# SAN and FICON Long Distance Connectivity

**Session 16001**

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# Agenda

- Who are Brocade and ADVA

- Fundamentals of SAN and FICON FC Long Distance Connectivity
  - Mainframe Channel Cards and Long Distance Connectivity
  - MAN / WAN / SONET / SDH
  - Direct-attached storage
  - Switch-attached storage but FICON non-cascaded
  - Switch-attached storage and FICON cascaded

- Brocade and ADVA Products

- WDM options and benefits

Complete your session evaluations online at www.SHARE.org/Pittsburgh-Eval

# Brocade Communications Inc., Today

- Founded in 1995, currently has about 4,100 employees worldwide

- Serves a wide range of industries and customers in more than 160 countries

- An industry leader in providing reliable, high-performance network solutions

- Brocade provides our users:
  - Unmatched simplicity to overcome today's complexity
  - Non-stop networking to maximize business uptime
  - Optimized applications to increase business agility and gain a competitive advantage
  - Investment protection to provide a smooth transition to new technologies while leveraging existing infrastructure

- 90 percent of the Global 1000 rely on Brocade solutions

- 38.7 million SAN switch ports shipped, 200,000+ SANs in production, 50,000+ Brocade directors installed worldwide

**BROCADE**

# ADVA Optical Networking Today

## Mission

**Our MISSION**
is to be
the trusted partner for
innovative connectivity
solutions that ADVANCE
next-generation
networks for cloud and
mobile services.

## Key Facts

**Our NUMBERS**
>1400 employees
€311* million revenue
20 years of innovation

**Our CUSTOMERS**
Hundreds of carriers
Thousands of enterprises

**Our QUALITY**
TL 9000, ISO 14001
Award-winning
supply chain

*2013

We bring differentiation, quality and ease-of-use to next-generation networks

# FUNDAMENTALS OF FIBRE CHANNEL LONG DISTANCE CONNECTIVITY

# FICON: Analysis of Mainframe Channel Cards

Standard PCIe card



**8G**

FICON Express8S – 2 ports
800MBps+800MBps=1600MBps

Max CHPIDs

320
128
320
128

## FICON Express8S

- zEC12, zBC12, z196, z114
- 2, 4 or 8 Gbps link rate
- FICON never creates full frames
- Buffer Credits:
  - 2Gbps – 107 BCs per port
  - 4Gbps – 200 BCs per port
  - 8Gbps –   40 BCs per port
  - Out to 5km assuming 1K frames
  - No "Long Distance" capability
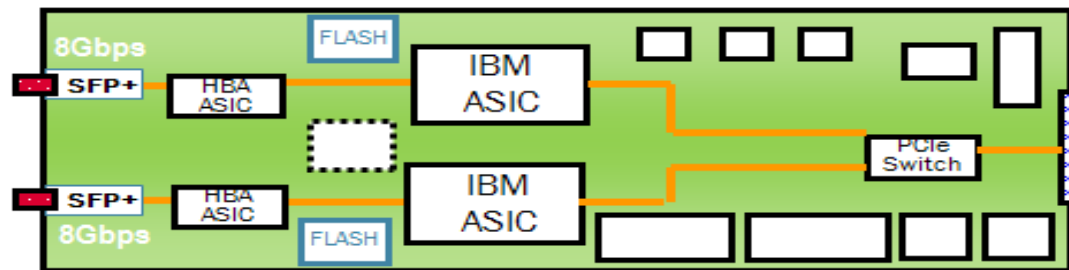
- For FICON, zHPF, and FCP environments
  - CHPID types: FC and FCP   (2 PCHIDs/CHPIDs)
- Auto-negotiates to 2, 4, or 8Gbps
- Increased performance versus FICON Express8
- 10KM LX - 9 micron SM fiber
  - Unrepeated distance - 10 km which 6.2 miles
- SX - 50 or 62.5 micron multimode fiber
  - Distance variable with link data rate and fiber type
- 2 channels of LX or SX (no mix)
- Small form factor pluggable (SFP) optics
  - Concurrent repair/replace action for each SFP

# Metropolitan-Area/Regional-Area Networks

- A MAN or RAN covers a North American metropolitan area, or a small to medium-sized country in Europe or Asia

- Provides an optical ring/mesh topologies with adequate back-up and protection

- Main technologies:
  - SONET/SDH
  - OTN
  - Gigabit
  - 10-Gigabit Ethernet
  - CWDM, DWDM

- Several LANs could be connected to a single MAN

- The graphic shows how a ring topology might be beneficial.

# Wide-Area Networks (WAN)

- Long haul intra-city and intra-country connections

- Typically government-regulated or in the public network environment
  - WANS originated in telephony

- Main technologies: SONET/SDH, OTN, WDM
  - Voice circuits vs. data packets

# SONET/SDH  - OTN

- SONET (Synchronous Optical Nettworks) is the Time Division Multiplexing (TDM) optical network standard for North America (called SDH in the rest of the world)
  - It is the de-facto standard for fiber backhaul networks
  - WDM is usually the underlying transport structure
  - OC-1 (with a frame format of SONET STS-1) using optical fiber has:
    - A transmission speed of up to 51.84 Mbps
  - OC-12 (with a frame format of SONET STM-4) using optical fiber has:
    - A transmission speed of up to 622.08 Mbps
  - OC ranges from OC-1 up to OC-768 which has:
    - A transmission speed of up to 39.813 Gbps

- OTN (Optical Transport Network) is the new standard for optical data transmission
  - Is the evolutionary successor of SONET/SDH technology
  - OTU-1 with a transmission speed of 2.67Gbps
  - OTU-2 with a transmission speed of 10.7Gbps
  - OTU-3 with a transmission speed of 43.0Gbps
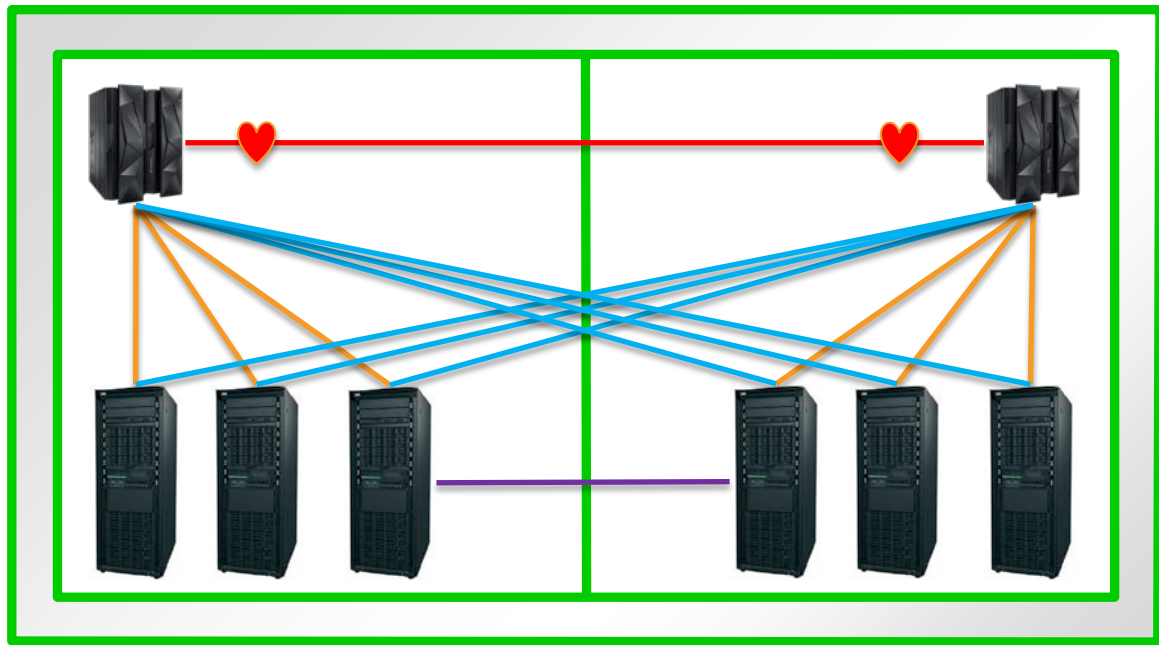  - OTU-2 with a transmission speed of 111.8Gbps

