (attached to 9035 ESCON Converter) to ESCON 3990 Storage Control

  – ESCON 3990 Storage Control to parallel channel through 9035 ESCON Converter (See 6.15, "IBM 9035 ESCON Converter Model 2" on page 202)

- Static

  – ESCON channel (TYPE=CVC) to non-ESCON control unit (attached to 9034 ESCON Converter)

  – One part of a chained ESCON Director pair

  – Dedication of a path resulting from an operator CONNECT command

The IOCP must contain an indication of the ESCON Director to which the ESCON channel is connected. For this reason, another keyword is provided:

    SWITCH= number

where number is an arbitrary number for the ESCON Director used for:

- Syntax checking by the IOCP program.

- Addressing the ESCON Director by the ESCON Manager.

- Problem determination by the operator or the service representative. This number is displayed on an IOPD frame on the service console.

- Save switching if the ESCD is controlled by the ESCON Manager.

The SWITCH keyword is required for channel paths to have dynamic connections through a director. The SWITCH keyword is not valid for non-ESCON TYPE=BL or BY channel paths. The SWITCH keyword is valid for TYPE=CVC channel paths. The number may range from X′00′ through X′FF′ for each IOCDS. Where

more than one ESCON Director is attached (chained ESCON Directors) this number specifies the ESCON Director, which enables dynamic connections for that specific channel path. With two chained ESCON Directors, the channel path that goes through both ESCON Directors has one dynamic connection and one dedicated connection in the ESCON Directors. The customer may choose which of the two ESCON Directors will provide the dynamic connections.

6.1.10.3 IOCP Definition Example

Figure 26 shows a possible ESCON channel configuration. Some of the CHPIDs are connected to an ESCON Director. The CHPID statement examples refer to the ESCON channels in Figure 26 on page 72:

HOST A has the following CHPIDs installed:

- CHPID 20 attached to a ESCON Converter
- CHPID 22 attached to a ESCON Converter through the ESCON Director
- CHPID 2F attached to two ESCON Directors
- ESCON Director (SWITCH=02) with dynamic connection possibilities.
- CHPID 32 attached to ESCON Director (SWITCH=02) (as a CTC)
- CHPID 3F attached to ESCON channel 20 on HOST B (as a CTC)

HOST B has the following CHPIDs installed:

- CHPID 20 attached to ESCON channel 3F on HOST A (as a CTC)
- CHPID 21 attached to ESCON Director (SWITCH=02) with dynamic connection possibilities
- CHPID 2F attached to ESCON Director (SWITCH=02) with dynamic connection possibilities
- CHPID 34 attached directly to ESCON control unit

The following CHPID statements provide the IOCP definitions:

- HOSTA IOCP definitions:

      CHPID20 CHPID PATH=20,TYPE=CVC

      CHPID21 CHPID PATH=22,TYPE=CVC,SWITCH=01

      CHPID2F CHPID PATH=2F,TYPE=CNC,SWITCH=02

      CHPID30 CHPID PATH=32,TYPE=CTC,SWITCH=02

      CHPID3F CHPID PATH=3F,TYPE=CTC

- HOSTB IOCP definitions:

      CHPID20 CHPID PATH=20,TYPE=CNC

      CHPID21 CHPID PATH=21,TYPE=CNC,SWITCH=02

      CHPID2F CHPID PATH=2F,TYPE=CNC,SWITCH=02

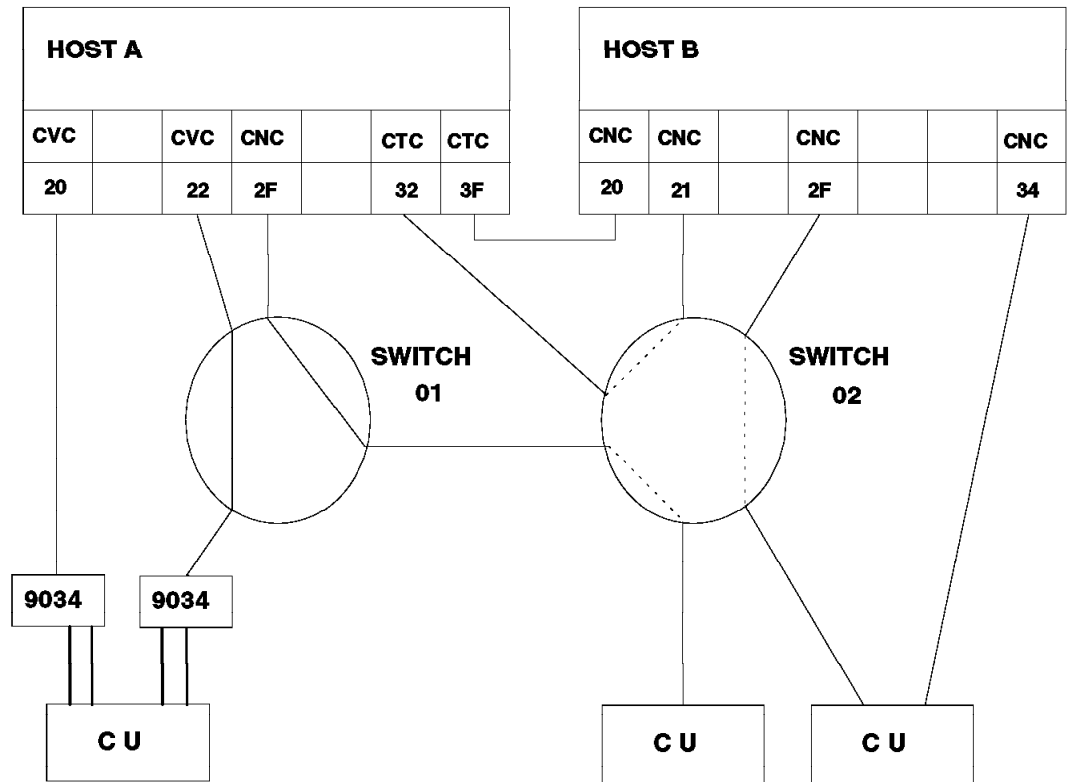   CHPID34 CHPID PATH=34,TYPE=CNC

Figure 26. CHPID Statement

6.1.11 ESCON Channel Configuration Guidelines

This section provides general guidelines for ESCON channels. If you use the EMIF in LPAR mode, additional items must be considered. Refer to 6.2, "ESCON Multiple Image Facility" on page 74 for additional information of EMIF.

When configuring ESCON Channels:

- All channel paths that access a device from the same system image must be of the same channel type (except 9221 and 9021 520-based models).

    All channel paths to a device from the same system image must be either:

        OEMI parallel interfaces (TYPE=BL or BY)

        ESCON interfaces (TYPE=CNC)

        ESCON interfaces in conversion mode (TYPE=CVC or CBY)

    The 9221 and 9021 520-based models can access a device from the same system image by block multiplexer and ESCON conversion channel (TYPE=CVC).

- Ensure that there is an active device at the end of a channel link.

    Bus and tag cables can be terminated, but fiber optic cables cannot. So, if there is no active device at the end of the link, many messages will appear on the hardware system console. These messages do not indicate a problem, but they can confuse the operator. An active device can be the ESCON Director (Model 1 or 2), or the ESCON Converter

Model 1, or a control unit with ESCON adapters. These devices must be in a power-on state.

If there is no active device, do not define any dummy devices and CHPIDs in IOCP or place the channel in SCS (Single Channel Service) mode. Configuring the channel offline will not be sufficient, because after the next Power-on Reset (POR), all the channels will be online again.

- For availability, the channel paths that access a device from the same processor complex should be configured on different channel cards.

  An ESCON channel card contains two CHPIDs. For example, CHPID 20 and CHPID 21 are in one ESCON channel card.

  The 9021 520-based models also provide concurrent channel maintenance. The field replaceable unit (FRU) is a channel card.

- On the CNTLUNIT statement in the IOCP deck, the system programmer may define only one control unit with the same CUADD definition on a switch to control unit link, or if there is no switch involved, on a CHPID to a control unit link.

  CUADD=0 is the default for all ESCON devices. The CHPID.LINK.CUADD must be unique in the configuration.

  For a 3990 in DLS mode, the system programmer defines the control unit as though there were separate 3880s, each consisting of two control unit definitions (in total four control unit statements). Following the rule that the CHPID.LINK.CUADD must be unique, the system programmer must define two control unit statements with the keyword CUADD=0, and the remaining two control unit statements with the keyword CUADD=1. For an example of the IOCP definition for a 3990 in DLS mode, see 6.5, "IBM 3990 Storage Subsystem" on page 132.

6.2 ESCON Multiple Image Facility

This section describes the ESCON Multiple Image Facility (EMIF). EMIF enhances the capability of LPAR to share resources. Existing LPAR features are assumed to be well known, so only the changes introduced with EMIF are discussed.

For more detailed information refer to *IOCP User's Guide and ESCON CTC Reference Volume A04* and, for MVS/ESA users, *MVS/ESA Support for EMIF*.

6.2.1 Overview

The ESCON Multiple Image Facility enables channel sharing among PR/SM logical partitions running on any IBM ES/9000 520 or 711-based processor, or IBM ES/9000 511-based processor or IBM S/390 9672 processor.

I/O sharing is already possible in a pre-EMIF ESCON environment, where multiple systems can share control units, devices, and common links through ESCON directors. Channel assignment, however, was more static. Channels could only be defined as reconfigurable, enabling them to be removed from one Logical Partition (LPAR) and attached to another. They were dedicated to one logical partition at any particular time and not to be shared by other logical partitions.

With EMIF, the processor channel subsystem provides physical path sharing by extending the logical addressing capability of the ESCON architecture to host images (PR/SM logical partitions).

Each partition has its own logical channel subsystem (logical CSS), and its own view of each shared channel (logical channel path image) and each control unit connected to the shared channel (subsystem image). Nevertheless, it is still possible to define non-shared channels (see Figure 27 on page 75).

Allocation of additional channels for adding new logical partitions or for availability reasons is no longer required, and elimination of underutilized channels is possible.

It is now possible to reduce the number of ESCON channels, director ports, and ESCON control unit adapters for ESCON-capable control units, which means great potential savings for our customers.

The ESCON Multiple Image Facility will ease systems and configuration management tasks such as varying workloads, enabling disaster backup solutions, consolidating applications, and providing migration, test, and other special environments. Moreover, EMIF improves systems configuration flexibility, especially in terms of handling greater numbers of logical partitions by easier access to control units and reduced operational complexity.
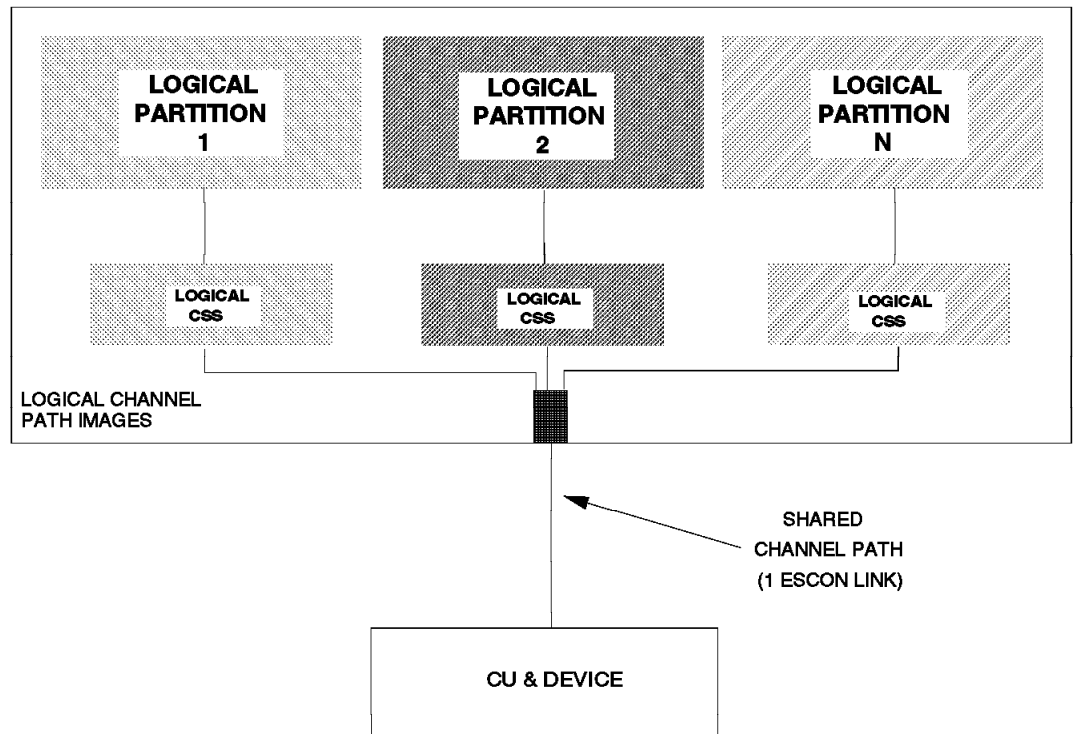
Figure 27. ESCON Multiple Image Facility

(CSS = Channel Subsystem)

6.2.2 Requirements

The requirements for the ESCON Multiple Image Facility are:

- An ES/9000 9021 processor model 520, 640, 660, 740, 820, 860 or 900 at SEC level 228150.

- An ES/9000 9021 711-based processor.

- An ES/9000 9121 511-based processor.

- A S/390 9672 Model E, P, or R.

- PR/SM LPAR mode.

- An ESCON-capable operating system.

- ESCON channels operating in native mode (CNC) or in channel-to-channel mode (CTC). Channels in conversion mode (CVC or CBY channels with 9034) can not be shared with EMIF.

- IBM ESCON-capable control units

6.2.3 Addressing

ESCON addressing uses various fields in the link header of a link-level frame. A source component sends a frame to a destination component. See Chapter 5, "ESCON I/O Architecture" on page 21 for more information.

In Figure 28 on page 76, two partitions are using dedicated channels to access an IBM 3990 and an IBM 3174.

The link address pair (01/0D) used for communication with the directly-attached IBM 3990 was selected during POR of the processor.

With EMIF, the partition number is used as a logical address to identify the partition to which a certain I/O belongs. All ESCON channels configured for a processor operating in Basic mode, and unshared ESCON channels for a processor in LPAR mode, continue to use a host logical address field of zero.
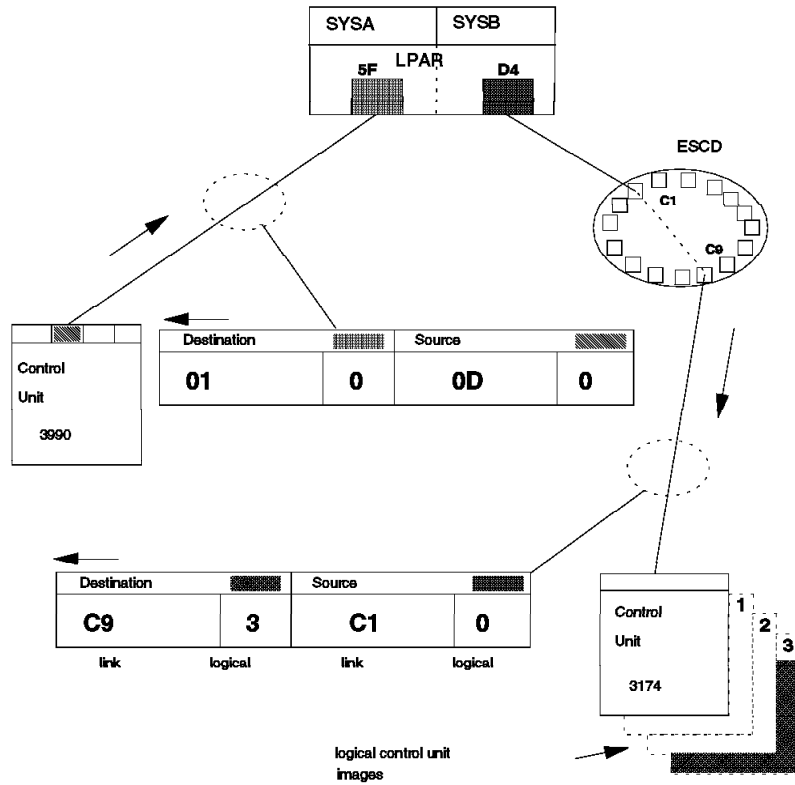

Figure 28. ESCON Pre-EMIF Addressing

In Figure 29 on page 77, two partitions are sharing two EMIF channels. Each partition has a unique identifier: SYSA is 2, and SYSB is 4. The difference between this example and the previous one is that host logical addresses in the ESCON link header are now used. Now the logical address contains the partition number of a logical partition. This information is used by the CSS to determine which partition is using the channel, and is defined using IOCP or HCD.

The link address pair (01/OD) used for communication with the directly-attached IBM 3990 were generated when the logical path was established.
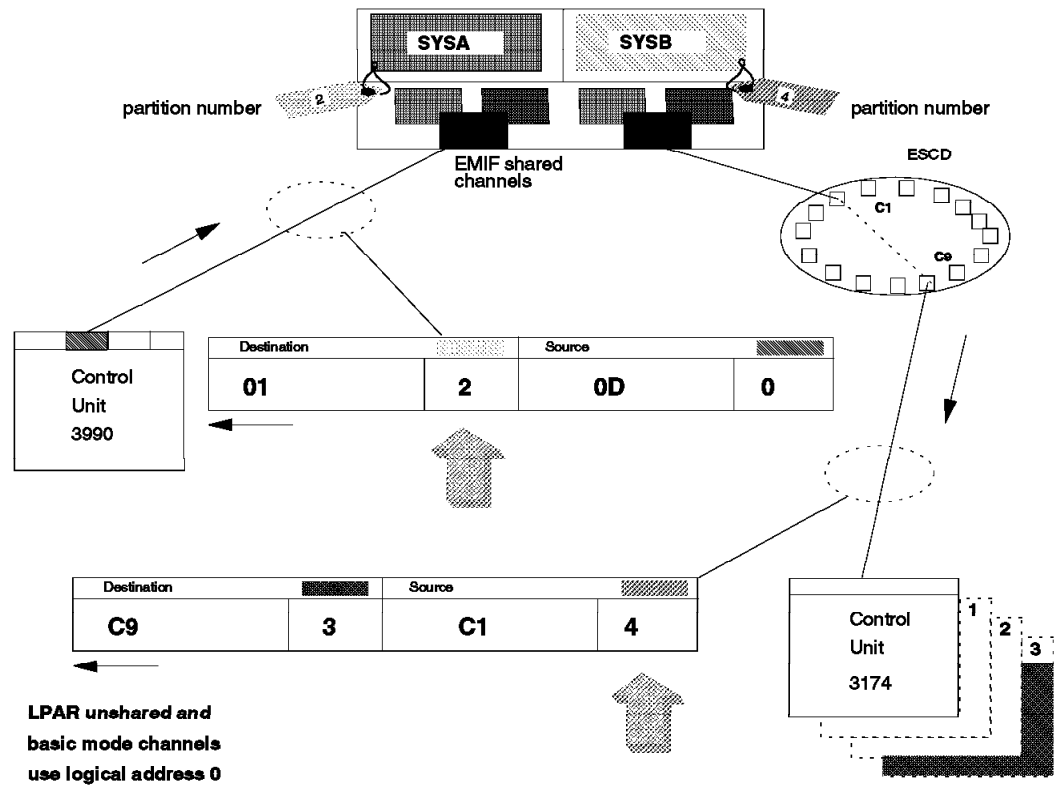
Figure 29. ESCON EMIF Addressing

6.2.4 Value

EMIF provides the same connectivity between logical partitions and I/O devices using fewer physical channels, and therefore, fewer director ports and control unit adapters. Furthermore, manual reassignment of channels in order to handle different workloads is no longer needed, and this improves reliability and availability.

Figure 30 on page 78 shows a configuration of four logical partitions in LPAR mode. Each logical partition has four dedicated channels attached to an IBM 3990 storage control unit. Although we have 16 physical links, the control unit can perform only four I/O operations simultaneously.
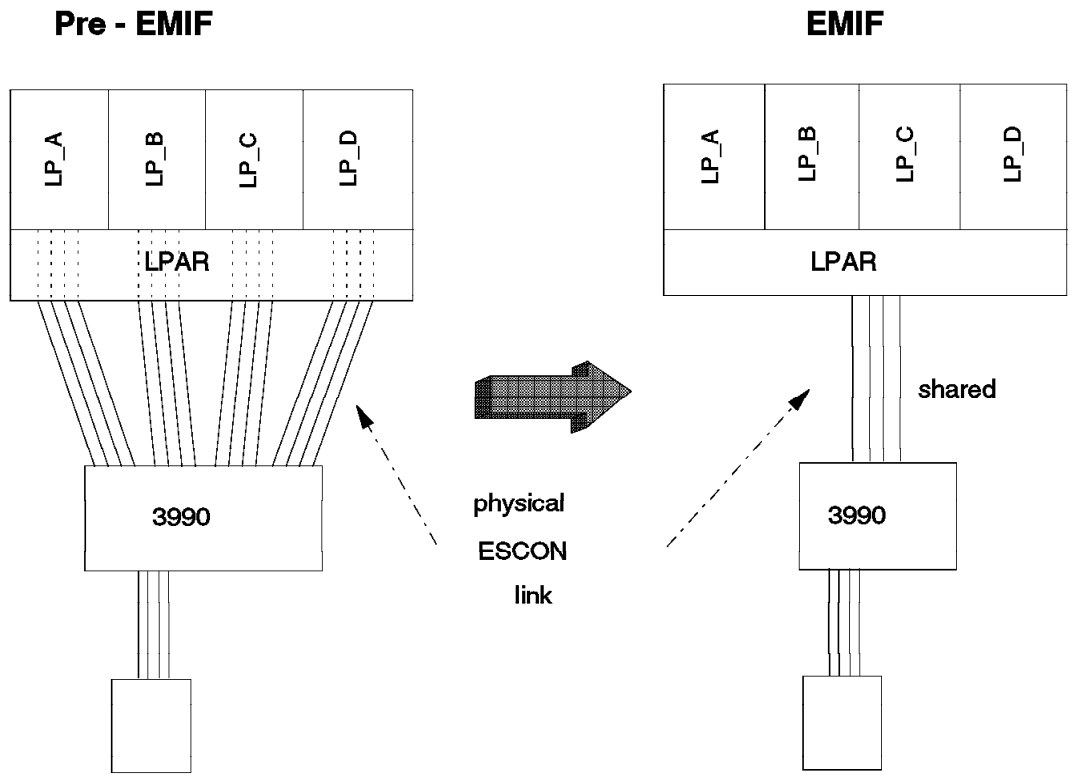
Figure 30. EMIF IBM 3990 Channel Consolidation Example

With EMIF, the 16 channels can be combined into four shared channels without performance or connectivity problems. We still have 16 logical paths to access the control unit.

In this example, we can save 12 channels in the CPU and 12 IBM 3990 storage control unit adapters.

An LPAR environment can also consolidate its CTC and CNC channels.

Refer also to 6.2.7, "General Consolidation Guidelines" on page 82.

Figure 31 on page 79 shows that, depending on channel utilization, EMIF can reduce CTC requirements to two channels (one in CTC mode and one in CNC mode).

In an ESCON configuration with ESCON directors, saving channels saves ESCON director ports as well. So for a customer who is planning to migrate from parallel channels to ESCON, the entry costs can be significantly reduced because of the need for fewer channels, ports, and control unit adapters. Moreover, a reduction in the number of channels necessary for MVS consoles is possible as EMIF provides access for each partition to a single shared channel which is connected, through an ESCD, to multiple IBM 3174s.
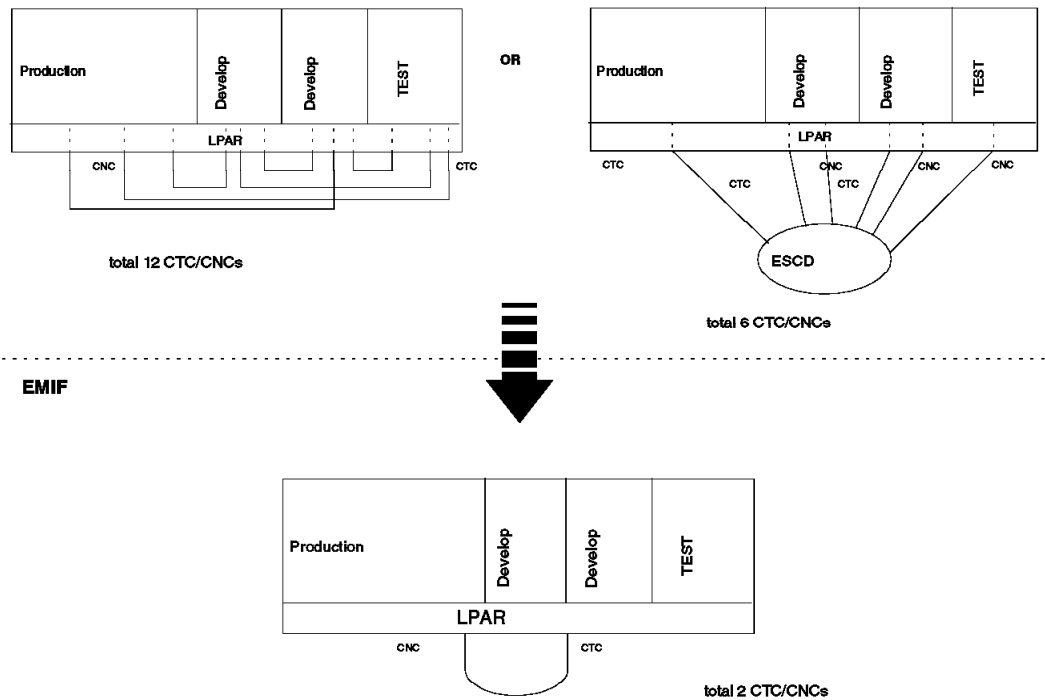
PRE-EMIF

total 12 CTC/CNCs

OR

total 6 CTC/CNCs

ESCD

EMIF

total 2 CTC/CNCs

Figure 31. EMIF CTC Channel Consolidation Example

6.2.5 Components

This section gives a brief description of the components of EMIF and the change
to the I/O configuration process. You will find more usage information on IOCP
and HCD in *ES/9000 Input/Output Configuration Program User's Guide* and
MVS/ESA HCD: Using the Dialog.

A new level of IOCP program (IZPIOCP) or a new HCD component (contained in
MVS/ESA Version 4.3 and above) is required for the definition of shared channels
or more than seven logical partitions on an EMIF-capable processor. All 9021
520 SEC 228150 machines are shipped with the stand-alone version of IOCP,
which is also available as a PTF to the base operating system. For HCD users,
additional panels and fields have been added; namely, Add Processor, Add
Partition (Partition Number), Add channel path, Define Access List, Define
Device/Processor, and Define Candidate List.

The IOCP RESOURCE statement allows an installation to define the name and
associated partition number for each partition. HCD now requires an explicit
definition of each partition.

The definition of a control unit shared by multiple logical partitions using shared
channels no longer requires separate CNTLUNIT/IODEVICE definitions for each
partition.

Two types of channels are allowed with EMIF: non-shared channels, which can
be dedicated or reconfigurable, and shared channels. New controls for shared

or reconfigurable channels are provided by the access list, which shows the partitions that have access at initial partition activation, and the candidate list, which shows partitions that can access the CHPID after initial activation. The status is saved by LPAR across PORs until IOCDS changes. This is called enhanced logical path management, and it makes it unnecessary for POR to establish logical paths needed for those channels activated after partition activation.

Device access control is another new mechanism presented by EMIF. This function can limit a partition's access to a device owned by a control unit connected to a shared channel. Benefits include an additional security control and improved logical path management, because logical paths will not be established between a partition and a control unit unless at least one of its devices is accessible to the partition.

There are some operational changes to hardware console frames to support EMIF. Please refer to the *IBM 9021 Operator Guide*.

6.2.6 Performance

ESCON Multiple Image Facility does not have a significant impact on channel performance. Additional path length in the CSS and channels represent a very small change in the I/O response time profile, (Figure 32).
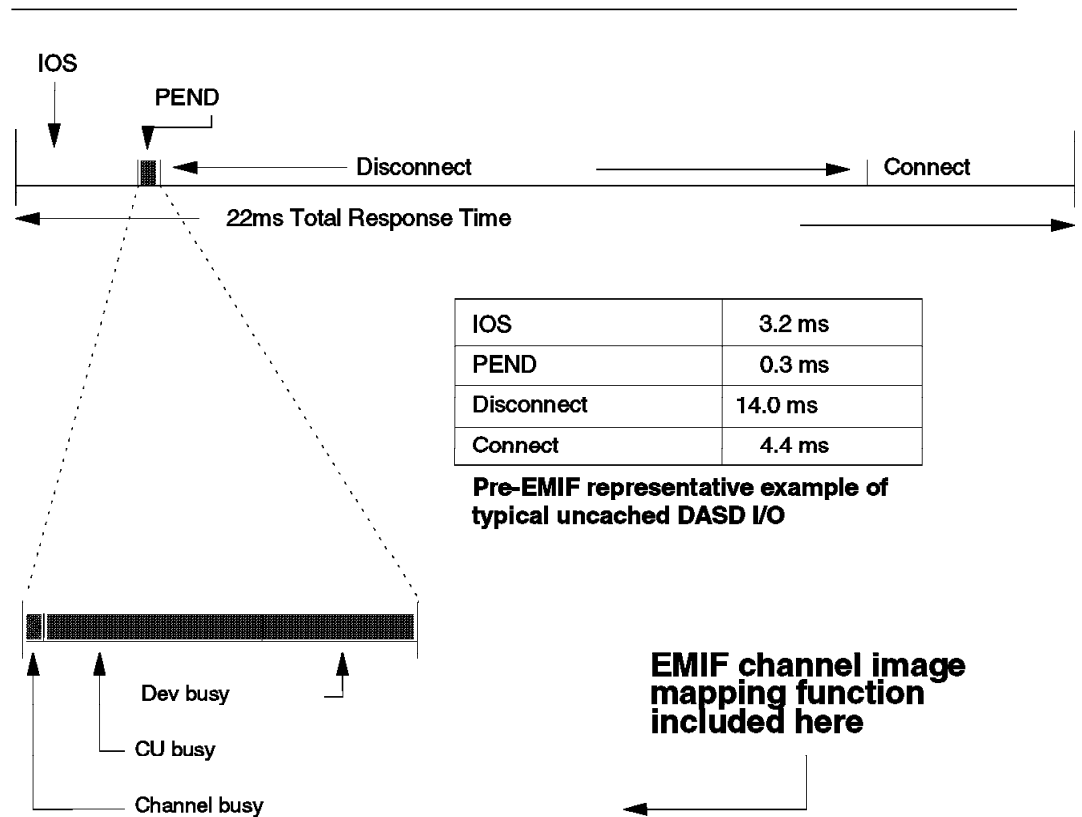

IOS	3.2 ms
PEND	0.3 ms
Disconnect	14.0 ms
Connect	4.4 ms

Pre-EMIF representative example of typical uncached DASD I/O

Figure 32. EMIF Performance Considerations

PEND is usually a small component in overall response time, and within PEND, channel queueing and CSS overhead represent minuscule components.

There may even be some control unit busy management improvements with EMIF, as show in Figure 33 on page 82.

In Figure 33 we can see that with point-to-point connectivity, busy conditions are detected in the link when the control unit presents the busy condition to the channel. The presentation and subsequent clearing of the busy condition takes several exchanges between the control unit and the channel, which takes some time.

With switched point-to-point connectivity implemented by using an ESCD, the "port busy" situation offloads the busy management from the control unit, saving some time since it is faster.
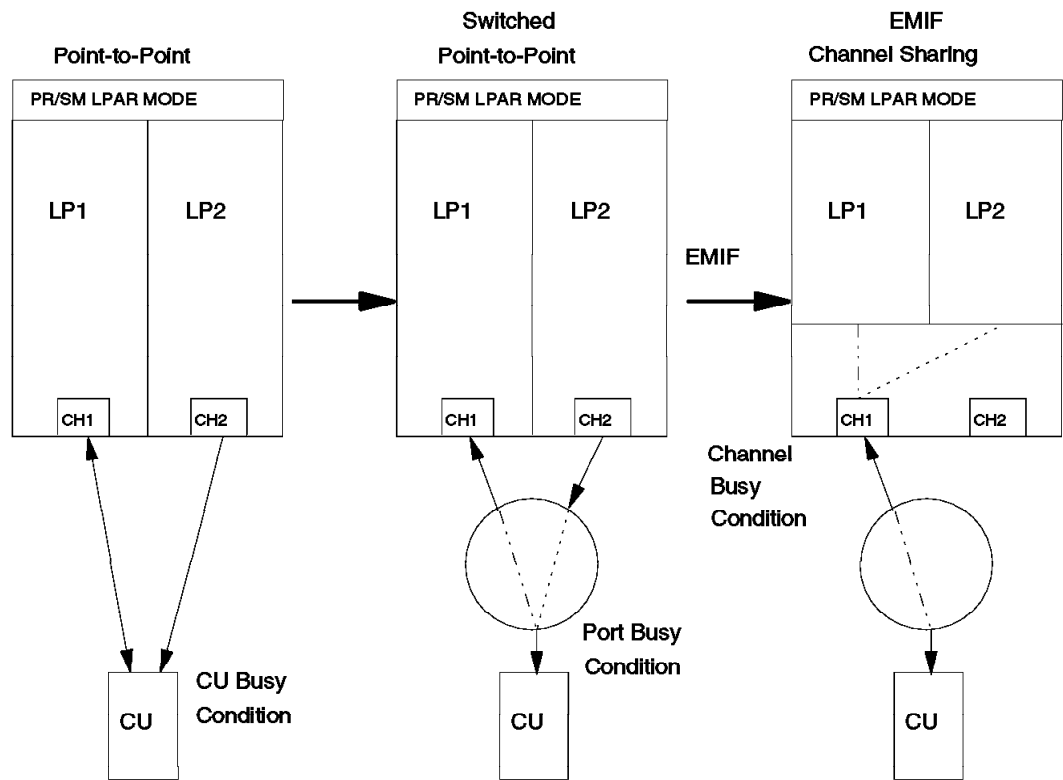
Figure 33. EMIF Control Unit Busy Management Improvements

After applying channel consolidation with EMIF, an LPAR detects channel busy before the I/O tries to go through the ESCD. Because CSS knows when the channel is in use and issues a SSCH only when the channel is available, channel busy is by far the most efficiently managed condition. This saves time again.

6.2.7 General Consolidation Guidelines

Channel consolidation can be seen as a 2-step methodology for reducing channel requirements.

Figure 34 on page 83 shows two control units accessed by PR/SM logical partitions. The starting configuration without EMIF shows how the CUs are accessed by the different LPARs and non-shared channels, which are dynamically switched by an ESCD. CU1 is an LPAR shared control unit, and CU2 is unshared.

6.2.7.1 STEP 1 - LPAR Shared Control Units

The first step in consolidating channels deals strictly with LPAR shared control units and results in the "Initial Channel Consolidation Configuration". In this configuration, ESCON channels on an EMIF capable processor are shared among multiple logical partitions, and dedicated to accessing a single control unit.
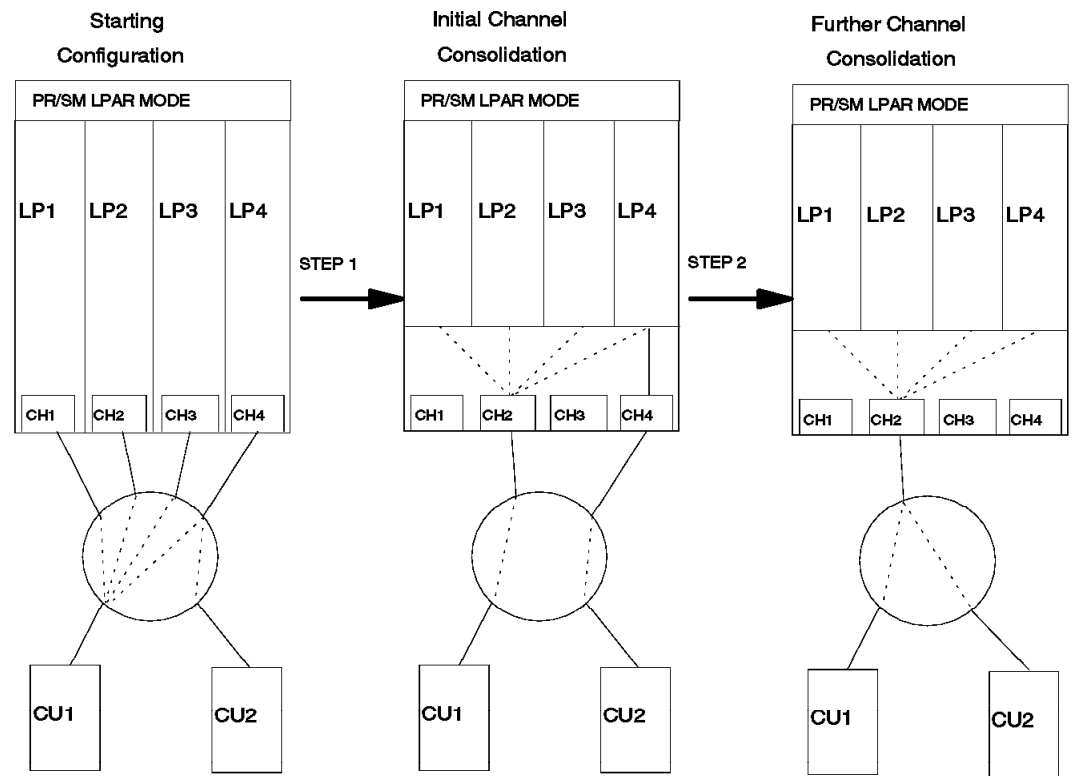
Figure 34. EMIF Two Step Consolidation Process

6.2.7.2 STEP 2 - Further Channel Consolidations

The second step addresses how further consolidations of any ESCON channels may be achieved, if the channels in the "Initial Channel Consolidation Configuration" exhibit low utilization rates. Customer surveys show that most of today's channels run at low utilization. It is recommended that any ESCON consolidation effort commence with these channels. Channels with high utilization should not be candidates for consolidation. Use a modelling tool such as DCAT for simulating different channel configurations.

The System Activity Display (SAD) facility and RMF 4.3 or later releases can help to determine total channel utilization and the new channel image utilization.

6.2.8 Migration

Any ESCON-capable environment can use shared channels. The ability to make hardware and software changes in a dynamic I/O environment with shared channel paths is limited to certain MVS releases. Table 25 shows the minimum levels of system software needed to support EMIF-related capabilities.

In an LPAR environment it is possible to perform configuration definition and management in one partition on behalf of the other partitions. This technique can minimize software migration activity to a single partition.

Table 26. Software Support for Shared Channels	MVS/ESA			VM/ESA		TPF	VSE /ESA	AIX /ESA
Capability	4.3 4.2.2 +F C	4.2 4.2.2	4.1 3.1.3 3.1.0e	1.1.1	1.2	3.1	1.2• 1.3	2.1
Access devices on shared channels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Use shared CTC channel path•	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Define shared channels using IZPIOCP	Yes	Yes	Yes	Yes	Yes	n/a	Yes	No•
Define shared channels using HCD	Yes	No	No	n/a	Yes	n/a	n/a	n/a
Make dynamic hardware and software changes	Yes	Yes•	No	n/a	a/a•	n/a	n/a	n/a
Make dynamic software-only changes	Yes	Yes	No	n/a	Yes	n/a	n/a	n/a

Note:

1 VSE/ESA 1.2 does not support dynamic switching capability of ESCDs and is untested in a shared EMIF environment.

2 A pre-EMIF processor requires PTFs to IXPIOCP. VSE/ESA 1.3 supports ESCON/EMIF configurations.

3 AIX/ESA 2.1 provides IOCP definition capability but does not include definition of shared channels.

4 MVS/ESA 4.2 and 4.2.2 require Dynamic Reconfiguration Management PTFs, enabling HCD to make dynamic changes to an EMIF-capable processor with unshared channel definitions.

5 VM/ESA V1.2 as target partition supports dynamic hardware changes made by another operating system.

EMIF support (including dynamic I/O reconfiguration) is provided by MVS/ESA Version 4.3. The no-charge EMIF Migration Accommodation Feature used to provide full EMIF support for MVS/ESA 4.2.2 is no longer available from IBM.

For migration to EMIF, the following steps are necessary:

1. Install or upgrade to a 711-based machine, or a 511-based machine, or a 9672.

2. Upgrade all 520-based processors to SEC-Level 228150.

3. Retain an existing IOCDS created by IXPIOCP that can be used during POR of the 520-based machine at SEC level 228150.

4. Determine the amount of central storage that will be used for the HSA. The amount of HSA allocated will depend on the number of logical partitions and number of subchannels defined in the IOCDS. Refer to *Processor Resource/Systems Manager Planning Guide* for more information.

5. Perform POR of the processor.

6. For subsequent changes, use program IZPIOCP.

6.3 IBM 9032 and 9033 ESCON Directors

To implement the ESCON switching function, a new class of devices was introduced. These devices, called directors, connect channels with control units, or channels with channels (CTC). Connection may be either dynamic, lasting only for the duration of an I/O operation, or static, so that the connection will not be removed. Directors may have ports to attach both types of ESCON fibers, LED and XDF. A port can connect to another port regardless of its kind. Conversion from LED to XDF, or vice versa, is done transparently by the directors.

The ESCON Directors provide dynamic connections between ESCON channels and ESCON control units, or IBM 9035 Model 2 converter channels and ESCON capable 3990 control units, or between two ESCON channels. It is not possible to connect control units to each other (except for the 3990-6 pair in Peer-to-Peer Remote Copy mode). Two ESCON channels can be connected to form a CTC connection, if one is defined as a CTC and the other as an ESCON channel (TYPE=CTC and TYPE=CNC on the CHPID statement). See 6.4, "ESCON Channel-to-Channel Connection" on page 120.

Peer-to-peer remote copy (PPRC), available on MVS/DFP 3.1.0 and above, is a hardware solution to the problem of accurate and rapid disaster recovery, and also provides a workload migration and DASD migration solution. PPRC requires ESCON paths between application and recovery storage controls. Up to 16 paths can be defined between a single application site storage control and four recovery sites storage controls. Existing ESCON paths can be used, or other dedicated paths can be added. ESCON paths may include an ESCON Director or Directors, or IBM 9036 ESCON Remote Channel Extenders to provide configuration flexibility. For more information about the requirements, see *Remote Copy Administrator's Guide and Reference*.

The ESCON Directors also provide dedicated connections. A dedicated, or static, connection is required when an ESCON channel is connected to a 9034 converter for communication with a parallel interface of a control unit. Also, for chaining the ESCON Directors, one of the directors must have a dedicated connection, but the other one may have either a dedicated or dynamic connection.

There are four models of the ESCON Director, Model 001, 002, 003 and 004. Model 002 was withdrawn from marketing in January 1995, replaced by the new Model 003. Model 001 was withdrawn and replaced by the Model 004 in early 1996.

Figure 35 shows the varieties of IBM devices that can be attached to the ESCON Director.
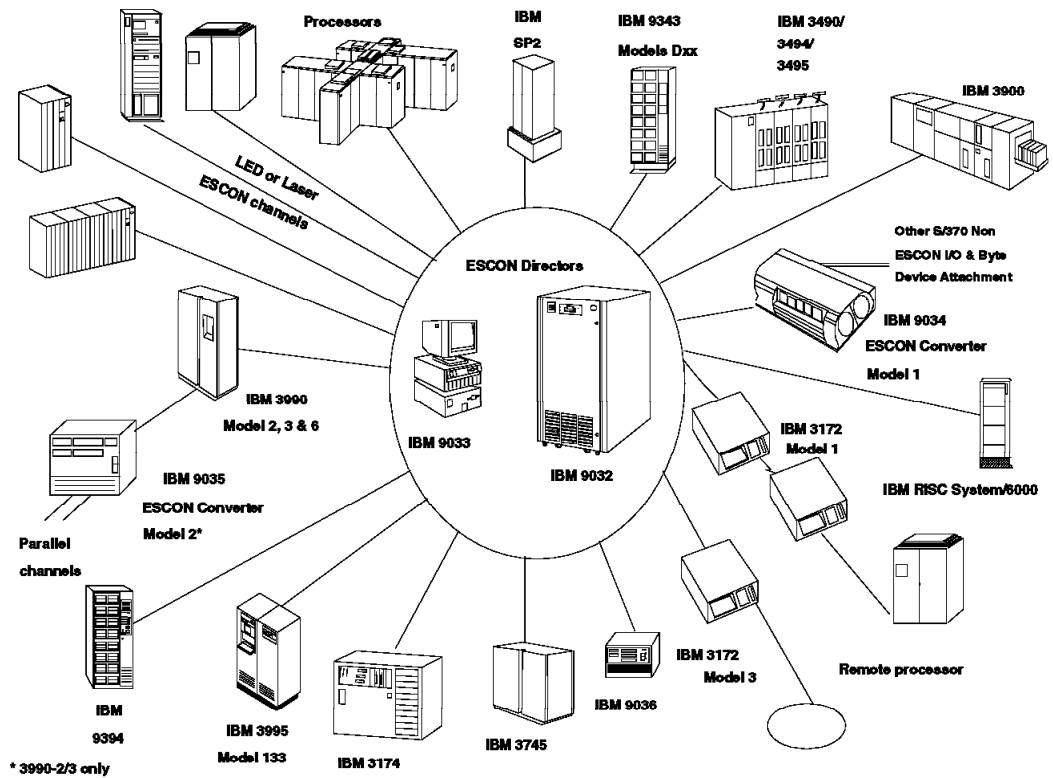
Figure 35. Spectrum of ESCON Products

6.3.1 9033 Models 001 and 004

There are two models of the IBM 9033 EXCON Director:

6.3.1.1 ESCON Director Model 1 (IBM 9033)

The signigicant properties fo the ESCON Director model 1 are:

- Basic configuration of eight ports (addresses X′C0′ to X′C7′).

- Can be ordered with eight to 16 ports in 4-port increments.

- Ports can be all LED, all XDF, or mixed on 4-port basis.

- Port addresses range from X′C0′ to X′CF′.

- Ports are installed sequentially in ascending order.

- Port address X′FE′ is used for communication between the host and an ESCON Director Model 1.

- Console sharing option is available on the ESCON Director Model 1.

- Spare console may be installed when console sharing is used.

- Spare ports are not available on the ESCON Director Model 1.

6.3.1.2 ESCON Director Model 4 (IBM 9033)

The signigicant properties fo the ESCON Director model 4 are:

- The 9033-4 is similar to the 9033-1 but with enhanced console environment.

  - The console for the 9033-4 has a graphical user interface following WIN-OS/2 standards, including the use of a mouse.

  - The console is attached to the Director through Token-Ring, and may share the same console for the 9032-3.

- It has a basic configuration of eight ports. Port cards are initially installed in DVP slot 0 with port address X′C0′ to X′C3′. The base configuration can be all LED ports, all XDF ports, or a combination of 4 LED and 4 XDF ports.

- Port cards do not have to be installed contiguously.

- Can be ordered with eight to 16 ports in 4-port LED or XDF increments. Each port card holds 4 ESCON ports.

- Port addresses range from X′C0′ to X′CF′.

- Default port addresses assignment for the physical port numbers starts at X′C0′ for X′60′ and goes up to X′CF′ for X′6F′ respectively.

6.3.2 9032 Models 002 and 003

There are two models of the IBM 9032 EXCON Director:

6.3.2.1 ESCON Director Model 2 (IBM 9032)

The signigicant properties fo the ESCON Director model 2 are:

- Can be ordered with 28 to 60 ports in 4-port increments.

- Port addresses range from X′C0′ to X′FB′.

- Ports can be all LED, or mixed LED and XDF.

- Ports are installed sequentially in descending order.

- Ports from X′FB′ to X′EC′ are LED only.

- Console sharing option is available on the ESCON Director Model 2.

- Spare console may be installed when console sharing is used.

- Can be ordered with the high availability feature, which gives two spare ports (either LED, or LED and XDF), and an extra fan and power supply:

  - With this feature, a failing port can be replaced by a spare port, still maintaining port addressing. A service representative does not have to switch off power to the 9032, but simply moves the connector from the affected port to the spare port and transfers all connection capabilities to that spare port by entering commands on the ESCON director console.

  - The 9032 needs two power supplies to operate. If one power supply fails, the remaining one and the extra power supply will maintain 9032 operations.

- Port address X′FE′ is used for communication between the host and the ESCON Director Model 2.

6.3.2.2 ESCON Director Model 3 (IBM 9032)

The signigicant properties fo the ESCON Director model 3 are:

- Basic configuration of 28 ports, of which 16 must be LED.

- Can be ordered with 28 to 124 ports in 4-port increments.

- Ports can be all LED, or mixed LED and XDF on a 4-port basis.

- 31 port card slots are numbered Device Ports (DVP) 0 through 30. When fully installed, the Director contains 124 device ports (with 4 LED or XDF device ports on each port card), numbering from X′00′ to X′7B′.

- Default port address range from X′80′ for physical port number X′00′ to X′FB′ for physical port number X′7B′. The default port addresses can be mapped to other ports through a console maintenance function, which may be useful to quickly transfer connections from a failed port to a spare port.

- Ports are installed sequentially in ascending order from address X′80′ when first delivered to the customer. However, port cards do not have to be installed contiguously and may be relocated to other DVP slots with desired port addresses to ease the migration from another Director.

- Enhanced console environment:

  - The console for the 9032-3 has a graphical user interface following WIN-OS/2 standards, including the use of a mouse.

  - Directors and consoles must connect through a 4/16 Mbit/sec Token-Ring LAN. The consoles can be connected through a bridged LAN; but it cannot connect through routers, unless the routers are used for bridging only. It can be located anywhere up to the limit of the installed Token Ring.

  - A console can manage from 1 to 16 Directors in a cluster.

  - Although a single console can control multiple Directors, two or more consoles cannot share control of a Director. For maximum availability in event of a console failure, a second backup console should be available on the Token-Ring LAN.

  - The 9032-003 console does not support the 9032-002 or 9033-001 Directors. The consoles for the 9032-002 and 9033-001 do not support the 9032-003 Director.

  - The 9032-003 Director requires a console to be ordered separately through the console feature 4900. The console feature will cause the current, recommended IBM console configuration to be shipped, together with all the software needed for the console. It is strongly recommended that customers use the IBM-supplied console, and place the order for the console feature at the same time as the order for the Director to ensure co-ordinated shipment. Should the customer decide to supply their own console, then they must meet the minumum specifications for the hardware and software requirements. For more information about the requirements, see *Planning for the 9032 Model 003*.

  - The Multistation Access Unit (MAU) must also be ordered separately. An eight-port MAU is optionally available with the Director through feature code 4400.

  - Remote service access to the console is allowed through the DCAF software and modem attachment to the console's communication port.

- ESCON Manager for MVS Version 1 Release 3 supports the 9032-3, but must have PN51474 installed prior to starting the ESCON Manager. Version 1 Release 2 does not support the 9032-3, but may coexist with the 9032-3 with PN65104 installed prior to installing the 9032-3.

- Port sparing is supported by any installed port that is not in use, unlike the 9032-2 which designate port sparing on a two-port spare card optional feature. Port sparing can be accomplished with a simple command on the console, non-disruptively and without changing the hardware configuration on the processor.

- 4 optional redundancy features can be ordered to enhance the availability of the Director.

  - *Redundant Token-Ring Card* (f/c 4800). A second Token-Ring card can be installed on the Director, and attached to the same Token-Ring as the primary console, for automatic take over in the event of a failure of the primary Token-Ring card. Another option would be to install the redundant Token-Ring card with attachment to a separate Token-Ring, with a spare console on the separate Token-Ring.

  - *Redundant Power Supply* (f/c 4700). Provides a second power supply, which can be plugged into a separate power circuit.

  - *Redundant Control Processor* (f/c 4600). Provides a second control processor card, which automatically takes over in the event of a failure of the active control processor card. Concurrent Licenced Internal Code (LIC) maintenance can also be achieved by loading the new LIC onto the backup control processor card, and then switching operation to the backup control processor card while the primary control processor is being updated with the new LIC.

  - *Redundant Matrix Controller and Matrix Switch* (f/c 4500). The matrix controller and matrix switch pair of cards handle the switching operation of the Director. Should any of these card fail, the appropriate redundant card automatically takes over the switching operation without disrupting the Director's operation.

- Port address X'FE' is used for communication between the host and the Director.

6.3.3 Model 1 Physical Components

The ESCON Director Model 1 seen in Figure 36 has the following components:

- Main Unit - performs the connection process.

- Director Ports - ports are configured as shown in Table 27.

- Console - required for:

  - Installing the ESCON Director Model 1

  - Initializing the ESCON Director Model 1

  - Creating, changing, saving, and activating configurations

  - Changing the attributes of the ports

  - Maintaining the ESCON Director Model 1

  - Managing passwords

  - Storing the error log on an ESCD console diskette

  - Maintaining the audit trail on an ESCD console diskette

  Note: ESCON Directors Model 1 shipped before March 27, 1992 will use the PS/2 Model 30 (with an 80286 processor) or equivalent as the ESCD console. Those shipped after March 27, 1992 will use the PS/2 Model 35 or equivalent. ESCD consoles shipped prior to March 27, 1992, can be upgraded by the addition of PS/2 features #1076 (30 MB Fixed Disk) and #7833 (2 MB Storage Option). An 8518 or equivalent display, 2.0 MB of storage, an enhanced keyboard, a double-sided 1.44 MB diskette drive (3.5 inch), and a 20 MB (or larger) fixed disk are required. The console sharing option allows one to eight clustered ESCON Directors (Model 1 and Model 2 can be intermixed) to share a single console. The Directors must placed adjacent to each other. Depending on the configuration, several cables may be needed for sharing a console. Also, all the directors must be at the EC level supporting this enhancement (EC #83781) or higher, and feature code 9100 must be installed.

- Operator panel - containing:

  - Power-on switch

  - Power-on indicator

- ESCD console adapter card

  - The adapter card provides communication between the ESCD console and the 9033. This card may already be installed in the ESCD console. If it is not, the service representative must install this card in the ESCD console and attach the signal cable provided with the 9033.

- ESCD power cable

- ESCD console adapter cable

- ESCD console diskettes

  - These diskettes contain operational support for the 9033 (such as configurations, error log, and audit trail) and diagnostics to test the 9033. Operational support for the directors is provided by a subset of the DOS operating system and is delivered with the director.

Figure 36. ESCON Director Model 1 (IBM 9033)

Table 27. 9033-1 Director Port Configuration		
Base Ports	X′C0′ - X′C3′	X′C4′ - X′C7′
#4020, #4020	LED	LED
#4020, #4030	LED/XDF	XDF/LED
#4030, #4030	XDF	XDF
Optional Ports	X′C8′ - X′CB′	X′CC′ - X′CF′
#4040	LED	N/A
#4040, #4040	LED	LED
#4050	XDF	N/A
#4040, #4050	LED/XDF	XDF/LED
#4050, #4050	XDF	XDF

6.3.4 Model 2 Physical Components

The ESCON Director Model 2 as seen in Figure 37 has the following components:

- Main Unit - handles the dynamic connection process.

- Director Ports - ports are configured as shown on Table 28 and Table 29.

- Console - used for:

  - Installing the ESCON Director Model 2

  - Initializing the ESCON Director Model 2

  - Creating, changing, saving, and activating configurations

  - Changing the attributes of the ports

  - Maintaining the ESCON Director Model 2

  - Managing passwords

  - Storing the error log on an ESCD console diskette

  - Maintaining the audit trail on an ESCD console diskette

  Note: The ESCON Directors Model 2 shipped before March 27, 1992 will use the PS/2 Model 30 (with an 80286 processor) or equivalent as the ESCD console. Those shipped after March 27, 1992 will use the PS/2 Model 35 or equivalent. ESCD consoles shipped prior to March 27, 1992, can be upgraded by the addition of PS/2 features #1076 (30 MB Fixed Disk) and #7833 (2 MB Storage Option). An 8518 or equivalent display, 2.0 MB of storage, an enhanced keyboard, a double-sided 1.44 MB diskette drive (3.5 inch), and a 20 MB (or larger) fixed disk are required. The console sharing option allows one to eight clustered ESCON Directors (model 1 and model 2 can be intermixed) to share a single console. The Directors must be placed adjacent to each other. Depending on the configuration, several cables may be needed for sharing a console. Also, all the directors must be at the EC level supporting this enhancement (EC #83780) or higher, and feature code 9100 must be installed.

- Operator panel - containing:

  - Power-on switch

  - Status display with status codes that identify errors in:

    - Initialization routines (during power-on and IML)

    - Programming interface

    - Connectivity control

    - Host (VM and MVS) status codes

  - Status indicator

  - Power-on indicator

- ESCD console adapter card

  - The adapter card provides communication between the ESCD console and the 9032. This card may already be installed in the ESCD console. If it is not installed, the service representative must install this card in the ESCD console and attach the signal cable provided with the 9032.

