



# SHARE in San Francisco

February 3 - 8, 2013



## The IBM zEnterprise® EC12 (zEC12) System: I/O Subsystem, Parallel Sysplex Coupling, and Installation Planning

**Session ID: 13077**

Tuesday, February 5, 2013, 11:00 AM  
Grand Ballroom B, San Francisco Hilton

**Speaker: Harv Emery**



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# zEC12 I/O Subsystem Introduction



## IBM zEC12 Functions and Features

### Processor, Memory, RAS

#### Five Hardware Models

Six core 32nm processor chip with 25% greater capacity per core than z196<sup>1</sup>

Up to 101 configurable cores with 50% greater capacity than z196 model M80<sup>1</sup>

#### 60 CP Subcapacity Settings

Up to 3 TB memory

z/Architecture Enhancements including 2 GB Pages, Transactional Execution and Runtime Instrumentation

Flash memory resiliency improvements and pageable large page support

Improved availability with IBM zAware

### Parallel Sysplex, Security, I/O

CFCC Level 18 Enhancements

NTP security enhancements for STP

OSA-Express4S 1000BASE-T

Crypto Express4S  
(FIPS 140-2 cert and PKCS#11 support)

Trusted Key Entry (TKE) 7.2



**Upgradeable from  
z10 EC and z196**

### Environmental

Optional Non Raised Floor

Optional Overhead Power and Overhead I/O Cabling

Improved N+1 Radiator-based Air Cooling

Improved Optional Water Cooling with Air Cooled Backup

Static Power Save Mode

Optional High Voltage DC Power

### Ensemble, Platform Management

IBM zEnterprise BladeCenter Extension Model 3

Unified Resource Manager enhancements for zEC12 and zBX Model 3

Unified Resource Manager support for ensembles with zEC12, z196, z114, and zBX Models 2 and 3

Doubled IEDN bandwidth internal to the zBX Model 3

Upgraded POWER7 and System x General Purpose Blades Hypervisor Levels

Continued incremental improvements

<sup>1</sup>Based on preliminary internal measurements and projections against a z196. Official performance data will be available upon announce and can be obtained online at LSPR (Large Systems Performance Reference) website at: <https://www-304.ibm.com/servers/resourceclink/lib03060.nsf/pages/lsprindex?OpenDocument> . Actual performance results may vary by customer based on individual workload, configuration and software levels.



## I/O Subsystem Internal Bus Interconnect Speeds (GigaBytes per second)



PCIe  
zEC12  
z196 GA2  
z114



8 GBps



InfiniBand  
zEC12  
z10/z196 GA1



6 GBps



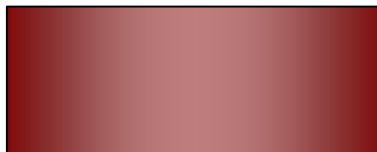
STI  
z9



2.7 GBps



STI  
z990/z890



2 GBps



STI  
z900/z800



1 GBps

PCIe: Peripheral Component Interface (PCI) Express  
STI: Self-Timed Interconnect

## zEC12 still supports two I/O infrastructures for I/O feature cards

### ▪ **PCI Express 2 I/O infrastructure**

- PCIe fanouts supporting 8 GBps PCIe I/O interconnect
- PCIe switches with Redundant I/O interconnect in for I/O domains in the 7U, 32-slot, 4-domain PCIe I/O drawer introduced with z114 and z196 GA2
- PCI Express I/O feature cards

Based on selected industry standard PCIe I/O

Designed to:

**Improve I/O port purchase granularity (fewer ports per card)**

**Improve performance**

**Increase I/O port density**

**Lower energy consumption**

### ▪ **InfiniBand I/O infrastructure (Carry forward only, NO MES adds)**

- InfiniBand fanouts supporting a 6 GBps InfiniBand I/O interconnect
- InfiniBand I/O card domain multiplexers with Redundant I/O interconnect in:
  - The 14U, 28-slot, 7-domain I/O cage
  - The 5U, 8-slot, 2-domain IO drawer
- Selected legacy I/O feature cards

# I/O Subsystem Structure



## Multiple subchannel sets on zEC12

Note: zEC12 supports 60 LPARs (15 per LCSS). Each LCSS provides three subchannel sets

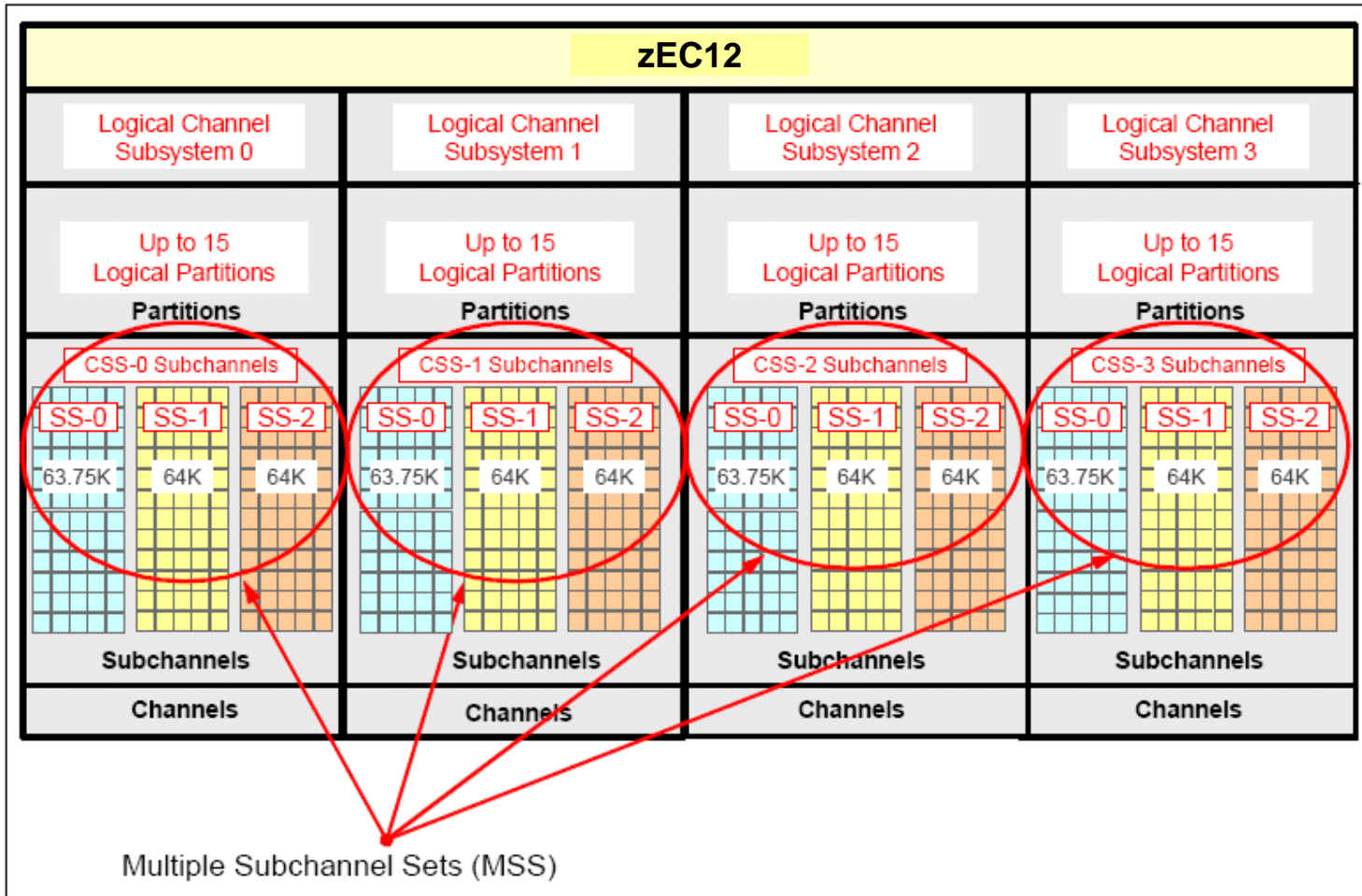
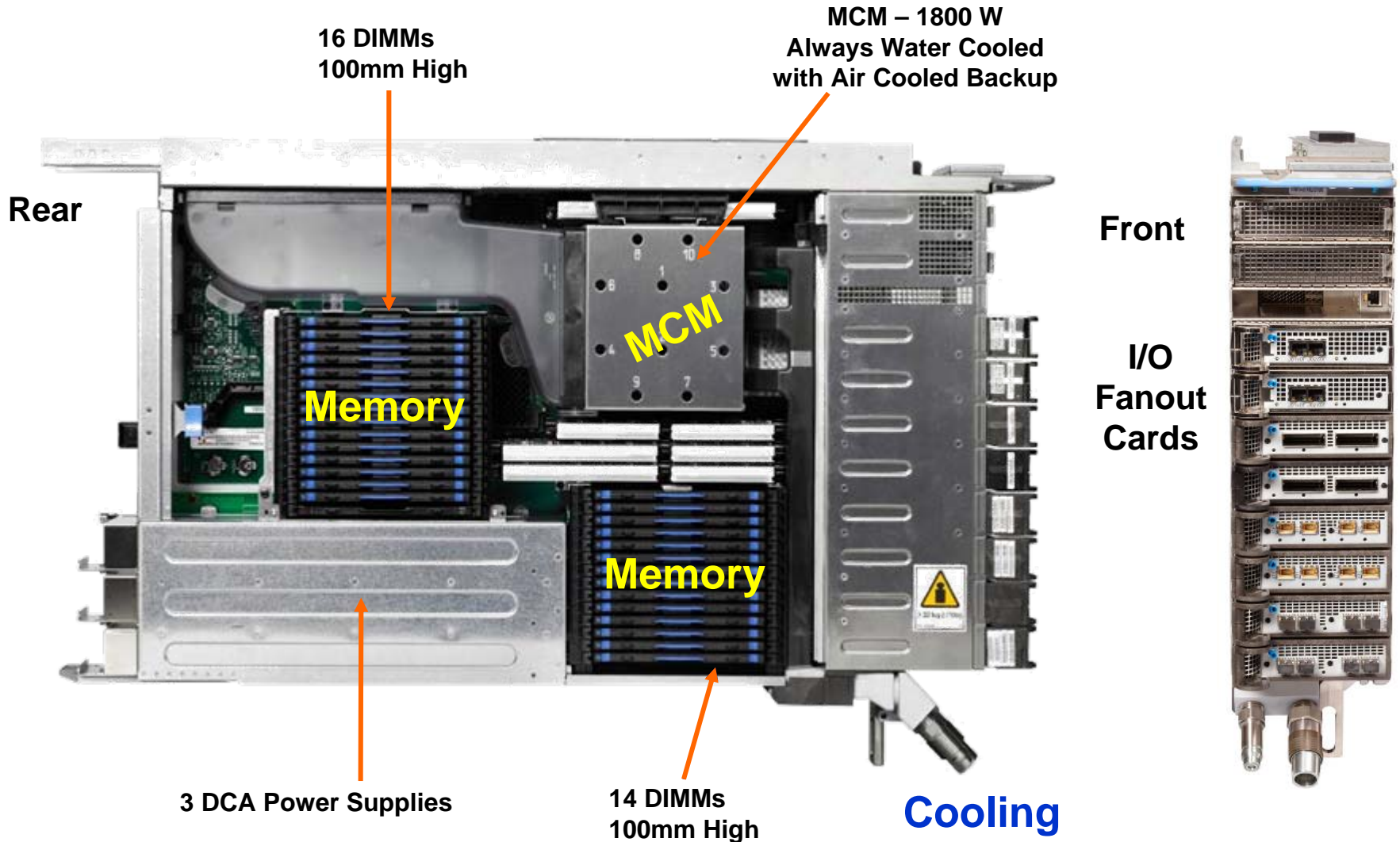


Figure 1-4 Multiple subchannels sets



## zEC12 Book Layout



## zEC12 Model H89 or HA1 Radiator (Air) Cooled – Under the covers Front view

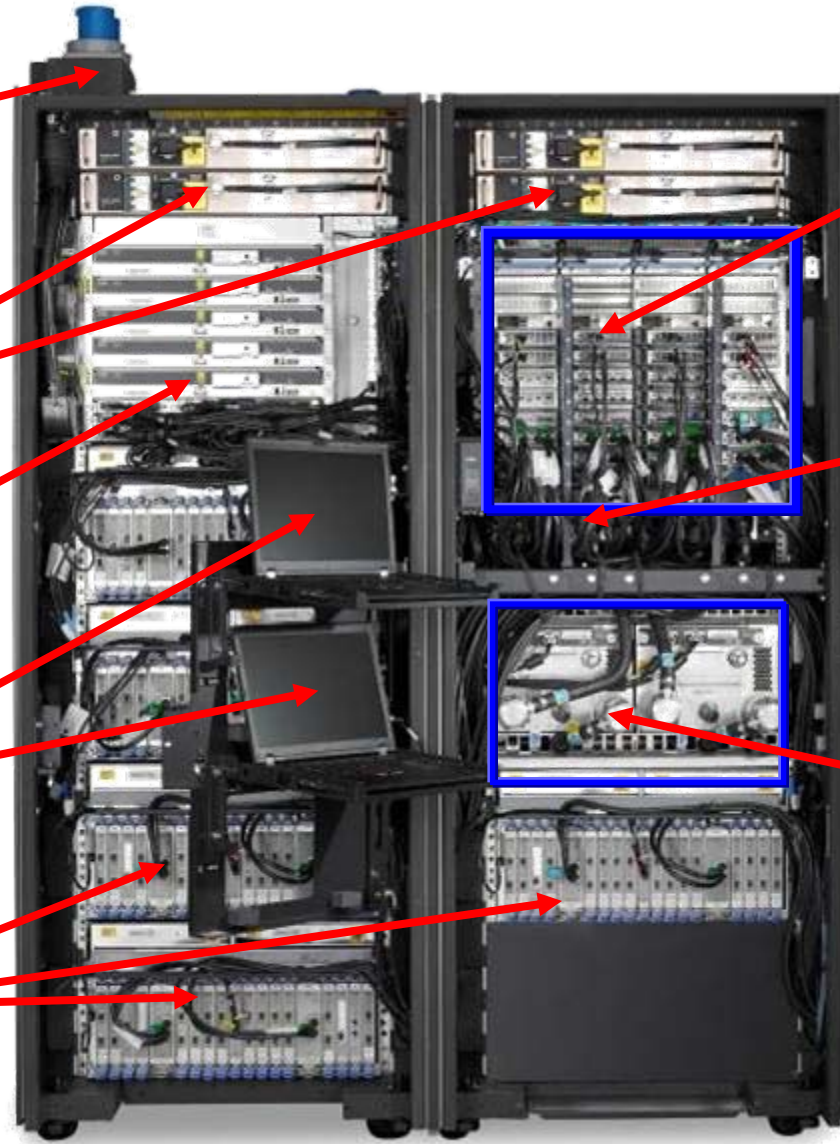
Overhead  
Power Cables  
(option)

Internal  
Batteries  
(option)

Power  
Supplies

2 x Support  
Elements

PCIe I/O  
drawers  
(Maximum 5  
for zEC12)



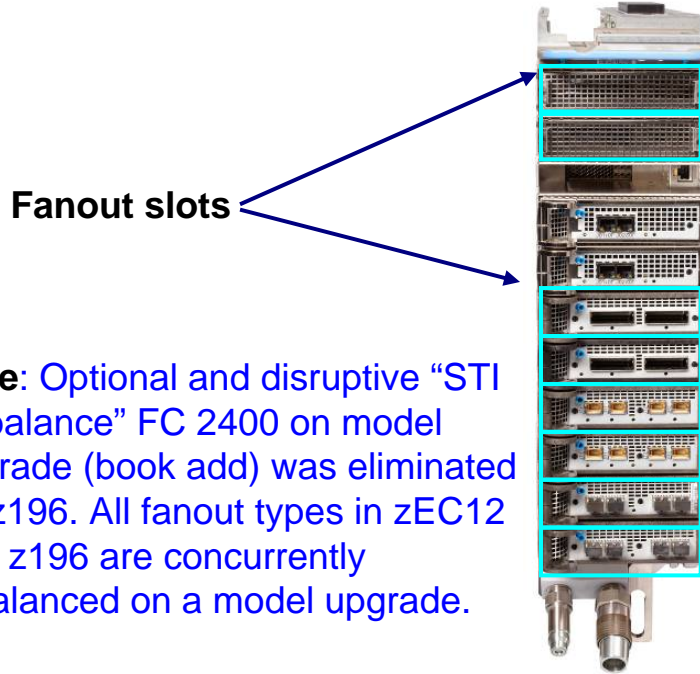
Processor Books  
with Flexible Support  
Processors (FSPs),  
PCIe and HCA I/O  
fanouts

PCIe I/O interconnect  
cables and Ethernet  
cables for FSP cage  
controller cards

N+1 Radiator-based  
Air Cooling Unit

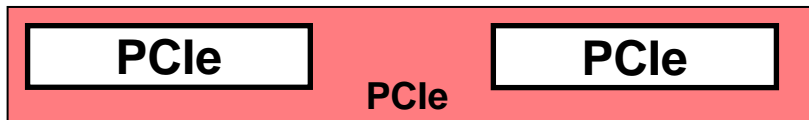
**Optional FICON LX  
Fiber Quick Connect  
(FQC) not shown**

## zEC12 Connectivity for I/O and Coupling

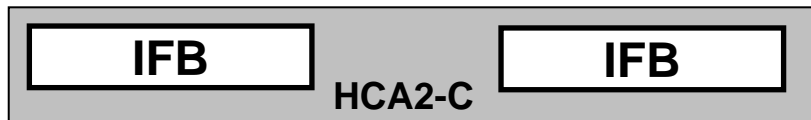


**Note:** Optional and disruptive “STI Rebalance” FC 2400 on model upgrade (book add) was eliminated on z196. All fanout types in zEC12 and z196 are concurrently rebalanced on a model upgrade.