# Storage: Direct attached

- Data storage connected directly to a server or workshop through Host Bus Adapter (HBA), there is no network between storage and host servers
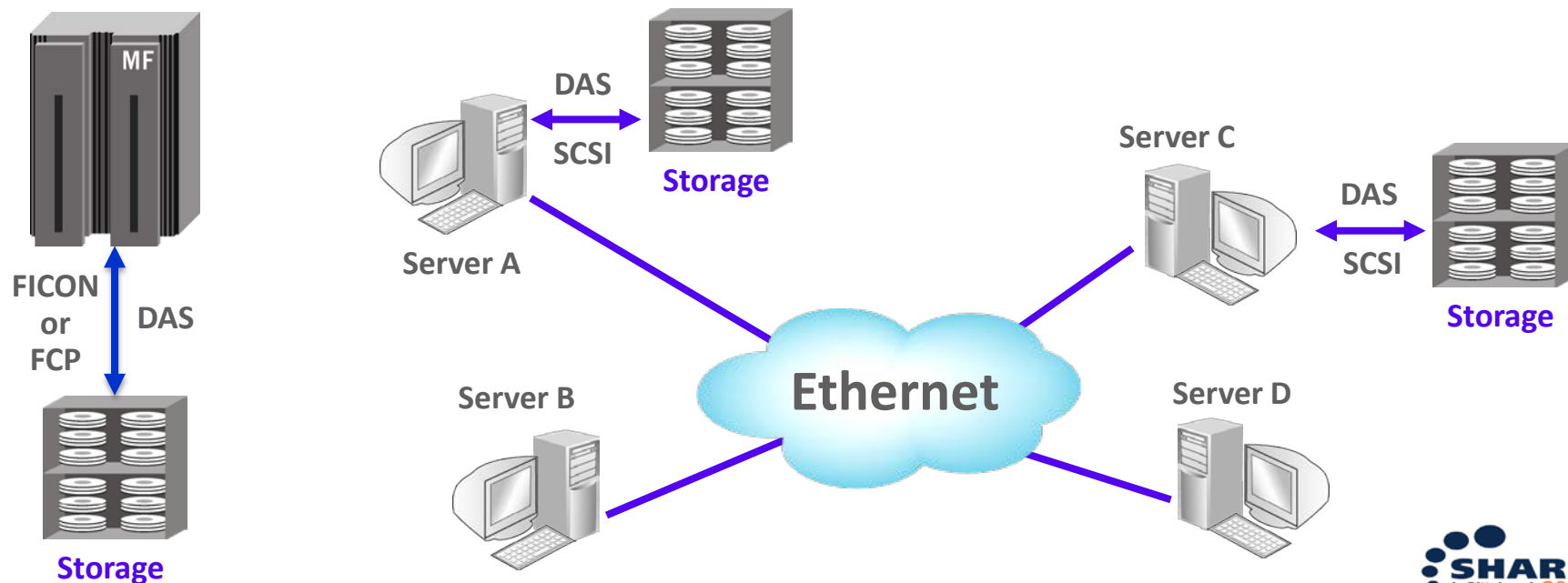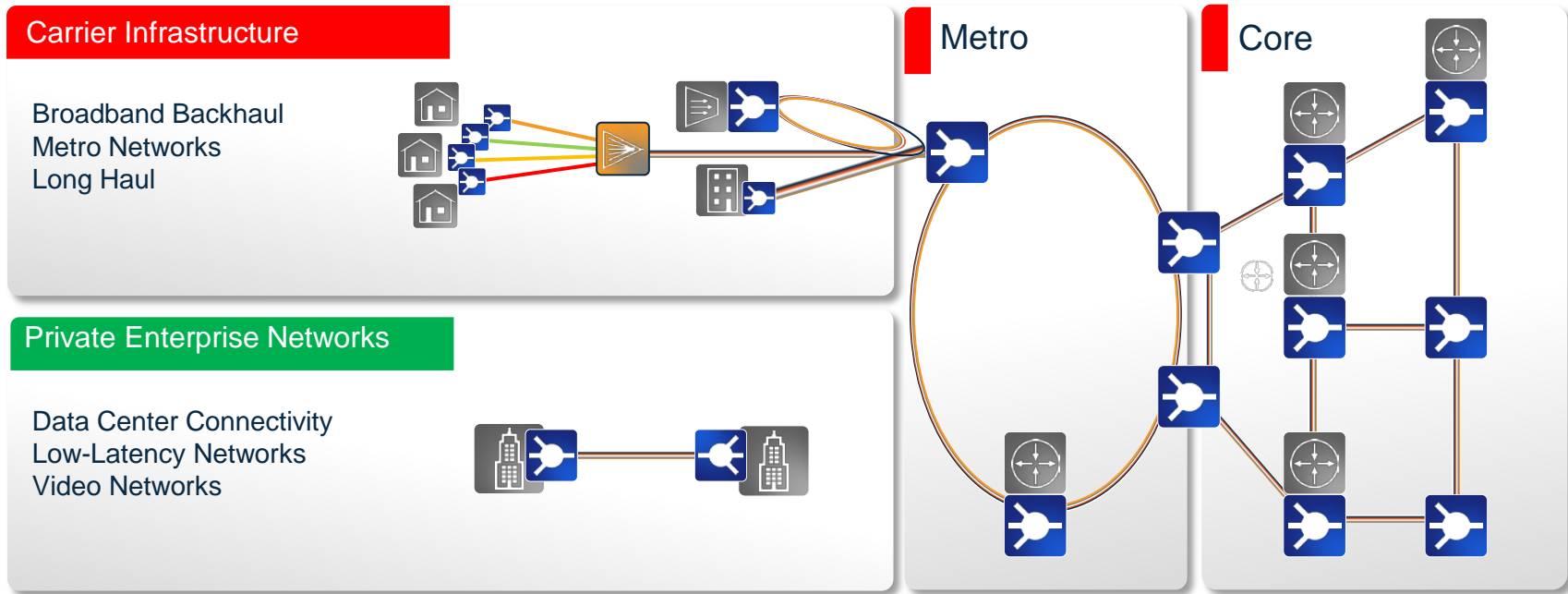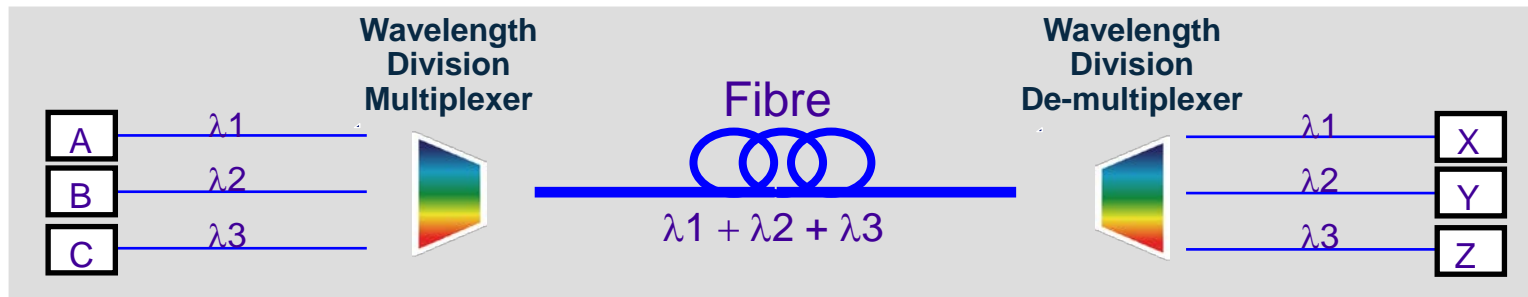
# Storage: Direct attached <10km