- ESCD power cable

- ESCD console adapter cable

- ESCD console diskettes

  - These diskettes contain operational support for the 9032 (such as configurations, error log, and audit trail) and diagnostics to test the 9032. Operational support for the directors is provided by a subset of the DOS operating system and is delivered with the director.
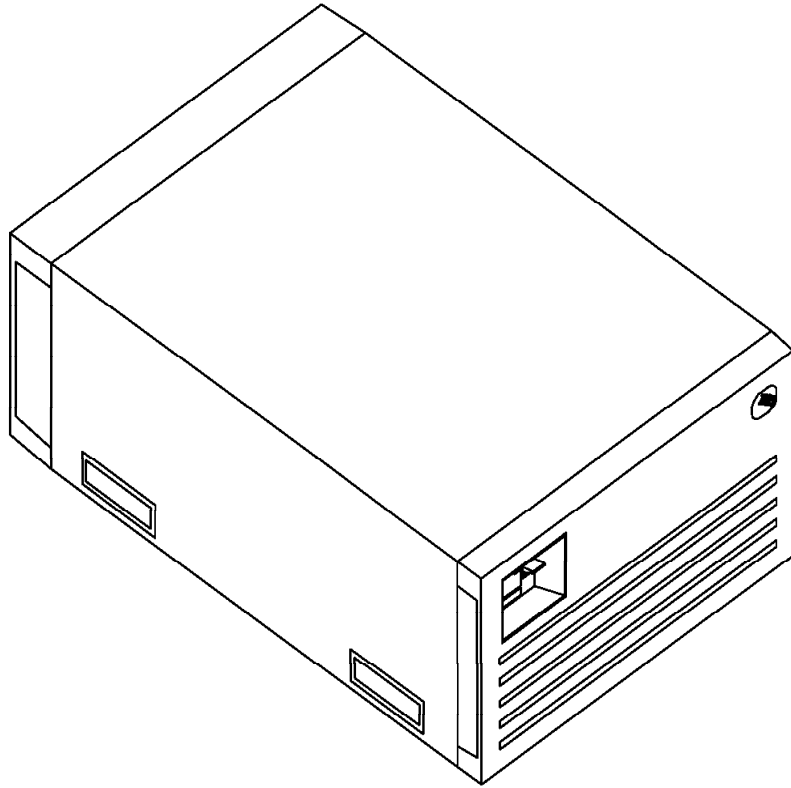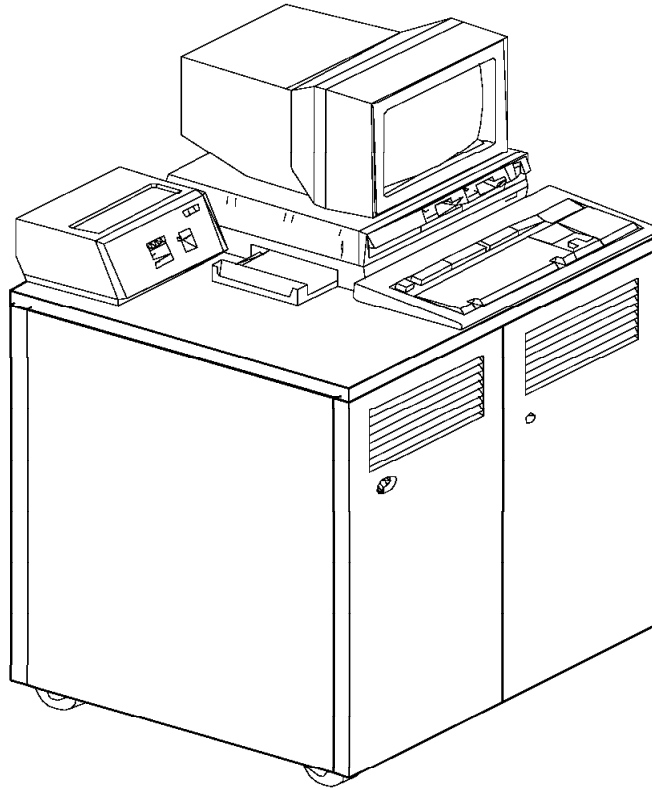

Figure 37. ESCON Director Model 2 (IBM 9032)

Table 28. 9032-2 Base and Spare Ports Configuration			
Ports	**Addresses**	**Technology**	
		LED	**XDF**
1 - 16	FB - EC	Standard	N/A
17 - 20	EB - E8	Standard	#4034
21 - 24	E7 - E4	Standard	#4035
25 - 28	E3 - E0	Standard	#4036
Spares	FC - FD	#4048 (note)	N/A
Spares	FC - FD	#4058 (note)	
Note:			
Features #4048 and #4058 cannot coexist.			

Table 29. 9032 Additional Ports Configuration			
Ports	Addresses	Technology (note)	
		LED	XDF
29 - 32	DF - DC	#4040	#4050
33 - 36	DB - D8	#4041	#4051
37 - 40	D7 - D4	#4042	#4052
41 - 44	D3 - D0	#4043	#4053
45 - 48	CF - CC	#4044	#4054
49 - 52	CB - C8	#4045	#4055
53 - 56	C7 - C4	#4046	#4056
57 - 60	C3 - C0	#4047	#4057
Note:			
Features #404x and #405x cannot coexist.			

6.3.5 Model 3 Physical Components

The ESCON Director Model 3 as seen in Figure 38 has the following components:

• Power on/off switch

• Operator panel - containing:

    – Initial machine load (IML) button

    – System error indicator LED

    – Power-on LED

    – Liquid crystal display (LCD) for a status and event messages display
       using two 16-character lines, with four button controls

• Document storage compartment

• Fans

    – Two fans provide cooling for internal components while a third fan
       provides redundancy for continued operation in case a fan fails.

• Control processor (CTP) card

    – This provides overall coordination for the Director, supporting the
       Director CUP, maintenance port, operator panel, ESCON port exception
       handling, error recovery, and initializing hardware components of the
       system after power or reset.

• Device port (DVP) cards:

    – Default configuration for the base 28 ports are 28 LED ports (7 LED port
       cards) and 0 XDF ports (0 XDF port card). The customer may order a
       different base configuration of any combination of LED and XDF port
       cards, up to a maximum of 3 base XDF port cards, by specifying one
       quantity of feature code 4250 for each of the base XDF port cards. That
       is, the base configuration must have at least 16 LED ports and a
       maximum of 12 XDF ports. The base configuration port cards will be
       pre-installed in DVP slots 0 to 6, but may be relocated to any other DVP
       slot.

    – Additional ports, in increments of 4, may be ordered beyond the base
       configuration. Specify one quantity of feature code 4240 for every 4 LED

ports, and one quantity of feature code 4251 for every 4 XDF ports. The total quantity of additional port cards, LED and XDF, must not exceed 24 (providing 96 ports). The additional port cards can be installed on any empty DVP slot.

- Matrix controller and matrix switch (MXC/MXS) cards

    - The two-card matrix controller/switch pair makes decisions on dynamic allocation requests. They also provide for connection paths between ports specified by port attributes as configured through the Director's Console or ESCON Manager.

- Token-Ring controller adapter card

    - This card provides a port to connect the Director to a 4/16 Mbit/sec Token-Ring local area network (LAN) for access by a console on the LAN.

- Power supplies

    - A 90 to 264 V ac variable power supply provides dc power to the Director.

- AC power input

    - There are two plug receptacles for AC power.

- Fiber optic cable restraints

- Console with operational support software - must be ordered separately from the ESCON Director, together with the MAU; is used for:

    - Installing a Director

    - Cycling Director power

    - Performing a Director IPL

    - Making configuration changes to a Director

    - Saving various configurations on the console's fixed disk

    - Storing the event logs on the console's fixed disk

    - Providing password protection for each level of Director management

    - Maintaining the audit trail on the console's fixed disk

    - Troublingshooting Director operation and connection problems

    - Performing maintenance operations

    - Maintaining a library of multiple Director configurations

    - Maintaining a library of multiple Director LIC versions for downloading to any attached Director

    - Mapping logical address to any physical port on any Director

- Token-Ring cable for the Director's Token-Ring Controller Adapter card

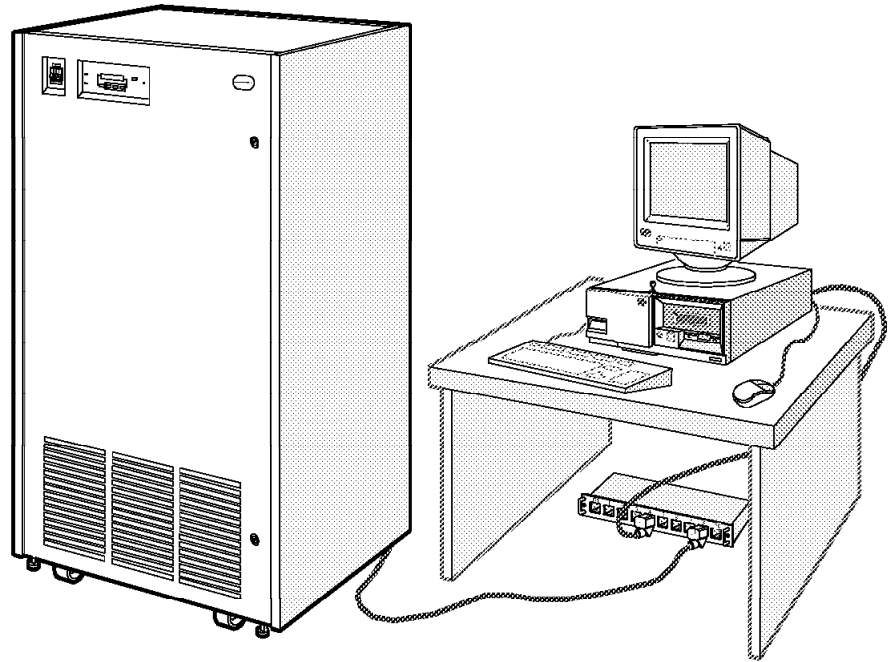- Fiber optic cables

- Power cords

- Power cable

Figure 38. ESCON Director Model 3 (IBM 9032)

6.3.6 Model 4 Physical Components

The ESCON Director Model 4 as seen in Figure 39 has the following components:

- Control processor (CTP) card

  - CTP cards are interchangeable between the 9032-3 and 9033-4 Directors.

- Device port (DVP) cards:

  - DVP cards are interchangeable between the 9032-3 and 9033-4 Directors.

  - Default configuration for the base 8 ports are 8 LED ports (2 LED port cards) and 0 XDF ports (0 XDF port card). Customer may order a different base configuration of all XDF or a combination of 4 LED and 4 XDF ports.

  - The 9033-4 can contain a maximum of 4 port cards, with either 4 LED or 4 XDF ports on each card.

- Token Ring controller adapter card

  - TKRG cards are interchangeable between the 9032-3 and 9033-4 Directors.

  - This card provides a port to connect the Director to a 4/16 Mbit/sec Token-Ring local area network (LAN) for access by a Console on the LAN.

- Power supply assembly (includes operator panel and fans)

- Matrix controller and matrix switch (MXC/MXS) card

- Logic board

  - Provides the power and logic connections for the logic cards

- AC power input

- Document storage compartment

- Fiber optic cable restraints

- Token Ring cable (20 feet) for connection to the MAU.
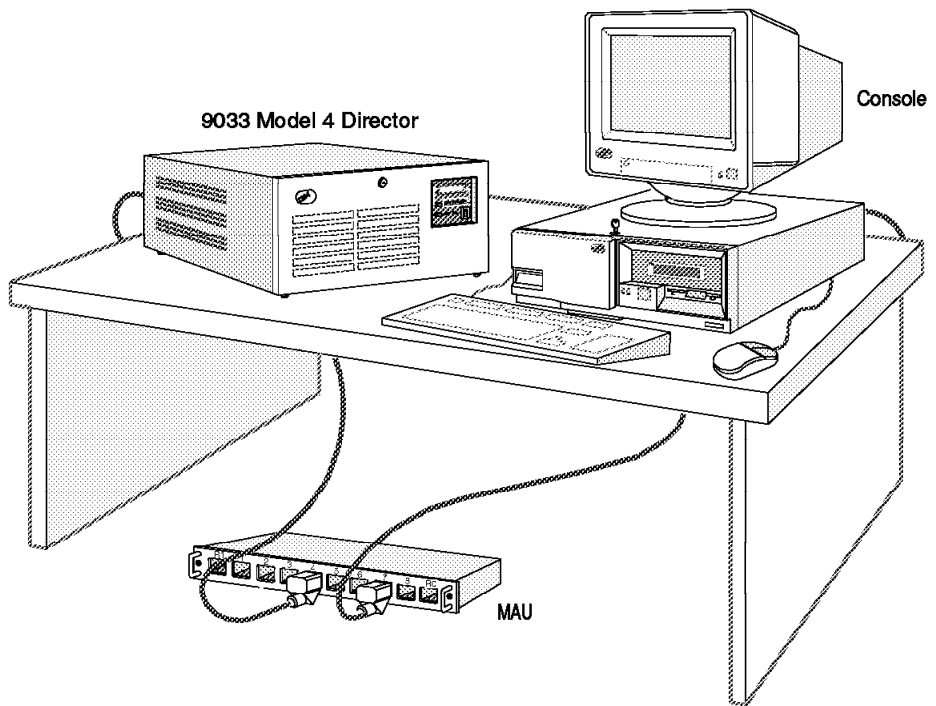
- Fiber optic cables.

- Director power cord.

Figure 39. ESCON Director Model 4 (IBM 9033)

6.3.7 ESCD Functional Components

The ESCON Director has the following major functional components; their location in the Model 2 can be seen in Figure 40:

Matrix Switch - provides the port-to-port connection under control of the matrix controller.

Matrix Controller - establishes a port-to-port connection based on the information the ESCON Director gets from a frame it receives. The frame provides source and destination information, which is interpreted by the matrix controller, and the ESCON Director makes the connection required. Upon request to remove the connection, the matrix controller makes the port available for other connections. With a dedicated connection, the matrix controller will not interpret the frame information.

Control Unit Port - reserved for communication between the host and the ESCON Director (address X'FE'). It acts as a control unit with address 00. The control unit executes commands and provides the means to attach channels.

Control Processor - provides control of the power and thermal system. It controls the system clock, the operator panel, and the self-test circuitry.
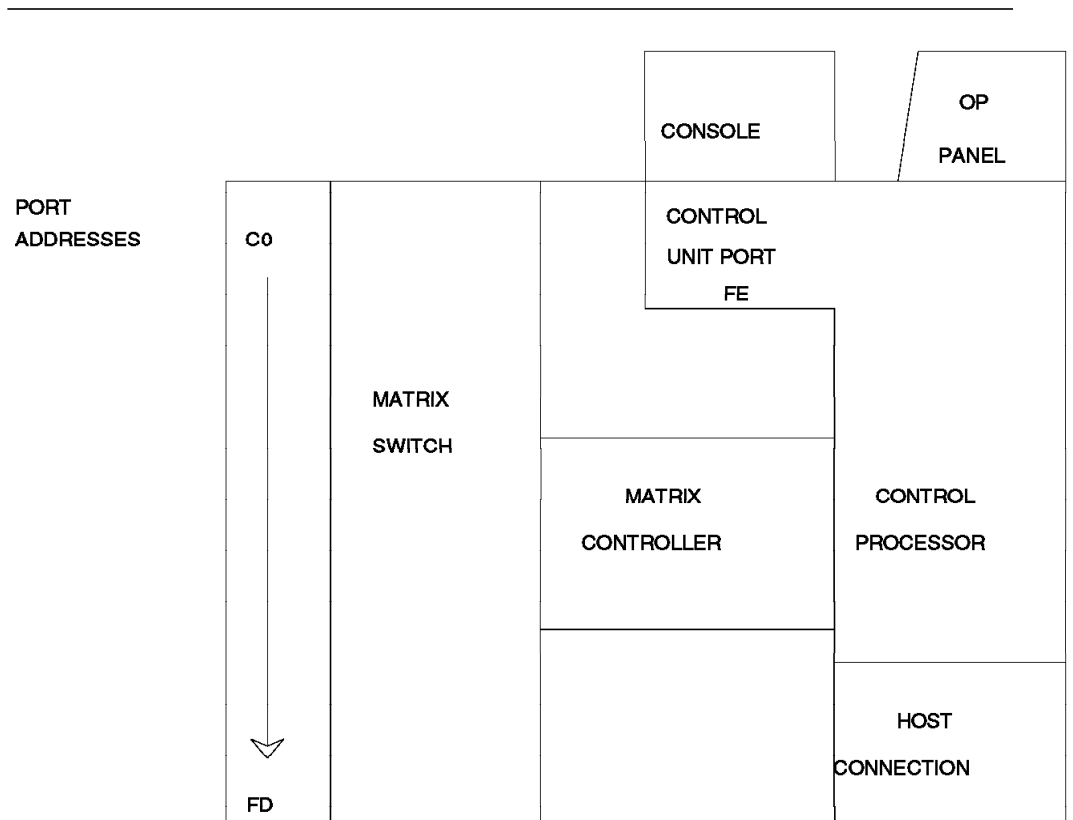

Figure 40. ESCON Director Model 2 Functional Components

6.3.8 ESCD Port Attributes

Each ESCON Director port has an attribute that describes its relationship to other ports. A hierarchy exists among those attributes. When the ESCON Director is installed, any port can be connected to any other port. The operator may assign attributes to ports to restrict these 'any-to-any' connections. Figure 41 is an example of attributes assigned to ports, and what they mean. The attributes are:

- BLOCK

   This attribute is used for blocking a specific port from connecting to any other port in the ESCON Director.

   Note: This attribute permits you to install new control units, connected to a blocked port, without impacting an active configuration.

- CONNECT

   This attribute defines a dedicated connection. Two dedicated ports cannot exchange information with any other ports. This attribute *must* be assigned to those ports that communicate through a 9034 Converter. With chained ESCON Directors, one of the connections through the ESCON Directors must be dedicated.

- PROHIBIT

   This attribute prevents communication between two specific ports. It does not prohibit communication between these two ports and any other ports.

- ALLOW

   This attribute describes a port that can communicate with any other port in the matrix except those that are blocked or dedicated.

6.3.8.1 Attribute Hierarchy

The port attributes are set in the port matrix and have the following hierarchy:

1. BLOCK

2. CONNECT

3. PROHIBIT

4. ALLOW

If no other attribute is specified, a connection between two ports is allowed. However, if a prohibit is placed on the connection between two ports, they cannot be connected. The prohibit attribute would be overridden by a dedicated connection between two ports. Finally, the block attribute overrides all the others, and a connection cannot be established with a blocked port. Therefore:

- The BLOCK attribute overrides the CONNECT attribute.
- The CONNECT attribute overrides the PROHIBIT attribute.
- The PROHIBIT attribute overrides the ALLOW attribute.

The operator may assign these attributes using the ESCON Director console or the ESCON Manager (ESCM) running under MVS/ESA or VM/ESA.
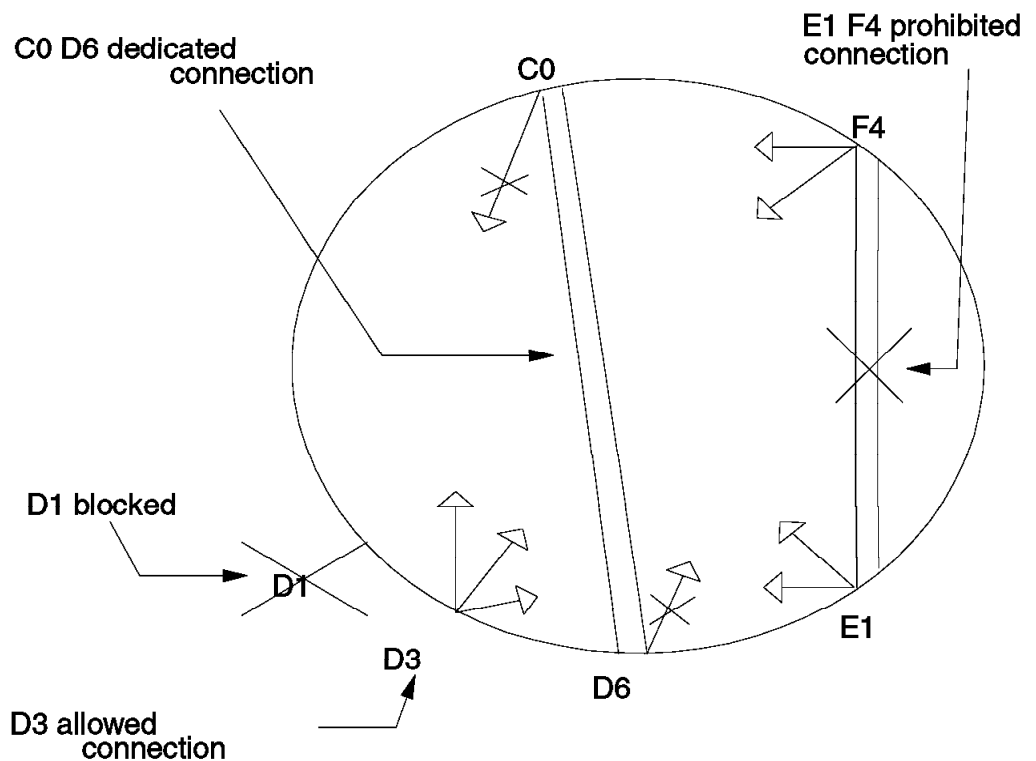
Figure 41. ESCD Port Attributes

6.3.8.2 Switch Partition

After the ESCON Director has been installed and is activated for the first time, the matrix shows that any port can communicate with any other port. You should, however, restrict this, and let ports communicate with other ports only as necessary. This section describes how to define a switch partition.

To define switch partitions, proceed as follows:

1. After the ESCON Director has been installed, *prohibit* all the ports on the screen (X′C0′ to X′FB′ in a maximum configuration).

   This means that no port can communicate with any other port. The operator uses the ESCON Director console to do this, or he can use the ESCON Manager commands, if an ESCON channel and IOCP definitions are already provided.

   By using the ESCON Director console, the operator or system programmer types all Ps in the corresponding address columns from left to right, starting with the lowest port address. On the matrix screen, a map is displayed (refer to 6.3.12, "Matrix Display" on page 106).

   On the right side of the matrix display, there are a number of Xs displayed if there are more than 16 ports installed. If there are only 16 ports installed, every port address can be displayed on one screen. The uppercase X shows you the group of 16X16 intersections you are in.

After the operator or system programmer has finished typing in the Ps on the row belonging to the lowest port address, he can copy this row to the other rows, from top to bottom.

2. Assign self-explaining names to the ports that are used.

   The port address name can be 24 characters long and must be unique within the same ESCON Director. Examples are, PROD_CHPID30 (meaning: CHPID 30 belonging to LPAR partition PROD, or system PROD), or 3990_CU01_PATH01 (meaning: Interface 1 on storage cluster 0 on 3990 control unit number 01).

3. Following the IOCP definitions for your facility, allow only those port-to-port connections that are "active".

   Do this for every system or system image connected to that ESCON Director. "Active" means that there is a channel connected to a port, and a control unit (or ESCON CTC) connected to a port. You may further restrict the connections by allowing only those port-to-port connections that are needed by a system or system image in normal day-to-day operations. All other port-to-port connections remain prohibited.

4. Save the created matrix in the IPL configuration file, or in any other file that you can activate using the configuration file name.

5. If you have several systems in your facility, which can be used as backups for each other, create several matrix configuration files, each of them representing a different situation.

   For instance, in normal operation, you will not allow SYSTEM-B to have access to the control units of SYSTEM-A. In the active configuration matrix of the ESCON Director, the channel paths coming from SYSTEM-B to those control units of SYSTEM-A are prohibited. If, for instance, SYSTEM-A is not available because of maintenance, and the online service must be continued on SYSTEM-B, the operator can activate another matrix configuration file, which is specific for this situation, and the channel paths coming from SYSTEM-B can have access to the control units of SYSTEM-A (PROHIBIT attribute has been removed). After this activation, the operator can, for instance, IPL the SCP software from SYSTEM-A on SYSTEM-B.

In this way you have defined switch partitions, so only those connections that have to communicate with each other are allowed to do so. You have, for instance, the production system control units and data separated from the test system control units and data. Of course, if an ESCON channel is re-plugged into another port of the ESCON Director, the operator or system programmer must not forget to change the port status from PROHIBIT to ALLOW for the corresponding control unit port. Also, the operator must change the port status of the original port from ALLOW to PROHIBIT for the corresponding control unit port.

If a link breaks, all the ports are informed. So, if you have not defined switch partitions, all the systems or system images are informed of the problem. If you have defined switch partitions, then only the systems or system images that can connect to the port of the failing link get information about the event.

6.3.9 ESCON Director Models 1 and Model 4 Addresses

Each port has a 2-hexadecimal-digit identifier between X′C0′ and X′CF′. The address ranges are:

X′C0′ to X′C7′ for 8-port units
X′C0′ to X′CF′ for 16-port units

Note: X′FE′ is the port address used by the ESCON Director Model 1 control unit to communicate with the host.

Figure 42 shows the 9033-4 logic card layout, physical port numbering, and default port addressing.

Figure 42. ESCON Director Model 4 Ports

6.3.10 ESCON Director Model 2 Addresses

Each port has a 2-hexadecimal-digit identifier between X′C0′ and X′FBX′. The address ranges are

X′E0′ to X′FB′ for 28-port units
X′C0′ to X′FB′ for 60-port units

Note: X′FE′ is the port address used by the ESCON Director Model 2 control unit to communicate with the host. Addresses X′FC′ and X′FD′ are reserved for optional spare ports.

The ESCON Director Model 2 matrix can be displayed by groups of addresses. There are up to 16 groups, which reflects the total ESCON Director Model 2 matrix. The different groups can be scrolled using function keys (PF7, PF8, PF10, and PF11).

Figure 43 shows an example of how a port configuration looks with its addresses.
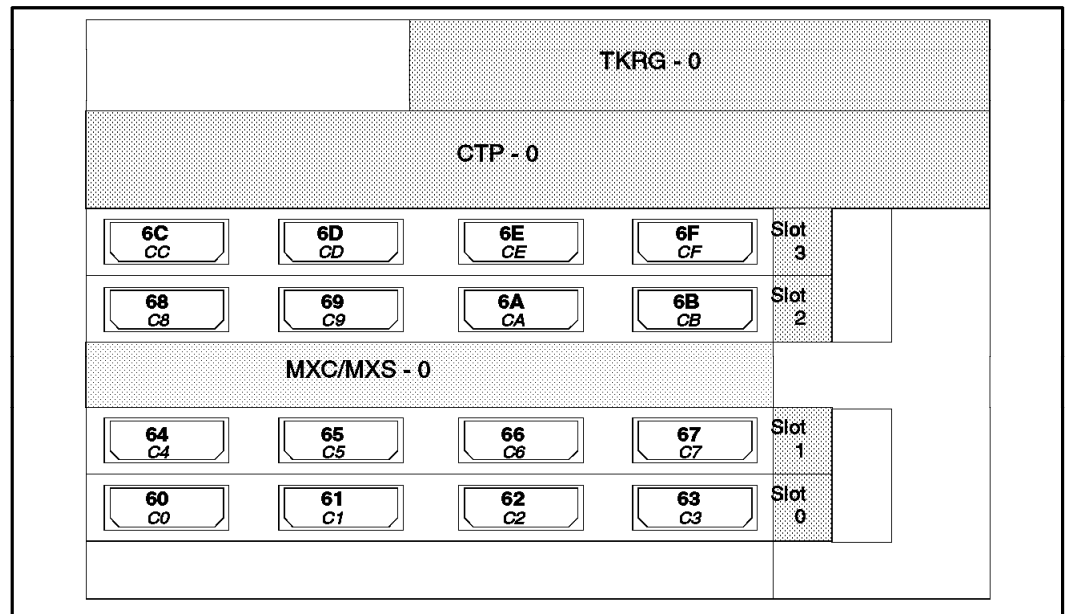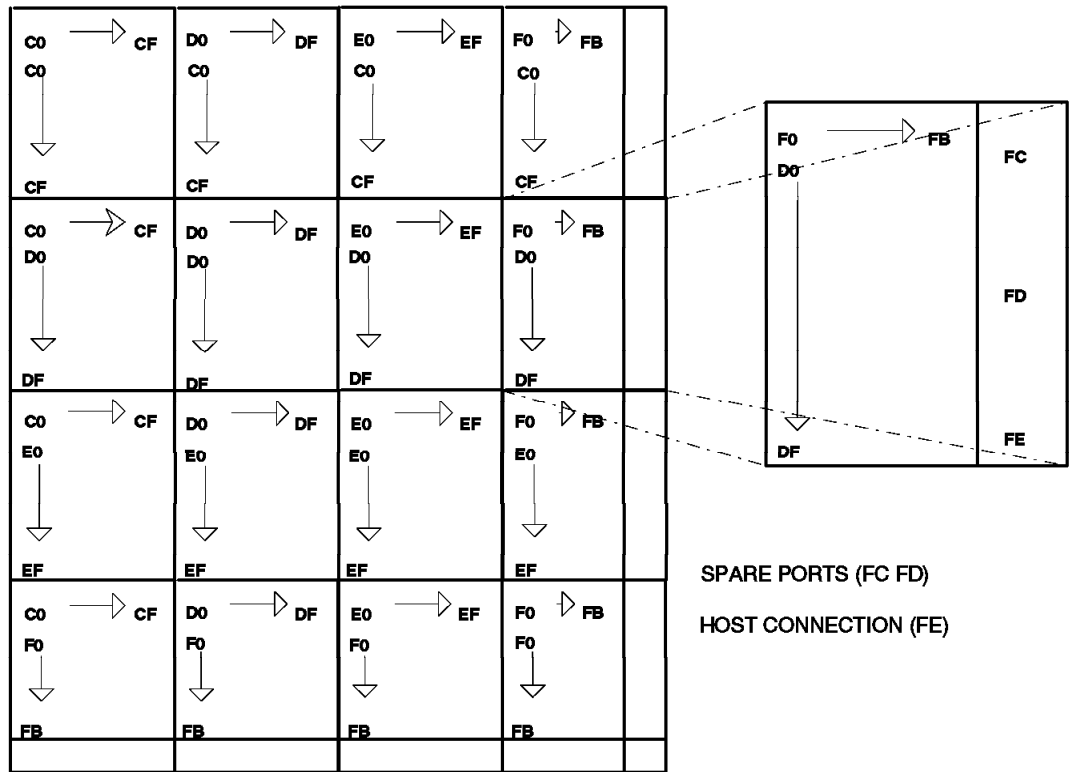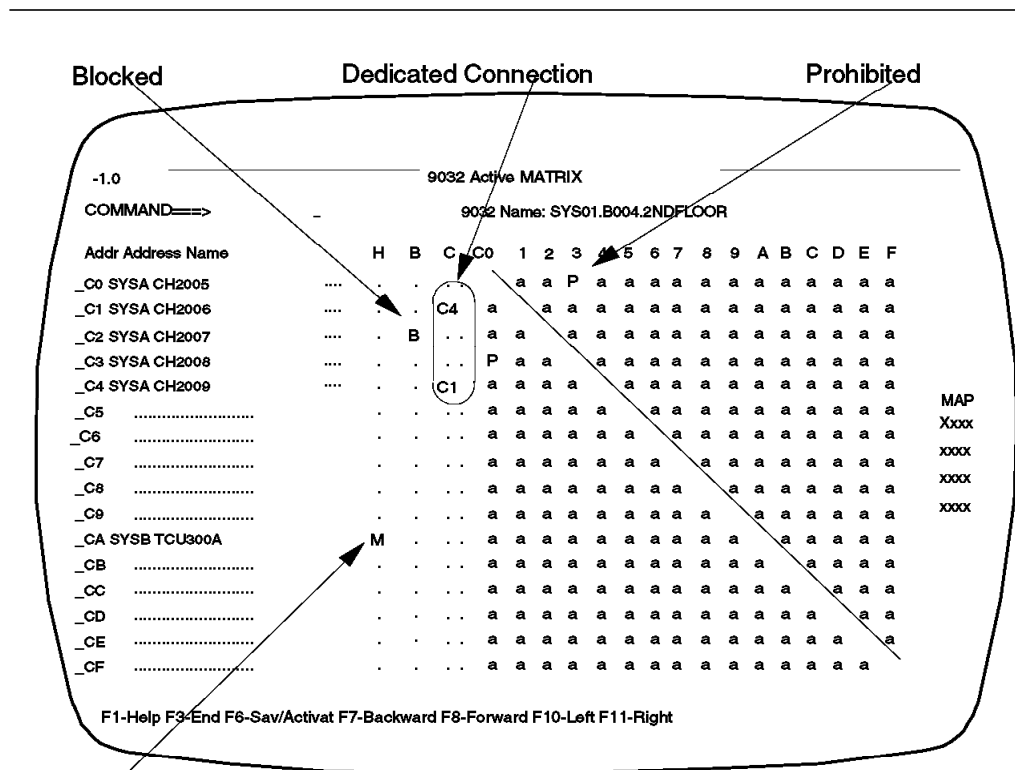

Figure 43. ESCON Director Model 2 Ports

6.3.11 ESCON Director Model 3 Addresses

Each port has a 2-hexadecimal-digit identifier between X′80′ and X′FB′. The address ranges, for default configuration shipment, are

> X′80′ to X′9B′ for 28-port units

- It should be noted that the shipped port cards may be relocated to other DVP slots, thereby changing the default port address range when shipped.

> X′9C′ to X′FB′ for 60-port units

Note: X′FE′ is the port address used by the ESCON Director Model 3 control unit to communicate with the host.

Figure 44 shows an example of how a port configuration looks with its addresses.

D — Quadrant D / DVP

78 / F8	74 / F4	70 / F0	6C / EC	68 / E8	64 / E4	60 / E0
79 / F9	75 / F5	71 / F1	6D / ED	69 / E9	65 / E5	61 / E1
7A / FA	76 / F6	72 / F2	6E / EE	6A / EA	66 / E6	62 / E2
7B / FB	77 / F7	73 / F3	6F / EF	6B / EB	67 / E7	63 / E3
30	29	28	27	26	25	24

C — Quadrant C / DVP

5C / DC	58 / D8	54 / D4	50 / D0	4C / CC	48 / C8	44 / C4	40 / C0
5D / DD	59 / D9	55 / D5	51 / D1	4D / CD	49 / C9	45 / C5	41 / C1
5E / DE	5A / DA	56 / D6	52 / D2	4E / CE	4A / CA	46 / C6	42 / C2
5F / DF	5B / DB	57 / D7	53 / D3	4F / CF	4B / CB	47 / C7	43 / C3
23	22	21	20	19	18	17	16

CTP -0- | CTP -1- | MXC -0- | MXS -0- | MXC -1- | MXS -1-
← Slot Number →

Slot (Quadrant B): 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8
Slot (Quadrant A): 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0

B — Quadrant B / DVP

3C / BC	38 / B8	34 / B4	30 / B0	2C / AC	28 / A8	24 / A4	20 / A0
3D / BD	39 / B9	35 / B5	31 / B1	2D / AD	29 / A9	25 / A5	21 / A1
3E / BE	3A / BA	36 / B6	32 / B2	2E / AE	2A / AA	26 / A6	22 / A2
3F / BF	3B / BB	37 / B7	33 / B3	2F / AF	2B / AB	27 / A7	23 / A3

A — Quadrant A / DVP

1C / 9C	18 / 98	14 / 94	10 / 90	0C / 8C	08 / 88	04 / 84	00 / 80
1D / 9D	19 / 99	15 / 95	11 / 91	0D / 8D	09 / 89	05 / 85	01 / 81
1E / 9E	1A / 9A	16 / 96	12 / 92	0E / 8E	0A / 8A	06 / 86	02 / 82
1F / 9F	1B / 9B	17 / 97	13 / 93	0F / 8F	0B / 8B	07 / 87	03 / 83

TKRG -0- | TKRG -1-

KEY: **Bold Numbers** = Port Numbers
Italic Numbers = Default Port Address
Shaded Numbers = Port Card Slots

Figure 44. Physical Port Numbering and Default Addressing in the 9032-3 Director

6.3.12 Matrix Display

Figure 45 shows a port matrix display of the 9032-2. The fields are:

Field	Content
Name	Name of the ESCON Director in the configuration.
Addr	2-digit address of the port.
Address Name	24-character field used to identify the CHPID or control unit attached to this port. You (optionally) supply this information.
H	Field describing the hardware status, as follows: S = Service required M = Under maintenance O = Offline port L = Link failure N = Port not installed
B	Blocking attribute.
C	Dedicated connection.

Note: All the fields except the H field are input fields.

Figure 45. 9032-2 ESCD Matrix Display

In the ESCON Director Model 2 matrix, there are up to 16 groups of ports that
can be scrolled using PF keys. The map on the right of the screen shows which

sets of addresses you are dealing with. An upper-case ′X′ in the map shows which group you are looking at. In Figure 45, we are looking at the first group of 16 ports, and how they connect to the first 16 ports.

In Figure 45 you can see what actions the operator has taken:

1. Port C1 has a dedicated connection with port C4.

   To achieve this, the operator uses the TAB key or the cursor key and puts the characters C4 in the row SYSA_CH2006 (address C1) under column C. The ESCON Director fills in the second (reciprocal) setting for him or her (C1 in row SYSA_CH2009 (address C4) under column C.).

2. Port C2 is blocked.

   To achieve this, the operator uses the TAB key or the cursor key and puts the character B in row SYSA_CH2007 (address C2) under column B.

3. Port C0 cannot communicate with Port C3.

   To achieve this, the operator uses the TAB key or the cursor key and puts the character P in the row SYSA_CH2005 under the column 3 (address C3 at the top of the matrix). The ESCON Director fills in the second (reciprocal) setting for him or her (P in row SYSA_CH2008 (address C3) under the column C0.).

4. Port CA is under maintenance.

   The H column is under system control, so the operator cannot change this field.

After the operator has made the changes on the matrix screen, he uses key PF6 to process the changes. Then another screen is displayed and the operator can save or activate the changes (or both). If the operator has activated the ACTIVE=SAVED option, then the changes are automatically saved in the IPL configuration file after activation.

6.3.12.1 Models 3 and 4
The console for the new ESCD Models 3 and 4 uses a graphical user interface following WIN-OS/2 standards, including the use of a mouse. Figure 46 on page 108 shows an example of a graphical display of the Configuration Matrix.
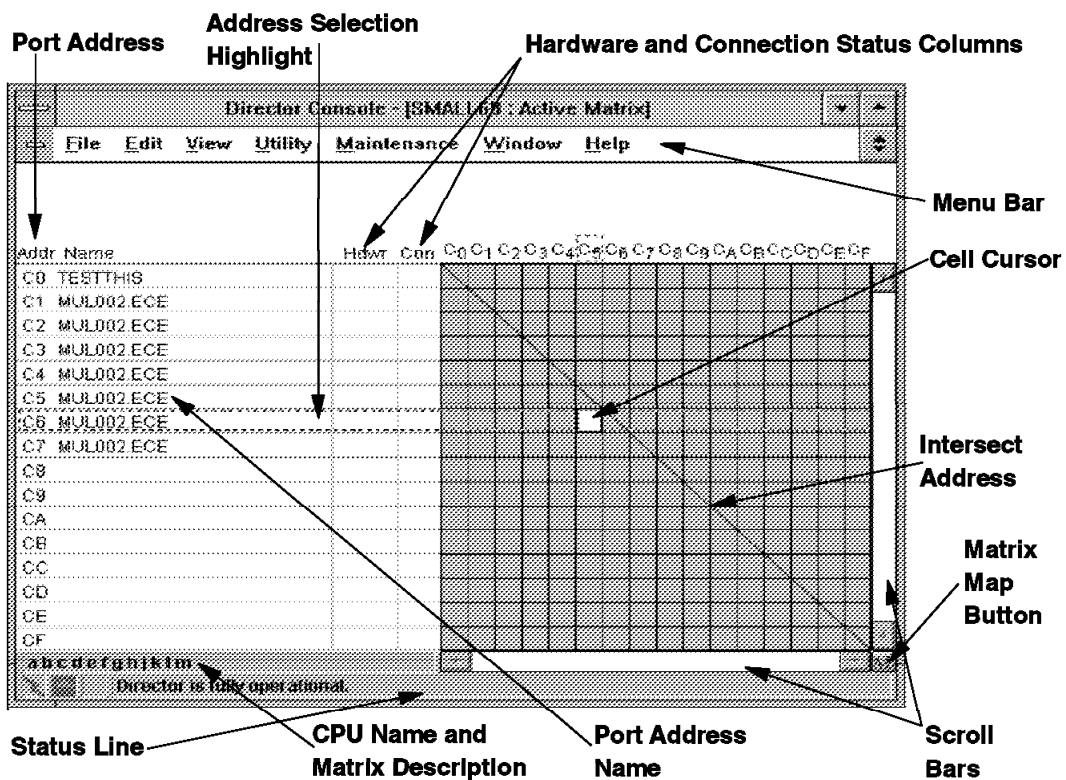
Figure 46. The Matrix Screen and its Components for the 9032-3 and 9033-4 Directors

6.3.13 ESCON Director Main Menu

When initialization is complete the main menu is displayed. The following options are available:

1. Active Configuration - Display or change the active matrix.

   Selecting this option will display the matrix that is now controlling the ESCD. Changes made to this copy of the active configuration will not take effect until it is activated.

2. Saved Configuration - Display or change a saved matrix.

   Selecting this option will display the saved matrix files. You can then delete or select a saved matrix to be changed or activated.

3. Passwords - Display or change passwords.

   There are three levels of passwords:

   > Level 1 - Contains overall password authorization, allowing system administrators to display, define, and change level 1, 2, and 3 passwords.
   > Level 2 - Contains maintenance passwords, allowing a service representative to access maintenance and diagnostics functions and to make configuration changes.
   > Level 3 - Contains operator passwords, allowing the user to change, save, and activate configurations.

4. Utilities - Access customer utilities.

   Selecting this option will display the Utilities menu.

   On this menu, you find options such as: Audit trail, Backup, Time/Date setting, ACTIVE=SAVED, ESCD status information, and display port types (LED or Laser).

5. Power Off - Power Off the ESCD.

6. Maintenance - Access maintenance procedures.

7. 903X selection - select a director in console sharing.

8. Console sharing option maintenance - to modify console configuration.

6.3.14 ESCD Connections

Figure 47 shows an example of one dynamic and one dedicated connection through an ESCON Director.

The ESCON Director provides two types of connection:

- Dynamic
- Dedicated

Dynamic connections are established and removed as needed. Only one dynamic connection can exist at a time between two ports. A port cannot have two concurrent dynamic connections.

Dedicated connections act as cabled links between two ports. To establish or remove this connection, the operator has to modify the ESCON Director port attributes.

Note: Port addresses are not used with a dedicated connection. Received data is propagated through the ESCON Director without checking.

CHANNELS

| CNC | | CVC | |

DYNAMIC
CONNECTION

ESCON
Director

DEDICATED
CONNECTION

ESCON
CU

9034

BUS / TAG

PARALLEL
CU
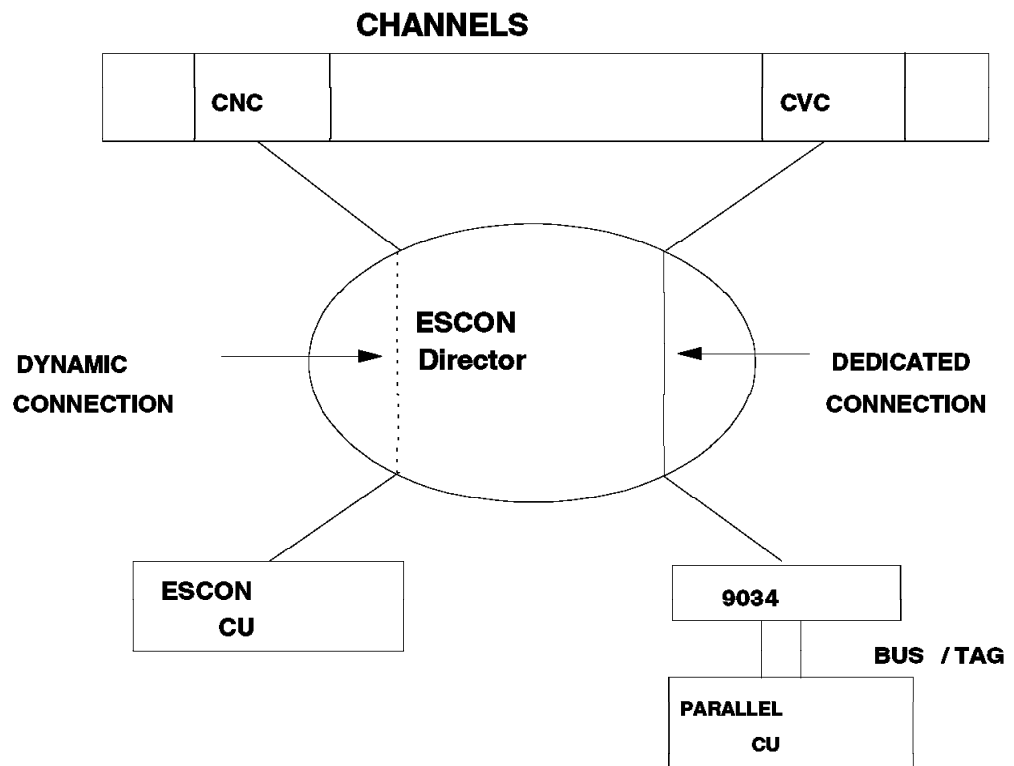
Figure 47. ESCD Connections

6.3.15 IOCP Example

The IOCP CNTLUNIT macro has been enhanced to permit specification of the ESCON Director port to which the ESCON control unit is attached. An example of these enhancements is illustrated in Figure 48.
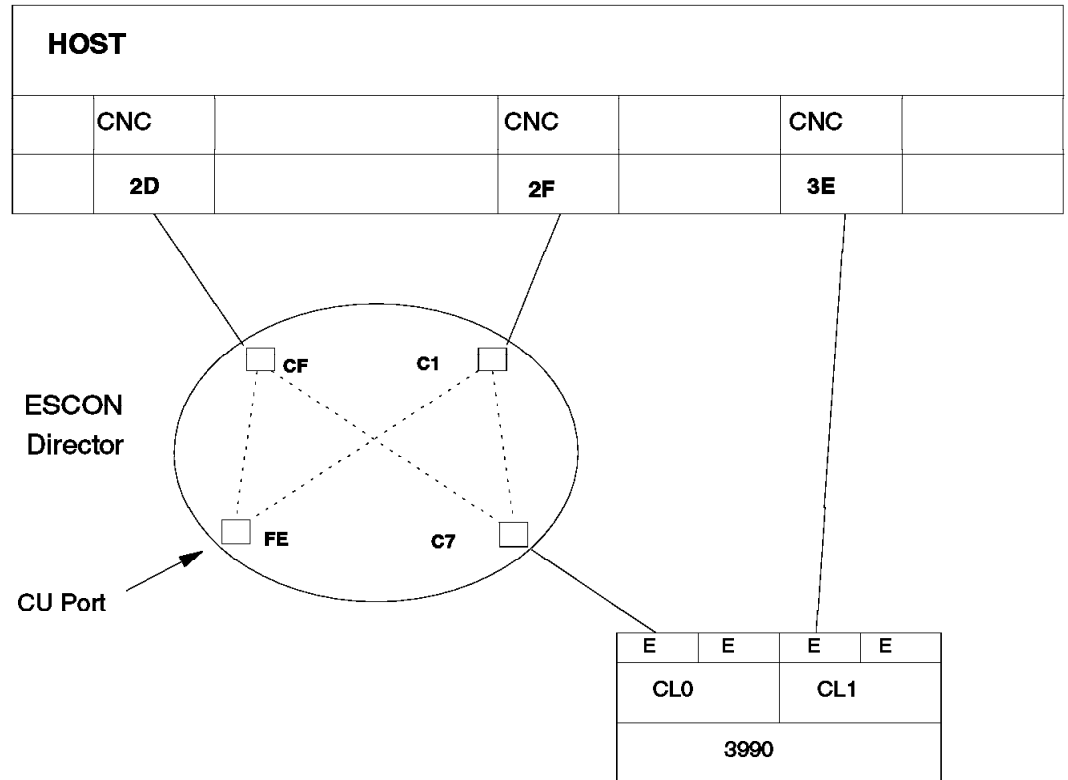

Figure 48. IOCP Example

The IOCP CNTLUNIT definitions required for the configuration show in Figure 48 are as follows:

```
SWITCH keyword in the CHPID statements
    CHPID PATH=3E,TYPE=CNC
    CHPID PATH=(2D,2F),TYPE=CNC,
        SWITCH=01

LINK keyword in the CNTLUNIT statements
    CNTLUNIT CUNUMBR=B00,UNIT=9032,
        UNITADD=(00,1),
        PATH=(2D,2F),
        LINK=(FE,FE)
    CNTLUNIT CUNUMBR=C00,UNIT=3990,
        UNITADD=(00,64),
        PATH=(2D,2F),
```

```
                    LINK=(C7,C7)
           CNTLUNIT CUNUMBR=D00,UNIT=3990,
                UNITADD=(00,64),
                PATH=(3E)
      IODEVICE statements
           IODEVICE CUNUMBR=B00,UNIT=SWCH,ADDRESS=A00
           IODEVICE CUNUMBR=(C00,D00),UNIT=3380,ADDRESS=(140,64),
                     UNITADD=00
```

6.3.15.1 LINK Keyword

The LINK keyword specifies the link addresses to which the control unit is attached. The order in which the link addresses are specified corresponds to the order in which the channel paths are specified in the PATH keyword. In the IOCP example in Figure 48 on page 111, you see that for control unit number C00 (3990), PATH 2D connects to PORT C7 and PATH 2F also connects to PORT C7 in the ESCON Director.

In other words, there can be a logical path from the channel subsystem over PATH 2D, going through the ESCON Director to PORT C7, and finally to the 3990 control unit itself. Another logical path can be established from the channel subsystem over PATH 2F, going also through the ESCON Director to PORT C7, and finally to the 3990 control unit itself.

The LINK keyword is optional if none of the channel paths in the PATH keyword attach to a director. The valid link address range is X′01′ through X′FE′. If the LINK keyword is specified, either a valid link address or ** must be specified for every channel path in the PATH keyword in the CNTLUNIT macro.

If the LINK keyword is not specified, or if ** is specified, IOCP assumes that the link address is arbitrary and the channel subsystem selects the link address. It is recommended that for channel paths having dedicated connections through an ESCON Director, the corresponding link address on the CNTLUNIT macro be specified as the link address associated with the physical port on the director.

6.3.15.2 ESCD IOCP Definition

You should define the ESCON Director control unit port (CUP) in the IOCP input deck. Otherwise, it is not possible to communicate between the host and the CUP. The port for CUP should be specified as a dynamic port in the ESCD matrix; otherwise, frames are not passed to the control unit port address X′FE′. This does *not* mean that no traffic would go between the channel subsystem and the control units through the switch. Those connections are there and work as they have to. However, without the definition of the control unit itself in the IOCP deck, the operator cannot send commands from the operating system (or ESCON Manager) to the switch. Also, the definition is necessary for logging error information in the SCP LOGREC data set. The control unit must have a unit address of X′00′.

In the IOCP example in Figure 48, paths 2D and 2F can be dynamically connected to port FE. It is advisable to have at least two non-dedicated paths to the ESCON Director for availability. These paths cannot be part of a dedicated connection, because, in this case, there will be no interpretation of the frames by the ESCON Director.

If there were only one path to the control unit port, the operator could never vary that path offline, because MVS will not vary offline the last path to a device, unless the operator uses the FORCE keyword. With at least two paths to the control unit port (port X′FE′), the operator does not have this problem.

Still referring to Figure 48, the same paths are used for communication through the ESCON Director with the 3990. As you can see in the IOCP example, the 3990 control unit with CUNUMBR=C00 can dynamically connect to ESCON channel 2D or 2F through the same link address (C7). The UNITADD keyword has been added to the IODEVICE statement because the device number is 140, and the control unit (3990) must have a unit address of X′00′. The operator still uses the device number range X′140′ to X′17F′ for communication with these DASD devices.

Because ESCON channel 3E has a direct connection (not through the ESCD), there is no need to specify a LINK keyword in the CNTLUNIT macro. If you specify the keyword, it should be specified as:

    LINK=(**)

Asterisks in the LINK keyword mean that for that specific path, there is a direct connection between the channel subsystem and the control unit.

6.3.15.3 IBM 3990-6 Peer-to-Peer Remote Copy
Figure 49 shows an example of a system configured with two separate storage subsystems attached to the host through a Director.
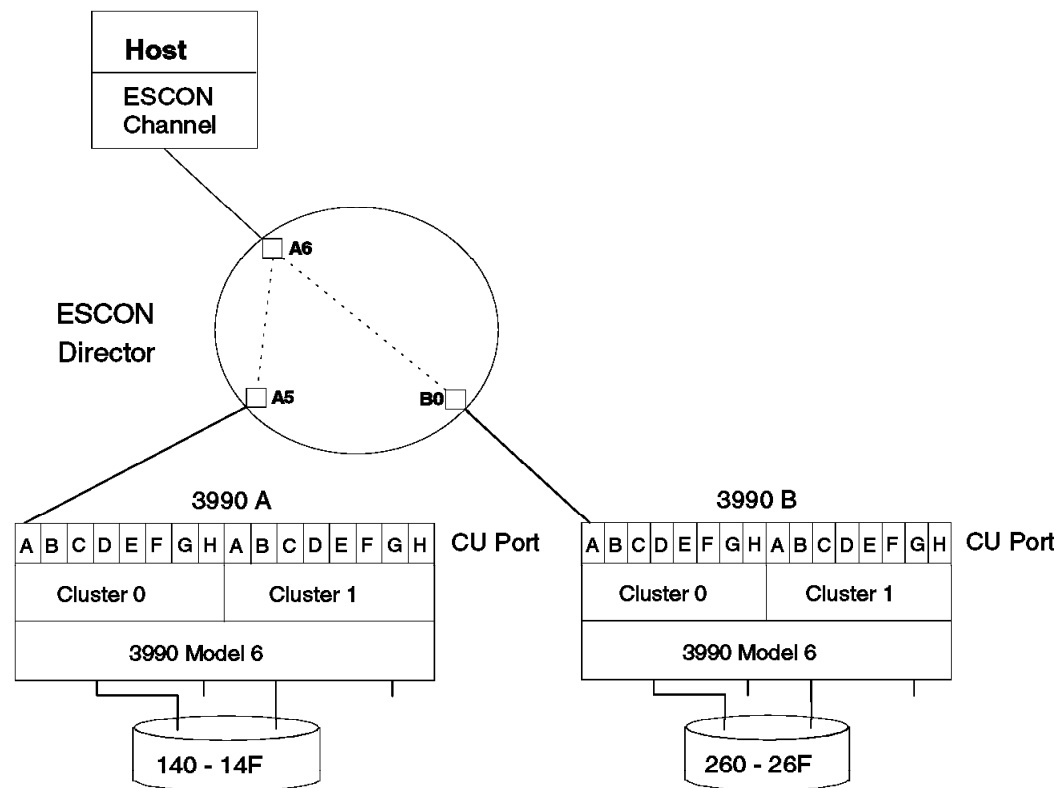

Figure 49. Storage Subsystems for Primary and Secondary Volumes

It is not necessary to go through a Director to establish a PPRC link, but if a Director is used, Figure 50 on page 114 shows an example of a PPRC configuration. A PPRC command CESTPATH will be used to establish the link. For more information, please see *Remote Copy Administrator's Guide and Reference.*
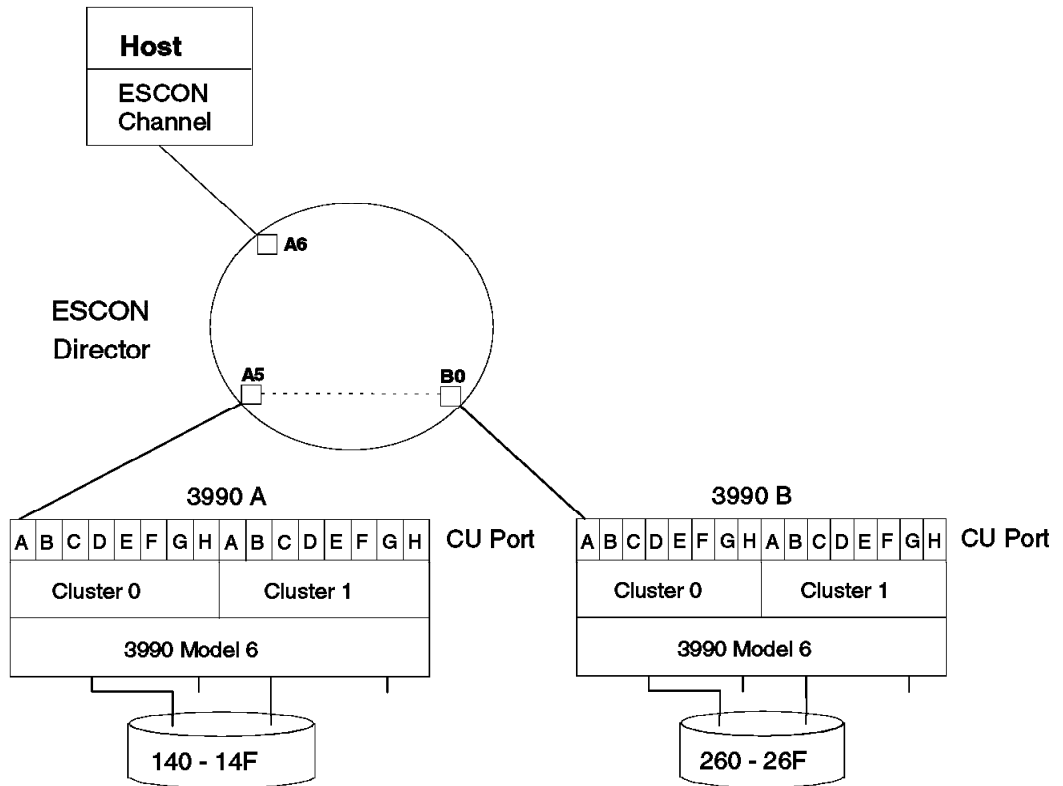

Figure 50. Establishing a PPRC Path through an ESCD

6.3.16 Software Support and Requirements

ESCON Directors can be used in the software environments listed in Table 30 through Table 33, and for VSE/ESA using a dedicated connection. The tables show the minimum software level needed, but additional PTFs are probably necessary, so always check with your software representative.

