

IBM GLOBAL SERVICES



Session G10, Nov. 1, 2004

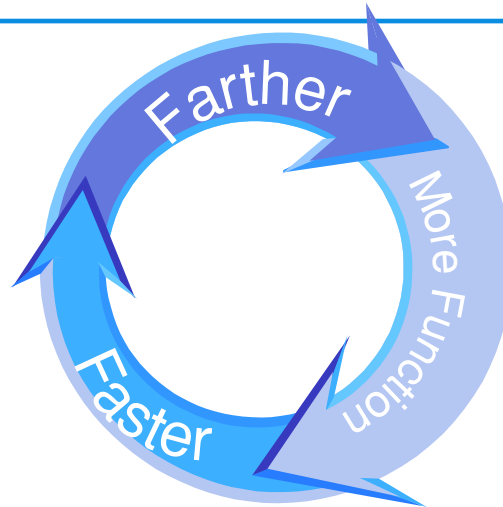
# FICON Express: The answer for your zSeries SAN requirements

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**zSeries Expo**

Nov. 1 - 5, 2004

**Miami, FL**



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## Acronyms used in this presentation

Acronym	Full name	Use
CCW	Channel Control Word	An architecture supporting I/O communications
CHPID	Channel path identifier	Identifier for channel path type
CRH	Channel Request Handler	Internal host bus for I/O communication
CTC	Channel-to-Channel	Protocol for host-to-host communication
dB	decibel	Metric used to measure signal strength in fiber
DWDM	Dense Wavelength Division Multiplexer	Technology that allows multiple protocols to flow over a single fiber
ESCON	Enterprise Systems Connection	Storage, Printers
EREP	Environmental Record Editing and Printing Program	Processes SYS1.LOGREC dataset
FCP	Fibre Channel Protocol	SCSI devices (Linux only)
FICON	Fibre Connection	Storage, Printers
ISL	Inter-Switch Link	The path data travels between Directors over fiber optic cabling
km	kilometer	
LCSS	Logical Channel Subsystem	Architecture that allows more than one physical channel subsystem
LUN	Logical Unit Number	Used with FCP
GB	Gigabytes per second	
Gbps	Gigabits per second	Link data rate of a protocol
LED	Light Emitting Diode	Light source for transceiver
LX	Long wavelength	Long wavelength light source
MB or MBps	MegaBytes per second	Link data rate of an architecture/protocol
MBA	Memory Bus Adapter	Building block - Part of Central Electronic Complex and MCM
MCM	Multichip Module	The "brick" that contains the Processor Units (PUs)
MCP	Mode Conditioning Patch	Cable used with sm fiber to accommodate reuse of mm
MM	Multimode	Fiber optic cabling
PCI	Peripheral Component Interconnect	Local bus standard
PCI-X	Peripheral Component Interconnect Extended	Enhanced PCI bus - for increased performance over PCI
RAS	Reliability, Availability, Serviceability	
SAN	Storage Area Network	
SCSI	Small Computer System Interface	Storage - fixed block devices
SM	Single mode	Fiber optic cabling
STI	Self-Timed Interconnect	Internal host bus for I/O communication
SX	Short wavelength	Source wavelength light source



# Agenda

- 1. Modes of operation (CHPIDs)**
- 2. The "bus"**
- 3. Function overview**
- 4. Speeds and feeds**
- 5. Architecture**
- 6. FICON hardware**
- 7. Cascading and ISLs**
- 8. FCP LUN access control**
- 9. FPPE (FICON purge path extended)**
- 10. Directors/switches**
- 11. Link budgets, distances**
- 12. Beyond 2 gigabits per second**

## Appendices

FCP information (attaching to SCSI devices in Linux environment)  
Tested product lists with supported transceivers, fiber optic cabling  
Publications  
www

# FICON - it is more than an architecture

- ★ **Fibre** - refers to an architecture
- ★ **Fiber** - refers to a glass cable
  
- ★ **FICON = Fibre Connection**
  - An architecture and an IBM registered trademark
  - IBM's implementation of the Fibre Channel standard
- ★ **FICON** - Data pipe for attachment to disks, tapes, printers
  
- ★ **FICON** is a feature that supports three CHPID types and a link data rate of 1 or 2 Gbps (auto-negotiated)
  
- ★ **FC (native FICON)** supported by five operating system environments
  - OS/390, z/OS, z/OS.e, as well as z/VM, VSE/ESA, TPF, Linux on zSeries



# The personalities of FICON

	Bridge	Native FICON and CTC	SCSI
<b>Mode / CHPID</b>	<b>FCV</b>	<b>FC</b>	<b>FCP</b>
<b>Link data rate</b>	1 Gbps	1 or 2 Gbps	1 or 2 Gbps
<b>Talks to</b>	ESCON control units via ESCD	Disk (ECKD), Tape, Printers	SCSI devices
<b>Cascading</b>	N/A	Yes	Yes
<b>Intermix FC/FCP</b>	N/A	Yes	Yes
<b>CTC</b>	N/A	Yes	N/A
<b>Concurrent Patch</b>	Yes	Yes	Yes


**May 04**

# Spanned channels on z990 and z890

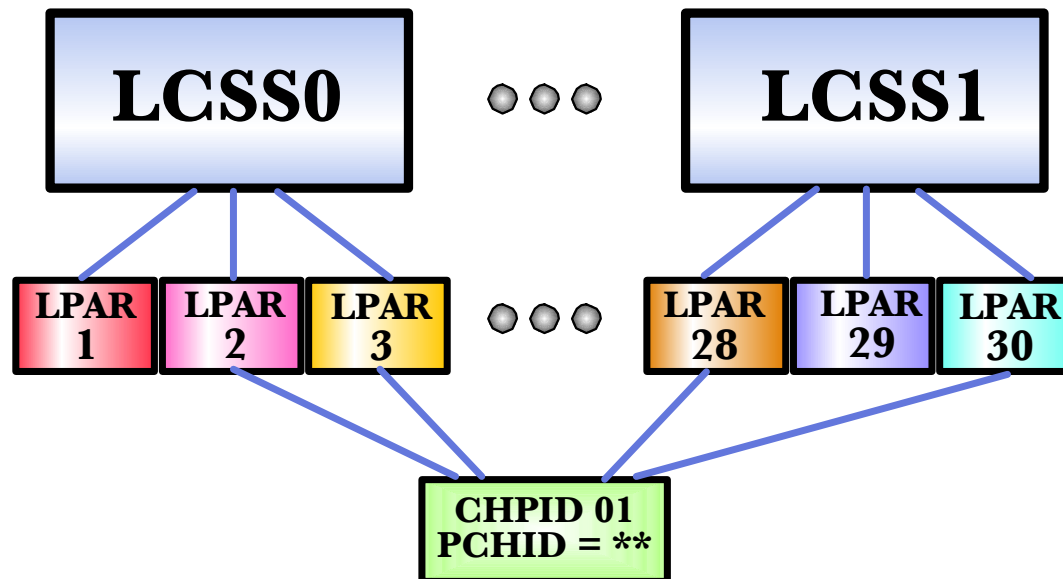
## Share channels among LPARs across LCSSs

### ★ Internal spanned channels

- HiperSockets and Internal Coupling links

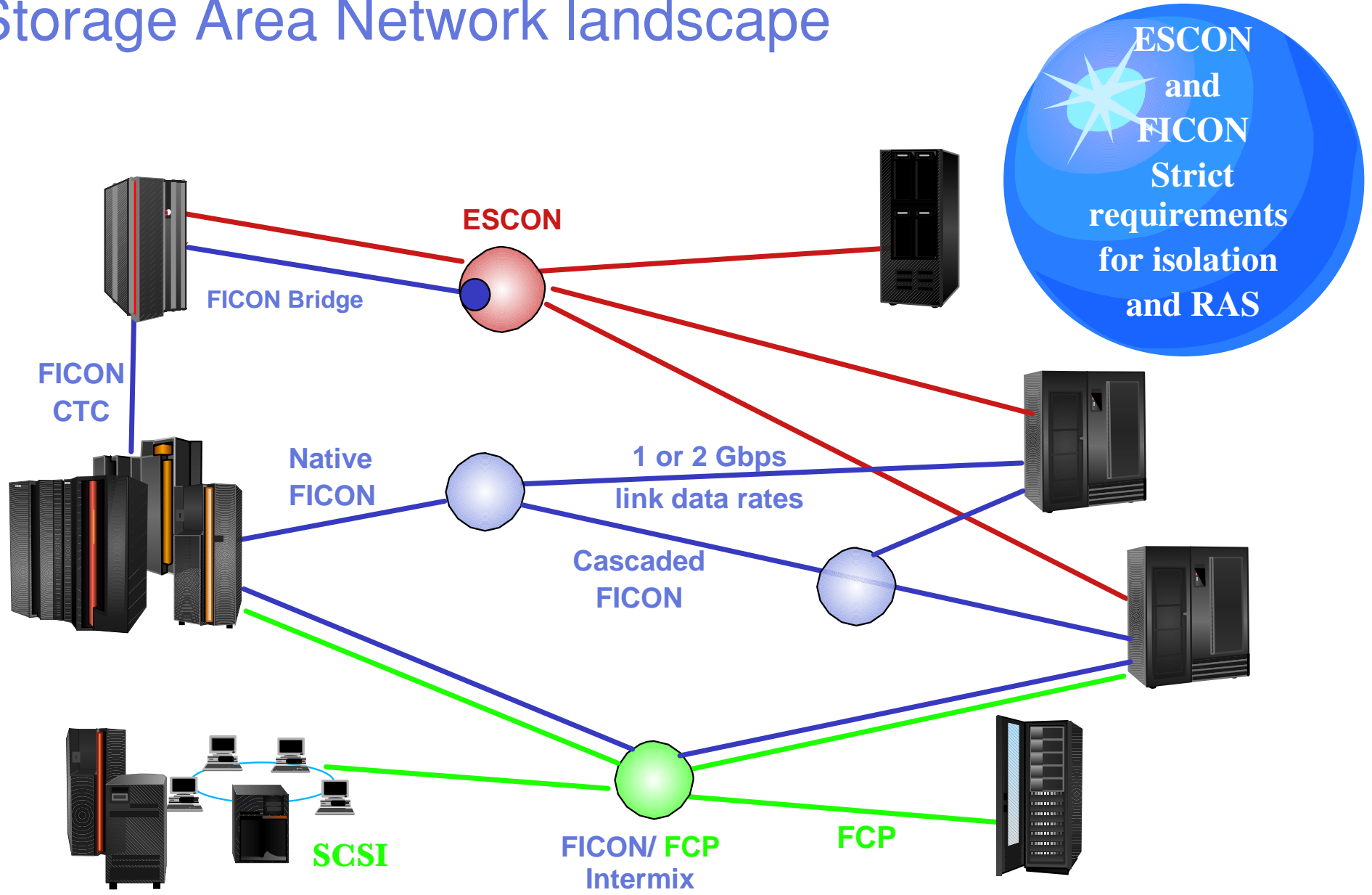
### ★ External spanned channels

- FICON Express
- ICBs, ISC-3
- OSA-Express



\*\* No PCHID for HiperSockets and Internal Coupling links. PCHID required for FICON, ICs, ICBs, ISC-3, OSA  
Spanning reduces the number of channels that can be defined for all LCSSs on server  
Worst case - 256 if all channels are spanned between all LCSSs

# Storage Area Network landscape







# Compare **FICON** to **ESCON**

(F) FICON (E) FICON Express  
 FCV = CHPID type for FICON Bridge  
 FC = CHPID type for Native FICON

## ■ Increased data transfer rate

Parallel	ESCON	FICON	FICON Express 1 Gbps	FICON Express 2 Gbps
4.5 MB	17 MB	74 MB	120 MB	170 MB

## ■ Improved performance

- ▶ Native FICON attachment offers much higher data transfer rates than ESCON attachments
- ▶ For critical data-intensive applications this can translate into significant improvements in **overall elapsed time**
- e.g., QSAM workloads (typical of batch) and large non-parallel DB2 queries (typical of data warehousing and data extracts) *can run over two times faster with FICON than with ESCON.*

## ■ Increased number of I/O operations at a time

	ESCON	FICON Bridge (FCV)	FICON (FC)
I/O Operations	1	8	Up to 32

## ■ Increased number of start I/Os per second per channel (average - 4k block size) % shows channel utilization

ESCON	FCV G5/G6	FC G5/G6	FCV (F) zSeries	FCV (E), FC (F) 1 Gbps, zSeries	FC (E) 2 Gbps, zSeries
300	1600	1800	2500	3000	3600
25 %	50 %	50 %	50 %	50 %	50 %

## ■ Reduced backup windows

- ▶ IBM's FICON-attached Enterprise Storage Server (ESS) and 3590-A60 *can slash elapsed times for backup operations by up to half* (depending on data compressibility).



# Compare **FICON** to **ESCON**

## ■ Increased unrepeated distances

Parallel	<b>ESCON</b>	FICON, G5/G6	FICON, z900	FICON Express, 2 Gbps
400 feet	<b>3 km</b>	see next slide	see next slide	see next slide

## ■ Reduced data rate droop

	<b>ESCON</b>	FICON
Droop beginning at	<b>9 km</b>	100 km

- ▶ ESCON (depending upon application)
- ▶ FICON (depending upon the buffer credits available in the director)

## ■ Combined CTC and channel function

- ▶ A single FICON "FC" CHPID can be *simultaneously used* for native and CTC traffic
- ▶ **CTC exploiters: XCF and VTAM MPC, IMS V7 Multiple Systems Coupling (MCS)**

## ■ Increased addressability

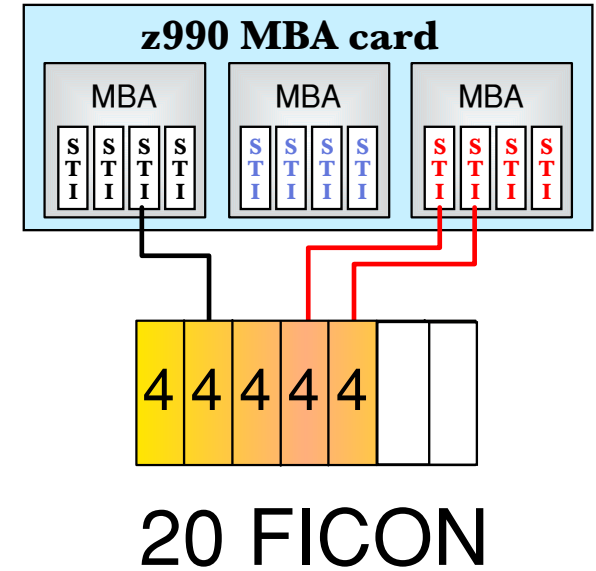
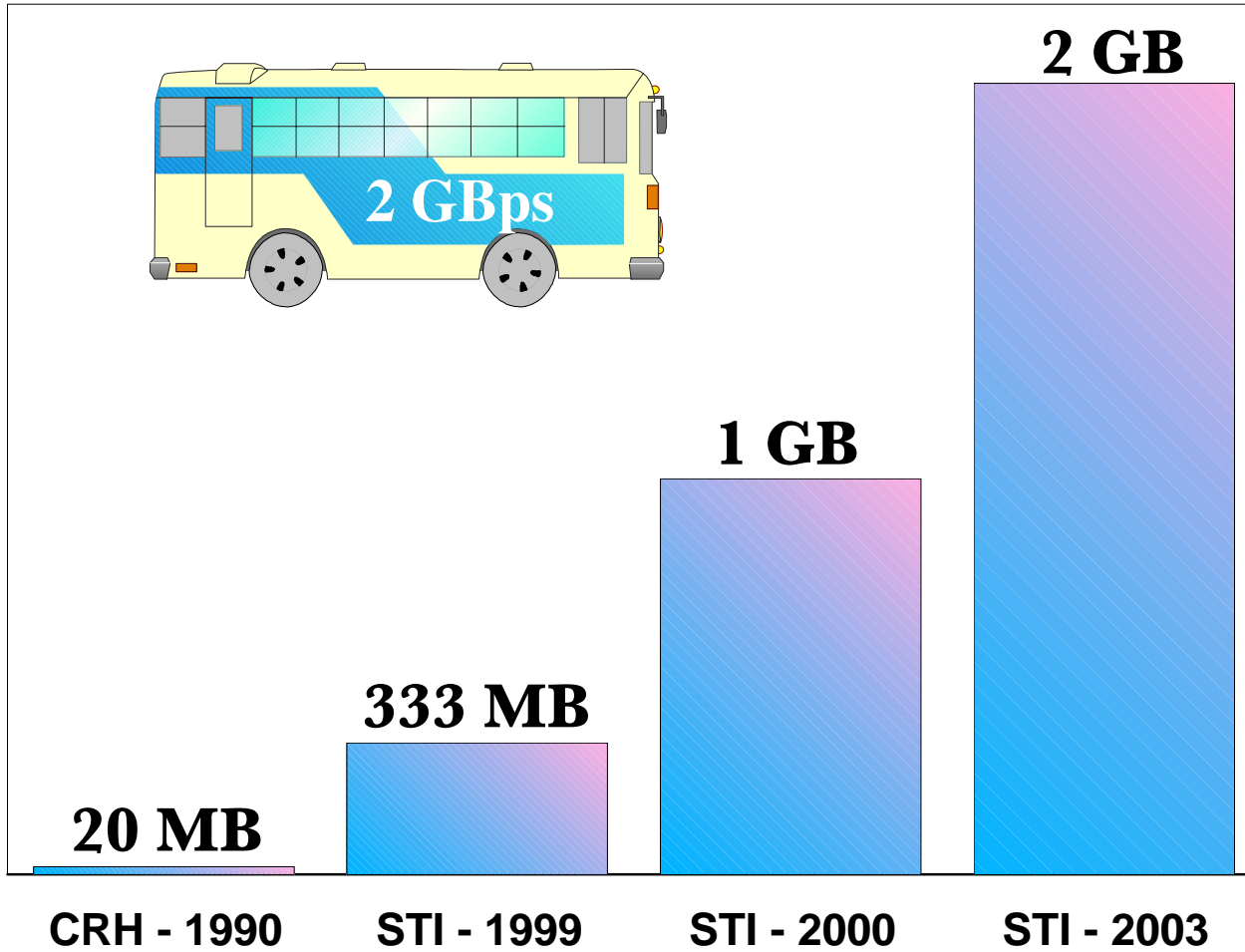
	Unit Addresses per channel	Unit Addresses per Control Unit	Logical Control Units	CTC Unit Addresses
<b>ESCON, CNC</b>	<b>1024</b>	<b>1024</b>	<b>120</b>	<b>512</b>
FCV, FC	16,384	4096	256 *	16,384