- **Up to 8 fanout cards per zEC12 book**
  - H20 (1 book) – up to 8
  - H43 (2 books) – up to 16
  - H66 (3 books) – up to 20
  - H89 and HA1 (4 books) – up to 24
  
- **I/O fanouts compete for fanout slots with the the InfiniBand HCA fanouts that support coupling:**
  - HCA2-O 12x two InfiniBand DDR links (CF)
  - HCA2-O LR two 1x InfiniBand DDR links (CF)
  - **HCA3-O two 12x InfiniBand DDR links**
  - **HCA3-O LR four 1x InfiniBand DDR links**
  -



- **PCIe fanout – PCIe I/O Interconnect links**  
Supports two copper cable PCIe 8 GBps interconnects to two 8-card PCIe I/O domain multiplexers.  
**Always plugged in pairs for redundancy.**



- **HCA2-C fanout – InfiniBand I/O Interconnect**  
Supports two copper cable 12x InfiniBand DDR 6 GBps interconnects to two 4-card I/O domain multiplexers. **(Carry forward only)**  
**Always plugged in pairs for redundancy.**

## zEC12 Book and I/O fanout plugging

### H20

ECF	OSC	ECF	OSC
filler	D1 I/O	filler	filler
	D2 I/O		
	D3 FSP		
	D4 FSP		
	D5 I/O		
	D6 I/O		
	D7 I/O		
	D8 I/O		
	D9 I/O		
	DA I/O		

### H43

ECF	OSC	ECF	OSC
filler	D1 I/O	filler	filler
	D2 I/O		
	D3 FSP		
	D4 FSP		
	D5 I/O		
	D6 I/O		
	D7 I/O		
	D8 I/O		
	D9 I/O		
	DA I/O		

- **I/O fanouts**
  - H20 up to 8
  - H43 up to 16
  - H66 up to 20
  - H89/HA1 up to 24

### Front views

### H66

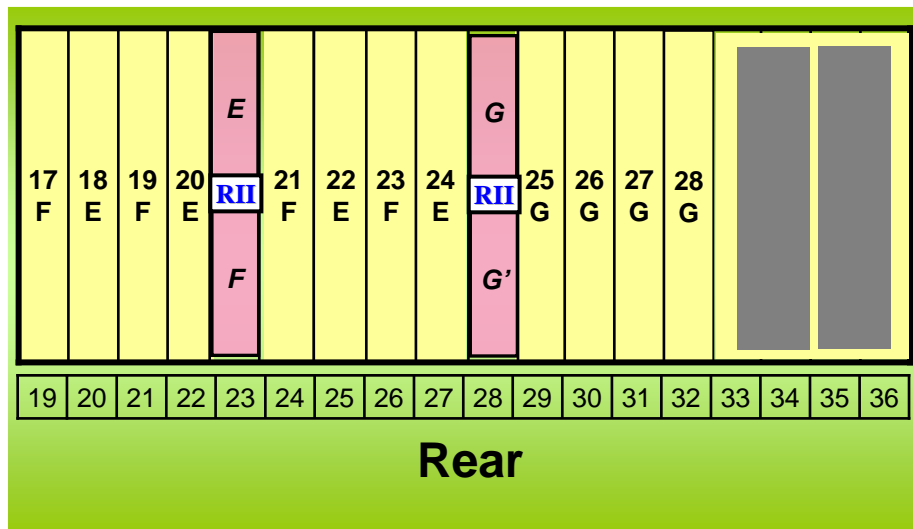
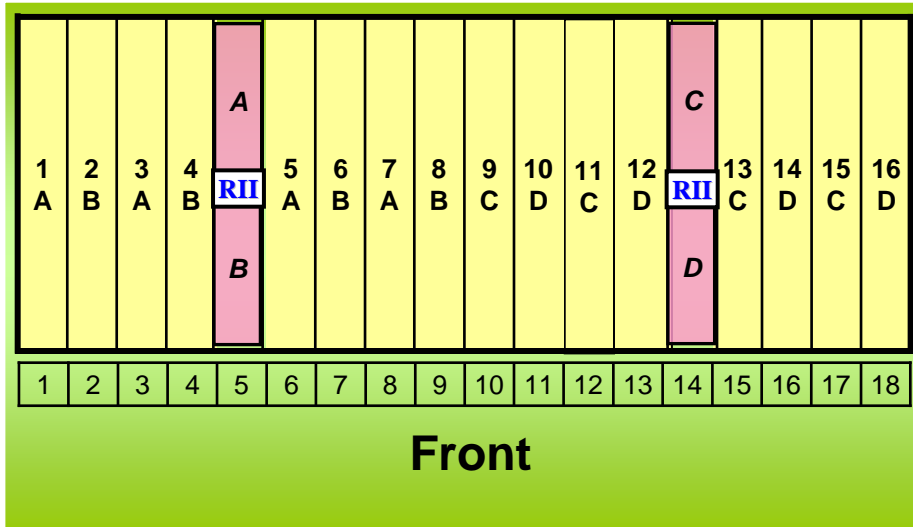
ECF	OSC	ECF	OSC		
filler	D1 I/O	filler	filler		
	D2 I/O				
	D3 FSP			D3 FSP	D3 FSP
	D4 FSP			D4 FSP	D4 FSP
	D5 I/O			D5 I/O	D5 I/O
	D6 I/O			D6 I/O	D6 I/O
	D7 I/O			D7 I/O	D7 I/O
	D8 I/O			D8 I/O	D8 I/O
	D9 I/O			D9 I/O	D9 I/O
	DA I/O			DA I/O	DA I/O

### H89 and HA1

ECF	OSC	ECF	OSC		
filler	D1 I/O	filler	filler		
	D2 I/O				
	D3 FSP			D3 FSP	D3 FSP
	D4 FSP			D4 FSP	D4 FSP
	D5 I/O			D5 I/O	D5 I/O
	D6 I/O			D6 I/O	D6 I/O
	D7 I/O			D7 I/O	D7 I/O
	D8 I/O			D8 I/O	D8 I/O
	D9 I/O			D9 I/O	D9 I/O
	DA I/O			DA I/O	DA I/O

- **Cooling Design**
  - Fanout locations D1 and D2 are NOT used in the 2<sup>nd</sup> or 3<sup>rd</sup> Book for Model H66
  - Fanout locations D1 and D2 are NOT used in any Book for Models H89 and HA1

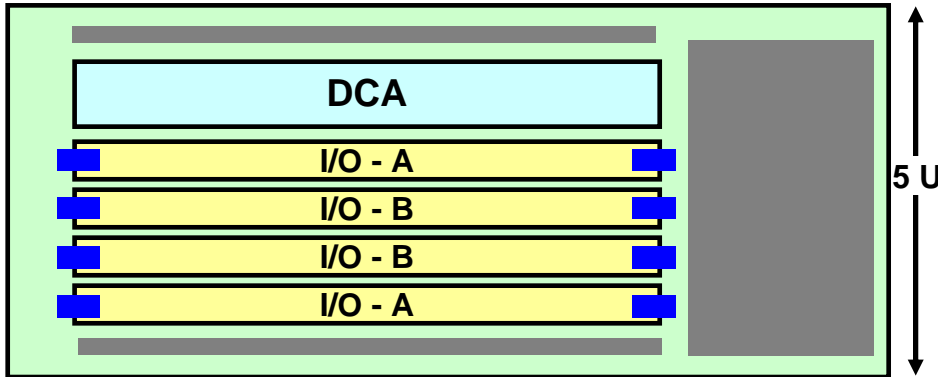
## 28-slot I/O Cage (Introduced with z900, Carry Forward only)



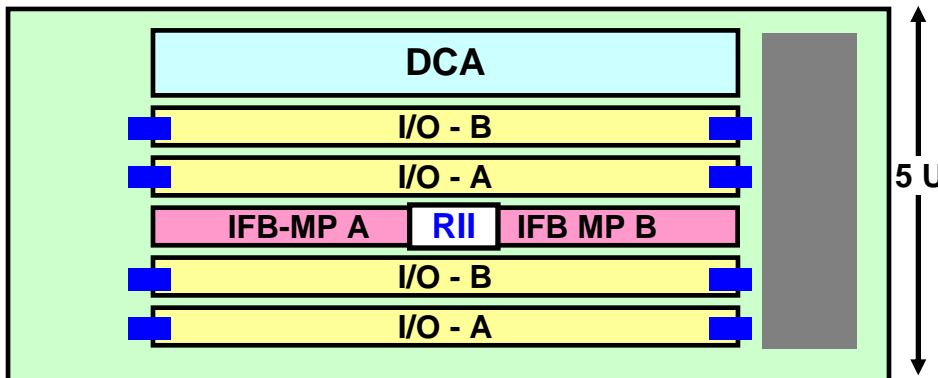
- Supports all carry forward non-PCIe I/O and Crypto Express3 cards
- Supports 28 I/O cards, 16 front and 12 rear, vertical orientation, in seven 4-card domains (shown as A to G)
- Requires eight IFB-MP daughter cards (A to G'), each connected to a 6 GBps InfiniBand I/O interconnect to activate all seven domains.
- To support **Redundant I/O Interconnect (RII)**, the two interconnects to each domain pair (A-B, C-D, E-F, and G-G') must come from two different InfiniBand fanouts. (All seven domains in one of these cages can be activated with four fanouts.)
- **Disruptive** field install or remove
- Requires 14 EIA Units of space (24.5 inches ≈ 622 mm)

## 8-slot I/O Drawer (Introduced with z10 BC, Carry Forward only)

**Front**



**Rear**



- Supports carry forward non-PCIe I/O and Crypto Express3 cards
- Supports 8 I/O cards, 4 front and 4 back, horizontal orientation, in two 4-card domains (shown as A and B)
- Requires two IFB-MP daughter cards, each connected to a 6 GBps InfiniBand interconnect to activate both domains.
- To support **Redundant I/O Interconnect (RII)** between the two domains, the two interconnects must be from two different InfiniBand fanouts. (Two fanouts can support two of these drawers.)
- **Concurrent add, repair.**
- Requires 5 EIA Units of space (8.75 inches ≈ 222 mm)

## PCIe I/O drawer and PCIe I/O features

- **Increased infrastructure bandwidth**

- PCI Express 2 x16 - **8 GBps interconnect**  
(Compared to 6 GBps 12x InfiniBand DDR interconnect)
- PCI Express 2 x8 - **4 GBps** available to PCIe I/O feature cards  
(Compared to 2 GBps or less available to I/O feature cards in the 8 slot drawer or 28 slot cage)

- **Compact**

- Two 32-slot PCIe I/O drawers occupy the same space as one 28-slot I/O cage
- Increases I/O port density 14% (Equivalent to an increase from 28 to 32 slots)

- **Improved I/O port purchase granularity**

- “Half high” I/O feature cards compared to older I/O feature cards
- Two **FICON Express8S** channels per feature (Four on FICON Express8)
- One or two **OSA-Express4S** ports per feature (Two or four on OSA-Express3)

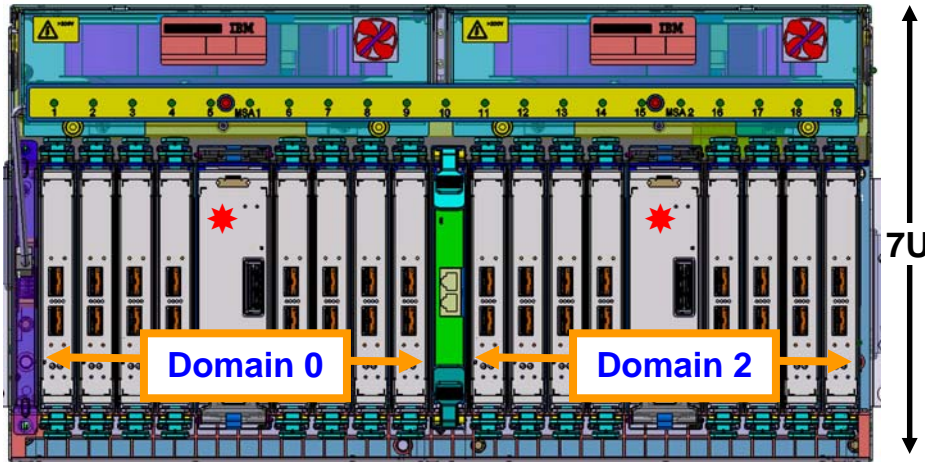
- **Reduced power consumption**

- **Designed for Improved Reliability, Availability, and Serviceability**

- Concurrent field MES install and repair
- Symmetrical, redundant cooling across all cards and power supplies
- Temperature monitoring of critical ASICs

## PCIe 32 I/O slot drawer (New build or Carry Forward)

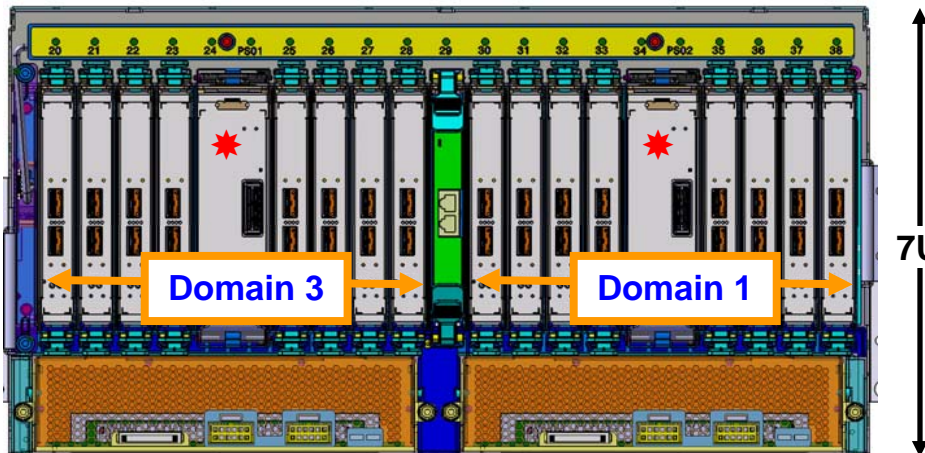
### Front



7U

- Supports only new PCIe I/O cards.
- Supports 32 PCIe I/O cards, 16 front and 16 rear, vertical orientation, in four 8-card domains (shown as 0 to 3).
- Requires four PCIe switch cards (★), each connected to an 8 GBps PCIe I/O interconnect to activate all four domains.
- To support **Redundant I/O Interconnect (RII)** between front to back domain pairs 0-1 and 2-3 the two interconnects to each pair must be from 2 different PCIe fanouts. (All four domains in one of these cages can be activated with two fanouts.)