- Scalability ?  ☹
- Management ?  ☹
- Link Utilization ?  ☹
- Long Distance ?  ☹

--- Coupling
--- FICON/FC
--- PPRC

# WDM transport – The big picture



**Carrier Infrastructure**

Broadband Backhaul
Metro Networks
Long Haul

**Private Enterprise Networks**

Data Center Connectivity
Low-Latency Networks
Video Networks

Metro

Core

# Wavelength Division Multiplexing (WDM)



- Multiple channels of information carried over the same fibre, each using an individual wavelength

- Attractive multiplexing technique
  - High aggregate bit rate without high speed electronics or modulation
  - Low dispersion penalty for aggregate bit rate
  - Very useful for upgrades to installed fibres
  - Commonly used for distances up to 3000km

- Loss, crosstalk and non-linear effects are potential problems
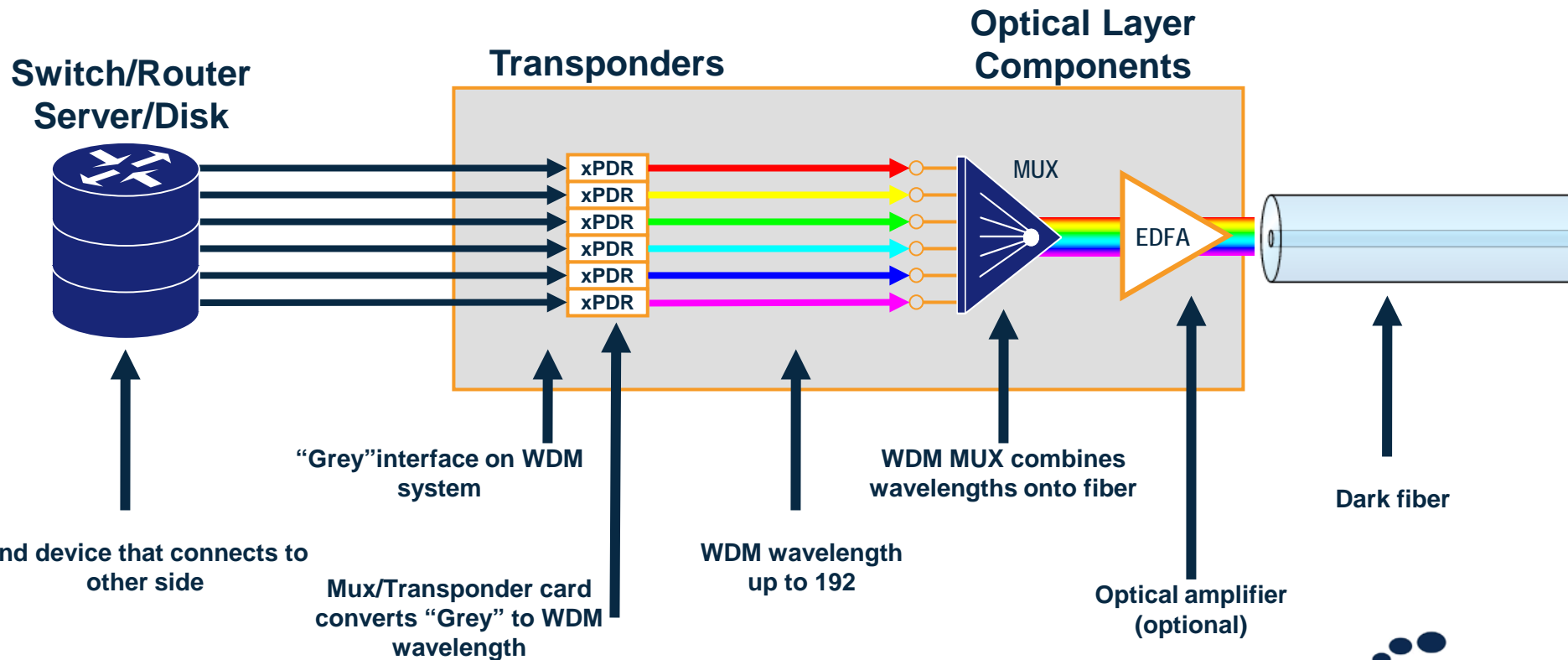
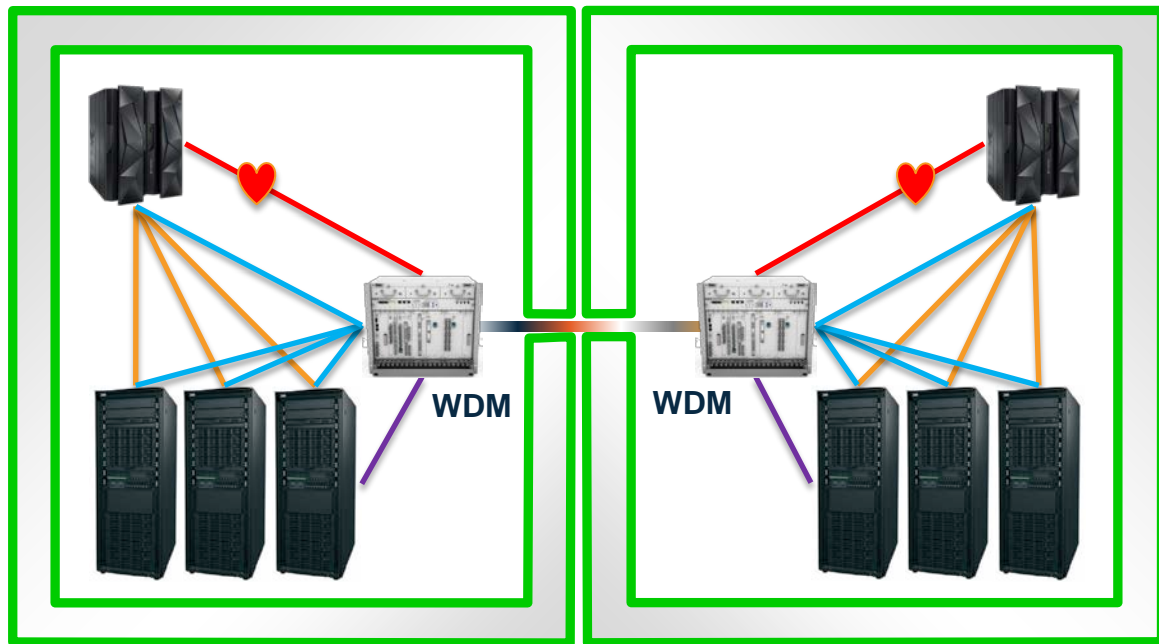# Wavelength Division Multiplexing