- ▶ Defined in HDC or IOCP
- ▶ Refer to zSeries 900 Input/Output Configuration Program User's Guide for IYP IOCP (SB10-7029)
- \* G5/G6 limit was 255. zSeries limit is 256

## ■ Channel aggregation reduces infrastructure costs

- ▶ *A single FICON channel can replace multiple ESCON channels* - fewer resources to configure and manage

# I/O subsystem bus - feeding FICON

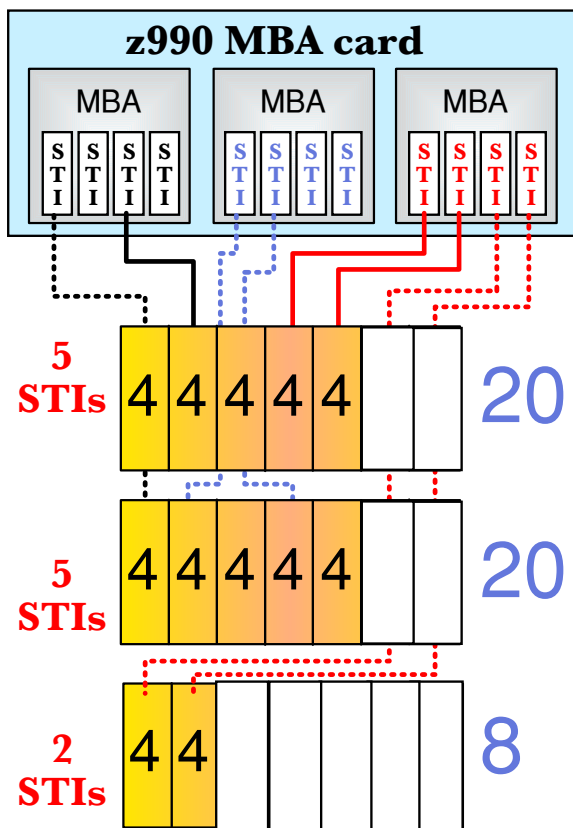


- ★ Channel Request Handler bus
- ★ Self-Timed Interconnect bus

# Plugging Rules: Total cannot exceed 20 features per I/O cage for: FICON Express, OSA-Express, PCIXCC, PCICA

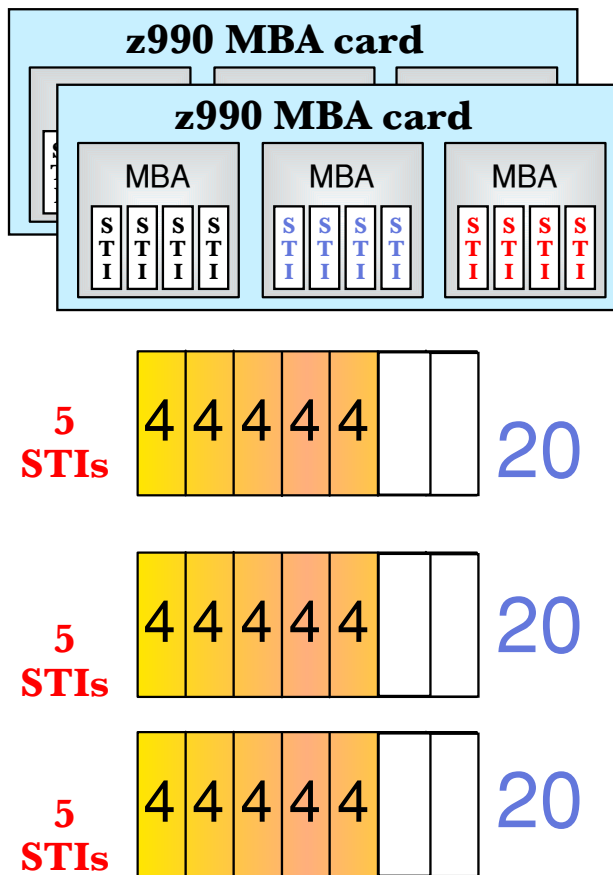
## FICON Examples

### z990 Model A08



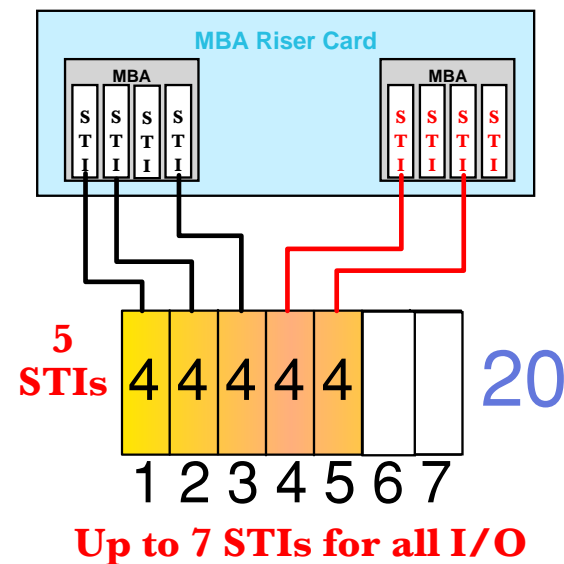
Up to 12 STIs for all I/O

### z990 Models B16, C24, D32



Up to 21 STIs for all I/O

### z890 Model A04



# Refresh of FICON Technology

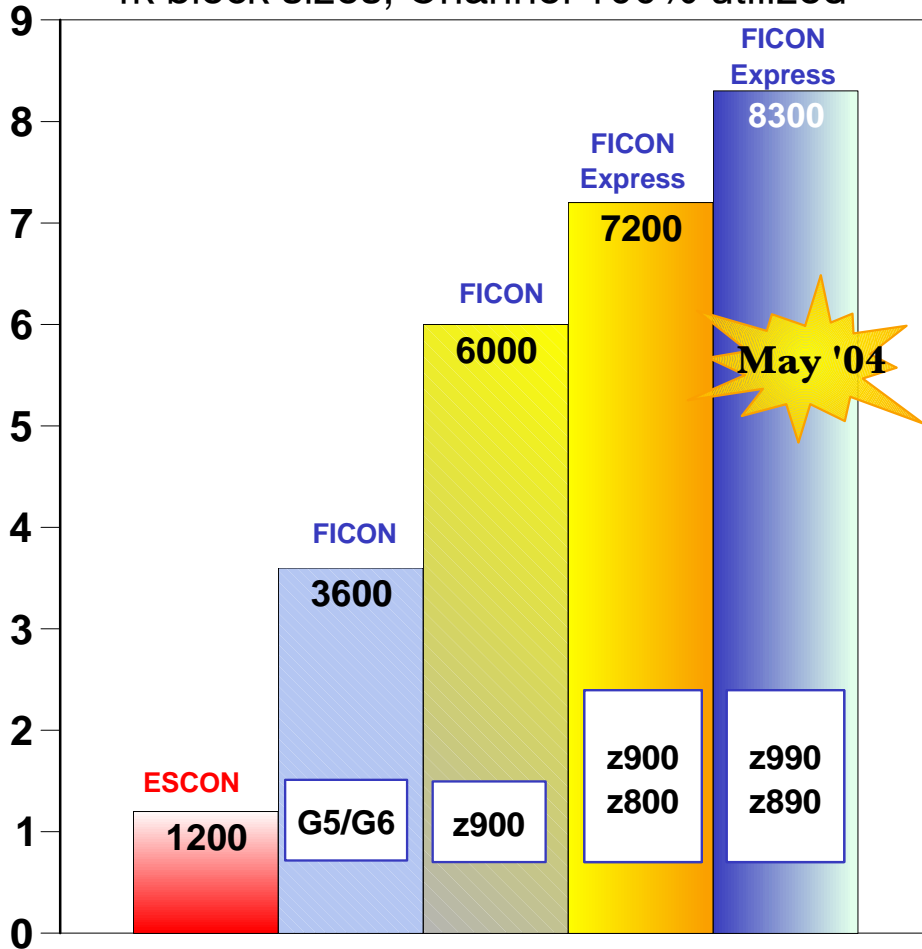
	1st Generation	2nd Generation	3rd Generation
	<b>08/99 (LX) 03/01 (SX)</b>	<b>12/00 (LX) 03/01 (SX)</b>	<b>10/01 (z900) z800, z990, z890</b>
	<b>G5/G6 FICON</b>	<b>z900 FICON</b>	<b>zSeries FICON Express</b>
<b>Feature Code</b>	<b>2314 (LX) 2316 (SX)</b>	<b>2315 (LX) 2318 (SX)</b>	<b>2319 (LX) 2320 (SX)</b>
<b>Number of Ports</b>	<b>One port per feature</b>	<b>Two ports per feature</b>	<b>Two ports per feature</b>
<b>Microprocessor</b>	<b>166 MHz</b>	<b>333 MHz</b>	<b>333 MHz</b>
<b>PCI Bus</b>	<b>32-bit 33 MHz</b>	<b>32-bit 33 MHz</b>	<b>64-bit 66 MHz</b>
<b>Maximum Features/Ports</b>	<b>24 / 24 (G5) 36 / 36 (G6)</b>	<b>48 / 96</b>	<b>16 / 32 (z800) 20 / 40 (z890) 48 / 96 (z900) 60 / 120 (z990)</b>
<b>Link data rate</b>	<b>1 Gbps</b>	<b>1 Gbps</b>	<b>1 or 2 Gbps Auto-negotiate</b>



# FICON Express/FICON - Breaking the Barrier

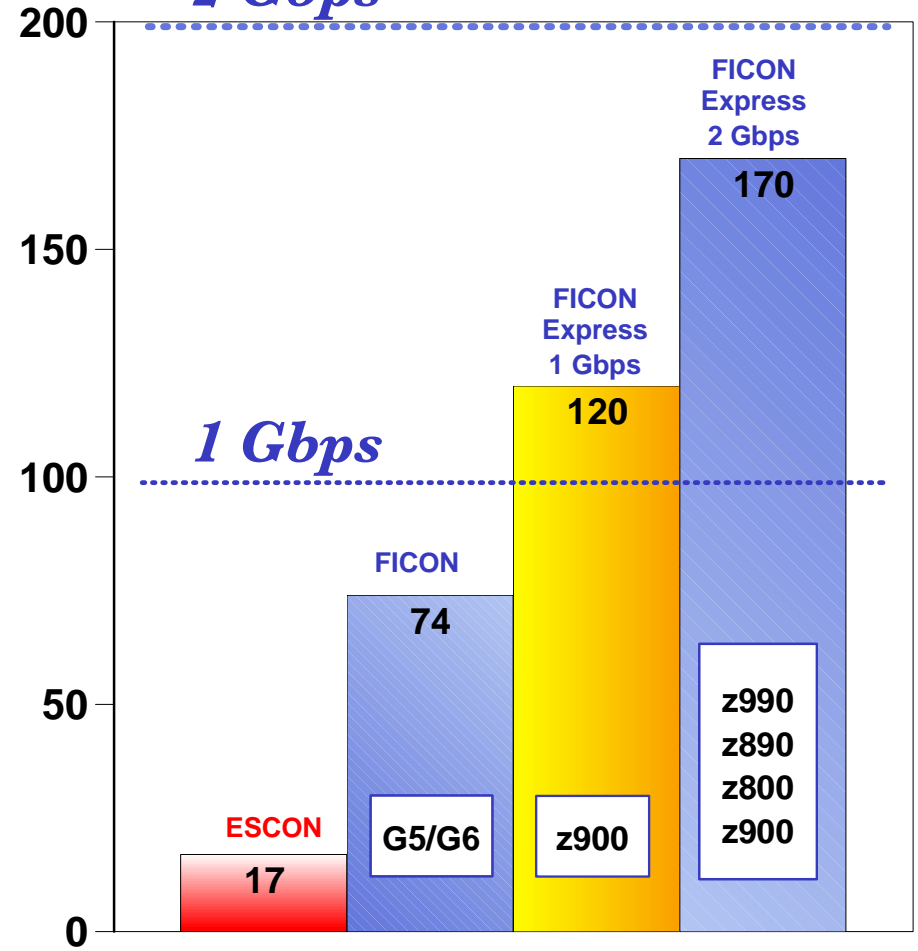
## I/Os per second (k)

4k block sizes, Channel 100% utilized



## MB/sec throughput

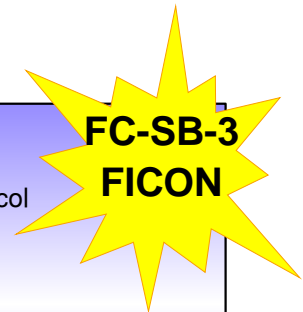
*2 Gbps*



FICON Express = SX (2320), LX (2319)  
 FICON numbers represent native mode (FC mode)