### Rear



7U

- **Concurrent** field install and repair.
- Requires 7 EIA Units of space (12.25 inches ≈ 311 mm)

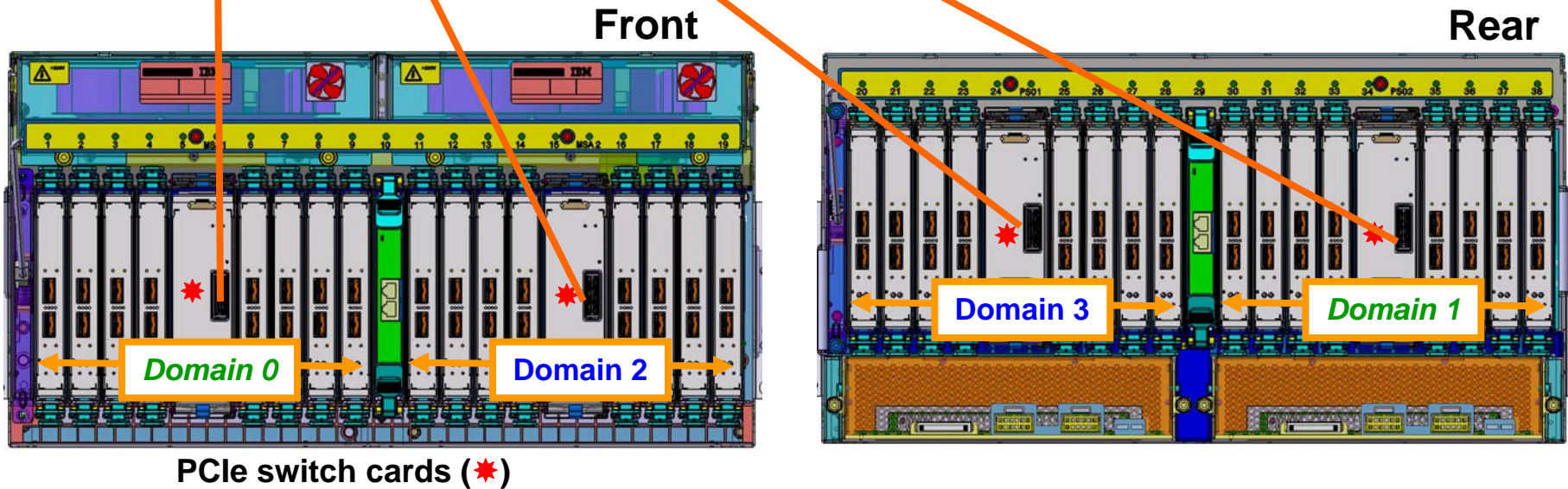


## zEC12 H89 or HA1 Redundant I/O Interconnect Example – PCIe Drawers

H89 or HA1

ECF		OSC		ECF		OSC	
D3	FSP	D3	FSP	D3	FSP	D3	FSP
D4	FSP	D4	FSP	D4	FSP	D4	FSP
D5	I/O	D5	I/O	D5	I/O	D5	I/O
D6	I/O	D6	I/O	D6	I/O	D6	I/O
D7	I/O	D7	I/O	D7	I/O	D7	I/O
D8	I/O	D8	I/O	D8	I/O	D8	I/O
D9	PCle	D9	PCle	D9	PCle	D9	PCle
DA	I/O	DA	I/O	DA	I/O	DA	I/O

- Two different **PCle** Fanouts Support Each Domain Pair:
  - 0 and 1
  - 2 and 3
- Normal operation: Each PCIe interconnect in a pair supports the eight I/O cards in its domain.
- Backup operation: One PCIe interconnect supports all 16 I/O cards in the domain pair.
- Four fanouts support **two PCIe drawers**, 64 total PCIe slots, **up to 128 FICON Express8S channels**



## zEC12 I/O Features supported

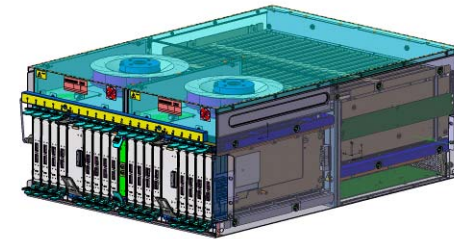
Note - zEC12 does not offer “Plan Ahead” for I/O drawers or cages.

### Supported features

#### ■ Features – PCIe I/O drawer

- **Crypto Express4S**
- **Flash Express**
- **FICON Express8S**  
SX and LX
- **OSA-Express4S**  
10 GbE LR and SR  
GbE SX, LX, and **1000BASE-T**

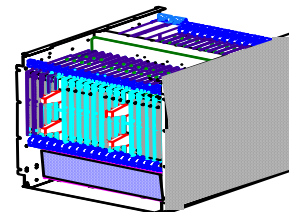
PCIe I/O drawer



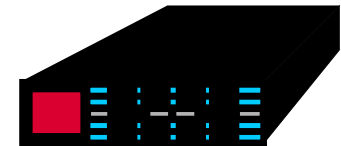
32 I/O slots

#### ■ Features – I/O cage and I/O drawer (No MES adds)

- **Not Supported: ESCON, older FICON, FICON Express4 LX 4 km, OSA-Express2, PSC**
- Crypto Express3 (Carry forward)
- FICON Express8 (Carry forward)
- FICON Express4 10 km LX and SX (Carry forward)
- ISC-3 (Carry forward – **except RPQ 8P2602**)
- OSA-Express3 (Carry forward)  
10 GbE, GbE, GbE 1000BASE-T



28 slot I/O cage



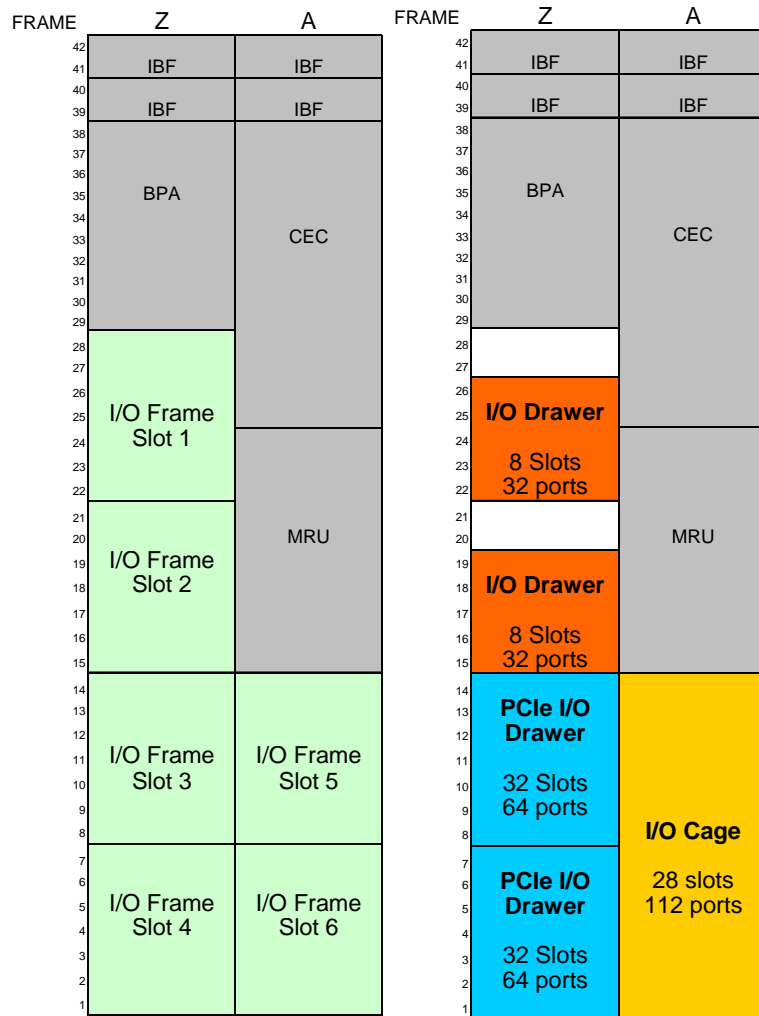
8 slot I/O drawer

## zEC12 Carry Forward (Field Upgrade) Rules for I/O Features (All PCIe I/O Features Can be Carried Forward)

<b>Non-PCIe Feature Cards Carried Forward</b>	<b>8-slot I/O Drawers</b>	<b>28-slot I/O Cages</b>	<b>Maximum PCIe Drawers/ Slots (CF or Add)</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>5/160</b>
<b>1 to 8</b>	<b>1</b>	<b>0</b>	<b>5/160</b>
<b>9 to 16</b>	<b>2</b>	<b>0</b>	<b>4/128</b>
<b>17 to 28</b>	<b>0</b>	<b>1</b>	<b>4/128</b>
<b>29 to 36</b>	<b>1</b>	<b>1</b>	<b>3/96</b>
<b>37 to 44</b>	<b>2</b>	<b>1</b>	<b>2/64</b>
<b>45 or more</b>	<b>Not Supported!</b>		

**Note:** Maximum I/O configurations require a zEC12 H43 (2 books) even without IFB links.

## zEC12 Frame Layout for Carry Forward I/O – Air Cooled\*



- An **I/O frame slot** is a physical location in the A or Z frame for an I/O cage, I/O drawer or PCIe I/O drawer to be inserted = 7u
- **PCIe I/O drawer** uses 1 I/O frame slot = 7u
  - 32 two port I/O slots = 64 ports
  - 5 drawers maximum
- **I/O cage** uses 2 I/O frame slots = 14u
  - 28 four port I/O slots = 112 ports
  - 1 cage carry forward only maximum in I/O frame slots 5+6 only
- **I/O drawer** uses 0.7 frame slot = 5u
  - 8 four port I/O slots = 32 ports
  - Requires 2u of free space for future upgrade to the PCIe I/O drawer
  - 2 drawers carry forward only maximum in I/O frame slots 1 and 2 only

\* Locations differ if water cooled; but the number of I/O frame slots is identical.

## What happened to RPQ 8P2534? It is not available on zEC12.

- **RPQ 8P2534 History Lesson**

- Introduced for z114 and z196 at GA2
- Allows non-PCIe I/O cards to be added to “fill empty slots” if there is no way to add PCIe I/O cards (All PCIe slots full, no space to add a PCIe drawer)
- Still available on z196 and z114

- **What do I do on zEC12 if more I/O features are needed and there is no way to add PCIe I/O?**

- MES remove enough carry forward I/O to allow removal of an 8-slot I/O drawer (possibly concurrent) or a 28-slot I/O cage (definitely disruptive)
- MES add PCIe I/O features and a 32-slot PCIe I/O drawer

- **Teaching points:**

1. **Only a possible issue on “same serial number” push-pull MES upgrades from z10 or z196 to zEC12 because only those machines can carry forward non-PCIe I/O features.**
2. **Plan ahead. Remove enough non-PCIe I/O on those upgrades to ensure that future PCIe I/O can be added.**



## Removal of Support for ESCON

(July 12, 2011 Statement of Direction ) – FULFILLED

- **The IBM zEnterprise 196 and the IBM zEnterprise 114 ~~will be~~ are the last System z servers to support ESCON channels:** IBM plans not to offer ESCON channels as an orderable feature on future System z servers. In addition, ESCON channels **cannot be carried forward** on an upgrade to such follow-on servers. This plan applies to channel path identifier (CHPID) types CNC, CTC, CVC, and CBY and to featured 2323 and 2324. System z customers should continue migrating from ESCON to FICON. Alternate solutions are available for connectivity to ESCON devices. IBM Global Technology Services offers an ESCON to FICON Migration solution, Offering ID #6948-97D, to help simplify and manage an all FICON environment with continued connectivity to ESCON devices if required.
- Notes:
  - For z196, this new Statement of Direction restates the SOD in Announcement letter 111-112 of **February 15, 2011**. It also confirms the SOD in Announcement letter 109-230 of **April 28, 2009** that “ESCON Channels will be phased out.”

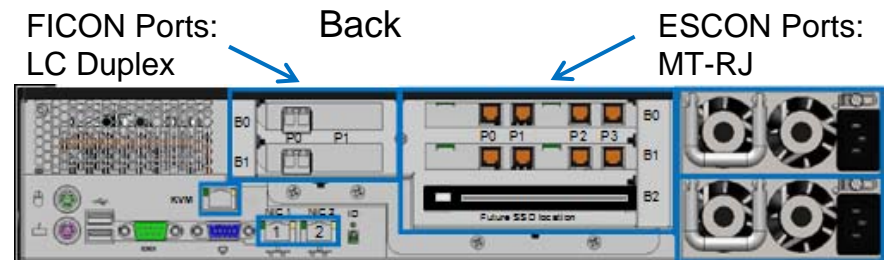
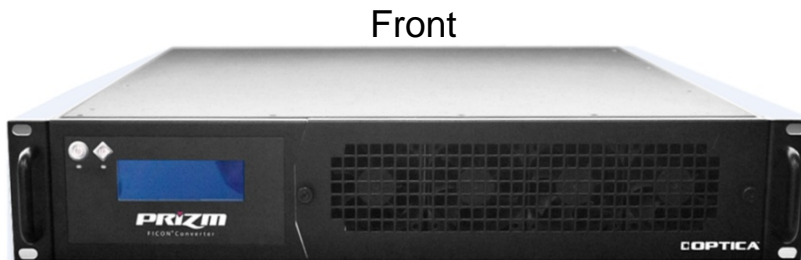
## Optica PRIZM FICON Converter

<http://www.opticatech.com/>

Supports the elimination of ESCON channels on the host while maintaining ESCON and Bus/Tag-based devices and applications