6.3.16.1 MVS Environment

Table 30 (Page 1 of 2). ESCON Director, Minimum MVS Software		
	MVS Release	
MVS SCP	3.1.0e (1)	4.1.0 (1)
RMF	4.1.1 (2)	4.2.0 (2)
RACF	1.8.1 (2)	1.8.1 (2)
EREP	3.4.2	3.4.2
IXPIOCP	2.0	2.0

Table 30 (Page 2 of 2). ESCON Director, Minimum MVS Software	
	MVS Release
Note:	
1. Use of ESCDs require that the director feature on MVS/ESA (Feature code 5870, 5871, or 5872) be installed. 2. Additional PTFs must be applied.	

6.3.16.2 VM Environment

Table 31. ESCON Director, Minimum VM Software		
	VM Release	
VM SCP	ESA 1.0 with ESA feature	ESA 1.1
EREP	3.4.2	3.4.2
RACF	1.8.2 (note)	1.8.2 (note)
IXPIOCP	2.0	2.0
Note: Additional PTFs must be applied.		

6.3.16.3 VSE Environment

The VSE/ESA Release 1.1.0 support for an ESCON environment is limited to ESCON channels operating in conversion mode (connected to a 9034 ESCC), as discussed in 6.1.3, "ESCON Channel Software" on page 42. If this connection is through an ESCON Director, it has to be dedicated, as discussed in 6.14, "IBM 9034 ESCON Converter Model 1" on page 194. Therefore, there is no communication possible between a VSE system and an ESCD.

6.3.16.4 AIX Environment

Table 32. ESCON Director, Minimum AIX Software	
	AIX/ESA Release
AIX/ESA	2.1

6.3.16.5 TPF Environment

Table 33. ESCON Director, Minimum TPF Software	
	TPF Release
TPF SCP	3.1

6.3.17 Distance Limitations

The maximum distance for a single LED link is three kilometers for a 62.5/125 um fiber and two kilometers for a 50/125 um fiber. Channel and control unit attachments are always LED. Using ESCON Directors or IBM 9036 ESCON Remote Channel Extenders, the distance can be extended. Figure 51 shows examples for different director configurations. There may be one or multiple intermediate links, which can be either LED or XDF. Each XDF link can extend the maximum distance by 20 km.

The examples in Figure 51 show a maximum of one intermediate link, using two ESCON Directors. There may be only two ESCON Directors in any given path, but multiple IBM 9036 ESCON Remote Channel Extenders can be used to build chains of multiple links.

There are limits to the maximum distance that can be realized, however. It depends on the type of control unit being used. If there is an ESCON to Parallel converter in the path (9034 or 9035), the maximum distance may be further reduced.

For more information about maximum distances for control units attached to 9034 converters, see *Planning for the 9034*.
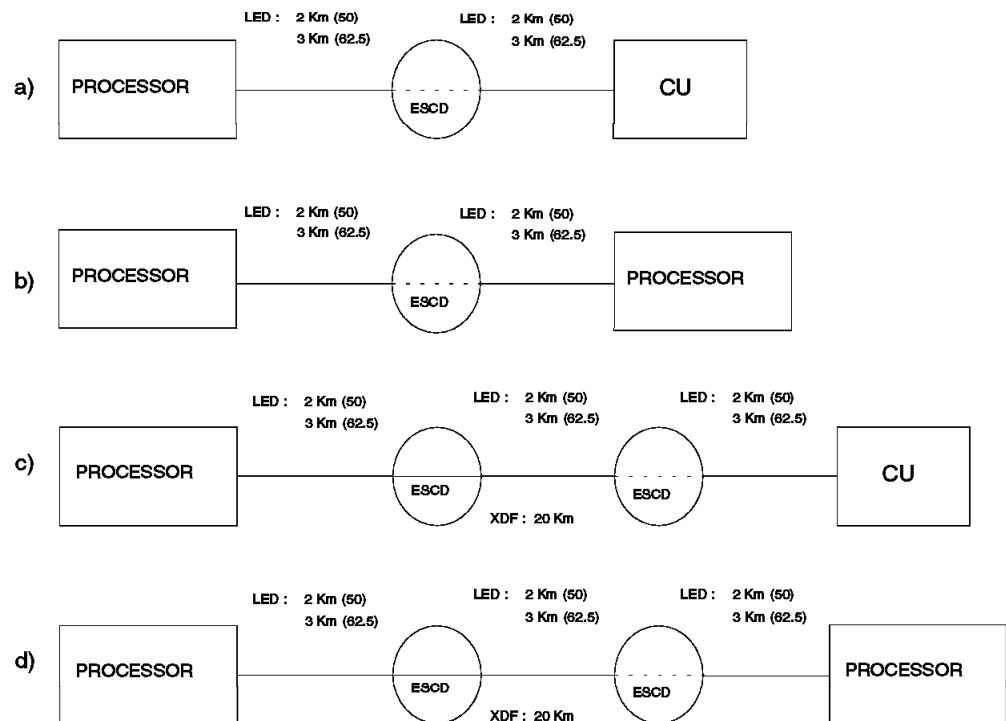

Figure 51. ESCON Director Distances. Multiple intermediate links are possible by using IBM 9036 ESCON Remote Channel Extenders

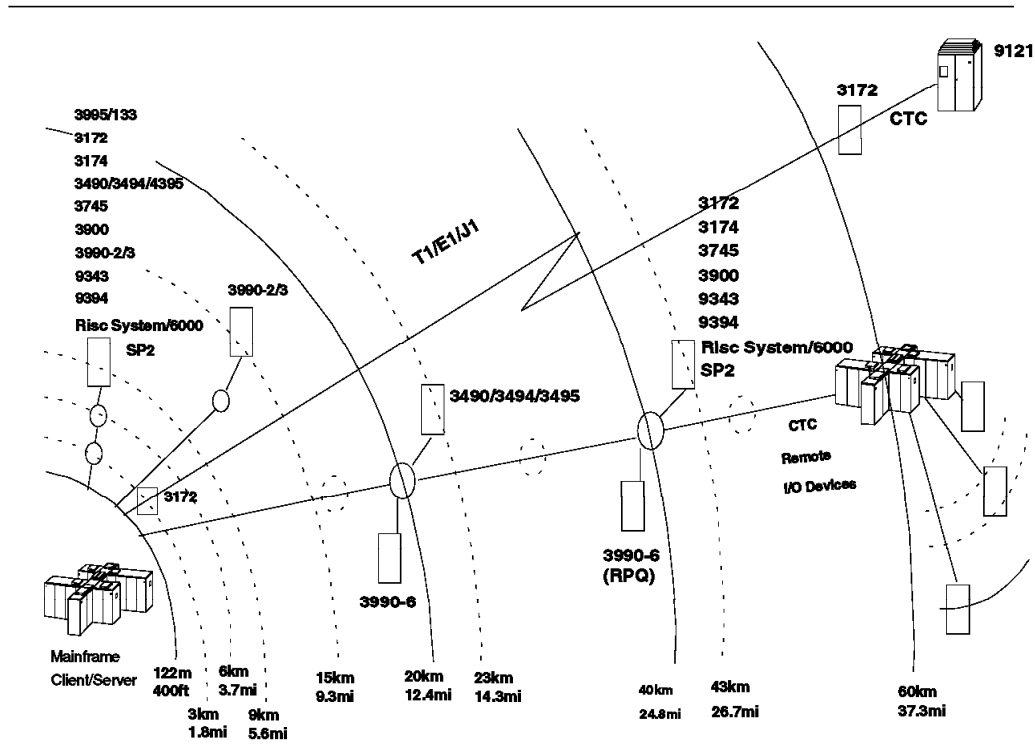Figure 52 on page 117 shows the ESCON distances for various IBM devices.

Figure 52. IBM ESCON Device Distances

6.3.18 Chaining ESCON Directors

ESCON Directors can be chained to increase the maximum distance between ESCON channels and control units, (see Figure 53). One of the connections through the ESCON Directors must be a dedicated connection. The dedicated connection on one of the two ESCON Directors may be on either of the directors, or you may have dedicated connections on both of the directors. This arrangement is required when a control unit is attached using, a 9034 converter, to a path through cascaded directors.

It is also possible to use a 9034 converter with chained ESCON Directors, but then there must be dedicated connections on both ESCON Directors for that path.

There may be distance limitations when you use a 9034 converter with chained ESCON Directors. IBM offers an RPQ process to determine the maximum distance for any specific case. For more information about distance limitations when using the 9034 converter, see *Planning for the 9034.*
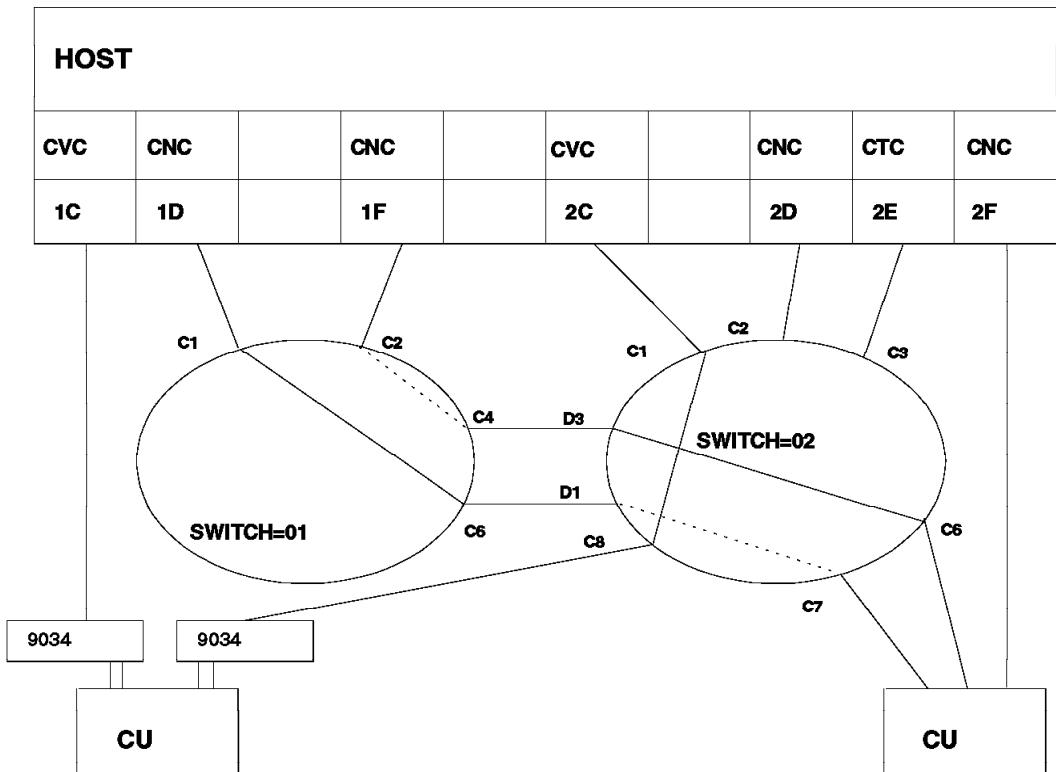
HOST

CVC	CNC		CNC		CVC		CNC	CTC	CNC
1C	1D		1F		2C		2D	2E	2F

SWITCH=01   C1   C2   C4   D3   D1   C6   C8   C7

SWITCH=02   C1   C2   C3   C6   C7

9034   9034

CU   CU

Figure 53. Chaining ESCON Directors

6.3.19 ESCD Configuration Guidelines

The following guidelines apply to configuring installations using ESCON Directors:

- For high availability, you should have at least two ESCON Directors.

  If you spread the channel connections equally through two ESCON Directors, if one director should fail, half of the connections will still be available for data transfer. If you have only a single ESCON Director, and the director fails, all the connections through the switch are lost.

- Each control unit should have connections through several ESCON Directors whenever possible for availability.

- Some ports on each ESCON Director should be reserved for growth and conversion.

  For ESCON Director Model 2, addition or replacement of a port card requires that the ESCON Director be powered off.

- The number of ports required depends on the number of channel and control unit interfaces, the number of connections between chained directors, and an allowance for growth.

- Connect paths through ports on different port cards.

  Each port card contains four ports. If you have four channel interfaces from a system or system image to a control unit, you should not connect

all four interfaces to ports on a single port card. In case the port card fails, you will lose all four connections.

- Define at least two paths from each system image to the ESCON Director control unit port (CUP).

- Manage the ESCON Director through the ESCON Manager running on the host, not from the ESCD console.

  If you manage the ESCON Director from the ESCON Manager, and change ESCON director connections using the ESCD console, the ESCON Manager will not be aware of these changes. Of course, if you do not have the ESCON Manager installed, you have to manage the ESCON Director from the ESCD console. Use of the ESCON Manager is recommended in an EMIF environment.

- Create switch partitions on the ESCON Director.

  For an explanation of creating switch partitions see 6.3.8.2, "Switch Partition" on page 101.

- Set the Missing Interrupt Handler to 15 seconds for each 9032 or 9033 device number (MVS).

  Default time for the MIH is three minutes. In practice, this means that it can take three to six minutes before the MIH takes action.

- Order the High-Availability Feature if there are CTC connections through the ESCON Director (feature available only on the ESCON Director Model 2).

  If an ESCON channel cable is moved from a port and plugged to another port, a link initialization process takes place. The channel subsystem will identify the port to which the channel is now plugged in, and the director port to which the CHPID is connected. This is not the case with an ESCON channel that has been defined as a CTC. If that link is re-plugged, there will be no CTC connection between the two ESCON channel links unless a spare port provided by the High-Availability Feature is used. The IBM service representative can then re-plug the cable in one of the two spare ports. The service representative does not have to switch off power on the 9032, but can simply move the fiber optic cable connector from the affected port to the spare port and transfer all connection capabilities to the spare port. Of course, any control unit port can be re-plugged to spare ports, not only a CTC connection link.

- Evaluate additional configurations for CTC availability such as connection through chained ESCDs and symmetric CTC configuration between host images.

6.4 ESCON Channel-to-Channel Connection

This section describes how to define and use an ESCON channel that is connected to another ESCON channel on the same or on a different central electronic complex.

6.4.1 Description

The ESCON Channel-to-Channel Connection (CTC) is an IOCP option on an ESCON capable processor. The CTC option is specified in the IOCP and the CTC microcode is loaded into the ESCON channel interface at POR. By using an IBM 9032 ESCON Director Model 2, up to 59 other processors can be connected to this single ESCON channel interface.

An IBM 3088 Multisystem Channel Communication Unit (MCCU) supports both the System/360 compatibility mode (called "basic mode" hereafter) and the System/370 extended mode. When planning for ESCON channels operating in CTC mode, you must verify that the CTC access method you are using supports ESCON CTC connections (the System/370 extended mode). If the access method you are currently using does not support the System/370 extended mode, you must continue to use the 3088 MCCU or you must run the ESCON CTC in basic mode. Running the ESCON CTC in basic mode is supported by MVS/ESA Version 4 Release 3, and it requires a specific microcode level (see 6.4.4, "ESCON CTC Basic Mode" on page 123). You may have both CTC basic mode and CTC extended mode connections in the same channel.

In planning CTC migration, there are three major items to consider:

- Addressing in the ESCON channel operating in CTC mode is increased from 256 devices per channel to 512. The number of subchannels between each host is flexible and is defined in the IOCP and SCP.

- The IOCPs in the different system images have to be coordinated.

- The number of redundant CTC communication paths between host processors should be determined.

The ESCON CTC performs at the channel speed of the ESCON channels of the communicating processor pair. The ESCON CTC is superior to the 3088 in providing longer connections, and a more flexible configuration.

The 3088 can be no more than 122 meters from a CPU. This distance can be extended to 2 or 3 km through the use of a 3044 Model 2 and a fiber optic link (50 or 62.5 micron).

TYPE=CVC channels allow CTC communication from an all-ESCON processor to a non-ESCON processor through a 9034 attached 3088. A TYPE=CVC channel is required on each ESCON-capable processor attached to the 3088, and each requires a 3088 port.

The 3088 operates at up to 4.5 MB/sec on a data streaming channel.

Existing CTC communication on parallel channels through 3088s is still supported and is unaffected by ESCON.

6.4.2 CTC Architectures

The parallel interface architecture described in *IBM Channel-to-Channel Adapter*, SA22-7091, defines both the Basic and Extended CTC operating modes.

The ESCON interface described in *ESA/390 ESCON Channel-to-Channel Adapter*, SA22-7203, defines only one operation mode, the Extended mode. This operating mode is similar to the Extended mode for the parallel interface described in *IBM Channel-to-Channel Adapter*, but with changes that support the ESA/390 ESCON I/O interface architecture. See *ESCON I/O Interface*, SA22-7202 for more information.

The architecture described in *ESA/390 ESCON Channel-to-Channel Adapter* does not support CTC basic Mode. However, engineering change (EC level) is now available for the ES/9000 processors with ESCON CTC channels to provide CTC basic mode support, to accommodate CTC programs running in basic mode. Please see 6.4.4, "ESCON CTC Basic Mode" on page 123 for additional EC level details. The implementation is based on the basic mode section of the parallel interface architecture described in *IBM Channel-to-Channel Adapter*, with minor modifications for adapting to the ESCON I/O interface.

6.4.3 ESCON CTC Configuration Guidelines

The following guidelines apply when configuring ESCON CTC installations (refer to Figure 54 on page 122):

- Channels supporting CTC communications must be paired, one operating in CTC mode (TYPE=CTC), and the other operating in native mode (TYPE=CNC).

- An ESCON channel operating in CTC mode must connect directly or through an ESCON Director (ESCD) to an ESCON channel path.

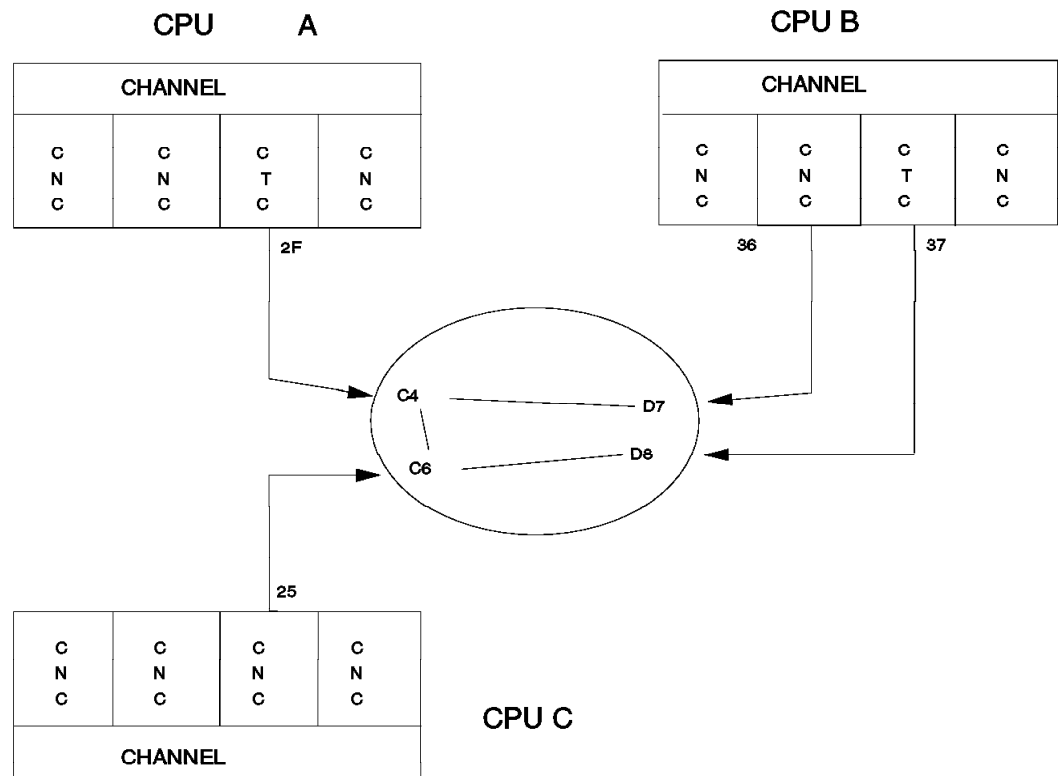- Each host involved in the communication must have the CTC defined as a control unit.

Figure 54. CTC Link through ESCON Director

- When using a single ESCD, the total number of CTC- and CNC-type channel paths required is n - 1 for each type, where n is the number of system images or host processors.

  In Figure 54, CPU A can talk through its CHPID 2F (TYPE=CTC) with CPU B (CHPID 36, TYPE=CNC) and CPU C (CHPID 25, TYPE=CNC), but CPU B cannot talk to C through this set of channel paths. Adding CHPID 37 (TYPE=CTC) for CPU B will solve this problem.

  A rule for a CTC configuration using a single ESCON Director that allows any one image to communicate with any other image is:

  - One host image will have just a CTC-type channel path.
  - One host image will have just a CNC-type channel path.
  - The others will have both a CTC-type and an CNC-type channel path.

  In order to avoid outages by single channel or ESCD failures, full redundancy should be planned by using two ESCON Directors. An any-to-any CTC configuration requires that:

  - The first two images have one CTC-type and one CNC-type channel path.
  - The subsequent images have two CTC-type and two CNC-type channel paths.

  The total number of channel paths in this redundant configuration using two ESCDs can be calculated as $2 \times (n - 1)$ for each of the CTC and CNC type channel paths. Figure 55 shows the configuration for four host images using one or two ESCDs.
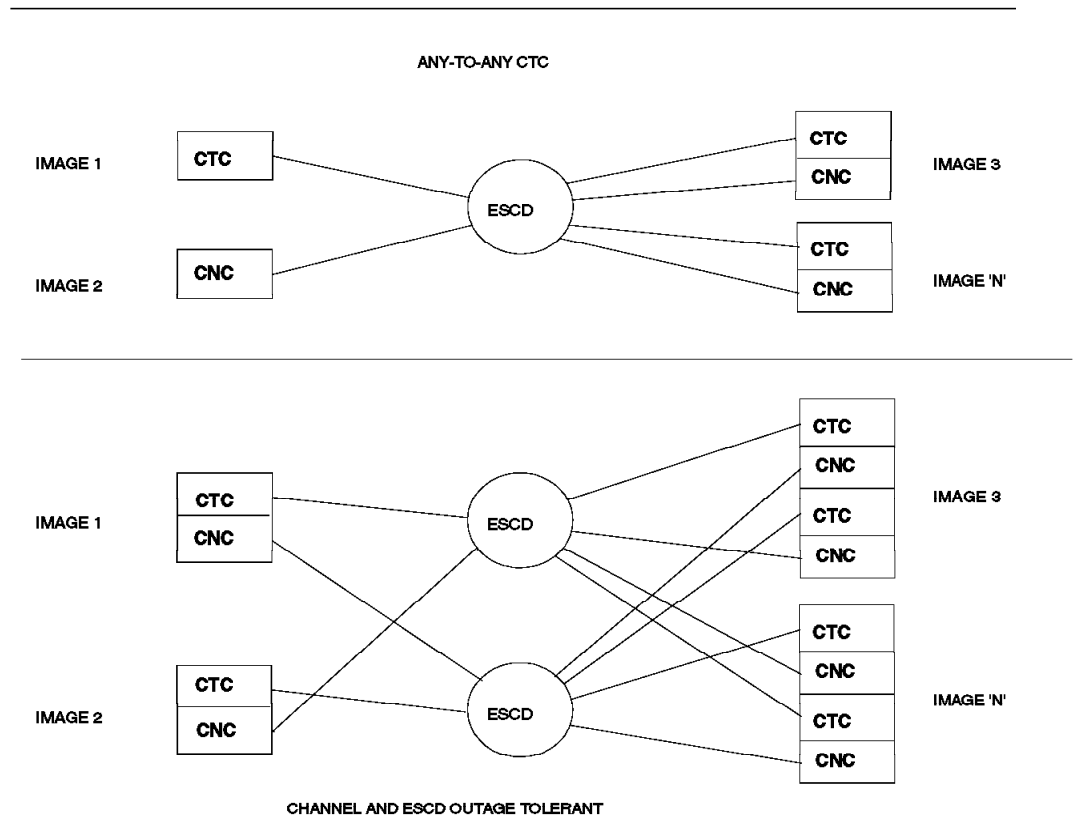
ANY-TO-ANY CTC

CHANNEL AND ESCD OUTAGE TOLERANT

Figure 55. Channel Type Configuration for CTC Communications

- There is a limit to the maximum number of devices on an ESCON CTC type and CNC type channel that is processor dependent. Refer to the *IOCP User's Guide* for limitations on your processor.

- Configure at least two XCF (Cross-system Coupling Facility) PATHINs and two PATHOUTs on each system over at least two links, due to possible disruption of one path.

  - Insure the PATHINs are on separate links.
  - Insure the PATHOUTs are on separate links.

6.4.4 ESCON CTC Basic Mode

If your application does not support the ESCON CTC in System/370 extended mode, you can eliminate the need for an IBM 3088 by defining the ESCON CTC in basic mode. The basic mode is supported on ES/9000 processors, which run MVS/ESA Version 4 Release 3, and have the microcode listed in Table 34.

Table 34. ESCON CTC Basic Mode Minimum EC Level	
ES/9000 Processor Model	**Minimum EC Level**
9021 340-based	SEC 229914
9021 520-based	SEC 228112
9021 711-based	Standard Feature
9121 320-based	SEC C22840
9121 511-based	Standard Feature
9221 170-based	FC 9391 and EC C49104

Running ESCON CTC basic mode instead of using an IBM 3088 has the following advantages for the customer:

- No need for an IBM 3088 MCCU or the equivalent feature #6200 on the ES/9000 entry model (IBM 9221 processors).

- No need for ESCON Converters to support the IBM 3088 in an all-ESCON environment.

- Both basic and extended mode CTCs can concurrently operate on the same ESCON channels, thus reducing the number of ESCON channels.

- In an LPAR environment with an EMIF supporting processor, there is another reduction on the number of required channels.

- The applications can immediately benefit from the ESCON environment (high channel speed, up to 60 km distance, dynamic I/O reconfiguration).

The definition of the CTC has to be made with the HCD configuration program. The UNIT for the IODEVICE is BCTC. CNTLUNIT has the same UNIT=SCTC as for extended mode CTCs.

MVSCP is not supported. VM/ESA supports only the ESCON CTC extended mode, not the basic mode.

6.4.5 ESCON CTC Software Support

Care must be taken to ensure that the customer has software installed that can support the ESCON CTC (System/370 extended mode), if the basic mode CTC cannot be used.

Table 35 through Table 38 list IBM subsystems and applications and show whether they support the ESCON CTC. Applications marked with *no* in these tables can continue to use the IBM 3088 with parallel channels or channels in conversion mode operating with an ESCON Converter Model 1 (9034), or use the ESCON CTC basic mode (see 6.4.4, "ESCON CTC Basic Mode" on page 123) if the CTC basic mode is applicable to your environment.

6.4.5.1 MVS Environment

Table 35. ESCON CTC Support, Minimum MVS Software		
CTC Application	Primary CTC Access Method	ESCON CTC Extended Mode
GRS (MVS/SP 4.1 with SYSPLEX)	XCF	YES
GRS (no SYSPLEX)	Native	NO
JES3 Global/Local	Native	NO
VTAM/ESA 4.1 (5695-117)	Native	YES
VTAM/ESA 3.3 (5685-085)	Native	YES
VTAM/XA (5665-289)	Native	NO
TCP/IP CICS-ISC DB2-IRLM MVS/BDT NetView FTP IMS-IRLM IMS-ISC SNA NJE JES2/JES3	VTAM 3.3 (5685-085)	YES
BSC NJE-JES 2/3	Native	NO
IMS-MSC	Native	NO

6.4.5.2 VM Environment

Table 36. ESCON CTC Support, Minimum VM/ESA Software		
CTC Application	Primary CTC Access Method	ESCON CTC Extended Mode
VTAM V3 (5684-095)	Native	YES
VTAM V3 (5664-280)	Native	NO
PVM 2.1 (5684-100)	Native	YES
PVM 1.4 (5748-RC1)	Native	NO
TCP/IP RSCS V2/3 PVM TSAF	VTAM 3 (5684-095)	YES
RSCS V1	Native	NO
TSAF	Native	NO

6.4.5.3 TPF Environment

Table 37. ESCON CTC Support, Minimum TPF Software		
CTC Application	Primary CTC Access Method	ESCON CTC Support
MPIF	Native	YES
SNA/CTC	Native	YES

6.4.5.4 AIX Environment

Table 38. ESCON CTC Support, Minimum AIX Software		
CTC Application	Primary CTC Access Method	ESCON CTC Support
AIX/ESA	Native	YES

6.4.6 ESCON CTC IOCP Rules

The following rules apply to the IOCP defining a CTC environment:

- An ESCON channel operating in CTC mode can communicate with an ESCON channel operating natively. CTC CHPIDs require TYPE=CNC CHPIDs as a destination. This rule is not checked by the IOCP.

- Unit definitions for CTC communication should have UNIT=SCTC (extended mode) or UNIT=BCTC (basic mode) coded on the IODEVICE statements. If defined as CTC, limited recovery support is provided by MVS.

- An ESCON channel operating in CTC mode cannot communicate with another ESCON channel operating in CTC mode. Also, an ESCON channel operating in native mode cannot communicate with another ESCON channel operating in native mode.

- If an ESCON channel operating in CTC mode is to communicate with more than one channel, an ESCD is required and the SWITCH keyword must be coded on the CHPID statement.

- CTC communication requires CNTLUNIT and IODEVICE statements. Also, communicating systems must specify the same unit address(es) in the corresponding CNTLUNIT and IODEVICE statements.

- Only one CHPID is permitted per control unit.

- Only one control unit is permitted per device, which implies only one path per CTC device.

- Both systems or system images using CTC must use the same UNITADD values in their CNTLUNIT statements.

- A control unit is considered as CTC when attached to a TYPE=CTC path, or if UNIT=SCTC and attached to TYPE=CNC CHPID.

- The ESCON CTC basic mode is specified as UNIT=BCTC in the IODEVICE statement. The CNTLUNIT statement is not changed (UNIT=SCTC). Both IODEVICE UNIT=BCTC and UNIT=SCTC can be connected to the same CNTLUNIT.

- In case of shared channels (EMIF) there can be more than one CNTLUNIT statement per channel path. For each logical partition you wish to communicate with, you must specify a separate CNTLUNIT statement with the remote LPAR number (defined with the RESOURCE statement) in the CUADD keyword. If the remote channel path is not shared, then CUADD must be zero or not specified. This rule applies to both remote CTC and CNC channel path types.

6.4.7 ESCON CTC IOCP Examples

This section provides examples of IOCP configurations.

6.4.7.1 Without Shared Channels

Figure 56 on page 128 shows a point-to-point CTC connection from HOSTA (path 2C) to HOSTB (path 1C) and a shared CTC connection through ESCD 01 from HOSTA (path 1C) to HOSTB (path 1F), and HOSTC (path 2E). The IOCP definitions are shown for the more complex shared configuration only:
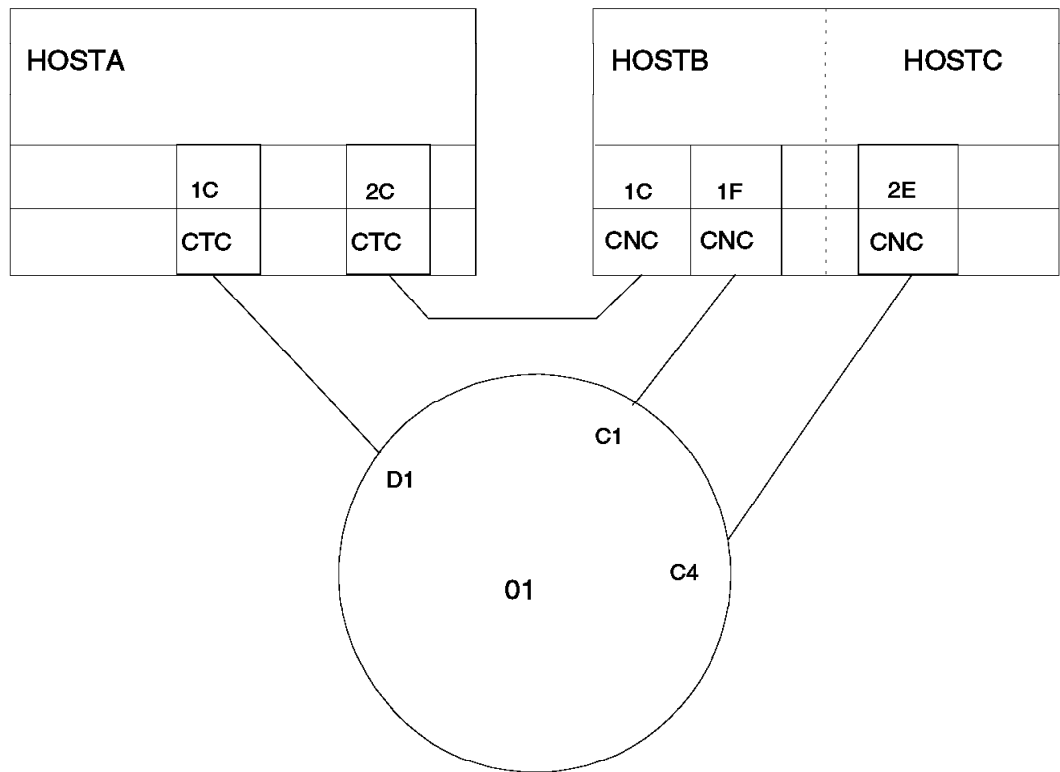
HOSTA (1C) to HOSTB (1F)

Connecting through ports D1 and C1 of ESCD 01.
The corresponding addresses are UNITADD=00.

HOSTA (1C) to HOSTC (2E)

Connecting through ports D1 and C4 of ESCD 01.
The corresponding addresses are UNITADD=08.

Following the rules discussed in 6.4.6, "ESCON CTC IOCP Rules" on page 126, one side of the CTC connection is TYPE=CTC and the opposite is TYPE=CNC.

```
HOSTA
    CHPID PATH=1C,TYPE=CTC,SWITCH=01

HOSTB
    CHPID PATH=1F,TYPE=CNC,PART=HOSTB,SWITCH=01

HOSTC
    CHPID PATH=2E,TYPE=CNC,PART=HOSTC,SWITCH=01


HOSTA
    CNTLUNIT CUNUMBER=XXXX,UNIT=SCTC,PATH=1C,LINK=(C1),UNITADD=((00,8))
    IODEVICE CUNUMBER=XXXX,UNIT=SCTC,UNITADD=00,ADDRESS=(120,8)

    CNTLUNIT CUNUMBER=CCCC,UNIT=SCTC,PATH=1C,LINK=(C4),UNITADD=((08,8))
    IODEVICE CUNUMBER=CCCC,UNIT=SCTC,UNITADD=08,ADDRESS=(128,8)

HOSTB
    CNTLUNIT CUNUMBER=XXXX,UNIT=SCTC,PATH=1F,LINK=(D1),UNITADD=((00,8))
    IODEVICE CUNUMBER=XXXX,UNIT=SCTC,UNITADD=00,ADDRESS=(220,8)

HOSTC
    CNTLUNIT CUNUMBER=CCCC,UNIT=SCTC,PATH=2E,LINK=(D1),UNITADD=((08,8))
    IODEVICE CUNUMBER=CCCC,UNIT=SCTC,UNITADD=08,ADDRESS=(320,8)
```

Figure 56. IOCP CTC Definition for Two Hosts

6.4.7.2 With Shared Channels

Figure 58 shows a single CEC that is capable of running shared channels (EMIF). There are three partitions running MVS/ESA 4.3 with JES3 Global/Local (requiring three CTC connections in basic mode) ACF/VTAM, and GRS (requiring six CTC connections in extended mode). For each LPAR-to-LPAR connection there are three CTCs, one in basic mode and two in extended mode.

Only two ESCON channels are required: one TYPE=CTC and one TYPE=CNC. These channels are shared between partitions. Figure 57 shows the logical connections of this example for VTAM, XCF, and JES3. The device numbers from the IODEVICE statement ADDRESS keyword are also shown. These numbers must be defined in the subsystems. The device numbers we have chosen have the following format:

```
        ADDRESS=xyz

                z --> Application  0 = XCF
                                   1 = VTAM
                                   2 = JES3

              y  --> LPAR Number  (1, 2, or 3)

              x   --> CHPID       3 = 30 (CNC)
                                  4 = 40 (CTC)
```

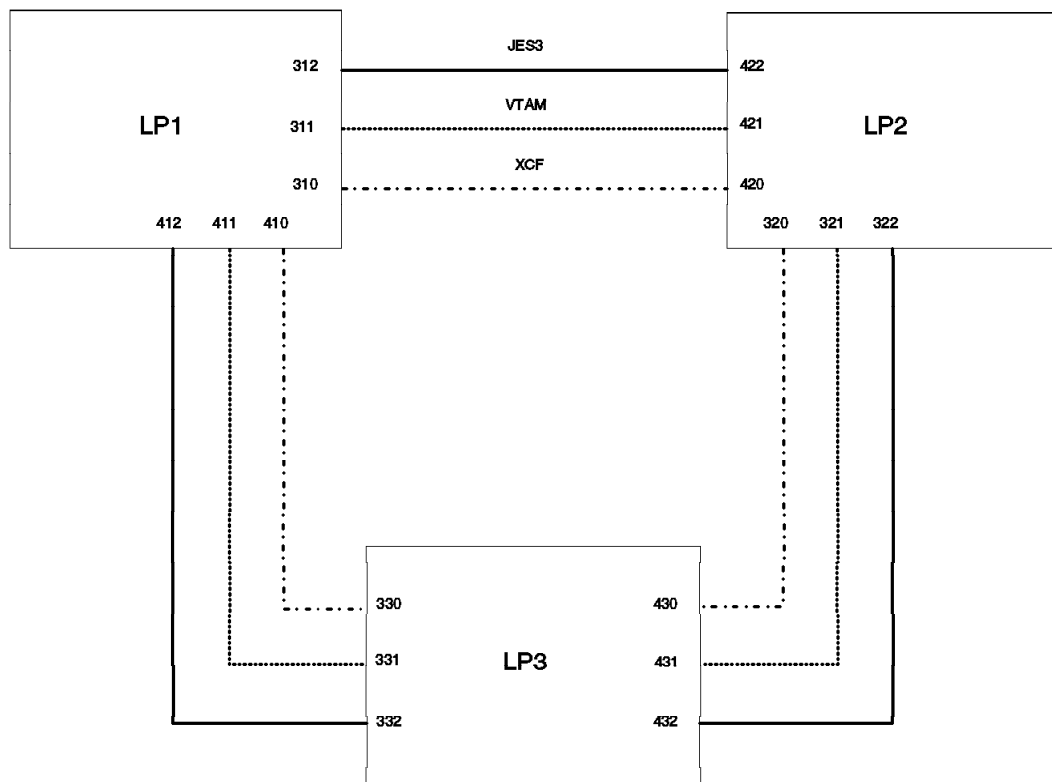For more information on EMIF refer to 6.2, "ESCON Multiple Image Facility" on page 74.

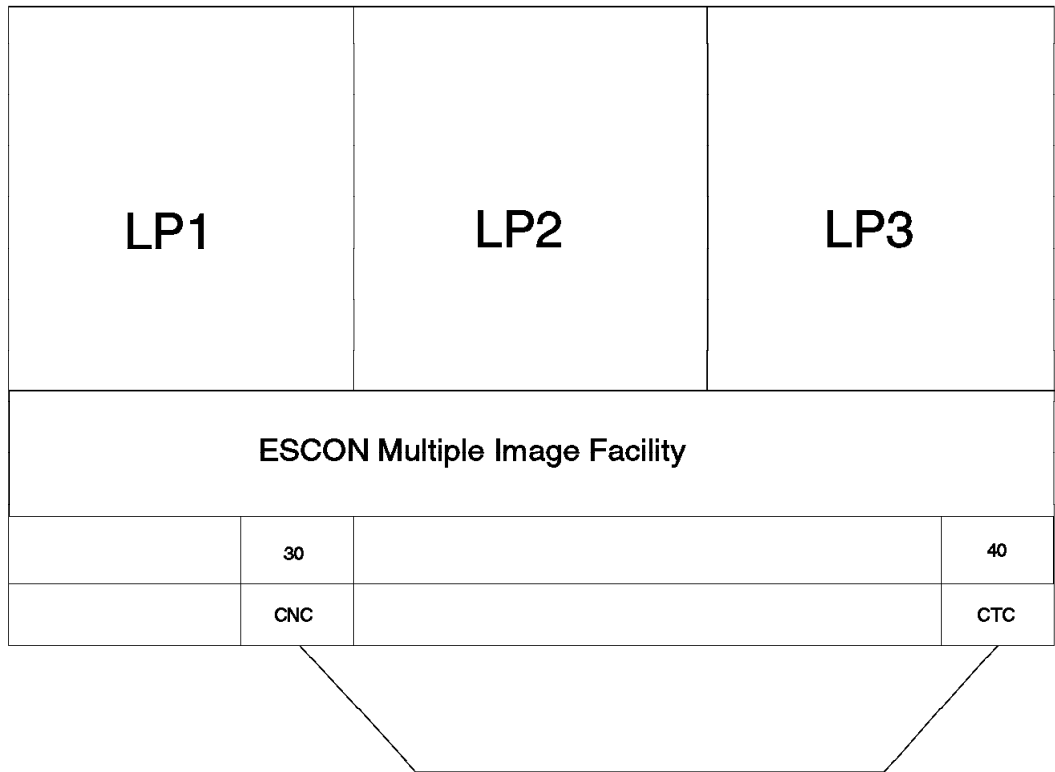*Figure 57. Logical Connections for a Single Host with EMIF*

```
┌─────────────────┬─────────────────┬─────────────────┐
│                 │                 │                 │
│                 │                 │                 │
│      LP1        │      LP2        │      LP3        │
│                 │                 │                 │
│                 │                 │                 │
├─────────────────┴─────────────────┴─────────────────┤
│          ESCON Multiple Image Facility               │
├──────────┬──────────────────────────────────┬───────┤
│          │   30     │                        │  40   │
│          ├──────────┤                        ├───────┤
│          │  CNC     │                        │  CTC  │
└──────────┴──────────┴────────────────────────┴───────┘
```

Figure 58. A Single Host with EMIF

The IOCP CTC definitions required for a single host with EMIF with EMIF as shown in Figure 58 are as follows:

```
     RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
     CHPID    PATH=30,TYPE=CNC,SHARED
     CHPID    PATH=40,TYPE=CTC,SHARED
* Define control units representing each partition for each channel
* for LP1:
*   connecting LP2:
     CNTLUNIT CUNUMBR=31,PATH=30,UNIT=SCTC,UNITADD=((80,3)),CUADD=2
     IODEVICE ADDRESS=(310,2),CUNUMBR=31,UNIT=SCTC,UNITADD=80,PART=(LP1)
     IODEVICE ADDRESS=(312,1),CUNUMBR=31,UNIT=BCTC,UNITADD=82,PART=(LP1)
*   connecting LP3:
     CNTLUNIT CUNUMBR=41,PATH=40,UNIT=SCTC,UNITADD=((90,3)),CUADD=3
     IODEVICE ADDRESS=(410,2),CUNUMBR=41,UNIT=SCTC,UNITADD=90,PART=(LP1)
     IODEVICE ADDRESS=(412,1),CUNUMBR=41,UNIT=BCTC,UNITADD=92,PART=(LP1)
* for LP2:
*   connecting LP3:
     CNTLUNIT CUNUMBR=32,PATH=30,UNIT=SCTC,UNITADD=((A0,3)),CUADD=3
     IODEVICE ADDRESS=(320,2),CUNUMBR=32,UNIT=SCTC,UNITADD=A0,PART=(LP2)
     IODEVICE ADDRESS=(322,1),CUNUMBR=32,UNIT=BCTC,UNITADD=A2,PART=(LP2)
*   connecting LP1:
     CNTLUNIT CUNUMBR=42,PATH=40,UNIT=SCTC,UNITADD=((80,3)),CUADD=1
     IODEVICE ADDRESS=(420,2),CUNUMBR=42,UNIT=SCTC,UNITADD=80,PART=(LP2)
     IODEVICE ADDRESS=(422,1),CUNUMBR=42,UNIT=BCTC,UNITADD=82,PART=(LP2)
* for LP3:
*   connecting LP1:
     CNTLUNIT CUNUMBR=33,PATH=30,UNIT=SCTC,UNITADD=((90,3)),CUADD=1
     IODEVICE ADDRESS=(330,2),CUNUMBR=33,UNIT=SCTC,UNITADD=90,PART=(LP3)
```

```
        IODEVICE ADDRESS=(332,1),CUNUMBR=33,UNIT=BCTC,UNITADD=92,PART=(LP3)
*  connecting LP2:
        CNTLUNIT CUNUMBR=43,PATH=40,UNIT=SCTC,UNITADD=((A0,3)),CUADD=2
        IODEVICE ADDRESS=(430,2),CUNUMBR=43,UNIT=SCTC,UNITADD=A0,PART=(LP3)
        IODEVICE ADDRESS=(432,1),CUNUMBR=43,UNIT=BCTC,UNITADD=A2,PART=(LP3)
```

6.5 IBM 3990 Storage Subsystem

This section describes the ESCON-capable 3990 Storage Control units features and configuration.

6.5.1 Nonsynchronous I/O and Extended Count Key Data

In nonsynchronous mode, channel commands do not have to be fetched during the traversal of the inter-record gap on the disk. This allows for significant extensions of the distance between the storage control and processor.

Nonsynchronous operation makes use of Extended Count Key Data (ECKD) data access commands. The principal ECKD commands that provide nonsynchronous operation are DEFINE EXTENT and LOCATE RECORD. They convey the following information to the subsystem before data transfer:

- Type of data transfer to be performed: Read or Write.

- Number of records to be operated upon.

- Track, sector, and record ID to which the device must be positioned prior to initiating data transfer.

See *Introduction to Nonsynchronous Direct Access Storage Subsystems* for more information on this subject.

One of the major advantages of using these commands is that you do not have to reconnect to the channel as was necessary after the former SEARCH command. Only the device and the storage control are involved in the reconnect operation. Thus, with nonsynchronous operation, there is no need for the TIC *-8 command, which is part of the CKD command sequence. The resulting timing problem, caused by reading data from the device and transferring it on the channel at different times, can be solved by buffering the data in the storage control. Not all of the functions are completely implemented in the ESCON 3990, at present. Figure 59 on page 133 shows the scheme of the nonsynchronous data flow within the 3990 Storage Control.

Nonsynchronous mode operations, together with the fiber optic cables and other ESCON-capable products, allow significant extension of the distance between the storage control and host processor complex.
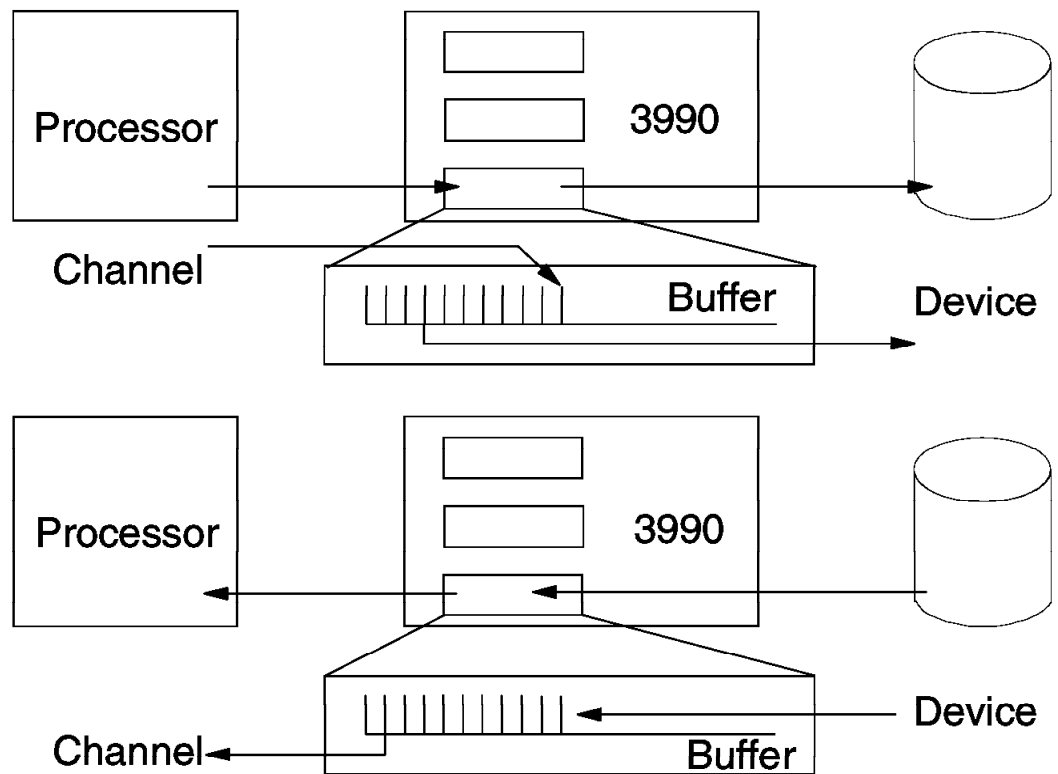
Figure 59. Nonsynchronous DASD - Non-Cached Operation

6.5.2 Description

The nonsynchronous 3990 Storage Control is characterized by:

- ESCON adapter

- Buffer

- Licensed Internal Code

The ESCON adapter feature:

- Is not available for the 3990 Model 1

- Enables 3990 Models 2 or 3 and attached 3390 and 3380 (excluding AA4, A04) DASD to participate in the ESCON environment

- Enables 3990 Model 3 and attached RAMAC 1 (but not RAMAC 2) DASD to participate in the ESCON environment

- Enables 3990 Model 6 and attached 3390 (not 3380), RAMAC 1, and RAMAC 2 DASD to participate in the ESCON environment

- Does not support 3380 track compatibility mode for 3390 DASD

The 3990 ESCON adapter features provide additional flexibility in relocating equipment beyond the currently imposed restriction of 122 meters (400 feet). These features allow 3990 Models 2 or 3 with supported DASD be located up to 15 kilometers from the host processor complex, when using one or two ESCON Directors, or one, two, or three IBM 9036 ESCON Remote Channel Extenders. This distance is increased to 20 kilometers (43km with RPQ) for 3990 Model 6.

The 3990 Model 1 and the 3380 Model CJ2 do not support ESCON channels, but they can be attached to an ESCON channel using an ESCON Converter Model 1.

In addition, in an ESCON environment, 3990 Storage Control units and attached DASD can be installed or removed concurrent with system operation, providing greater availability to the end user and, with appropriate systems planning, minimal disruption to data center operations.

6.5.2.1 Connection Features

After the announcement of ESCON, a 3990 Model 2 or 3 had to be ordered with at least TWO of the following features, one for each cluster:

- Four Channel Switch Parallel = FC # 8171

- ESCON Adapter with Two Interfaces (3990 Models 2 and 3 only) = FC # 6151

- (6171) ESCON Adapter with Four Interfaces (3990 Models 2 and 3 only) = FC # 6171

Prior to the ESCON announcement, the 4-channel switch parallel attachment was standard on all models of the 3990. This capability is now a feature (Four Channel Switch Parallel # 8171) and is one of several possible channel configurations for the 3990 Models 2 and 3.

A 3990 Model 6 must be ordered with ONE of the following nine channel/adapter features:

- 4 ESCON Ports providing 64 Logical Paths = #3001

- 8 ESCON Ports providing 128 Logical Paths = #3002

- 8 ESCON Ports providing 64 Logical Paths = #3003

- 16 ESCON Ports providing 128 Logical Paths = #3004

- 16 ESCON Ports providing 128 Logical Paths = #3006

- 8 Parallel Ports providing 8 Logical Paths = #3008

- 16 Parallel Ports providing 16 Logical Paths = #3009

- 8 Parallel and 4 ESCON Ports providing 72 Logical Paths (8 parallel and 64 ESCON) = #3005

- 8 Parallel and 8 ESCON Ports providing 72 Logical Paths (8 parallel and 64 ESCON) = #3007

For Model 6 order ONE of the above features. If four ESCON ports are ordered two are placed on each cluster, if eight are ordered four are placed in each cluster, and so on. Each feature provides support for both clusters. This is a change from the Model 2 and Model 3.

6.5.2.2 Data Transfer Characteristics

ESCON channels may effectively transfer data at up to 10MB/sec or 17 MB/sec on 3990 Model 3 and Model 6 through cache operations. Each ESCON interface provides a 64-KB buffer. This buffer, used for error checking and correction (ECC), is also used for the nonsynchronous I/O operation to hold the data of one I/O request temporarily (single-thread buffer). The buffer holds the data for a single data transfer. The data is discarded from the buffer after the I/O, but may be retained in cache and NVS depending upon the caching/DFW status of the device. The buffer speed of the parallel implementation is up to 4.5 MB/sec. However for the Model 3 or 6, in the case of a cache hit operation, the data does

not have to pass through the device buffer and can be transferred at up to 10 MB/sec or 17 MB/sec.

Faster microprocessors in the 3990 Model 6 provide improved performance overall. The internal bandwidth of the storage control has been substantially increased to allow for faster transfer of data among the various components of the storage control such as cache, NVS and the storage paths. All internal paths are capable of 18MB/sec transfer rates. The 3990 Model 6 is able to deliver data at an aggregate data rate of up to 120MB/sec. This contributes to the Model 6's improved performance. For example, the Model 6 is able to transfer data on all concurrently active ESCON channels at the full ESCON channel data transfer rate. The 3990 Model 6 asynchronous data transfer (ADT) buffer supports higher data transfer rates than the Model 3 ADT, enabling it to support higher data transfer rates even when the cache is not involved, as in RPS (Rotational Positional Sensing) Miss Avoidance.

6.5.2.3 Summary

The 3990 Storage Subsystem (except Model 1) provides:

- Direct ESCON channel attachment:

    - No ″daisy chaining″ on ESCON channels

    - No attachment of 3380 Models on 3990 Model 6

    - No attachment of 3380 Models AA4 and A04 on Models 2 and 3

    - No attachment of RAMAC 2 on Models 2 or 3

    - No 3380 track compatibility mode on 3390

- Effective data transfer rate of up to 10 MB/sec or 17 MB/sec.

- Up to 3 Km between the processor and the 3990 without an ESCON Director or IBM 9036 ESCON Remote Channel Extender.

- Up to 15 Km between the processor and the 3990 Model 2 or 3 with one or two ESCON Directors, or one or more IBM 9036 ESCON Remote Channel Extenders. This increases to 20Km (43Km with RPQ) for 3990 Model 6.

- ESCON and parallel channels may be installed in the same 3990. (See 6.5.5, "Configuration Guidelines" on page 139 for rules regarding mixed channel types.)

- ESCON adapters may be added to existing 3990s.

6.5.3 IBM 3990 Logical Paths

Any 3990 Model 2 or 3, with or without ESCON channels, has a maximum of 16 logical paths (the 3990 Model 6 increases this to 128). A 3990 Model 2 or Model 3 with ESCON adapter features can attach 16 ESCON processor channels, up to eight on each 3990 cluster. Each ESCON channel adapter can have one or more logical paths. Installed parallel channels use one logical path each, whether in use or not, and any installed ESCON adapter utilizes the remaining logical paths. If parallel channels are installed, there is a minimum of four per cluster. As the 3990 has two clusters this is a minimum of 8 parallel channels, therefore if parallel channels are present, the number of ESCON logical paths is reduced from 16 to 8 for 3990 Model 2 and Model 3.

Figure 60 on page 136 shows two 3990s that may be Model 2 or Model 3. The left one has 16 parallel interfaces and the right one has four ESCON interfaces

connecting to an ESCON Director. Both 3990s can attach 16 paths to the hosts. The ESCON Director may allow more paths to connect to the 3990. In this case the console on the ESCON Director or the ESCON Manager program should be used to prohibit these additional paths (indicated by dotted lines in the figure) from accessing the 3990 ESCON interfaces.
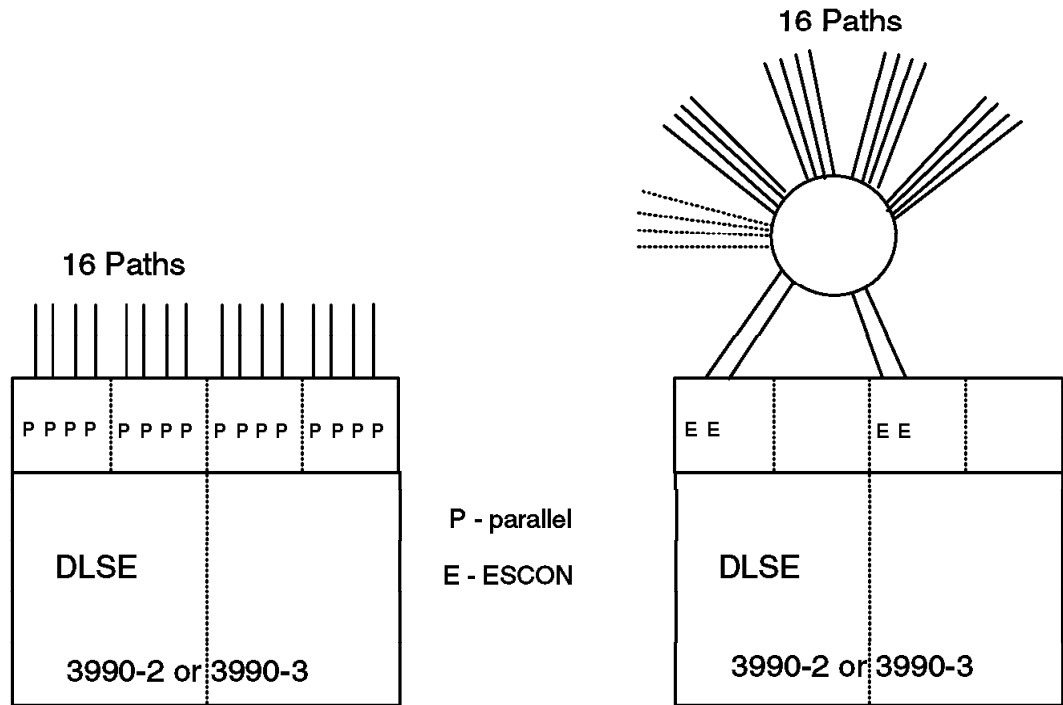

Figure 60. IBM 3990 Model 2 and Model 3 Logical Paths

A question to be asked at this point is how can these logical paths be used? Traditionally a single host image (MVS, VM...) has a maximum of 4 data paths to any model of 3990 controller.