- Two WDM flavors available
  - CWDM (Coarse WDM)
    - Up to 16 optical lambdas max
    - Cheaper than DWDM
    - No amplification, optical switching (80km max)
  - DWDM (Dense WDM)
    - Up to 192 optical lambdas
    - Up to thousands of kilometers
    - Lambda switching, 100G, advanced features
    - DWDM is qualified for System Z only

# Basic WDM scheme



**Optical Layer Components**

**Transponders**

**Switch/Router Server/Disk**

xPDR
xPDR
xPDR
xPDR
xPDR
xPDR

MUX

EDFA

"Grey"interface on WDM system

WDM MUX combines wavelengths onto fiber

Dark fiber

End device that connects to other side

Mux/Transponder card converts "Grey" to WDM wavelength

WDM wavelength up to 192

Optical amplifier (optional)

# Storage: Direct attached with WDM <10km
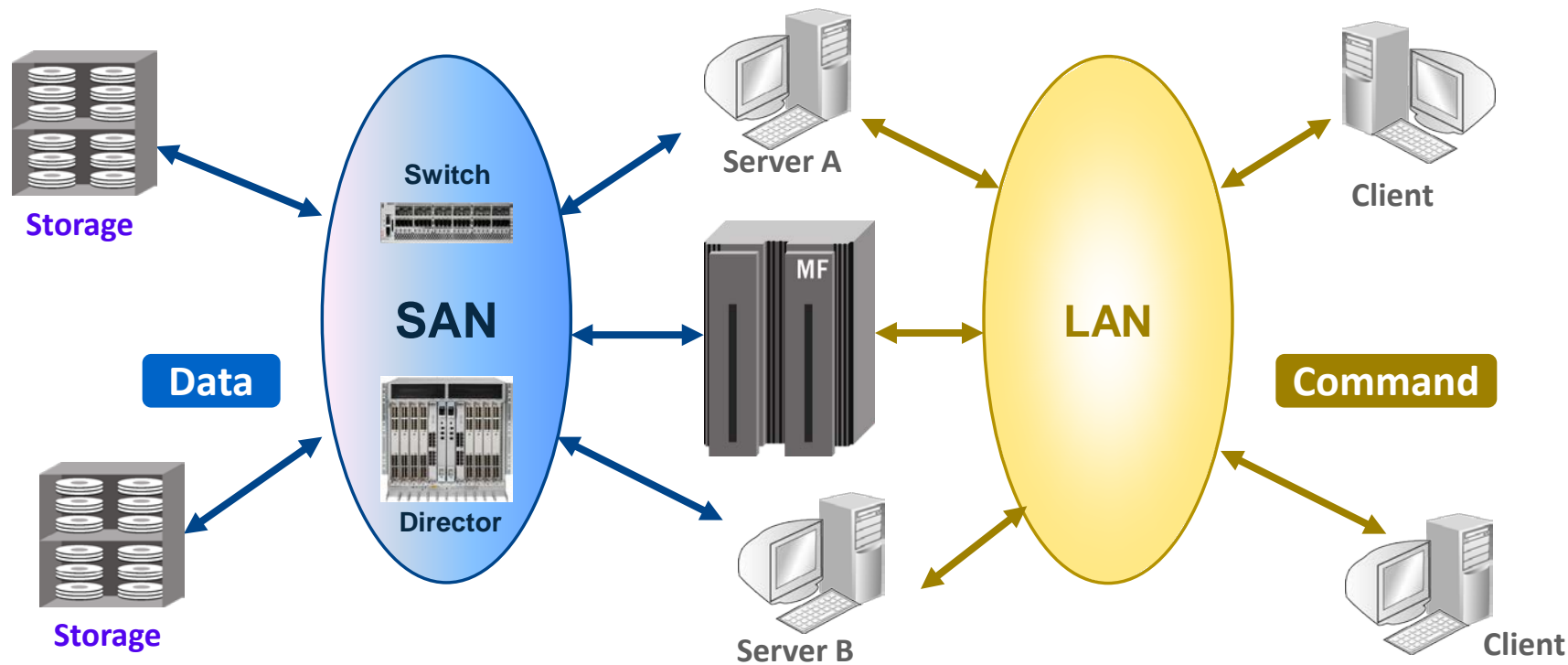


- Scalability ?            ☺
- Management ?         😐
- Link Utilization ?      ☹
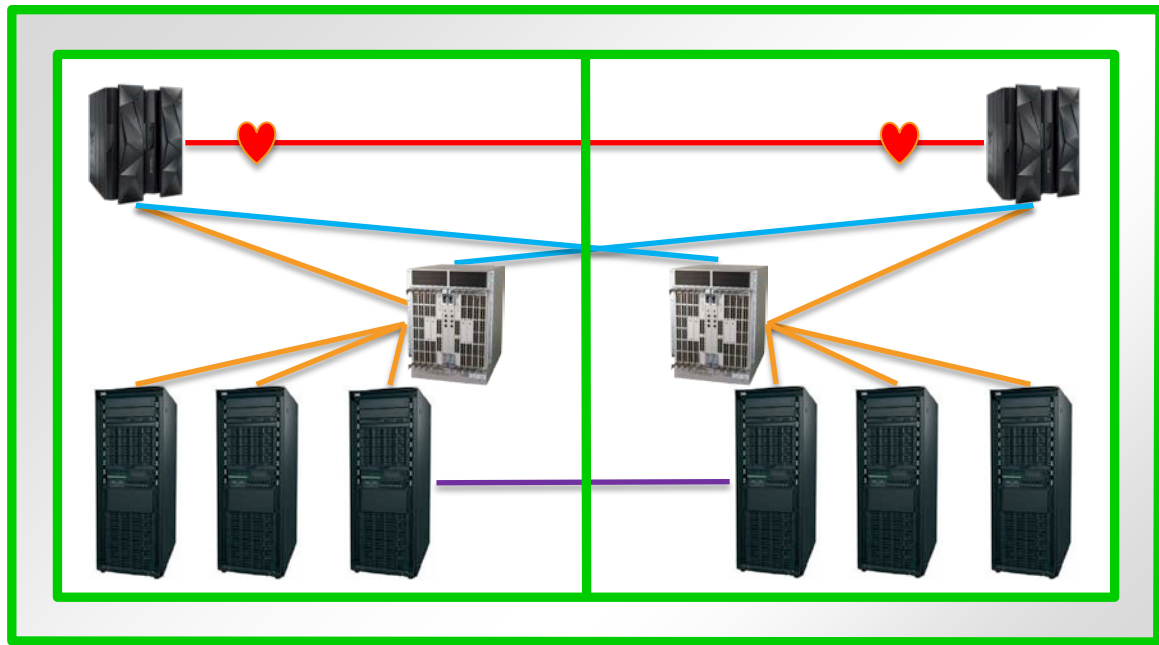- Long Distance ?        ☹