### What is PRIZM?

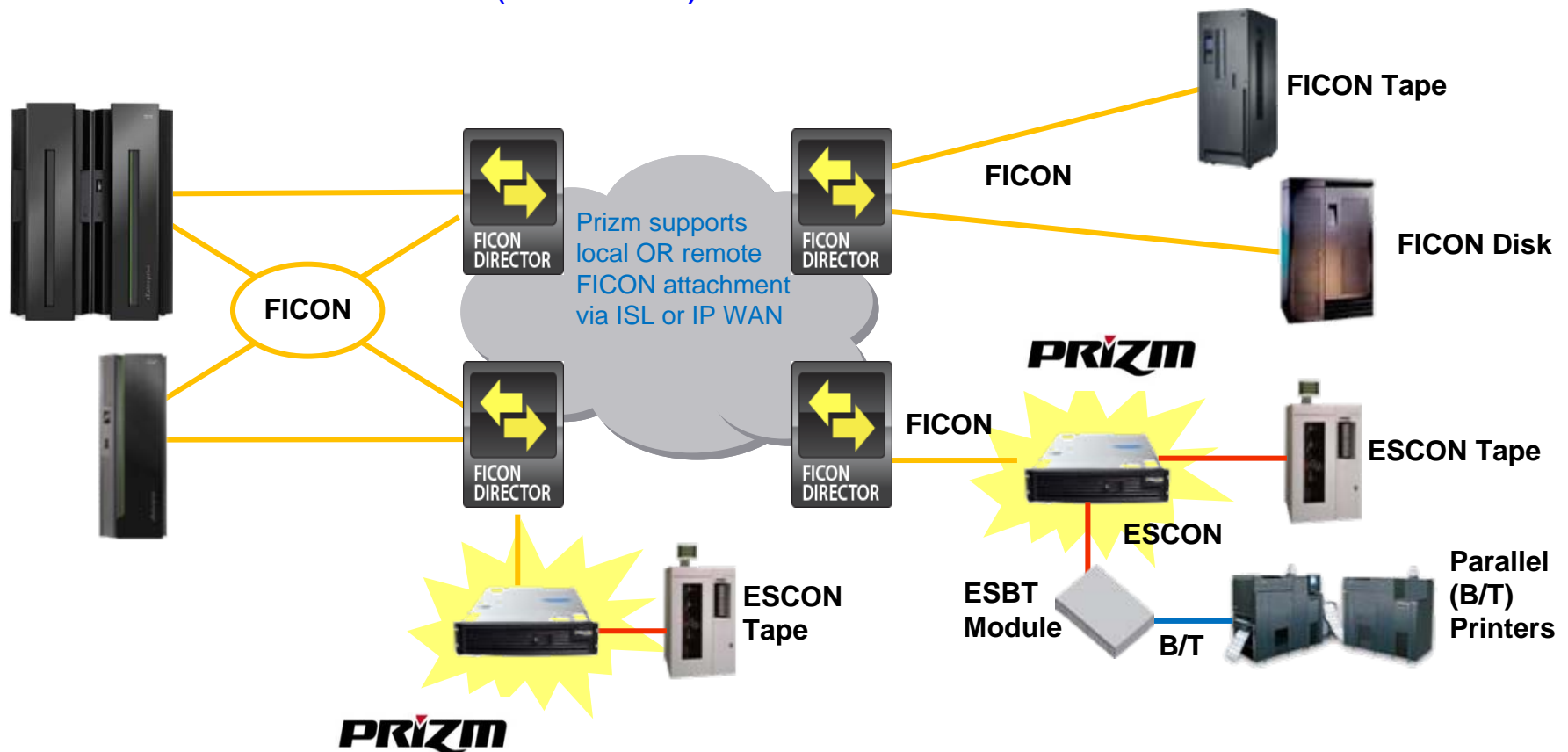
- A purpose-built appliance designed exclusively for IBM System z; enables ESCON devices to be connected to FICON channels or fabrics
- Allows ESCON devices to connect to FICON channels and FICON fabrics/networks
  - Prizm also supports attachment of parallel (bus/tag) devices to FICON channels via ESBT module
- Converts FICON channels (CHPID type FC) into ESCON channels: 1 FC to 4 or 2 FC to 8
  - Replace aging ESCON Directors with PRIZM (maintenance savings)
  - Achieve streamlined infrastructure and reduced Total Cost of Ownership
- Qualified by the IBM Vendor Solutions Lab in POK for all ESCON devices; qualified for connectivity to Brocade and Cisco FICON switching solutions
  - Refer to: <http://www-03.ibm.com/systems/z/hardware/connectivity/index.html>
    - Products -- > FICON / FCP Connectivity -- > Other supported devices
- PRIZM is available via IBM Global Technology Services: ESCON to FICON Migration offering (#6948-97D)



## Where Does Prizm Fit in the Data Center?

### Topologies supported by Prizm

- Local: direct attached or switched
- Remote: ISL (cascaded) or IP channel extended





# Flash Express



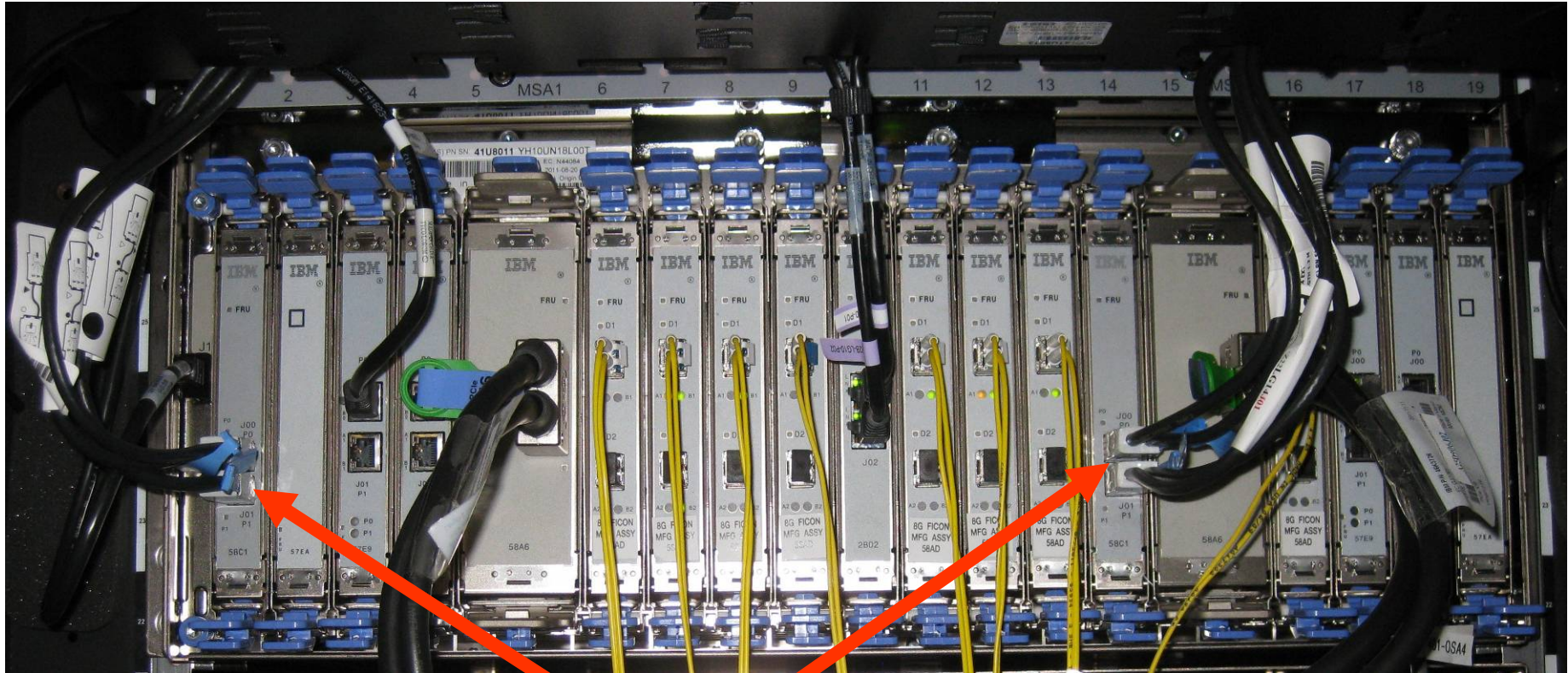
## What Is Flash Express?

- Flash Express is internal storage implemented via NAND Flash SSDs (Solid State Drives) mounted in PCIe Flash Express feature cards
  - Which plug into PCIe I/O drawers in pairs
  - Data security provided on the feature cards
  - A pair provides 1.4 TB of storage class memory (1 TB =  $2^{30}$  bytes)
  - A maximum of 4 pairs are supported in a system
  
- Flash Express card “plugging rules”
  - Only two pairs of Flash Express cards per PCIe I/O drawer
  - Slots 1 and 14 on the front side and 25 and 33 on the rear are reserved for Flash Express
  - These will be the last slots used to plug other PCIe features
  
- Internal Flash is accessed using the new System z architected EADM (Extended Asynchronous Data Mover) Facility
  - An extension of the ADM architecture used in the past with expanded storage
  - Flash Express cards do NOT require definition in the IOCDS
  - Access is initiated with a Start Subchannel instruction
  - Flash Express does not reduce the number of available I/O device subchannels
  - Subchannels used were previously reserved

## Twin-Cable Two Together to Form a RAID 10 Mirrored Pair



## Flash Express - Twin-Cable Interconnects a RAID 10 Mirrored Pair



Twin-Cable interconnect between two Flash Express cards in slots 1 and 14

## Crypto



## Crypto Express4S



- One PCIe adapter per feature
  - › Initial order – two features
- FIPS 140-2 Level 4
- Installed in the PCIe I/O drawer
- Up to 16 features per server
- Prerequisite: CPACF (#3863)



### Three configuration options for the PCIe adapter

- Only one configuration option can be chosen at any given time
- Switching between configuration modes will erase all card secrets
  - Exception: Switching from CCA to accelerator or vice versa
- Accelerator
  - For SSL acceleration
  - Clear key RSA operations
- **Enhanced: Secure IBM CCA coprocessor (default)**
  - Optional: TKE workstation (#0841) for security-rich, flexible key entry or remote key management
- **New: IBM Enterprise PKCS #11 (EP11) coprocessor**
  - Designed for extended evaluations to meet public sector requirements
    - Both FIPS and Common Criteria certifications
  - **Required:** TKE workstation (#0841) for management of the Crypto Express4S when defined as an EP11 coprocessor

## Crypto Enhancements

- **IBM Enterprise Public Key Cryptography Standards #11 (EP11)**
  - Based on PKCS #11 specification v2.20 and more recent amendments
  - Designed to meet Common Criteria EAL 4+ and FIPS 140-2 Level 4
  - Conforms to Qualified Digital Signature (QDS) Technical Standards
  
- **IBM Common Cryptographic Architecture (CCA)**
  - Secure Cipher Text Translate
  - DUKPT for derivation of MAC and Encryption Keys
  - Wrap weaker keys with stronger keys for security and standards compliance
  - Compliance with new Random Number Generator standards
  - EMV enhancements for applications supporting American Express cards
  
- **IBM Trusted Key Entry (TKE) 7.2 Licensed Internal Code (LIC)**
  - Support for Crypto Express4S defined as a CCA coprocessor
  - Support for Crypto Express4S as a Enterprise PKCS #11 coprocessor
  - Support for new DES operational keys
  - New AES CIPHER key attribute
  - Allow creation of corresponding keys
  - New smart card part 74Y0551
  - Support for 4 smart card readers
  - Support for stronger key wrapping standards
  - Compatible with current TKE Workstation hardware

## FICON





## FICON Express8S – PCIe I/O drawer

- **For FICON, zHPF, and FCP environments**

- CHPID types: FC and FCP
- 2 PCHIDs/CHPIDs

- **Auto-negotiates to 2, 4, or 8 Gbps**

- **Increased performance compared to FICON Express8**

- **10KM LX - 9 micron single mode fiber**

- Unrepeated distance - 10 kilometers (6.2 miles)
- Receiving device must also be LX
- **Note: Only LX has FQC support**

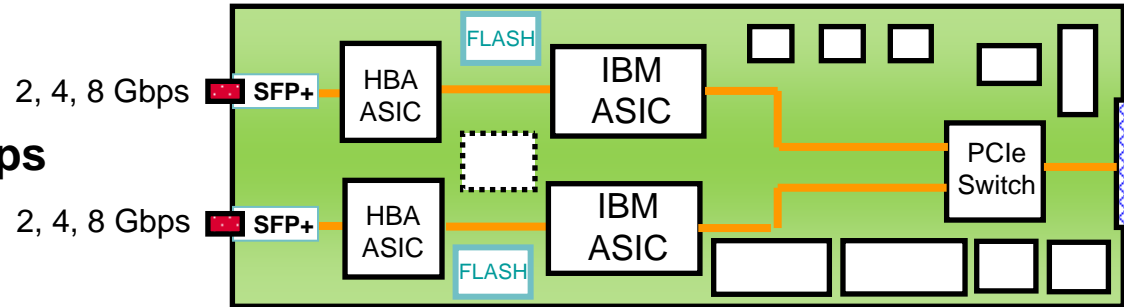
- **SX - 50 or 62.5 micron multimode fiber**

- Distance variable with link data rate and fiber type
- Receiving device must also be SX

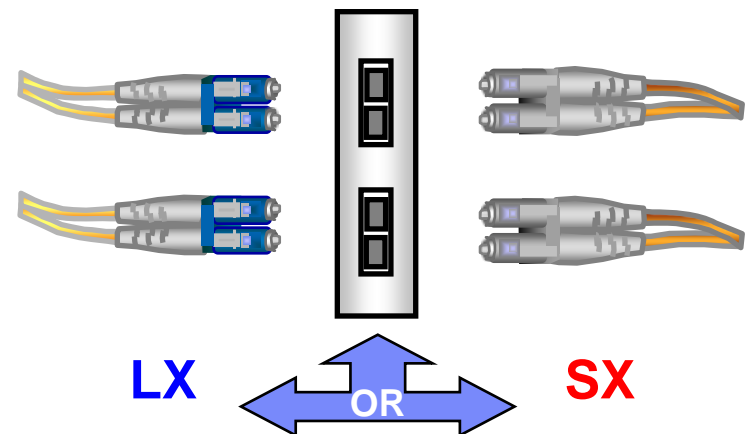
- **2 channels of LX or SX (no mix)**

- **Small form factor pluggable (SFP) optics**

- Concurrent repair/replace action for each SFP



# 0409 – 10KM LX, # 0410 – SX

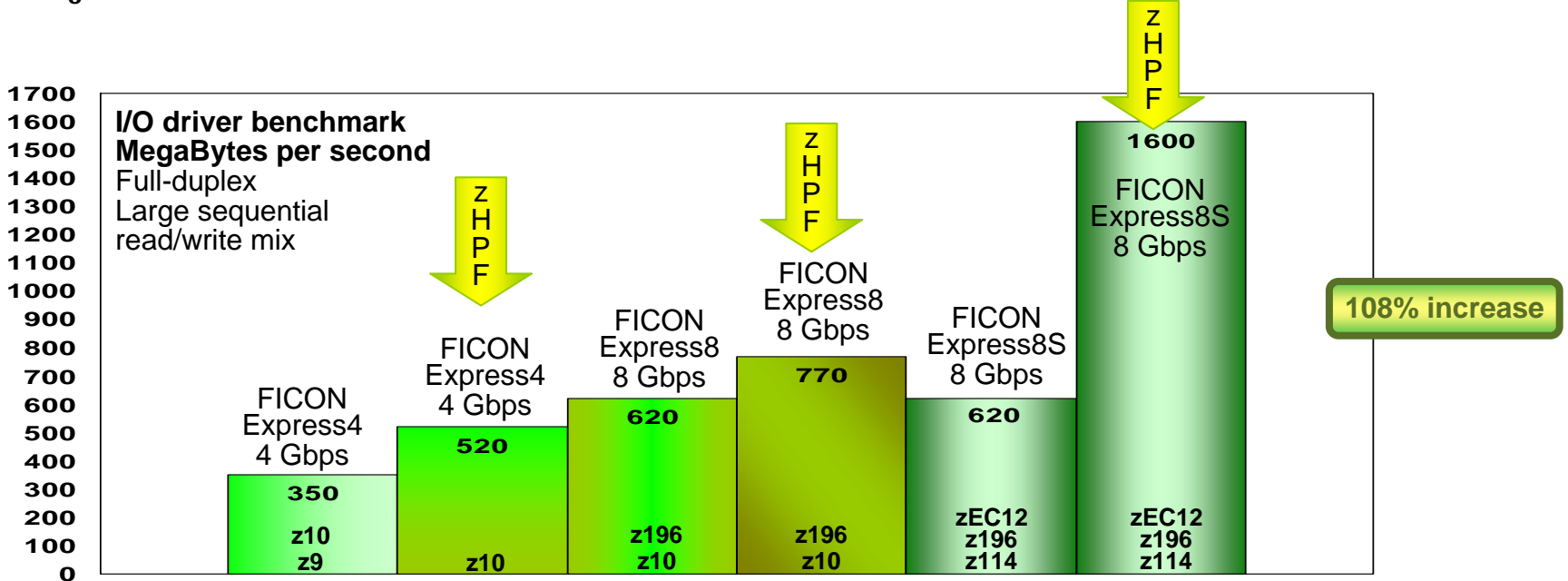
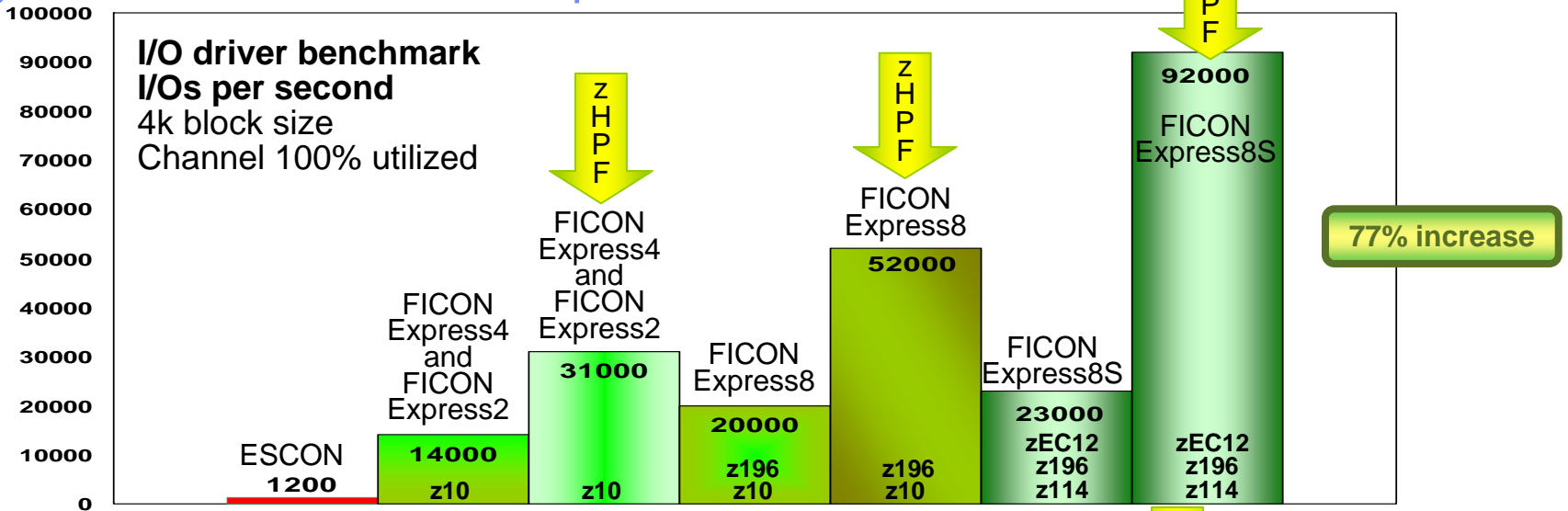