In this, as in many things, there are exceptions. In some processor complexes it is possible to define 8 paths to a device. However, only 4 of the 8 can be transferring data at one time. Therefore there is an increase in availability from having 8 paths, but no increase in performance, as there can be only 4 active data paths at any one time.

A configuration of mixed channel interface types connected to two systems, each with one host image, is shown in Figure 61 on page 137.

One has four parallel channels, the other has six ESCON channels. Nevertheless, the basic rule still applies, that you cannot have more than four active paths to one host image. If the system with six ESCON paths had more than one image on it (in separate LPARs), then all 6 ESCON channels could be active. Using the 16 logical paths of a 3990 Model 2 or Model 3 and the 128 logical paths of a Model 6 implies having multiple host images accessing the storage controller. Since a large processor complex can support up to 10 LPARs (20 on a partitioned multiprocessor) it is perhaps not surprising that many

customers, with multiple LPARs and/or multiple processor complexes, have found the 16 logical paths of the older 3990 models to be a restriction, if they require 4 paths to more than 4 host images.
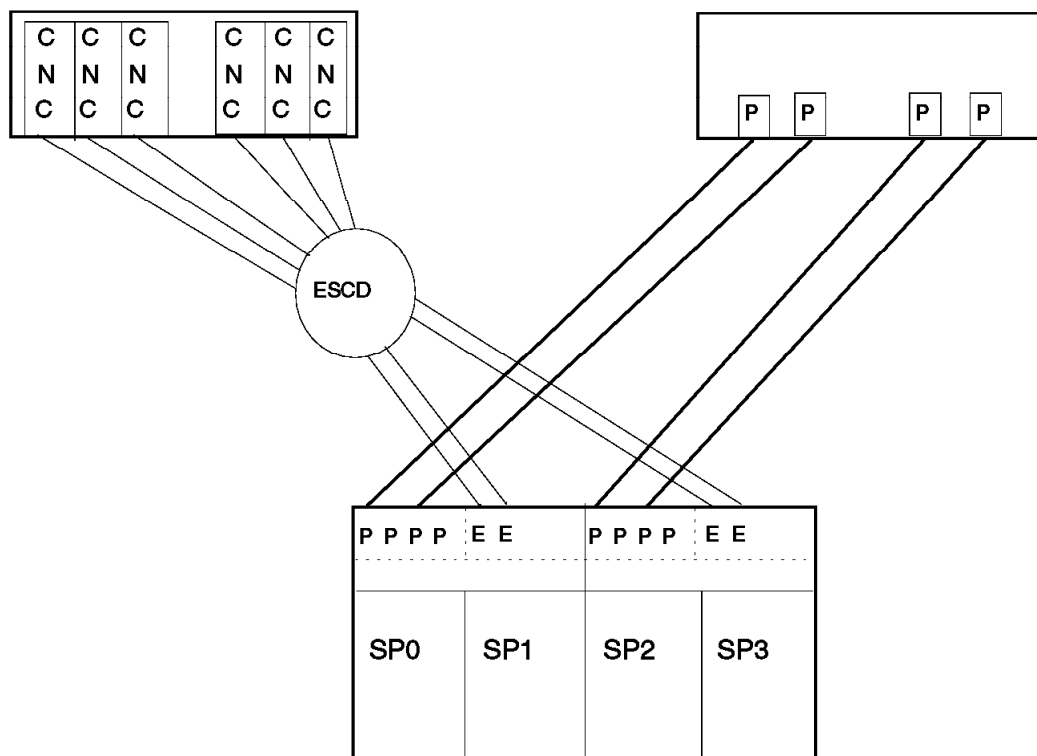
```
┌─────────────────────┐ ┌─────────────────────┐       ┌───────────────────────────────┐
│ ┌─┐┌─┐┌─┐  ┌─┐┌─┐┌─┐ │                              │                               │
│ │C││C││C│  │C││C││C│ │                              │  ┌─┐  ┌─┐      ┌─┐  ┌─┐       │
│ │N││N││N│  │N││N││N│ │                              │  │P│  │P│      │P│  │P│       │
│ │C││C││C│  │C││C││C│ │                              │  └─┘  └─┘      └─┘  └─┘       │
│ └─┘└─┘└─┘  └─┘└─┘└─┘ │                              │                               │
└─────────────────────┘                              └───────────────────────────────┘

                      ( ESCD )


        ┌───────────────────────────────────────────────┐
        │ P P P P  E E    P P P P  E E                   │
        │ ··············  ··············                 │
        │                                                │
        │   SP0      SP1      SP2      SP3                │
        │                                                │
        └───────────────────────────────────────────────┘
```

Figure 61. IBM 3990 Logical Paths Implementation

Be aware of the following logical path rules, when configuring the 3990 Storage Control:

- The maximum number of logical paths available in a cluster is eight for 3990 Model 2 and Model 3. For a 3990 Model 6 with two ESCON adapters in each cluster, each adapter supports 32 logical paths giving a total of 64 logical paths per cluster and 128 logical paths for the entire 3990 Model 6. Figure 62 on page 138 shows two 3990 Model 6 controllers. The left one has 16 parallel interfaces, providing 16 logical paths, the right one has four ESCON adapters providing 128 logical paths.

- A logical path is reserved by each parallel channel interface in a storage cluster. The logical path is reserved regardless of whether the parallel interface is attached to a parallel channel. The parallel interfaces must be physically removed to regain the logical paths assigned to them.

- An ESCON adapter can provide multiple logical paths in a single cluster. On a 3990 Model 6, ESCON logical paths are reserved by adapter card with each card supporting up to 32 logical paths.
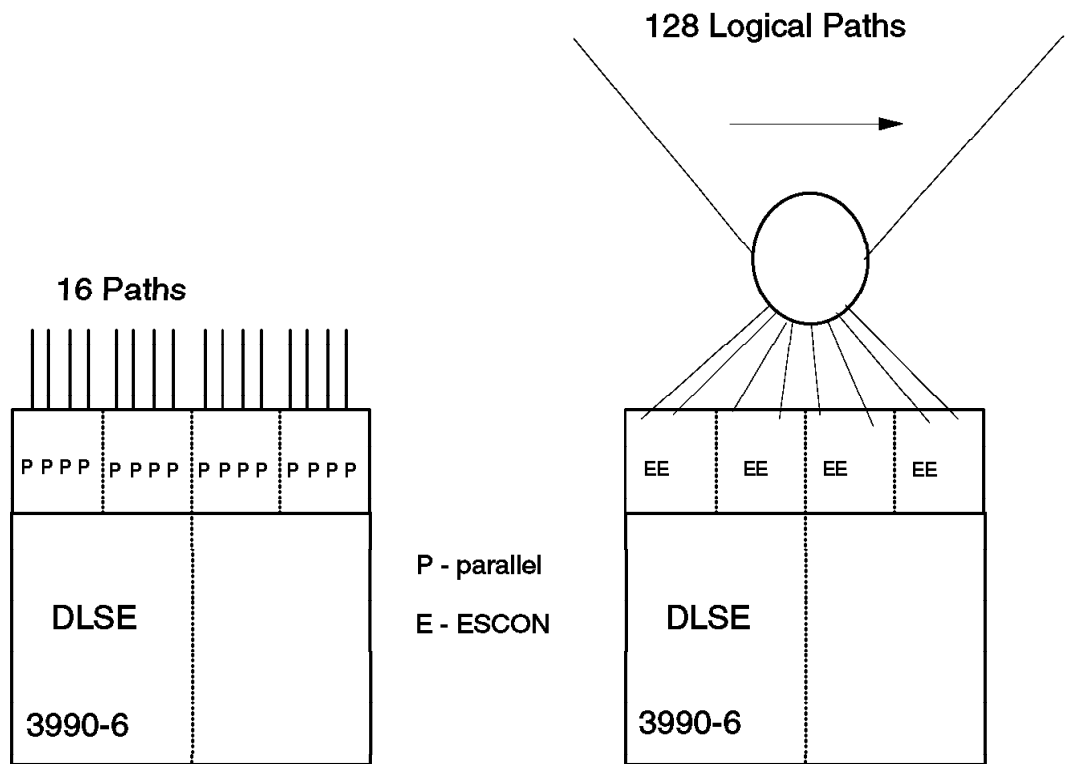
128 Logical Paths

16 Paths

P P P P | P P P P | P P P P | P P P P

DLSE

3990-6

P - parallel

E - ESCON

EE   EE   EE   EE

DLSE

3990-6

Figure 62. IBM 3990 Model 6 Logical Paths

6.5.4 IBM 3990 Model 6

The 3990 Model 6 expands the logical pathing capability in an ESCON environment by a factor of eight, from 16 to 128. The removal of this 16 logical path restriction enables customers to take full advantage of EMIF-capable IBM processors. For example, full four path connectivity was only available for up to four LPARs on a single processor in the past, which was not enough for many customers. The 128 logical path capability of the 3990 Model 6 solves this problem. In most environments, ESCON directors are needed to configure full 128 logical path capability.

A further ESCON enhancement in the 3990 Model 6 is the ability to attach the storage subsystem at up to 20Km from the host system. This distance can be extended by RPQ to enable attachment at up to 43Km from the host. This represents a significant increase in the 15Km distance capability of earlier 3990 models.

The 3990 Model 6 offers cache and NVS sizes of up to 2Gb and 64MB respectively, far more than the 256Mb of cache and 4Mb (16Mb RPQ) of NVS available on the Model 3. The Model 6 also introduces record caching with multiple path locking facility (MPLF), improving on the volume and dataset caching options previously available.

Of all the new features of the 3990 Model 6, however, perhaps the most interesting are the new Remote Copy facilities introduced with this storage subsystem. There are two options available:

- Extended Remote Copy (XRC) allows a customer to copy data from DASD on a 3990 Model 6 at a Primary site to DASD on another 3990 at a Secondary site. The copy is done asynchronously and is performed within seconds of the initial write to the primary DASD.

- Peer-to-Peer Remote Copy (PPRC) performs the copy synchronously writing to primary and secondary DASD simultaneously. The price to be paid for keeping the secondary DASD fully in step with the primary is in slightly longer I/O times.

Peer-to-Peer Remote Copy can be implemented by direct ESCON links between the two 3990 Model 6 controllers at each site or by connecting the 3990 at each site to a local ESCON director, which then communicates with the remote 3990 directly, or through an ESCON director at the remote site to which it is attached. Further information on remote copy is available in the *Remote Copy Administration Guide and Reference (SC35-0169).* The ESCON Director section of this chapter also discusses the use of ESCON directors for PPRC.

6.5.5 Configuration Guidelines

This section discusses the ESCON channel attachments and the planning considerations of configuring a 3990 with and without an ESCON Director, and the maximum distances that the 3990 can be located from the host processors.

- Table 39 gives all possible combinations of channel interfaces and adapter cards used. Unless otherwise stated, ESCON adapters with four interfaces are assumed.

Table 39. 3990 Channel Adapter Combinations																
Cluster 0								**Cluster 1**								**Adapter**	
A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H	Parallel	ESCON
E	E							E	E							0	2 (*)
E	E	E	E					E	E	E	E					0	2
E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	0	4
P	P	P	P					P	P	P	P					2	0
P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	4	0
P	P	P	P	E	E			P	P	P	P	E	E			2	2 (*)
P	P	P	P	E	E	E	E	P	P	P	P	E	E	E	E	2	2
Note: P - Parallel Channel; E - ESCON Channel (*) - ESCON Adapter with two Interfaces																	

- All the ESCON interfaces can be directly connected to the ESCON channels.

- Configure with ESCD(s) when:

  - The 3990 is located at an extended distance from the CP site.

  - There are more systems to connect to than the number of ESCON interfaces installed.

  - There is more than one CU per CHPID.

  - Switching flexibility is required for backup purposes.

- When higher availability is required, connecting to two or more ESCDs will reduce the impact on the 3990 subsystem should an ESCD fail.

- If more than 16 channels are connected to an ESCON Director, they must not attempt to access a 3990 Model 2 or 3, and they should be prohibited from doing so through an ESCON Director console or through the ESCON Manager. This restriction does not apply to a 3990 Model 6 which supports up to 128 Logical Paths.

- All the channels to a system image or partition from a 3990 must be of the same type:
  - ESCON channels
  - Parallel channels
  - ESCON channels operating in conversion mode
  - Parallel channels using ESCON Converter Model 2

- Cluster symmetry of channel adapters is required.

- 3380-compatibility mode of the 3390 is not allowed if the 3990 control unit is attached to ESCON channels or converters (or IBM 3044 Model 2).

- If mixed parallel and ESCON interfaces are installed, the 3990 operates in nonsynchronous mode on the ESCON interfaces and in synchronous mode on the parallel interfaces.

- Self-configuration rules apply to ESCON devices; see 6.1.11, "ESCON Channel Configuration Guidelines" on page 72 for more information. In addition, you will not be able to bring the additional channel path online for 3990 attached devices if:
  - They do not provide the same DASD VOLSER.
  - They do not have matching RCDs (Read Configuration Data).

6.5.6 CKD Compatibility

If you issue a CKD channel program to a nonsynchronous storage control, the channel program might be converted in an MVS environment by the EXCP Scan routine to ECKD format, if it is *well-formed*. A description of *well-formed* can be found in *Introduction to Nonsynchronous Direct Access Storage Subsystems*. If this conversion cannot be made because of a different operating system environment, or the CKD channel program is not *well-formed*, normal read operations will not suffer from significant performance degradation. The current Program Fetch, which uses PCI, and DFSORT, which uses head switching for work files on DASD using slot sorting technique, will not work efficiently.

The nonsynchronous 3990 Storage Control is not designed to process the ending status of a Search and get the new instruction to the device within the gap. Thus, one revolution will be lost every time a CKD-type write operation is performed. (If using IMS WADS and MSDB Dump/Checkpoint, check for required level and PTFs.)

6.5.7 ESCON Distance

Figure 63 on page 141 depicts the maximum distances of different connection combinations for 3990 without XDF. The configurations are described following the figure.
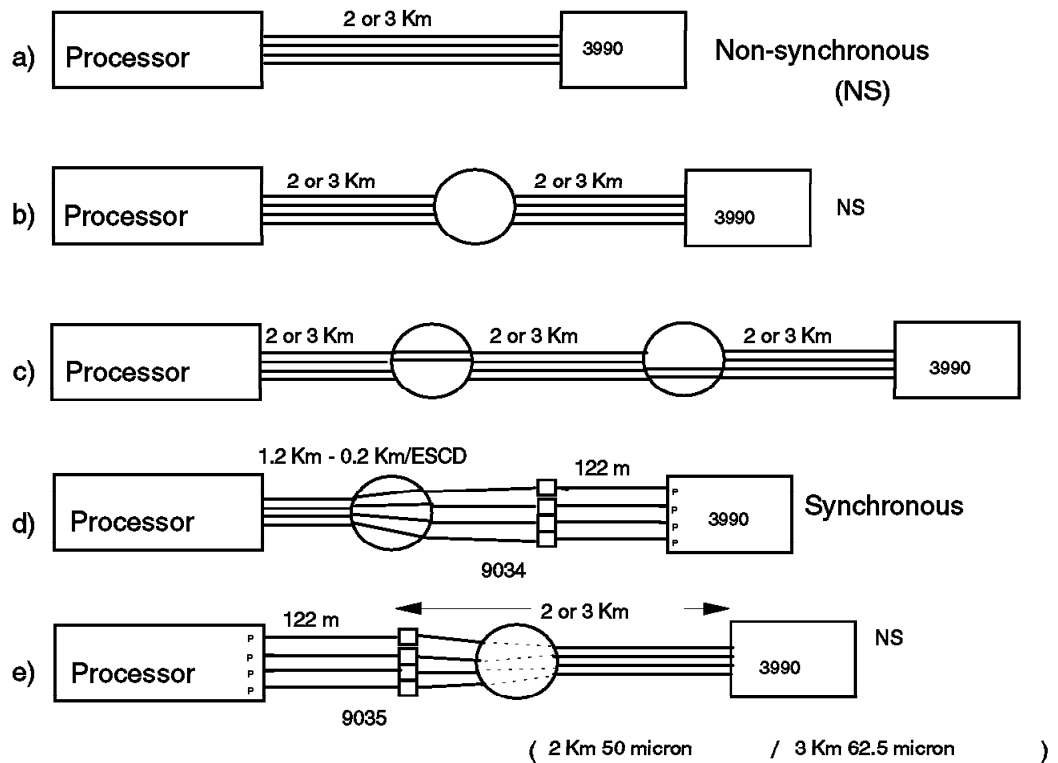
Figure 63. IBM 3990 ESCON Distances (LED)

- a) 3990 with ESCON adapters attached directly to a processor with an ESCON channel.

  The distance in this case is 2 km when using 50/125 micron fiber and 3 Km when using 62.5/125 micron fiber. The 3990 operates in nonsynchronous mode, and therefore the correct level of software must be installed on the host processor(s).

- b) 3990 with ESCON adapters that pass through ans ESCON Director and attach to a processor with ESCON channels.

  Each ESCON link can be up to 2 or 3 km, giving an overall distance of 4 or 6 km. The 3990 operates in nonsynchronous mode.

- c) 3990 with ESCON adapters that pass through two ESCON Directors and attach to a processor with ESCON channels.

  Each ESCON link can be up to 2 or 3 km, giving an overall distance of 6 or 9 km. The 3990 operates in nonsynchronous mode.

- d) 3990 with parallel adapters attached to a processor with ESCON channels, optionally through an ESCON Director.

  The 3990 operates in synchronous mode using parallel interfaces. The ESCON channels must be defined to the processor as ESCON channels operating in conversion mode and four ESCC units provide the conversion from ESCON to parallel. Any paths through an ESCON Director must be dedicated using a CONNECT command.

Distances are 1.2 km for both 50/125 micron and 62.5/125 micron fiber when connected without an ESCON Director. The parallel cables extend the distance up to 122 m (or 400 feet).

If connected through an ESCON Director, the total distance is reduced by 0.2 km for each ESCON Director.

- e) 3990 with ESCON adapters attached to a processor with parallel adapters, optionally through an ESCON Director.

  This combination is restricted to 2 km (50/125) or 3 km (62.5/125) regardless of whether the connection is through an ESCON Director. An ESCON Converter Model 2 provides the parallel-to-ESCON conversion. The 3990 operates in nonsynchronous mode. See 6.15, "IBM 9035 ESCON Converter Model 2" on page 202 for more information.

ESCON XDF links allow a IBM 3990 storage control unit to be attached up to 15 km from its host system for Model 2 or 3, and up to 20Km for Model 6 (43Km with RPQ). This enhancement does apply if a 3990 is attached using IBM 9034 or IBM 9035 ESCON Converters. An ESCON attachment can use two ESCDs and any number of IBM 9036 ESCON Remote Channel Extenders. The maximum length of an ESCON LED link is 3 km; hence, XDF links are required to achieve the 15 km or 20Km (or 43Km with RPQ) maximum supported by the IBM 3990. Figure 64 shows the possibilities with the ESCON extended distance feature (XDF) for 3990 Model 2 or 3.
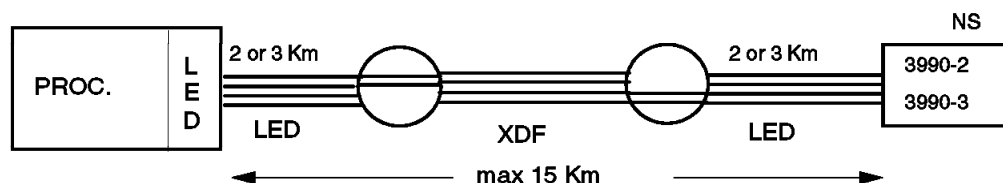
Figure 64. IBM 3990 Model 2 and Model 3 ESCON Distances (XDF)

Figure 65 shows the possibilities with the ESCON extended distance feature (XDF) for 3990 Model 6. For the Model 6 the maximum distance is 20Km. This can be increased by RPQ to 43Km.
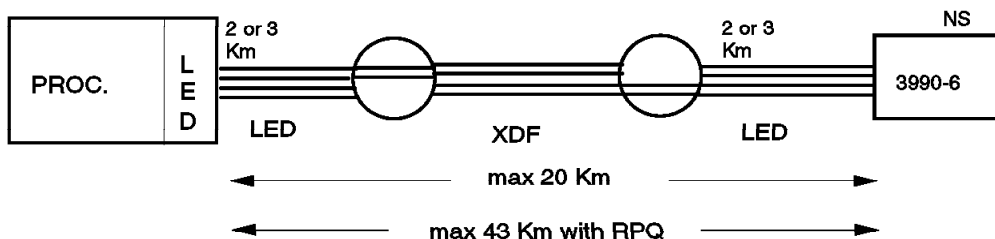
Figure 65. IBM 3990 Model 6 ESCON Distances (XDF)

6.5.8 IOCP

The ESCON architecture requires a new IOCP, IOCDS format and parameters, and new configuration rules. Much of this applies to the 3990 subsystem with ESCON adapters.

The new IOCP coding rules include the following:

- All paths to a control unit from the same system image (processor, LPAR) must be of the same type; TYPE=CNC/CVC/BL cannot be intermixed (except in the 9221 and 9021-520 based models). No IOCP changes are required to define 9035 ESCON Converters. This rule, along with 3990 parallel and ESCON interface mix restrictions, means that careful attention must be given to the planned adapter configuration on a 3990. This also means that channels with logical control units that describe paths of different types are not reconfigurable across LPARs.

- Only one link address (CHPID.LINK) per ESCON channel path is allowed unless the path goes through a switch, because there is no daisy chaining in an ESCON environment.

- All 3990 DASD subsystem device addresses must start at ′00′ in either DLS or DLSE mode:

  - DLSE:

        CNTLUNIT UNITADD=((00,nn));
        IODEVICE ADDRESS=(x00,nn) or UNITADD=00

  - DLS:

        CNTLUNIT UNITADD=((00,nn));
        IODEVICE ADDRESS=(x00,nn) or UNITADD=00;
        CNTLUNIT CUADD required (0 for SP0/SP2 and 1 for SP1/SP3)

Parallel configuration rules apply and the ESCON 3990 establishes all necessary protocols with the converter.

An example of a 3990 DLSE configuration is shown in Figure 66 on page 144. The IOCP definition is given below. In the example, the new parameters used with ESCON are underlined. Note that these parameters are not defaults.

```
 CHPID PATH=(00,01,02,03),TYPE=CNC,SWITCH=01

 CNTLUNIT CUNUMBR=100,UNIT=3990,PATH=(00,02),LINK=(D0,D1),
          UNITADD=((00,64))

 CNTLUNIT CUNUMBR=200,UNIT=3990,PATH=(01,03),LINK=(D2,D3),
          UNITADD=((00,64))

 IODEVICE CUNUMBR=(100,200),UNIT=3380,UNITADD=00,
          ADDRESS=(140,64)
```

Note that:

- The CHPIDs must be defined as TYPE=CNC and also with a SWITCH parameter if the paths go through an ESCON Director.

- The LINK statements specify the port connections on the ESCON Director.

  If an ESCON channel does not go through the ESCON Director, an ′**′ can be placed in the appropriate LINK position.

- The UNITADD must start at address X′00′.

- The device address can remain as before, but a UNITADD=00 must be added if the device address range does not start at X′00′.
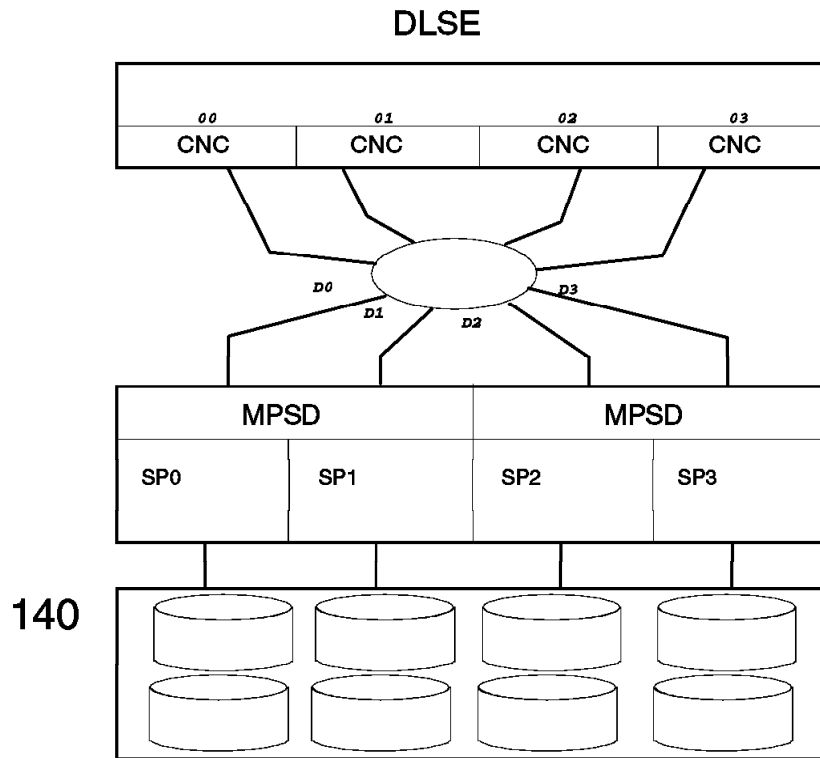
DLSE

Figure 66. IBM 3990 DLSE IOCP

An example of a 3990 DLS configuration is shown in Figure 67 on page 145. In DLS mode, a logical DASD subsystem consists of two single-path storage directors (SPSD) and the 2-path 3380 strings attached to those storage directors. The IOCP definition is given below. In the example, the new parameters used with ESCON are underlined. Note that these parameters are not defaults.
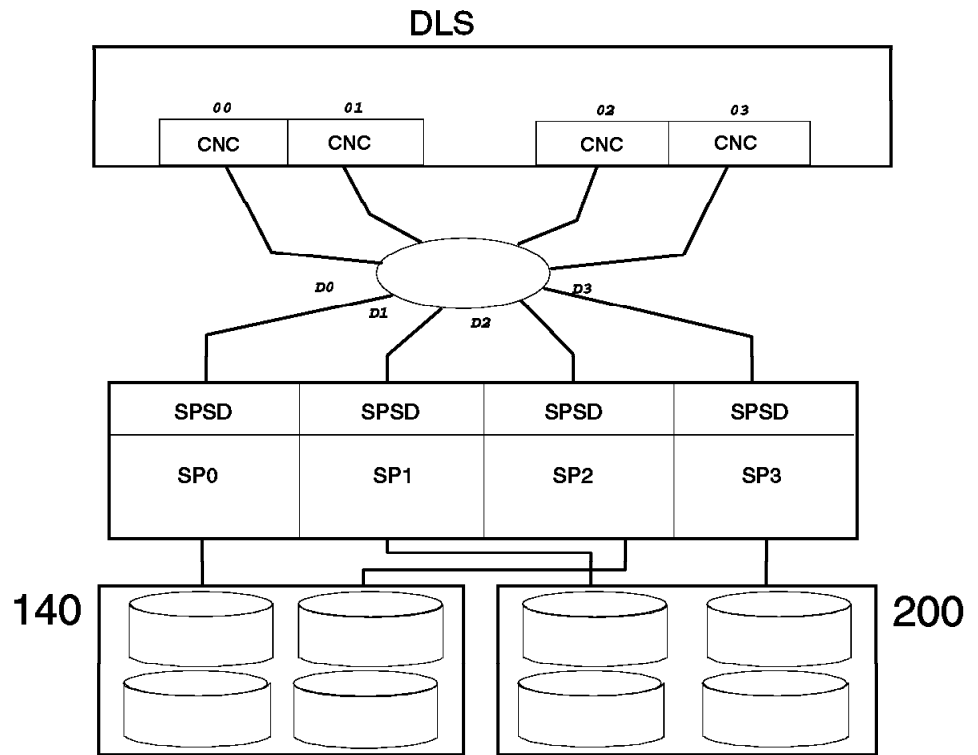
Figure 67. IBM 3990 DLS IOCP

```
CHPID PATH=(00,01,02,03),TYPE=CNC,SWITCH=01

CNTLUNIT CUNUMBR=100,UNIT=3990,PATH=(00),LINK=(D0),
         CUADD=0,UNITADD=((00,32))

CNTLUNIT CUNUMBR=200,UNIT=3990,PATH=(02),LINK=(D2),
         CUADD=0,UNITADD=((00,32))

CNTLUNIT CUNUMBR=300,UNIT=3990,PATH=(01),LINK=(D1),
         CUADD=1,UNITADD=((00,32))

CNTLUNIT CUNUMBR=400,UNIT=3990,PATH=(03),LINK=(D3),
         CUADD=1,UNITADD=((00,32))

IODEVICE CUNUMBR=(100,200),UNIT=3380,
         UNITADD=00,ADDRESS=(140,32)

IODEVICE CUNUMBR=(300,400),UNIT=3380,ADDRESS=(200,32)
```

Note that:

- Following the previous rule, each controller must start at address X′00′. Therefore, the CUADD parameter is required to designate the logical DASD subsystem that is associated with a specific device address. The control unit consisting of SP0 and SP2 must be defined as CUADD=0 and the control unit consisting of SP1 and SP3 must be defined as CUADD=1.

- If the CNTLUNIT address parameter conflicts with the device address on the IODEVICE statement, a UNITADD=00 must be specified (see example on IODEVICE for address 140).

6.5.9 Software Requirements

This section describes the minimum software required for IBM 3990 Storage Subsystem operation in various environments.

6.5.9.1 MVS Environment

Table 40 shows MVS/ESA support for 3990 ESCON. The number in each column defines the minimum required level of a program. Where more current levels, modifications, or releases exist, they also support the listed ESCON products.

Where a small program enhancement (SPE) adds support for ESCON channel control units, "PTF" appears in the column; it will be shipped as a Program Temporary Fix (PTF), and you have to install the PTF as the base level of support.

Table 40. MVS/ESA Support for 3990 ESCON			
	Version 3	*Version 4*	*Version 5*
MVS	3.1.0e + PTF	4.1.0 + PTF	5.1.0
RMF	4.1.1	4.2.0	5.1.0
EREP	3.4.2	3.4.2	3.5.0 + PTF
IXPIOCP	2.0	2.0	2.0
DFP	3.1.1 + PTF	3.2.0 + PTF	3.3.0 + PTF
DFDSS	2.5	2.5	2.5 + PTF
DFHSM	2.5	2.5	2.6 + PTF
ICKDSF	13.0	13.0	15.0

6.5.9.2 VM Environment

If you want to use ESCON channels and 3990 with VM the minimum levels of software required are shown below.

Table 41 shows the releases and levels of VM/ESA and their support for 3990 with ESCON adapters.

Table 41. VM/ESA Support for 3990 ESCON	
VM/ESA	1.1
EREP	3.4.2
IXPIOCP	2.0

6.5.9.3 VSE Environment

VSE/ESA 1.2. or higher is required for support of the 3990 with ESCON adapters.

6.5.9.4 TPF Environment

TPF 3.1 and 4.1 support basic mode operation for 3990 models and record cache with MPLF for the 3990 Model 6.

6.5.9.5 AIX/ESA

All AIX/ESA levels support the 3990 with ESCON adapter.

6.6 IBM RAMAC Array Subsystem

To fully exploit the high availability design of the IBM RAMAC Array Subsystem, its ESCON channel connection layout needs to be designed for high availability as well.

6.6.1 Overview

Customers needing the most powerful, full function, storage subsystem from IBM would typically use a 3990 Model 6 with RAMAC DASD attached. The 3990 would provide read and write caching and dual copy and remote copy capability, among its many other functions. The DASD, attached to the 3990 through a 9391-A10 rack, would be either 9392-B13 or 9392-B23 drawers. The B13, normally referred to as RAMAC 1, has a capacity of 5.67Gb and emulates two 3390 Model 3 devices. The double capacity B23 drawer, referred to as RAMAC 2, has a capacity of 11.35Gb and emulates four 3390 Model 3 devices.

For smaller installations who do not require the powerful capabilities of the 3990 Model 6, but who wish to benefit from using RAMAC technology, IBM provides the RAMAC Array Subsystem. This storage subsystem attaches directly to the host processor through a 9394 Array Controller which emulates a 3990 Model 2. Attached to the controller are either 9395-B13 or 9395-B23 drawers. These have the same capacities as the 9392-B13 and 9392-B23, respectively. The B23 drawer supports 3390 Model 3 emulation. The B13 drawer supports 3390 Model 3 emulation and 3380 Model K emulation, and both of these emulation formats can be installed in a single 9394 Model 3 Array Controller.

6.6.2 Model Descriptions

Descriptions of the three models of the 9394 follow:

9394 Model 1

- Dual Cluster Array Controller
- Emulates 3990 Model 2
- Cache sizes 64MB or 256MB
- 4 ESCON (128 logical) or 4 Parallel channels
- 2 to 16 RAMAC drawers
- Single phase power
- Single line cord

9394 Model 2

- Dual Cluster Array Controller

- Emulates 3990 Model 2

- Cache sizes 64MB or 256MB or 1024MB

- 4 ESCON (128 logical) or 8 Parallel or 4 Parallel and 4 ESCON (128 Logical) channels

- 2 to 16 RAMAC drawers

- Three phase power

- Dual line cord (single line cord option available)

9394 Model 3

- Quad Cluster Array Controller

- Emulates two 3990 Model 2 storage controllers

- Each of the two controllers manages 2 to 8 drawers in each of two cluster pair partitions

- Supports 3390 Model 3 and 3380 Model K emulation formats in a single rack

- Cache sizes 128MB or 512MB or 2048MB

- 8 ESCON (2x128 logical) or 8 Parallel or 4 Parallel and 8 ESCON (2x128 logical) channels

- Three phase power

- Dual line cord (single line cord option available)

6.6.3 ESCON Connectivity

The 9394 Array Controller can be attached to the host processor through ESCON channels. The 9394 ESCON implementation supports 128 Logical Paths and the ability to operate at distances of up to 43Km (26.7 miles).

6.7 IBM 9340 Storage Subsystem

This section describes the IBM 9340 DASD Subsystem, some of its features, and ESCON configuration.

6.7.1 Description

The IBM 9340 is a DASD subsystem providing nonsynchronous operations for mid-size storage needs.

The IBM 9341 Control Unit with IBM 9345 DASD provides uncached operations on an entry level by using parallel channels and a 2- or 4-path storage controller. The IBM 9343 Control Unit with IBM 9345 DASD offers cached and uncached operations (model dependent) while using parallel or ESCON channels.

The capacity ranges from 2 GB to 48 GB, with incremental growth of 2 or 3 GB. The cached models are available with either 32 or 64 MB of cache. Attachment capabilities include all ES/9000 models and a wide range of other IBM processors.

PROCESSOR	STORAGE CONTROLLER	PARALLEL 3.0 MB/sec	PARALLEL 4.5 MB/sec	ESCON
ES/9221	9341	X	X	-
	9343	X	X	X
ES/9121	9343	-	X	X
ES/9021	9343	-	X	X
ES/3090	9343	-	X	X

Table 42. IBM 9340 Processor Connectivity

Let's have a look at the different models:

- Model C02 contains a single storage cluster controller and provides 2 paths to each 9345 DASD actuator, allowing 2 simultaneous data transfers. It has 2 parallel channel interfaces that support 3.0 or 4.5 MB/sec channel data rate.

- Model CC2 has all the capabilities of Model C02, plus 32 MB of cache.

- Model C04 provides dual 2-path storage controllers, 4 paths to DASD, and allows up to 4 data transfers to occur simultaneously. Attachment is to 4 parallel channels at 3.0 or 4.5 MB/sec.

- Model CC4 has all the capabilities of Model C04, plus 64 MB of cache.

- Model D04 provides dual 2-path storage controllers, four ESCON paths to DASD, and allows 4 data transfers to occur simultaneously.

- Model DC4 has all the capabilities of Model D04, plus 64 MB of cache.

6.7.2 ESCON Connectivity

Four ESCON LED attachments allow data transfers at channel rate for the models D04 and DC4. They can be located 2 or 3 km from the processor (see Figure 68). When using XDF links with any combination of up to two ESCDs and any number of IBM 9036 ESCON Remote Channel Extenders, a maximum distance of 43 km from the processors is possible.

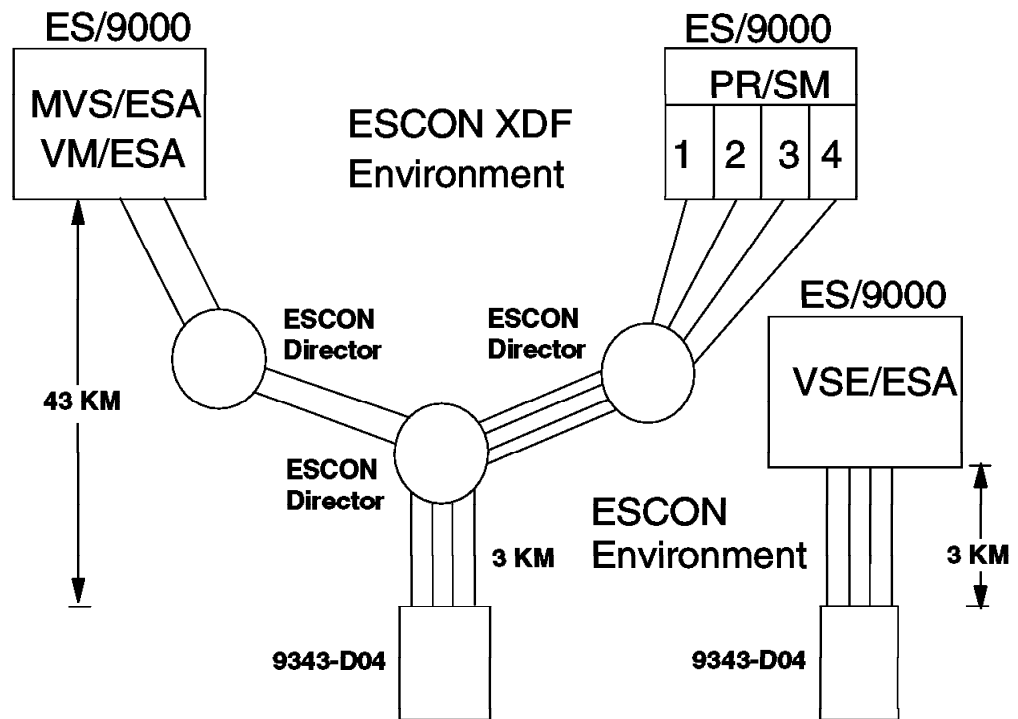These models provide up to 64 logical paths (16 per ESCON adapter).

Figure 68. IBM 9343/9345 ESCON Connectivity

6.7.3 IOCP

The rules for the IOCP are the same as for other control units like a 3990. Take the appropriate UNIT for the CNTLUNIT statement (UNIT=9343) and the IODEVICE statement (UNIT=9345).

6.7.4 Software Requirements

There are no special requirements for the 9340 to operate in an ESCON environment. The requirements are the same as for operating in a parallel environment. Obviously, the operating system itself must support ESCON.

For more information refer to the following documentation:

IBM 9340 Direct Access Storage Subsystems Introduction

Using IBM 9340 Direct Access Storage Subsystems in a MVS Environment

Using IBM 9340 Direct Access Storage Subsystems in a VM Environment

Using IBM 9340 Direct Access Storage Subsystems in a VSE Environment

6.8 IBM 3490 and 3490E ESCON Magnetic Tape Subsystem

This section describes the ESCON capable 3490 and 3490E magnetic tape subsystem. A brief discussion of the 3590 ESCON subsystem has also been included.

6.8.1 3490/3490E

The IBM 3490/3490E magnetic tape subsystem consists of the following models:

- 3490 models

    - 3490 A01-A02 (Control Unit)/B02-B04 (Drive Unit)
    - 3490 D31/D32

- 3490E models

    - 3490 A10-A20 (Control Unit)/B20-B40 (Drive Unit)
    - 3490 C10/C11/C22
    - 3490 C1A/C2A

        - Specifically designed for use in the 3494 library

        - Functionally equivalent to the Model C11 and C22, respectively

    - 3490 D41/D42

Each model with control unit function can be equipped with ESCON adapters. Full participation in the ESCON environment with the tape subsystem requires:

- ESCON channels

- Appropriate host software

- 3490/3490E with ESCON adapters

The concept of logical paths was covered earlier. This section gives details and examples of 3490/3490E configurations and the related IOCP definitions.

Table 43 shows the maximum data rate of the 3490/3490E.

Table 43. Maximum Data Rate of 3490/3490E		
Model	**Parallel MB/Sec**	**ESCON MB/Sec**
A01/A02	4.5	4.5
D31/D32	4.5	4.5
A10/A20	4.5	9.0
C10/C11/C22/C1A/C2A	4.5	9.0 (1)
D41/D42	4.5	9.0 (2)
Note:		
1. Performance Enhancement RPQ #8B3130 required.		
2. Performance Enhancement Feature (#5036) required.		

Older tape subsystems, such as the 3803, 3420, 3422, 3480, and the 3490/3490E with parallel adapters, are accommodated through use of the 9034 ESCON Converter. See 6.14, "IBM 9034 ESCON Converter Model 1" on page 194 for more information on IBM 9034 ESCON Converter.

6.8.2 3590

The IBM 3590 is a high performance tape subsystem with a drive data rate of 9 MB/sec on an ESCON channel. It offers expanded capacity with the new 3590 cartridge, which has an uncompacted data capacity of 10GB, or typically over 30GB assuming a 3:1 compaction ratio.

The 3590 drives are supported on the ES/9000 systems for attachment with ESCON channels only through the Model A00 controller.

The following models are available:

- A14 frame

  This is a frame designed for attachment to ESCON channels on ES/9000 systems. It may be installed as a stand-alone 3590 ESCON subsystem or it may be placed in a 3495 Automated Tape Library Dataserver.

- A00 controller

  This provides attachment to ESCON channels with feature code 3312. Two ESCON channel attachments are provided with each feature. It can be placed in a 3494 library or in a 3590 Model A14 frame.

- B1A drive

  This can be installed in a 3494 library. For attachment to ESCON channels, a Model A00 is required.

- B11 drive

  This can be installed in a rack, or with a Model A00 in the Model A14 frame.

The Model A00 can be placed in a 3494 library or in a 3590 Model A14 frame.

ESCON channel attached 3590 does not support the IBM 9035 ESCON Converter Model 2.

6.8.3 3490 Logical Paths

The 3490/3490E ESCON tape unit, together with ESCON directors, allows connection to many system images. Figure 69 on page 153 shows an example.

Up to 16 System Images
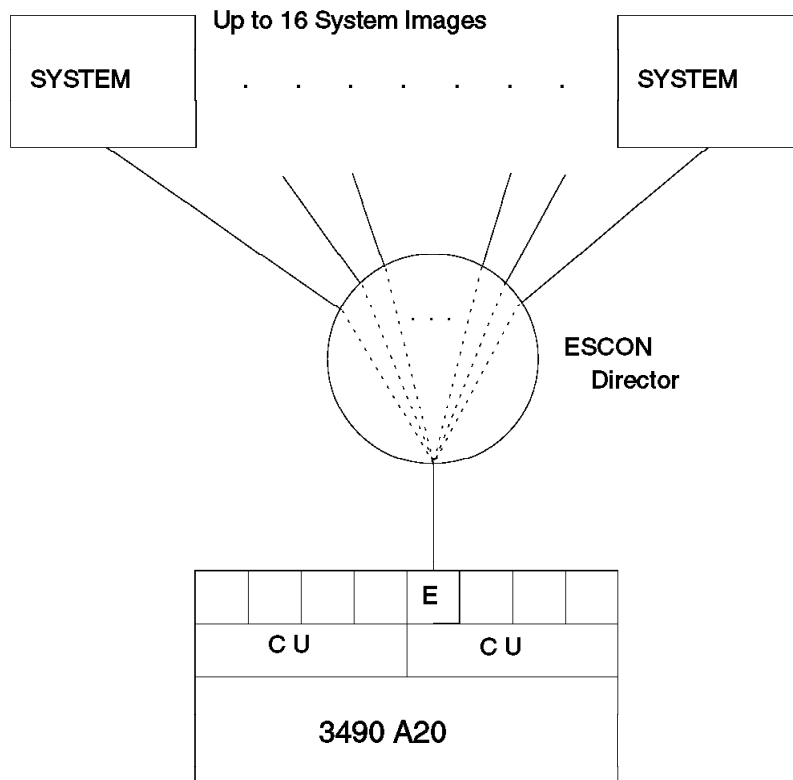
Figure 69. IBM 3490 Logical Paths

A maximum of 16 logical paths per ESCON adapter is allowed.

Table 44 shows combinations of logical paths with ESCON adapters for the 3490 models A01/A02. For instance, through the use of two ESCON Directors, a single 3490 Model A02 with four ESCON adapters installed could attach to 64 channels (64 system images) or 32 system images if two paths were connected to each system image.

Table 44. Logical Path Combinations of 3490 Models A01/A02			
Installed Parallel Feature Per CU	**Maximum ESCON Ports Per CU**	**Maximum ESCON Logical Paths Per CU**	**Maximum Total ESCON Logical Paths A01/A02**
0	2	32	32/64
1	1	16	16/32
2	1	16	16/32
3	0	0	0/0
4	0	0	0/0
Note: Model A02 requires both control unit functions to be configured symmetrically with the same number of parallel and ESCON ports			

Table 45 shows combinations of logical paths with ESCON adapters for 3490 models A10/A20.

Table 45. Logical Path Combinations of 3490 Models A10/A20			
Installed Parallel Feature Per CU	**Maximum ESCON Ports Per CU**	**Maximum ESCON Logical Paths Per CU**	**Maximum Total ESCON Logical Paths A10/A20**
0	4	64	64/128
1	3	48	48/96
2	2	32	32/64
3	1	16	16/32
4	0	0	0/0
Note: Model A20 requires both control unit functions to be configured symmetrically.			

Table 46 shows combinations of logical paths with ESCON adapters for 3490 model D31/D32.

Table 46. Logical Path Combinations of 3490 Models D31/D32		
Installed Parallel Feature Per CU	**Maximum ESCON Ports Per CU**	**Maximum Total ESCON Logical Paths**
1	1	16
2	0	0
Note: One Parallel adapter is standard and cannot be removed.		

Table 46 shows combinations of logical paths with ESCON adapters for 3490 models C10-C11-C12/D41-D42.

Models C10-C11-C22-C1A-C2A/D41-D42

Table 47. Logical Path Combinations of 3490		
Installed Parallel Feature Per CU	**Maximum ESCON Ports Per CU**	**Maximum Total ESCON Logical Paths**
0	2	32
1	1	16
2	0	0

6.8.4 3590 Logical Paths

The ESCON Adapter Card feature 3312 on the Model A00 controller provides two ESCON channels for attachment to the host system and allows two concurrent I/O operations. 64 logical paths are available for each ESCON channel attached to the 3590.

6.8.5 Configuration Guidelines

The 3490/3490E ESCON adapters can be installed on each model of the 3490.

Configuration Rules for 3490 Models A01/A02:

- Maximum of four parallel adapters per control unit.

- Maximum of two ESCON adapter per control unit.

- Up to a maximum of four channel adapters per control unit.

- A mix of ESCON and parallel adapters is possible.

- One ESCON adapter replaces two parallel adapters.

- The two control units in the A02 tape unit must have symmetrical channel adapters.

- Only one type of path can be connected to a system image.

Configuration Rules for 3490 Models A10/A20:

- Maximum of four parallel adapters per control unit.

- Maximum of four ESCON adapters per control unit.

- Up to a maximum of four channel adapters per control unit.

- Adapters may be intermixed.

- One ESCON replaces one parallel adapter.

- The two control units in the A20 tape unit must have symmetrical channel adapters.

- Only one type of path can be configured to a system image.

Configuration Rules for 3490 Models D31/D32:

- One parallel adapter is standard, cannot be removed.

- Maximum of two parallel adapters.

- Maximum of one ESCON adapter.

- Up to a maximum of two channel adapters.

- One ESCON adapter can be intermixed with one parallel adapter.

- Only one type of path can be configured to a system image.

Configuration Rules for 3490 Models C10-C11-C12-C1A-C2A/D41-D42:

- One parallel adapter is standard on Models D41/D42.

- Maximum of two parallel adapters.

- Maximum of two ESCON adapters.

- Up to a maximum of two channel adapters.

- ESCON adapter can be intermixed with parallel adapter.

- Only one type of path can be configured to a system image.

Note: In General, all the channels from a particular 3490/3490E to a given system image must be of the same type: all parallel, all ESCON native mode (TYPE=CNC), or all ESCON conversion mode (TYPE=CVC). The "system image" could either be a processor or a PR/SM logical partition. However, support has since been announced, for certain processors, for an intermix of

parallel channels (Block or Byte), and ESCON conversion channels (TYPE=CVC). Intermix with ESCON native channels is not supported. The support is intended to connect to a parallel-capable device through the 9034 Model 1 ESCON Converter, which converts fiber optic protocols to parallel protocols. The processors that will support the intermix of parallel and ESCON CVC channels are IBM 9021 520-based and 711-based models, IBM 9121, and IBM 9221.

When multiple system images share the magnetic tape subsystem, it is recommended that you have at least two paths to each system image. For more information, please refer to 6.1.11, "ESCON Channel Configuration Guidelines" on page 72.

Paths connecting to the same system or system image with non-matching read configuration data (RCD) comparison will not be brought online.

6.8.6 ESCON Distances

Figure 70 depicts different configuration distances. The configurations are described following the figure.
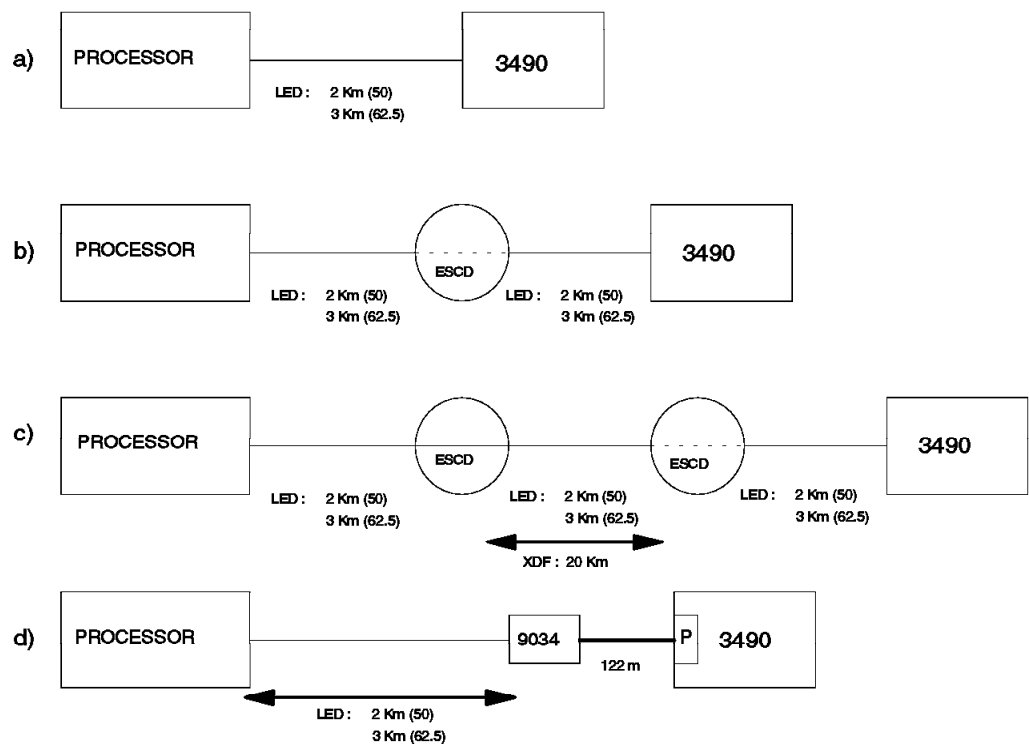
Figure 70. IBM 3490/3490E ESCON Distances

a) 3490/3490E with ESCON adapters attached directly to a processor with ESCON channels.

- The maximum distance is 2 km when using 50/125 micron fiber.
- The maximum distance is 3 km when using 62.5/125 micron fiber.

b) 3490/3490E with ESCON adapters connected to a processor with ESCON channels through an ESCON Director or an IBM 9036 ESCON Remote Channel Extender Model 1.

- Each ESCON LED link can be up to 2 or 3 km, giving a maximum overall distance of 6 km.

c) 3490/3490E with ESCON adapters connected to a processor with ESCON channels through two ESCON Directors or through two IBM 9036 ESCON Remote Channel Extenders.

- Each ESCON LED link can be up to 2 or 3 km, giving an maximum overall distance of 9 km.

- The distance between the channel and the 3490/3490E is limited to 23 km, even if you use two ESCON Directors or two IBM 9036 ESCON Remote Channel Extenders. The ESCON LED link between an ESCON Director or an IBM 9036 ESCON Remote Channel Extender and the 3490/3490E can be up to 2 or 3 km using a LED link.

d) 3490/3490E with parallel adapters attached to a processor with ESCON channels, optionally through an ESCON Director.

- The ESCON channels must be defined to the processor as ESCON channels operating in conversion mode. The 9034 ESCON Converter Model 1 provides the conversion from ESCON to parallel. Any paths through an ESCON Director must be dedicated.

- Distance is 2 km for 50/125 micron or 3 km for 62.5/125 micron fiber. The parallel cables extend the distance up to 122 m (or 400 feet).

- ESCON XDF link cannot attach to 9034 ESCON Converter Model 1 directly.

6.8.7 IOCP

The following rules apply to the 3490/3490E IOCP definition:

- The control unit address must start at X′00′. If the device number does not start at X′00′, the UNITADD=00 must be included on the IODEVICE macro.

- Always generate the full address range.

- The 3490/3490E has a maximum of 16 logical paths per ESCON adapter.

- The 3590 has a maximum of 64 logical paths per ESCON adapter.

The example in Figure 71 describes a configuration of a 3490 model A20 with two ESCON Directors. In the example, the new parameters used with ESCON are underlined. Note that these parameters are not defaults.
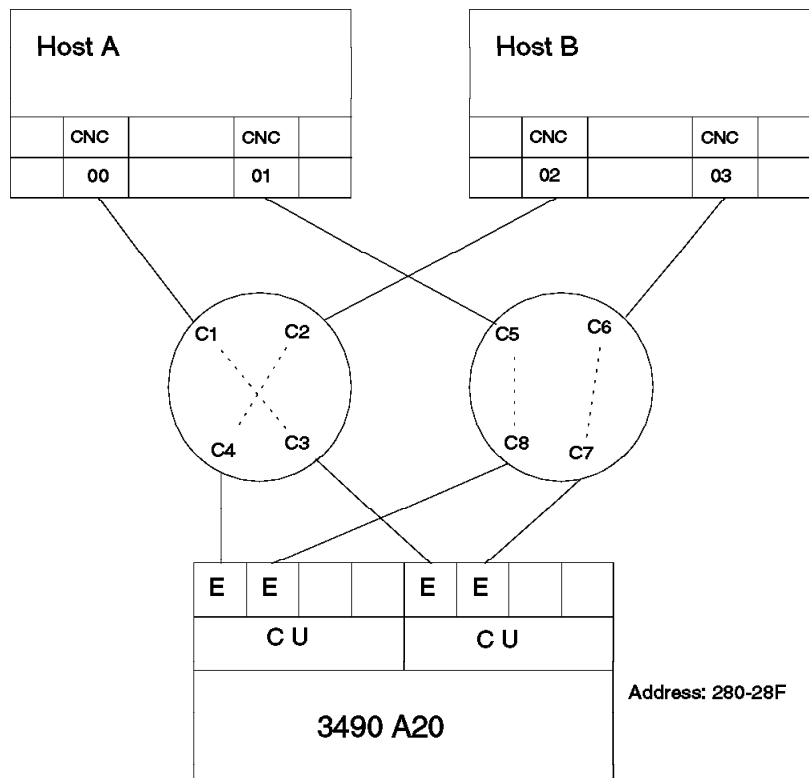
Host A Definition:

```
CHPID PATH=00,TYPE=CNC,SWITCH=01

CHPID PATH=01,TYPE=CNC,SWITCH=02

CNTLUNIT CUNUMBER=010,UNIT=3490,PATH=(01),
    UNITADD=((00,16)),LINK=(C8)

CNTLUNIT CUNUMBER=011,UNIT=3490,PATH=(00),
    UNITADD=((00,16)),LINK=(C3)

IODEVICE CUNUMBER=(010,011),UNIT=3490,
    ADDRESS=(280,16),UNITADD=00
```

Host B Definition:

```
CHPID PATH=02,TYPE=CNC,SWITCH=01

CHPID PATH=03,TYPE=CNC,SWITCH=02

CNTLUNIT CUNUMBER=010,UNIT=3490,PATH=(02),
    UNITADD=((00,16)),LINK=(C4)

CNTLUNIT CUNUMBER=011,UNIT=3490,PATH=(03),
    UNITADD=((00,16)),LINK=(C7)

IODEVICE CUNUMBER=(010,011),UNIT=3490,
    ADDRESS=(280,16),UNITADD=00
```

Figure 71. IBM 3490 IOCP Definition Example: Two ESCDs

6.8.8 Software Requirements - 3490/3490E

This section describes the minimum software requirement for the IBM 3490/3490E ESCON Magnetic Tape Subsystem operating in various environments.