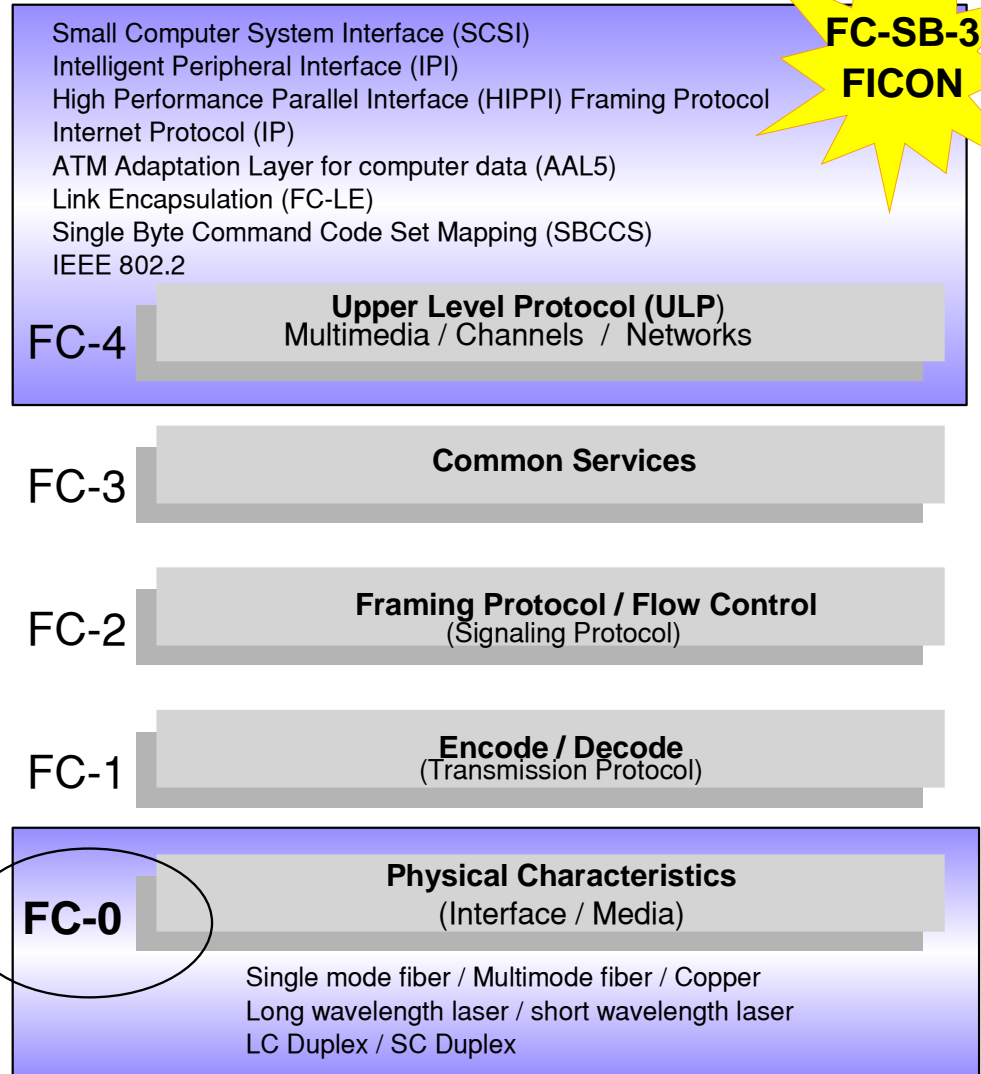


# Fibre Channel Architecture



## ■ Fibre Channel Architecture

- ▶ An integrated set of rules (FC-0 through FC-4) for serial data transfer between computers, devices and peripherals developed by INCITS
- ▶ FICON
  - zSeries implementation of Fibre Channel Architecture
    - Fibre Channel - Single-Byte-2 (FC-SB-2) ANSI/ INCITS standard
    - Fibre channel Single byte command code Sets-2 Mapping Protocol (FC-SB-2) ISO/IEC standard
- ▶ FCP
  - Fibre Channel Protocol for SCSI
  - Mapping of the SCSI command protocol onto the Fibre Channel Architecture



Fiber Cabling for FICON & Fibre Channel Protocol (FCP)

INCITS = InterNational Committee for Information Technology Standardization

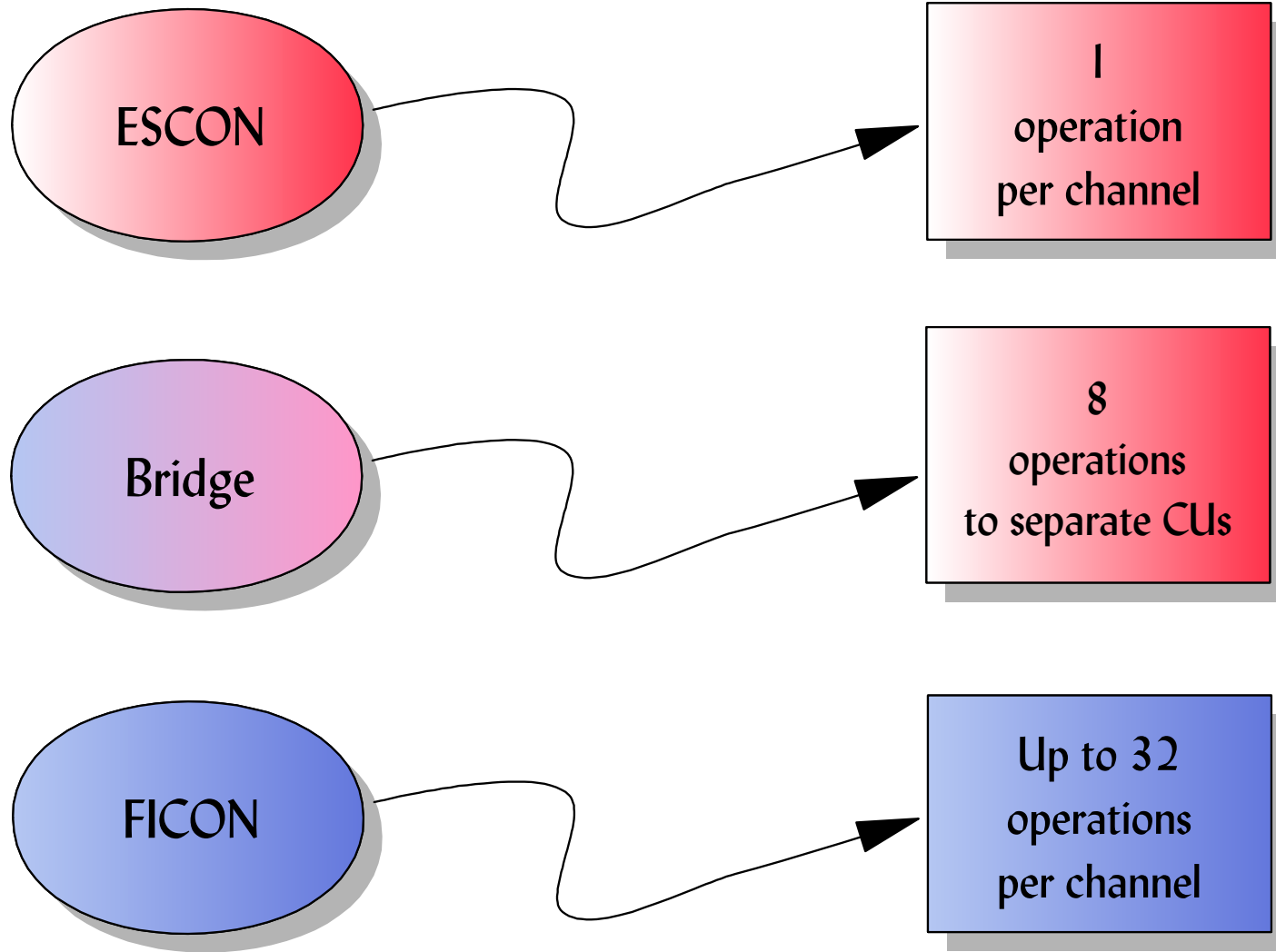
# Architecture Comparisons

ESCON Channel	FICON Channel	FCP Channel
Circuit Switching	Packet switching	Packet Switching
Read or write Half-duplex data transfers	Simultaneous read and write Full-duplex data transfers	Simultaneous read and write Full-duplex data transfers
Connection-oriented	Connectionless	Connectionless
Dedicated path pre-established	Packets individually routed	Packets individually routed
When data is sent, connection is locked	When data is sent connection is released	When data is sent connection is released
Synchronous data transfer	Asynchronous data transfer	Asynchronous data transfer
Uses CCW Architecture	Uses CCW Architecture	Uses zSeries QDIO * architecture

\* Uses zSeries QDIO architecture for communication with the operating system. Defines data devices that represent QDIO queue pairs, consisting of a request queue and a response queue.



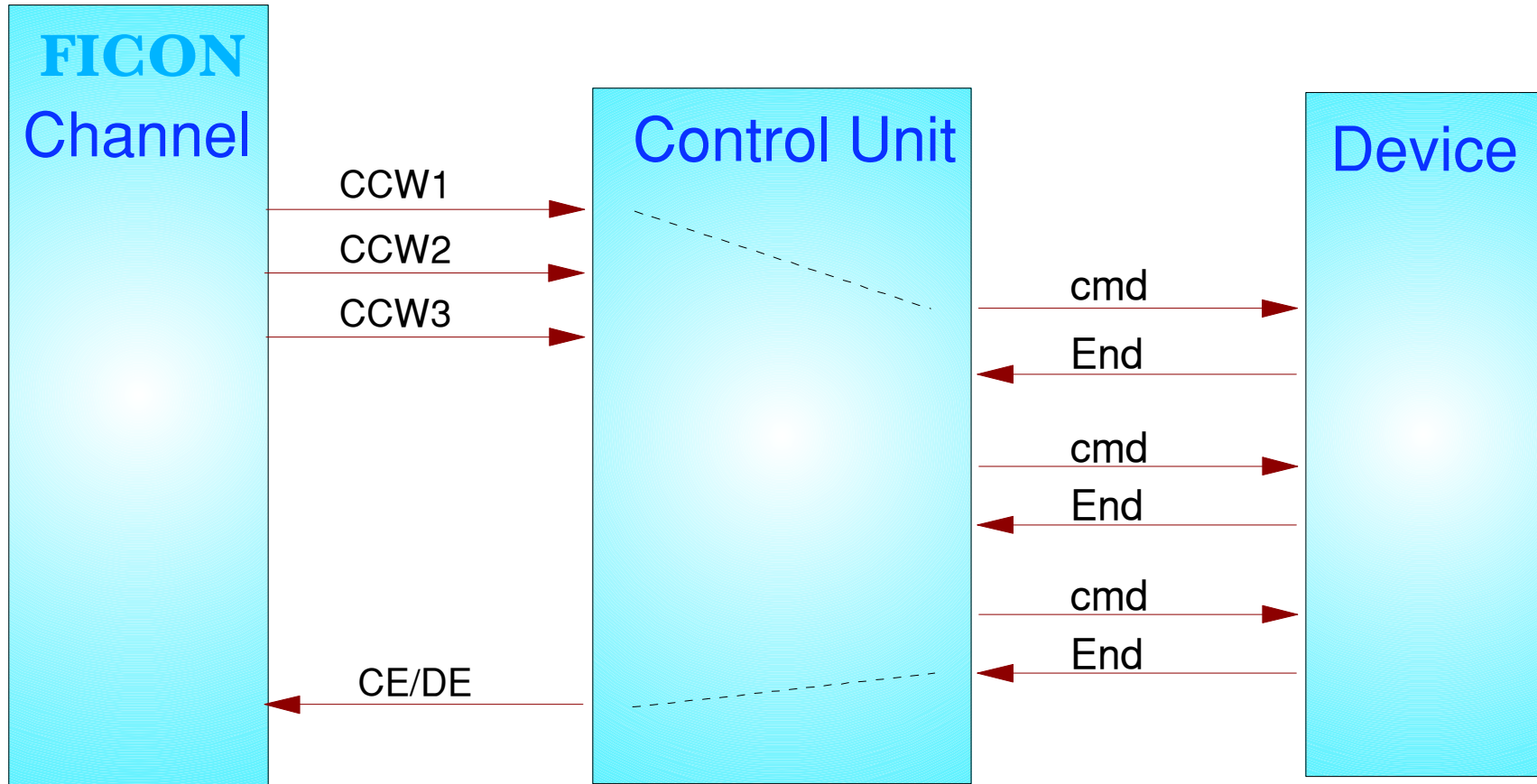
# Concurrent I/O Operations





# FICON Express / FICON Command/Data Transfer

CCW=Channel Control Word    CE=Channel End    DE=Device End



Channel can communicate with other devices on same or different control unit

# FICON Express on z990, z890

- **For Storage Area Networks**

- **FICON Express LX (long wavelength)**

- ▶ CHPID types: FC (including CTC), FCP, FCV
- ▶ Supports 9 micron single mode fiber
  - Accommodates reuse of existing 50, 62.5 micron multimode fiber at reduced distances using MCP cables
    - For 1 Gbps links only

- **FICON Express SX (short wavelength)**

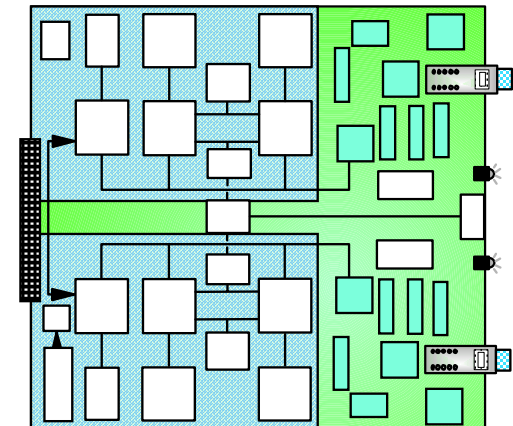
- ▶ CHPID types: FC, FCP
- ▶ Supports 50, 62.5 micron multimode fiber
- ▶ Not Compatible with FICON Bridge

- **Both ports/channels identically configured (LX or SX)**

- **1 or 2 Gbps link data rate**

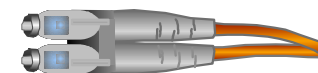
- Auto-negotiated

## FICON Express 3rd Generation

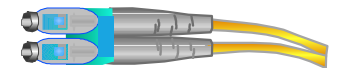


Feature code 2319 (LX)

Feature code 2320 (SX)



LC Duplex MM



LC Duplex SM

24 → 36 → 96 → 120 channels (model dependent)

# Cascaded Directors Cross-Site Connectivity

January 2003

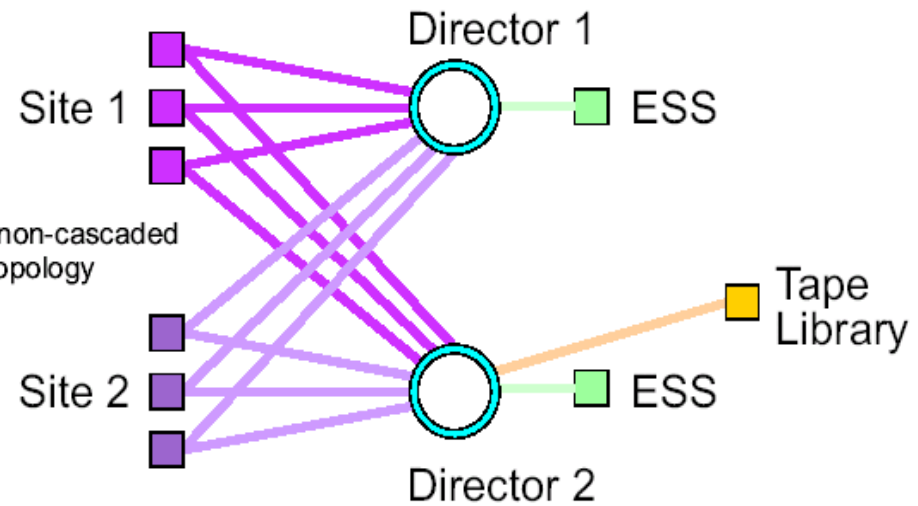
**Two site non-cascaded director topology.**

Each CEC connects to directors in both sites.