## Channel subsystem enhancement for I/O resilience

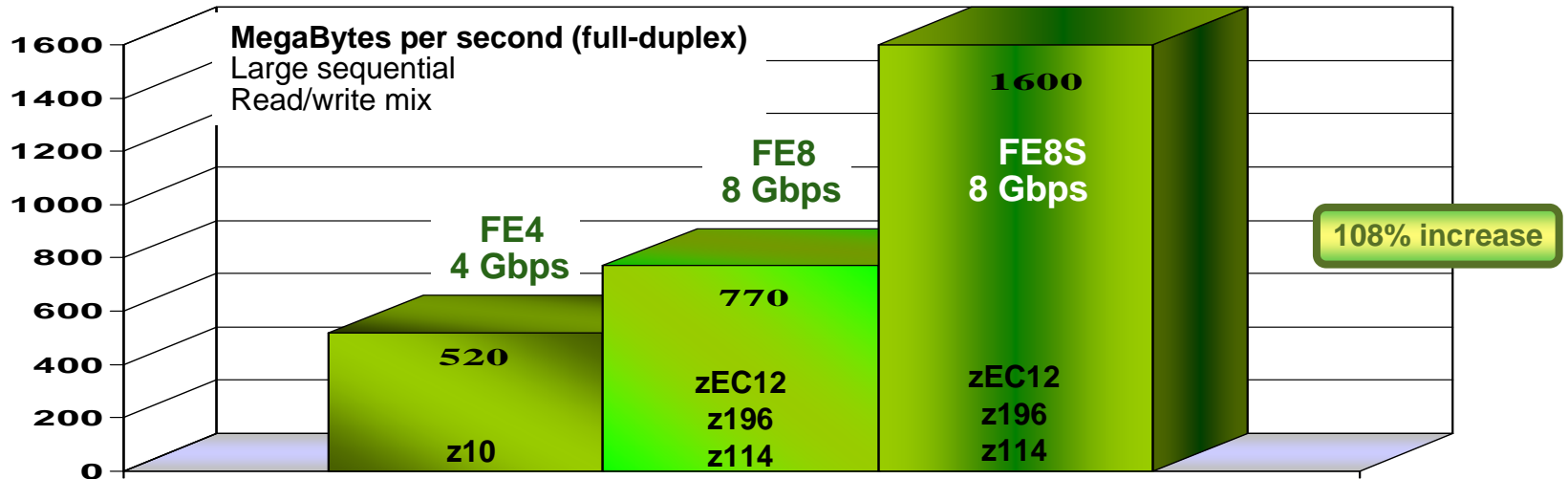
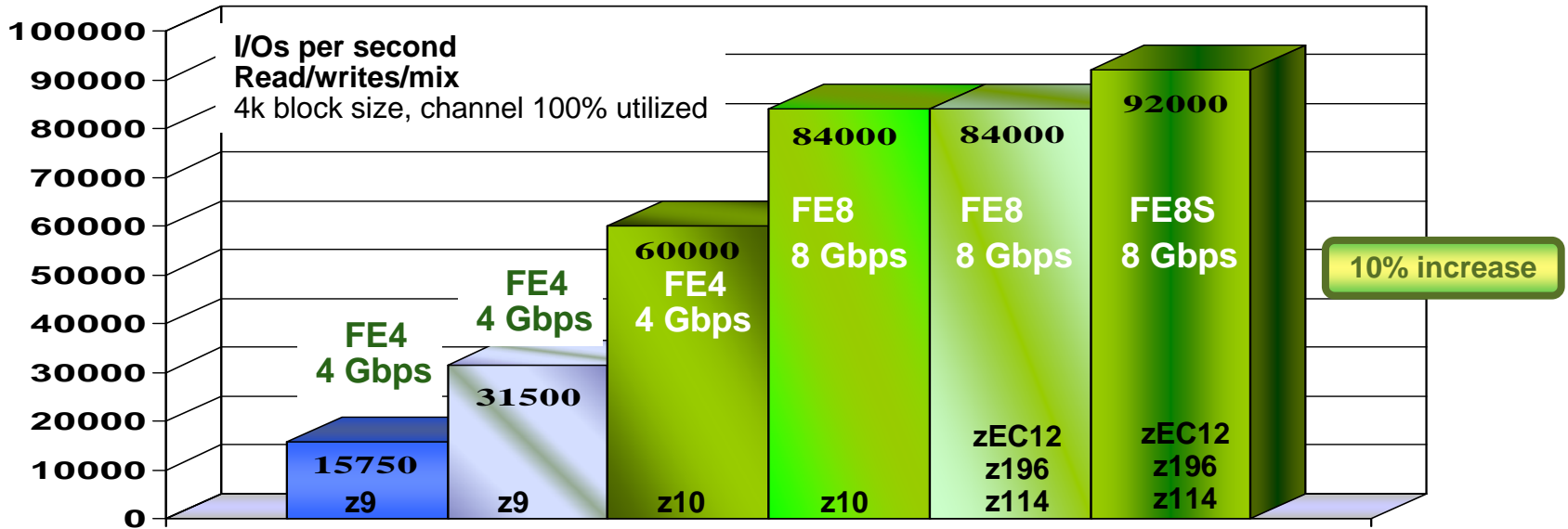


- The zEC12 I/O subsystem has been enhanced to provide improved throughput and I/O service times when abnormal conditions occur such as multi-system work load spikes, multi-system resource contention in the storage area network (SAN) or at the control unit ports, SAN congestion, improperly defined SAN configurations, dynamic changes in fabric routing, and destination port congestion.
- When abnormal conditions occur which can cause an imbalance in I/O performance characteristics (such as latency and throughput) across a set of channel paths to the control unit, the channel subsystem is designed intelligently to utilize the channels that provide optimal performance. This enhancement is accomplished by exploiting the in-band I/O instrumentation and metrics of the System z FICON and System z High Performance FICON (zHPF) protocols.
- This channel subsystem enhancement is exclusive to zEC12 and is supported on all FICON channels when configured as CHPID type FC.
- This enhancement is transparent to operating systems.

## System z FICON and zHPF performance



## FCP performance on System z

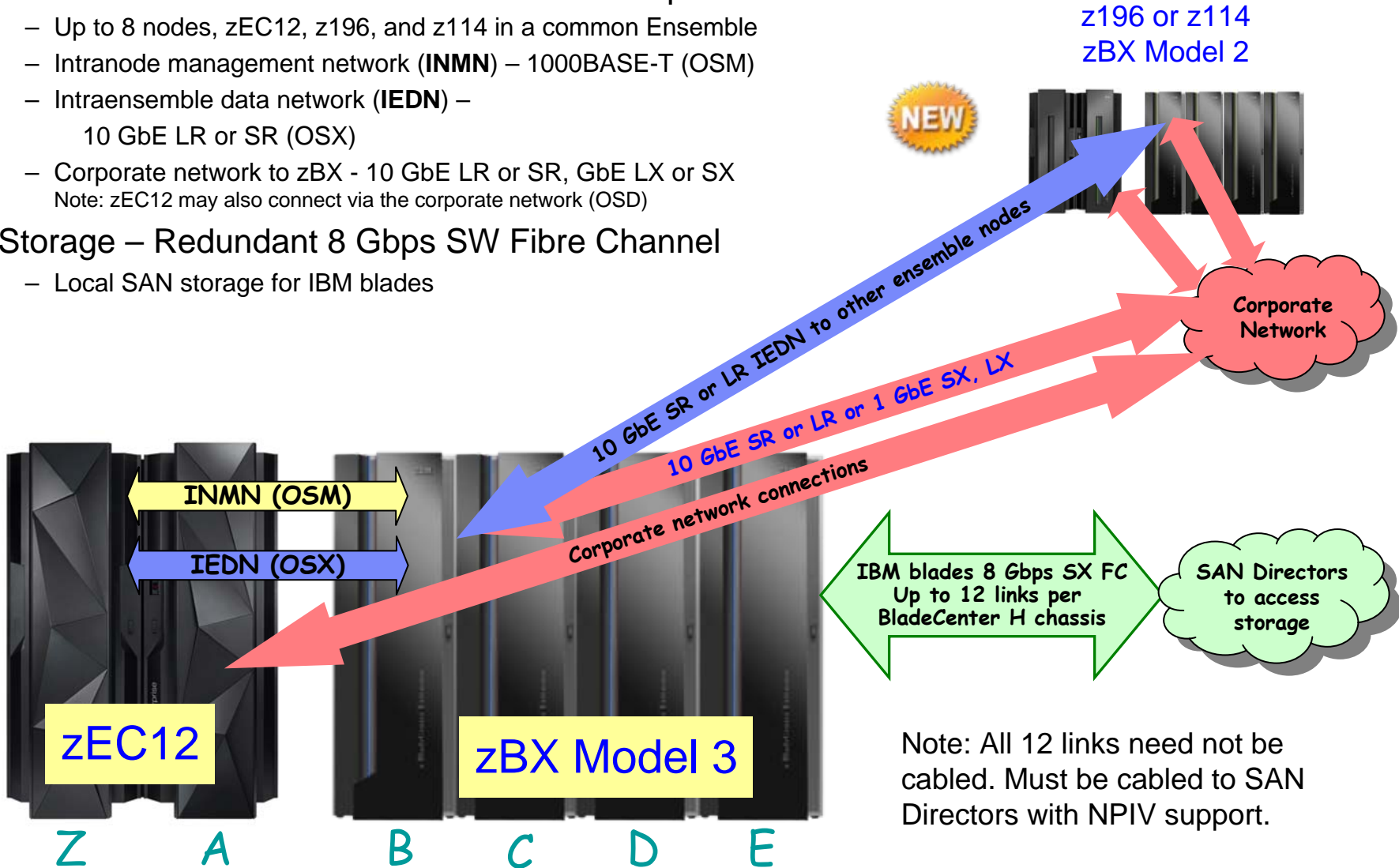


## Networking



## zEC12 and zBX Model 3 Ensemble Connectivity

- Networks – Redundant zBX-003 “B” frame top of rack switches
  - Up to 8 nodes, zEC12, z196, and z114 in a common Ensemble
  - Intranode management network (**INMN**) – 1000BASE-T (OSM)
  - Intraensemble data network (**IEDN**) – 10 GbE LR or SR (OSX)
  - Corporate network to zBX - 10 GbE LR or SR, GbE LX or SX  
 Note: zEC12 may also connect via the corporate network (OSD)
- Storage – Redundant 8 Gbps SW Fibre Channel
  - Local SAN storage for IBM blades



Note: All 12 links need not be cabled. Must be cabled to SAN Directors with NPIV support.

## IBM DB2 Analytics Accelerator V3.1



“The evolution of IBM Smart Analytics Optimizer V1”

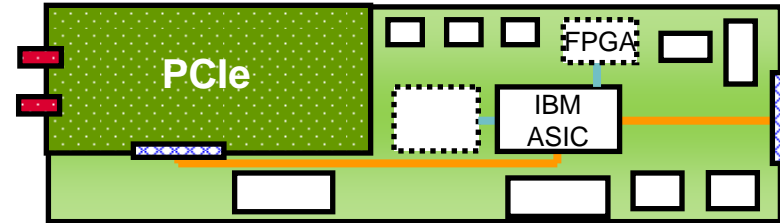


- A high-performance software offering that is part of an integrated hardware/software solution designed to work with IBM System z® to deliver dramatically faster analytic query responses. Integrates with DB2 for z/OS Version 10 running on a zEnterprise server. DB2 for z/OS “owns the data” and does updates, “single record” lookups, backup, and recovery.
- Based on the IBM Netezza 1000 analytics platform, a workload-optimized, LAN-attached appliance that incorporates IBM blade servers, storage, and data filtering technology. Scalable up to 10 Netezza cabinets.
  - The Netezza 1000 is **not** integrated into a zEnterprise BladeCenter Extension and can **not** be managed by the Unified Resource Manager.
  - The Analytics Accelerator can be connected to zEnterprise using 10 Gbps Ethernet (OSD CHPIDs) **OR can connect via the zBX Model 3 or Model 2 IEDN TOR switches as a customer network server.**
- **Designed to plug seamlessly into the System z hardware and software stack without requiring any change to existing application software.**

## OSA-Express4S 1000BASE-T Ethernet Feature - PCIe I/O Drawer



- **PCI-e form factor card supported by PCIe I/O drawer**
  - One two-port CHPID per card
  - Half the density of the OSA-Express3 version
- **Auto-negotiation to 10, 100, 1000 Mbps over Category 5 or better copper**
- **RJ-45 connector**
- **Operates at “line speed”**
- **CHPID TYPE Support:**



FC 0408



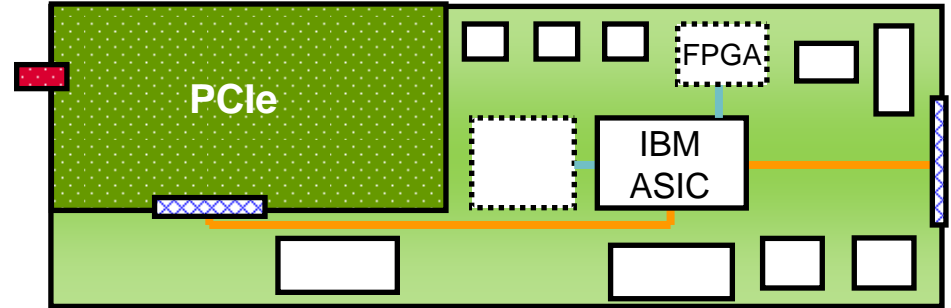
**Connector = RJ-45**

Mode	TYPE	Description
OSA-ICC	OSC	TN3270E, non-SNA DFT, OS system console operations
QDIO	OSD	TCP/IP traffic when Layer 3, Protocol-independent when Layer 2
Non-QDIO	OSE	TCP/IP and/or SNA/APPN/HPR traffic
<b>Unified Resource Manager</b>	<b>OSM</b>	<b>Connectivity to intranode management network (INMN)</b>
OSA for NCP (LP-to-LP)	OSN	NCPs running under IBM Communication Controller for Linux (CCL)



