Understanding FICON Performance

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Brocade FICON Professional Certification

- Certification for Brocade Mainframe-centric Customers – updated as of 3Q10
- For people who do or will work in FICON environments
- There is both an Brocade instructor lead 3-day class, Brocade Design and Implementation for a FICON Environment (CAF200), or a 2-day field class (FCAF200) to assist you in obtaining the knowledge to pass the certification examination
- Certification tests your ability to understand IBM System z I/O concepts, and demonstrate knowledge of Brocade FICON Director and switching fabric components.
- After the class you should be able to design, install, configure, maintain, manage, and troubleshoot common issues for Brocade FICON fabrics for local, metro area and global distance environments.
- Check the following website for complete information:
System z FICON

Some FICON Performance Considerations

Considerations for End-to-End Performance
A Few Good Reasons Why Customers Should Always Deploy Switched-FICON
You Should Deploy Switched-FICON
Just One of the many good reasons

• System z10 and beyond will limit the number of buffer credits that are on a CHPID such that a CHPID with long wave optics and single mode cable can reach <=10km

• Each 8G CHPID provides a maximum of 40 buffer credits
  • FICON typically creates 1/2 to 2/3 of full size frames significantly limiting distance connectivity compared to 2G or 4G of the past
  • A port on a FICON switching device can provide 100s of buffer credits to maintain high utilization of a link across long distances
  • Tools can be utilized to determine how many buffer credits are required to be allocated to a port to keep a link busy over distance
Mainframe Channel Cards

FICON Express4
- z10, z9
- 200 Buffer Credits per port
  - 101km @ 4G full frame/port
  - 51km @ 4G half frame/port
  - 40km @ 4G 819 byte payloads

FICON Express8
- z10
  - 40 Buffer Credits per port
    - 10km @ 8G full frame/port
    - 5km @ 8G half frame/port
    - 4km @ 8G 819 byte payloads

FICON Director
- zSeries, System z
  - From 8 to 1,300 Buffer Credits/port

FICON Express4 provides the last native 1Gbps CHPID support
CHPIIDs no longer designed to reach beyond 10km
FICON switching devices will provide BCs for long distances
You Should Deploy Switched-FICON
Just One of the many good reasons

- Long wave, single mode connections are often deployed on CHPIDs out of the mainframe
  - Long wave (LX) optics are basically the same price as short wave (SX) optics

- Short wave, multi-mode connections are often deployed on storage ports within a data center
  - Long wave (LX) optics cost more than short wave (SX) optics on both FICON switching devices and storage devices

- But at 8Gbps and beyond the older multi-mode cables (50m) are just not up to carrying data very far
  - OM2 50m (orange cables)
  - OM3 50m (aqua cables)
  - OM4 50m (new cable type)
Multi-mode cable distance limitations

- Long wave single mode (SM) still works well
  - 1/2/4/8/10 Gbps out to 10km with SM
- **Short wave multi-mode might be limiting!**
- 4G optics auto-negotiate back to 1, 2G
- 8G optics auto-negotiate back to 2, 4G
  - 1G storage connectivity requires 2/4G SFPs

Distance with Multi-Mode Cables (meters)

<table>
<thead>
<tr>
<th>Protocol (FC)</th>
<th>Encoding</th>
<th>Line Rate (Gb/sec)</th>
<th>OM1-62.5m (200mHz) Multi-Mode</th>
<th>OM2-50m (500mHz) Multi-Mode</th>
<th>OM3-50m (2000mHz) Multi-Mode</th>
<th>OM4-50m (4700mHz) Multi-Mode</th>
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<tbody>
<tr>
<td>1G</td>
<td>8b10b</td>
<td>1.0625</td>
<td>300</td>
<td>500</td>
<td>860</td>
<td>~</td>
</tr>
<tr>
<td>2G</td>
<td>8b10b</td>
<td>2.125</td>
<td>150</td>
<td>300</td>
<td>500</td>
<td>~</td>
</tr>
<tr>
<td>4G</td>
<td>8b10b</td>
<td>4.25</td>
<td>70</td>
<td>150</td>
<td>380</td>
<td>400</td>
</tr>
<tr>
<td><strong>8G</strong></td>
<td><strong>8b10b</strong></td>
<td><strong>8.5</strong></td>
<td><strong>21</strong></td>
<td><strong>50</strong></td>
<td><strong>150</strong></td>
<td><strong>200</strong></td>
</tr>
<tr>
<td>10G</td>
<td>64b66b</td>
<td>10.53</td>
<td>33</td>
<td>82</td>
<td>~300</td>
<td>~300</td>
</tr>
<tr>
<td>16G</td>
<td>64b66b</td>
<td>14.025</td>
<td>10.5</td>
<td>25</td>
<td>100</td>
<td>130</td>
</tr>
</tbody>
</table>
You Should Deploy Switched-FICON
Just One of the many good reasons

• Point-to-point, CHPID-to-storage port, wastes both types of connections and is the least reliable way of providing I/O connectivity for mainframe environments
  • Must deploy a CHPID for every storage port that is enabled
  • A single optic or cable failure renders two ports disabled
  • Regardless of I/O workload each DASD port requires a CHPID
Availability After A Component Failure

- A failure of a FE8 card …*or*… FE8 channel port …*or*… failure of the P-2-P cable …*or*… failure of the storage port optic …*or*… storage adapter causes:
  - FE8 port to become unavailable AND
  - Storage port becomes unavailable for everyone!