— Coupling
— FICON/FC
— PPRC

WDM        WDM

# Storage: Switch attached

- A dedicated data storage network which can be accessed by multiple servers



**Storage**

**Switch**

**SAN**

**Data**

**Director**

**Storage**

Server A

MF

**LAN**

**Command**

Client

Server B

Client

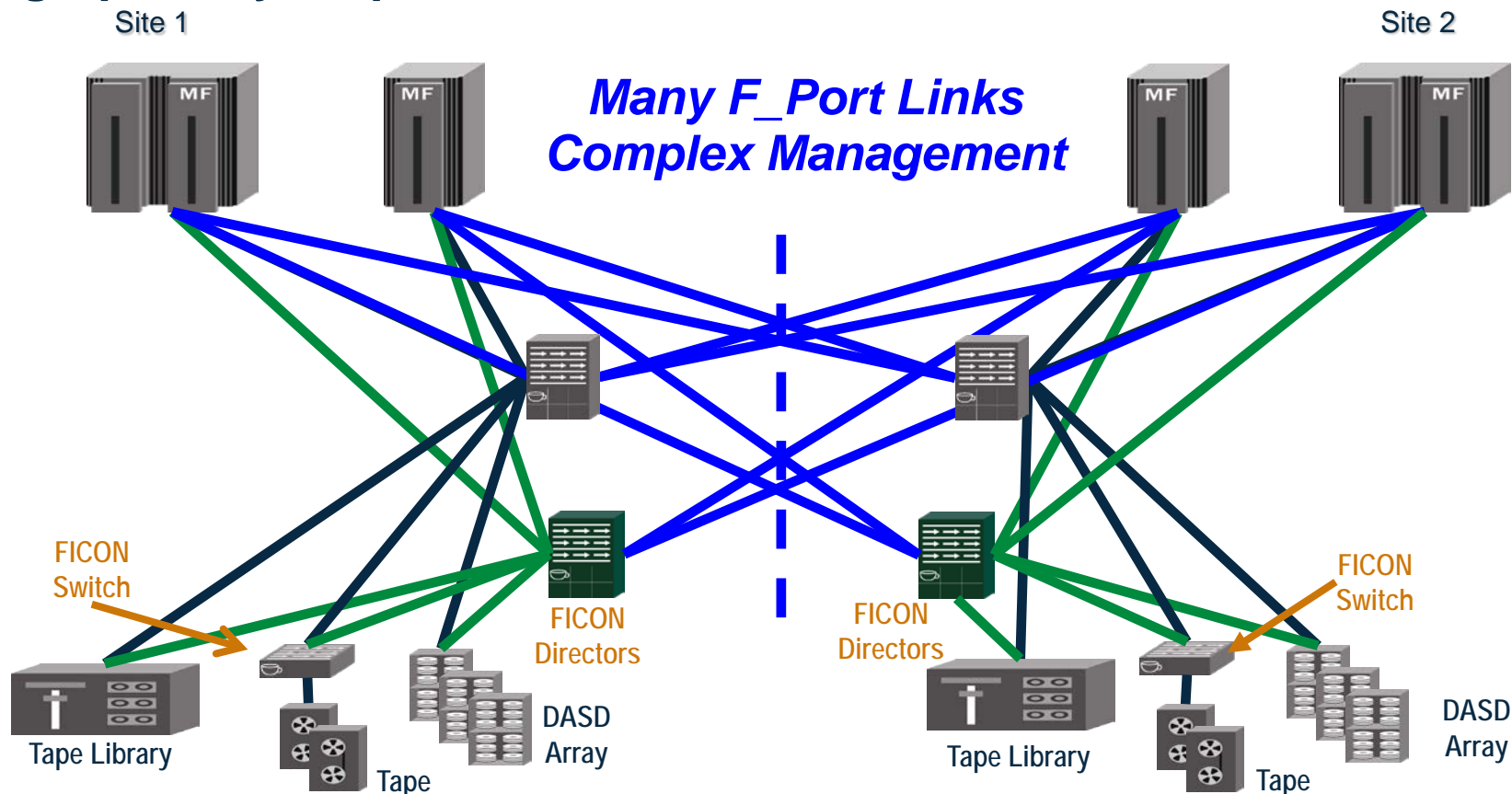# Storage: Switched but non-cascaded <10km



- Scalability ?        😐
- Management ?       😐
- Link Utilization ?   😐
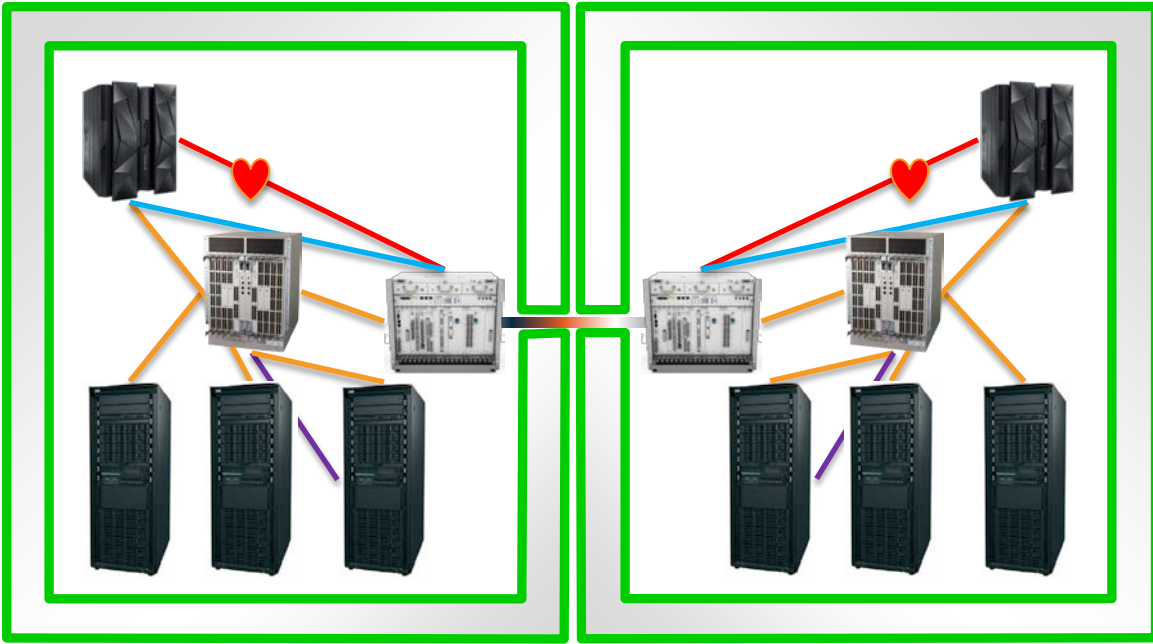- Long Distance ?    ☹