6.8.8.1 MVS Environment

Table 48 shows the required releases and levels of MVS/ESA for 3490 ESCON. The number in each column defines the minimum required level of a program. Where more current levels, modifications, or releases exist, they also support the listed ESCON products.

Where a small program enhancement (SPE) is used to add support for ESCON channel control units, it will be shipped as a Program Temporary Fix (PTF); "PTF" appears in the column, and you have to install the PTF as well as the base level of support.

Table 48. MVS/ESA Minimum Requirement for 3490/3490E ESCON			
Products	**A01/A02 D31/D32**	**A10/A20 D41/D42**	**C10/C12/C22**
MVS	3.1.0e + PTF 4.1.0 + PTF	3.1.0e + PTF 4.1.0 + PTF	3.1.3 + PTF 4.1.0 + PTF
DFP (1)	3.1.1 + PTF		
EREP	3.4.2 + PTF		
DFDSS	2.5 + PTF		
DFHSM	2.5	2.6	2.6
DFSORT	11.0 + PTF		
Note: When ESCON adapters are installed on a 3490, PTFs must be installed on all other systems to which the 3490 is attached, including those attached through parallel adapters.			

6.8.8.2 VM Environment

The following release of VM/ESA is required for using 3490/3490E with ESCON adapters:

  VM/ESA Version 1 Release 1.1 or higher.

6.8.8.3 VSE Environment

The following release of VSE/ESA is required for using 3490/3490E with ESCON adapters:

  VSE/ESA Version 1 Release 2 or higher.

6.8.8.4 TPF Environment

The following release of TPF is required for using 3490/3490E with ESCON adapters:

  TPF Version 3 Release 1 + additional SPE.

6.8.8.5 AIX Environment

The following release of AIX/ESA is required for using 3490/3490E with ESCON adapters.

AIX/ESA Version 2 Release 1 or higher.

6.8.8.6 3490 Models C1A and C2A

Support for 3490E Models C1A & C2A is provided in OS/400, AIX, VM, MVS, AIX/ESA and operating environments. See 6.9, "IBM 3494 Tape Library Dataserver" on page 161 for more details.

6.8.9 Software Requirements - 3590

This section describes the minimum software requirement for the IBM 3590 ESCON Magnetic Tape Subsystem operating in various environments.

6.8.9.1 MVS/ESA:

- MVS/ESA SP 4.3.0, 5.1.0, or 5.2.0 (For JES3, JES3 5.1.1 is required) plus SPEs
- DFSMS/MVS 1.2.0 or higher plus SPEs
- EREP 3.5.0 plus SPEs
- ADSM/MVS in a future release
- DFSORT (TM) Release 12 plus SPEs
- DITTO/ESA Release 1
- DB2 (through DFSMShsm)

6.8.9.2 VM/ESA:

- VM/ESA Version 2
- DITTO/ESA Release 1
- ADSM/VM in a future release
- EREP 3.5.0 plus PTFs

6.8.9.3 AIX/ESA:

- AIX/ESA 2.2.0

6.8.9.4 VSE/ESA:

- VSE/ESA Version 2
- EREP 3.5.0 plus PTFs
- ADSM/VSE in a future release
- DITTO/ESA Release 1

6.8.9.5 Transaction Processing Facility (TPF):

- TPF 4.1

6.9 IBM 3494 Tape Library Dataserver

This section describes the ESCON capable 3494 Tape Library Dataserver.

6.9.1 Description

The 3494 Tape Library Dataserver is a low-cost automated, small footprint tape library, providing an automated tape solution to a variety of system environments. The 3494 can be accessed by multiple systems (AS/400, RISC/6000, ES/9000, and SUN).

The 3494 incorporates two new models of the IBM 3490E CXX family of tape drives, namely the 3490E Models C1A and C2A, which are fully compatible with existing 3490E models, and are upgradable from Models C10, C11, and C22. The 3494 also incorporates the use of the new 3590 tape and/or tape controller models (B1A/A00).

The 3494 supports the ES/9000 environment through both parallel and ESCON channel attachments for the 3490 Models C1A and C2A, and ESCON channel attached 3590 subsystem (Model A00 controller and Model B1A drive).

The 3494 Tape Library Dataserver is a linear aisle configuration composed of one Control Unit Frame and, optionally, any combination of up to seven Storage Unit and/or Drive Frames. The Control Unit Frame houses cartridges, a cartridge accessor, a library manager, support components, and optionally tape drive subsystem(s). The Drive Frames contain (zero to two) IBM 3490E or (zero to six) 3590 tape drives, as well as cartridge storage. The Storage Frame provides cartridge storage only.

The intelligence that controls all operations in the 3494 Tape Library Dataserver is the Library Manager. It is an OS/2 based software code implemented in an industrial PC console. It manages the resources within the 3494, exchanges information with the 3490 and 3590 control units and their associated processors, and communicates with operators and library personnel when required. It is also used for service and test operations. In addition, the Library Manager maintains both a primary and secondary database for volume inventory and storage cell location.

6.9.2 Configuration Guidelines

The Library Manager system unit contains one, and optionally a second, Artic card. Each Artic card manages up to 4 control units, allowing up to a maximum of eight tape control units in the 3494. The number of tape drives in the tape library will depend on the combination and model of the tape control units configured. For example, with 8 x 3490-C2A, up to sixteen drives are supported, whereas with 8 x 3590-A00/B1A, only eight drives are available.

Seven different models of the 3494 are provided. Three of the seven models are control unit models (L10, L12 and L14). Another three of the seven models are drive unit models (D10, D12 and D14). The last of the seven models is a storage unit model (S10). Each 3494 subsystem contains one control unit model and from zero to seven other drive unit or storage unit models (or frames).

The 3590 Model B11 is the rack mountable version and the Model B1A is designed for automation in the IBM 3494 Tape Library Dataserver. Both models include an integrated SCSI-3 controller, two SCSI differential 16-bit interface

ports, and a 3590 tape transport. The IBM 3590 Model A00 is intended to connect the 3590 Model B11 or B1A drives through ESCON channels for use on ES/3090, ES/9000, or S/390 Parallel Transaction or Enterprise Servers.

At time of writing this book, the SCSI channel attached 3590 subsystem has been announced and is generally available. However, the ESCON channel attached 3590 subsystem was announced but will not be generally available until late 1996.

There are various models of the ESCON capable 3494 Tape Library Dataserver:

- The Model L10 contains (in addition to the normal library control hardware) one 3490E Model C1A or one Model C2A.

- The Model L12 contains (in addition to the normal library control hardware) zero, one, or two 3590 Model B1As.

- The Model L14 contains (in addition to the normal library control hardware) zero, one, or two 3590 Model B1As, and zero or one 3590 Model A00 (if one (or more) Model B1A is present).

- The Model D10 contains either zero drives, one 3490E model C1A, or one 3490E Model C2A.

- The Model D12 contains zero to six 3590 Model B1As.

- The Model D14 contains zero to four 3590 Model B1As, and control hardware, zero, one, or two 3590 Model B1As, and zero to one 3590 Model A00 (if one or more Model B1A is present).

The 3590 does not support IBM 9035 Converter Model 2.

For the 3490 Models C1A and C2A:

- Only one type of channel attachment can be configured, that is, only parallel or ESCON channel adapter(s).

- Up to two ESCON Adapters (feature code 3319) can be ordered. Each ESCON Adapter provides one ESCON channel attachment.

- Improvement in subsystem performance is available to the ESCON attached Models C1A and C2A through the Performance Enhancement feature code 5045. This feature improves the control unit data rate up to 9 MB/sec.

The 3494 Library Manager communicates to the host through the channels of the tape subsystems configured.

Figure 72 shows the 3494 configuration ranges.

IBM 3494 Tape Library Dataserver

Configuration Flexibility
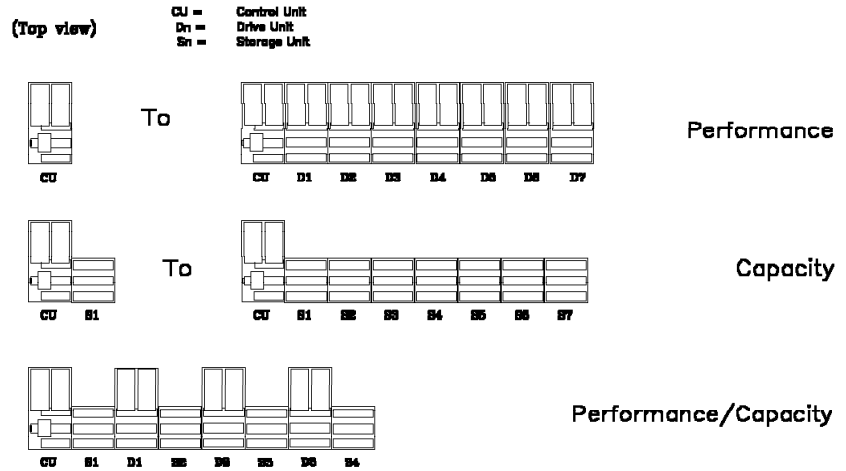
Figure 72. IBM 3494 Tape Library Dataserver Configuration

6.9.3 ESCON Distances

The IBM 3494 Tape Library Dataserver is configured with IBM 3490E and/or 3590 Tape subsystems. The IBM 3494 has no direct access to host channels. The configuration distances are dependant on the 3490E and 3590 Tape Subsystem capability. Figure 73 on page 164 shows configuration distances.
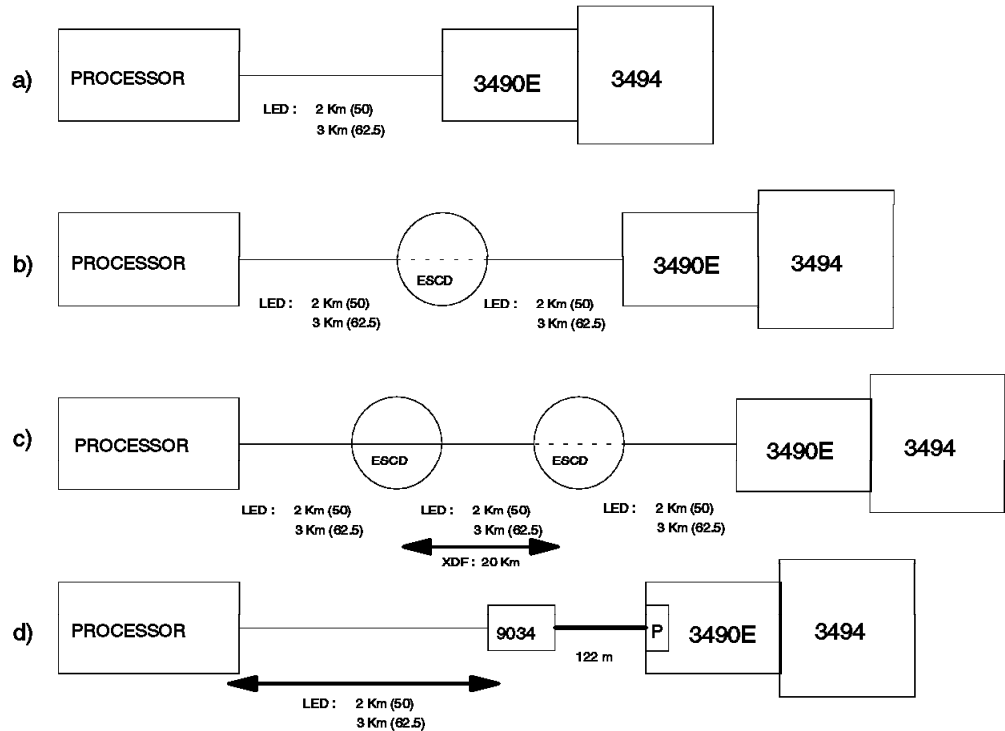
Figure 73. IBM 3494 ESCON Distances with 3490E

a) 3490E and 3590 with ESCON adapters attached directly to a processor with ESCON channels.

  • The maximum distance is 2 km when using 50/125 micron fiber.
  • The maximum distance is 3 km when using 62.5/125 micron fiber.

b) 3490E and 3590 with ESCON adapters connected to a processor with ESCON channels through an ESCON Director or an IBM 9036 ESCON Remote Channel Extender.

  • Each ESCON LED link can be up to 2 or 3 km, giving a maximum overall distance of 6 km.

c) 3490E and 3590 with ESCON adapters connected to a processor with ESCON channels through two ESCON Directors or through two or more IBM 9036 ESCON Remote Channel Extenders.

  • Each ESCON LED link can be up to 2 or 3 km
  • Each ESCON XDF link can be up to 20 km
  • The total maximum distance for 3490E is 23 km.
  • The total maximum distance for 3590 is 43 km.

d) 3490E with parallel adapters attached to a processor with ESCON channels, optionally through an ESCON Director.

  • The ESCON channels must be defined to the processor as ESCON channels operating in conversion mode. The 9034 ESCON Converter Model 1 provides the conversion from ESCON to parallel. Any paths through an ESCON Director must be dedicated.

- Distance is 2 km for 50/125 micron or 3 km for 62.5/125 micron fiber. The parallel cables extend the distance up to 122 m (or 400 feet).
- ESCON XDF link cannot attach to the 9034 ESCON Converter Model 1 directly.

6.9.4 Software Requirements

Programming support for the 3494 includes:

- Operating System/400 (OS/400)
- Advanced Interactive Executive/Enterprise System Architecture (AIX/ESA)
- IBM AIX for RISC System/6000 (AIX/6000)
- Basic Tape Library Support for Multiple Virtual Storage (MVS/ESA)
- Multiple Virtual Storage/Enterprise System Architecture (MVS/ESA)
- Virtual Machine/Enterprise System Architecture (VM/ESA)
- Virtual Storage Extended/Enterprise System Architecture (VSE/ESA)
- Sun Device Driver

This section describes the minimum software requirement on the IBM 3494 Tape Library Dataserver for the appropriate ESCON-capable environment.

6.9.4.1 ES/9000 Environment

MVS DFSMS System-Managed Tape 3490E support:

- MVS/ESA SP 4.3.0 or 5.1.0 (for JES3, JES3 4.2.1 or 5.1.1 is required)
- DFSMS/MVS 1.1.0 or higher
- EREP 3.5.0 plus APAR IR97455

For additional information about JES3 support of BTLS, refer to Washington Systems Center Flash #9421.

MVS DFSMS System-Managed Tape 3590 support:

- MVS/ESA SP 4.3.0, 5.1.0, or 5.2.0 (For JES3, JES3 5.1.1 is required) plus SPEs
- DFSMS/MVS 1.2.0 or higher plus SPEs
- EREP 3.5.0 plus SPEs

Basic Tape Library Support (BTLS) for MVS/DFP 3490E support:

- MVS/DFP 3.1.1 with MVS/SP 3.1.3
- MVS/DFP 3.2.0 with MVS/SP 3.1.3, MVS/ESA SP 4.2.0, or 4.2.2
- MVS/DFP 3.2.1 with MVS/SP 3.1.3, MVS/ESA SP 4.2.0, or 4.2.2
- MVS/DFP 3.3.0 with MVS/ESA SP 4.2.0, 4.2.2, 4.3.0, or 5.1.0 or higher
- MVS/DFP 3.3.1 with MVS/ESA SP 4.2.0, 4.2.2, 4.3.0, or 5.1.0 or higher
- MVS/DFP 3.3.2 with MVS/ESA SP 4.2.0, 4.2.2, 4.3.0, or 5.1.0 or higher

For JES3, DFP 3.3.0 or higher and JES3 4.2.1 or 5.1.1 is required. For additional information about JES3 support of BTLS, refer to Washington Systems Center Flash #9421.

For MVS, corresponding PTFs for the following APARs are required:

- OY63009 for MVS/ESA SP 4.3, 4.2.2, 4.2 and MVS/SP 3.1.3

Basic Tape Library Support (BTLS) for DFSMS/MVS 3490E support:

- MVS/ESA SP 4.3.0 or 5.1.0 (for JES3, JES3 4.2.1 or 5.1.1 is required).
- DFSMS/MVS 1.1.0 only (DFSMS/MVS 1.2.0 support in 2Q95)

For additional information about JES3 support of BTLS, refer to Washington Systems Center Flash #9421.

6.9.4.2 TPF Environment

Transaction Processing Facility (TPF) 3490E support:

- TPF 3.1

Transaction Processing Facility (TPF) 3590 support:

- TPF 4.1

6.9.4.3 VM/ESA Environment

VM/ESA 3490E support:

- VM/ESA 1.2.0 or higher for guest operating system support
- DFSMS/VM Function Level 221 required for native VM support

VM/ESA 3590 support:

- VM/ESA Version 2
- DFSMS/VM Function Level 221 required for native VM support
- EREP 3.5.0 plus SPEs

6.9.4.4 VSE/ESA Environment

Native VSE/ESA 3490E support:

- VSE/ESA 1.3.5 with PTF for APAR DY43306
- 3494 #9203 VSE LAN Library Control Device Driver

Native VSE/ESA 3590 support in 2Q96:

- VSE/ESA Version 2
- 3494 #9203 VSE LAN Library Control Device Driver
- EREP 3.5.0 plus SPEs

VSE/ESA as a VM guest 3490E support:

- VSE: VSE/ESA 1.3.5 with PTF for APAR DY43306
- VM: VM/ESA 1.2.0
- VM: DFSMS/VM Function Level 221 with PTF for APAR VM58787

Some OEM tape management products provide basic library control for guest running VSE/ESA 1.2.0 or higher.

VSE/ESA as VM Guest 3590 support in 2Q96:

- VSE: VSE/ESA Version 2
- VM: VM/ESA Version 2
- VM: DFSMS/VM Function Level 221 with PTF
- EREP 3.5.0 plus SPEs

6.10 IBM 3495 Magnetic Tape Library

This section describes the ESCON capable 3495 magnetic tape library.

6.10.1 Description

The 3495 Tape Library Data server is an automated cartridge tape library for use with supported members of the 3490 family of magnetic tape subsystem, including the intermix of 18 and 36 track recording, and the intermix of Cartridge System Tape and the Enhanced Capacity Cartridge System Tape. The 3495 automatically controls the retrieval and storage of the Cartridge System Tape. With appropriate software, it permits the mounting and demounting of tape cartridges on tape drives without operator intervention.

Figure 74 shows 3495 Model L20 configuration.

IBM 3495 Model L20
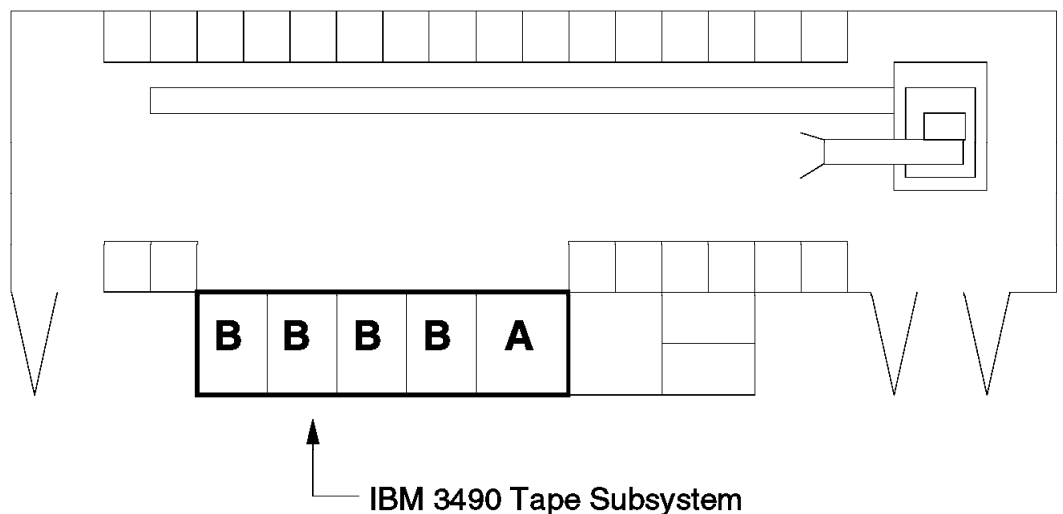
Figure 74. IBM 3495 Tape Library Configuration

The library manager controls all operations in the tape library. Licensed Internal Code operates in the library manager to control tape library automation, communicate with the host through 3490 control units equipped with the library attachment feature, and allow communications paths for operators and service personnel. It is also used for service. Operator status, information, and control panels are provided. An activity log is provided as a problem determination aid. Up to four 3490 Models A01, A10, A02, or A20 control units can be connected to the library manager with the library attachment.

The library manager provides:

- Operator display panels
- Primary and secondary (backup) inventory databases for:
  - Volume inventory

– Storage cell inventory and location data

– 3490 device addresses and information

– Transaction and error log files

• 3495 command interpretation and execution

6.10.2 Configuration Guidelines

Table 49 shows the minimum and maximum number of 3490 tape subsystems
that can be configured within a 3495 tape library.

Table 49. IBM 3495 Tape Library Models		
Models	Minimum Number of 3490 Drives	Maximum Number of 3490 Drives
L20	4	16
L30	4	32
L40	4	48
L50	4	64

Each model of the 3495 tape library has a minimum of one 3490 tape subsystem
(four drives).

• The following 3490 models can be configured with the 3495:

– IBM 3490 Models A01/A02/B04
– IBM 3490 Models A10/A20/B40

• IBM 3490 Model B02/B20/Dxx/Cxx cannot be configured with the 3495.

• The following communication lines are required between the host system
  and the 3495 tape library:

– Each 3490 control unit requires a channel path (the IBM 3495 has no
  direct access to a host channel).

– The library attachment facility must be installed in each 3490 control unit.

– RS-422 communication path.

• The 3495 Tape Library must be defined through HCD; the 3495 cannot be
  defined through MVSCP.

6.10.2.1 ESCON Distances

The IBM 3495 Tape Library is configured with IBM 3490 Tape subsystems. The
IBM 3495 has no direct access to host channels. The configuration distances are
dependent on the 3490 Tape Subsystem capability. Figure 75 on page 169
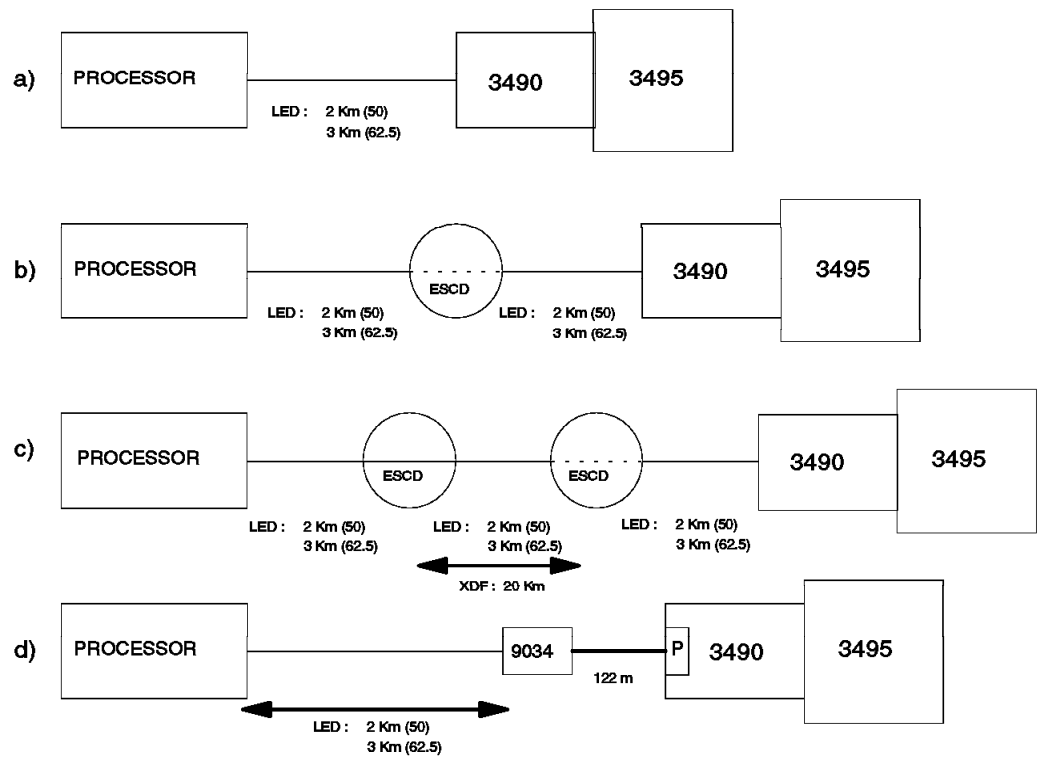shows configuration distances.

Figure 75. IBM 3495 ESCON Distances

a) 3490/3490E with ESCON adapters attached directly to a processor with ESCON channels.

- The maximum distance is 2 km when using 50/125 micron fiber.
- The maximum distance is 3 km when using 62.5/125 micron fiber.

b) 3490/3490E with ESCON adapters connected to a processor, with ESCON channels through an ESCON Director or an IBM 9036 ESCON Remote Channel Extender Model 1.

- Each ESCON LED link can be up to 2 or 3 km, giving a maximum overall distance of 6 km.

c) 3490/3490E with ESCON adapters connected to a processor, with ESCON channels through two ESCON Directors or through two IBM 9036 ESCON Remote Channel Extenders.

- Each ESCON LED link can be up to 2 or 3 km, giving an maximum overall distance of 9 km.

- The ESCON link between the channel and the 3490/3490E is limited to 23 km, even if you use two ESCON Directors or two IBM 9036 ESCON Remote Channel Extenders. The ESCON LED link between an ESCON Director or an IBM 9036 ESCON Remote Channel Extender and the 3490/3490E can be up to 2 or 3 km using a LED link.

d) 3490/3490E with parallel adapters attached to a processor with ESCON channels, optionally through an ESCON Director.

- The ESCON channels must be defined to the processor as ESCON channels operating in conversion mode. The 9034 ESCON Converter Model 1 provides the conversion from ESCON to parallel. Any paths through an ESCON Director must be dedicated.

- Distance is 2 km for 50/125 micron or 3 km for 62.5/125 micron fiber. The parallel cables extend the distance up to 122 m (or 400 feet).

- ESCON XDF link cannot attach to 9034 ESCON Converter Model 1 directly.

6.10.3 Software Requirements

This section describes the minimum software requirement for the IBM 3495 Magnetic Tape Library.

6.10.3.1 MVS Environment

Table 50 shows the MVS level required for 3495 support.

Table 50. MVS Minimum Level Required for 3495 Support	
Product	**Level**
MVS	4.3.0
JES2	4.3.0
JES3	4.2.1
DFSMS/MVS	1.1.0
EREP	3.5.3

6.10.3.2 VM Environment

VM/ESA Release 2 allows the guest to perform library functions, and passes back interrupts and asynchronous messages generated by the Data Server to the guest. VM will also provide a directory option to control which guests can use the Tape Library Data Server.

MVS/ESA can control the Data server while running as a guest of VM/ESA.

DFSMS/VM Functional Level 221 provides native support for the 3495 Tape Library.

6.10.3.3 VSE Environment

There is *no* support for the 3495 Tape Library in the VSE Environment.

6.10.3.4 TPF Environment

There is *no* support for the 3495 Tape Library in the TPF Environment.

6.10.3.5 AIX Environment

There is *no* support for the 3495 Tape Library in the AIX Environment.

6.11 IBM 3745 Communication Controller

The 3745 Models 170, 210, 310, 410, and 610 can be extended to permit the use of ESCON channels in native mode. This extension provides additional flexibility in the design of host front-end installations. ESCON adapters can be installed as a field upgrade or ordered with new boxes.

With ESCON adapters on the 3745, the customer is able to:

- Use distances up to 43 km, allowing off-site connectivity.

- Access multiple host channels.

- Share an ESCON adapter between two active ACF/NCPs.

- Save host channel paths in conjunction with EMIF.

- Have up to five times the performance of a parallel channel adapter, allowing for consolidation of multiple 3705s, 3725s, and 3745s.

6.11.1 Description

To install ESCON adapters in an IBM 3745, the 3745 has to be upgraded from Model 210, 310, 410, or 610 to the corresponding Model 17A, 21A, 31A, 41A, or 61A (includes the enhanced Operator and Service Processor), and a new expansion frame, the 3746 Model 900, must be installed. The basic 3745 may optionally have an additional 3746 Model A11 or A12, and additional 3746 Model L13, L14, or L15 expansion frames attached to it. The new 3746-900 must be bolted to the 3745 or, if present, to the 3746 Model A11 or A12. Figure 76 shows some possible configurations.
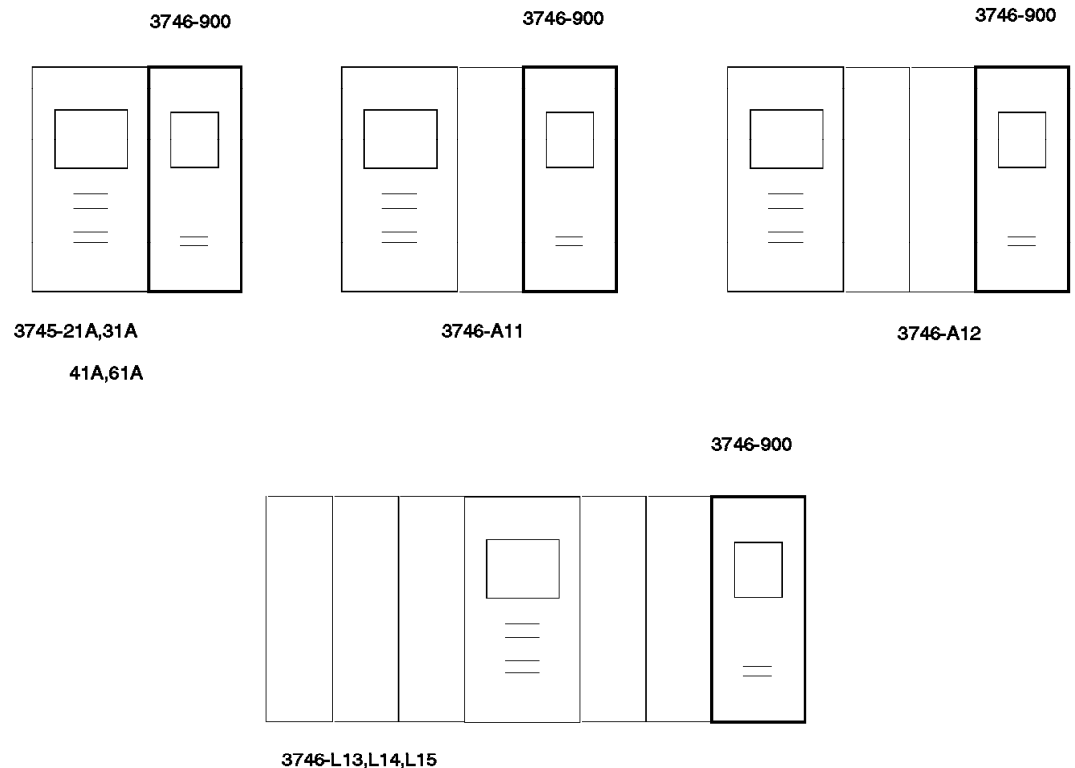

Figure 76. IBM 3745 Configurations with the IBM 3746 Model 900 Expansion Frame

The ESCON adapters are located in the 3746 Model 900 expansion frame on a double-sided board. Two types of cards plug into it:

- One to six processors into the front side.

- Up to two couplers per processor into the back side of the board.

The combination of one processor facing one or two couplers is called an adapter, making a total of six adapters. Both processors and couplers are hot-pluggable. That is, they can be inserted into and removed from the 3746-900 when it is powered on, without damaging the cards or the operation of the machine.

6.11.1.1 Adapter Types

There are up to six adapters in a 3746-900 connected to the Connectivity Switch. Figure 77 shows the basic elements of a 3746 attached to a 3745 with two Central Control Units (CUU), where up to three of the six adapters can be either ESCON adapters or Token-Ring adapters or a mix of them. In our example, we have one Token-Ring and one ESCON adapter. In configurations with only one CUU (3745 Model 21A or 31A) only two adapters are used by the system, so four adapters are left for ESCON or Token-Ring.

The Connectivity Switch is a high-speed cross-bar that allows any-to-any communication among adapters. Currently, communication among 3746-900 adapters always occur between the CBSP adapter, acting as NCP's "agent" and a "target adapter" such as a Token-Ring or ESCON adapter. The communication speed is 12 MB/sec.
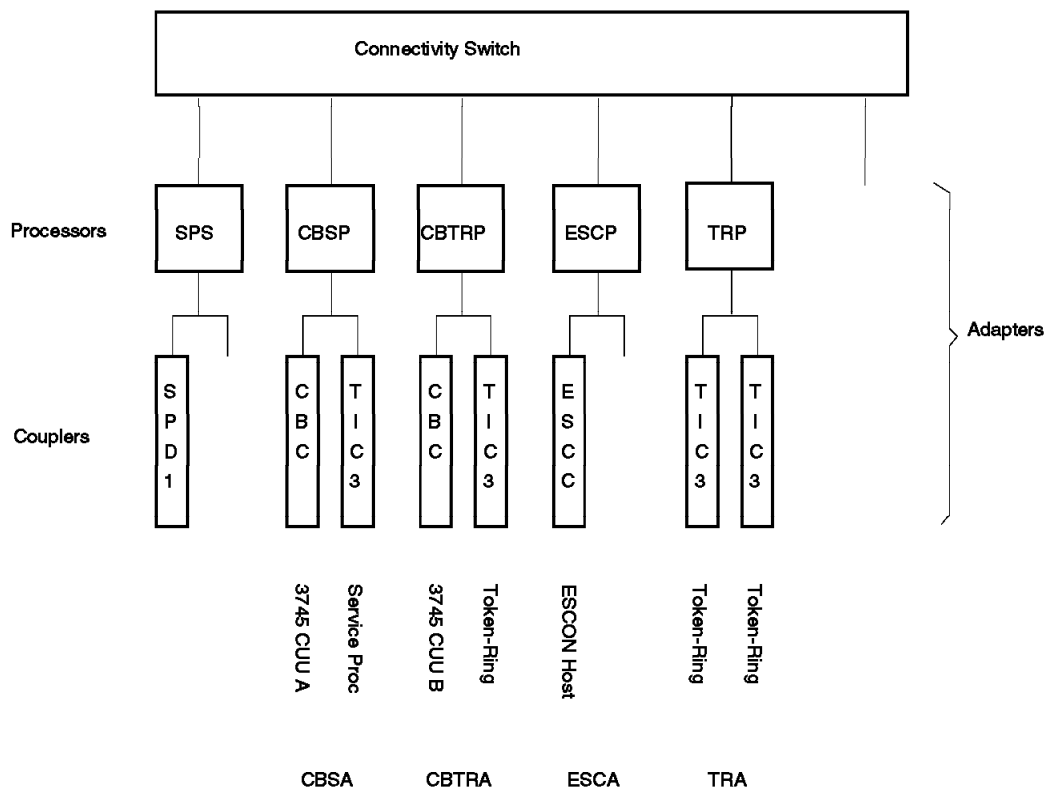

Figure 77. Internal Structure of a 3746-900

The following adapter types are connected to the Connectivity Switch:

- The Service and Power Support (SPS) with its associated card, the Signal and Power Distribution 1 (SPD1), monitors the power subsystem of the 3746-900. The SPS is always included with the 3746-900.

- The Controller Bus and Service Adapter (CBSA) with the Controller Bus Coupler (CBC) and a Token-Ring Interface Coupler (TIC3) performs three main functions:

  - Connects to the buses of one 3745 CUU through the CBC, allowing the 3746-900 adapters to communicate with the NCP.
  - Connects to the Service Processor Token-Ring through the TIC3.
  - Controls the SPS.

  The TIC3 may also be used to handle user traffic. Since the 3745 has at least one CCU and a Service Processor, the CBSA is always included with the 3746-900.

- The Controller Bus and Token-Ring adapter (CBTRA) is necessary only if the 3745 has a second CCU. Like the CBSA, it uses a CBC to connect to the buses of CCU B, but it does not connect to the Service Processor. Therefore, an optional TIC3 may be installed to handle user traffic.

- The Token-Ring Adapter (TRA) is optional and consists of a processor and one or two Token-Ring Interface Couplers (TIC3).

- The ESCON Adapter is optional and connects the 3746-900 to an ESCON channel. It consists of an ESCON Processor (ESCP) and one ESCON Coupler (ESCC). The second coupler slot on the ESCA is reserved for future use.

6.11.1.2 ESCON Adapter (ESCA)

The ESCA allows a 3745 to communicate with subarea (PU 5) and peripheral (PU 2.1) hosts. Connections may be point-to-point with a single host, or may connect to an ESCON Director that permits connection to a maximum of 16 hosts or logical partitions.

NCP allows Parallel Transmission Groups (TGs) in the same way for the ESCA as it does for the Type 6 (CADS) and Type 7 (BCCA) 3745 channel adapters. This capability provides availability in case an ESCON path fails.

The ESCA is designed to meet the growing need for fast transfer of high volumes of data, specifically in client/server applications. For a typical batch transfer (one way, 8000 byte transfers) the ESCA can provide five times the throughput of the CADS (Type 6 CA) and 2.5 times the throughput of the BCCA (Type 7 CA). As the length of the ESCON channel increases, propagation delays reduce this advantage: at 43 km, the ESCA transfer rate is approximately up to twice that of the CADS and slightly better than the BCCA. But keep in mind that the parallel channels cannot even operate at a length of 43 km. In pure interactive environments, the ESCA throughput is comparable to that of CADS. ESCA performance improves as the ratio of batch to interactive traffic increases. The 3745 configuration tool, CF3745, should be used to estimate the ESCA performance for specific traffic mixes and distances. This is especially useful when consolidating front-end processors.

6.11.2 IBM 3745 Logical Paths

A maximum of four ESCON Adapters can be installed in the 3745 Models 21A and 31A containing one CUU. A maximum of three ESCA can be installed in the 3745 Models 41A and 61A containing two CUUs. Each ESCA can have a maximum of 16 host connections (in other words, each ESCA can appear to be 16 separate devices). These connections may be attached to physically separate hosts, to different channels on the same host, to shared channels, or to different SSCPs on the same channel. Figure 78 shows three examples for hosts without shared channel capability (EMIF).
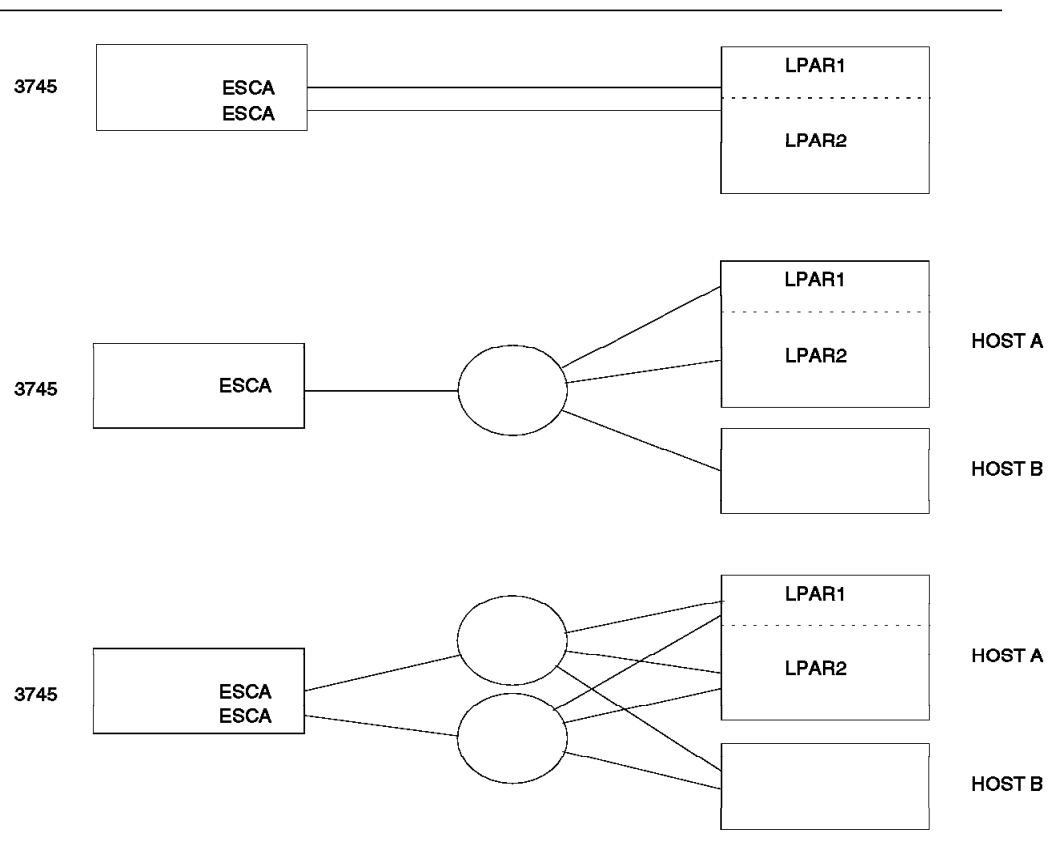
Figure 78. IBM 3745 Logical Paths without EMIF

In the first example, there are no ESCON Directors (ESCDs); therefore, only point-to-point connections are possible. These connections can be to different hosts or to different LPARs. There is a limit of three or four ESCAs depending on the 3745 model, so this configuration limits the possibilities.

The second example introduces an ESCD. Now it is possible to connect up to 16 host images to one 3745 ESCA, allowing a total of 48 or 64 connections per 3745. Note that there is only a single physical path from all images to the 3745, so this type of consolidation has to be checked for performance with the CF3745 tool.

In the third example, we improve the configuration's availability. Each host image has two channel paths leading to two ESCDs. Each ESCD is connected to a separate 3745 ESCA. NCP allows Parallel Transmission Groups to each host image, so each host image can access the 3745 over two paths. A total of 16 SSCPs can communicate with NCP over 32 logical paths.

Figure 79 shows two examples for hosts with the shared channel capability
(EMIF). For more information on EMIF, refer to 6.2, "ESCON Multiple Image
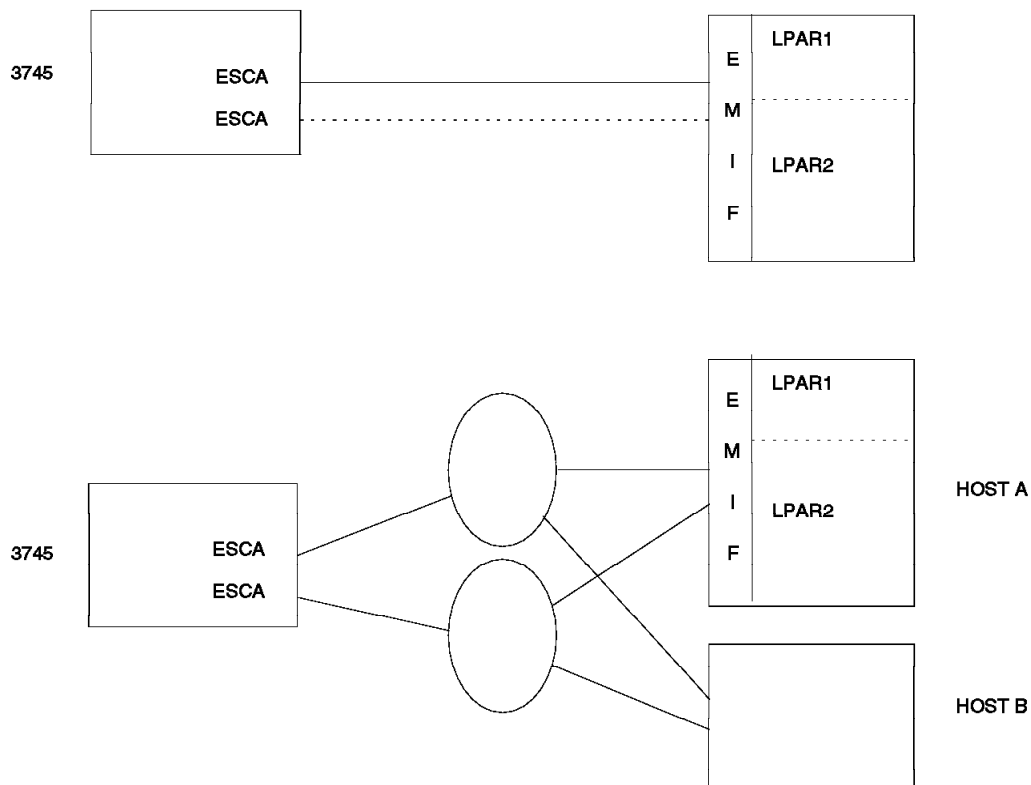Facility" on page 74.

Figure 79. IBM 3745 Logical Paths with EMIF

In the first example we have only one host. If the 3745 is within three kilometers,
there is no need for an ESCD. The example can be improved for availability by
adding a second 3745 ESCA (dotted line), using NCP's capability of Parallel
Transmission Groups to the SSCPs. A total of 16 SSCPs can communicate with
NCP over 32 logical paths.

The second example shows a multi-host environment configured for availability.
With ESCDs, a maximum of 16 host images can be connected.

6.11.3 Configuration Guidelines

Table 51 shows the host adapter possibilities of the 3746-900 for various 3745
models. The number of possible ESCON adapters varies with the number of
Token-Ring adapters.

Table 51 (Page 1 of 2). ESCON / Token-Ring Adapters Possible Configurations in 3746-900		
ESCON Channels	**Token-Rings (3746-900 on 3745-21A/31A)**	**Token-Rings (3746-900 on 3745-41A/61A)**
0	9	8
1	7	6
2	5	4

Table 51 (Page 2 of 2). ESCON / Token-Ring Adapters Possible Configurations in 3746-900		
ESCON Channels	**Token-Rings (3746-900 on 3745-21A/31A)**	**Token-Rings (3746-900 on 3745-41A/61A)**
3	3	2
4	1	0

Other 3745 models do not support ESCON channels. Models 170, 210, 310, 410, and 610 can be converted to the corresponding A models in the field.

In addition to the Token-Ring adapters in the 3746-900, you can also have Token-Ring adapters in the 3745 that do not affect the maximum number of ESCON Channels.

If EP or PEP is required, then depending on the host processor being used, it may be necessary to also have the corresponding parallel channel adapters on the 3745. (Maximum of 16, does not affect the maximum number of ESCON channels).

A channel path with keyword TYPE=CBY is an ESCON channel path that permits 3745, 3725 and 3720 devices to operate in byte multiplexor mode when attached to a 9034 converter model 1. This support is only available on 9021 711-based models, 9121 511-based models and 9672 E,P, and R models. The SEC levels required for these processors and relevant 9034 serial number information is summarized below:

- 9021 711-based   SEC 236420
- 9121 511-based   SEC C35954
- 9672 E,P and R   EC D57262
- 9034 Serial Number 41 53345 and above is at the correct level
- 9034 Serial Number below 41 53345 requires logic card P/N F8047

For availability, configure two ESCON adapters and two paths to each host image. If more than one SSCP uses a path, the configuration should be checked for performance using the CF3745 tool.

6.11.4 ESCON Distances
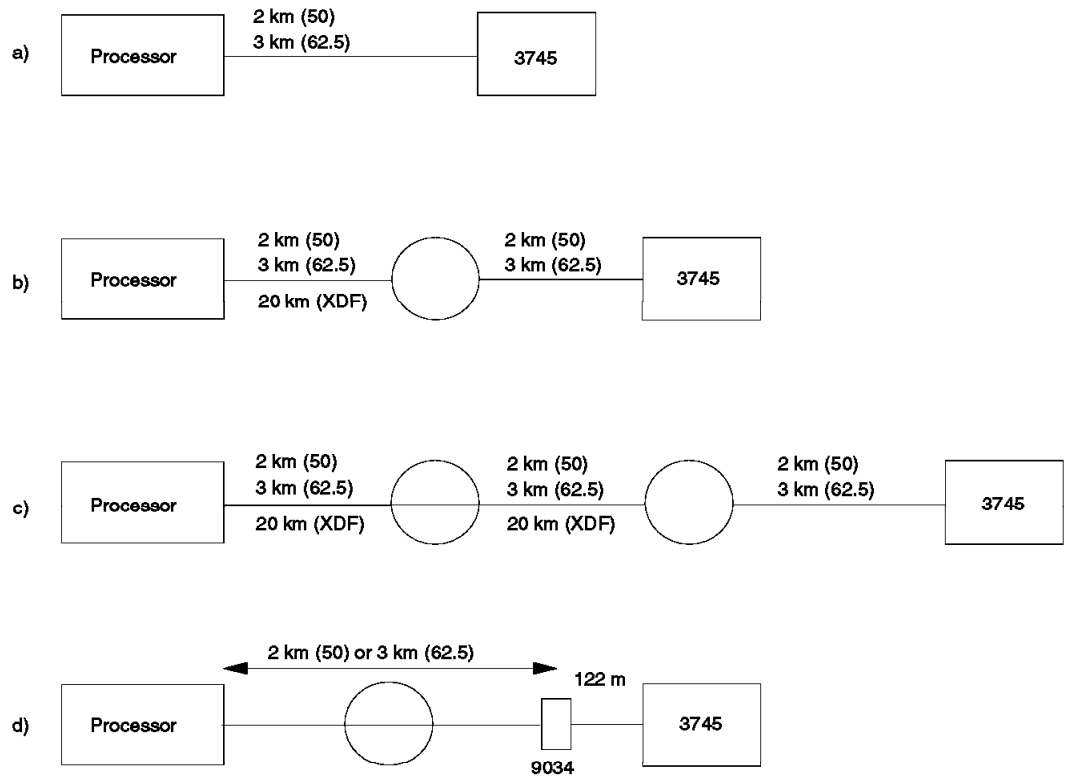
Figure 80 depicts different configuration distances.

Figure 80. IBM 3745 ESCON Distances

a) 3745 with ESCON adapters attached directly to a processor with ESCON channels.

> The distance is 2 km when using 50/125 micron fiber and 3 km when using 62.5/125 micron fiber.

b) 3745 with ESCON adapters connected to a processor, with ESCON channels through an ESCON Director or an IBM 9036 ESCON Remote Channel Extender.

> Each ESCON LED link can be up to 2 or 3 km, giving an overall distance of 4 to 6 km.

c) 3745 with ESCON adapters connected to a processor, with ESCON channels through two ESCON Directors or through two IBM 9036 ESCON Remote Channel Extenders.

> Each ESCON LED link can be up to 2 or 3 km, giving an overall distance of 6 to 9 km. XDF links between the ESCON Directors or IBM 9036 ESCON Remote Channel Extenders increase the overall distance to up to 24 to 26 km (one XDF link), or 42 to 43 km (two XDF links).

d) 3745 with parallel adapters attached to a processor with ESCON channels, with or without an ESCON Director.

> The ESCON channels must be defined to the processor as ESCON channels operating in conversion mode. The 9034 ESCON Converter Model 1 provides the conversion from ESCON to parallel. Any path through an ESCON Director must be dedicated.

Distances are 2 km for 50/125 micron or 3 km for 62.5/125 micron fiber, regardless of connecting through an ESCD. The parallel cables extend the distance up to 122 m (400 ft).

6.11.5 IOCP

ESCON operation requires definitions for several software components. To reduce the possibility of error, you should use the ESCON Generation Assistant tool. This OS/2 Presentation Manager application generates cross-referenced IOCP, NCP, and MOSS-E (Maintenance and Operator Subsystem-Extended) definitions.

ESCON Generation Assistant produces machine-readable output, which can, for example, be uploaded to a host and merged into the appropriate system generation files.

The ESCON Generation Assistant is distributed with the *3745 21A-61A Migration Guide* and, internally, through the MKTTOOLS disk.

6.11.6 Software Requirements

The minimum level of software required for the IBM 3745 with ESCON adapters is described below.

6.11.6.1 Netware Control Program

The 3745 models 21A, 31A, 41A, and 61A must use ACF/NCP Version 6 Release 2 with the 3746 Model 900 Feature.

Note that the 3746 Model 900 Feature has to be ordered separately. It is not included in the ACF/NCP base.

The Partitioned Emulation Programming (PEP) extension of ACF/NCP Version 6 Release 2 is provided by Emulation Program (EP) Release 11 and is supported only on byte-multiplexor channels or on host processors which support the TYPE=CBY ESCON byte-multiplexor channel (9672 and ES9000 511-based and 711-based machines).

6.11.6.2 Host-Resident Communications Support

A 3745 using ESCON channels require the following minimum versions communication support:

- For MVS/ESA:

    ACF/VTAM Version 3 Release 3 with ESCON PTF (APAR OY29256)

    ACF/VTAM Version 4

- For VM/ESA:

    ACF/VTAM Version 3 Release 3

- TPF Version 3

AIX/ESA does not support the 3745. ACF/TCAM does not support native ESCON channel adapters.

6.11.6.3 Other Programming Support

NetView is recommended for network management of the 3745. A 3745 with a 3746-900 must use at least:

NetView Version 2 Release 3

Network Performance Monitor Version 1 Release 6

ACF/SSP Version 3 Release 8

If a NetView Graphic Monitor Facility (NGMF), a remote PS/2, or a LAN-attached PS/2 is used for operator access, the following programs are necessary:

OS/2 Version 2.0

OS/2 Extended Services

Distributed Console Access Facility (DCAF)

6.12 IBM 3174 Establishment Controller Models 12L/22L

This section describes ESCON planning aspects related to the IBM 3174 Establishment Controller Models 12L/22L.

6.12.1 Description

The IBM Establishment Controller 3174 Models 12L and 22L are available with ESCON adapters. The IBM 3174 Model 12L and 22L controllers are customer set up (CSU) units. The Model 12L is floor standing. One of the benefits of the Model 22L is that it can be rack-mounted in an IBM 9309 Model 2 rack or industry standard rack.

The channel adapter can be defined as a local SNA controller, in which case it has a single address; or it can be defined as a local non-SNA controller, where multiple addresses are defined with an address range of either 16 or 32.

The 3174 Models 12L and 22L can be used as MVS/ESA MCS (Multiple Console Support) console control units, if they are defined as local non-SNA control units and MVS/ESA is at least at level 4.2.0 with the required maintenance. If defined as non-SNA, single-link multi-host (SLMH) attachment is not supported.

The 3174 Models 12L and 22L are available with one ESCON adapter only. Parallel interfaces are not available on these models.

Models 12L and 22L are full-function IBM 3174s that include all features of Models 11L and 21L with the exception of remote power. Models 12L and 22L have the same physical and environmental characteristics as the existing 3174s, but can be attached at increased distances from the host through the fiber optic cable attachment.

The IBM 3174 with an ESCON interface provides the same multisession/multihost capability as the IBM 3174 Model 11L, but in addition, it can connect to up to eight host images through the single ESCON interface attached to an ESCON Director or, if the host images are in an EMIF capable processor, through a shared channel. Unlike the IBM 3490, for instance, the Model 12L or 22L provides up to a maximum of eight control unit images (virtual control units), each having one logical path with a host image, if it is defined as a local SNA controller.

Models 12L and 22L support up to eight control unit images, which provide up to eight logical hosts through the fiber optic link to the host (Figure 81). The logical host connection can be to the same host or to different hosts. Each control unit image appears to the host as a separate physical IBM 3174. Non-SNA controller support permits only one logical host connection on the existing single physical channel port.

The 3174 Models 1L, 11L, and 21L can also be used in an ESCON environment. These models use the S/370 parallel channel attachment. They can communicate with an ESCON host through the IBM 9034.
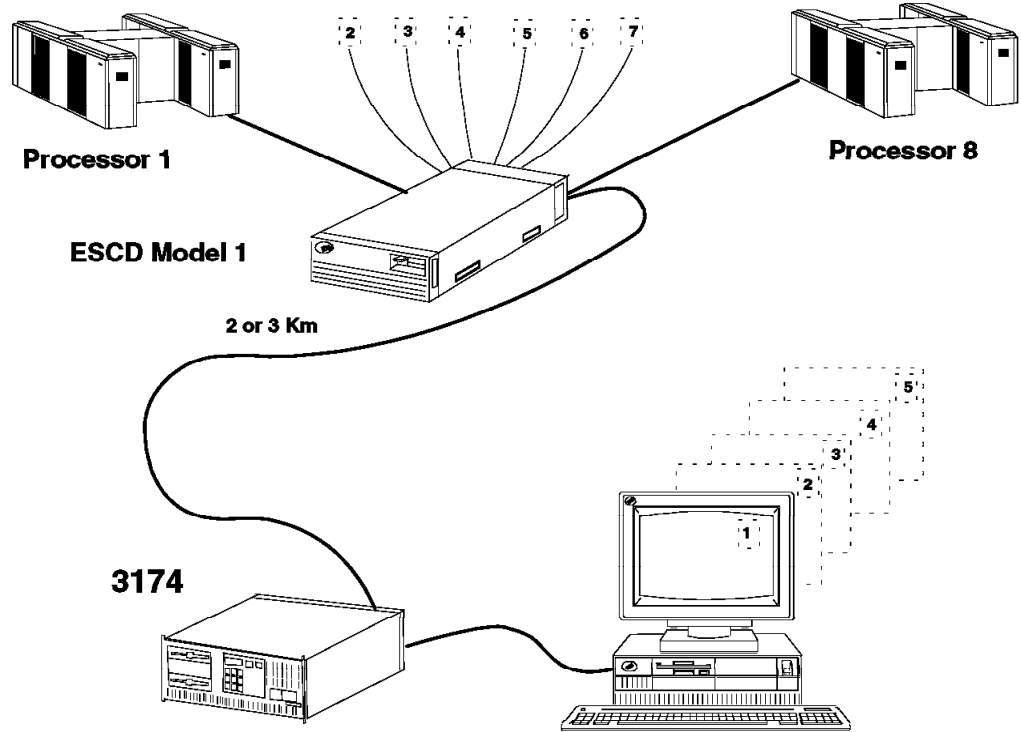
Figure 81. IBM 3174 Model 22L Logical Paths

6.12.2 Configuration

Models 12L and 22L have the following base configuration:

- 2 MB control storage
- 2.4 MB diskette drive
- Four (Model 22L) or 10 (Model 12L) feature slots
- Terminal adapter
- ESCON channel adapter

In addition, these models can include the following optional features:

- Storage expansion
- Second diskette drive
- 20-MB fixed disk drive
- Asynchronous communication adapter
- Concurrent communication adapter
- Token-Ring adapter 16/4 Mbit/sec
- Type 1 communication adapter
- Type 2 communication adapter (X.21)
- Terminal multiplexer adapter

- Fiber optic terminal multiplexer adapter

6.12.3 Product Highlights

- One ESCON port is available on Models 12L and 22L.