- A failure **anywhere** affects both the mainframe connection and the storage connection
  - Lose an SFP and lose host + storage connect
  - The WORST possible reliability and availability is provided by a P-2-P topology!
  - FC optics are most likely element to fail in the channel path – same as in a SAN
  - FC cables are second most likely failure in a fabric

- In a switched-FICON environment, only a segment is rendered unavailable:
  - The non-failing side remains available
  - If the storage has not failed, its port is still available to be used by other CHIPDs
You Should Deploy Switched-FICON
Just One of the many good reasons

- Fan In-Fan Out was not available with switched-ESCON
  - It was a half-duplex architecture and could not take advantage of Fan In-Fan Out
  - There was never enough bandwidth available in ESCON to allow Fan In-Fan Out to provide any efficiencies anyway

- Fan In-Fan Out is the best way to maximize port utilization
  - Plenty of bandwidth is now available and it is full duplex
  - Can keep CHPIDs and storage ports at optimal utilization

- Fan In-Fan Out can only be deployed when using switched-FICON
FI-FO Overcomes System Bottlenecks

- Total FICON path usually does not support full speed
  - Must deploy Fan In – Fan Out to utilize connections wisely
    - Multiple I/O flows funneled over a single channel path

Example Fan In:
To one CHPID = 12
(trying to keep the CHPID busy)

Example Fan Out:
From 12 Storage Adapters

135-740 MBps @ 2/4/8Gbps per CHPID (transmit and receive)

System z

Fiber Cable

FICON Director

Cascaded FICON

380 MBps @ 2Gbps
760 MBps @ 4Gbps
1520 MBps @ 8Gbps
1900 MBps @ 10Gbps
per link (transmit and receive)

FICON Director

Storage

70-740 MBps
Best link rate performance is achieved when the channel, switch and control unit all operate at the same link rate.

Link rate does not guarantee that data will flow at that speed.

Take the speed of the local ...AND... cascaded links into consideration.

Cascaded Links will flow at their rated speeds even when connected with ports of lower speed.
Maximum End-to-End Link Rates

- Is the above a good configuration for data flow?
- If you deployed this configuration, is there a probability of performance problems and/or slow draining devices or not?
- This is actually the ideal model!
- Most application profiles are 90% read, 10% write. So, in this case the "drain" of the pipe are the 8Gb CHPIDs and the "source" of the pipe are 4Gb storage ports.
- This represents an end-to-end network that will generally require the least amount of buffer credit pacing (assuming you implemented the correct number of ISLs)
Maximum End-to-End Link Rates

- Is the above a good configuration for data flow?
- If you deployed this configuration, is there a probability of performance problems and/or slow draining devices or not?

- For 4G tape this is OK – Tape is about 90% write and 10% read on average
- The maximum bandwidth a tape can accept and compress is about 240MBps for SUN and about 320MBps for IBM (at 2:1 compression)
- An 8G CHPID in Command Mode can do about 510MBps
- A 4G Tape channel can carry about 380MBps (400 * .95) = 380
- So a single CHPID attached to a 4G tape interface:
  - Can run a single IBM tape drive (510 / 320 = 1.594)
  - Can run two Oracle (STK) tape drives (510 / 240 = 2.125)
Directors versus Switches for FICON

- Directors are strategic devices, that solve most connectivity issues, and provide very long term investment protection and value over time in an ever changing enterprise environment
  - Excellent 5-7+ year investment
  - Non-disruptive failure repair
  - Non-disruptive and extensive scalability due to port density
  - Non-disruptive change to new and faster technology

- Switches, on the other hand, are tactical devices that solve a specific connectivity issue and provide poor investment value over time especially since technology is ever changing at a rate of about 18-24 months – best use is probably for standalone tape drives
  - Good 2+ year investment (how long have your switches lasted?)
  - Disruptive failure repair (except fans, power supplies and SFPs)
  - Limited scalability due to port density
  - Disruptive change to new and faster technology
My Story Today is:

• IT IS ALL GOOD!

• BUT...

• You Have To Know **What It Really Means** In Order To Deploy FICON Technology Successfully!