— Coupling
— FICON/FC
— PPRC

# Non-Cascaded FICON Environment
## Geographically Dispersed Data Center Connections

*Many F_Port Links*
*Complex Management*

FICON
Switch

FICON
Directors

FICON
Directors

FICON
Switch

Tape Library

Tape

DASD
Array

Tape Library

Tape

DASD
Array

Complete your session evaluations online at www.SHARE.org/Pittsburgh-Eval
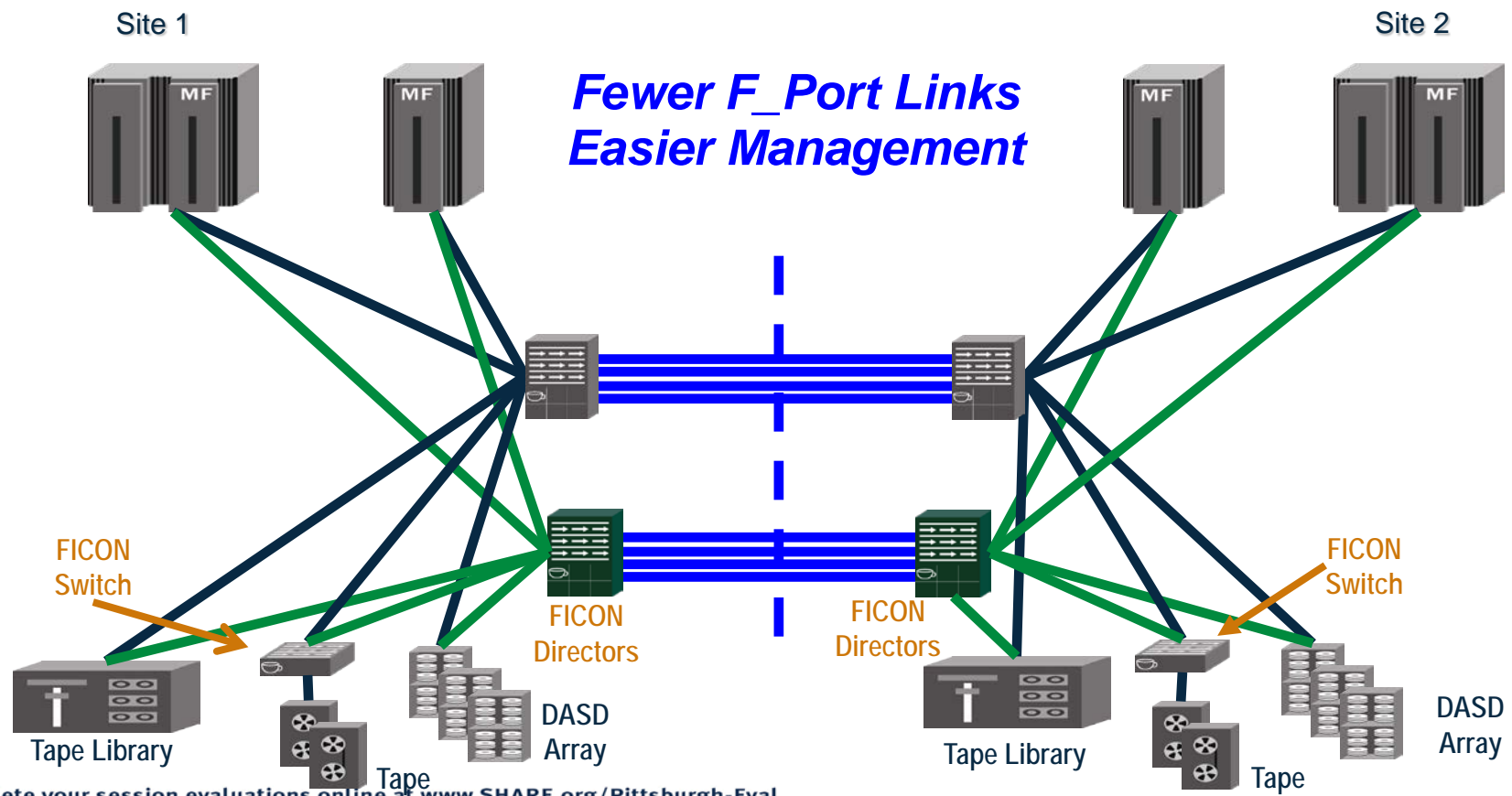
# Storage: Switched non-cascaded with WDM



- Scalability ?  ☺
- Management ?  ☺
- Link Utilization ?  😐
- Long Distance ?  ☹

— Coupling
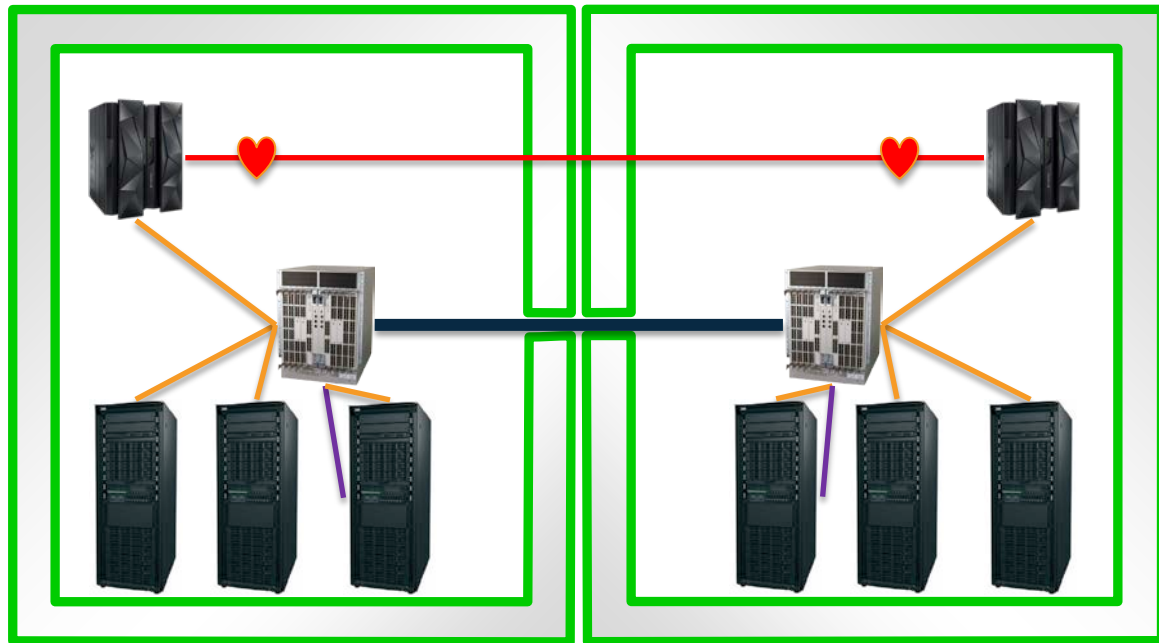— FICON/FC
— PPRC

# Cascaded FICON Environment
## Geographically Dispersed Data Center Connections

Site 1

Site 2

*Fewer F_Port Links*
*Easier Management*

MF

MF

MF

MF

FICON
Switch

FICON
Switch

FICON
Directors

FICON
Directors

Tape Library

Tape

DASD
Array

Tape Library

Tape

DASD
Array

Complete your session evaluations online at www.SHARE.org/Pittsburgh-Eval

# Storage: Switched – cascaded >10km



- Scalability ?       😐
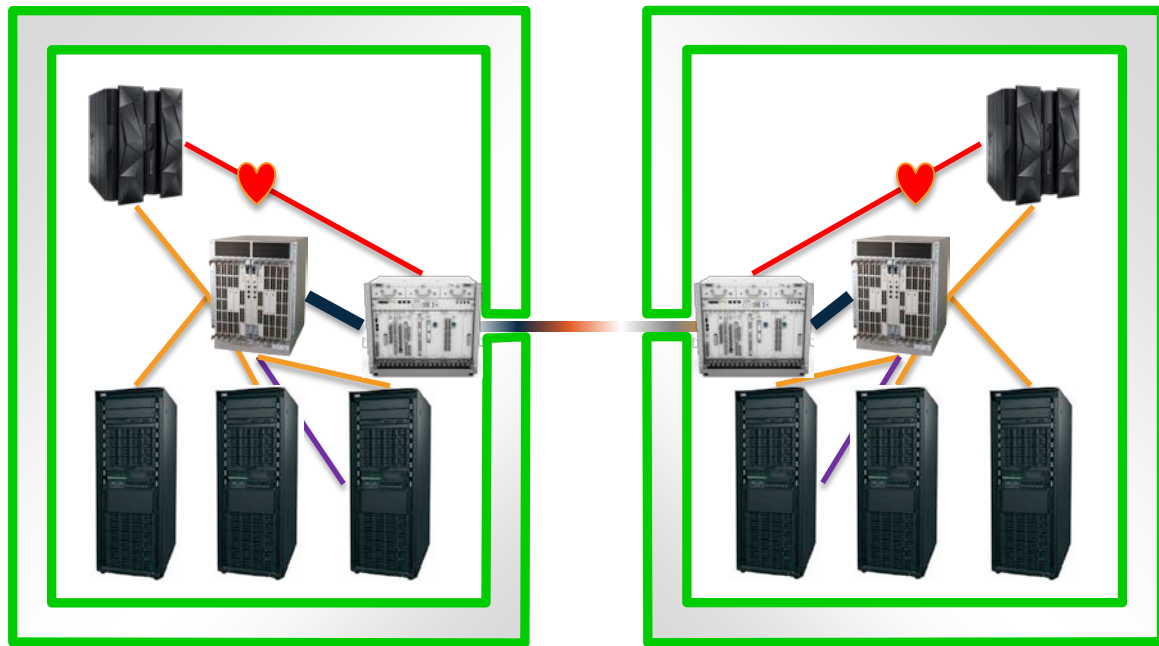- Management ?        😐
- Link Utilization ?  ☺
- Long Distance ?     😐