- Eight control unit images logically use this ESCON port.

- Each host connection is defined to the 3174 as a virtual control unit (VCU).

- One logical path is used for each control unit image.

- Up to 64 3270-Type-A devices (with Port Expansion Feature Code 3100) and up to 24 ASCII devices can be supported on the 3174 Models 12L and 22L.

- One physical 3270 device can become five logical terminals (or have five logical sessions to host) through the MLT feature.

- There are 16 hexadecimal addresses (0 through F), of which eight can be configured in the IBM 3174 to support eight host processors. These addresses correspond to the CUADD value in the host IOCDS with inter-relationships to VTAM, MVS, IOCP, and the ESCD.

- Configuration Support B Release 3 Licensed Internal Code or higher is required with 3174 Models 12L and 22L.

- The IBM 3174 Models 12L and 22L are supported by ACF/VTAM 3.3 and MVS/SP 3.1.0e plus ESCON PTFs or later MVS Releases.

6.12.4 Distances

Using 2 ESCON directors or 2 IBM 9036 ESCON Remote Channel Extenders, 3174 models 12L and 22L can be located up to 26 km from the processor, as shown in Figure 82. When directly attached to the channel, the maximum distance between a processor and a 3174 is 2 or 3 km. Using one ESCON Director or one IBM 9036 ESCON Remote Channel Extender, the maximum distance is 6 km. Using an intermediate XDF link with any combination of ESCON Directors or IBM 9036 ESCON Remote Channel Extenders the maximum distance is 26 km. If the intermediate link is LED, the maximum distance between a processor and a 3174 is 9 km.
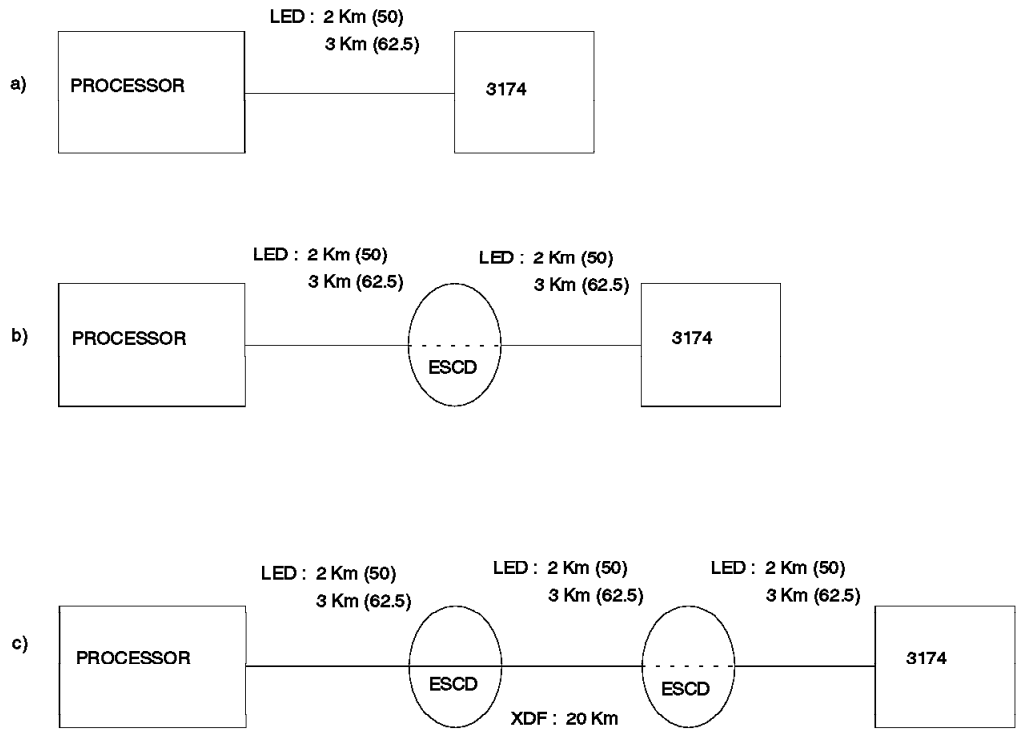
Figure 82. IBM 3174 ESCON Distances

6.12.5 Customization

For information on customization of a 3174, please refer to *IBM 3174 Planning Guide* and *IBM 3174 User's Guide*.

6.12.6 IOCP

An SNA 3174 is defined as a 3791L to the IOCP and MVS, and as a 3705 to the IOCP and VM (Figure 83).
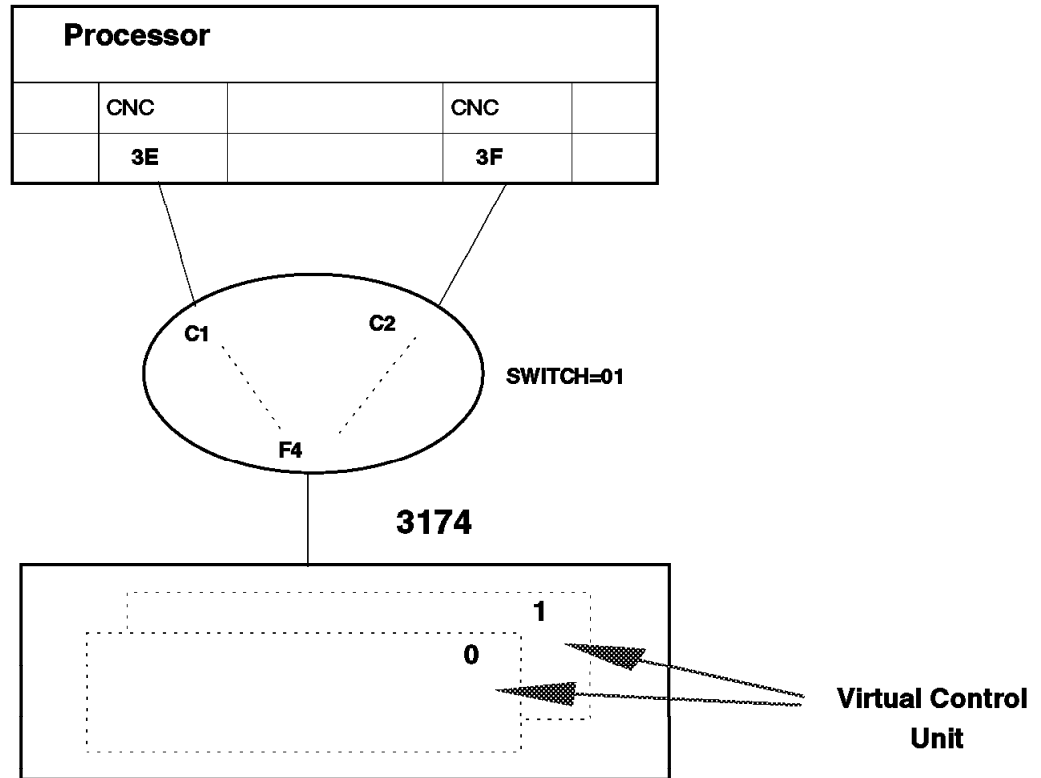
Figure 83. IBM 3174 Models 12L/22L IOCP (MVS)

6.12.6.1 Multisession Capability (MVS)

IOCP examples are in *Enterprise System/9000 Input/Output Configuration Program User Guide* . The MVS multisession capability is defined as follows:

```
CHPID PATH=3E,TYPE=CNC,SWITCH=01

CHPID PATH=3F,TYPE=CNC,SWITCH=01

CNTLUNIT CUNUMBER=3E00,UNIT=3791L,PATH=3E,LINK=(F4)
         CUADD=0,UNITADD=((00,1))

CNTLUNIT CUNUMBER=3F00,UNIT=3791L,PATH=3F,LINK=(F4)
         CUADD=1,UNITADD=((00,1))

IODEVICE ADDRESS=E00,CUNUMBR=3E00,UNIT=3791L

IODEVICE ADDRESS=F00,CUNUMBR=3F00,UNIT=3791L
```

6.12.6.2 Multisession Capability (VM)

When you are configuring a 3174 through an ESCD to different hosts with the same channel address, the VTAM (PU macro: CUADDR=XXX) and IODEVICE (ADDRESS=XXX) can be the same:

```
CHPID PATH=3E,TYPE=CNC,SWITCH=01

CHPID PATH=3F,TYPE=CNC,SWITCH=01

CNTLUNIT CUNUMBER=3E00,UNIT=3705,PATH=3E,LINK=(F4)
         CUADD=0,UNITADD=((50,1))

CNTLUNIT CUNUMBER=3F00,UNIT=3705,PATH=3F,LINK=(F4)
         CUADD=1,UNITADD=((50,1))

IODEVICE ADDRESS=3E50,CUNUMBR=3E00,UNIT=3705

IODEVICE ADDRESS=3F50,CUNUMBR=3F00,UNIT=3705
```

6.12.7 Guidelines

The following guidelines apply when configuring a 3174:

- Each of the eight possible logical control images has its own CNTLUNIT statement (CUADD) within the IOCP.

- A unique CUADD address has to be specified for each logical path (VCU).

- CNTLUNIT statement CUADD and Question 240 - Controller Logical Address - are the new parameters in order to find the correct image.

- For Customization Question 108: - Unique Machine Identifier - enter the serial number of the control unit. Do not copy diskettes for an another 3174 without adding the serial number of the control unit.

- The 3174 control unit uses status code 507 to show that not all CU image interfaces are initialized.

- The ESCON 3174 communicates with one host at a time.

- When adding new devices to your 3174, VTAM updates will be necessary.

- If you are using an ESCD in your 3174 configuration, the ESCD will also require updates.

- Because of these changes we recommend incorporating any other modifications needed for other hardware updates with the ESCON 3174 installation to minimize the potential disruptions to your environment.

6.12.8 Performance

An ESCON interface is capable of operating at speeds of up to 17 MB/second. However, the maximum rate of the 3174 control unit is only 1.2 MB/second. This is the main factor of the actual data transmission rate. There are other factors that have influence on the data transmission rate such as blocksize, number of buffers, channel load, configuration, distance, and so on. For example, as discussed above, using the maximum RU size of 8 KB allows up to 8192 bytes of data to be received in a single RU. A larger RU size decreases the number of transmissions from the host and thus improves performance.

6.13 IBM 3172 Interconnect Controller

This section describes the 3172 Interconnect Controller.

6.13.1 Description

The IBM 3172 Interconnect Controller provides three functions required by today's networks:

- Attachment of LANs to IBM hosts
- Attachment of FDDI to IBM hosts
- Connecting host-to-host at high speed

The IBM 3172 Interconnect Controller is a gateway that allows different types of local area networks (LANs) to communicate with one or more host processors. The channel attachments can be an ESCON interface at 10 or 17 MB/sec or parallel interface at 1, 3, or 4.5 MB/sec.

Using XDF links between ESCON Directors or IBM 9036 ESCON Remote Channel Extenders, a 3172 Model 1 can be located up to 43 km from the processor, as shown in Figure 84. If all the links are LED, then the maximum distance between a processor and 3172 Model 1 is 9 km.

The ESCON adapters can be connected through an ESCON Director and support eight logical paths each. This extends the quantity of point-to-point connections that can be defined in VTAM.
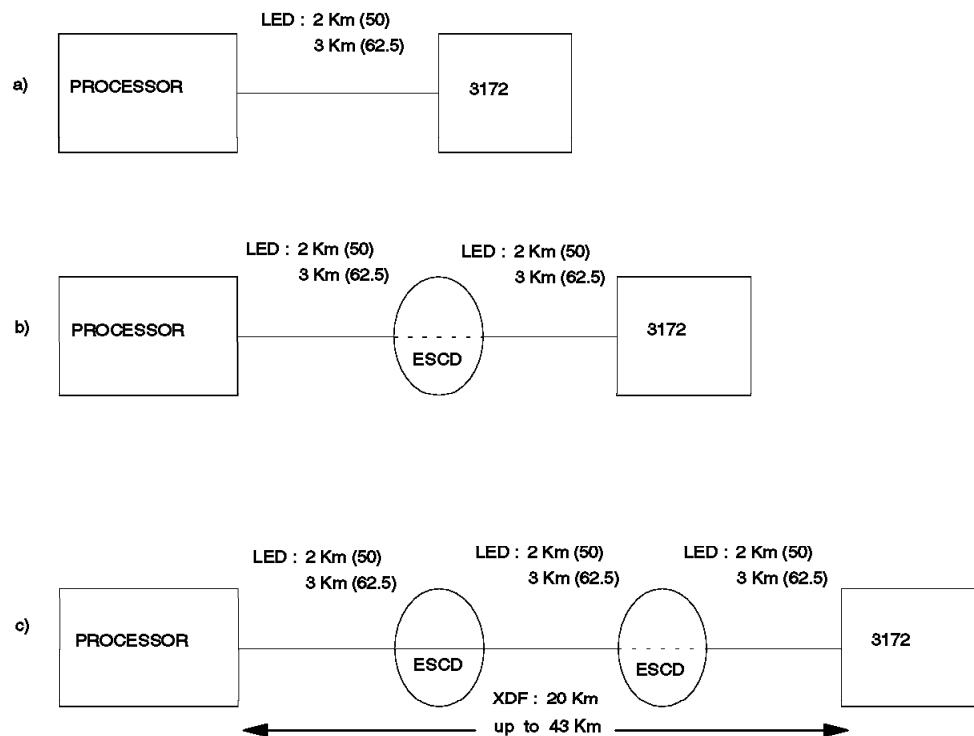

Figure 84. IBM 3172 ESCON Distances

6.13.2 The 3172 Model 1

The 3172 Model 1 is a Micro Channel/80386-based intelligent controller that can operate as a LAN-to-host gateway and as a remote Channel-to-Channel (CTC) controller. When the 3172 is configured to operate as a CTC controller, it provides host attachment through a Parallel channel or an ESCON channel, and can be configured with up to four TP Adapters. Four LAN attachments and two channel attachments give the 3172 Interconnect Controller the flexibility and performance required for heterogeneous networks. The 3172 Model 1 was withdrawn from marketing on March 25, 1994.

6.13.3 The 3172 Model 2

The IBM 3172 Model 2 is a member of the IBM 3172 Interconnect Controller family. With the inclusion of the more powerful Intel 80486 microprocessor, the 3172 Model 2 provided improved performance and capacity over the 3172-001. By supporting the 100 Mbit/sec Fiber Data Distributed Interface (FDDI), the 3172 Model 2 provided host gateway connectivity for high function engineering and scientific workstations as well as providing host connectivity for high-speed FDDI backbone networks. The 3172 Model 2 was withdrawn from marketing on July 8, 1994.

6.13.4 3172 Model 1 and 2 Comparisons

High 3172 throughput is provided by the hardware and the software. Both models are built upon IBM's Micro Channel bus architecture. They have cache memory to speed the transfer of data between the adapters and system storage. The 3172 Model 1 includes an INTEL 80386 microprocessor, while the Model 2 includes the more powerful INTEL 80486.

The multitasking design of the controller program provides efficient routing of data to and from the 3172 adapters, transforming the 3172 into a high-performance LAN gateway, FDDI gateway, or Remote CTC controller.

The Model 1 provides LAN gateway and remote CTC functions.

The Model 2 provides performance greater than Model 1 performance. The Model 2 supports the FDDI LAN with 100 Mbit/sec ring speed.

The role of the 3172 has been expanded to provide three functions:

- The Model 1 gives LAN attached devices access to SNA, TCP/IP, AIX, and MAP 3.0 applications on local hosts. This function is referred to as the LAN gateway.

- The Model 2 gives FDDI LAN attached devices access to TCP/IP or SNA applications on local hosts. This is referred to as the FDDI LAN gateway.

- The Model 1 can now connect an IBM host, through high speed links, to another IBM host. VTAM in both hosts provides normal CTC routing. This function is called the Remote Channel-to-Channel Controller.

6.13.5 3172 Model 3

The IBM 3172 Interconnect Controller is a Micro Channel*/ 80486SX 25 MHz Processor-based intelligent controller. Three optional processors are available, the 50 MHz 80486DX, the Pentium 66 MHz, or the Pentium 90 MHz. The Pentium 90Mhz processor developed by Intel features a 32-bit CPU, a 64-bit external data bus, a 32-bit external address bus, a 16Kb internal cache, 256Kb of level 2 cache and 256Kb of flash memory. Also available is a new ESCON Single Slot Adapter with direct host attachment providing the same function as the previous ESCON adapter but in a single slot configuration and at a lower price. Two of the ESCON Single Slot Adapters may be installed in one 3172 Model 3 providing concurrent operation of both ESCON single slot adapters and backup of ESCON connections. OS/2 users can add optional memory in 8Mb increments (2 x 4MB non-EEC SIMMS), up to a total of 16MB of RAM. The 3172 Model 3 provides powerful LAN/WAN to host gateway function with an expanded set of hardware and software solutions:

- IBM 3172 Interconnect Controller Program (ICP) Version 3 Release 4 supporting TCP/IP and SNA protocols across Token-Ring, Ethernet and FDDI LANs

- TCP/IP Offload for VM and MVS that reduces host cycles across Token-Ring, Ethernet, ATM, or FDDI LANs

- Multiprotocol Networking Software Solution (MPNS) that reduces host cycles and allows connectivity across Frame-Relay networks to TCP/IP and bridges SNA, NetBIOS, IPX, and Banyan Vines from Token-Ring to Frame-Relay networks

- LAN File Services/Enterprise Systems Architecture (LFS/ESA) for VM, and LAN Server for MVS, client/server solutions for clients on OS/2 LANs

- LAN Resource Extension Services (LANRES)/VM and LANRES/MVS, which allows NetWare users on Token-Ring or Ethernet LANs access to IBM System/390 or System/370 host DASD, print server, and LAN administrative services

- 3172 SNA Communications Program, which provides users the ability to access VTAM/SNA host applications from Token-Ring, Ethernet, ATM, and FDDI LANs, and Frame-Relay and SDLC networks

- Auto LANStreamer MC 32 and EtherStreamer MC 32 adapters

- Support for Frame-Relay networks using the SNA Communications Program, with up to two dual port WAC adapters for X.21, V.35, RS-232, and RS-422/449

- 3172 support for SDLC networks using SNA Communications Program with up to four ARTIC Portmaster adapters (X.21, V.35, RS-232, RS-422), for a maximum of 32 SDLC ports

- 3172 ESCON Multiple Image Facility (EMIF) compatible support

- Pre-loaded software packages for SNA Communications and TCP/IP Offload applications installed on the 3172 Model 3 hardfile at the factory

6.13.6 Remote Channel-to-Channel Communication

The ability of the Model 1 to perform Remote Channel-to-Channel controller functions is a feature unique to the Model 1. The 3172 connects one local 3172 with up to four remote 3172 controllers, although most likely only to one remote 3172 controller.

A T1 adapter is used at speeds up to 1.544 Mbit/sec. Additional high-speed link adapters provide remote CTC support in some countries. CEPT adapters provide an interface for connecting to an OEM converter product, operating at speeds of up to 2.048 Mbit/sec, so up to four channel high-speed links can each operate at speeds up to 2.048 Mbit/sec.

A function known as data striping (like ACF/NCP transmission groups), distributes the data across multiple links for effective bandwidth utilization. Data striping ensures continued availability if a subset of the links fails.

The 3172 Model 1 can use both ESCON or parallel channel adapters, but adapters of only one type can be installed. The CTC application in the 3172 can support 256 subchannels spread between the two adapters.

Since VTAM uses a single subchannel address for both read and write, a theoretical maximum of 256 links can be defined, but this ignores the amount of buffer space available. Future asynchronous CTC implementations will use two subchannels for a maximum of 128 links.

The remote CTC implementation is supported by VTAM 3.4 as a 3088 channel-to-channel connection (Figure 85).

Note that with the remote CTC feature, a Token-Ring can be configured solely for connection of a PS/2 running the ICP Operator Facility. The Token-Ring occupies one of the channel or T-Carrier slots.
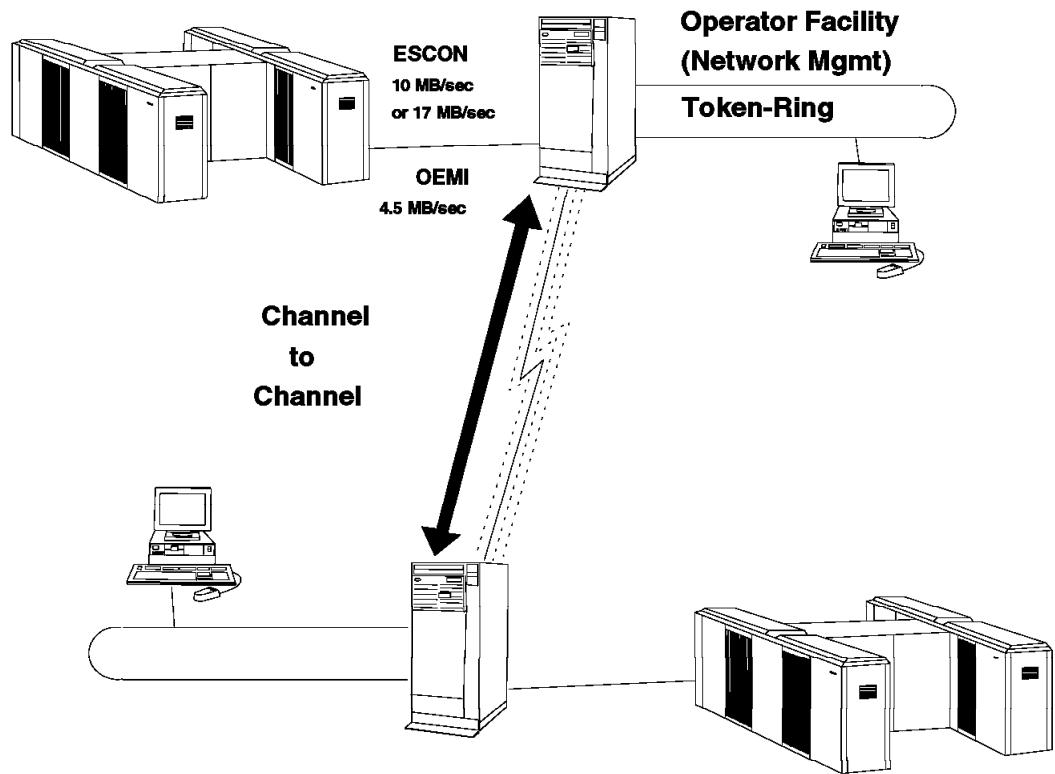
Figure 85. IBM 3172 Interconnect Controller Model 1 - Remote CTC

6.13.6.1 Remote CTC Configuration Guidelines

The following rules apply for configuring a Model 1 in a remote CTC environment:

- 3172 gateway and CTC configurations are mutually exclusive.

- ESCON channel support is available only on the Model 1 remote CTC controller.

- Both channel adapters must be of the same type. The channel adapters at opposite ends of a CTC link must match (either both parallel or both ESCON).

- A Model 1 cannot be upgraded to a Model 2 or a Model 3.

The ESCON architecture introduces the concept of a logical path between a channel and a control unit. A logical path is defined by a link address for the channel, a link address for the control unit, and a logical address for a control unit image within the physical control unit.

The number of logical paths (Figure 86) that can be established with a control unit is determined by the control unit. The 3172 Model 1 supports up to eight control unit images on each of the two ESCON channel attachments.

6.13.6.2 IBM 3172 Remote CTC Definitions to the Operating System

VM/ESA HCPRIO Definition:

```
RDEVICE ADDRESS=(XXX,32),DEVTYPE=CTCA
```

MVS Definition:

```
IODEVICE ADDRESS=(XXX,32),UNIT=CTC
```

6.13.6.3 IBM 3172 Remote CTC IOCP Definition

Each control unit image is defined in the IOCP using a separate CNTLUNIT
macro as though it were a physical control unit.

The CUADD parameter, in combination with the control unit link address, defines
a unique logical path for each channel accessing the control unit image.

The definition for ESCON channels is as follows:

```
        CPHID    TYPE=CNC,PATH=3E,SWITCH=01

    VCU1  CNTLUNIT CUNUMBER=XXX,UNIT=3088,PATH=3E,LINK=(F4),
                 CUADD=0,UNITADD=((20,32))
    A3172 IODEVICE ADDRESS=(XXX,32),CUNUMBR=XXX,UNIT=CTC

    VCU2  CNTLUNIT CUNUMBER=YYY,UNIT=3088,PATH=3E,LINK=(F4),
                 CUADD=1,UNITADD=((40,32))
    B3172 IODEVICE ADDRESS=(YYY,32),CUNUMBR=YYY,UNIT=CTC
```
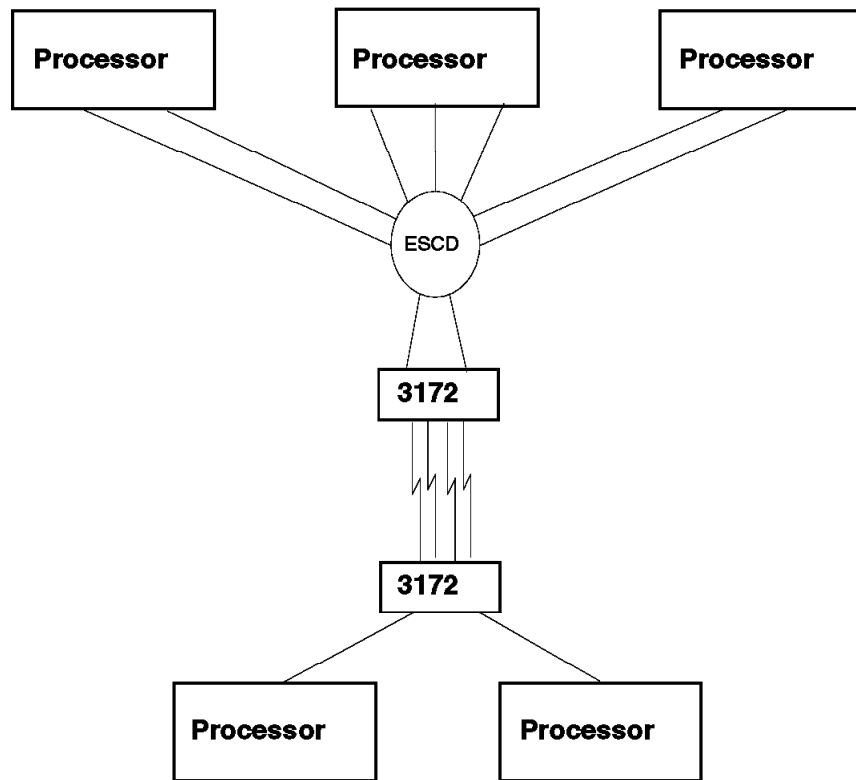
Figure 86. IBM 3172 Model 1 Remote CTC -Logical Paths

6.13.6.4 Performance of 3172 Remote CTC Feature

The IBM 3172 is not limited by distance, although performance is impacted by the links and distances.

The IBM 3172 provides a significant increase in remote CTC performance and connectivity over that of the IBM 3737.

The two basic parameters that characterize the performance of the IBM 3172 are:

- Maximum throughput
- Latency

Maximum throughput is defined as the maximum number of frames per second that the controller is capable of receiving, blocking, deblocking, and forwarding to the destination without errors.

Latency is the transit time of frames through the controller.

The IBM 3172 design allows received LAN frames to be combined into blocks of up to 20 KB before sending them over the channel to the host.

The 3172 Interconnect Control Program implements two parameters that determine when a block of data is sent to the host:

- Block Delay Timer

At the expiration of this timer, the 3172 will send the block, even though the block size is smaller than the maximum.

- Response Length

    Received frames that are smaller than this threshold value will be sent to the host immediately without delay.

    Default values are recommended for most environments.

Buffers are needed to match the different speeds of channels, transmission links, and LAN gateways. Two MB of the system storage is used for buffer space. In addition, each of the adapters has its own buffer space. The channel adapter has 512 KB of on-card-shared RAM. Similarly, the Token-Ring and Ethernet adapters have 64 KB and 16 KB of shared RAM, respectively.

Throughput can be summarized as follows:

- The IBM 3172 Model 1 has a maximum throughput of 1 MB/sec for large frames (1500 bytes for Ethernet and 4 KB for 16-Mbit/sec Token-Ring).

- Maximum 3172 throughput is achieved with one LAN adapter for Ethernet and an adapter for 16-Mbit/sec Token-Ring; for 4-Mbit/sec Token-Ring, two adapters are required.

- When 3172 maximum throughput is reached with one LAN adapter, adding a second adapter will not increase or decrease throughput.

- The Model 1 latency for 100-byte frames is 1.6 milliseconds for Ethernet, and 2 milliseconds for Token-Ring.

- In a TCP/IP-FTP environment, the 3172 Model 1 can sustain throughput of up to 716 KB/sec.

6.14 IBM 9034 ESCON Converter Model 1

This section describes the IBM 9034 ESCON Converter Model 1, which is used to attach a control unit with a parallel interface to an ESCON channel.

6.14.1 Description

The 9034 has two interfaces, one for connecting a parallel control unit and the other for connecting an ESCON channel. The maximum data rate is 4.5 MB/sec. Figure 87 shows the 9034's connectivity.
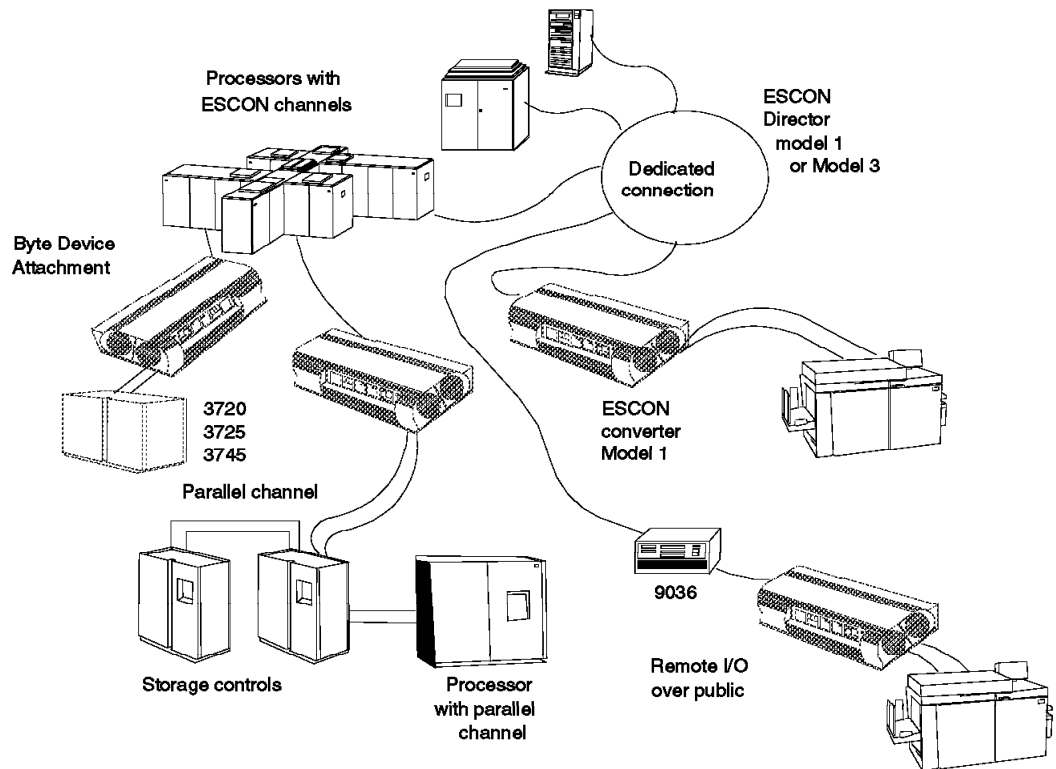

Figure 87. 9034-1′s ESCON Channel to Parallel I/O & Byte Device Attachment

ESCON channel operating in conversion mode can attach I/O devices only in block-multiplexer mode. It also provides both data streaming mode (DS) and direct-coupled interlock (DCI) mode of channel interface. ESCON channel operating in conversion mode can not attach I/O devices in byte-multiplexer mode or selector mode. However, 9034 Converter Byte Channel (TYPE=CBY) Support has since been announced for certain devices:

- Attachment of selected devices operating in byte multiplexor mode attached to a 9034 Converter Model 1 is supported by IBM 9021 711-based processors, 9121 511-based processors, and 9672 processors (E-models, P-models, and R-models). The following summarizes the requirements for this support:

  - Processor

    - The following SEC levels are required:

      - SEC 236420 for 9021 711-based models

- SEC C35954 for 9121 511-based models

- EC D57262 for 9672 E/P/R models

- LIC (Licensed Internal Code) Engineering Change updates for 9672 processors can contain updates for both the CPC (Central Processor Complex) and the HMC (Hardware Management Console) application. A separate EC number (different from the reference or distribution EC number) is associated with the CPC LIC updates and the HMC updates. For CBY support:

    - D57262 is the reference or distribution EC number

    - D79533 is the CPC LIC EC number

    - D79524 is the HMC LIC EC number

- CBY support is contained in the CPC LIC.

− 9034 Converter Model 1

  - While all existing 9034s will function on Converter Block Channels (TYPE=CVC), the latest level 9034 hardware is required for Converter Byte Channel support (TYPE=CBY). Any 9034 with serial number 41 53345 or higher is at the correct level. Any 9034 with serial number 41 53344 or lower may require installation of logic card P/N 42F8047 if it is to be attached to a TYPE=CBY channel. IBM service should be contacted if the 9034 is not at the correct level and is to be attached to a TYPE=CBY channel. Installation of the new logic card is handled through RPQ 8P1767.

  - The following devices are currently supported for attachment to TYPE=CBY channels through the 9034 Converter Model 1 at the correct hardware level:

    - 3745

    - 3725

    - 3720

− Software

  - Support for byte device attachment to 9034 Converter Model 1 is provided by MVS/ESA 4.3 and later releases. Support was integrated into MVS/ESA 5.2 and is provided by the following APARs for MVS/ESA 5.1 and MVS/ESA 4.3:

    - MVS - OW07728, OW07729, OW07560

    - HCD - OW03355

  - IOCP support for TYPE=CBY channels is provided by IOCPIZP V1R3 (APAR OW03025).

A 9034 requires a dedicated connection when using an ESCON Director. It can support up to eight parallel channel control units on a multi-drop configuration.

For information about which devices have attachment capability to the 9034, see *Planning for the 9034*.

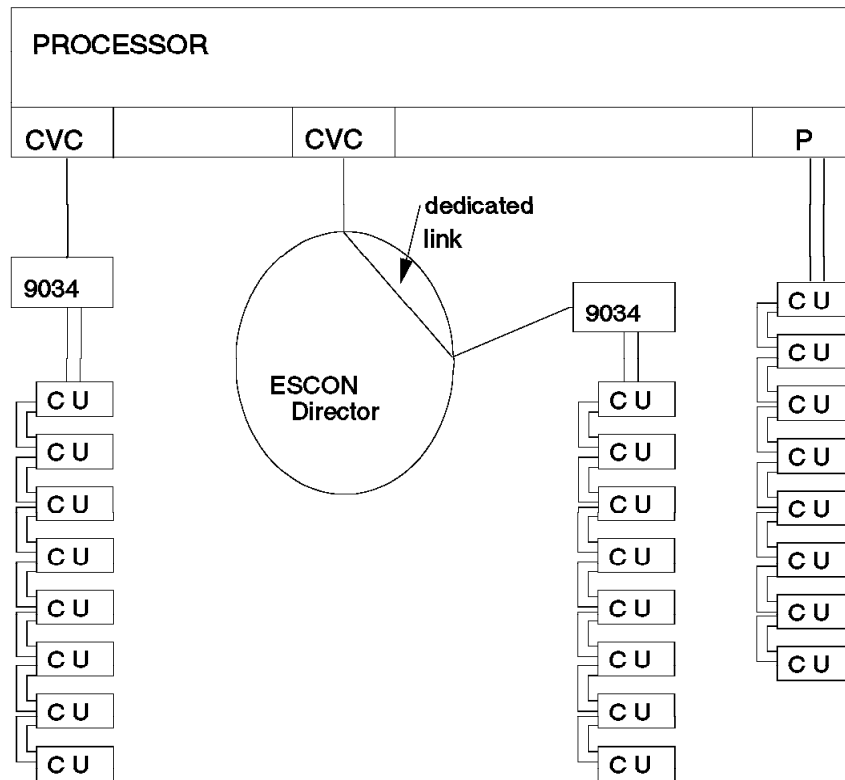Figure 88 shows the connection options of the 9034.

Figure 88. IBM 9034 ESCON Converter Connections

The 9034 can be connected to an ESCON channel directly or indirectly through an ESCON Director, but an indirect connection through the director must be dedicated. ESCON channels that have a 9034 attached either directly or indirectly are called ESCON channels operating in conversion mode.

Up to eight parallel control units can be connected to a 9034 by multi-dropping (daisy chaining). Compared with the eight control units connected to a conventional parallel channel, an ESCON channel operating in conversion mode together with the 9034 is functionally equivalent to a parallel channel.

The 9034 power switch is used to control 9034 power sequencing. The 9034 does not provide remote power control for either itself or the attached control unit(s).

The operation of the 9034 itself is very simple. The operator can only power on or off the 9034 and there are no other controls on the box. However, there are two operation indicators on the panel. To verify proper operation, the POWER-ON indicator should be ON and the NOT OPERATIONAL indicator should be OFF. Any other indicator status means that the 9034 is not operating properly.

For customers who have several 9034s installed in a common area, a rack is available that allows stacking a maximum of eight 9034s.

The bus and tag cables are shipped with the associated control unit. One 62.5/125 um duplex-to-duplex fiber optic jumper cable is provided with the 9034. This cable is used to attach to the channel, and is available in standard lengths of up to 122 meters. Custom lengths are available to a maximum of 500 meters.

6.14.2 Distance

As a general rule, the maximum link distance is 3 km. Longer distances can be made available through an RPQ request. Table 52 shows the distance between a parallel I/O control unit and the attached ESCON processor, through an ESCON Converter Model 1.

Table 52. ESCON Converter Model 1 distance support		
I/O control units	*w/o ESCD (km)*	*w/ ESCD (km)*
3990-1/2/3	1.2	1.0
3880, 3380-CJ2	0.9	0.7
3422, 3803, 3480, 3490, 3494 & 3495	3.0	3.0
3088 CTC	3.0	3.0
3403-5,3262-5, 4245, 4248, 6262, 3800/25/35/20/27 & 3900	3.0	3.0
3172, 3174, 3274, 3720, 3725 & 3745	3.0	3.0
3814/3848	3.0	3.0
3890/XP	3.0	3.0
6098	3.0	3.0
RISC/6000	3.0	3.0
Note: Assumes 62.5/125-micron fiber (2 km or less with 50.0/125-micron fiber), includes optional use of 9036.		

6.14.3 Switching a 9034 Attached Device

This section gives an example of what the operator has to do to switch a device attached to a 9034 converter from one system to another. The discussion is based on the configuration in Figure 89 on page 199.

The ESCON Director provides a flexible switching capability between control units and processors. Control units connected to an ESCON Director can be shared between processors connected to the same ESCON Director or through another chained ESCON Director. The 9034 allows an installation to implement this flexibility even with parallel control units by providing an interface between the control units and the ESCON Director.

However, the switching capability of a control unit with ESCON adapters and a parallel control unit with a 9034 is different. The ESCON Director can switch between control units with ESCON adapters and channels dynamically, while switching between a 9034 and the channel requires operator intervention. This is because the 9034 requires a dedicated link between the channel port and the 9034 port.

Switching off the 9034 when the channel is online will present a light-off situation to the operating systems. The operating system will signal an interface control check to the operator console. However, the ESCON Director will not notice the light-off situation because the link between the 9034 port and the channel port is a dedicated connection. Thus, the light-off situation will not be reflected on the ESCON Director console or the ESCON Manager console.

Therefore, the channel should always be varied offline (for instance, using the MVS CONFIG command) before powering off a 9034 or removing the dedicated link of the ESCON Director from the channel to the 9034. For example, if you want to switch a device from System A to System B (Figure 89), the operator must first:

1. Vary the channel and device offline at the System A operator console using the mvs config command.

2. Remove the dedicated connection between the two ports connecting the device and System A channel using the following:

   • ESCON manager DISCONNECT command
   • ESCON director operator console by removing the CONNECT attribute between these two ports

3. Establish the dedicated connection between the two ports connecting the device and System B channel using the:

   • ESCON manager CONNECT command, or
   • ESCON director operator console by assigning the CONNECT attribute between these two ports.

4. Vary the channel and device online at the System B operator console using the MVS CONFIG command.

You do not need the above operation sequence when using ESCON Manager Version 1 Release 2, because it can operate with TYPE=CVC channel paths. ESCON Manager Version 1 Release 2 issues vary channel and device offline/online commands when you use ESCON Manager commands to a TYPE=CVC channel path.

Compared with a 3814, the switching capability of the ESCON Director as a parallel control unit is similar, but a bit more flexible. The ESCON Director has up to 60 ports and the switching can be from any channel port to any control unit port. A single 3814 provides only a 4x8 or 8x4 switching capability and a single-switch matrix of up to 8x16 or 16x8 by chaining different 3814 models together. The operation is complicated and the number of ports is limited. Many control units are forced to be multidropped at each port and switching one port implies switching the entire string of control units.

With the capability of the ESCON Director (up to 60 ports), more control units can be separated from each other and resources are used more efficiently. On the other hand, more flexibility costs more channels. If you do not want to multidrop control units, then every control unit needs its own channel and 9034, because every 9034 must have a dedicated connection in an ESCON Director.
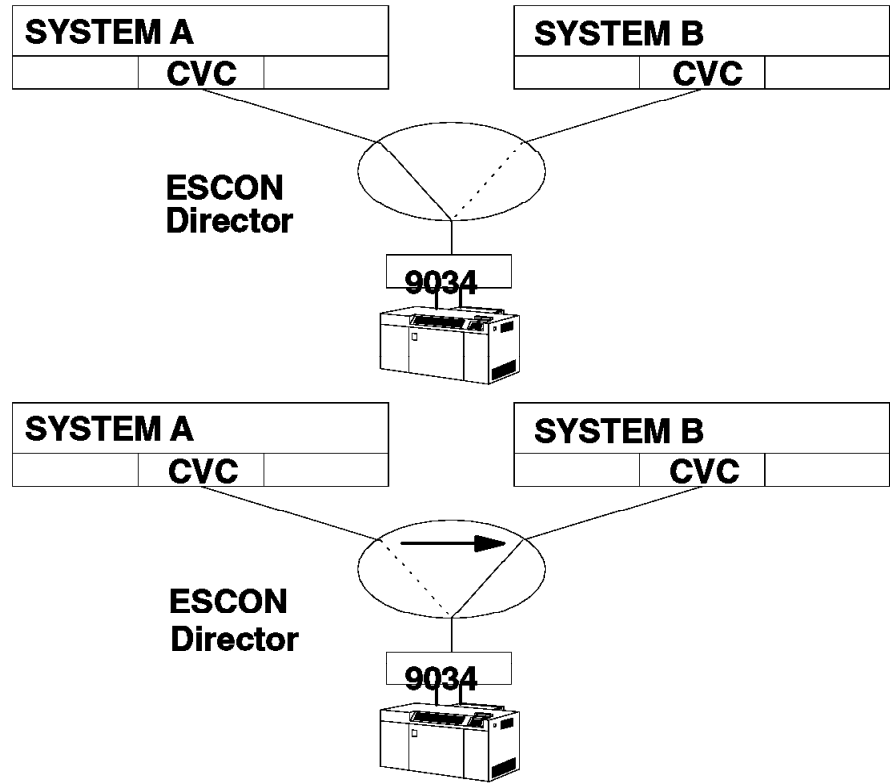
Figure 89. ESCC Model 1 Device Sharing Examples

6.14.4 Distance Limitations

The 9034 permits a distance of up to 2 km (50 um) or 3 km (62.5 um) between a channel and a 9034. Longer distances can be made available through an RPQ request. Between a 9034 and a control unit, the distance can be up to 122 m. Figure 90 shows maximum distances of 9034 connection.
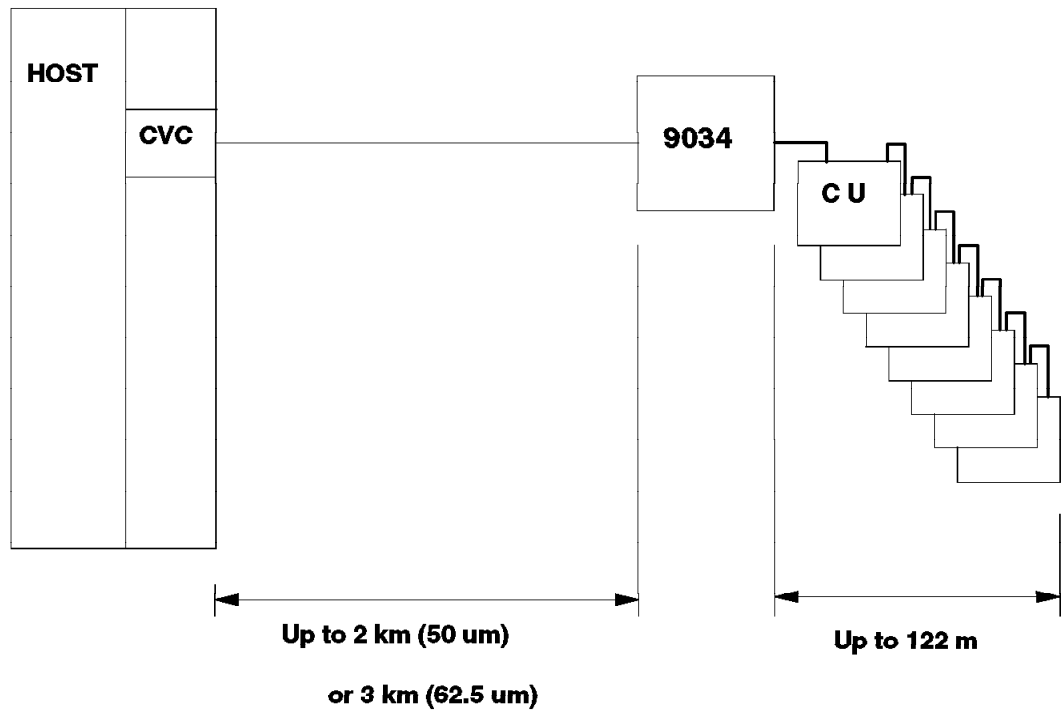
Figure 90. ESCC Model 1 Distance

Distances differ by control unit type. For more information about distances see *Planning for the 9034*.

Control units and devices need not be located close to the processor in a machine room. Looking at Figure 91, the processors and storage devices can be on different floors. The user terminals in a nearby building can be connected through a locally attached controller running at channel speed instead of through a remotely attached controller running at line speed. Printers can now be located in the same location as the users so that the users can obtain their printout immediately instead of waiting for it to be delivered from the data center building.

In some countries, finding a large computer site is not easy. Frequently, the computer center has to be located in a remote factory building while the users are in the business district. Allowing the control units to be separated from the processors gives the customer more flexibility in locating a computer site. Customers can now have multi-story computer sites instead of a single large machine room.

The new distance limitation also has implications on system backup and recovery. A backup site within the allowable distance can have tapes or DASD directly connected to the production systems. The database or other critical data can now be written directly to the storage devices at the backup site, no more shipping of dump tapes and restoring from dump tapes during a system recovery.
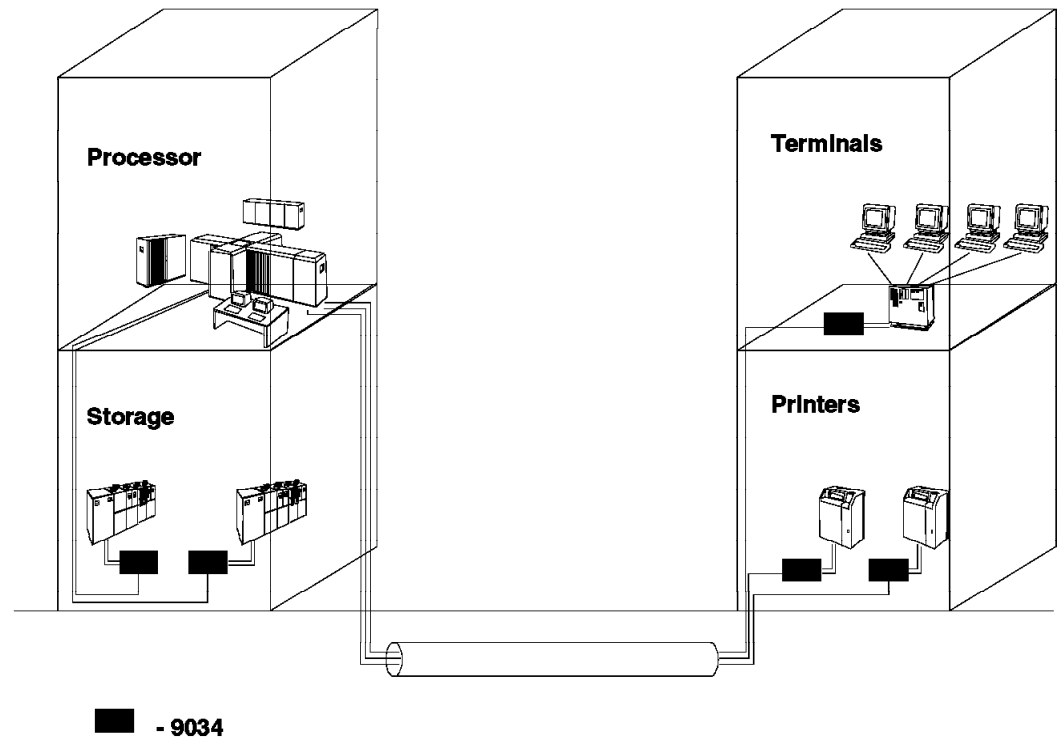
Figure 91. ESCC Model 1 Distance Extension

6.14.5 IOCP Example

Each path working in 9034 mode must be defined to the IOCP with a new keyword, TYPE=CVC. This keyword is part of the CHPID statement.

The following example shows the definition of a CHPID, working in conversion mode:

CHPID30 CHPID PATH=30,TYPE=CVC,SWITCH=01

6.14.6 Software Requirements

The ESCON converter can be used in the software environments meeting the ESCON channel software requirements. For more information, refer to 6.1.3, "ESCON Channel Software" on page 42.

6.15 IBM 9035 ESCON Converter Model 2

This section describes the IBM 9035 ESCON Converter Model 2. The converter can be used to attach certain processors, that cannot be equipped with ESCON channels, to one ESCON adapter interface of a 3990-2/3 Storage Control. The 3990-6 is not supported by the IBM 9035 Model 2.

For more detailed information refer to *IBM 9035 Planning, Configuration, Installation and Performance*.

6.15.1 Description

The 9035 allows attachment of ESCON-capable 3990-2/3 Control Units to parallel channels at extended distances. The fiber-optic cable of the ESCON-capable 3990 attaches to the 9035, which attaches to the parallel channel through bus-and-tag cables. Fiber optic cable can also be attached through an ESCD (refer to 6.3, "IBM 9032 and 9033 ESCON Directors" on page 85).

The 9035 consists of a fiber optic transmitter and receiver, and the logic that supports the attachment of parallel channels. The 9035 receives outbound information from the parallel channel, converts and encodes the information, and transmits it to the ESCON-capable 3990. Inbound information is decoded, converted, and transmitted to the parallel channel.

The 9035 can be multi-dropped as a parallel control unit. When the ESCON-capable 3990-2/3 is connected to the parallel channel through a 9035, the data transfer (data streaming) rate is up to 4.5 MB/sec. Figure 92 illustrates an example of how a 9035 can be used in migrating to an ESCON environment.

6.15.2 Configuration Guidelines

When the 3990-2/3 is to be configured with 9035, there is a minimum EC level or LIC required. The ECA number is 320.

The 9035 can be attached only to a parallel channel on the following host processors:

- ES/4381 Models 90E, 91E, and 92E
- ES/3090 E models, S models, and J models
- ES/3090-9000T models
- ES/9000 models - excluding ES/9000-9221 models that are not Enterprise Systems Architecture (ESA) capable

When the 9035 is installed the 3990 will require VPD (microcode) updates. If the 9035 is replaced by another 9035, the 3990 VPD information may have to be updated.

- Only one ESCD or ECSON adapter port on a 3990 can be physically attached to the 9035.

- One channel can multidrop up to eight 9035s or other parallel control units.

- A 9035 is associated with only one 3990 ESCON adapter, even if it is connected through an ESCD.

- On the other hand, an ESCON adapter of a 3990 may communicate with both ESCON channels and 9035s.

- If one 3990 ESCON adapter connects to a system image through a 9035, all of the other 3990 ESCON adapters for that system image must connect through 9035s.

- A logical path is reserved for each 9035 that is configured in the VPD.
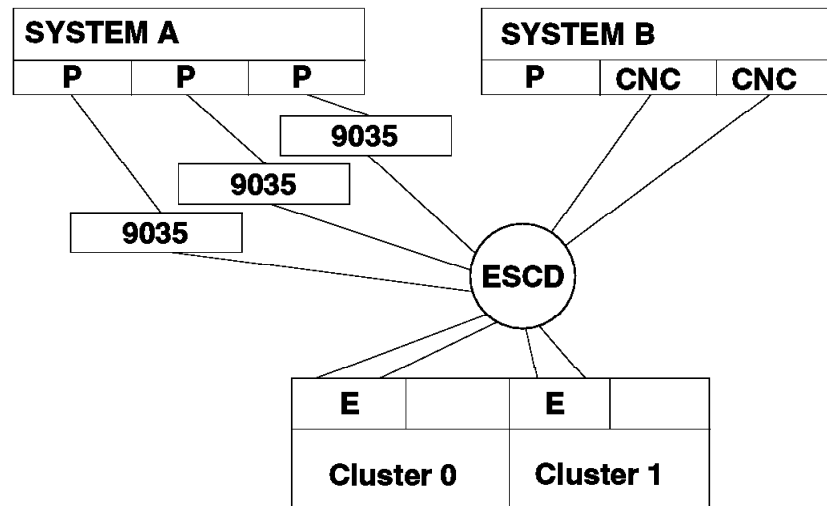
Figure 92. IBM 9035 Converter Model 2 Environment

6.15.3 Distance Limitations

The maximum distance between the parallel channel and the 9035 is 122 meters (400 feet). The maximum distance between the 9035 and the 3990 is 3 km for the 62.5/125 cable, regardless of whether the connection is through an ESCON Director. The 9035 does not support ESCON distance extension configurations using XDF. Only connections to LED cables are allowed. See Chapter 4, "Fiber Optic Technology" on page 13 for more information on cable technology.

6.15.4 IOCP

The 9035 is transparent to the host processor complex channel subsystem and is not defined in the IOCP. A 3990 with an ESCON adapter connecting through 9035s to a parallel channel is defined in the same way as a 3990 with parallel interface connecting to parallel channels.

6.15.5 Software Requirements

This section describes the minimum software level required for the 9035 in various environments.

6.15.5.1 MVS Environment

Table 53 shows the releases and levels of MVS/ESA and their support for 9035. This table reflects the support for 3990 Models 2 and 3 running ECKD applications in nonsynchronous mode. The number in each column defines the minimum required level of a program (higher versions and releases like MVS/ESA 4.2.2 and 4.3 and their appropriate software products fit as well).

Table 53. MVS/ESA Support for IBM 9035		
	Version 3	*Version 4*
MVS	3.1.0e	4.1.0
RMF	4.1.1	4.2.0
EREP	3.5.0 + PTF	3.5.0 + PTF
IOCP	n/a (Note)	n/a (Note)
DFP	3.1.1	3.2.0
DFDSS	2.5	2.5
DFSORT	11.0	11.0
DFHSM	2.5	2.5
ICKDSF	13.0	13.0
Note: The ESCON-capable 3990 attaching to parallel channels through 9035s requires no change in IOCP definition for the 3990. The channels and 3990 Control Unit are defined as parallel channels attaching through 3990 parallel ports.		

6.15.5.2 VM/ESA Environment

Table 54 shows the minimum software support in a VM/ESA environment.

Table 54. VM/ESA Support for 9035	
VM/ESA	1.1
EREP	3.5 + PTF
ICKDSF	11.0
IOCP	n/a (Note)
Note: The ESCON-capable 3990 attaching to parallel channels through 9035s requires no change in IOCP definition for the 3990. The channels and 3990 Control Unit are defined as parallel channels attaching through 3990 parallel ports.	

6.15.5.3 VSE Environment

There is no support for the 3990 models connected to the 9035 under VSE/SP or VSE/ESA 1.1.0.

6.15.5.4 TPF Environment

TPF 3.1 base level supports the 3990 Model 2 connected to the 9035.

6.15.5.5 AIX/ESA Environment

There are no special requirements for AIX/ESA.

6.16 IBM 9036 ESCON Remote Channel Extender

This section describes the IBM 9036 ESCON Remote Channel Extender.