- Fewer cross-site connections
- Reduces implementation costs for disaster recovery applications and remote copy
- Require single vendor high integrity fabric
- Software support
  - OS/390 V2.10
    - z/OS V1.3 or V1.3 with enabling PTFs is required in an LPAR to dynamically define a cascaded director, for dynamic I/O changes, and to use the enhanced display functions.
  - z/VM V4.4
  - VSE/ESA V2.5
  - Linux Kernel V2.4
  - TPF V4.1 at PUT 16

Before

Two-site non-cascaded director topology



**Two Site cascaded director topology.**

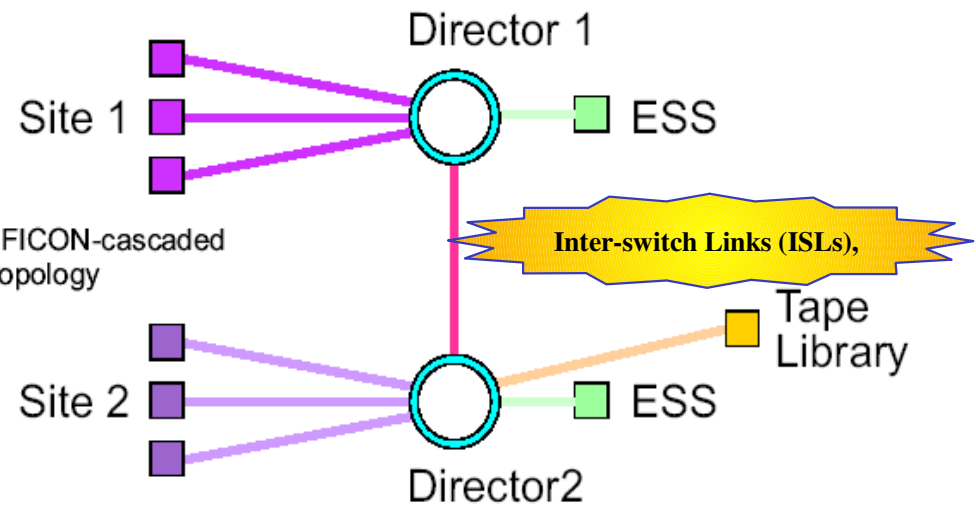
Each CEC connects to local directors only.

- For maximum unrepeated distance between directors refer to:

▸ <http://www.storage.ibm.com/products/index.html>

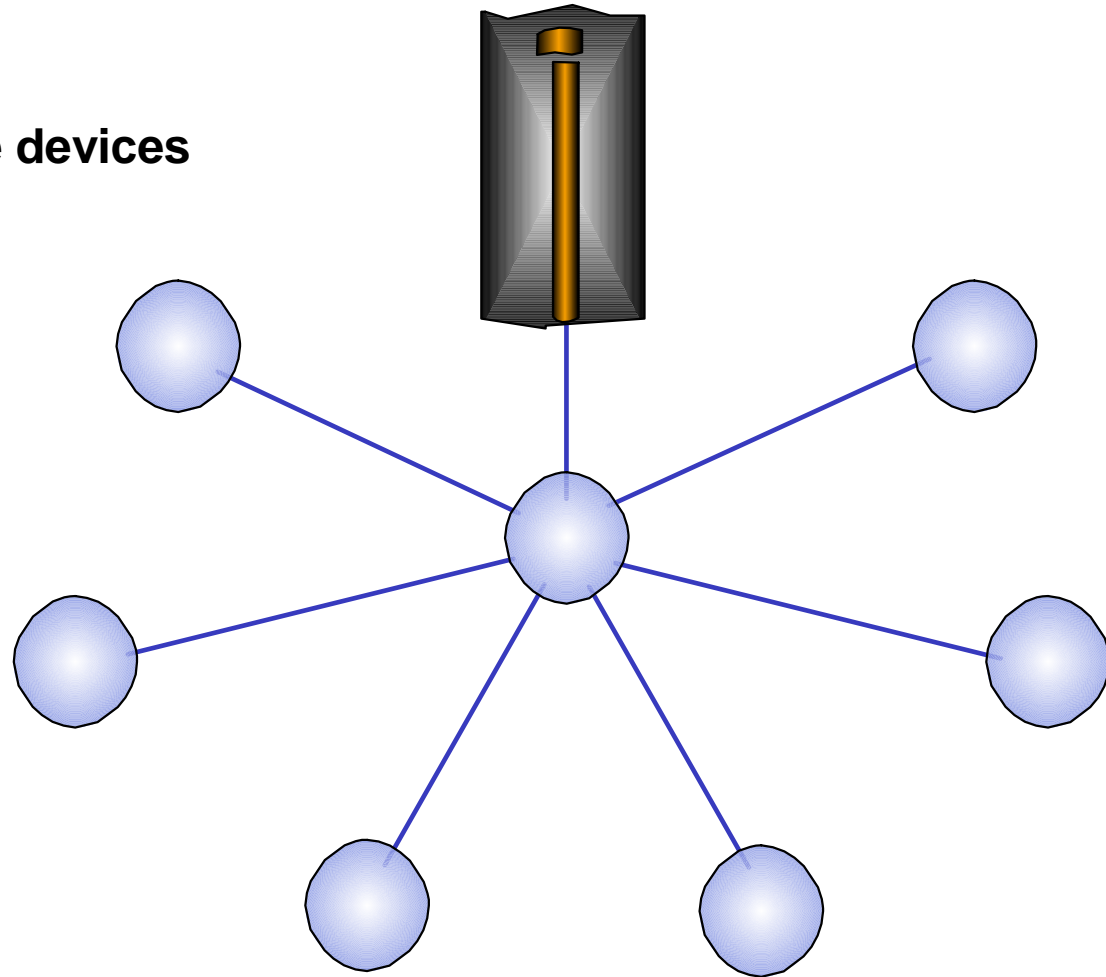
After

Two-site FICON-cascaded director topology

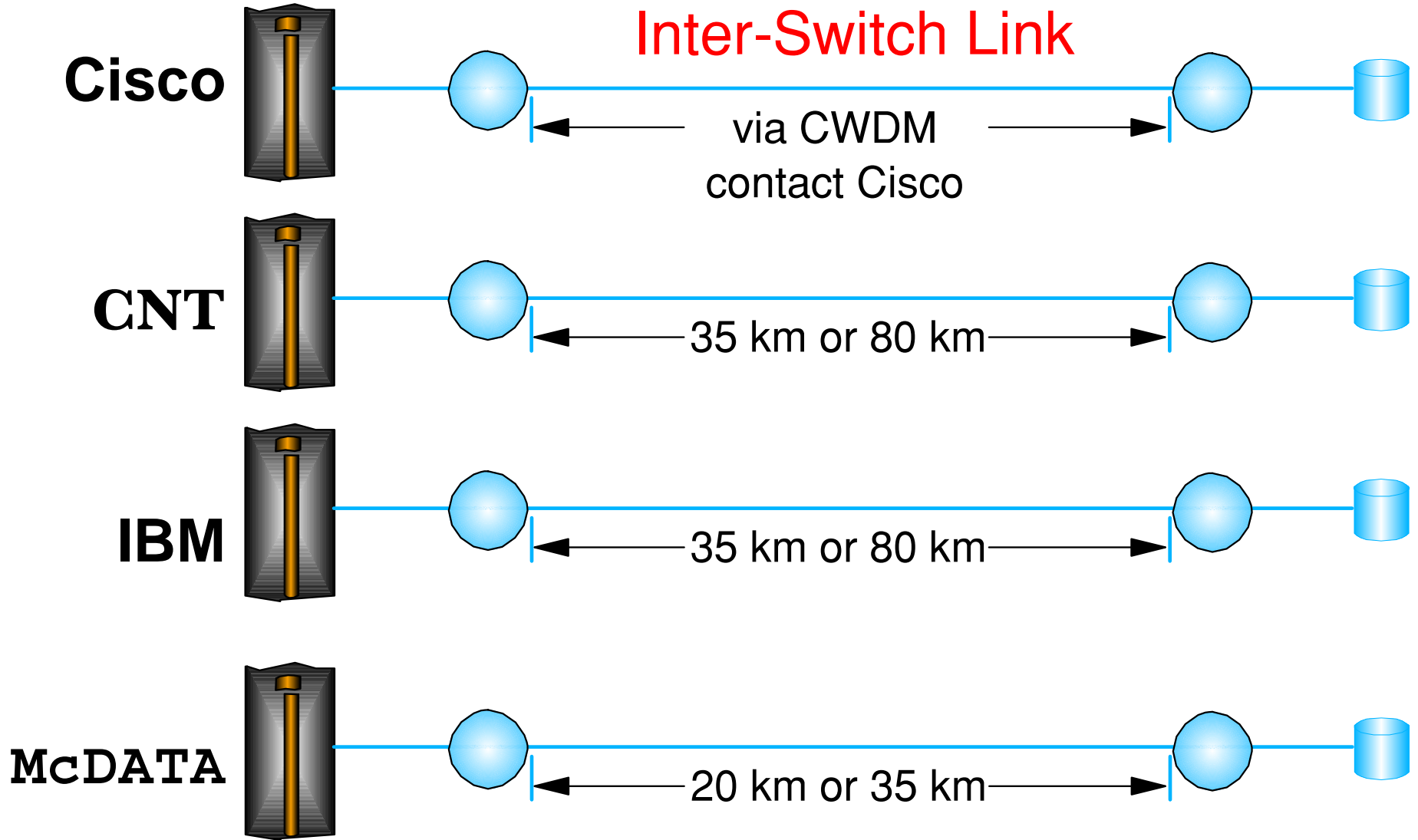


# Cascaded configuration

- **Single hop**
- **One core, multiple edge devices**
  - Vendor-dependent

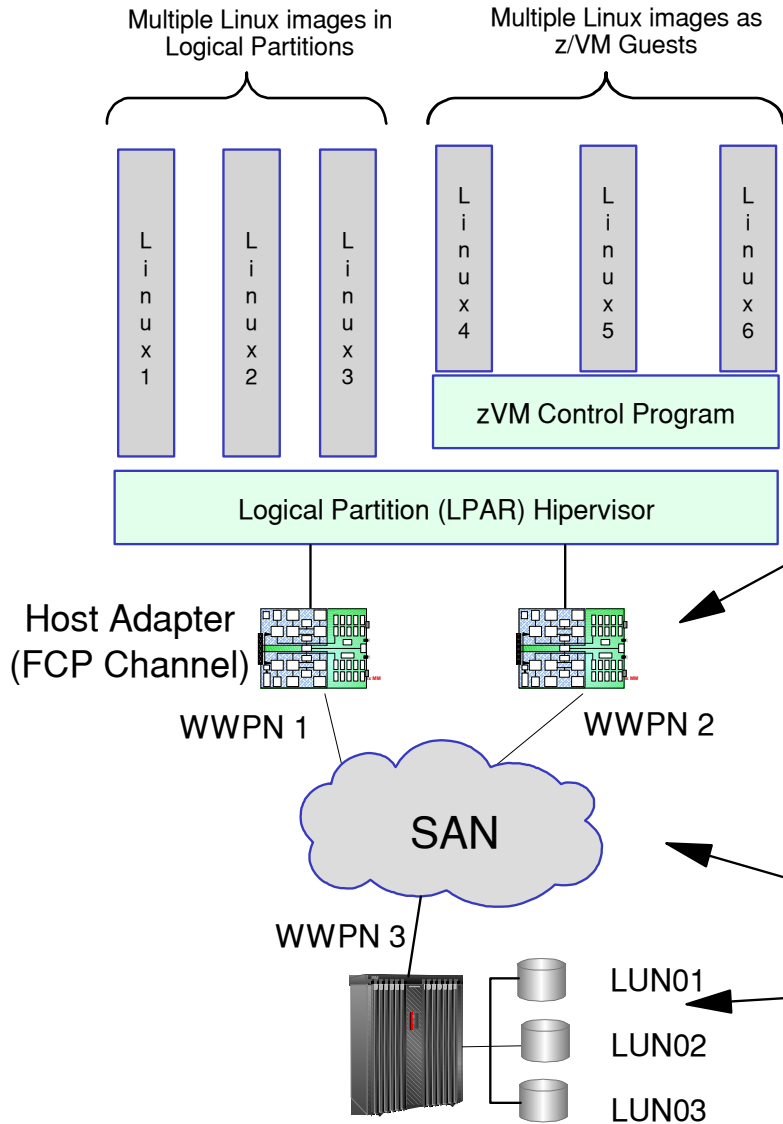


# Cascaded distances - - ISL distance (Sept. 16, 2004)



# FCP LUN access control

- Without FCP LUN access control
  - ◆ Any Linux guest can communicate with any LUN on a first-come, first-serve basis.
- With FCP LUN access control
  - ◆ Can specify separate permissions for z/VM and each Linux guest.
  - ◆ Allows LUNs on disk controllers to be shared in read-only mode as well as read/write access.
  - ◆ Provides improved security and access protection.



**With FCP LUN Access Control**  
 Channel "policies" accesses for OSs sharing an FCP channel

LP04 Linux4	- WWPN3 LUN01 read/write access
LP04 Linux5	- WWPN3 LUN02 read/write access



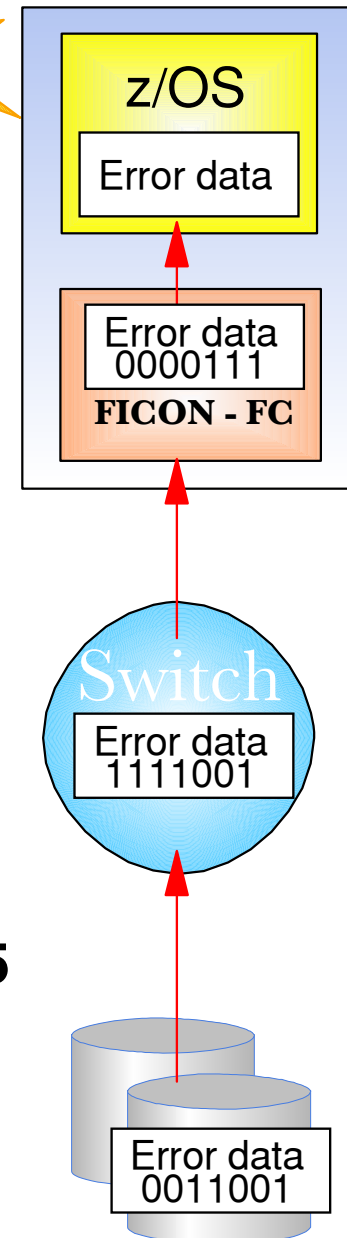
**LUN masking and zoning**

Access to controller ports and devices (LUNs) is controlled by zoning (in switches) and LUN masking (in controllers), based on identity of host adapter (WWPN).

# FICON purge path extended for native FICON (CHPID type FC)

Oct '04

- **Enhanced FICON problem determination**
- **Error-recovery function is extended**
  - ▶ Transfers error-related data and statistics
    - Between the channel and entry switch
    - Control unit and its entry switch
    - To the host operating system
      - ✓ Reported in EREP
- **Exclusive to z990 and z890**
- **Supported by z/OS and z/OS.e V1.4, and later, with PTFs for APAR 0A06846 and EREP APAR IR51695**





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# zSeries Expo

Nov. 1 - 5, 2004

**Miami, FL**

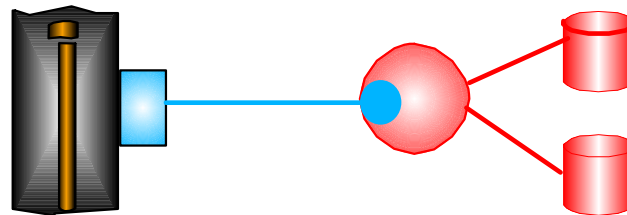
# The Bridge



## ESCON Director: 9032 Model 5

Don't forget!