| | |
|---|---|
| —— | Coupling |
| —— | FICON/FC |
| —— | PPRC |
| —— | ISL's |

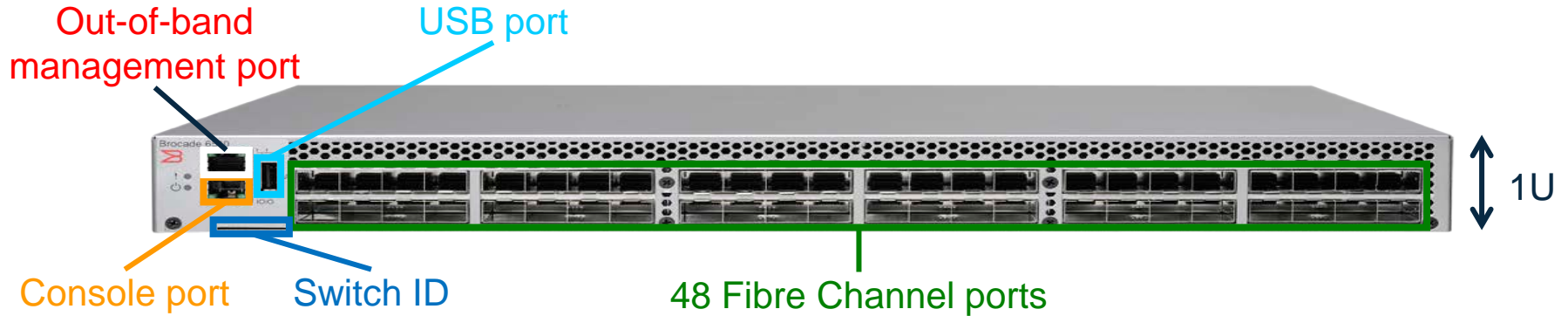# Storage: Switched – cascaded with WDM >10km



- Scalability ?  ☺
- Management ?  ☺
- Link Utilization ?  ☺
- Long Distance?  ☺

— Coupling
— FICON/FC
— PPRC
— ISL's

# Brocade Gen 5 6510 Switch

Front view

Out-of-band
management port

USB port

Console port

Switch ID

1U

48 Fibre Channel ports

- 48×16/10/8/4/2 Gbps Fibre Channel ports
- System Ethernet port (RJ45) for out-of-band management
- System RS232 console port (RJ45)
- USB port for firmware upgrades and system log downloads
- Switch ID pull-out tab containing serial number and MAC address
- Small footprint (1U and less than 18 inches deep) for flexible deployments

# Brocade Gen 5 8510 Director

Up to 384 ports with 1:1 subscription at 8 Gbps
- FICON: 256 ports 1.0:1 at 16 Gbps  (z/OS limitation)
- FCP:    384 ports 1.0:1 at 16 Gbps using local switching

Aggregate Bandwidth:
- 4 Tbps per chassis for central switching
  - *256 user ports * 16 Gb = 4 Tbps/chassis*

512 Gbps data rate bandwidth per connectivity s

12-slot card cage:
- 8 port and/or special purpose blades (e.g. FCIP)
- 2 control processor blades
- 2 core routing blades

Buffer Credits
- 8,000 per 16-port group on 32-port blades

16Gbps blades are interchangeable between the
8510-4 and 8510-8



Brocade-branded Optics

8510-4

8510-8

# ADVA FSP 3000

- State of the art 1G-100G transport platform

- Up to 192 optical channel/19.2Tbps per fiber pair

- Qualified with all SAN/Storage vendors and applications

- Physical Layer inspection vie optical line monitoring and build in OTDR

- Dedicated modules especially for datacenter connectivity

- Ultra low latency (down to 5ns) per link

- Less than 1W per Gbit transport

- Full support of <u>all</u> Brocade features over distance
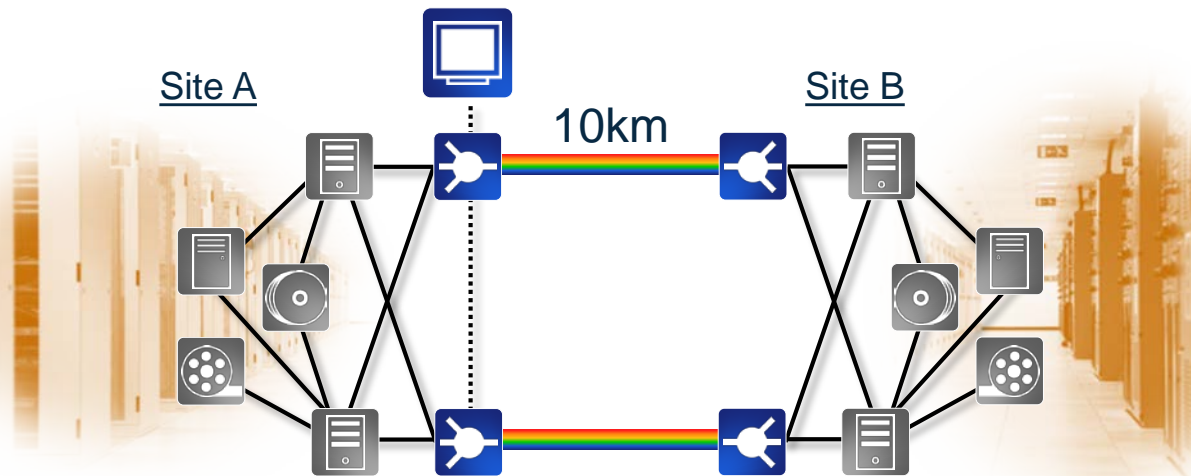
# Brocade and ADVA for System z
## The best of two worlds

