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# A Deeper Look into the Inner Workings and Hidden Mechanisms of FICON Performance


- David Lytle, BCAF
- Brocade Communications Inc.


- Tuesday March 13, 2012 – 1:30pm to 2:30pm

- Session Number - 12071

QR Code

SHARE in Anaheim 2012

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This will usually give you more information than just what the slide contains.

I hope this helps in your educational efforts!

# A deeper look into the Inner Workings and Hidden Mechanisms of FICON Performance

This technical session goes into a fairly deep discussion on some of the design considerations of a FICON infrastructure.

- Among the topics this session will focus on is:
  - Congestion and Backpressure in FC fabrics
  - How Buffer Credits get initialized
  - How FICON utilizes buffer credits
  - Oversubscription and Slow Draining Devices
  - Determining Buffer Credit Requirements
  - FICON RMF Reporting

NOTE: Please check for the most recent copy of this presentation at the SHARE website as I make frequent updates.

# This Section

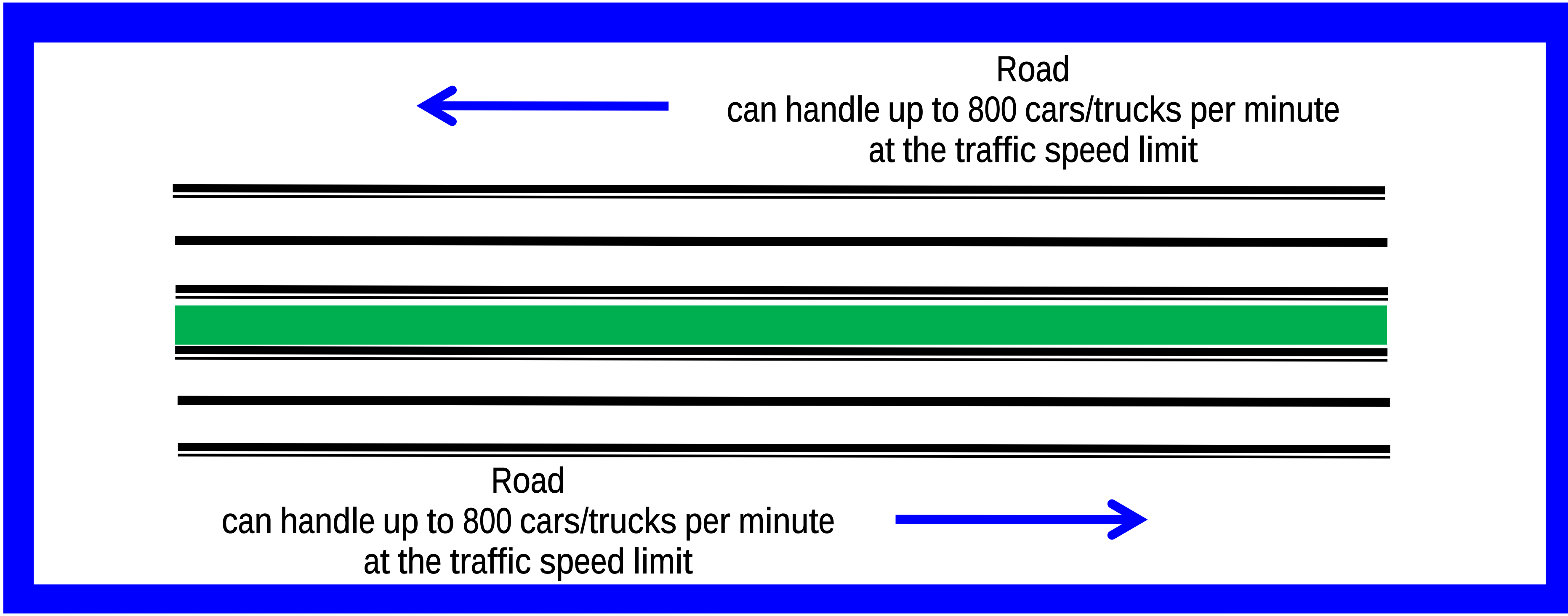
- Congestion and Backpressure Overview

Complete your sessions evaluation online at SHARE.org/AnaheimEval

# Congestion and Backpressure Overview
## These two conditions are not the same thing

- **Congestion** occurs at the point of restriction
- **Backpressure** is the effect felt by the environment leading up to the point of restriction