- **Withdrawal from marketing announced April 7, 2004**
- **ESCON Director Model 5 and all features**
- **Effective December 31, 2004**
- **No orders for ESCON Director accepted after December 31, 2004**
- **No orders for features accepted after December 31, 2004**



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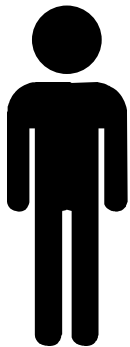
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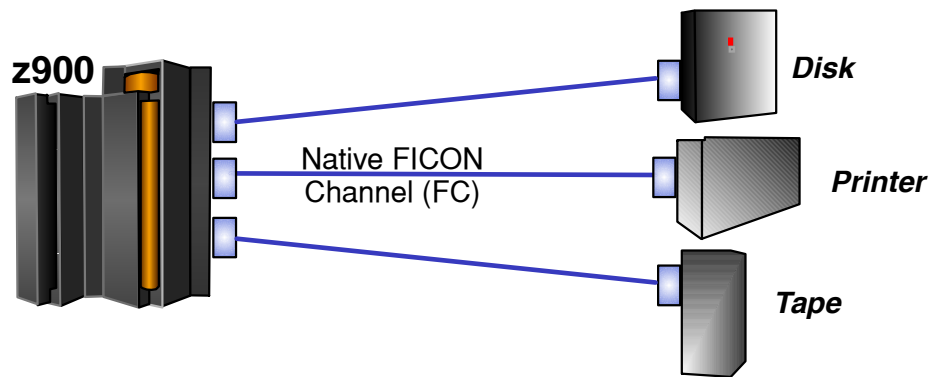
**Miami, FL**

**FICON / FCP / DWDM**

**Tested Products**



# FICON: Tested product List




## ■ Direct attachment

- ▶ IBM TotalStorage Enterprise Storage Server
  - IBM 2105-F10, F20, [750](#), 800
- ▶ IBM TotalStorage Enterprise Tape Controller
  - IBM 3590-A60, IBM [3592-J70](#)
- ▶ IBM TotalStorage Virtual Tape Server
  - IBM 3494-B10, B20
- ▶ IBM Infoprint Color 130 Plus
- ▶ IBM Infoprint 4100
  - IBM 4100-HD1, PD1, HS1, PS1, PD2, HD2
- ▶ IBM Infoprint 2000

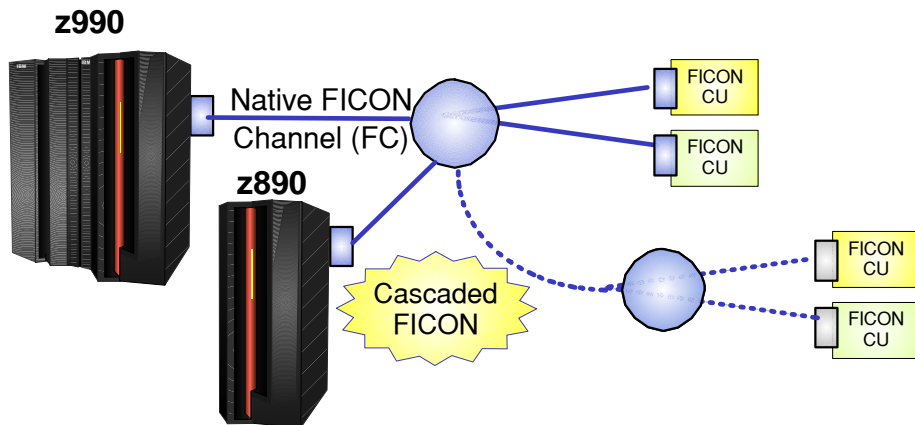
## ■ Switched connectivity

- ▶ [McDATA Sphereon 3232 Fabric Switch](#)
- ▶ McDATA ED-5000

## ■ Switched and cascaded directors

- ▶ [Cisco MDS 9000](#)
- ▶ CNT FC/9000 Directors
- ▶ [CNT UltraNet Multi-service Director](#) 
- ▶ IBM TotalStorage SAN Switch M12
- ▶ [IBM TotalStorage SAN32M-1, SAN140M](#)
- ▶ McDATA Intrepid 6000 Series Directors

## ■ Refer to Appendix for machine types/models



Blue = Added 1 H 2004, Red = Added 2 H 2004

## FICON/FCP products tested at 2 Gbps link data rate

### ■ Devices - FICON, FCP

- ▶ IBM TotalStorage Enterprise Storage Server
  - Models [750](#), 800
- ▶ IBM TotalStorage Enterprise Tape Controller
  - IBM 3590 A60 and [3592-J70](#)

### ■ Switches - FICON, FCP

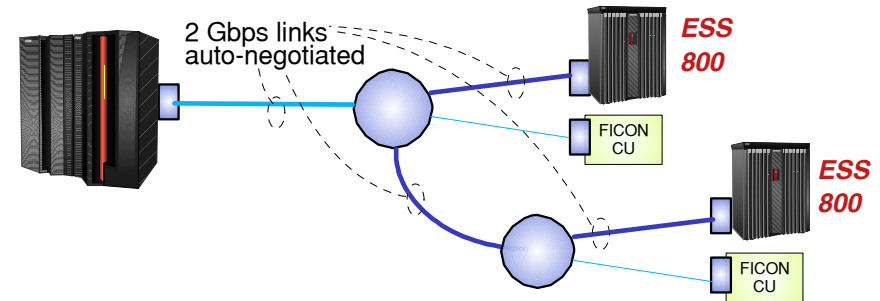
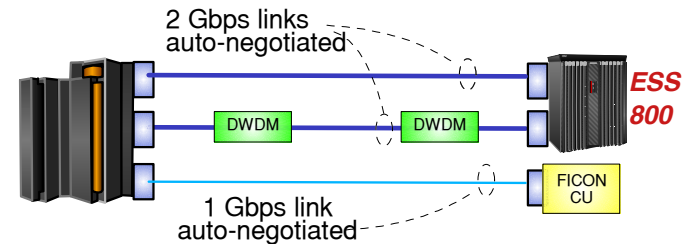
- ▶ Cisco MDS 9000 - 9216, 9506, 9509
- ▶ CNT FC/9000 Directors
- ▶ **CNT UltraNet Multi-service Director**
- ▶ IBM TotalStorage SAN Switch M12
- ▶ **IBM TotalStorage SAN32M-1, SAN140M**
- ▶ McDATA Sphereon 3232 Fabric Switch
- ▶ McDATA Intrepid 6000 Series Directors



### ■ Switches - FCP

- ▶ IBM TotalStorage SAN Switch 2109

- Refer to Appendix for machine types/models



### ■ 2 Gbps link speed capability is:

- ▶ FICON Express features 2319, 2320
- ▶ Native FICON, FICON CTC, FICON Cascaded Directors, FCP
  - FCV is not supported at 2 Gbps
- ▶ Auto-negotiated point-to-point
  - Between server, switch, and device
  - Transparent to user and application

# FCP product support list

## ■ Supported IBM devices (via switch):

- ▶ IBM TotalStorage Enterprise Storage Server (ESS)
- ▶ IBM TotalStorage Enterprise Tape Controller
  - ✓ IBM 3590-A60, [3592-J70](#)
- ▶ IBM TotalStorage Virtual Tape Server
- ▶ IBM UltraScalable Tape Library
  - with Ultrium 2 Fibre Channel Tape Drives feature #1476
  - (3584-D32, L32)

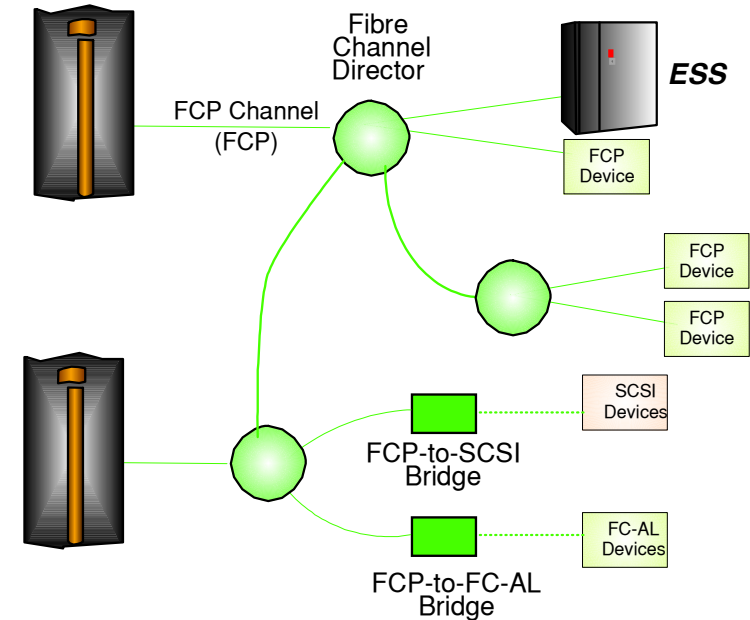
## ■ Supported directors and switches:

- ▶ Cisco MDS 9000
- ▶ CNT FC/9000 Directors
- ▶ **CNT UltraNet Multi-service Director** ★
- ▶ IBM TotalStorage SAN Switches (2109-S08, S16, F16, [M12](#))
- ▶ **IBM TotalStorage SAN32M-1, SAN140M**
- ▶ [McDATA Sphereon 3232 Fabric Switch](#)
- ▶ McDATA Intrepid 6000 Series Directors
- ▶ McDATA ED-5000 Fibre Channel Director
- ▶ McDATA Sphereon 4500 Fibre Channel Switch

## ■ Supported bridges (via switch)

- ▶ IBM Storage Area Network Data Gateway  
(FC-to-parallel SCSI connectivity for non-IBM storage)
- ▶ McDATA Model L00 ES-1000 Loop Switch (FC-to-FC-AL)

## ■ Refer to Appendix for machine types/models



**No direct attachment  
to controllers, devices,  
or bridges**

# FICON and FCP Intermix

March 2003

- **FICON (CHPID type FC) and Fibre Channel (CHPID type FCP) can be intermixed in the same director**

- **Supported by**

- ▶ Cisco MDS 9000 - 9216, 9506, 9509
- ▶ CNT FC/9000 Directors
- ▶ **CNT UltraNet Multi-service Director** ★
- ▶ IBM TotalStorage SAN Switch M12
- ▶ **IBM TotalStorage SAN32M-1, SAN140M**
- ▶ McDATA Sphereon 3232 Fabric Switch
- ▶ McDATA Intrepid 6000 Series Directors

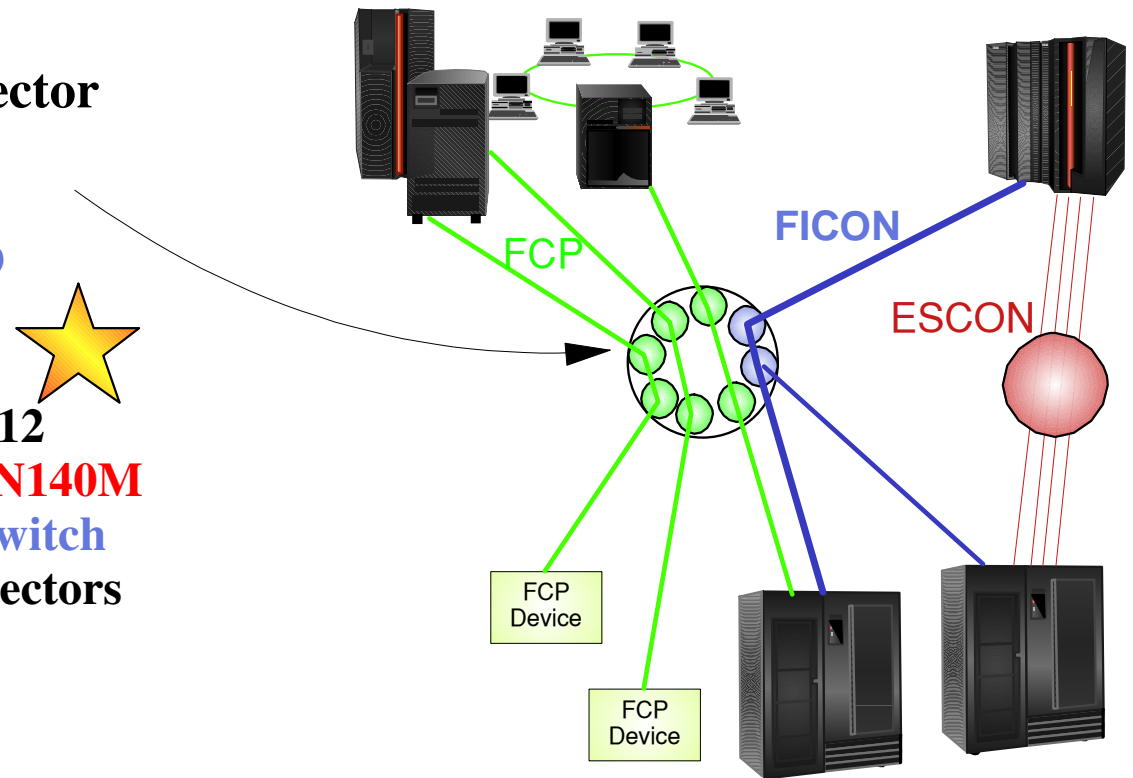
- **Shared on a port-by-port basis**

- **Refer to FICON/FCP intermix white papers**

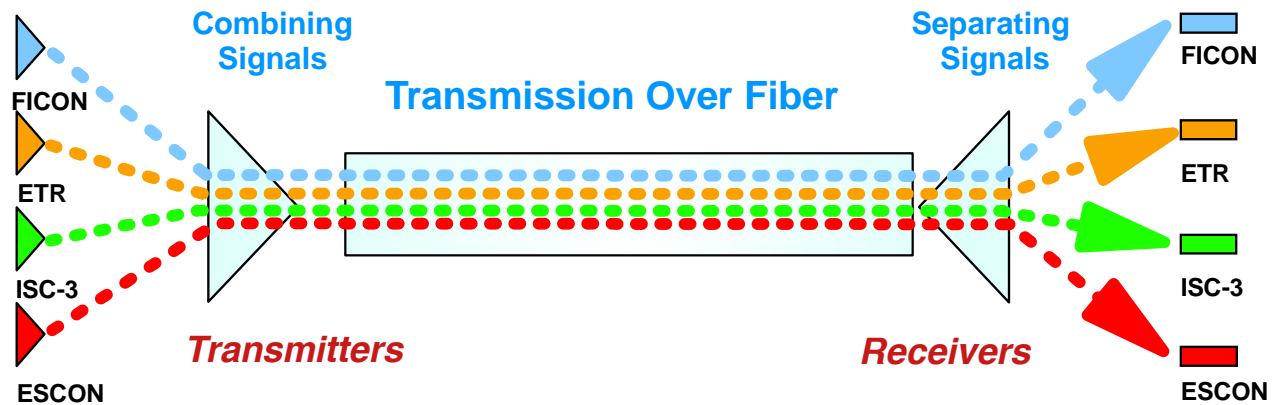
- ▶ <http://www.cnt.com/literature/documents/PL673.pdf>
- ▶ [http://www.mcdata.com/downloads/mkt/wpaper/ficon\\_intermix.pdf](http://www.mcdata.com/downloads/mkt/wpaper/ficon_intermix.pdf)

- **For Linux on zSeries support of FCP**

- ▶ <http://www10.software.ibm.com/developerworks/opensource/linux390/index.shtml>



# DWDM product support



- Dense Wavelength Division Multiplexers (DWDMs)
- The following vendors are supported for attachment to G5/G6 servers, z900, z800, z990, z890
  - ▶ Cisco Systems - ONS 15530 and 15540 ESPx
  - ▶ Lucent - Metro EON
  - ▶ Nortel Networks - Optera Metro 5100, 5200, 5300E
  - ▶ ADVA Fiber Service Platform (FSP) 2000 system
- The DWM qualification applies to:
  - ▶ GDPS/PPRC up to 40 km
  - ▶ GDPS/XRC up to 100 km
  - ▶ GDPS/PPRC up to 100 km
    - For Sysplex Timer and ISC-3 extension to 100 km require RPQ
- The DWDM qualification applies to the following protocols:
  - ▶ ESCON, FICON/Fibre Channel, ISC-3, OSA-Express GbE, Sysplex Timer (ETR and CLO)
- Refer to the following web site for a services brochure and further information:
  - ▶ <http://www-1.ibm.com/services/files/gss1860f.pdf>



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**zSeries Expo**

Nov. 1 - 5, 2004

**Miami, FL**

**Extended distance  
How far can you go?**

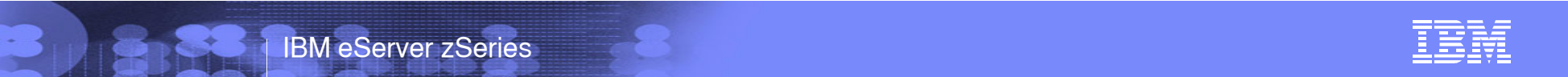
## Light Delay in Fiber over Distance

- **The limitation of the speed of light within a fiber optic cable will increase the delay in the response time by 100 microseconds (us) for 10 kilometers (km)**
  - ▶ Propagation delay is
    - 5 us per km one way
    - 10 us per km round trip
      - $5 \text{ us / km (one way)} \times 10 \text{ km} \times 2 \text{ (round trip)} = 100 \text{ us (0.1 milliseconds - ms)}$
- **There is an increased response time for every 10 km of distance and every interlocked handshake or round-trip per channel program**