6.16.1 Description

The IBM 9036 ESCON Remote Channel Extender provides new connection
options for ESCON environments. Previously, the IBM 9032 or 9033 ESCON
Directors had to be used whenever the required distance was beyond the reach
of unrepeated links. You may think of an 9036 as of an ESCON Director limited
in function to link extension through dedicated connections.

The 9036 has the following functions:

- Converts between multi-mode fiber (LED) and single-mode fiber (Laser).

- Extends ESCON link distance by optical signal regeneration between the
  attached pair of fibers.

There may be two ESCON directors and any number of IBM 9036 ESCON Remote
Channel Extenders within a channel to the control unit/processor path. There
are device-specific limits to the length of an ESCON path. The maximum is 60
kilometers, as in the case of a CTC connection. Therefore, in practice, most
applications require no more than three, if any, IBM 9036 devices in a path.

Each IBM 9036 adds a negligible latency (200 nanoseconds, equivalent to
approximately 40 meters of fiber) to the link. In practice, link timeouts and data
rates are not affected. Figure 93 shows a few connection options and different
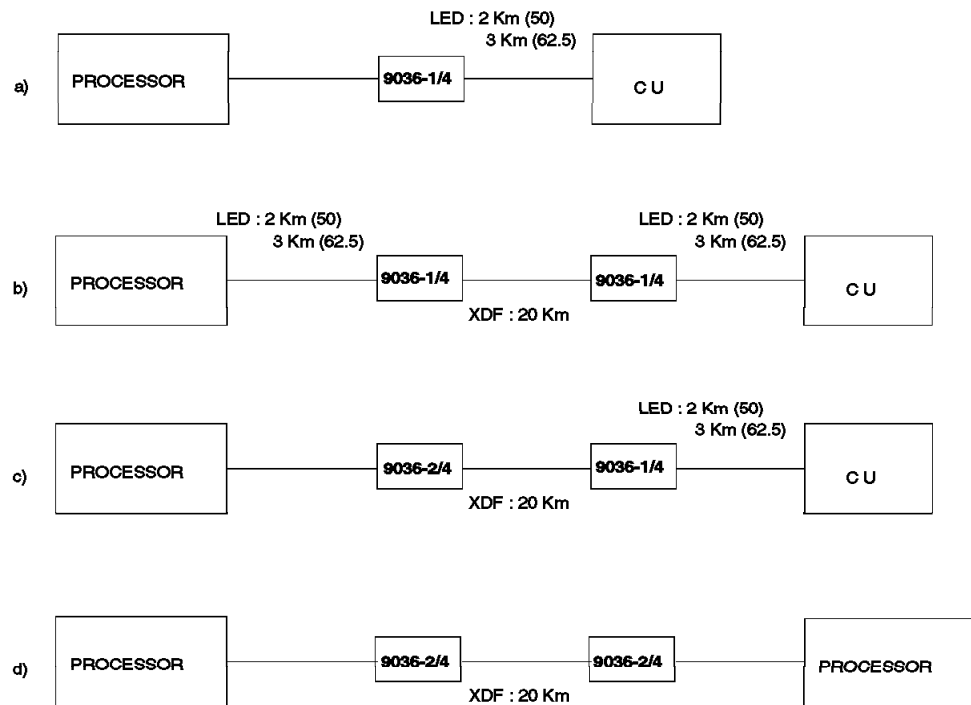configuration distances of the IBM 9036.

Figure 93. IBM 9036 Connection Options

This figure does not attempt to depict all the connection options using the IBM 9036. For information about which devices have attachment capability to the IBM 9036, and what other connection options there are when using the IBM 9036, see *Planning for the 9036*.

6.16.2 9036 Models 001 & 002

Model 001 supports multi-mode to single-mode fiber conversion and signal repeat.

Model 002 supports single-mode to single-mode fiber signal repeat.

6.16.3 9036 Model 003

The 9036 Model 003 is a remote channel extender specially designed for the IBM 9037 Sysplex Timer. It has been available as an RPQ product, 8K1919, since September 1994.

The Model 3 provides ESCON connection support between the processor and the 9037. The RPQ generates an order for a 9036 Model 003.

It comes only in multi-mode to single-mode conversion model. Two units are required to support a link between the 9037 and the processor.

The ESCON distance for LED is 3 km, and for XDF it is 20 km. However, in practice the distance is limited by the 9037's restriction of 3 km point-to-point distance between the 9037 and the attached processors.

The 9037 must have engineering change C65184 installed.

6.16.4 9036 Model 004

The new 9036 Model 004 has been generally available since July 1995 as an RPQ product. Unlike the Models 001 and 002, which support only 1 ESCON channel for each box, Model 004 can support up to 14 ESCON channels in a single power mechanical chassis. The 9036 Model 004 consists of the following orderable components:

- Chassis (RPQ 8P1841)

- Single-mode to single-mode channel extender module (RPQ 8P1842)

- Multi-mode to single-mode converter and channel extender module (RPQ 8P1843)

The chassis is designed for installation in telecom industry standard racks, such as a 23-inch WECO or EIA equipment rack, with adjustable mounting brackets that allow the chassis to be mounted with either a 2-inch or 5-inch recess. Power requirement is -48 Vdc voltage. A Main Processing Unit (MPU) is included in the chassis. The MPU contains a central processor, memory, and communication interface to provide centralized system control and status/alarm reporting for all the installed channel extender modules. The chassis should be ordered with at least one channel extender module to create a functional 9036 unit.

Up to 14 channel extender modules, in any combination of single-mode to single-mode and multi-mode to single-mode channel extender modules, can be supported by a single chassis. Both the multi-mode and single-mode light sources operate at the same wavelength of 1300 nm. The channel extender

modules are capable of monitoring, detecting and reporting data integrity errors and keeping a running count of all active data passed through them as defined by the ESCON architecture specification. The data is logged and tabulated by the MPU to present channel statistic reports in regular time intervals.

The 9036 Model 004, with the MPU installed, provides connection to the customer's or service provider's operations support system (OSS). The chassis can be monitored, maintained, either remotely or locally, through a variety of user interfaces, such as the Craft Interface, TBOS Operation, Front Panel Interface, and X.25 protocol.

6.16.5 Software Requirements

The IBM 9036 ESCON Remote Channel Extender is not visible in the link to any hardware or software, and thus can be used in any software environment that supports ESCON channels. For more information, refer to 6.1.3, "ESCON Channel Software" on page 42.

6.17 IBM 9037 Sysplex Timer

This section describes the IBM 9037 Sysplex Timer Model 1. For more detailed information refer to *GA23-0365 Planning for the 9037 Sysplex Timer*, and Washington System Center Technical Bulletin *GG66-3264 IBM 9037 Sysplex Timer and S/390 Time Management*.

6.17.1 Description

The systems complex (Sysplex) is a combination of hardware and software facilities for addressing customer requirements for growth, continuous availability, enterprise-wide access to data and applications, and systems management and operations. The IBM Sysplex Timer is a centralized, time reference unit designed to distribute Time-of-Day (TOD) information to all attached processors.

The Sysplex Timer maintains TOD clock synchronization between certain IBM S/370 and S/390 processors.

Online applications, with access to a common data base, require an effective mechanism for concurrent access and update by multiple users from multiple systems. The Sysplex Timer allows systems to operate in this environment and provides functions, such as event recording, across the entire system complex as each event occurs.

Fiber optic cable pairs between the Sysplex Timer and the same processor Sysplex Timer Attachment feature are no longer required to be within 30 meters (98.4 feet) of each other in overall length. The effects of cable propagation delay have been eliminated with the introduction of an automatic propagation delay adjustment function. Cable length effects are made nearly transparent to processor time-of-day (TOD) clock synchronization. The point-to-point distance between a 9037 and the attached processor can now be extended up to 3 km with an IBM 9036 Model 3. See 6.16.3, "9036 Model 003" on page 206 for more details.

6.17.2 Configuration

The base unit is supplied with four ports. Three Port Expansion Features, each with four ports, can be ordered for a maximum of 16 ports. This provides for attachment of up to 16 processors or processor sides.

The Sysplex Timer Attachment Feature is required on each processor side in order to attach the processor to the Sysplex Timer. Each attachment feature has two ports.

A maximum of 16 ports can be installed on the Sysplex Timer. In addition, the Sysplex Timer Attachment Feature on each processor side has two ports available. This permits the attachment of two fiber optic cables to two ports at the Sysplex Timer and two ports on each processor side (a primary and a backup).

The Expanded Availability configuration, which links two Sysplex Timers, provides a synchronized redundant configuration. This ensures that the failure of one Sysplex Timer does not cause loss of time synchronization. Each 9037 can be attached to one of two ports on the Sysplex Timer Attachment Feature on each processor side. If a failure occurs in either a Sysplex Timer or a fiber optic

cable, time synchronization is maintained using the backup Sysplex Timer or fiber optic cable.

6.17.3 Requirements

The IBM 9037 sysplex timer has specific processor as well as software requirements.

6.17.3.1 Processor Requirements

The following IBM processors are supported:

- ES/3090 Models 180J, 200J, 280J, and above

  − ES/3090 J Models must have System EC 227574 or above installed

- ES/3090-9000T, all models

- ES/9000, all models

The Sysplex Timer Attachment Feature is required for each processor or processor side.

A customer-supplied console dedicated to a single Sysplex Timer or the Expanded Availability configuration (two Sysplex Timers with the Expanded Availability feature) is required to allow the user or service representative to communicate with the Sysplex Timer. An optional console can be ordered from IBM by specifying feature code 9603 during ordering. Ordering this feature will cause a plant merge of the console with the Sysplex Timer. This will ensure that the console order is routed to the Sysplex Timer manufacture, and will ensure the console is shipped with the Sysplex Timer from the plant of manufacture.

6.17.3.2 Software Requirements

TPF 3.1: Support for the Sysplex Timer is also provided by TPF 3.1 with APAR WP12248.

VM: Support is not available under VM (native or guest).

MVS/ESA SP Version 4.1: Support for the Sysplex Timer is provided by MVS/ESA SP Version 4.1 and subsequent releases. Refer to Figure 94 on page 210 for PTF requirements.

| APAR | MVSESA | | | | | |
	V4.1	V4.2	V4.2.2	V4.3	V5.1	V5.2
OW08332		UW11047	UW11407	UW11408	UW11409	
OW04279		UW07078	UW07078	UW07079	UW07080	
OW04181		UW07125	UW07125	UW07126	UW07127	
OY65132	UY96288	UY96289	UY96292	UY96290		
OY55659	UY83996	UY83997	UY83998	UY83999		
OY47359	UY70415	UY70416	UY70416			
OY46492	UY68916	UY68917	UY68918			
OY45107	UY68694		UY68695			
OY46148	UY68359	UY68360	UY68360			
OY44865	UY67912	UY67913	UY67914			
OY47995	UY71585	UY71586	UY71586			
OY30610	UY90890	UY90891	UY90891			
OY46138			UY90919			
OY47322	UY72773	UY72774	UY72775			
OY66813	UW00567	UW00568		UW00569	UW00570	
OY67128		UW00272	UW00275	UW00273	UW00274	
OW05915		UW08030		UW08031	UW08032	
OW06049		UW08535		UW08536	UW08537	
OW12017				UW16867	UW16868	UW16880
OW13984					UW20048	UW20049
OY67004	UW01656	UW01657		UW01658	UW01659	
OY66138	UY99361	UY99362	UY66362	UY99363		
OY55659	UY83996	UY83997	UY83998	UY83999		
OW09850						
OW15831		UW21963	UW21963	UW21964	UW21965	

Figure 94. MVS/ESA APAR/PTF Requirements for Sysplex Timer

Chapter 7. ESCON and RISC System/6000 Systems

While much of this publication describes the use of ESCON in a S/390 environment, it is worth remembering that non-S/390 systems may also support ESCON attachment. As an example, this chapter describes the ESCON support available to RISC System/6000 systems.

In contrast to Chapter 6, "ESCON I/O Architecture Implementation" on page 41, which describes the S/390 ESCON components, this section provides just an overview of the topic of using ESCON with RISC System/6000. For detailed implementation advice and experiences, you should refer to *RISC/6000 370 Channel Support ESCON and Block Multiplexor* and *Migrating and Managing Data on RS/6000 SP* bulletins, combined with the relevant product publications.

7.1 ESCON Benefits

Before getting down to details, it is worth spending a few moments to assess the benefit that ESCON can provide to heterogeneous systems.

Most organizations today already use multiple platforms; they may use mainframes, mid-range servers and workstations, each with their own operating systems and facilities. The figure below shows a hybrid datacenter which consists of traditional IBM mainframes, newer IBM CMOS S/390 servers and the RISC System/6000 SP.

An ongoing challenge is how to better manage these platforms as a single entity by using common and consistent management tools with flexible ways of moving data between the platforms. This is a growing requirement as new client/server applications emerge, combined with the growing need to propagate data and replicate databases across an organization.

In this environment ESCON offers high bandwidth and the potential to share common resources, such as an automated tape library, between the servers.

The Vision: Hybrid Datacenter
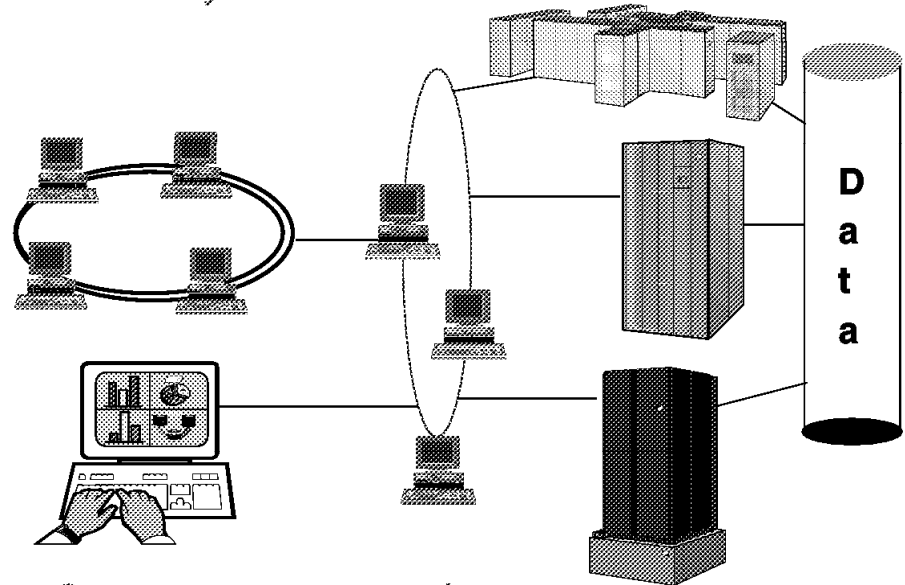
- Common management tools
- High-bandwidth connectivity
- Flexible operation

The Hybrid Datacenter

7.2 Overview

ESCON support for RISC System/6000 systems is achieved by installing an optional Micro Channel adapter card, in the same way that you would use an adapter card to provide additional SCSI or LAN capabilities.

Two cards are available (actually they are identical cards but with different drivers and packaging).

ESCON Control Unit Adapter (FC2756)

> Provides channel-to-channel (CTC) capability between an RS/6000 and S/390. The adapter is ordered as a feature (FC2756) against a base RISC System/6000 system.

S/390 ESCON Channel Emulator (FC2754)

> Enables the attachment of certain S/390 tape devices to a RISC System/6000 system.

The following figure shows how each can be used. For the remainder of this chapter, any feature code for hardware or software will be shown as FCxxxx.
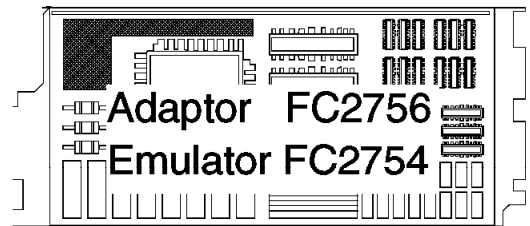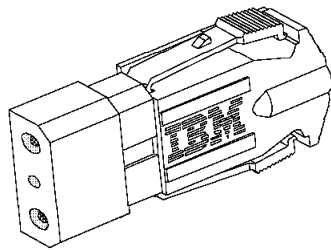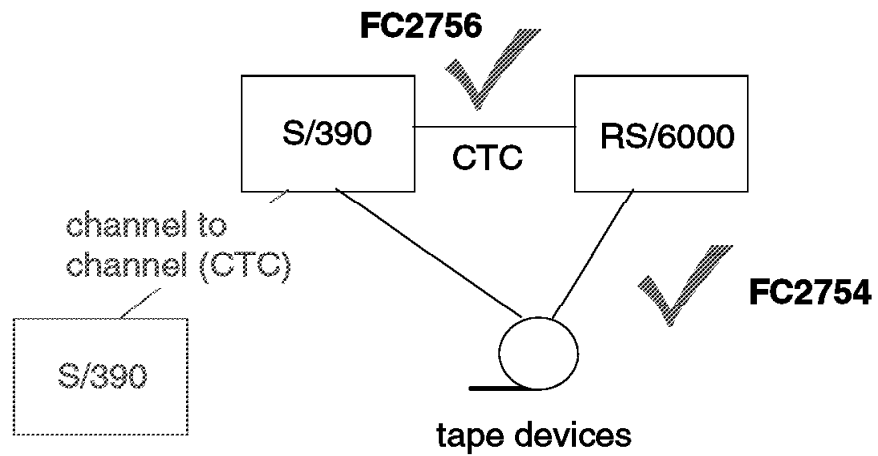
Figure 95. RS/6000 ESCON Summary

The remainder of this chapter provides additional details about each of these adaptors.

7.3 Control Unit Adapter (FC2756)

This adapter provides CTC capability between an RS/6000 system and a S/390 system, and supports TCP/IP and SNA connections to MVS/ESA, VM, and VSE.

7.3.1 Connectivity

Depending upon which S/390 processor is attached, the channel speed is 10 or 17 MB/sec. This is an LED-based adapter, only. As with other ESCON channels, up to two ESCON Directors can be installed between the RISC System/6000 and the S/390 system, which means that a maximum distance of 26 km (using XDF) can be achieved.

This adapter cannot be connected to an EMIF shared channel (defined as CHPID .... TYPE=SHARED), since it only supports a host destination logical address of 0. Refer to 6.2.3, "Addressing" on page 75 and "Link Header" on page 31 for a fuller description of EMIF channel sharing and its use of the host logical address field.

You can, however, define logical control units for a physical control unit, which enables (assuming an ESCON Director is used) a single adapter to have sessions with multiple MVS systems, either as partitions within the same machine or as separate footprints.

Note that this adapter can only communicate with a S/390 system. It cannot, for example, be paired with an RISC System/6000 channel emulator since there is no provision in the channel emulator to drive a CTC connection.

7.3.2 Machine Dependencies

The following table lists those RISC System/6000 systems that support this adapter. This is an MCA-based adaptor, which means that the list excludes PCI-based systems and portables. The package consists of a primary card with a piggy-back daughter card, which together occupy two MCA-adaptor slots.

RISC System/6000 Machine Type	Maximum	Notes
7009	0-2	
7012	0-2	
7013	0-2	
7015	0-4	
9076 (wide node) 9076 (thin node)	0-1 0-2	Adaptor not supported on 9076 SP1

Table 55. RS/6000 Adaptor Configuration Maximums

7.3.3 Software Requirements

In general, you need an AIX device driver and an additional product exploiter which will drive the connection. The packaging of these components differs according to the version of AIX used, as outlined in the following table. The TCP/IP column only shows the level of S/390 TCP/IP product, since AIX includes TCP/IP capability as standard, while the SNA column shows the products required on both the S/390 and AIX sides of the channel.

AIX Version	Base Environment	TCP/IP	CLIO/S	SNA
3.2.5	Device driver provided by AIX FC5056 or SNA Server/6000 (5765-247) FC4761•	TCP/IP MVS V2 and later or TCP/IP VM V2 and later	As for TCP/IP with CLIO/S V2R1	SNA Server/6000 V2.1.2 with one of MVS VTAM V3R4, VSE/VTAM V3R3, VM/ESA VTAM V3R3 and later
4.1.4	5765-603 IBM ESCON Channel Connectivity for AIX 1.1	TCP/IP MVS V2 and later. or TCP/IP VM V2 and later	As for TCP/IP with CLIO/S V2R1 and its APAR PN74395.	SNA Server/AIX V3.1 with Channel Attach for SNA (FC4001) S/390 VTAM components are identical to those required for an AIX V3.2.5 environment
Note:				
•AIX programming feature FC4761 provides a driver for SNA and TCP/IP connection, while FC5056 provides TCP/IP support only.				

Table 56. Software Requirements for FC2756. Note that this table does not show detailed prerequisites for the subsystems (TCP/IP, SNA and CLIO/). Once you have selected a target environment, these must be researched.

7.3.4 Application Exploitation

This section describes the ways to use an ESCON CTC channel connection.

Note that it is possible to run multiple concurrent sessions using different protocols over the same physical channel by defining logical control units. This would allow, for example, an FTP operation under TCP/IP to coexist with SNA user traffic on the same adaptor.

TCP/IP This connection enables distributed socket-based applications, file transfer (using FTP), terminal emulation (such as *telnet* and *tn3270*) and other TCP/IP-based applications.

SNA A channel-attached RISC System/6000 appears as a PU type 2.0 or 2.1 peripheral node and enables user sessions with mainframe VTAM applications. SNA-based file transfer can be accomplished using one of the following:

- AFTP (part of APPC Application Suite) which is part of SNA Server/AIX and VTAM/MVS V4R2, and a chargeable feature with VTAM V3R4.

- NetView FTP versions for MVS, VM, VSE and NV Server for AIX

- NetView Distribution Manager versions for MVS and Netview DM/6000

The list above is not exhaustive.

Client Input/Output Sockets
While TCP/IP and SNA are general purpose network protocols, IBM Client Input/Output Sockets (CLIO/S) primarily provides high-speed (ie. compared with that achieved using TCP/IP alone) channel communication between AIX workstations, particularly the RISC System/6000 SP, and MVS mainframes. CLIO/S cannot be used with other mainframe systems such as VM or VSE.

This section provides an overview of CLIO/S and some recommendations for its configuration using the ESCON adaptor. Refer to *CLIO/S User Guide and Reference* for full details for prerequisites and setup.

CLIO/S is a set of commands and application APIs that can be used for high speed communication and for accessing tape devices between MVS systems and CTC channel-attached RISC System/6000 workstations. Note that CLIO/S can use either ESCON or Block Multiplexor channels and can operate over other hardware, but will be limited to the throughput achieved using TCP/IP alone.

CLIO/S capabilities include:

- Transfer files using more of the available channel bandwidth, often with reduced CPU utilization, using commands similar to those of TCP/IP FTP.

- Access an MVS tape from AIX as though it were a locally-attached device, using standard AIX commands.

- Build applications spanning MVS and AIX. By using MVS Batch Pipes (a separately orderable license), you can enable an MVS application to send output directly across to AIX where another program using an AIX named pipe can do further processing.

Although licensed and packaged as an MVS product, CLIO/S consists of two components, one residing on MVS, and the other running on AIX. TCP/IP is a key prerequisite since it is used to establish the connection before CLIO/S uses its own channel protocol to perform the data transfer. This means that you will need a TCP/IP MVS license.

Note that CLIO/S has optional features which may be needed, depending upon the functions you wish to use. Although beyond the scope of this chapter, CLIO/S also provides remote tape support between network-attached AIX systems using any TCP/IP-based media.

Although CLIO/S can provide near-channel speed data transfer, in practice a limiting factor will be the transfer speed of the disk or tape. Higher bandwidth is achieved by running multiple concurrent transfers, and it is recommended that you define many devices to achieve concurrency.

7.3.5 Configuration Summary

Configuration definition data is needed at both MVS and RS/6000 sides, involving HCD or IOCP definitions under MVS, and SMIT under AIX. The following figure shows IOCP statements needed to define direct attachment (no use of an ESCON Director) for TCP/IP and SNA use across a single channel.

```
*
*        Define RS6000 ESCON Emulator FC 2754 with two logical
*        control units for (1) TCP/IP and (2) SNA.
*
         RESOURCE PARTITION=((LABUSER,7),(P2,2),(P1,1))
*
*        ESCON CHPID, note it is reconfigurable but NOT shared
*
         CHPID PATH=(3D),                                        *
               PARTITION=((LABUSER),(P2,P3),REC),TYPE=CNC
*
*        Define TCP/IP CU (also used by CLIO/S) and devices
*
         CNTLUNIT CUNUMBR=09B0,PATH=(3D),UNITADD=((00,016)),     *
               CUADD=1,UNIT=RS6K
         IODEVICE ADDRESS=(9A0,016),UNITADD=00,CUNUMBR=(09A0),STADET=Y,*
               UNIT=RS6K
*
*        Define SNA CU (note different CUADDR value) and devices
*
         CNTLUNIT CUNUMBR=0AA0,PATH=(3D),UNITADD=((A0,032)),     *
               CUADD=2,UNIT=3174
         IODEVICE ADDRESS=(AA0,032),CUNUMBR=(0AA0),STADET=Y,UNIT=3279
```

Figure 96. Sample Definitions for RS/6000 ESCON Adapter

The following considerations are specific to the application types that will use
the adaptor.

TCP/IP and CLIO/S

- If you are defining using HCD, specify the control unit as type SCTC.

- Using SMIT, define device type as CLAW.

SNA

- Using SMIT, define device type as 3174.

7.4 Channel Emulator (FC2754)

This adaptor enables S/390 tape units to be directly attached to RISC
System/6000 systems. The channel speed of this adaptor is 17 MB/sec, although
transfer speed will be limited by the attached device.

Note that the equivalent (bus and tag) adaptor, feature FC5055, also supports
attachment of some S/390 printers.

7.4.1 Supported Systems

The following table lists those systems that can support this adaptor. This
adaptor has the same attributes as the control unit adaptor feature described in
7.3, "Control Unit Adapter (FC2756)" on page 214.

Model	Maximum	Notes
7009	0-2	
7012	0-2	
7013	0-2	May require Incremental Cooling Fan (FC6506) where one is not already installed
7015	0-4	
9076 (wide node) 9076 (thin node)	0-2 0-1	Not Supported on 9076 SP1

Table 57. RS/6000 Emulator Configuration Maximums

7.4.2 Supported Devices

The following tape devices are supported:

IBM 3490 Magnetic Tape Subsystem, all models

IBM 3490E Magnetic Tape Subsystem, all models

IBM 3494 Tape Library Dataserver

IBM 3495 Tape Library Dataserver

7.4.3 Software Support

The following table lists the software requirements for tape access using standard AIX commands such as *tar*, *backup/restore*, *dd*, and *cpio*, and for exploiting software such as ADSM.

At the time of writing (12/95), support for this adaptor was limited to AIX 3.2.5 environments, although an AIX 4.x driver will likely be available soon.

AIX version	Base environment	Exploiters
3.2.5	Device driver packaged with hardware	ADSM/AIX 1.2.1 or 2.1 REELlibrarian 4.2 with RTAPI•
4.1.x	Not available	N/A
Note: •Remote Tape Application Interface (RTAPI) is an IBM service offering.		

Table 58. Software Requirements for FC2754

7.5 IBM 3995 Optical Library Dataserver

This section describes the IBM 3995 Optical Library Dataserver.

7.5.1 Description

The IBM 3995 Optical Library Dataserver family introduces a new level in the storage hierarchy by offering a unique balance of capacity, performance, and cost. By providing economical, high-capacity storage with direct, random access, the 3995 is ideally suited for infrequently accessed information which currently resides on magnetic disk, tape, paper, or microfilm/fiche.

Models of the 3995 are available to support both rewritable and write-once technology on industry-standard 1.3 GB or 650 MB (unformatted) optical disk cartridges. The newer models have multifunction optical drives capable of reading and writing both rewritable and write-once cartridges in both single- and double-capacity formats. Four different model sizes are available, ranging from 20 GB (unformatted) to 376 GB (unformatted) in a single subsystem, to support application solutions for Token Ring and Ethernet LAN, PS/2, AS/400, RISC System /6000, IBM Personal Computer (PC), MVS/ESA, VM/ESA and VSE/ESA environments.

The IBM 3995 Optical Library Server does the following:

- Complements magnetic disk and tape, offering economical, direct access to gigabytes of online information

- Supports write-once and rewritable technologies using industry-standard cartridges to provide storage capacities ranging from 20 GB (unformatted) to 376 GB (unformatted) in a single subsystem

- Provides granular flexibility since additional capacity can be achieved incrementally with the addition and/or removal of cartridges from the library and with the addition of multiple subsystems

- Utilizes cartridges which are durable and suited for long-term library or shelf storage

- Is ideally suited for historical or infrequently accessed information currently stored on magnetic disk, tape, paper, or microfiche/film

- Supports typical application solutions such as COM (Computer Output to Microfilm/fiche) replacement, imaging, hierarchical storage management, and backup/archive

- Supports IBM SAA ImagePlus applications as well as other IBM, IBM Business Partner, and independent software vendor applications

7.5.2 IBM 3995 Model 133

The IBM 3995 Optical Library Dataserver Model 133 provides 188 gigabytes of storage (unformatted), doubling the storage capacity of the predecessor Models 131 and 132. The optical drives in the Model 133 have multifunction capability and can read and write single and double-capacity write-once (WORM) media, as well as single and double-capacity rewritable media. The 3995 Model 113, the expansion unit for the 3995 Models 153, which has multifunction capability, will attach as an expansion unit to the 3995 Model 133, providing an additional 188 gigabytes of storage.

The 3995 Model 133 can be attached to the host processor through one or two ESCON channels, or through the two parallel channels which were previously standard. While attachment through ESCON does not provide multi-host support, it does support remote attachment of the 3995 up to 9 kilometers. Highlights of the 3995 Model 133 include:

- The IBM 3995 Model 133, when combined with the 3995 Model 113, provides up to 376 gigabytes of cost-effective online data storage.

- The 3995 Model 133 provides storage which can be readily accessed by ImagePlus, IAFC, and numerous business partner applications performing functions including image, workflow management, and applications that were traditionally implemented using microfiche.

- The 3995 Model 133 provides ESCON attachment to a single host. ESCON provides remote attachment of the 3995 to up to 9 kilometers, as well as improved dynamic switching, simplified cabling, and reduced cable bulk.

- While the 3995 Model 133 attaches to a single host, requests from multiple hosts for data can be serviced by the 3995 Model 133 when the application takes advantage of the communications front end.

- The 3995 Model 133 utilizes the new double-capacity WORM media, as well as single-capacity WORM media. It can alternatively use single and double-capacity rewritable media.

- The double-capacity media stores 1.3 gigabytes of data (unformatted) on each cartridge, providing a new level of storage density.

- The WORM capability provided in the 3995 Model 133 utilizes non-erasable recording techniques, where a hole is permanently burned in the media to represent a data bit. This provides an extra measure of data security over software-protected WORM.

- Customers using OAM for the storage of data objects in the 3995 Model 133 get the indexing power of OAM for the storage of extremely large quantities of data. System Managed Storage (SMS) is available for the management of the optical volumes and the data within the 3995 from data creation through data expiration.

- The 3995 Model 133/113 provides cost-effective storage, enabling customers to bring online data currently stored on paper, microfilm, diskette, or magnetic tape, or to extend the online life of data currently maintained on DASD.

- The 3995 Model 133 offers support for one or two ESCON channels for attachment to the host. While not providing multi-host attachment, this does allow customers to locate the 3995 remotely from the processor. It also enables the use of ESCON throughout the data center, without requiring the use of converters, and also facilitates more rapid switching to a backup system, if the ESCON attachment is made through an ESCON director.

A 3995 Model 133 Optical Library Dataserver with a 188 gigabyte (unformatted) capacity includes:

- Four optical disk drives capable of reading and writing single and double-capacity IBM rewritable and write-once optical disk cartridges.

- One operator-accessible disk drive capable of reading and writing single and double-capacity IBM rewritable and write-once erasable optical disk cartridges.

- Entry/exit slot for introducing or removing disks from the Dataserver.

- One keyboard for operator and service personnel use.

- One output display for operator and service personnel use.

- A mechanism for moving optical disk cartridges between storage cells, optical disk drives, and/or the entry/exit facility.

- 144 optical disk cartridge storage cells.

- Capability to attach one Model 113, the Optical Library Expansion Unit.

- One integrated control unit with:

  - 32 megabytes of main storage in the controller

  - Two fixed disks for controller use, containing the 3995 Licensed Internal Code

  - One 1.44-megabyte flexible disk drive

  - Back-up Licensed Internal Code diskettes

  - Parallel Attachment (specify code 3304) or ESCON attachment (feature 3302 and optionally 3303)

- The addition of the expansion unit Model 113 does not necessarily change the library's appearance to the host: however, the library capacity will double.

7.5.3 Software Support for the IBM 3995 Model 133

The 3395 Optical Library Dataserver Model 133 requires one of the following miniumum levels of system software:

- If using MVS/DFP 3.3.1:

  - MVS/ESA SP 4.2 (+ PTFs UY69189 and UY69191) or later

  - MVS/ESA SP-JES2 Version 4 (5695-047)

  - MVS/ESA SP-JES3 Version 4 (5695-048)

  - MVS/DFP 3.3.0 (+ PTFs UY60098, UY62889, UY67491, UY67902, UY90867)

  - MVS/DFP 3.3.1 current maintenance per SPA

- If using DFSMS/MVS 1.1.0:

  - MVS/ESA SP 4.3 or later

  - Any MVS/ESA SP-JES2 supported by MVS/ESA SP 4.3

  - MVS/ESA SP-JES3 Version 4 Release 2

  - Assembler H V2.1 with current maintenance

  - SMP/E P V1.6 with current maintenance at minimum, V1.7 recommended

  - DFSMS/MVS 1.1.0 current maintenance per SPA

- VM/XA SP Release 2.1, VM/ESA Release 1.0 (ESA Feature), and VM/ESA Release 1.1 and later levels support the 3995 Model 133 when defined to VM as a 3088 and dedicated to an MVS/ESA SP Version 4 Release 2 guest virtual machine.

7.5.4 IBM 3995 Model 153

The IBM 3995 Optical Library Dataserver Model 153 offers improved levels of price/capacity to the IBM storage family. The 3995 Model 153 provides 178 gigabytes of storage, almost twice the storage capacity of the predecessor Model 151. When used with the new 3995 Model 113 expansion box, the 153/113 combination contains nearly the storage capacity of six strings of 3390 Model 2 DASD, in a fraction of the floorspace. Since the Model 153 utilizes the same channel commands as DASD and attaches to the same platforms, data sets can be moved to or from 3390 DASD with, in most cases, no application change required. This enables the customer to optimize the cost of storage by migrating between 3390 DASD and the 3995 Model 153 based on the end-user's performance and access requirements. Multi-host attachment for the 3995 Model 153 through up to four parallel channels is available. It is IBM's intention to provide ESCON connectivity for the 3995 Model 153. Highlights of the 3995 include:

- The IBM 3995 Model 153, when combined with the 3995 Model 113, provides up to 356 gigabytes of cost-effective online data storage.

- The 3995 Model 153 provides storage which can be readily accessed by most applications written to access 3390 Model 2 DASD on ESA/390 and ESA/370 systems, under the appropriate releases of MVS/ESA and VSE/ESA. VM support is provided for single-capacity 3390 Model 2 logical volumes under VM/XA Release 2.1 and VM/ESA releases prior to Release 2.1, with double-capacity volumes supported under VM/ESA Release 2.1.

- The 3995 Model 153 provides a multi-host attachment that allows connection through parallel channels to up to four processors. The parallel channels can also be utilized to provide redundant attachment to fewer processors.

- The 3995 Model 153 utilizes the new double-capacity rewritable media. When formatted for use on the Model 153, each cartridge stores over 1.2 gigabytes of data.

- The 3995 Model 153/113 provides cost-effective storage, enabling customers to bring online data currently stored on paper, microfilm, diskette, or magnetic tape, or to extend the online life of data currently maintained on DASD.

A 3995 Model 153 Optical Library Dataserver, with a 178 gigabyte (formatted) capacity, includes:

- Four optical disk drives capable of reading and writing the IBM erasable optical disk cartridge

- Entry/exit slot for introducing or removing disks from the Dataserver

- One keyboard for operator and service personnel use

- One output display for operator and service personnel use

- A mechanism for moving optical disk cartridges between storage cells, optical disk drives, and/or the entry/exit facility

- 144 optical disk cartridge storage cells, configured as 48 3390 Model 2 volumes (3 cartridges per volume)

- Capability to attach one Model 113 Optical Library Expansion Unit; the use of the expansion unit, 3995 Model 113, requires that 48 additional addresses be defined to the host

- One integrated control unit with:

- 32 megabytes of main storage in the controller

- 2400-megabyte fixed disks for controller use containing the 3995 Licensed Internal Code, including the mount avoidance code designed to improve performance

- One 1.44-megabyte flexible disk drive

- Back-up Licensed Internal Code diskettes

- 2 Parallel Channel Attachment Cards

- (Optional) Second 2 Parallel Channel Attachment Feature

The 3995 Model 113 Optical Library Dataserver Expansion Unit, with a 178 gigabyte (formatted) capacity, includes:

- Four optical disk drives capable of reading and writing the IBM erasable optical disk cartridge

- Entry/exit slot for introducing or removing disks from the Dataserver

- A mechanism for moving optical disk cartridges between storage cells, optical disk drives, and/or the entry exit facility

- 144 optical disk cartridge storage cells, configured as 48 3390 Model 2

7.5.5 Software Support for the IBM 3995 Model 153

The 3395 Optical Library Dataserver Model 153 requires one of the following minimum levels of system software:

- MVS/ESA V5.1 plus DFSMS V1.1

- MVS/ESA V4.3 plus DFSMS V1.0

- MVS/ESA V4.2 plus MVS/DFP V3.2

- MVS/SP V3.1.0 plus MVS/DFP V3.2

- MVS/SP V2.2.3 plus MVS/DFP V3.1.1

- VM/ESA Release 2.1 and above (4365 cylinders/volume)

- VM/ESA Release 1.1 and 2.0 (2226 cylinders/volume)

- VM/ESA Release 1.0 (ESA feature) (2226 cylinders/volume)

- VM/XA Release 2.1 (2226 cylinders/volume)

- VSE/ESA Version 1 Release 3.1

7.6 IBM 3900 Advanced Function Printer

This section describes the IBM 3900 Advanced Function Printer family.

7.6.1 Description

The IBM 3900 family of Advanced Function Printers offers a broad range of highly reliable, continuous-form simplex and duplex page printing solutions at throughput speeds ranging from 91 to 708 impressions per minute, very high print quality, and a rich assortment of performance and productivity enhancement features and functions. The 3900 models offer simplex and duplex printing with paper widths up to 18 inches.

7.6.2 The IBM 3900 Advanced Function Printer

The IBM 3900 Advanced Function Printer Model 1 and "base" IBM 3900 Model 0W1 offer high-speed simplex production printing at throughput speeds of up to 354 impressions per minute (IPM) with a 16-inch paper path and an 18-inch paper path, respectively. By ordering the 3900 Model 0W1 with feature code 4290 (plant) or 4291 (field MES), the throughput speed is increased up to 310 IPM in 1-up format or 480 IPM in 2-up 8.5 x 11-inch side-by-side format. The 3900 Model 0W3 offers an 18-inch paper path with simplex printing at 232 IPM, and is upgradable to the faster 3900 Model 0W1. The 3900 Models 0W1 and 0W3 can be attached to any ESCON-capable host processor through an ESCON channel at any distance up to 43 KM. The maximum distance requires two XDF links between ESCON Directors or IBM 9036 ESCON Remote Channel Extenders.

7.6.3 The IBM 3900 Advanced Function Duplex Printing System

The IBM 3900 Advanced Function Duplex Printing System is comprised of the 3900 Model D01 and 3900 Model D02, and produces duplex output at throughput speeds of up to 300 IPM. The 3900 Duplex System can also be operated in dual simplex mode with the models D01 and D02 each printing up to 150 IPM simplex output (229 IPM with features #4241 and #4242 installed). Models D01 and D02 support paper-path widths up to 16 inches. The 3900 Models D01 and D02 can be attached to any ESCON capable host processor through an ESCON channel at any distance up to 43 KM. The maximum distance requires two XDF links between ESCON Directors or IBM 9036 ESCON Remote Channel Extenders.

7.6.4 The IBM 3900 Advanced Function Wide Duplex Printing System

The IBM 3900 Advanced Function Wide Duplex Printing System is comprised of the 3900 Model DW1 and the 3900 Model DW2, and produces duplex output at throughput speeds of up to 708 IPM when printing 2-up 8.5 x 11-inches side-by-side impressions with the optional high-speed duplex features. The 3900 Wide Duplex System can also be operated in dual simplex mode with the models DW1 and DW2 each printing up to 354 IPM simplex output with either the optional 150-229 Dual Simplex Mode features or the high-speed duplex features installed. Models DW1 and DW2 support paper-path widths up to 18 inches. The 3900 Models DW1 and DW2 can be attached to any ESCON-capable host processor through an ESCON channel at any distance up to 43 KM. The maximum distance requires two XDF links between ESCON Directors or IBM 9036 ESCON Remote Channel Extenders.

7.6.5 The IBM 3900 High Resolution Duplex Printing System

The IBM 3900 High Resolution Duplex Printing System Models DR1 and DR2 offer high-quality, on-demand duplex printing at a high resolution of 600 dots per inch (DPI). The DR1 and DR2 work in tandem to produce duplex output at 300 IPM in 1-up letter format and up to 464 IPM in 2-up 8.5 x 11-inch side-by-side format. The first version of the 3900 High Resolution Duplex Printing System is limited to certain functional capabilities:. Token-Ring (TCP/IP) and Ethernet (TCP/IP) are the two supported connectivity attachments.

7.7 IBM ESCON Manager

This section describes the IBM ESCON Manager.

7.7.1 Description

ESCON Manager, program number 5688-008, provides a centralized approach to controlling ESCON Directors. Instead of physically walking out to the ESCON Director Console(s), possibly the processor system hardware console(s) and the MVS console(s), you can manage all of the directors and other I/O through one terminal. The ESCON Manager can make configuration changes to the director(s) even if a director console has failed.

There are two different dialogs available to use the ESCON Manager. There is an ISPF dialog through a TSO session, and also a workstation feature both of which provide graphical interface on a PC attached to one of the hosts. These two interfaces are not mutually exclusive, and multiple terminals or PCs for ESCON Manager access are possible. In addition, ESCON Manager commands can also be entered on the system console.

ESCON Manager provides much more than centralized control of ESCON Directors. Using the workstation feature, ESCON Manager creates and displays accurate and current configuration diagrams of the shop floor dynamically, including both ESCON and parallel devices, directors, channels (ESCON, Parallel, Coupling Facility and OSA), and processors. It builds a configuration and connectivity map in virtual storage, gathering the data from various sources, MVS, HCD, the channel subsystem, ESCON Directors, and ESCON Manager running on other systems. ESCON Manager will pick up the new configuration even when the changes are made dynamically with HCD. A clear, up-to-date diagram is quickly available, in both online or hardcopy, on the installed and coded configurations. It includes how a device is attached, through which Directors (if any with port numbers labeled), and to which CHPIDs on which systems.

7.7.2 ESCON Manager V1R3

ESCON Manager 1.3 integrates the I/O configurations of multiple systems into a single configuration image. In the past, the I/O configuration was presented exclusively from the perspective of the ESCON Manager host from which commands are submitted, and included only I/O resources owned by that host. With Release 3, an ESCON Manager host is aware of all hosts that share an ESCON Director with another known host. This is achieved by starting the ESCON Manager as a host VTAM application. Once started, it will automatically establish VTAM links to pre-defined peer (VTAM) ESCON Manager systems. This allows an ESCON Manager host to obtain the I/O configuration data from other ESCON Manager hosts with which it can communicate. Figure 97 shows a graphical view of cross systems configuration.
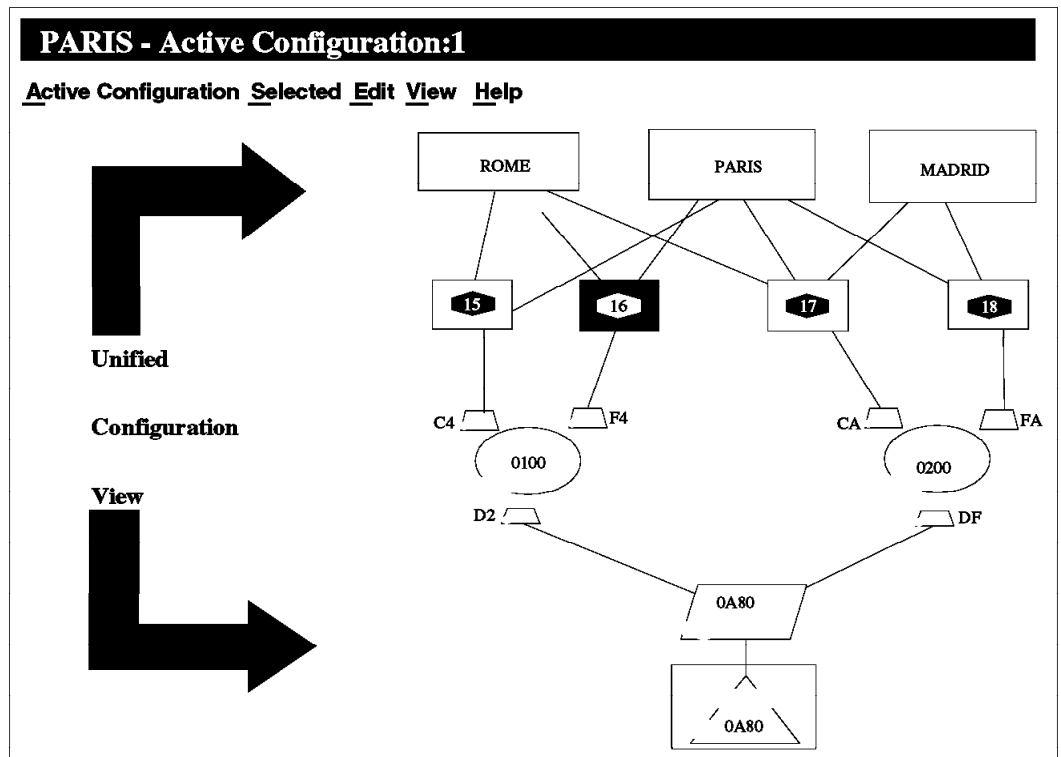
Figure 97. Multi-system Image View of Device 0A80. as Displayed by ESCON Manager

Although one of the primary functions of the ESCON Manager is to control the ESCON Director, it is nonetheless not required for the ESCON Director to be present for the ESCON Manager to be installed. With Release 3, the ESCON Manager can be used to manage (from a single point of control) the I/O configuration of a S/390 computer installation that has no ESCON Directors installed, as well as mixed configurations in which some systems are connected to ESCON Directors and others are not.

ESCON Manager 1.3 supports the 9032 Model 3.

The ESCON Manager workstation can be operated both manually and through software. EHLLAPI communication is supported in addition to existing support for Advanced Program-to-program Communications (APPC), to the ESCON Manager Workstation feature.

A special enhancement provides Release 3 with the support of MVS/ESA 5.2 capability to specify UCBs above the 16-megabyte line. The function of this enhancement does not affect the ability of ESCM 1.3 to coexist with other ESCMs on the same level or at different levels (for example, ESCM 1.2, and 1.3 with or without this enhancement).

ESCON Manager 1.3 on MVS/ESA 4.3 and above will support the S/390 Open Systems Adapter (OSA) integrated hardware feature, which allows direct LAN connectivity to a heterogeneous environment. Configuration information can be displayed. In addition, it will allow a user to configure OSA channels on and off, and vary OSA devices defined to the S/390 I/O configuration. However, it will not

be able to display or control the network configuration that is physically attached to the OSA channel, as the network is not defined in the S/390 I/O configuration.

In addition to using ESCON Manager to display accurate diagrams of the installation, it can also be used to generate appropriate VARY commands on multiple systems automatically and in a safe manner. The ESCON Manager will communicate with other ESCON Managers to ensure that the I/O operation of other systems will not be disrupted as a result of the VARY action, such as taking away the last path to an allocated device caused by a BLOCK command for the ESCON Director. This is especially beneficial in a multi-systems shared ESCON Director environment.

7.7.3 Requirements

The following are requirements for the machine and software.

7.7.3.1 Machine Requirements

- ESCON capable processors
- Native ESCON channel (CNC) to each ESCON Director installed
- VTAM communication between host systems

7.7.3.2 Software Requirements

- MVS/ESA 5.1 with ESCON Director Support feature
- MVS/ESA 4.2 or 4.3 with ESCON Director Support feature + PTFs
- VTAM/ESA 3.4.1 + PTFs
- TSO/E 2.4
- ISPF 3.5 and ISPF/PDF 3.5
- RACF 1.9 + PTFs
- Netview 1.3
- Support for OSA is available with:
    - MVS/ESA APARs OW07560, OW07728, OW07729
    - HCD APAR OW03355
    - IOCP APAR OW03025
    - VM APAR VM58290
- APAR PN51474 is required if 9032-3 is installed
- APAR PN65104 if ESCM 1.2 is to coexist with 9032-3

7.7.4 VM Guest

This section describes the scenario where the ESCON Manager is running on an MVS system that is a guest under VM.

Running ESCM (ESCON Manager) with MVS in a VM guest environment is a valid configuration if these procedures are followed: device numbers must be real for devices with paths that go through switches owned by a guest, and switches owned a guest can only contain paths for that guest. The following sections are descriptions of ESCM function in a guest environment, various examples of guest combinations, and configuration guidelines and operating procedures.

7.7.4.1 Why Guest Support Is Complex

An ESCM user should be able to attempt switch configuration changes with full confidence that ESCM will allow only safe changes. That is, changes that affect the operating system or an active user will be refused by ESCM. Normally, ESCM "asks" its operating system for permission to make switch configuration changes by converting the changes into VARY PATH requests for a device. The operating system replies according to its knowledge about the device's use and the number of paths available to it. This is straight-forward when ESCM is running on the native operating system. However, when the operating system is a VM guest, there is no communication between that guest's VARY PATH processing and VM's VARY PATH processing. Thus, only the guest's knowledge will be used to respond to ESCM's VARY PATH requests.

Figure 98 on page 230 with MVS as a guest, demonstrates how real and virtual device numbers can be confused. The MVS guest owns the DASD and the switch which contains a path to the DASD. Assume that the DASD control unit:

- Is defined in VM's HCPRIO as device 300

- Is defined in the IOCDS as device 300 on port C3 of switch 100

- Is used by an MVS guest but is defined in the IOGEN as device 500

So the person running the MVS guest issues: "ATT 300 - 500" to map the DASD device number correctly. (Assume that MVS retains 100 as the switch's device number.)
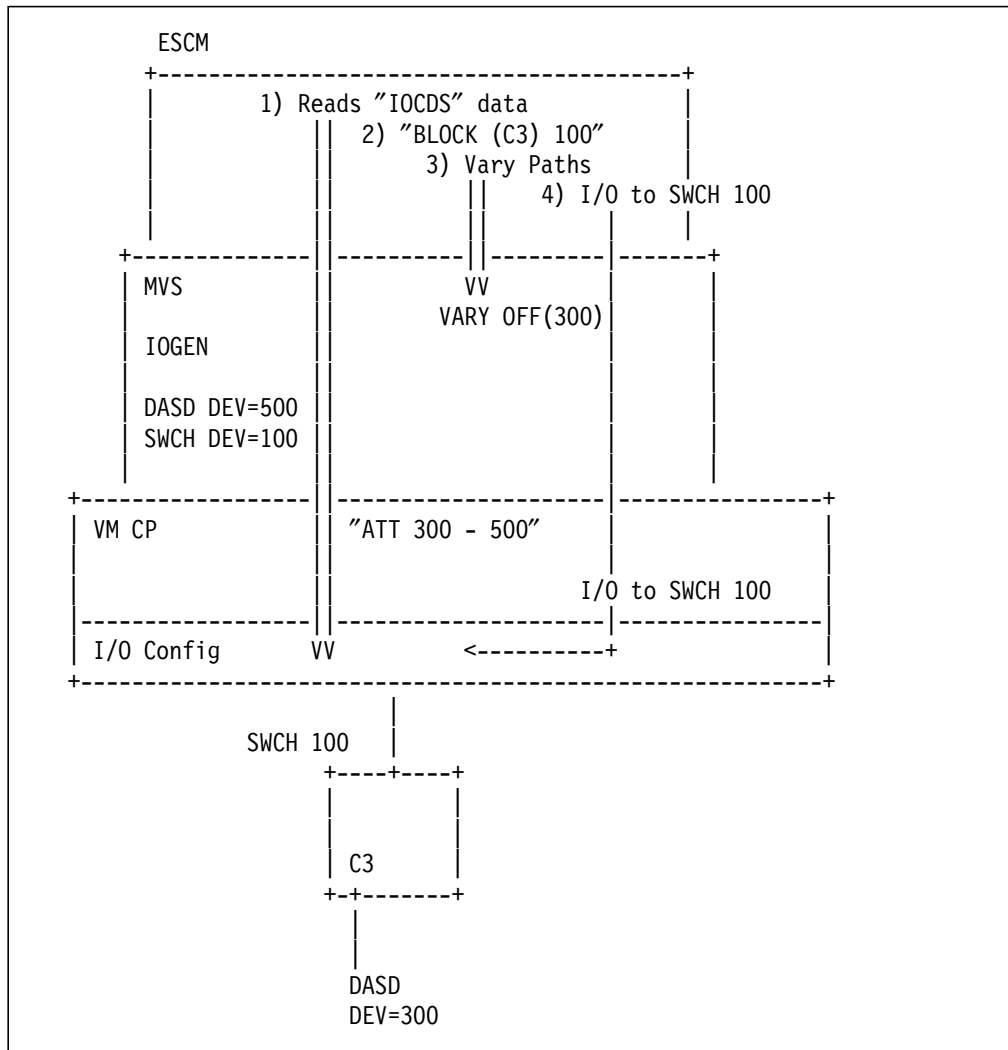
```
                ESCM
                +-----------------------------------------+
                |            1) Reads "IOCDS" data        |
                |             || 2) "BLOCK (C3) 100"       |
                |             ||    3) Vary Paths          |
                |             ||         ||  4) I/O to SWCH 100
                |             ||         ||      |          |
          +-------------||----------||---------|-------+
          |  MVS                    VV                 |
          |                    VARY OFF(300)           |
          |  IOGEN             ||                       |
          |                    ||                       |
          |  DASD DEV=500      ||                       |
          |  SWCH DEV=100      ||                       |
     +------------------||-------------------|---------------+
     | VM CP            ||  "ATT 300 - 500"  |               |
     |                  ||                   |               |
     |                  ||              I/O to SWCH 100       |
     |------------------||-------------------|---------------|
     | I/O Config       VV        <----------+              |
     +----------------------------------------------------------+
                               |
                  SWCH 100     |
                     +----+----+
                     |    |
                     | C3 |
                     +-+-------+
                       |
                       |
                      DASD
                      DEV=300
```

Figure 98. MVS as VM Guest

This demonstrates where the problem occurs:

1. ESCM reads "IOCDS like" data to get the CHPIDs and device numbers on those CHPIDs.

2. An ESCM user blocks port C3 on SWCH 100. ESCM determines that device 300 will be affected (instead of MVS's device 500).

3. ESCM issues a VARY PATH request to MVS, "Can you VARY off 300 on path xx|". MVS responds to the request and replies to ESCM. Let's say the reply is, "Yes, 300 was VARYed offline on path xx."

4. ESCM issues "Block Port C3" to SWCH 100.

The problem is that the VARY PATH request was for device 300 instead of the device 500 known to MVS. ESCM took its information from the real I/O definition and was unaware of the mapping from real 300 to virtual 500.

Another problem would have occurred if VM CP or another guest had paths that went through SWCH 100. Since the MVS guest answers ESCM's VARY PATH requests and VM CP is never contacted, these paths will not be included in MVS's reply. Both of these are severe problems that result in unsafe switching.

7.7.4.2 IOCDS Equivalence

Certain definitions and procedures will ensure that ESCM properly controls the switches. A partial solution is that device numbers in the IOCDS, VM′s HCPRIO, and MVS′s IOGEN are all equivalent, hereafter called ″IOCDS equivalence″. This eliminates the confusion about which device is being referenced.

This limitation would be quite strict, though, if it were applied to all guest devices. Updating the test system to match the MVS guest is a time-consuming process. Less restrictive procedures have been found though, and this document describes where ″IOCDS equivalence″ is necessary.

The rest of the solution involves segregating the I/O paths for a guest-owned switch.

7.7.4.3 Segregated and Integrated Switches

For switches controlled by an MVS guest with ESCM, the ownership of the I/O going through the switch determines whether it is segregated or integrated. If the guest that owns the switch owns all of the I/O going through it, then that switch is segregated. If paths for CP owned I/O or I/O for other guests go through that switch, then that switch is integrated. ESCM cannot support integrated switches. The reasons for this are described in 7.7.4.6, "Configuration Examples" on page 233.

7.7.4.4 Communication between ESCMs

Multiple ESCMs on the same host will not communicate with each other. The reason is that switches cannot be shared; they can only be attached to a single virtual machine. So once a switch is attached to one ESCM, the other ESCMs cannot issue I/O to it.