## OSA-Express4S Fiber Optic Ethernet Features – PCIe I/O drawer

- **10 Gigabit Ethernet (10 GbE)**
  - CHPID types: OSD, **OSX**
  - LR - Single mode or SR - Multimode fiber
  - One port of LR or one port of SR
  - **One one-port CHPID**

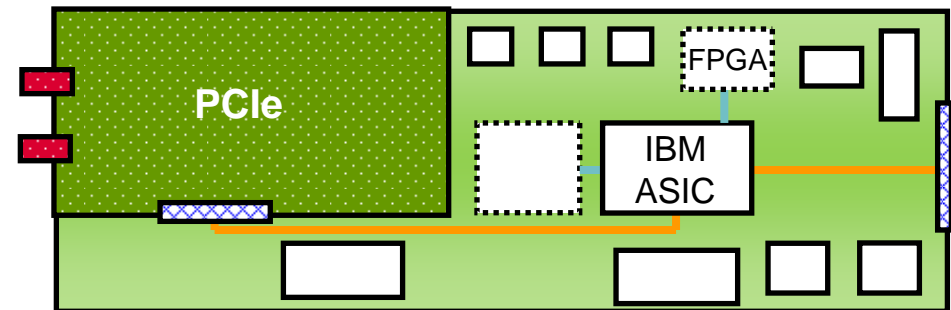


FC#0406 – 10 GbE LR, FC# 0407 – 10 GbE SR



- **Small form factor optics – LC Duplex**

- **Gigabit Ethernet (GbE)**
  - CHPID types: OSD (**OSN not supported**)
  - LX - Single mode or SX - Multimode fiber
  - Two ports of LX or two ports of SX
  - **One two-port CHPID**



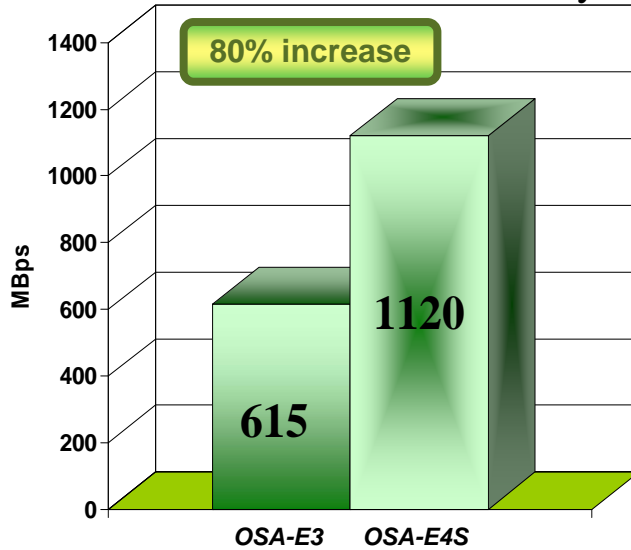
FC# 0404 – GbE LX, FC# 0405 – GbE SX



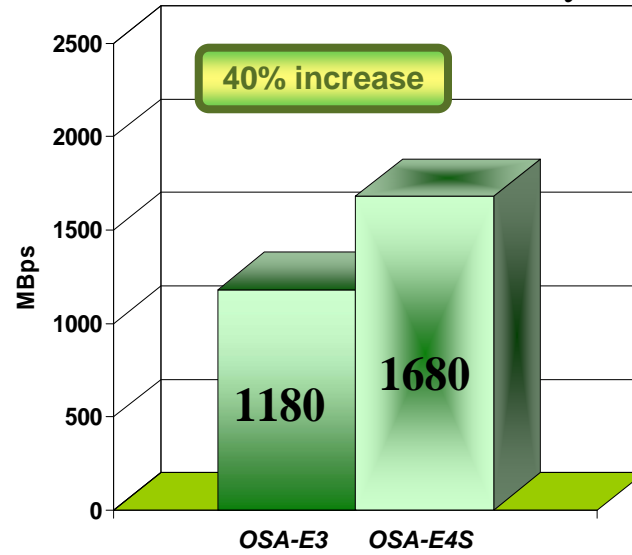
- **Small form factor optics – LC Duplex**

## OSA-Express4S 10 GbE performance (laboratory)

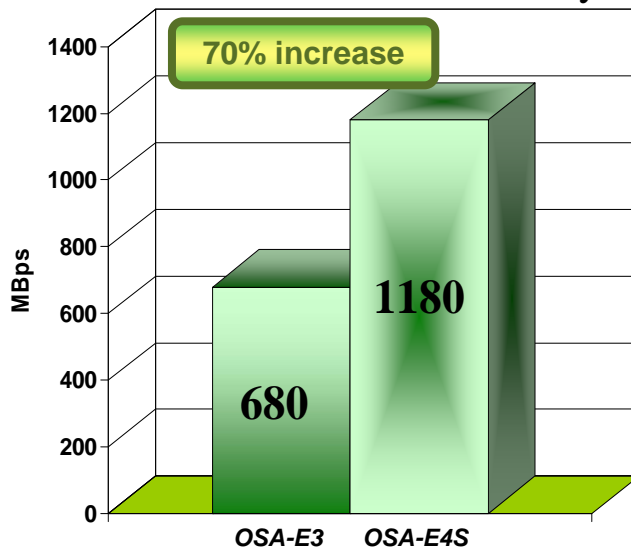
### Inbound Streams – 1492 Byte MTU



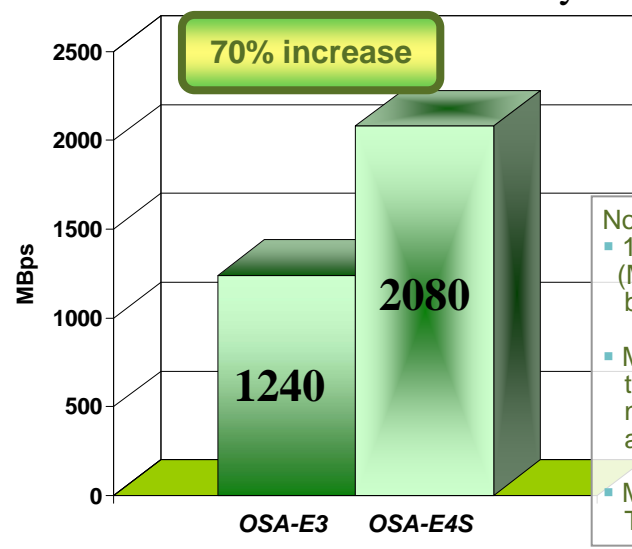
### Mixed Streams – 1492 Byte MTU



### Inbound Streams – 8000 Byte MTU



### Mixed Streams – 8000 Byte MTU



- Notes:
- 1 megabyte per second (MBps) is 1,048,576 bytes per second
  - MBps represents payload throughput (does not count packet and frame headers)
  - MTU = Maximum Transmission Unit

# Parallel Sysplex and Server Time Protocol



## Parallel Sysplex CFCC Level 18



### ▪ Performance Improvements

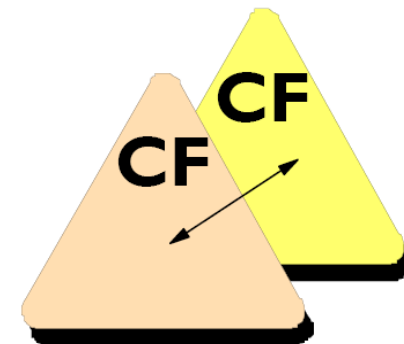
- Elapsed time improvements when dynamically altering the size of a cache structure
- DB2 conditional write to a group buffer pool (GBP) cache which allows selected entries be written around the cache to disk to reduce overhead
- Performance improvements for coupling facility cache structures to avoid flooding the coupling facility cache with changed data and avoid excessive delays and backlogs for cast-out processing.
- Performance throughput enhancements for parallel cache castout processing by extending the number of RCC cursors beyond 512.
- Storage class and castout class contention avoidance by breaking up individual storage class and castout class queues to reduce storage class and castout class latch contention

### ▪ Resiliency Improvements

- Enhanced capabilities to non-disruptively capture and collect extended diagnostic structure data from Coupling Facility structures that have encountered an error.
- Verification of local cache controls for a Coupling Facility cache structure connector during registration of connection interest in a data item against lost cross-invalidation signals. .

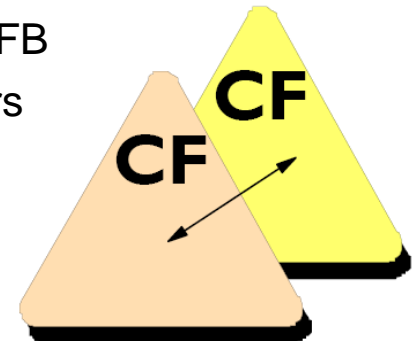
### ▪ Structure and CF Storage Sizing with CFCC level 18

- Moving to CFCC Level 18 may increase storage requirements
- Use of the CF Sizer Tool is recommended: <http://www.ibm.com/systems/z/cfsizer/>



## Sysplex Scalability and Monitoring Enhancements

- **Support for up to 101 Integrated Coupling Facility (ICF) processors**
  - The limit on previous System z servers was 16 ICFs
  - The maximum number of logical processors in a Coupling Facility LPAR remains at 16
- **Support for up to 64 1x InfiniBand Coupling Links**
  - The limit on previous System z servers was 48
  - Provides additional link connectivity for STP and for Parallel Sysplex configurations with members of more than on Sysplex on the same zEC12
  - Facilitates migration from ISC-3 to 1x InfiniBand Links
- **Coupling link characteristics reporting to z/OS**
  - Identifies underlying InfiniBand hardware characteristics for CIB CHPIDs to help with Sysplex monitoring and tuning
  - Enables RMF Monitor III to report additional information
    - InfiniBand Link type and protocol: 12x IFB, 12x IFB3 and 1x IFB
    - CHPID mapping to physical links – HCA IDs and port numbers
    - Calculated fiber optic link length
    - Fully functional or degraded status



## zEC12 Server Time Protocol Enhancements

### ▪ **Broadband Security Improvements for STP**

- Authenticates NTP servers when accessed by the HMC client through a firewall
- Authenticates NTP clients when the HMC is acting as an NTP server
- Provides symmetric key (NTP V3-V4) and autokey (NTP V4) authentication (Autokey is not supported if Network Address Translation is used)
- This is the highest level of NTP security available

### ▪ **Improved NTP Commands panel on HMC/SE**

- Shows command response details

### ▪ **Telephone modem dial out to an STP time source is no longer supported**

- All STP dial functions are still supported by broadband connectivity
- zEC12 HMC LIC no longer supports dial modems  
(Fulfills the Statement of Direction in Letter 111-167, dated October 12, 2011)

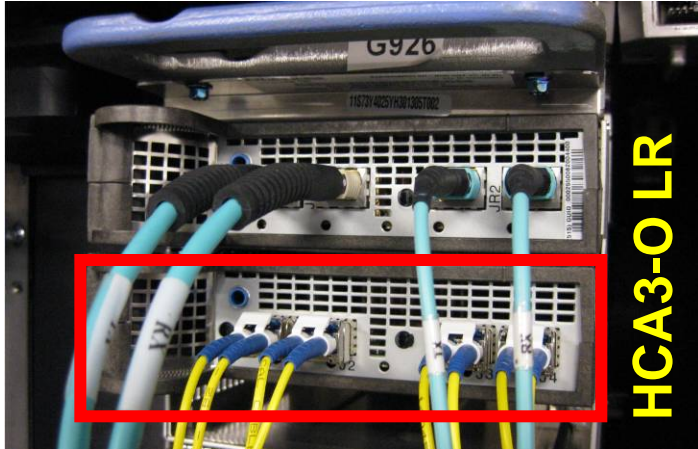
## zEC12 InfiniBand Coupling Fanouts

Description	F/C	Ports	Comments
HCA3-O LR 1x IB DDR	0170	4	PSIFB coupling (10 km unrepeated, 100 km with DWDM) Double port density. 32 subchannels per CHPID
HCA3-O 12x IB DDR	0171	2	PSIFB coupling (150 m) Improved IFB3 protocol (HCA3-O to HCA3-O)
HCA2-O 12x IB-DDR Carry Forward only	0163	2	Coupling (150 meters) Still available on zEnterprise if needed to connect to HCA1-O on System z9
HCA2-O LR 1x IB-DDR Carry Forward only	0168	2	Coupling (10 km unrepeated, 100 km with DWDM)
<p><b>Note: Coupling fanouts compete for slots with the HCA2-C and PCIe fanouts for I/O drawers and cages.</b></p>			

Note: The InfiniBand link data rates do not represent the performance of the link. The actual performance is dependent upon many factors including latency through the adapters, cable lengths, and the type of workload.

## zEC12 1x InfiniBand Coupling Links

Multiple CHPIDs per link, 7 or 32\* subchannels per CHPID (HCA3-O LR and HCA2-O LR)



HCA3-O LR



HCA2-O LR

- Up to 16 CHPIDs using same physical links
  - More subchannels per physical link
  - Link sharing by different Sysplexes
- **Now** more subchannels per CHPID
  - **32 subchannels per CHPID**
  - **Option to define 7 or 32\* subchannels**
  - **zEC12, z196 GA2, and z114 on HCA3-O LR or HCA2-O LR**



**32 subchannels per CHPID (7\* default)**  
**Up to 16 CHPIDs per HCA3-O LR**

---

**512 subchannels per HCA3-O LR**

For Example:

CHPID FF  
 32 subchannels

CHPID FE  
 32 subchannels

\*HCD with APAR 0A36617 fix changes the default back to 7 subchannels for CIB CHPIDs. Specify 32 when needed. (Recommended for extended distance.)

One 1x IFB link  
 64 subchannels



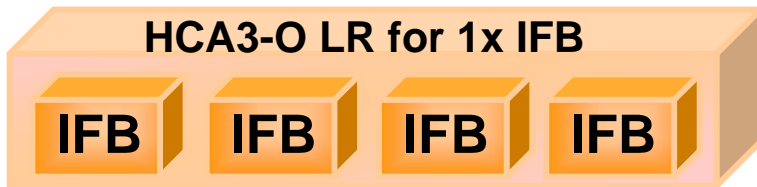
## zEC12 InfiniBand HCA3 Fanouts

- Exclusive to zEC12 and zEnterprise 196 and 114



Up to 16 CHPIDs – across 2 ports\*

- HCA3-O fanout for 12x InfiniBand coupling links
  - CHPID type – CIB
    - **Improved service times with 12x IFB3 protocol for HCA3-O to HCA3-O links**
    - Two ports per feature
    - Fiber optic cabling – 150 meters
    - Supports connectivity to HCA2-O
    - Link data rate of 6 Gbps



Up to 16 CHPIDs – across 4 ports\*

- HCA3-O LR fanout for 1x InfiniBand coupling links
  - CHPID type – CIB
    - **Four ports per feature**
    - Fiber optic cabling
      - 10 km unrepeated, 100 km repeated
    - Supports connectivity to HCA2-O LR
    - Link data rate server-to-server 5 Gbps
    - Link data rate with WDM; 2.5 or 5 Gbps

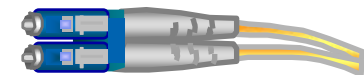
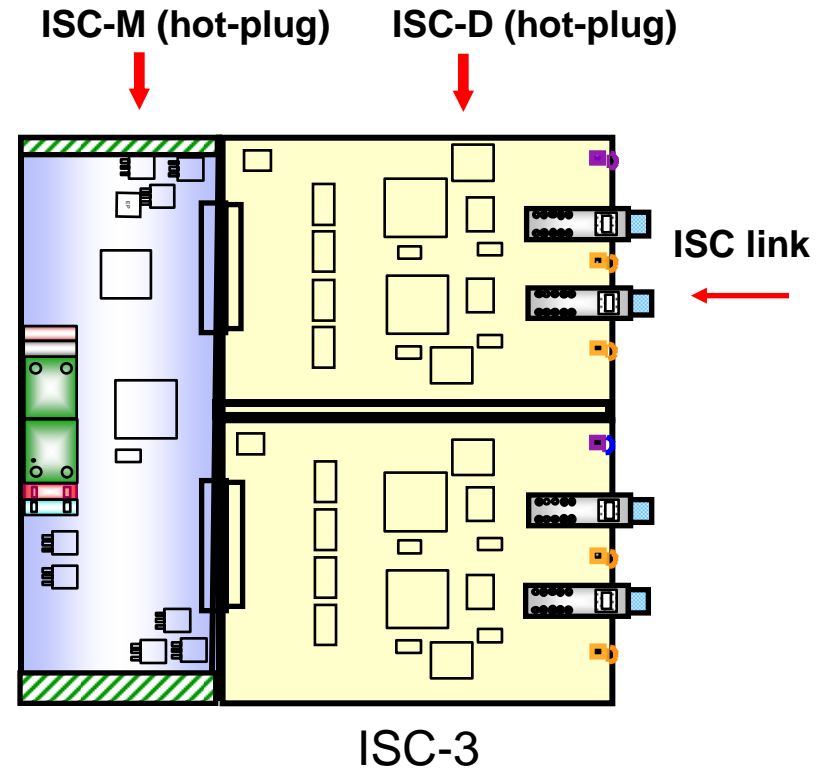
\* Performance considerations may reduce the number of CHPIDs per port.