Channel Type	Interlocked Handshakes Required <sup>2</sup>	Total "up to" delay per 10 km
ESCON	6	0.6 ms
FCV - Bridge	2	0.2 ms
FC - Native	1	0.1 ms

### ■ Notes:

1. The numbers in the matrix reflect a simple channel program (4 KB read hit)
2. For channel programs that have more interlocked handshakes built into it, distance delays could be larger



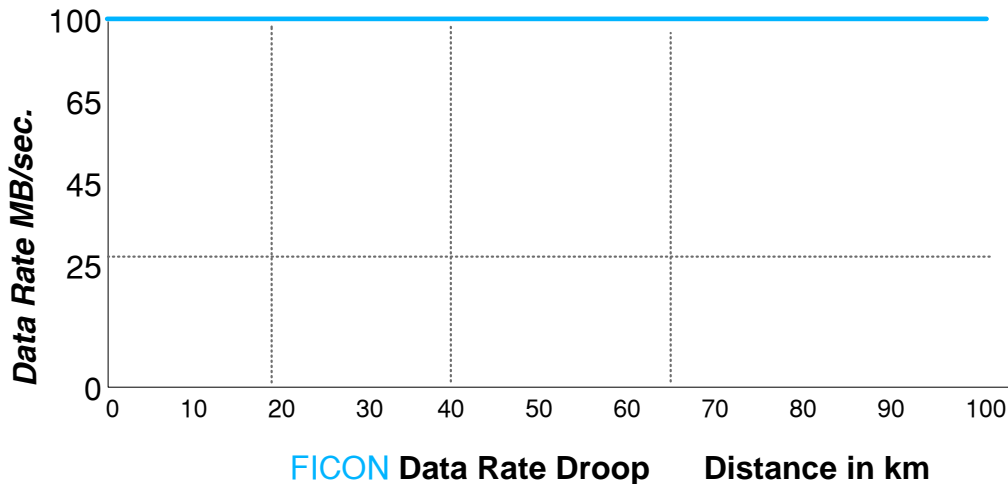
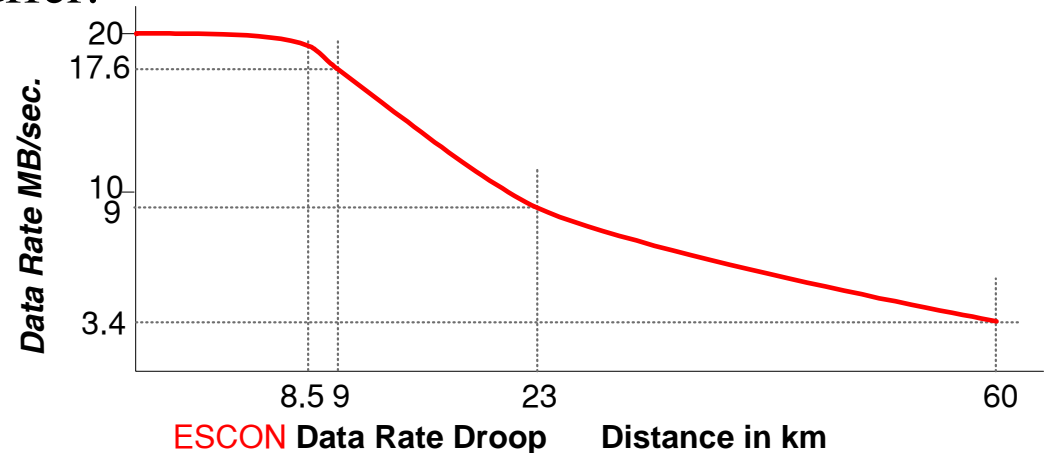
# Droop: Key Ingredients

## ■ Droop begins when

- ▶ The link distance reaches the point where the time light takes to make one round trip on the link is equal to the time it takes to transmit the number of bytes that will fit in the receiver's buffer.

## ■ Key factors

- ▶ Speed of light through fiber
- ▶ Link data rate
- ▶ Buffer capacity
- ▶ Packet size



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x Gbps	x.x dB	x km (x.x miles)
--------	--------	------------------

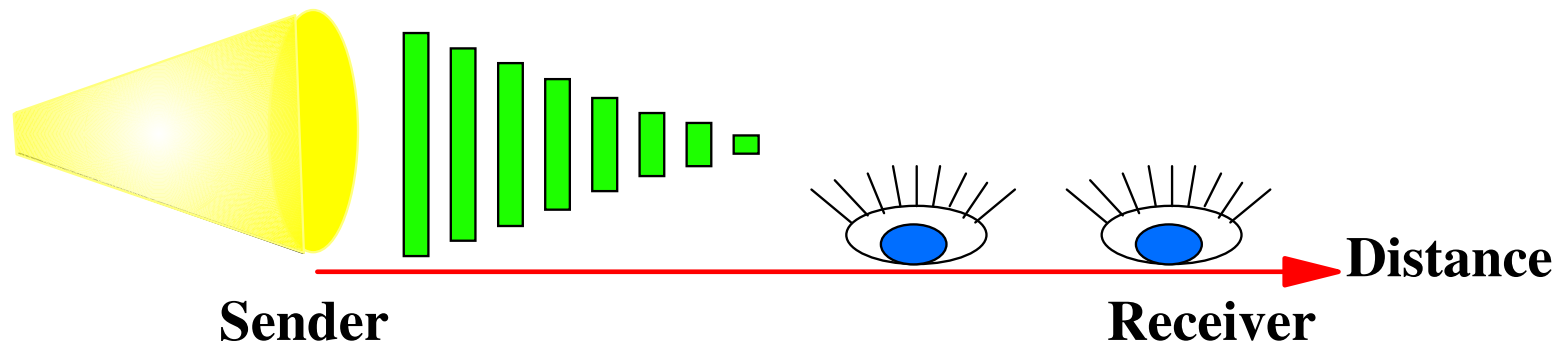
**Link speed**

**Link loss budget**

**Unrepeated distance**

## Link loss budget - What is it?

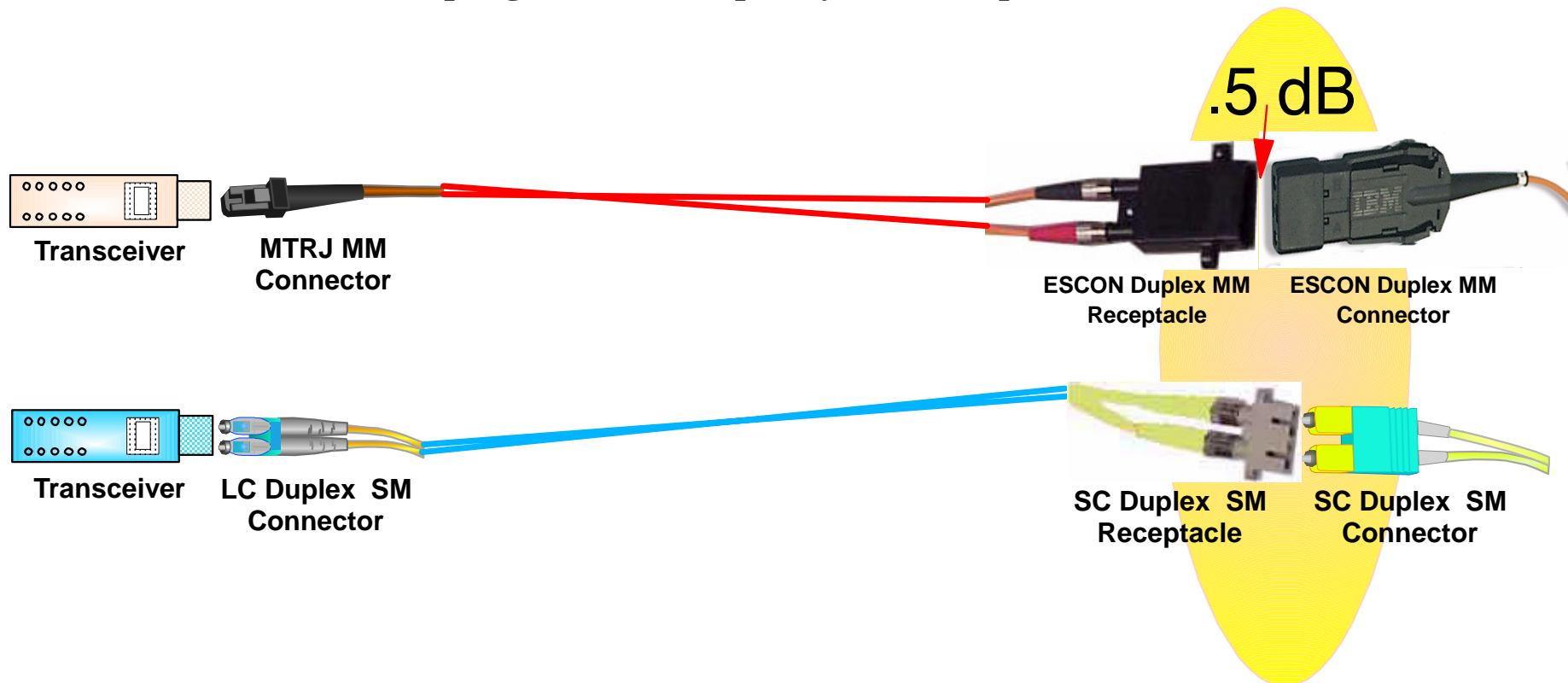
- **As a light signal travels through a fiber optic cable, the light signal loses strength**



- **dB (decibel) is the metric used to measure the signal strength (loss or gain)**
  - ▶ Result: A link loss budget
    - The maximum amount of link attenuation (loss), expressed in decibels (dB), that can exist without causing a possible failure condition (bit errors).
- **Factors that contribute to the loss of signal strength**
  - ▶ Number of connections (Conversion kits, MCP cables, jumpers, trunks, patch panels)
  - ▶ Length of the fiber optic cable

# Calculating link loss budget

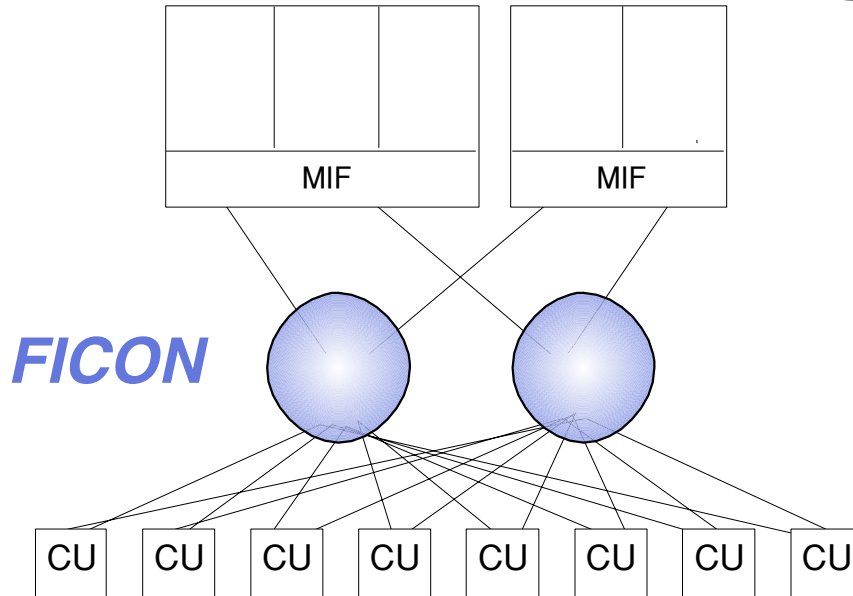
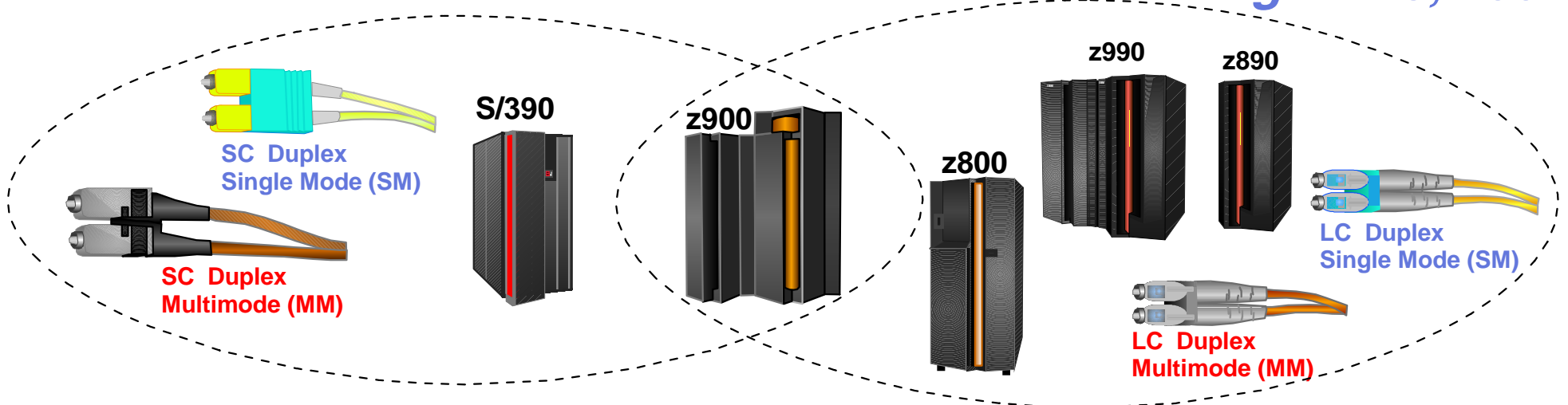
- **Fibre channel standard - no more than four fiber-to-fiber connections per link**
- **IBM position - if do not exceed link loss budget - OK**
- **Refer to: GA23-0367-07b Planning for Fiber Optic Links (ESCON, FICON, Coupling Links, and Open Systems Adapters)**



# IBM Fibre Connection - FICON

## FICON features

## FICON Express Features August 13, 2002



# I/O and Storage: FICON / FCP Cabling Options

LX = Long wavelength 1300 nm transceiver

SX - Short wavelength 850 nm transceiver

9 micron SM fiber

LX LX

ESCON \* or FICON DIRECTOR

\* ESCON Director requires FICON Bridge Card

- LX transceiver/feature on each end
- Requires 9 micron single mode (SM) fiber

1 Gbps	7.8 dB	10 km (6.2 miles)
2 Gbps	7.8 dB	10 km (6.2 miles)

**Unrepeated distance of 20 km (12.4 miles) with RPQ for 1 Gbps links**

**Unrepeated distance of 12 km (7.4 miles) with RPQ for 2 Gbps links**

50 or 62.5 micron MM fiber

LX MCP MCP LX

ESCON \* or FICON DIRECTOR

- LX transceiver/feature on each end combined with a pair of MCP cables
- Uses current 50 or 62.5 micron multimode (MM) fiber infrastructure
- Reduced distance** and link budget

1 Gbps	5 dB	550 meters (1804 feet)
2 Gbps	N / A	Not supported

50 micron MM fiber

SX SX

FICON DIRECTOR

- SX transceiver/feature on each end
- Requires 50 micron multimode fiber
- Reduced distance** and link budget

1 Gbps	3.9 dB	500 meters (1640 feet)
2 Gbps	2.8 dB	300 meters (984 feet)

62.5 micron MM fiber

SX SX

FICON DIRECTOR

- SX transceiver/feature on each end
- Requires 62.5 micron multimode fiber
- Reduced distance** and link budget