However, each ESCM will communicate with other ESCMs on other hosts as required using VTAM. In the configuration in Figure 99 on page 232, the host on the left has two ESCMs, and each controls one switch. The host in the right has one ESCM, and it can control all three switches. All switches are segregated.
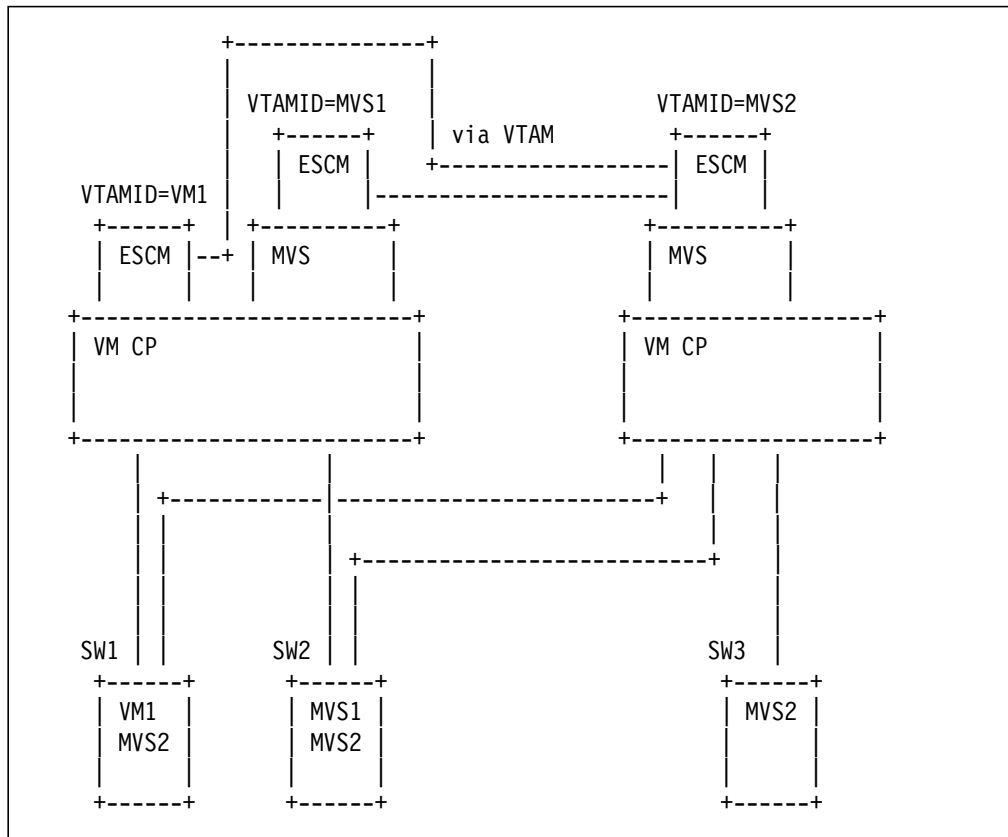
```
      +---------------+
      |               |
      | VTAMID=MVS1   |              VTAMID=MVS2
      |    +------+   | via VTAM     +------+
      |    | ESCM |   +------------------| ESCM |
VTAMID=VM1 |    |   |----------------------|      |
+------+   |    +----------+              +----------+
| ESCM |--+ | MVS      |              | MVS      |
|      |  | |          |              |          |
+-----------------------+              +-----------------+
| VM CP                 |              | VM CP           |
|                       |              |                 |
|                       |              |                 |
+-----------------------+              +-----------------+
    |   |       |                        |  |  |
    |   |  +-----------|-----------------------+ | |
    |   |  |          +-----------------------------+ |
    |   |  |          |
 SW1 | |  SW2 | |              SW3  |
  +------+   +------+              +------+
  | VM1  |   | MVS1 |              | MVS2 |
  | MVS2 |   | MVS2 |              |      |
  |      |   |      |              |      |
  +------+   +------+              +------+
```

Figure 99. Communication Between ESCMs

When each ESCM is started, it writes its VTAM ID into each switch that it can control. After all ESCMs are started:

 • SW1 contains VM1 and MVS2.

 • SW2 contains MVS1 and MVS2.

 • SW3 contains MVS2.

When an ESCM user wants to change a switch, ESCM contacts the other ESCMs by using the list of VTAM IDs in that switch:

 • VM1 would contact MVS2 for changes to SW1.

 • MVS1 would contact MVS2 for changes to SW2.

 • MVS2 would contact VM1 for changes to SW1 and would contact MVS1 for changes to SW2 (and contact no other system for changes to SW3.)

Notice that VM1 and MVS1 do not communicate with each other because neither is aware that the other exists.

7.7.4.5 ESCM Display of Non-switch I/O
Another ESCM function is the display of paths to all devices even if none of the paths go through switches. These displays are included in ESCM for completeness even though the paths are never involved in any VARY PATH requests. Nonetheless, these non-critical displays will be incorrect for the device numbers where ″IOCDS equivalence″ is not followed.

7.7.4.6 Configuration Examples

These configuration examples will be described:

1. Single ESCM running directly on VM with an MVS guest (where guest does not have ESCM)

2. Single ESCM running on the MVS guest with segregated switches (for example, only MVS's I/O having paths going through switches)

3. Single ESCM running on MVS guest with integrated I/O (for example, VM CP and other guests having I/O with paths going through switches)

4. Two ESCMs, one running in a virtual machine and one running on an MVS guest with segregated switches

5. Two ESCMs, one running in a virtual machine and one running on an MVS guest with guest using VM-controlled switch

6. Two or more MVS/ESCM guests and one ESCM running in a virtual machine all with segregated switches

Other configurations exist, but they will not be discussed.
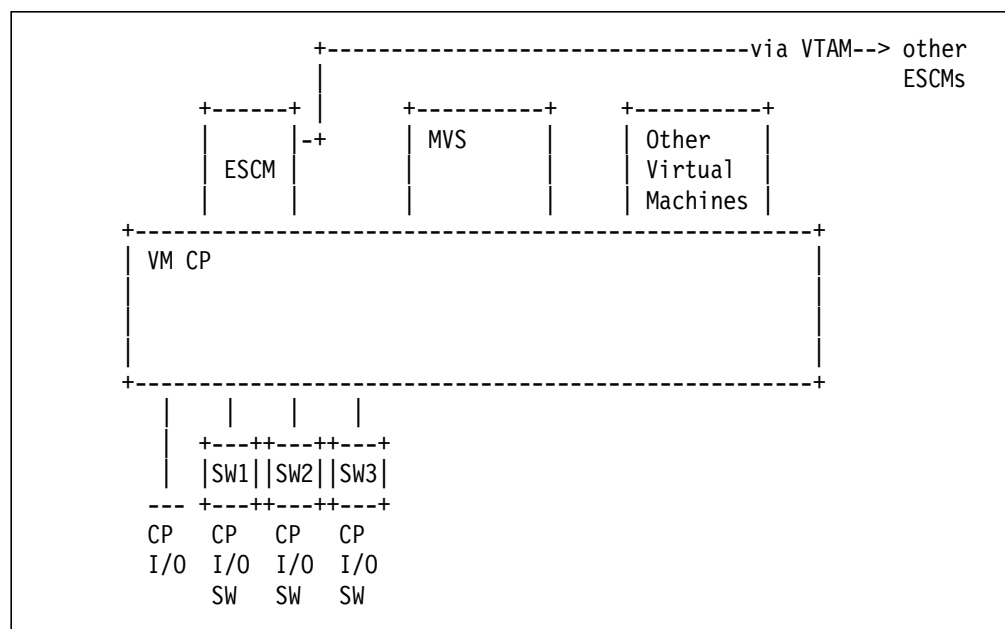
Single ESCM Running Directly on VM with MVS Guest:

```
+-----------------------------------via VTAM--> other
|                                                ESCMs
+------+ |    +----------+  +----------+
|      |-+    |   MVS    |  |  Other   |
|      | |    |          |  | Virtual  |
| ESCM |      |          |  | Machines |
|      | |    |          |  |          |
+------------------------------------------------+
| VM CP                                          |
|                                                |
|                                                |
|                                                |
|                                                |
+------------------------------------------------+
      |    |    |    |
      |  +---++---++---+
      |  |SW1||SW2||SW3|
  --- +---++---++---+
  CP   CP   CP   CP
  I/O  I/O  I/O  I/O
       SW   SW   SW
```

Figure 100. Example - Single ESCM running directly on VM with MVS guest

In Figure 100, all I/O is labelled ″CP I/O″ or ″CP I/O SW″ because all paths are controlled by CP. ESCM is running directly on VM, and ESCM controls all switches. The MVS guest does not have ESCM installed, but it does have I/O paths that go through the switches.

There are no setup restrictions for this configuration. It is the recommended environment for running ESCM with MVS guests.

Restrictions on procedures:

1. When ESCM changes the switches, CP is aware of these changes. If a path change affects the MVS guest, MVS is not contacted automatically about the

path change, so an operator must enter an MVS CHPID command to reflect the change in path status. (This is a normal MVS guest procedure.)

2. See "Operating Procedures" on page 240.

Communications between ESCMs:

- ESCM communicates through VTAM to other ESCMs installed on other hosts about resources shared through the switches.

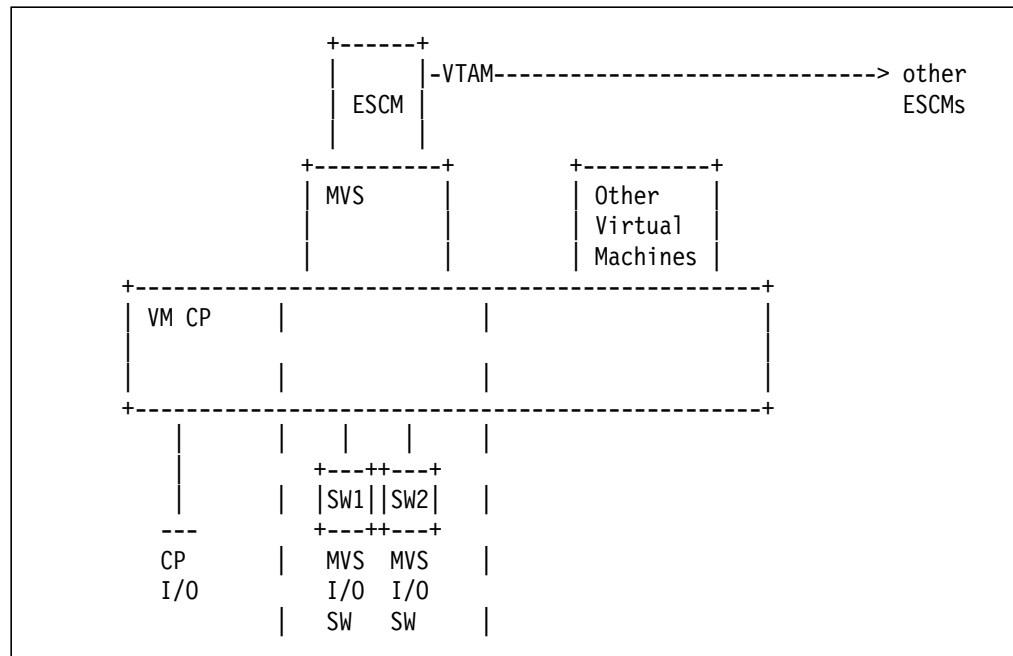***Single ESCM/MVS Guest with Segregated Switches:***

```
           +------+
           |      |-VTAM----------------------------> other
           | ESCM |                                    ESCMs
           |      |
        +----------+          +----------+
        |  MVS     |          | Other    |
        |          |          | Virtual  |
        |          |          | Machines |
  +-----------------------------------------------+
  | VM CP   |                 |                    |
  |         |                 |                    |
  |         |                 |                    |
  +-----------------------------------------------+
       |     |    |    |       |
       |     |  +---++---+     |
       |     |  |SW1||SW2|     |
       |     |  +---++---+     |
      ---    |   MVS  MVS      |
      CP     |   I/O  I/O      |
      I/O    |   SW   SW       |
             |                 |
```

Figure 101. Example - Single ESCM/MVS guest with Segregated Switches

In Figure 101, the ESCM running on the MVS guest controls the two switches,
and only MVS′s I/O goes through the switches. Thus, the switches are
segregated. Paths to ″CP I/O″ do not go through the switches.

Restrictions on device numbers:

1. For devices with paths going through SW1 and SW2, ″IOCDS equivalence″
   must be followed (the device numbers in the IOCDS, HCPRIO, and IOGEM
   must be equivalent). This includes the switches themselves.

2. For other MVS I/O, the numbers do not matter. However, be aware of the
   previous note on &q.ESCM Display of Non-Switch I/O=.

Restrictions on procedures:

- See "Operating Procedures" on page 240.

Communications between ESCMs:

- ESCM communicates through VTAM to other ESCMs installed on other hosts
  about resources shared through SW1 and SW2.

Single ESCM/MVS Guest, Integrated through MVS Switches (Invalid):

```
                       +------+
                       |      |-VTAM----------------------------> other
                       | ESCM |                                    ESCMs
                       |      |
              +----------+        +----------+
              | MVS      |        | Other    |
              |          |        | Virtual  |
              |          |        | Machines |
      +-------------------------------------------------+
      | VM CP   ___|__                |                 |
      |            \                  |                 |
      |          |  \                 |                 |
      +-------------------------------------------------+
         |     |   |   |        |
         |     |   |   |        |
         |     |  +---++---+    |
         |     |  |SW1||SW2|    |
        ---    |  +---++---+    |
        CP     |  CP   MVS      |
        I/O    |  I/O  I/O      |
               |  SW   SW       |

    +---------------------------------------------------------------------+
    |                                                                     |
    | This configuration is NOT VALID for safe ESCM control of switches.  |
    |                                                                     |
    +---------------------------------------------------------------------+
```
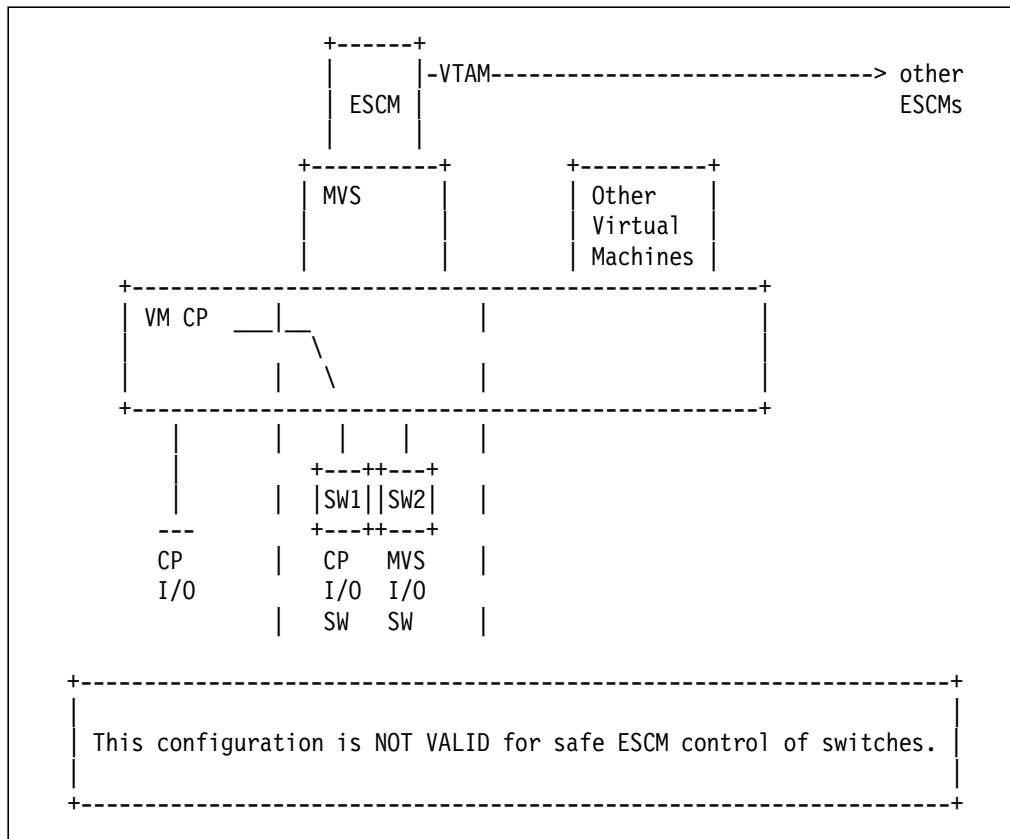
Figure 102. Example - Invalid Configuration

In Figure 102 the switches controlled by the ESCM/MVS guest are integrated. They contain paths for CP controlled I/O as well as MVS's I/O.

For simplicity, assume that all of MVS's I/O follows ″IOCDS equivalence″. When the ESCM user issues a command such as: ″Block port N on SW1″ and that port is part of a path to I/O that CP is using, ESCM and MVS cannot determine that the path is in use. ESCM already knows the VM device number and the CHPID from the IOCDS, but when it asks MVS to vary that device/path offline, MVS does not know of that device. ESCM will block the port, resulting in unsafe switching.

Thus, ESCM on an MVS guest cannot support integrated switches.

ESCM/MVS and ESCM/VM with Segregated Switches:

```
                    +----------------------------through VTAM--> other
                    |                                            ESCMs
                 +------+ 
                 |      |----------------through VTAM--> other
                 | ESCM |                                ESCMs
                 |      |
      +------+   |  +----------+   +----------+
      |      |-+ |  MVS        |   | Other    |
      | ESCM |   |  |          |   | Virtual  |
      |      |   |  |          |   | Machines |
   +-----------------------------------------------+
   | VM CP         |             |               |
   |               |             |               |
   |               |             |               |
   +-----------------------------------------------+
      |      |    |  |    |   |   |
      |   +---++---+   +---++---+ |
      |   |SW1||SW2||  |SW3||SW4| |
     --- +---++---+   +---++---+ |
      CP  CP  CP  |    MVS  MVS  |
      I/O I/O I/O |    I/O  I/O  |
          SW  SW  |    SW   SW   |
```
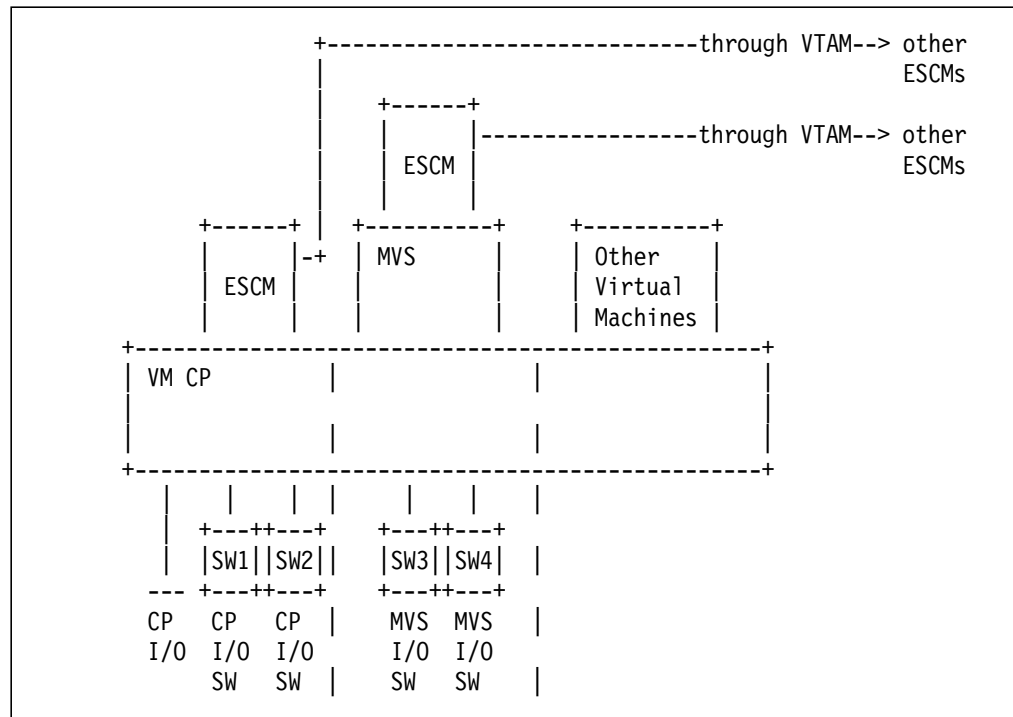
Figure 103. Example - ESCM/MVS and ESCM/VM with Segregated Switches

In Figure 103, the ESCM running directly on VM controls SW1 and SW2, and MVS's ESCM controls SW3 and SW4. SW1 and SW2 only contain I/O for CP or other users. SW3 and SW4 only contain I/O for MVS, so SW3 and SW4 are segregated.

Restrictions on device numbers:

1. &q.IOCDS equivalence= for devices with paths going through SW3 and SW4.

2. For other MVS I/O, the numbers do not matter.

Restrictions on procedures:

* The switches must be attached to the appropriate ESCM for proper control (see "Operating Procedures" on page 240).

Communications between ESCMs:

1. Each ESCM can communicate through VTAM to other ESCMs installed on other hosts about resources shared through the switches.

2. The two ESCMs on this host will not communicate with each other.

ESCM/MVS and ESCM/VM with MVS Guest Using VM′s Switch:

```
| OW15831 |          | UW21963 | UW21963 | UW21964 | UW21965 |          |
                      +----------------------------through VTAM--> other
                      |                                             ESCMs
                      |   +------+
                      |   |      |------------------through VTAM--> other
                      |   | ESCM |                                 ESCMs
                      |   |      |
            +------+  |   +----------+       +----------+
            |      |-+ |  | MVS      |       | Other    |
            | ESCM |  |  |          |       | Virtual  |
            |      |  |  |          |       | Machines |
            +----------------------------------------------------+
            | VM CP         |____          |                     |
            |              /               |                     |
            |             / |              |                     |
            +----------------------------------------------------+
               |    |   |  |    |    |    |
               |  +---++---+   +---++---+  |
               |  |SW1||SW2|   |SW3||SW4|  |
              --- +---++---+   +---++---+  |
              CP   CP   CP  |   MVS  MVS   |
              I/O  I/O  I/O |   I/O  I/O   |
                        SW  SW   SW   SW   |
```
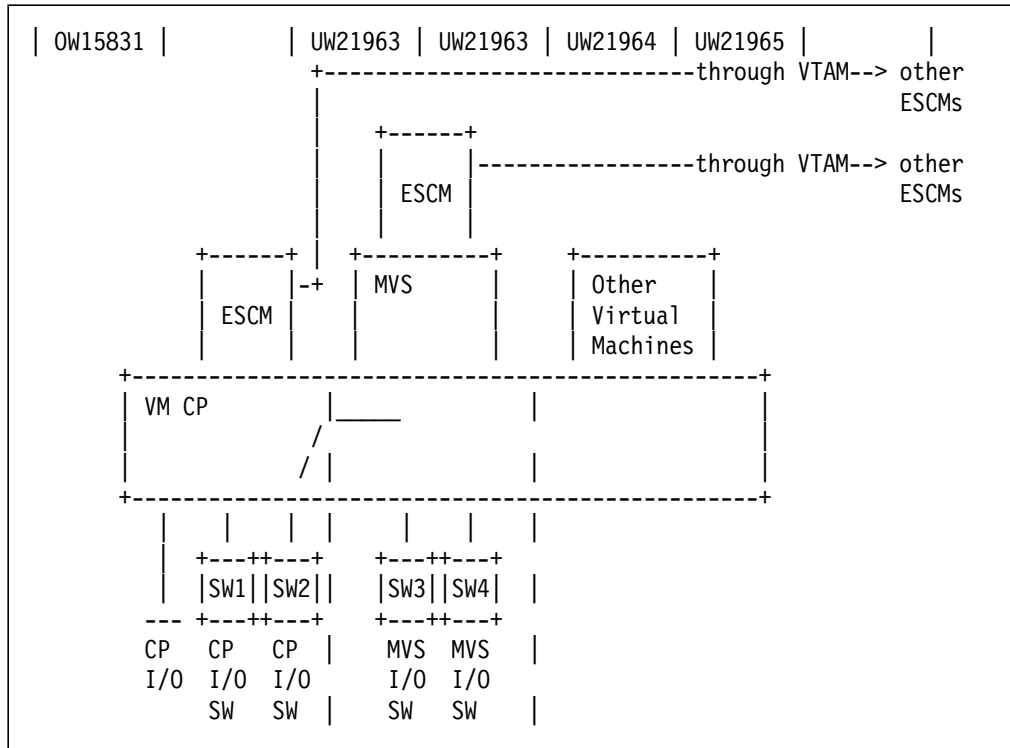
Figure 104. Example - ESCM/MVS and ESCM/VM with MVS Guest using VM′s Switch

In Figure 104, the ESCM running directly on VM controls SW1 and SW2, and MVS′s ESCM controls SW3 and SW4. SW3 and SW4 are segregated. The guest has I/O paths that go through a CP controlled switch.

This configuration is supported even though the two ESCMs do not communicate with each other.

Restrictions on procedures:

1. When ESCM on VM changes SW1 or SW2, VM responds correctly about paths through SW1 and SW2. If a path change affects the MVS guest, CP responds for the guest but MVS is not contacted about the path change, and an operator must enter an MVS CHPID command to reflect the change in path status. (This is a normal MVS guest operation.)

2. See "Operating Procedures" on page 240.

Thus, this configuration is supported, but without the automatic notification of some path changes for the guest.

Two or More ESCM/MVSs and ESCM/VM with Segregated Switches:

```
                    +-------------------------------via VTAM--> other
                    |                                           ESCMs
                    |              +------------------via VTAM--> other
                    |              |                             ESCMs
                    |    +------+  |          +------+
                    |    |     |-+ |          |     |---via VTAM--> other
                    |    | ESCM |  |          | ESCM |              ESCMs
                    |    |     |  |          |     |
       +------+     |    +----------+        +----------+
       |     |-+    |    | MVS1     |        | MVS2     |
       | ESCM |     |    |          |        |          |
       |     |     |    |          |        |          |
       |     |     |    |          |        |          |
    +----------------------------------------------------+
    | VM CP          |              |                    |
    |                |              |                    |
    |                |              |                    |
    +----------------------------------------------------+
         |    |   | |      |    |   |       |   |
         |  +---++---+  +---++---+      +---++---+
         |  |SW1||SW2||  |SW3||SW4|  |  |SW5||SW6|
         --- +---++---+  +---++---+      +---++---+
         CP   CP   CP |   MVS1 MVS1 |    MVS2 MVS2
         I/O  I/O  I/O |   I/O  I/O  |    I/O  I/O
              SW   SW |   SW   SW   |    SW   SW
```
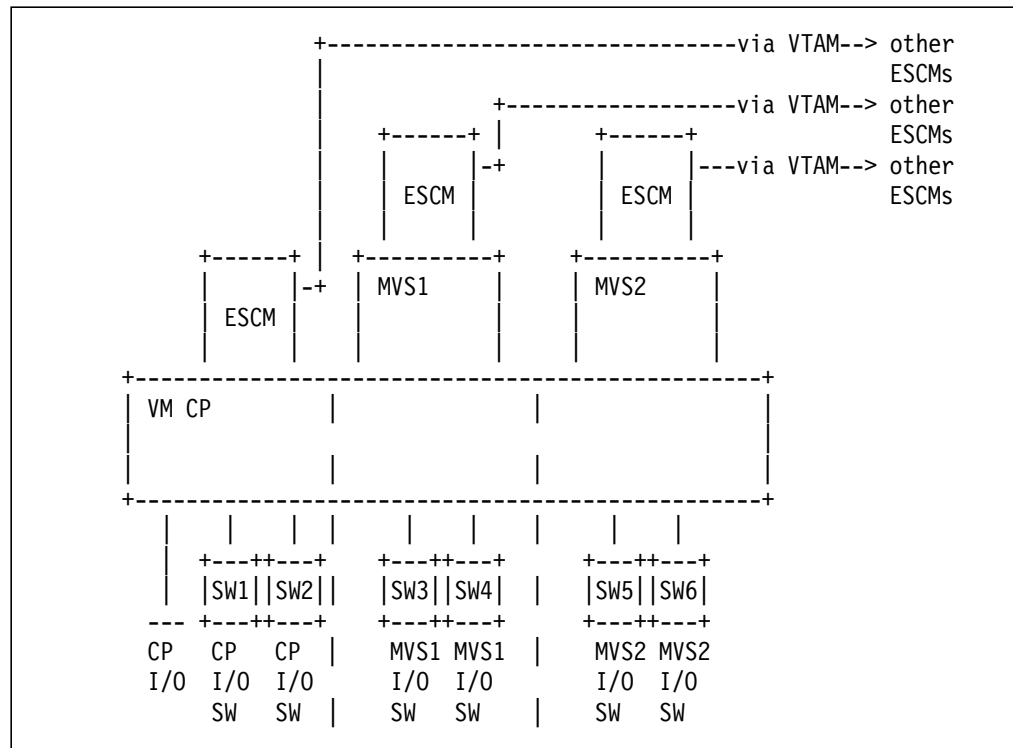
Figure 105. Example - Two or more ESCM/MVSs and ESCM/VM with Segregated Switches

In Figure 105, the ESCM runs directly on VM controls SW1 and SW2, the ESCM on MVS1 controls SW3 and SW4, and the ESCM on MVS2 controls SW5 and SW6. All switches controlled by guests are segregated because each only contains paths for its own guest.

Restrictions:

1. ″IOCDS equivalence″ for devices with paths through SW3, SW4, SW5, and SW6.

2. See "Operating Procedures" on page 240.

7.7.4.7 Guidelines

Configuration Planning:

1. Device numbers of any MVS device that goes through an MVS controlled switch must be in the range of 0000-0FFF. This includes the switch itself. (The range is an MVS restriction for device numbers.)

2. Device numbers of any MVS device that has paths through an MVS controlled switch must be real (IOCDS equivalence). This also includes the switch.

3. Switches attached to an MVS guest with ESCON Manager must be segregated.

Operating Procedures:

1. For configurations with multiple ESCMs, the switches must be attached to the appropriate ESCM for proper control. If one of the ESCMs is running directly on VM, it must started last.

   • Logon to each MVS guest and attach the switches to be controlled by that ESCM to that guest.

   • Start the ESCM on each MVS guest. Each ESCM will be able to display or control configurations for its switches, that is, switches defined in its own IOCDS data.

   • Logon to the ESCM that is to run directly on VM and start that ESCM. That ESCM will attach the remaining switches to itself and will only be aware of the switches owned by the MVS guests.

2. Converter channels require special operating restrictions to prevent channel errors. The following procedures must be followed for Converter/Static connections that are to be BLOCKed, UNBLOCKed, CONNECTed, or DISCONNECTed. Perform these before you make the change:

   • On MVS, CHPID(nn) OFF

   • On VM, VARY PATH offline

   • On system console, CHPID nn OFF

     After you make the change, perform these:

   • On system console, CHPID nn ON

   • On VM, VARY PATH online

   • On MVS, CHPID(nn) ON

Dynamic I/O and PR/SM Reconfiguration: Neither Dynamic I/O nor PR/SM Reconfiguration is supported by ESCM/MVS as a guest. If devices or CHPIDs are added after ESCM has been started, they are not recognized by ESCM.

For ESCM/MVS as a guest to handle additional I/O and CHPIDs:

1. Stop ESCM.

2. Make any additions (or deletions).

3. Start ESCM.

Chapter 8. ESCON Configuration Planning

This chapter provides a guide to planning a customer ESCON environment. For more detailed information on the different tasks, refer to the appropriate chapters in this book.

Before the customer orders ESCON hardware and software products there are some topics worth considering. It could be beneficial if, in conjunction with IBM staff if the customer wishes, the current configuration in the data center is reviewed. Some problems, or areas for improvement, might be identified. The goals that have to be achieved by the migration to ESCON should then be defined in discussions between the customer and IBM.

An ESCON project is a task with a defined start and end.

First, a logical plan has to be made. Its output is the logical configuration with all the hardware devices.

Once the logical plan has been made, you have to define the physical configuration by performing the physical planning. The physical planning deals, for example, with the appropriate quality and quantity of cables (trunks and jumpers) and patchfields that have to be identified and calculate and their location. Your country CE Organization gives support in these areas.

For both planning sessions, the following checklist provides for:

- Connectivity
- Availability
- Performance

Finally, the installation project can start.

8.1 General Procedure

Implementing an ESCON installation takes place as follows:

1. Review the current configuration, its problems and potential.

   - Connectivity

     Are there any connectivity bottlenecks today? For example, distance problems, raised floor stuffed with copper cables, demands for varying the configuration because of different workload profiles?

   - Availability

     Is there a need for less disruptive growth or less disruptive changes in the configuration for test and backup?

   - Performance

     Is there a need for better performance?

     Is there an understanding of the data rate performance factors (link rate, channel data rate, effective data rate, and the effect of cable distances)?

2. Identify the objectives of the project.

3. Define the target configuration (logical planning). Refer to 8.2, "Logical Planning" on page 242.

4. Evaluate benefits by using evaluation tools (MKTTOOLS).

5. Establish a migration plan with intermediate configurations:

   - Does the total number of channels allow a smooth transition from parallel to ESCON channels?

   - Determine the migration path, especially for storage control units.

6. Has the relevant hardware, software, and documentation been ordered?

7. Ensure that enough time is available to plan the total installation. Customization, documentation, education and physical planning must all be catered for.

   - Become familiar with Project Management and useful PM tools.

   - Provide education for programmers and operations personnel on IOCP, MVSCP, HCD, HCPRIO, VTAM, ESCON Director, and ESCON Manager as appropriate.

   - Check the necessary installation times for all hardware upgrades.

8. Start the installation project:

   - Upgrade any processor complexes or control units for operation in an ESCON environment.

   - Install all the necessary fiber cables, path fields, ESCDs, converters, and software prerequisites.

   - Update existing systems problems and change management procedures.

9. Start work on the project.

8.2 Logical Planning

Producing the target configuration is the main topic of this section which identifies what new hardware elements need to be installed, or what existing ones need to be upgraded for ESCON attachment. How many machines are affected? What are their logical connections and their backup connections? What configuration-dependent performance issues have to be addressed?

Although software definitions need not be coded at this stage in the planning, the appropriate actions needed for future software changes should be discussed.

8.2.1 ESCON Channels

For ESCON channels:

- Determine how many ESCON channels are required:

  - Consider the effect of EMIF on the target configuration. Try to consolidate channels. Be sure of the impact on performance.

  - Modify the use of parallel channels in the system if the number of parallel channels is reduced, as the installation of ESCON channels reduces the maximum number of parallel channels on the system.

- Consider that:

  - All ESCON channel paths from one system image to a logical control unit must have the same CHPID type.

– All ESCON channel paths defined as TYPE=CNC, CTC, CVC, or CBY do not operate in S/370 or 370-XA mode.

- For devices with two or more interfaces, configure at least two paths per system image to each device (also a valid consideration ESCD control unit ports).

- Configure ESCON channel paths symmetrically on each side of an MP.

- Plan to support byte-multiplexer channels if required. ESCON channel paths do not support attachment of devices that require operation in byte-multiplexer mode, except for 3745, 3725 and 3720 devices on 511, 711 or 9672 processor complexes supporting CBY channel types. These devices must be connected through a 9034 ESCON Converter.

- Ensure that if any I/O devices are shared between multiple images, they can still connect to all of them (do any of the images need ESCON channels?). Do not exceed the maximum number of logical paths that an ESCON control unit supports.

8.2.2 Processors

Processors should be upgraded to make them ESCON-capable.

- This requires hardware upgrades to the channels, and the installation of the correct level of microcode.

- When installing ESCON channels in 3090-J and 3090-T models, additional expansion frames must be ordered: feature code # 7330 for Side A and feature code # 7331 for Side B. Installation of the expansion frame may require a relocation of the processor complex.

8.2.3 IBM 9032 and 9033 ESCON Directors

- Configure ESCDs in all multi-system environments where device and channel sharing is required.

- Configure ESCDs for necessary connectivity, availability, and performance. Use at least two ESCDs and multiple physical paths for devices through both ESCDs (eliminating the ESCD as a single point of failure). Use four-pathing for best availability and performance for DASD.

- A path going through two chained directors must have one dedicated connection.

- Create switched partitions on the ESCON director if you have more than one system image.

- Define at least two paths from each system image to the ESCON Director control unit port if you do not use EMIF.

- Configure more ports than are actually needed.

- Check whether the enhanced availability feature is necessary.

- Ensure that the ESCON Manager is ordered for operating the ESCDs.

8.2.4 IBM 9034 and 9035 ESCON Converters

1. Check host processor complex:

   - 9035 Converters can be attached only to a parallel channel on an
     ES/4381 Model 90E, 91E, or 92E; ES/3090 E, S, and J models;
     ES/3090-9000T models; and ES/9000 models (only those ES/9000 models
     that are ESA-capable).

2. Check for the ESCON Converter rules:

   - One ESCON channel supports one IBM 9034 ESCON Converter.

   - The 9034 ESCON Converter supports IBM devices only when operating in
     block-multiplexer mode, except:

     - Attachment of 3745, 3725 and 3720 devices operating in byte
       multiplexor mode are now supported by the 9034 Model 1 attached to
       a TYPE=CBY ESCON channel on the IBM 9021 711-based
       processors, 9121 511-based processors, and 9672 processors
       (E-models, P-models, and R-models).

   - If the 9034 is connected through an ESCON Director, a dedicated
     connection must be established between the channel and the ESCON
     Converter.

   - The maximum number of control units that can be physically attached to
     one 9034 Converter is eight, although electrical limitations may further
     restrict this number.

   - One parallel channel supports up to eight IBM 9035 ESCON Converters.

   - Only one ESCON capable 3990 Channel Adapter can be physically
     attached to the 9035 Converter.

   - The maximum distance possibility must be checked on device type
     bases. The maximum distance between the 9035 and control units is 3
     km, whether an ESCD is used, or not.

   - ESCON XDF links can only be used with one or two ESCDs, since neither
     3990 nor 9035 supports ESCON XDF.

   - 9034 and 9035 ESCON Converters do not provide remote power control.

8.2.5 ESCON CTC

For ESCON CTCs, proceed as follows:

1. Determine the types of CTC you need:

   - Native mode CTC
   - Basic mode CTC
   - ESCON channel path to an IBM 3088

   Your hardware, your operating systems, and your applications must support
   the corresponding mode. For basic mode CTCs, you need at least IZPIOCP
   and the MVS Version 4 Release 3 HCD program, and new microcode levels
   in the processors.

2. Configure channels for performance.

   Measure the current CTC channel usage with RMF. Sharing can be
   accomplished per channel type (CTC, CNC, or CVC) on a system image
   basis, without EMIF, or on a processor basis, with EMIF (not CVC). Check

that the number of required CTC devices per channel is sufficient (the maximum number depends on the processor type).

3. Configure channels for availability.

   Some applications support an alternate CTC. This alternate CTC should have different channel paths specified.

4. Configure the ESCON CTC channel paths.

   Channels supporting CTC communications must be paired, one operating in CTC mode (TYPE=CTC) and the other operating in native mode (TYPE=CNC). Native mode and basic mode CTCs can share the channel paths.

   If an ESCON channel operating in CTC mode is to communicate with more than one channel, an EMIF or an ESCD is required. If you have an ESCD, the SWITCH keyword must be coded on the CHPID statement.

5. Configure the 3088 CTC channel paths.

   TYPE=CVC channels allow CTC communication from an all-ESCON processor to non-ESCON processors through a 9034 attached 3088. A TYPE=CVC channel is required on each ESCON-capable processor that has to attach to the 3088, and each requires a 3088 port.

6. Specify the CNTLUNIT and IODEVICE statements.

   There must be a separate CNTLUNIT statement for each connection between system images. Communicating systems must specify the same UNITADD numbers in the corresponding CNTLUNIT and IODEVICE statements. Shared channels (EMIF) require the LPAR number in the CUADD statement. A control unit can be shared between BCTC and SCTC devices.

8.2.6 IBM 3990 Storage Subsystem

For the 3990 storage subsystem proceed as follows:

1. Identify the IBM 3990s which should be connected to ESCON channels.

2. Connect them to the channels (through ESCDs if convenient):

   - Each 3990 Model 2 or 3 can have up to 16 logical paths (8 per cluster). Each 3990 Model 6 can have up to 128 logical paths (64 per cluster). Each adapter connected through a 9035 blocks one logical path.

   - For higher availability, connect more than one ESCD.

   - All logical paths in one 3990 path group must be of the same type.

   - At least two paths to each system image are recommended, for best DASD performance use four.

   - Define more than the minimum number of physical connections required through the ESCDs, for system image backup, or workload balancing.

   - Do not connect an IBM 3990 with an IBM 3390 working in 3380 compatibility mode through an ESCON interface.

   - The ESCON adapter features for the 3990 are ordered in pairs, one for each cluster. Consider the possible combinations. Validate the 3990 configuration with the IBM configuration tool CFSYSTEM.

3. Various migration paths to a full ESCON environment are available. An installation can convert from a 3880/3380 subsystem to a 3990/RAMAC subsystem with ESCON capability, or field upgrade an installed 3990.

Applying any preventive EC maintenance to control units may reduce MES installation times.

4. Give consideration to the maximum distance of at which a 3990 can be connected if remote connection is a requirement. The maximum distance for a 3990 Model 2 or 3 is 15 KM, and for a Model 6 it is 20 KM (43 with RPQ).

5. Software considerations:

   • Review the *3990 PISA Guide*.

   • Map out your logical paths.

   • Modify IOCP (check for the UNITADD parameter in CNTLUNIT and IODEVICE macros).

8.2.7 IBM 9340 Storage Subsystem

For the 9340 storage subsystem, proceed as follows:

1. Determine which IBM 9340s should be connected to ESCON channels.

2. Connect them to the channels (through ESCDs if convenient):

   • Each 9343 can have up to 64 logical paths.

   • For higher availability, connect more than one ESCD.

   • At least two paths to each system image are recommended. For best performance use four for DASD.

   • Configure ESCON control unit adapters. Consider the possible combinations. Validate the 9343 configuration with CFSYSTEM.

3. Give consideration to the maximum remote attachment of 43 KM.

8.2.8 IBM 3490/3490E/3590 and 3494/3495

For these devices proceed as follows:

1. Check the type of configuration that will be used.

   The 3490 configuration can be all parallel, mixed parallel and ESCON, or all ESCON:

   • All channel paths from one system image to a logical control unit must have the same CHPID type, TYPE=BL, TYPE=BY, TYPE=CNC, or TYPE=CVC (except 9221, 9021 520-based and 711-based models and 9121, where an intermix of parallel (BL or BY) and ESCON (CVC) is supported through a 9034 Converter Model 1).

2. Install enough channel adapters for performance and back-up.

   Maximum logical paths per ESCON adapter is 16 for the 3490/3490E, and 64 for the 3590. When you have to have more logical paths, the installation of an ESCON Director is necessary.

3. Set the software at the correct level.

   A toleration APAR is required for DFP 2.4.0 systems that are parallel attached to a 3490 with ESCON adapter capability.

8.2.9 IBM 3172 Interconnect Controller

For the 3172 Interconnect Controller, proceed as follows:

1. Does the 3172 configuration comply with the configuration rules?

    • 3172 gateway and CTC configurations are mutually exclusive.

    • An exception with the remote CTC feature is to allow a Token-Ring to be configured solely for connecting a PS/2 running the ICP Operator Facility. The Token-Ring occupies one of the channel or T-Carrier slots.

    • ESCON channel support is available only on the 3172 Model 1 remote CTC controller and the 3172 Model 3.

    • Both channel adapters must be of the same type. The channel adapters at opposite ends of a CTC link must match, either both parallel or both ESCON.

    • The 3172 Model 1 cannot be upgraded to the 3172 Model 2. The 3172 Model 1 or Model 2 cannot be upgraded to the 3172 Model 3.

2. A T1 or CEPT adapter is used for high speed links. When used with T1 links, it works at speeds up to 1.544 Mbit/sec, with CEPT links, it works at speeds up to 2.048 Mbit/sec.

3. Additional high-speed link adapters provide remote CTC support in some countries. CEPT adapters provide an interface for connecting to an OEM converter product operating at speeds up to 2.048 Mbit/sec; therefore, up to four channel high-speed links are each operating at up to 2.048 Mbit/sec.

4. The remote CTC implementation is supported by VTAM 3.4 as a 3088 CTC connection.

5. The 3172 connects one local 3172 with up to four remote 3172 controllers.

    • The 3172 Model 1 or Model 3 can use either ESCON or parallel channel adapters, but only adapters of one type can be installed. The 3172 Model 3 can have one or two ESCON Single Slot Adapters.

    • Each control unit image on an ESCON channel adapter is defined in the IOCP using a separate CNTLUNIT macro as though it were a physical control unit.

    • The CUADD parameter, in combination with the control unit link address, defines a unique logical path for each channel accessing the control unit image.

8.2.10 IBM 3174 Models 12L/22L

For the 3174 Models 12L and 22L, proceed as follows:

1. The older models (1L, 11L, and 21L) use the S/370 parallel channel cables and can communicate with an ESCON channel only through the 9034 ESCON Converter.

2. Does the 3174 configuration comply with the configuration rules?

    • 3174 Model 12L or 22L can be connected point-to-point to only one ESCON channel.

    • 3174 Models 12L and 22L are available with one ESCON adapter only.

    • Parallel interfaces are not available on Models 12L and 22L.

- Eight control unit images are logically using this physical port through an ESCON Director.

- Up to 64 3270 Type A devices (with Port Expansion Feature) and up to 24 ASCII devices can be supported on the 3174 Models 12L/22L.

- The new models (12L and 22L) are full-function IBM 3174s that include all features of the models 11L and 21L with the exception of remote power.

3. The 3174 Models 12L and 22L can be used as MVS/ESA MCS consoles control units in non-SNA mode on MVS/ESA V4.2 or later. MVS systems prior to V4.2 require consoles on parallel attached 3174 control units.

4. One logical path is required for each control unit image:

   - Each host connection is defined to the 3174 as a Virtual Control Unit (VCU).

   - There are 16 hexadecimal addresses (0 through F), of which eight can be configured in the IBM 3174 to support eight host processors. These addresses correspond to the CUADD values in the host IOCDS with inter-relationships to VTAM, MVS, IOCP, and the ESCD.

   - Each of the eight possible logical control unit images has its own CNTLUNIT statement (CUADD) within the IOCP.

   - A unique CUADD address has to be specified for each logical path (VCU).

   - For Customization Question 108: - Unique Machine Identifier - enter the real machine serial number.

   - CNTLUNIT statement CUADD and Question 240 - Controller Logical Address - are the new parameters in order to find the correct image?

5. Configuration Support B Release 3 Licensed Internal Code or higher is required with 3174 Models 12L and 22L.

6. The 3174 Control unit uses status code 507 to show that not all CU Image interfaces are initialized.

7. The ESCON 3174 communicates with one host at a time.

8. When adding new devices to your 3174, VTAM updates will be necessary.

9. If you are using an ESCD in your 3174 configuration, the ESCD will also require updates.

10. Because of these changes, we recommend incorporating any other modifications needed for other hardware updates with the ESCON 3174 installation to minimize the potential disruptions to your environment.

8.2.11 IBM 3745 Communication Controller

For the 3745 Communication Controller, proceed as follows:

1. Determine which current communication controllers should be consolidated. Run CF3745 to get the new 3745 configuration with an acceptable performance.

2. Configure for availability. Define two paths to each SSCP. Use at least two 3745 ESCAs. Define Parallel Transmission Groups in NCP and VTAM.

3. Check for limitations on the number of ESCON and Token-Ring adapters.

4. Check for limitations on the number of logical devices per ESCA.

5. Configure channels on each processor or LPAR. Consider shared channels (EMIF).

6. Configure ESCDs if there is more than one processor. Use a different ESCD with each 3745 ESCA.

7. Plan for upgrading the existing 3745 to attach a 3746-900.

8. Install the necessary software in all hosts, 3745, and workstations.

9. Run the ESCON Generation Assistant program to produce IOCP, NCP and MOSS-E definitions.

10. EP/PEP requires a parallel channel attachment of the 3745 to the host, unless the host is a 511, 711 or 9672 processor, in which case EP/PEP is supported on a 3745 attached to an ESCON channel through a 9034 Model 1 ESCON Converter.

8.2.12 Software

When planning for ESCON software levels, proceed as follows:

1. Identify all the relevant software by version, release, and maintenance level, especially MVS/ESA and its programs (such as EREP, RMF, ICKDSF, DF products). Alternatively VSE/ESA, VM/ESA, AIX/ESA, or TPF requirements, and their supporting programs, should be identified.

2. Apply any necessary PTFs.

3. Check whether IXPIOCP or IZPIOCP (for EMIF) is to be used.

4. Software vendors should be contacted to determine whether additional support may be required to run their applications over ESCON channels and whether there is support for nonsynchronous I/O operation. Check also for IMS WADS and MSDB requirements.

8.3 Physical Planning

Design the physical layout after completing the logical planning. Have your local CE organization support you.

- Design appropriate fiber backbone with trunks. Consider right-of-way and customer security requirements when thinking about on- and off-floor design.

- Calculate jumpers. IBM provides no-charge cables in various standard lengths from 4 to 122 meters.

- Calculate and specify appropriate quantities of distribution panels, connectors, and splice trays.

- Plan backup design for the fiber optic cabling system and for ESCDs. Make sure there are physical connections with ESCDs placed in different locations. Always have at least two physical connections between a CPU and a device.

- Verify the fiber cable distances. For distances over 3 km, use XDF links.

- Check the distance limitation when using ESCCs.

- Consider future demands. Install more cables than needed today. Consider conveyance capacity if needed.

- Reserve floor space for ESCDs and distribution panels considering future demands.

- Plan the location of converters. If there are many, place them in racks. Reserve floor space for the racks.

- Calculate the optical link loss budgets, which depend on the number of physical transitions in a physical connection. One physical transition is, for example, between a jumper and a patchfield. Do not exceed the maximum link loss for any physical link. Refer to *Planning for the Enterprise System Connection Links*.

- Develop appropriate documentation:

  - Schematic drawing of infrastructure

  - Marking of connection points in architectural plans

  - Detailed cabling plan

Chapter 9. Special Notices

This publication is intended to help the reader in his/her understanding of ESCON and ESCON products. The information in this publication is not intended as the specification of any programming interfaces that are provided by the ESCON architecture. See the Publications section of the IBM Programming Announcement for ESCON for more information about what publications are considered to be product documentation.

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The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

10.1 International Technical Support Organization Publications

For information on ordering these ITSO publications see "How To Get ITSO Redbooks" on page 257.

S/370 and ESA/390 Architecture

IBM System/360 and System/370 I/O Interface Channel to Control Unit Original Equipment Manufacturer's Information, GA22-6974

Enterprise Systems Architecture/390 Principles of Operation, SA22-7201

I/O Interface Review for IBM Systems Engineers, GG24-3578

ESCON Architecture

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ESCON I/O Interface, SA22-7202

ESCON I/O Interface Physical Layer, SA23-0394

ESCON Channel-To-Channel Adapter, SA22-7203

Common I/O-Device Commands, SA22-7204

Planning for Enterprise Systems Connection Links, GA23-0367

Introducing Enterprise Systems Connection, GA23-0383

CPU   *ES/3090 Processor Complex J-Model and 9000T-Model Functional Characteristics and Configuration Guide*, GA22-7135

ES/9000 Processor Complex:

Models 120, 130, 150, 170, and 200: Processor Characteristics, SA33-1609

Models 120, 130, 150, 170, and 200 SE Guide, GG24-3663

Models 180, 190, 210, 260, 320, 440, 480, 490, 570, and 610: Introducing the Processor Functional Characteristics, GA23-0380

Models 330, 340, 500, 580, 620, and 720: Functional Characteristics and Configuration Guide, GA22-7138

Models 520, 640, 660, 740, 820, 860, and 900: Functional Characteristics and Configuration Guide, GA22-7139

ES/9000 and ES/3090 Input/Output Configuration Program User's Guide and ESCON Channel-to-Channel Reference, GC38-0097

ES/9000 Processor Resource/Systems Manager Planning Guide, GA22-7123

ESCON Directors

Using Enterprise Systems Connection Directors, GA23-0354

Planning for the 9032 Enterprise Systems Connection Director, GA23-0364

Planning for the 9033 Enterprise Systems Connection Director, GA23-0372

Planning for the 9032 Model 3 and 9033 Model 4 Enterprise Systems Connection Director, SA26-6100

Using the 9032 Model 3 and 9033 Model 4 Enterprise Systems Connection Director, SA26-6101

DASD *Introduction to Nonsynchronous Direct Access Storage Subsystems*, GC26-4519

IBM 3990 Storage Control Planning, Installation, and Storage Administration Guide, GA32-0100

IBM 9340 Direct Access Storage Subsystems Introduction, GC26-4694

Using IBM 9340 Direct Access Storage Subsystems in a VM Environment, GC26-4644

Using IBM 9340 Direct Access Storage Subsystems in a VSE Environment, GC26-4645

Using IBM 9340 Direct Access Storage Subsystems in an MVS Environment, GC26-4646

IBM 3990 ESCON Function, Installation and Migration, GG66-3213

3990 Model 3 ESCON Performance Measurements, GG66-3233

Tape *IBM 3490 Magnetic Tape Subsystem Models A01, A02, A10, A20, B02, B04, B20, and B40: Planning and Migration Guide*, GC35-0116

IBM 3490 Magnetic Tape Subsystem Models D31, D32, D41, and D42: Planning and Migration Guide, GC35-0117

IBM 3745 *IBM 3745 Models 210, 310, 410, and 610*, GA33-0092

IBM 3745 Communication Controller Connection and Integration Guide, SA33-0129 (available at general availability)

IBM 3745 Communication Controller Migration Guide, GA33-0183

IBM 3172 *IBM 3172 Models 1 and 2 Planning Guide*, GA27-3867

IBM 3174 *IBM 3174 Establishment Controller Planning Guide Configuration B*, GA27-3862

IBM 3174 Establishment Controller Configuration Support C Release 2.0 User′s Guide, GA27-3966

Converters *Planning for the 9034 Enterprise Systems Connection Converter*, GA23-0362

Planning for the 9035 Enterprise Systems Connection Converter, GA23-0393

9035 Planning, Configuration, Installation and Performance, GG66-3232

RISC System/6000 *ESCON Adapter User′s Guide and Service Information*, SC23-2474

Migration *Planning for Enterprise Systems Connection Links*, GA23-0367

Enterprise Systems Connection: Planning for Migration, GG66-3181

Operation *MVS/ESA Hardware Configuration Definition: Using the Dialog*, GC33-6457

ES/9000 Models 520, 640, 660, 740, 820, 860, and 900 Operator Guide Volume A01, GC38-0086

ESCON Error Recovery Concepts and Procedures in an MVS Environment, GG24-3721

ESCON Operator Problem Determination in the MVS/ESA Environment, GG66-3239

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List of Abbreviations

ACK	Acknowledgment	**ESA**	Enterprise Systems Architecture
ANSI	American National Standard Institute	**EMIF**	ESCON Multiple Image Facility
ALA	Acquire Link Address	**EOF**	End-of-file
APA	all points addressable	**EP**	Emulation Program
BCCA	Buffer Chaining Channel Adapter	**ESCA**	ESCON Adapter
CADS	Data Streaming Channel Adapter	**ESCC**	ESCON Converter
		ESCD	ESCON Director
CBC	Controller Bus Coupler	**ESCON**	Enterprise Systems Connection
CBSA	Controller Bus and Service Adapter	**FCS**	Fiber Channel Standard
CBSP	Controller Bus and Service Processor	**FRU**	Field-replaceable Unit
CBTRA	Controller Bus and Token-Ring Adapter	**GHz**	Gigahertz
		HCD	Hardware Configuration Definition
CCITT	Comite Consultatif International Telegraphique et Telephonique	**HIPPI**	High Performance Parallel Interface
CCW	Channel Command Word	**IBM**	International Business Machines Corporation
CDR	Configuration Data Record	**IFI**	Information Field Identifier
CE	Channel End	**IML**	Initial Microprogram Load
CEC	Central Electronic Complex	**IOCDS**	Input/Output Configuration Data Set
CHPID	Channel Path-ID		
CKD	Count-key-data	**IOCP**	Input/Output Configuration Program
CLAW	Common Link Access to Workstations	**ITSO**	International Technical Support Organization
CP	Central Processor		
CPU	Central Processing Unit	**IXPIOCP**	Version of IOCP
CRC	Cyclic Redundancy Check	**IZPIOCP**	Version of IOCP
CSS	Channel Subsystem	**I/O**	Input/Output
CTC	Channel-to-channel	**LAN**	Local Area Network
CU	Control Unit	**Laser**	Light Amplification by Stimulated Emission of Radiation
CUU	Central Control Unit		
DASD	Direct Access Storage Device	**LED**	Light Emitting Diode
DE	Device End	**LIC**	Licensed Internal Code
DHF	Device header flag	**LPAR**	Logically Partitioned
DIB	Device Information Block	**LR**	Locate Record
DCI	Direct-coupled Interlock	**Mbit**	Megabits
DLS	Device Level Selection	**MB**	Megabytes
DLS	Device Level Selection Extended	**MCCU**	Multisystem Channel Communication Unit
ECKD	Extended Count-key-data	**MHz**	Megahertz

MIH	Missing Interrupt Handler		**SCP**	System Control Program
MOSS-E	Maintenance and Operator Subsystem - Extended		**SCS**	Single Channel Service
			SDH	Synchronous Digital Hierarchy
MP	Multiprocessor			
MVSCP	MVS Configuration Program		**SOF**	Start-of-frame
NIC	Numerically Intersive Computing		**SONET**	Synchronous Optical Network
			SPE	Small Programming Enhancement
OEMI	Original Equipment Manufacturer's Information			
			SSCH	Start Subchannel
PCI	Program-controlled Interrupt		**SSCP**	System Service Control Point
PEP	Partitioned Emulation Program		**TCP/IP**	Transmission Control Protocol / Internet Protocol
POR	Power-on Reset		**TIC**	Token-Ring Interface Coupler
PR/SM	Processor Resource / Systems Manager		**TRA**	Token-Ring Adapter
			um	Micrometer or Micron
PTF	Program Temporary Fix		**VPD**	Vital Product Data
RCD	Read Configuration Data		**XDF**	Extended Distance Feature
SAD	System Activity Display		**PROFS**	Professional Office System
SBCCS	Single Byte Command Chain Standard			

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