• Today’s presentation is an OVERVIEW – I have a six hour presentation that covers these considerations in much more detail!
End-to-End FICON/FCP Connectivity

- There are a series of Design Considerations that you must understand in order to successfully meet your expectations with your FICON fabrics.
End-to-End FICON/FCP Connectivity

- Channel Microprocessors and PCI Bus
- Average frame size for FICON
- CHPID – LX or SX and cabling
- Buffer Credit considerations
Mainframe Channel Cards

**FICON Express4**
- z10, z9
- 1, 2 or 4 GBps link rate
- **Cannot Perform at 4Gbps!**
- Standard FICON Mode: <= 350 MBps FD (out of 800 MBps)
- zHPF FICON Mode: <= 520 MBps FD (out of 800 MBps)
- 200 Buffer Credits per port
  - Out to 50km with 1K frames

**FICON Express8**
- z10
- 2, 4 or 8 GBps link rate
- **Cannot Perform at 8Gbps!**
- Standard FICON Mode: <= 510 MBps FD (out of 1600 MBps)
- zHPF FICON Mode: <= 740 MBps FD (out of 1600 MBps)
- 40 Buffer Credits per port
  - Out to 5km with 1K frames
FICON/FCP Switching Devices

- Single Mode and/or Multimode cabling
- SFP Considerations
- Buffer Credits
- FICON, FCP intermix and Virtualization capabilities
- FICON connectivity and scalability alternatives
- Ease of management

Some of the capabilities you should be looking for in a FICON switching device to provide you with a switched-FICON fabric deployment.

System z

Fiber Cable

Design Consideration

FICON Director

Considerations

SHARE in Boston

One or more IBM Graphics are used above
Majority of local storage connections are still short wave.

What is your current cable distance to farthest storage attachment point?

4Gbps allowed it to be 1,246 feet (380m) away using OM3
  - Will you have to relocate some storage closer in at 8G?
  - Do you need to re-cable from OM2 to OM3 or up to OS1?
Inter-Chassis Links
Scalability Through Innovative Director Features

- Can have cascaded connectivity as large as 384p x 6 DCX = 2,304 ports

Single FICON Fabric of 1,728 ports

3 DCXs with 384p
Equals 1,152 ports

1 DCX with 384p
1 DCX-4S with 192p
Equals 576 ports

Local
1,152 ports

Remote
576 ports

One Hop
Some of you need to start converting old ESCON and even old Bus and Tag equipment to function off of FICON fabrics.

Can use the Optica Technologies FICON-to-ESCON adapter box (Prizm) to address removing old ESCON Directors (9032s) while allowing ESCON legacy devices to continue to function – also converts Bus and Tag to ESCON.
Four basic things are required for long distance connectivity:
1 – Optics or IP that will push the data where you want it to be
2 – Cabling that allows data to be pushed where you want it to be
3 – Optimal buffer credits if it is an optical pathway over distance
4 – Certification from the vendor that it is supported
Control Unit Port for Use By RMF

Option FCD in ERBRMFxx parmlib member and STATS=YES in IECIOSnn tells RMF to produce the 74-7 records which it uses for the FICON Director Activity Report.

FICON Management Server (FMS) license per device enables CUP to provide information to the FICON Director Activity Rpt.

- FICON Management Server (FMS) is a license to enable Control Unit Port (CUP) on a FICON switching device.
- CUP, when enabled, uses an internal port “FE” to establish communications to RMF running on System z.
  - Even within Virtual Fabrics on a chassis, “FE” is always used for CUP.
FICON Director Activity Report

zHPF Enabled

FMS Key on, CUP enabled
RMF 74-7 records captured

Overall Averages: ~1116 ~1508
Note: zHPF Transport Mode results in larger frames

Command Mode FICON will probably have an average FICON frame size of 350-1100 bytes!

Average Frame Pacing Delay is the most important indication on this report.

Pacing Delay indicates that during the interval a port ran out of buffer credits while a frame was waiting to be sent.

This is an indication of a performance problem.
Connectivity with storage devices

Storage adapters can be throughput constrained
- Must ask storage vendor about performance specifics
- Is zHPF supported/enabled on your DASD control units?

Busy storage arrays can equal reduced performance
- Copy services, RAID used, RPMs, etc.
- Let’s look a little closer at this
Connectivity with storage devices

How fast are the Storage Adapters?
• Mostly 2 / 4Gbps today – some 8G – where are the internal bottlenecks

What kinds of internal bottlenecks does a DASD array have?
• 7200rpm, 10,000rpm, 15,000rpm
• What kind of volumes: 3390-3; 3390-54; EAV; XIV
• How many volumes are on a device? HiperPAV in use?
• How many HDDs in a Rank (arms to do the work)
• What Raid scheme is being used (RAID penalties)?
• Copy services? They have a higher priority than host I/O requests
• Etc.

RMF Magic from Intellimagic or Performance Associates I/O Driver

These tools perform mathematical calculations against raw RMF data to determine storage HDD utilization characteristics – use them or something like them to understand I/O metrics!
In order to fully utilize the capabilities of a FICON fabric a customer needs to deploy a Fan In – Fan Out Architecture.

If you are going to deploy Linux on System z, or private cloud computing, then switched FICON flexibility is required!

**FICON should never be direct attached!**
The End – Thank You For Attending!

Session #7345

Please fill out your evaluation forms

Please attend the Brocade session:
Customer Deployment Examples for FICON Technologies

Thursday at 8am!