1 Gbps	2.8 dB	250 meters (820 feet)
2 Gbps	2.2 dB	120 meters (394 feet)

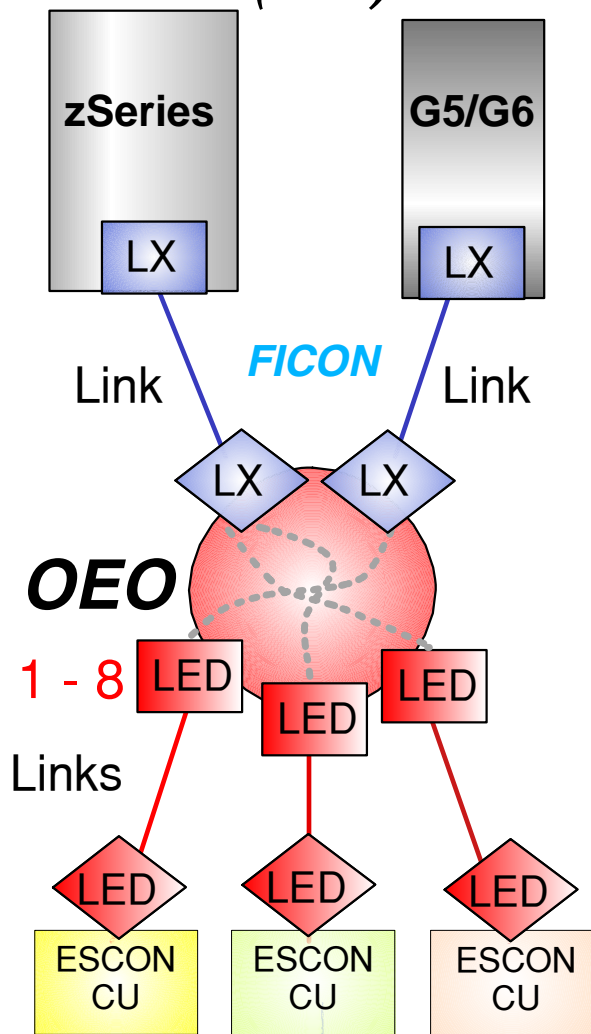
**Link Speed      Link Budget      Unrepeated Distance**



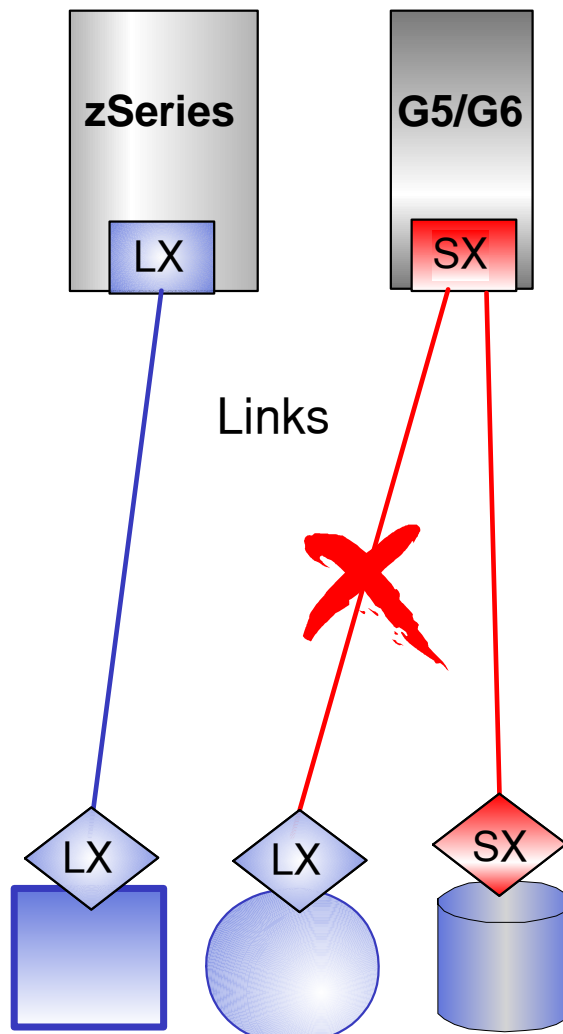
# FICON Link Planning: Sender and Receiver must be the same

OEO = Optical/Electrical/Optical

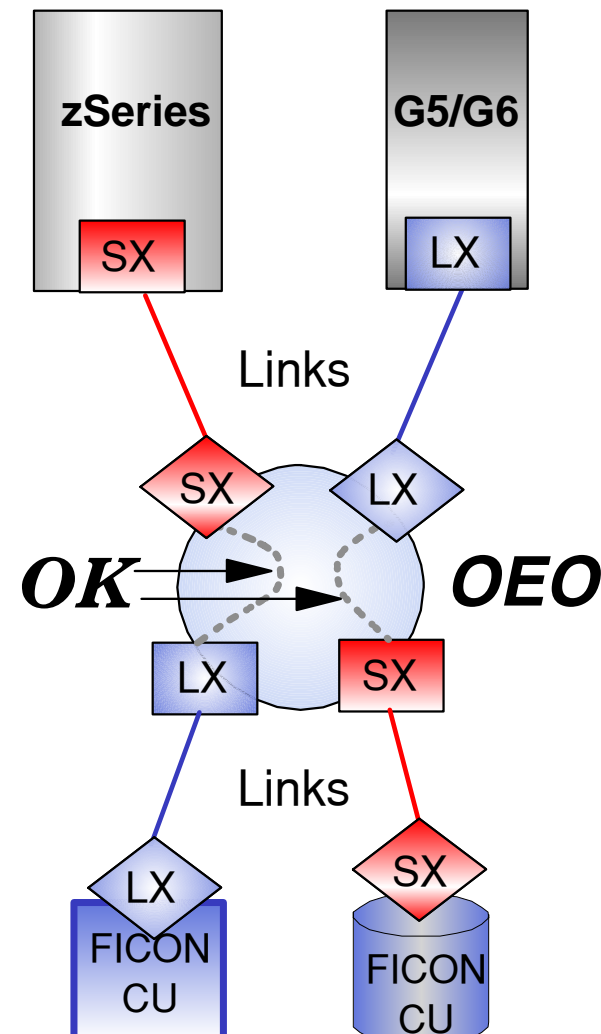
## FICON Bridge (FCV)



## Native FICON (FC) Direct Attachment



## FICON: FC or FCP Switched



As the Link Data Rate  
*INCREASES*

The Distance and Link Budget

*DECREASES*

When using Multimode Fiber

## Fibre channel specification

- The following charts summarize the unrepeated distances and link loss budgets supported by the standards. The link loss budget is the channel insertion loss plus the unallocated link margin as identified by the standard.
  - ▶ Fibre channel standard physical interface (FC-0)
- For 10 Gigabit speeds, the draft Fibre Channel specification (April 9, 2003) is closely aligned with the 10 Gigabit Ethernet physical layer specification (IEEE 802.3ae).
- As a light signal traverses a fiber optic cable, the light signal loses strength
  - ▶ dB (decibel) is the metric used to measure the signal strength (loss or gain)
  - ▶ The Link loss budget identified in the following slides is represented in dBs.
- Factors that contribute to the loss of signal strength
  - ▶ Number of connections (conversion kits, MCP cables, jumpers, trunks, patch panels)
  - ▶ Length of the fiber optic cable
- All industry standard links (FICON, FCP, Ethernet) follow published standards.

# Fibre channel standard physical interface (FC-0)

- Applies to FICON, FICON Express, and FCP (Fibre Channel Protocol)

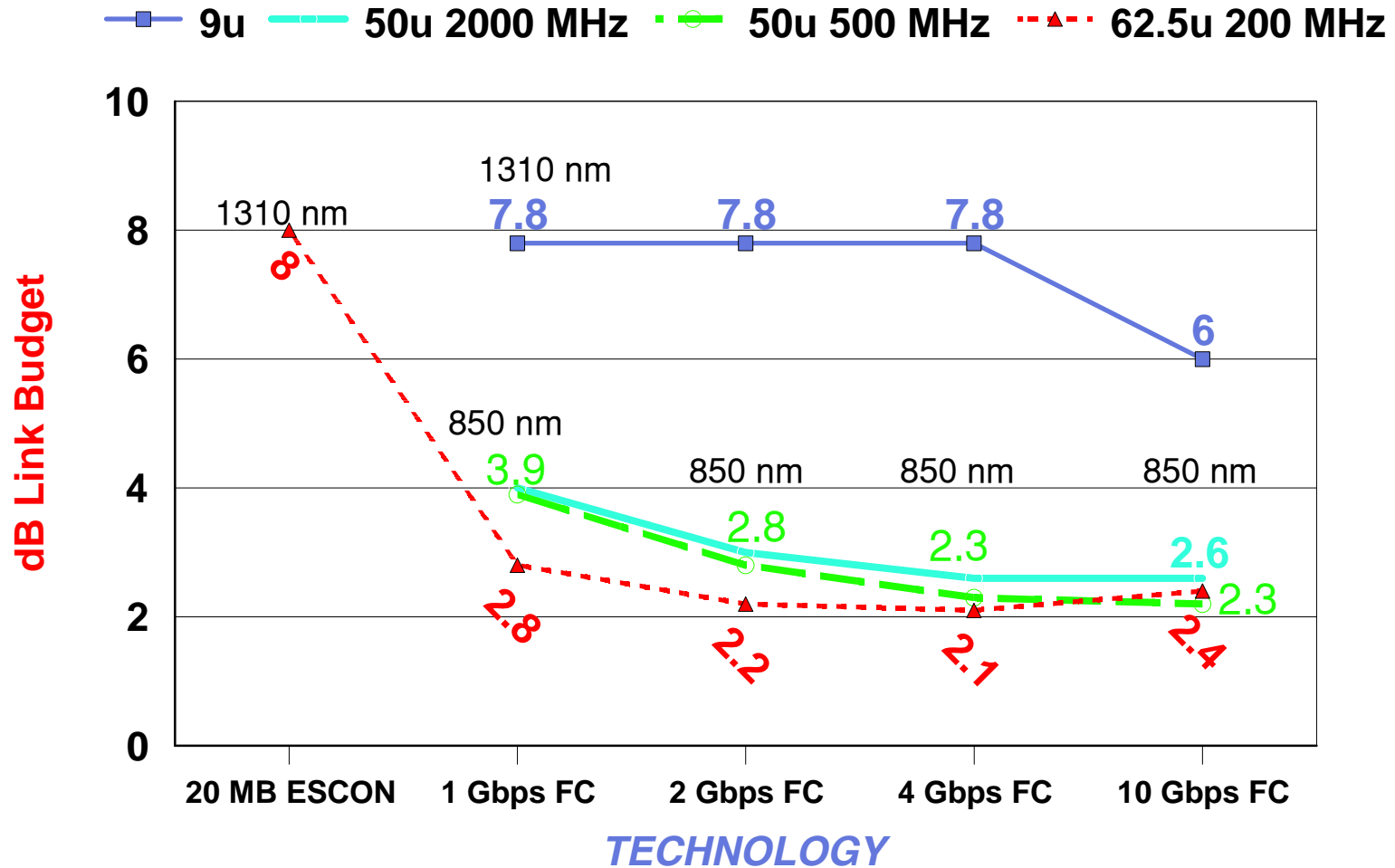
		1 Gigabit / sec	2 Gigabit / sec	4 Gigabit / sec	10 Gigabit / sec				
Fiber Core (u) Light Source	Fiber Bandwidth @wavelength	Unrepeated Distance	* Link loss Budget	Unrepeated Distance	* Link loss Budget	Unrepeated Distance	* Link loss Budget	Unrepeated Distance	* Link loss budget
9 u SM LX laser	@ 1310 nm	10 km 6.2 miles	7.8 dB	10 km 6.2 miles	7.8 dB	10 km 6.2 miles	7.8 dB	10 km 6.2 miles	6.0 dB
9 u SM LX laser w/MCP cable	500 MHz km (62.5u) 400 MHz km (50 u)	550 meters 1804 feet	5.0 dB	N / A	N / A	N / A	N / A	N / A	N / A
50 u MM SX laser <b>NEW</b>	2000 MHz km @850nm	Manufacturers guarantee to be equal or better than standard 50 um fiber although not yet qualified by IBM				300 meters 984 feet **	2.6 dB		
50 u MM SX laser	500 MHz km @850nm	500 meters 1640 feet	3.9 dB	300 meters 984 feet	2.8 dB	150 meters 492 feet	2.3 dB	82 meters 269 feet	2.2 dB
62.5 u MM SX laser	200 MHz km @850nm	300 meters 984 feet	3.0 dB	150 meters 492 feet	2.2 dB	70 meters 230 feet	2.0 dB	33 meters 108 feet	2.4 dB
62.5 u MM SX laser	*** 160 MHz km @850nm	250 meters 820 feet	2.8 dB	120 meters 394 feet	2.2 dB	55 meters 180 feet	2.1 dB	N / A	N / A

\* The **link loss budget** is the channel insertion loss + the unallocated link margin as defined by the standard.

\*\* The new aqua 2000 MHz km multimode fiber became available September, 2003.

\*\*\* Most often applicable to currently installed ESCON environments

# Fibre channel link loss budget at high data rates

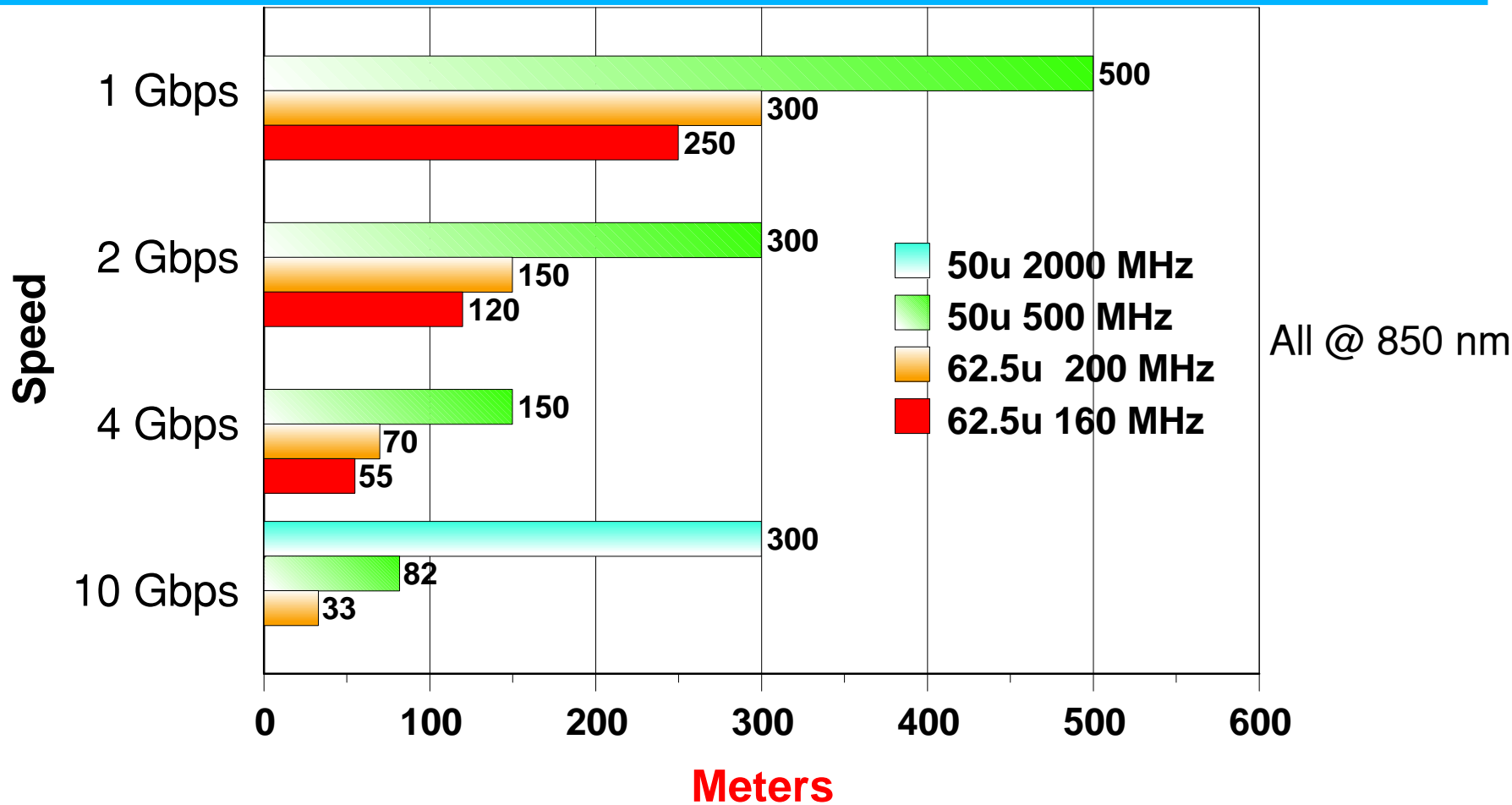




# Fibre channel distances when using multimode fiber optic cabling

1, 2, 4 and 10 Gbps = 9u @1310 nm - - 10,000 meters (10 km)