- Long distance trunking over WDM System

- 1000+ 16G FC; 2000 8G FC ports per WDM System

- Physical Layer inspection and WDM failover for System z connectivity

- Encryption on Brocade and or ADVA WDM possible

- WDM Encryption fro Ethernet/FC/FICON/Coupling up to 100G
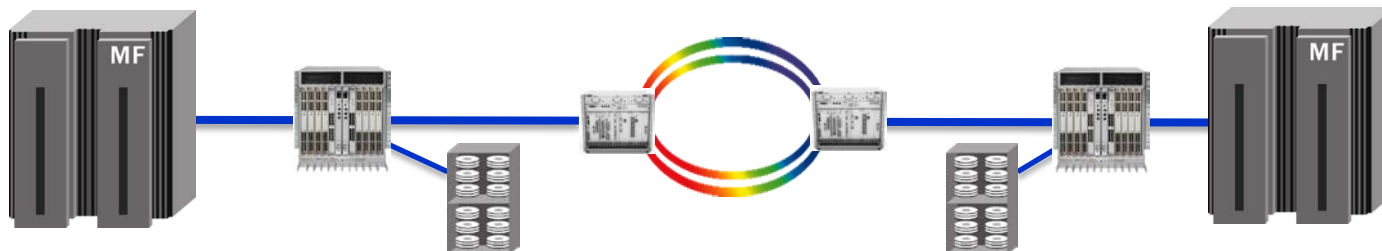
# A real world example



- 10 x 8G FC for PPRC
- 10 x 8G FICON over distance (each Host site to each disk side)
- 4 x Parallel Sysplex InfiniBand  (PSIFB) for Coupling
- Only one link used for calcualtions

# Model comparision

Different models (**one link**) vs long distance fiber need

- Direct :                          34 x Singlemode cables
- Direct w/ WDM:               1 Singlemode cable, 34 WDM links
- Switched:                        34 x Singlemode cables
- Switched w/ WDM:           1 Singlemode cable, 34 WDM links

- Cascaded                       10 x Singlemode long dist. Cables (16G ISL's) +
                                         4 WDM links
- Cascaded     w/ WDM:      1 Singlemode cable, 14 WDM links


- Fiber Cost estimated USD 600 per fiber pair, per km and per year
- With cascaded directors, the long distance connection bandwidth was reduced from 30 x 8G to 10 x 16G due to  better link utilization using 16G ISL's and trunking
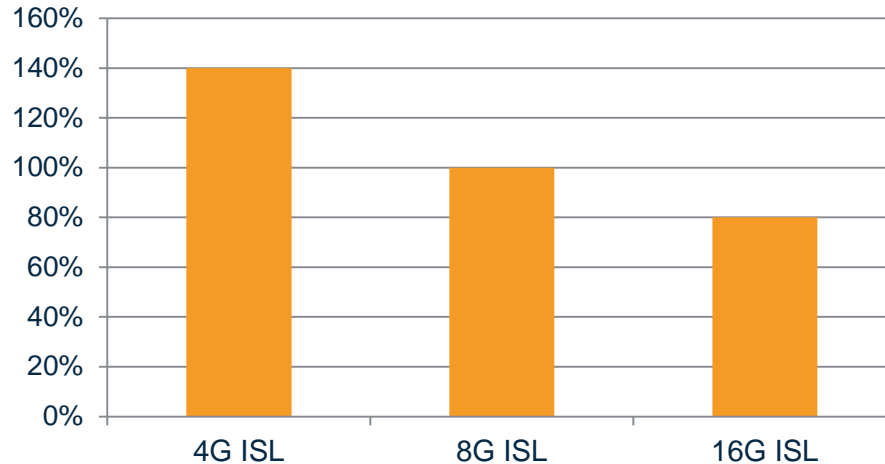
# CAPEX/OPEX in 1000USD
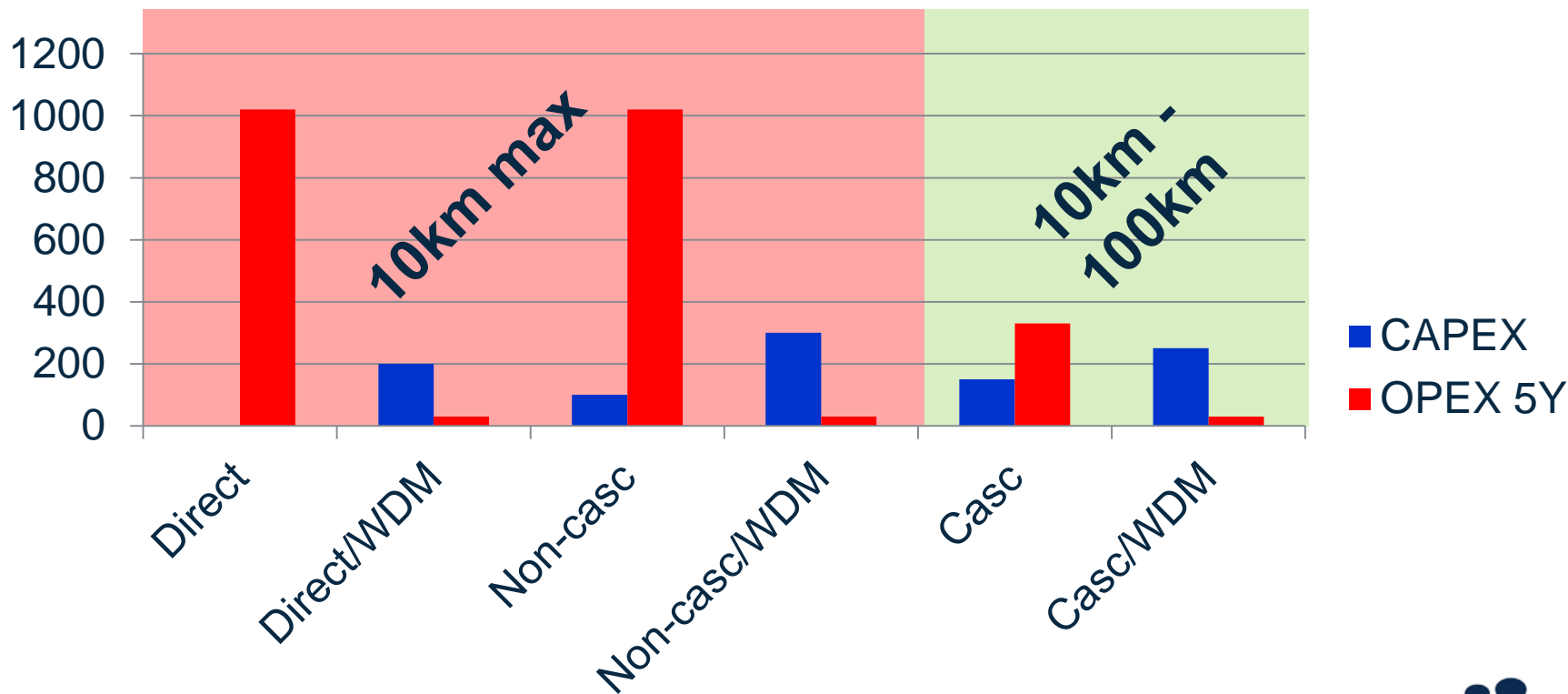
# WDM Connectivity cost versus ISL Speed

## WDM Capex



- 10 x 8G FC/FICON/ISL connectivity over a 50km WDM link

- WDM HW only

- + additional savings on FC director ports

- + better bandwidth utilization on 16G ISL's

- + more upgrade capacity on WDM and FC director

# Conclusion

- WDM should not be seen separately, it is part of the SAN/MF architecture to achieve best performance

- Cascaded directors is the #1 choice for longer distances, better performance/utilization

- ISL's should be used at the highest speed possible regardless the local connection speed

- See more on IBM Redbook SG248047:
  - *System z End-to-End Extended Distance Guide*

**Our `Reaction!**

*Your Eval*

5 = "Aw shucks. Thanks!"
4 = "Mighty kind of you!"
3 = "Glad you enjoyed this!"
2 = "A Few Good Nuggets!"
1 = "You Got a Nice Nap!"

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THE END

Session
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