Note: The InfiniBand link data rates do not represent the performance of the link. The actual performance is dependent upon many factors including latency through the adapters, cable lengths, and the type of workload.

## ISC-3 coupling links on zEC12

*(Carry Forward Only – except RPQ 8P2602\*, NO MES Add)*

- **InterSystem Channel-3 (ISC-3)**
  - ISC-3 links ordered in increments of one
  - Activated links balanced across features
- **Peer mode only – 2 Gbps**
  - #0217 (ISC-M), #0218 (ISC-D / ISC link)
  - Activate link - #0219
  - Four links per ISC-M
    - Two links per ISC-D
  - Supports 9μ single mode fiber
- **Up to 48 links per machine**
- \* **RPQ 8P2602 is only available if:**
  - A zEC12 H66, H89 or HA1 is ordered AND
  - The maximum supported 16 PSIFB fanouts are also ordered (e.g. 32 12x HCA3-O links)

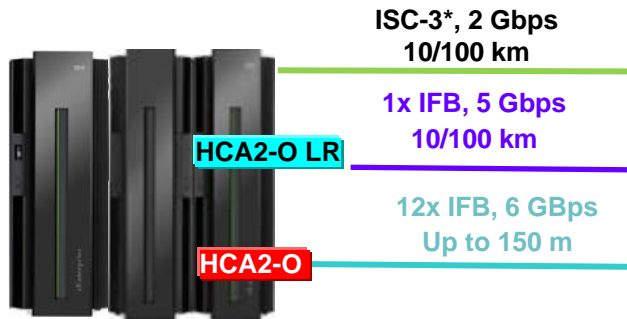


LC Duplex connector

**SOD:** The IBM zEC12 will be the last high-end server to support ISC-3. Enterprises should begin migrating from ISC-3 features (#0217, #0218, #0219), to 12x InfiniBand (#0171 – HCA3-O fanout) or 1x InfiniBand (#0170 – HCA3-O LR fanout) coupling links.

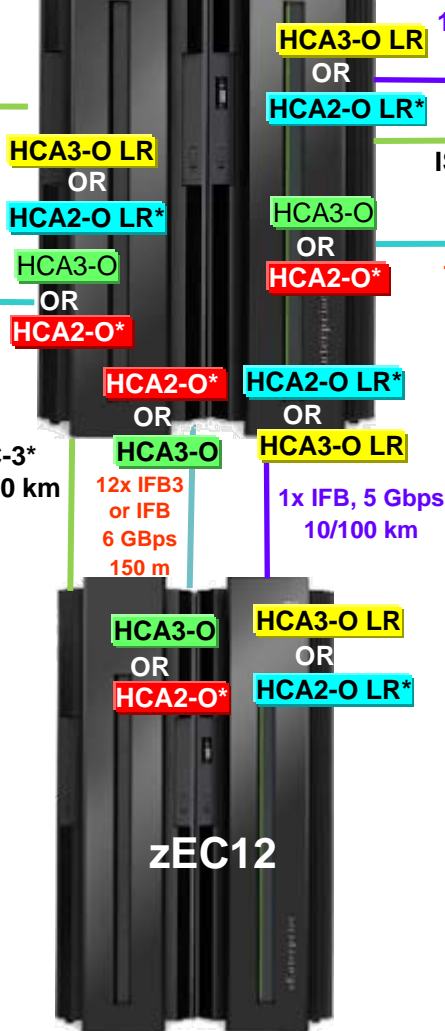
## zEC12 Parallel Sysplex Coupling Connectivity

**z10 EC and z10 BC**  
12x IFB, 1x IFB & ISC-3



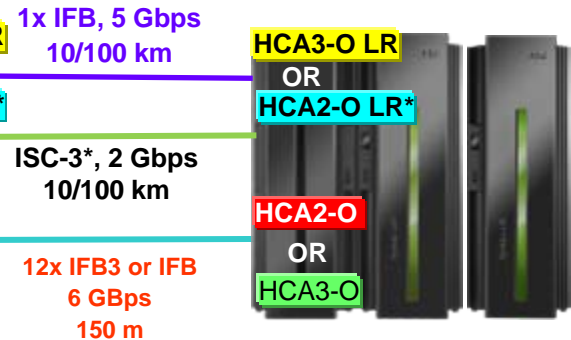
**z890, z990**  
**z9 EC and z9 BC**  
*Not supported in the same Sysplex or STP CTN with zEC12!*

**zEC12**



**z196 and z114**

12x IFB, 12x IFB3, 1x IFB, & ISC-3



\*HCA2-O, HCA2-O LR, & ISC-3 carry forward only on zEC12

**Note:** The InfiniBand link data rates do not represent the performance of the link. The actual performance is dependent upon many factors including latency through the adapters, cable lengths, and the type of workload.

# Statements of Direction



## Removal of Support for ISC-3 Coupling Links (August 28, 2012 Statement of Direction<sup>1</sup>)



- **The IBM zEC12 is intended to be the last high end System z server that will support ISC-3 coupling links.**

Enterprises should begin migrating from ISC-3 features (#0217, #0218, #0219) to 12x InfiniBand (#0171 - HCA3-O) or 1x InfiniBand (#0170 - HCA3-O LR) coupling links.

Note 1: All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

## Removal of Support for STP Mixed CTNs (August 28, 2012 Statement of Direction<sup>1</sup>)



- **The zEC12 is intended to be the last high-end System z server to support connection to a Server Time Protocol (STP) Mixed Coordinated Timing Network (CTN) that includes a Sysplex Timer.**

**Beginning with the high-end System z server after zEC12, System z servers that require time synchronization to will require STP and must be connected to an STP-only CTN.**

- Enterprises should continue migration away from STP mixed CTNs to STP-only CTNs.

Note 1: All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

## Removal of Support for Crypto Express3 (August 28, 2012 Statement of Direction<sup>1</sup> )



- **The IBM zEC12 is planned to be the last high-end System z server to offer support of the Crypto Express3 feature (#0864).**

Crypto Express3 will not be supported on future high-end System z servers as carry forward on an upgrade. Enterprises should begin migrating from the Crypto Express3 feature to the Crypto Express4S feature (#0865).

Note 1: All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

## Removal of Support for OSA-Express3 (August 28, 2012 Statement of Direction<sup>1</sup>)



- **The IBM zEC12 is planned to be the last high-end System z server to offer support of the Open System Adapter-Express3 (OSA-Express3 #3362, #3363, #3367, #3370, #3371) family of features. OSA-Express3 will not be supported on future high-end System z servers as carry forward on an upgrade.**

Enterprises should continue migrating from the OSA-Express3 features to the OSA-Express4S features (#0404, #0405, #0406, #0407, #0408).

Note 1: All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.



## Removal of support for Ethernet half-duplex operation and 10 Mbps link data rate (August 28, 2012 Statement of Direction<sup>1</sup>)



- The OSA-Express4S 1000BASE-T Ethernet feature is planned to be the last copper Ethernet feature to support half-duplex operation and a 10 Mbps link data rate. The IBM zEC12 is planned to be the last Enterprise Class System z server to support half-duplex operation and a 10 Mbps link data rate for copper Ethernet environments.**

**Any future 1000BASE-T Ethernet feature will support full-duplex operation and auto-negotiation to 100 or 1000 Mbps exclusively.**

- This restates the statement of direction in the March 6, 2012 announcement letter ENUS112-026 of March 6, 2012.

Note 1: All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

## Removal of Support for FICON Express4 (August 28, 2012 Statement of Direction<sup>1</sup>)



- **The IBM zEC12 is planned to be the last high-end System z server to offer support of the FICON Express4 features (#3321, #3322). FICON Express4 will not be supported on future high-end System z servers as carry forward on an upgrade.**

Enterprises should continue migrating from the FICON Express4 features to the FICON Express8S features (#0409, #0410).

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**Note: The August 28, 2012 announcement includes NO Statement of Direction about FICON Express8 support. Future “Carry Forward” support may or may not be possible.**

# THANK YOU

## Discussion and questions...



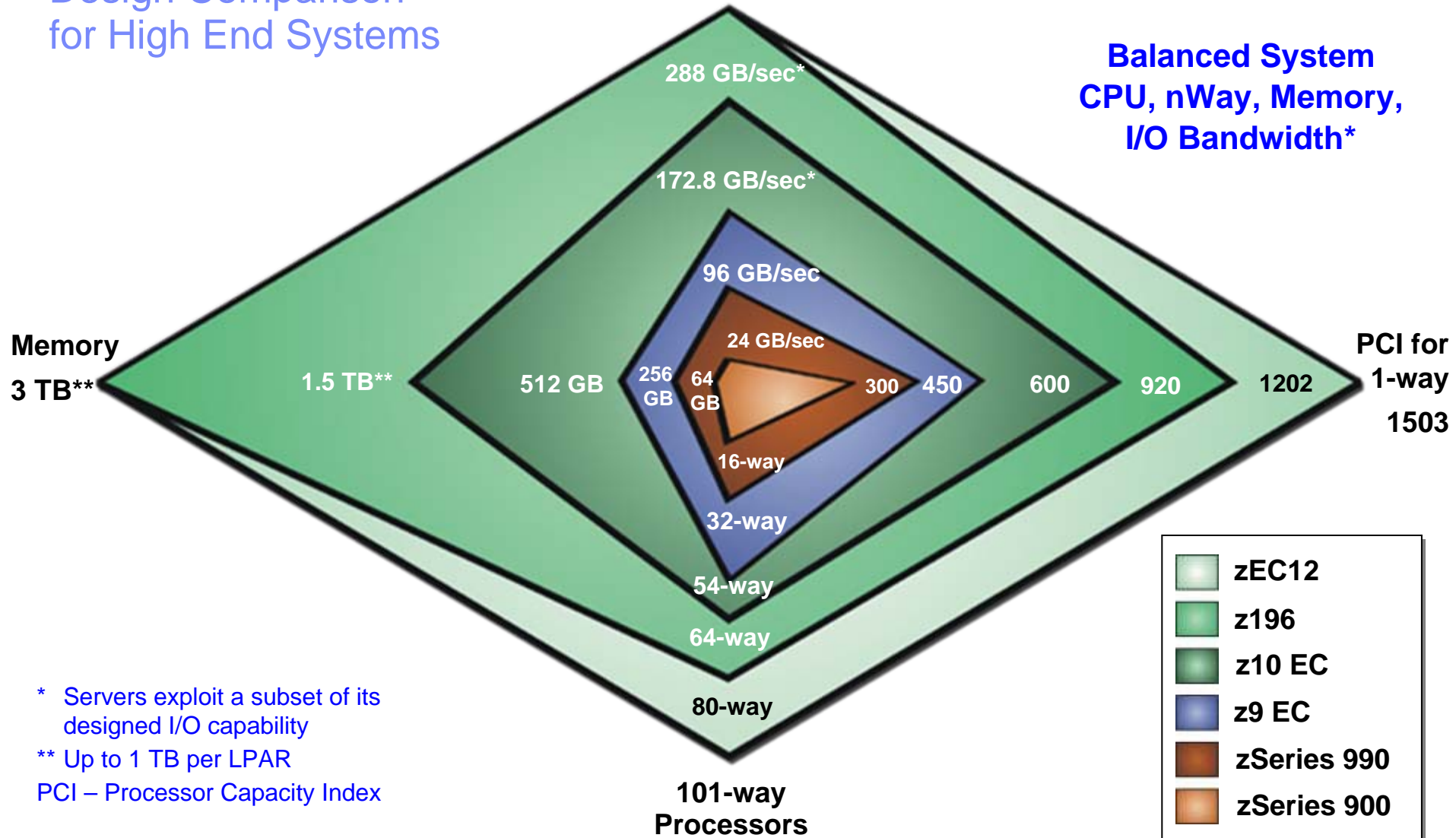
# Technical Backup Charts



## IBM System z: Design Comparison for High End Systems

**System I/O Bandwidth  
384 GB/Sec\***

**Balanced System  
CPU, nWay, Memory,  
I/O Bandwidth\***



\* Servers exploit a subset of its designed I/O capability

\*\* Up to 1 TB per LPAR

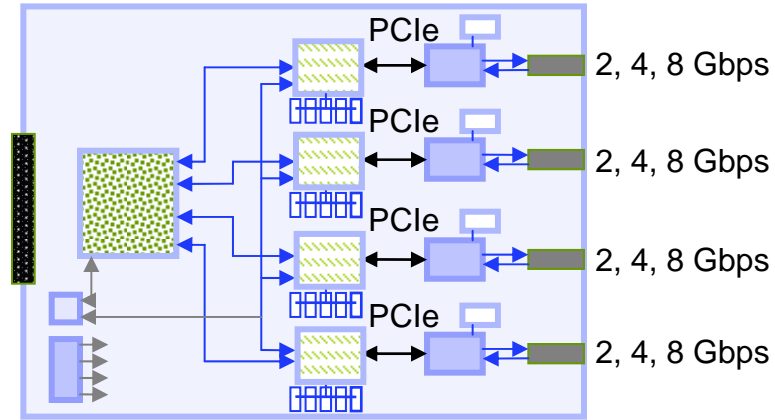
PCI – Processor Capacity Index

## zEC12 FICON Express8

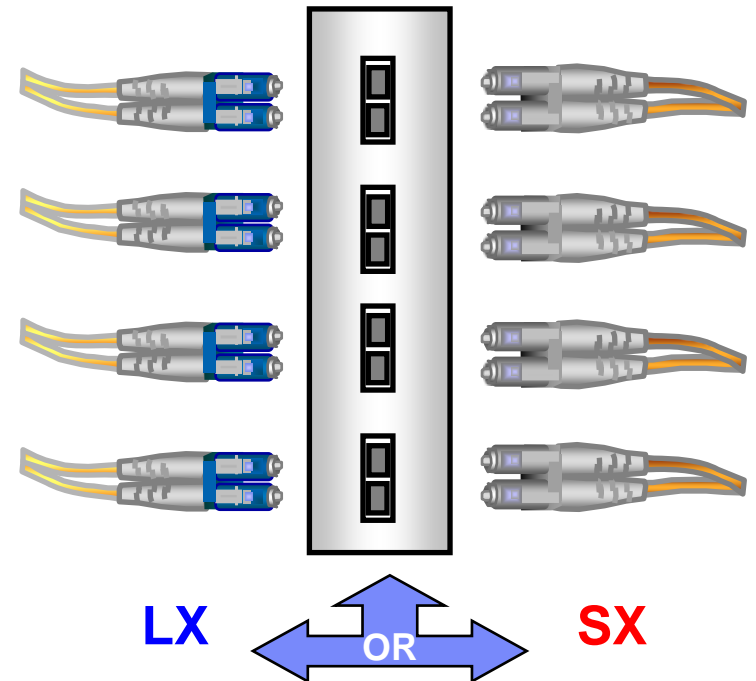
*(Carry Forward ONLY, NO MES Add)*

- **Auto-negotiate to 2, 4, or 8 Gbps**  
1 Gbps devices not supported point to point
- **Connector - LC Duplex**
- **Four LX ports (FC #3325)**
  - 9 micron single mode fiber
  - Unrepeated distance - 10 km (6.2 miles)
  - Receiving device must also be LX
  - **Note: Only LX has FQC support**
- **Four SX ports (FC #3326)**
  - 50 or 62.5 micron multimode fiber  
(50 micron fiber is preferred)
  - Unrepeated distance varies by fiber type and link data rate
  - Receiving device must also be SX
- **LX and SX performance is identical**
- **Additional buffer credits supplied by a director or DWDM are required to sustain performance beyond 10 km**