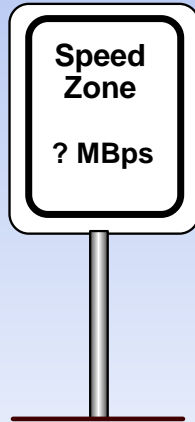
**Compare using 9u single mode fiber = 10,000 meters** →



# FICON feature and function introduction

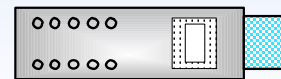
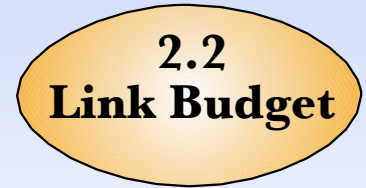
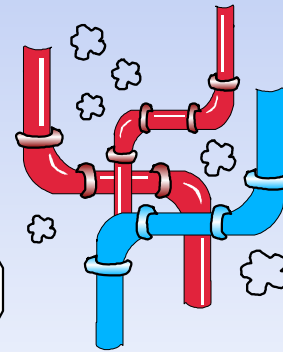
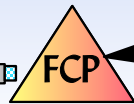
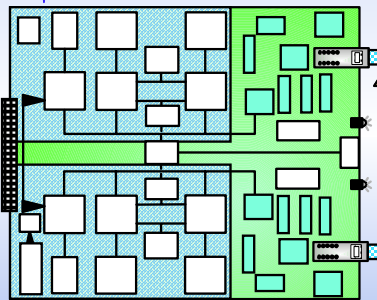
<i><b>Feature / Function - <u>first introduction</u></b></i>	<i><b>Availability Date</b></i>
<b>24 FICON</b> LX Bridge (FCV), G5	March 31, 1999
FICON LX Native (FC), G5/G6	August 31, 1999
<b>36 FICON channels</b> on G6	June 30, 2000
FICON LX, z900, <b>96 channels</b> , 2 ports	December 18, 2000
FICON SX, G5/G6, z900	March 30, 2001
FICON Express LX, SX, CTC, z900	October 31, 2001
FICON Express, 2 Gbps, z900, z800 with SFF, LC Duplex connectors	August 13, 2002
Cascaded Directors	January 31, 2003
FCP, z900 and z800	February 20, 2003
FICON/FCP Intermix	March 31, 2003
FICON Express - 2 Gbps, <b>120 channels</b> , z990 CHPID types FCV, FC	June 16, 2003
Availability of FCP on z990	October 31, 2003
FCP SAN management - supports HBA APIs	October 31, 2003
FCP - IPL of OS from SCSI disk #9904 on z990	October 31, 2003
FICON Express, 2 Gbps, z890	May 28, 2004
FICON Express spanned channels	May 28, 2004
FICON performance improvement - 15% increase in 4k SIOs (8300)	May 28, 2004
FCP concurrent patch	May 28, 2004
FICON purge path extended	October 29, 2004

# Sum it Up!



ESCON	FICON	FCP
Circuits	Packets	Packets
CCWs	CCWs	QDIO

For a complete list of software requirements visit:  
<http://www.ibm.com/wwoi>





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**Thank you!**  
**This is Session # G10**

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# More about FCP

## z890 and z990 Performance Assists - FCP

- **Adapter Interruptions - z890 and z990 + z/VM V4.4**
  - ▶ FICON Express (FCP CHPID type only)
  - ▶ Extension to QDIO architecture
  - ▶ New technique for I/O interruptions
    - Reduces programming overhead to process an I/O interruption
  
- **Performance Assist for V=V guests - z890 and z990 + z/VM V4.4**
  - ▶ FICON Express (FCP CHPID type only)
  - ▶ Direct presentation of adapter interruptions by server to pageable guests
  - ▶ No need to stop guest processing


# FCP SAN Management



January 2004

- **Exclusive to z890 and z990**
- **SCSI IPL feature enabler #9904 on z990 was available October 31, 2003.**
- **#9904 on z890 available at introduction May 28, 2004.**
  
- **FICON Express features (CHPID type FCP)**
  
- **Supports industry-standard interface for SAN management tools**
  - ▶ Leverage Common Host Bus Adapter Application Programming Interfaces (HBA APIs)
  
- **Manage FC HBAs**
  
- **Discovery of SAN resources**
  
- **Linux on zSeries support was delivered in January 2004 as an Open Source contribution via:**
  - ▶ <http://www10.software.ibm.com/developerworks/opensource/linux390>

# FCP Concurrent Patch



May 2004

- **Exclusive to z890 and z990 - May 2004 LIC**
- **FICON Express features (CHPID type FCP)**
- **Concurrent patch of new LIC**
- **Now, does not require a configuration off / on**

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# Miscellaneous

# FICON modes of operation

	CHPID Type	G5/G6 FICON	z900 FICON post 10/31/01	z890, z990 z800, z900 FICON Express
<b>Feature Code</b>		2314 (LX) 2316 (SX)	* 2315 (LX) * 2318 (SX) currently installed	2319 (LX) 2320 (SX)
<b>FICON Bridge</b>	FCV (FICON Converted) 1 Gbps only	YES, LX only	YES, LX only	YES, LX only 1 Gbps only
<b>FICON</b>	FC	YES	YES	YES
<b>FICON CTC</b>	FC	NO	YES Requires 10/01 LIC CC	YES
<b>FCP</b>	FCP	NO	YES	YES
<b>Cascading</b>	FC	NO	YES	YES
<b>Intermix</b>	FC, FCP	NO	YES	YES
<b>1 or 2 Gbps auto-negotiated links</b>	FC, FCP	NO 1 Gbps only	NO 1 Gbps only	YES



Link Data Rates

CHPID = Channel Path Identifier  
CTC = Channel-To-Channel

\* Features 2315 and 2318 were not available after 10/30/01

# FICON tested products

For latest supported list refer to: <http://www-1.ibm.com/servers/eserver/zseries/connectivity/>

Product	Transceiver	Connector
FICON Bridge in IBM ESCON Director (IBM 9032-005)	LX only	SC Duplex
Cisco MDS 9000 - 9216, 9506, 9509 (IBM 2062 - D01, D04, D07)	SX, LX, CWDM	<i>LC Duplex</i>
CNT FC/9000 Directors (IBM 2042-001, 128, 256)	SX, LX	1 Gbps features - SC Duplex <i>2 Gbps features - LC Duplex</i>
CNT UltraNet Multi-service Director (IBM 2042-N16)	<i>SX, LX</i>	<i>LC Duplex</i>
IBM TotalStorage SAN Switch M12 (2109-M12)	SX, LX	<i>LC Duplex</i>
IBM TotalStorage SAN32M-1 (2027-232)	<i>SX, LX</i>	<i>LC Duplex</i>
IBM TotalStorage SAN140M (2027-140)	<i>SX, LX</i>	<i>LC Duplex</i>
McDATA ED-5000 Fibre Channel Director (IBM 2032-001) 1 and 2 Gbps	SX, LX	SC Duplex
McDATA Intrepid 6000 Series Directors (IBM 2032-064, 140)	SX, LX	<i>LC Duplex</i>
McDATA Sphereon 3232 Fabric Switch (IBM 2031-232)	SX, LX	<i>LC Duplex</i>

Blue = Added 1 H 2004, Red = Added 2 H 2004



# FICON tested products

For latest supported list refer to: <http://www-1.ibm.com/servers/eserver/zseries/connectivity/>

Product	Transceiver	Connector
IBM Infoprint Color 130 Plus (IBM 3170-005)	LX only	SC Duplex
IBM Infoprint 4100 family (IBM 4100-HD1, PD1, HS1, PS1, PD2, HD2) IBM Infoprint 2000 (IBM 2710-AF1)	SX, LX	SC Duplex
IBM TotalStorage Enterprise Tape Controller (IBM 3590-A60, <a href="#">IBM 3592-J70</a> )	SX, LX	1 Gbps features - SC Duplex <i>2 Gbps features - LC Duplex</i>
IBM TotalStorage Virtual Tape Server (IBM 3494-B10, B20)	SX, LX	<i>LC Duplex</i>
IBM TotalStorage Enterprise Storage Server (IBM 2105-F10, F20) (IBM 2105- <a href="#">750</a> , 800 is 2 Gbps-capable)	SX, LX SX, LX	SC Duplex <i>LC Duplex</i>

# FCP tested products

For latest supported list refer to: <http://www-1.ibm.com/servers/eserver/zseries/connectivity/#fcp>

Product	Transceiver	Connector
Cisco MDS 9000 - 9216, 9506, 9509 (IBM 2062 - D01, D04, D07)	SX, LX, CWDM	LC Duplex
CNT FC/9000 Directors (IBM 2042-001, 2042-128, 2042-256)	SX, LX	1 Gbps features - SC Duplex 2 Gbps features - LC Duplex
CNT UltraNet Multi-service Director (IBM 2042-N16)	SX, LX	LC Duplex
IBM TotalStorage SAN Switch M12 (2109-M12)	SX, LX	LC Duplex
McDATA ED-5000 Fibre Channel Director (IBM 2032-001)	SX, LX	SC Duplex
McDATA Intrepid 6000 Series Directors (IBM 2032-064, 2032-140)	SX, LX	LC Duplex
McDATA Sphereon 3232 Fabric Switch (IBM 2031-232)	SX, LX	LC Duplex
McDATA Sphereon 4500 Fibre Channel Switch (IBM 2031-224)	SX (50 micron) LX	LC Duplex
IBM TotalStorage SAN32M-1 (2027-232)	SX, LX	LC Duplex
IBM TotalStorage SAN140M (2027-140)	SX, LX	LC Duplex
FCP-to-SCSI Bridge IBM Storage Area Network Data Gateway (IBM 2108-G07)	SX, LX	SC Duplex
IBM TotalStorage SAN Switch (2109 - S08, S16)	SX, LX	SC Duplex
IBM TotalStorage SAN Switch (2109 -F16, <a href="#">M12</a> )	SX, LX	LC Duplex
FCP-to-FC-AL Bridge McDATA Model L00 ES-1000 Loop Switch (IBM 2031-L00)	LX to Director SX (50 micron)	SC Duplex

# FCP tested products

For latest supported list refer to: <http://www-1.ibm.com/servers/eserver/zseries/connectivity/#fcp>

Product	Transceiver	Connector
IBM TotalStorage Enterprise Storage Server (IBM 2105-F10, 2105-F20) (IBM 2105- <a href="#">750</a> , 800)	SX, LX SX, LX	SC Duplex <i>LC Duplex</i>
IBM TotalStorage Enterprise Tape Controller (IBM 3590-A60, <a href="#">3592-J70</a> )	SX, LX	1 Gbps features - SC Duplex <i>2 Gbps features - LC Duplex</i>
IBM TotalStorage Virtual Tape Server (IBM 3494-B10 , B20)	SX, LX	<i>LC Duplex</i>
IBM UltraScalable Tape Library with LTO Ultrium 2 Fibre tape drives feature #1476 (IBM 3584-D32, L32)	SX (50 micron)	<i>LC Duplex</i>

## Publications: ESCON/FICON

- **SA24-7172**      **S/390 (FICON) I/O Interface Physical Layer**
  
- **GA23-0367-07b**    **Planning for Fiber Optic Links**  
**(ESCON, FICON, Coupling Links, and Open Systems Adapters)**
  
- **SG24-5176**      **Introduction to IBM S/390 FICON (*Redbook*)**
  
- **SG24-5444**      **IBM eServer zSeries I/O Connectivity Handbook (*Redbook*)**
  
- **SG24-5445**      **S/390 FICON Planning Guide (*Redbook*)**
  
- **SG24-5169**      **S/390 FICON Implementation Guide (*Redbook*)**
  
- **SG24-2005**      **ESCON Director 9032-005 Presentation (*Redbook*)**  
**(includes FICON Bridge card installation and use)**

# FCP documentation

- **Linux Device Drivers and Installation Commands (LINUX-1103-07)**
  - ▶ <http://www10.software.ibm.com/developerworks/opensource/linux390/docu/lx24jun03dd03.pdf>
- **Getting Started with zSeries Fibre Channel Protocol (Redbook)**
  - ▶ [www.redbooks.ibm.com/redpapers/pdfs/redp0205.pdf](http://www.redbooks.ibm.com/redpapers/pdfs/redp0205.pdf)
- **Linux 2.4 SCSI How To (White paper)**
  - ▶ [www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/pdf/SCSI-2.4-HOWTO.pdf](http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/pdf/SCSI-2.4-HOWTO.pdf)
- **Enterprise Storage Server, Fibre Channel Attachment (White paper)**
  - ▶ <http://www.storage.ibm.com/disk/ess/support/essfcwp.pdf>
- **Large Scale Web Serving Consolidation with zSeries servers running Linux and z/VM**
  - ▶ [http://www-1.ibm.com/servers/eserver/zseries/library/whitepapers/large\\_scale\\_web\\_serving.html](http://www-1.ibm.com/servers/eserver/zseries/library/whitepapers/large_scale_web_serving.html)

## On the Internet

- IBM Resource Link, Web-based tool
  - ▶ [www.ibm.com/servers/resourcelink/](http://www.ibm.com/servers/resourcelink/)
    - Services section: zSeries Fiber Cabling Service
    - Planning section/Physical Planning
      - Physical Planning manuals, GIM
    - Education section: zSeries courses (z800, z900)
      - General Information for Planning a Physical Site (GIM)
- <http://www.ibm.com/services/networking/>
  - ▶ Product and Enterprise cabling offerings
- <http://www.redbooks.ibm.com>
  - ▶ IBM Redbooks
- <http://www.ibm.com/servers/eserver/zseries/networking>
  - ▶ The network connectivity home page
- <http://www.ibm.com/servers/eserver/zseries/connectivity>
  - ▶ The I/O connectivity home page
  - ▶ Go to this location for a list of FICON/FCP supported devices
- <http://www.ibm.com/wwoi>
  - ▶ Announcement Letters



## On the Internet - Information on Directors/Switches

- Cisco Systems
  - ▶ <http://www.ibm.com/storage/cisco>
  - ▶ <http://www.cisco.com/go/ibm/storage>
  
- CNT FC/9000 Directors
  - ▶ <http://www.ibm.com/storage/cnt>
  - ▶ <http://www.cnt.com>
  
- IBM TotalStorage SAN Switch M12
  - ▶ <http://www.ibm.com/storage/FCSwitch>
  
- McDATA Sphereon 3232 Fabric Switch
  - ▶ <http://www.storage.ibm.com/ibmsan/products/2031/3216/index.html>
- McDATA Intrepid 6000 Series Directors and
  - ▶ <http://www.mcdata.com>
  
- For maximum unrepeated distance between directors refer to:
  - ▶ [http://www.ibm.com/servers/eserver/zseries/connectivity/ficon\\_cascaded.html](http://www.ibm.com/servers/eserver/zseries/connectivity/ficon_cascaded.html)
  
- Refer to FICON/FCP Intermix White Papers
  - ▶ <http://www.cnt.com/literature/documents/PL673.pdf>
  - ▶ [http://www.mcdata.com/downloads/mkt/wpaper/ficon\\_intermix.pdf](http://www.mcdata.com/downloads/mkt/wpaper/ficon_intermix.pdf)
  
- For Linux on zSeries support of FCP
  - ▶ <http://www10.software.ibm.com/developerworks/opensource/linux390/index.shtml>

# Performance

New additions include: FICON Express CTC performance, FICON Express performance at 2 Gbps link data rate, Cascaded FICON directors, and a discussion of Open Exchange capacities.

The document is available at:

[www.ibm.com/servers/eserver/zseries/library/techpapers/gm130120.html](http://www.ibm.com/servers/eserver/zseries/library/techpapers/gm130120.html)

***FICON and FICON Express Channel Performance Version 2.0  
November, 2003 by R. Basener and C. Cronin***

**FICON** for Performance

Learn how native **FICON** attachment offers much higher data transfer rates than ESCON attachments.



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