Small Form Factor Pluggable (SFP) optics.  
Concurrent repair/replace action for each SFP



# 3325 – 10KM LX, # 3326 – SX



## zEC12 zHPF supports data transfers larger than 64 k bytes

- **zHPF multi-track data transfers are no longer limited to 64 k bytes**
  - Up to 256 tracks can be transferred a single operation
  - Eliminating the 64 k byte limit is designed to allow a FICON Express8 channel to fully exploit its available bandwidth
  - This enhancement is exclusive to zEC12, z196 and z114
- **Designed to help provide**
  - Higher throughput for zHPF multi-track operations
  - With lower response time
- **Requires:**
  - FICON Express8S or FICON Express8
  - CHPID TYPE=FC definition
  - Control unit support for zHPF
- **z/OS operating system support**

**White Paper: “High Performance FICON (zHPF) for System z Analysis”**

<http://www.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP101789>

**High Performance FICON (zHPF) for DS8000 System z Attached Analysis:  
AG Storage ATS Offering**

<http://www.ibm.com/support/techdocs/atmastr.nsf/WebIndex/FLASH10668>

## Summary: OSA-Express CHPID types to control operation

CHPID type	Purpose / Traffic	Operating Systems
<b>OSC</b> 1000BASE-T zEC12, z196, z114, z10, z9 z990, z890	OSA-Integrated Console Controller (OSA-ICC) Supports TN3270E, non-SNA DFT to IPL CPCs & LPs	<b>z/OS, z/VM</b> <b>z/VSE</b>
<b>OSD</b> All OSA features zEC12, z196, z114, z10, z9, zSeries	Supports Queue Direct Input/Output (QDIO) architecture TCP/IP traffic when Layer 3 (uses IP address) Protocol-independent when Layer 2 (uses MAC address)	<b>z/OS, z/VM</b> <b>z/VSE, z/TPF</b> <b>Linux on System</b> <b>z</b>
<b>OSE</b> 1000BASE-T zEC12, z196, z114, z10, z9, zSeries	Non-QDIO; for SNA/APPN/HPR traffic and TCP/IP “passthru” traffic	<b>z/OS, z/VM</b> <b>z/VSE</b>
<b>OSM</b> 1000BASE-T zEC12, z196, z114	OSA-Express for Unified Resource Manager Connectivity to intranode management network (INMN) from zEC12, z196, or z114 to Unified Resource Manager functions	<b>z/OS, z/VM</b> <b>Linux on System</b> <b>z</b>
<b>OSN</b> GbE, 1000BASE-T zEC12, z196, z114, z10, z9 No OSN support for OSA-Express4S GbE	OSA-Express for NCP Appears to OS as a device supporting CDLC protocol Enables Network Control Program (NCP) channel-related functions Provides LP-to-LP connectivity OS to IBM Communication Controller for Linux (CCL)	<b>z/OS, z/VM</b> <b>z/VSE, z/TPF</b> <b>Linux on System</b> <b>z</b>
<b>OSX</b> 10 GbE zEC12, z196, z114	OSA-Express for zBX Connectivity and access control to intraensemble data network (IEDN) from zEC12, z196, or z114 to zBX	<b>z/OS, z/VM,</b> <b>z/VSE 5.1,</b> <b>Linux on System</b> <b>z</b>



## 10 Gigabit Ethernet cabling options

Channel insertion loss + additional insertion loss allowed as defined by the IEEE 802.3 standard



**Single mode (SM)**



**(OM3)**



**(OM2, OM1)**

LR = Long reach 1310 nm transceiver

SR - Short reach 850 nm transceiver

9 $\mu$  SM fiber

•LR transceiver/feature on each end
<b>10 Gbps</b>   <b>6.0 dB</b>   <b>10 km (6.2 miles)</b>
<b>Link Speed</b>   <b>Link Budget</b>   <b>Unrepeated Distance</b>

**Single mode (SM) fiber**

50 $\mu$  2000 MHz-km MM fiber

OM3

•SR transceiver/feature on each end
<b>10 Gbps</b>   <b>2.6 dB</b>   <b>300 meters (984 ft)</b>
<b>Link Speed</b>   <b>Link Budget</b>   <b>Unrepeated Distance</b>

**Multimode (MM) fiber**

50 $\mu$  500 MHz-km MM fiber

OM2

•SR transceiver/feature on each end
<b>10 Gbps</b>   <b>1.8 dB</b>   <b>82 meters (269 ft)</b>
<b>Link Speed</b>   <b>Link Budget</b>   <b>Unrepeated Distance</b>

**Multimode (MM) fiber**

62.5 $\mu$  200 MHz-km MM fiber

OM1

•SR transceiver/feature on each end
<b>10 Gbps</b>   <b>1.6 dB</b>   <b>33 meters (108 ft)</b>
<b>Link Speed</b>   <b>Link Budget</b>   <b>Unrepeated Distance</b>

**Multimode (MM) fiber**

All connectors = LC Duplex

micron =  $\mu$

## Gigabit Ethernet cabling options



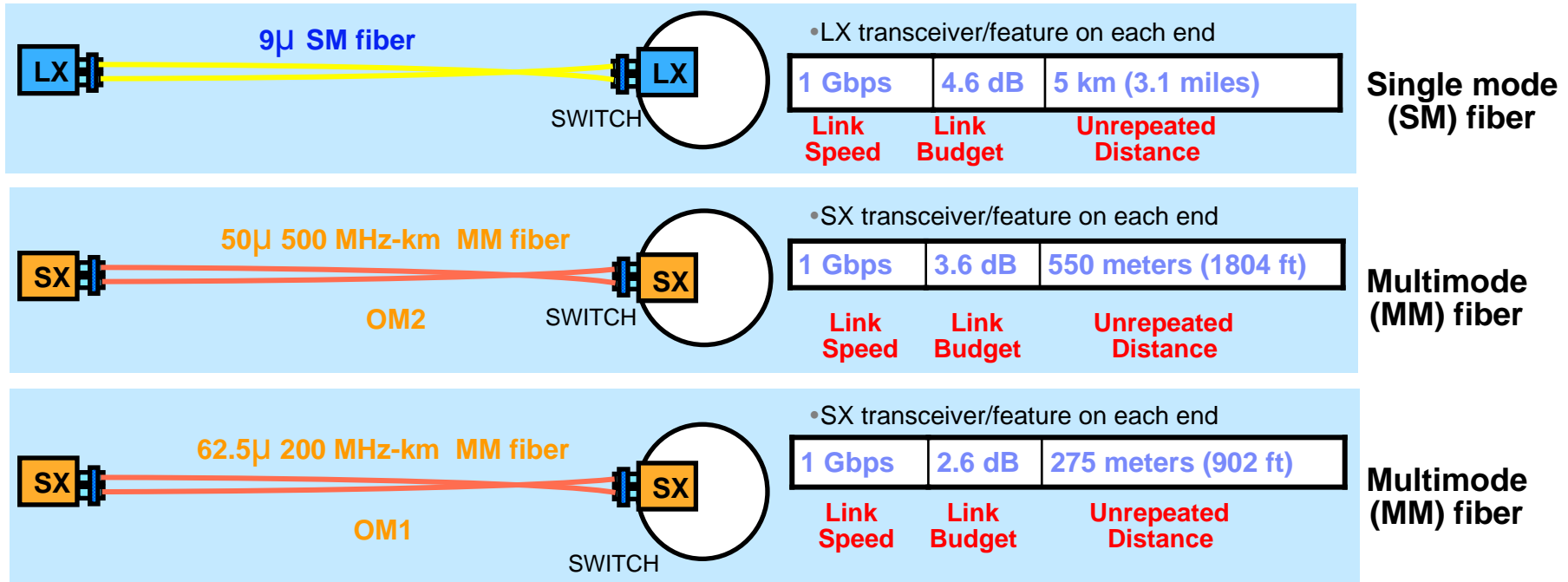
**Single mode (SM)**

LX = Long wavelength 1310 nm transceiver



**(OM2, OM1)**

SX - Short wavelength 850 nm transceiver



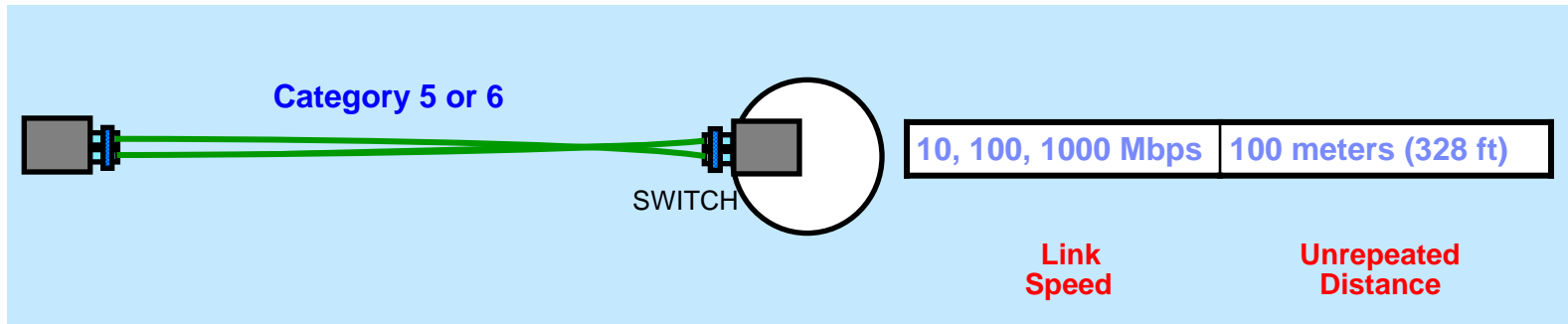
OM3 (2000 MHz-km): No changes have been made to the standard (1000BASE-SX) and no new variants. The distance remains at 550 meters for 50  $\mu$  fiber; independent of whether it is OM2 or OM3.

All connectors = LC Duplex

micron =  $\mu$

## 1000BASE-T Ethernet cabling

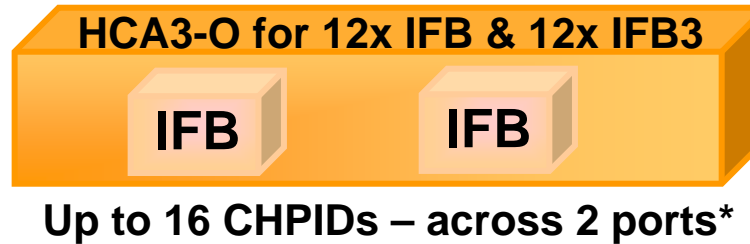
Cable type: EIA/TIA Category 5 or 6 Unshielded Twisted Pair (UTP) cable



- Connector = RJ-45



## 12x InfiniBand Coupling IFB3 Protocol (HCA3-O fanout)



- **Two protocols**
  1. 12x IFB – HCA3-O to HCA3-O or HCA2-O
  2. 12x IFB3 - improved service times for HCA3-O to HCA3-O  
*12x IFB3 service times are designed to be 40% faster than 12x IFB*
  
- **12x IFB3 protocol activation requirements**
  - **Four or fewer CHPIDs per HCA3-O port**  
 If more than four CHPIDs are defined per port, CHPIDs will use IFB protocol and run at 12x IFB service times

**\* Performance considerations may reduce the number of CHPIDs per port.**

Note: The InfiniBand link data rates do not represent the performance of the link. The actual performance is dependent upon many factors including latency through the adapters, cable lengths, and the type of workload.

# zEC12 I/O and Coupling Summary





## zEC12 I/O Feature Cards

Features	Offered As	Maximum # of features	Functional Limit	Increments per feature	Purchase increments
<b>FICON</b>					
<b>FICON Express8S</b>	<b>NB</b>	160	320 channels	2 channels	2 channels
FICON Express8	CF*	44	176 channels	4 channels	4 channels
FICON Express4 10km LX, SX	CF*	44	176 channels	4 channels	4 channels
<b>ISC-3 Coupling</b>	CF*	12	48 links	4 links	1 link
<b>OSA-Express</b>					
<b>OSA-Express4S 10 GbE</b>	<b>NB</b>	48	96 ports	1 port/1 channel	1 feature
<b>OSA-Express4S 1 GbE</b> <b>OSA-Express4S 1000BASE-T**</b>	<b>NB</b>	48	96 ports	2 ports/1 channel	1 feature
OSA-Express3	CF*	24	96 ports	2 (10 GbE) / 4 ports	1 feature
<b>Crypto</b>					
<b>Crypto Express4S**</b>	<b>NB</b>	16	16 PCIe adapters	1 PCIe adapter	1 feature ***
Crypto Express3	CF*	8	16 PCIe adapters	2 PCIe adapters	1 feature ***
<b>Storage Class Memory</b>					
<b>Flash Express**</b>	<b>NB</b>	8	8 PCIe adapters	1 PCIe adapter	2 features

\* Carry forward ONLY

\*\* New on zEC12

\*\*\* Two features initially, one thereafter

**NB = New Build**

**CF = Carry Forward**

**Not Supported – ESCON, FICON Express2 (or older FICON), OSA-Express2, and Power Sequence Control**

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## System z – Maximum Coupling Links and CHPIDs

Server	1x IFB (HCA3-O LR)	12x IFB & 12x IFB3 (HCA3-O)	1x IFB (HCA2-O LR)	12x IFB (HCA2-O)	IC	ICB-4	ISC-3	Max External Links	Max Coupling CHPIDs
<b>zEC12</b>	64* H20 – 32* H43 – 64*	32 H20 – 16* H43 – 32*	32 <sup>(4)</sup> H20 – 16* H43 – 32*	32 <sup>(4)</sup> H20 – 16* H43 – 32*	32	N/A	48 <sup>(4)</sup>	104 <sup>(1)</sup>	128
<b>z196</b>	48 M15 – 32*	32 M15 – 16* M32 – 32*	32 M15 – 16* M32 – 32*	32 M15 – 16* M32 – 32*	32	N/A	48	104 <sup>(1)</sup>	128
<b>z114</b>	M10 – 32* M05 – 16*	M10 – 16* M05 – 8*	M10 – 12* M05 – 8*	M10 – 16* M05 – 8*	32	N/A	48	M10 <sup>(2)</sup> M05 <sup>(3)</sup>	128
<b>z10 EC</b>	N/A	N/A	32 E12 – 16*	32 E12 – 16*	32	16 (32/RPQ)	48	64	64
<b>z10 BC</b>	N/A	N/A	12	12	32	12	48	64	64

\* Uses all available fanout slots. Allows no other I/O or coupling.

1. A z1Next H66, H89 or HA1 or a z196 M49, M66 or M80 supports a maximum 96 extended distance links (48 1x IFB and 48 ISC-3) plus 8 12x IFB links. A zEC12 H43 or z196 M32 supports a maximum 96 extended distance links (48 1x IFB and 48 ISC-3) plus 4 12x IFB links\*. A zEC12 H20 or z196 M15 supports a maximum 72 extended distance links (24 1x IFB and 48 ISC-3) with no 12x IFB links\*.
2. z114 M10 supports a maximum of 72 extended distance links (24 1x IFB and 48 ISC-3) with no 12x IFB links\*.
3. z114 M05 supports a maximum of 56 extended distance links (8 1x IFB and 48 ISC-3) with no 12x IFB links\*.
4. zEC12 supports ISC-3, HCA2-O and HCA2-O LR for carry forward only

## Last Slide