I will use an Interstate highway example to demonstrate these concepts



# Congestion and Backpressure Overview

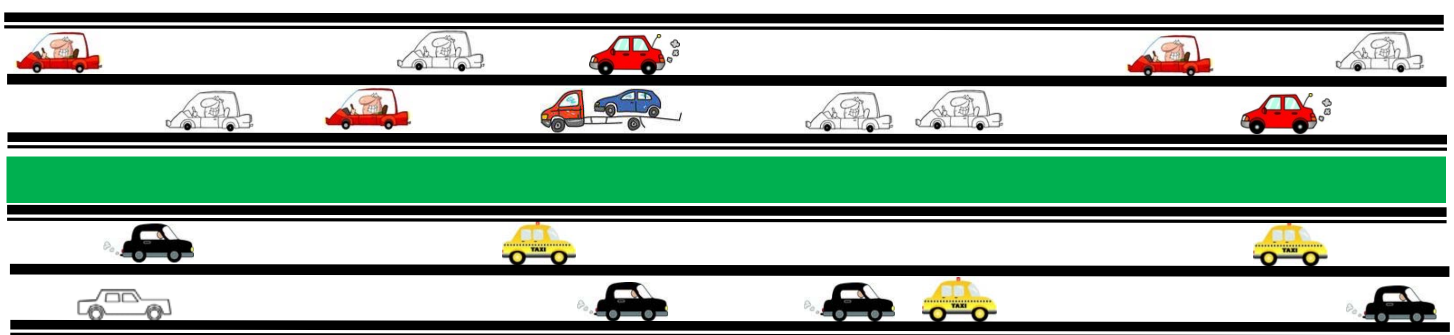
- **No Congestion and No Backpressure**
  - The highway handles up to 800 cars/trucks per minute and **less than** 800 cars/trucks per min are arriving

- Time spent in queue (behind slower traffic) is minimal
  - Cut-through routing (zipping along from point A to point B) works well

## No Congestion and No Backpressure

10am – 3pm ←

Road
can handle up to 800 cars/trucks per minute
so the traffic can run up to the speed limit

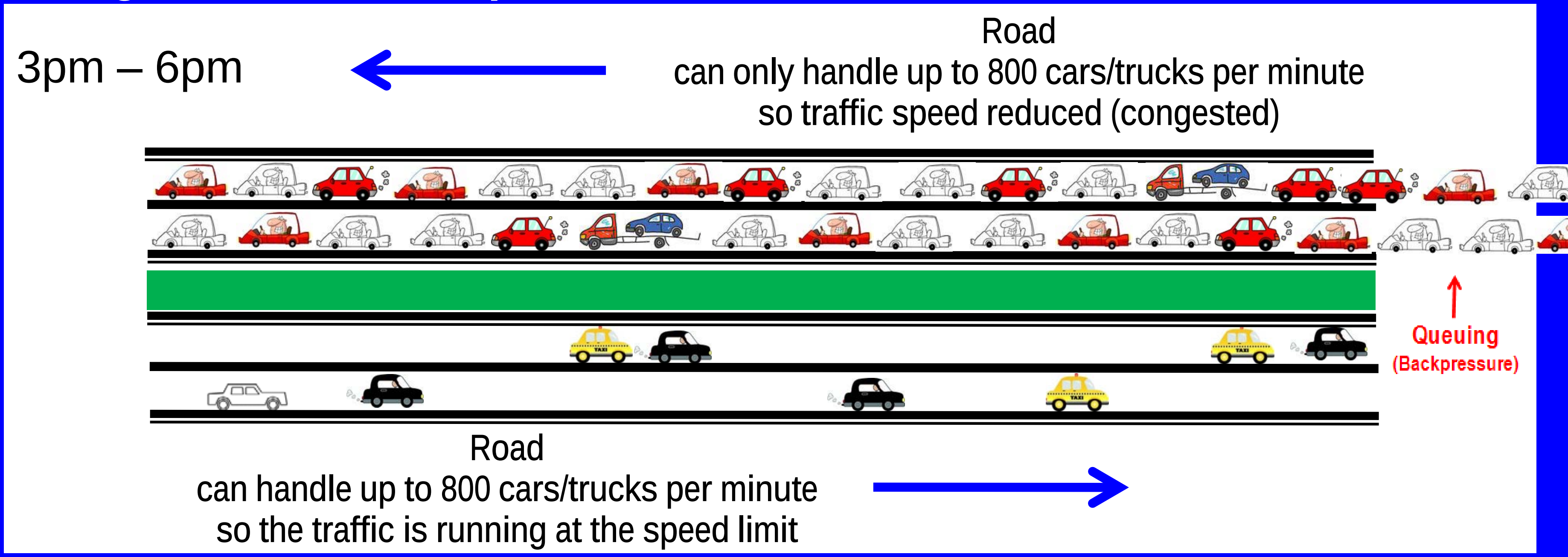


Road
can handle up to 800 cars/trucks per minute
so the traffic can run up to the speed limit →

# Congestion and Backpressure Overview

- **Congestion**
  - The highway handles up to 800 cars/trucks per minute and **more than** 800 cars/trucks per min are arriving
- Latency time and buffer credit space consumed increases
  - Cut-through routing cannot decrease the problem
- **Backpressure** is experienced by cars slowing down and queuing up

## Congestion and Backpressure



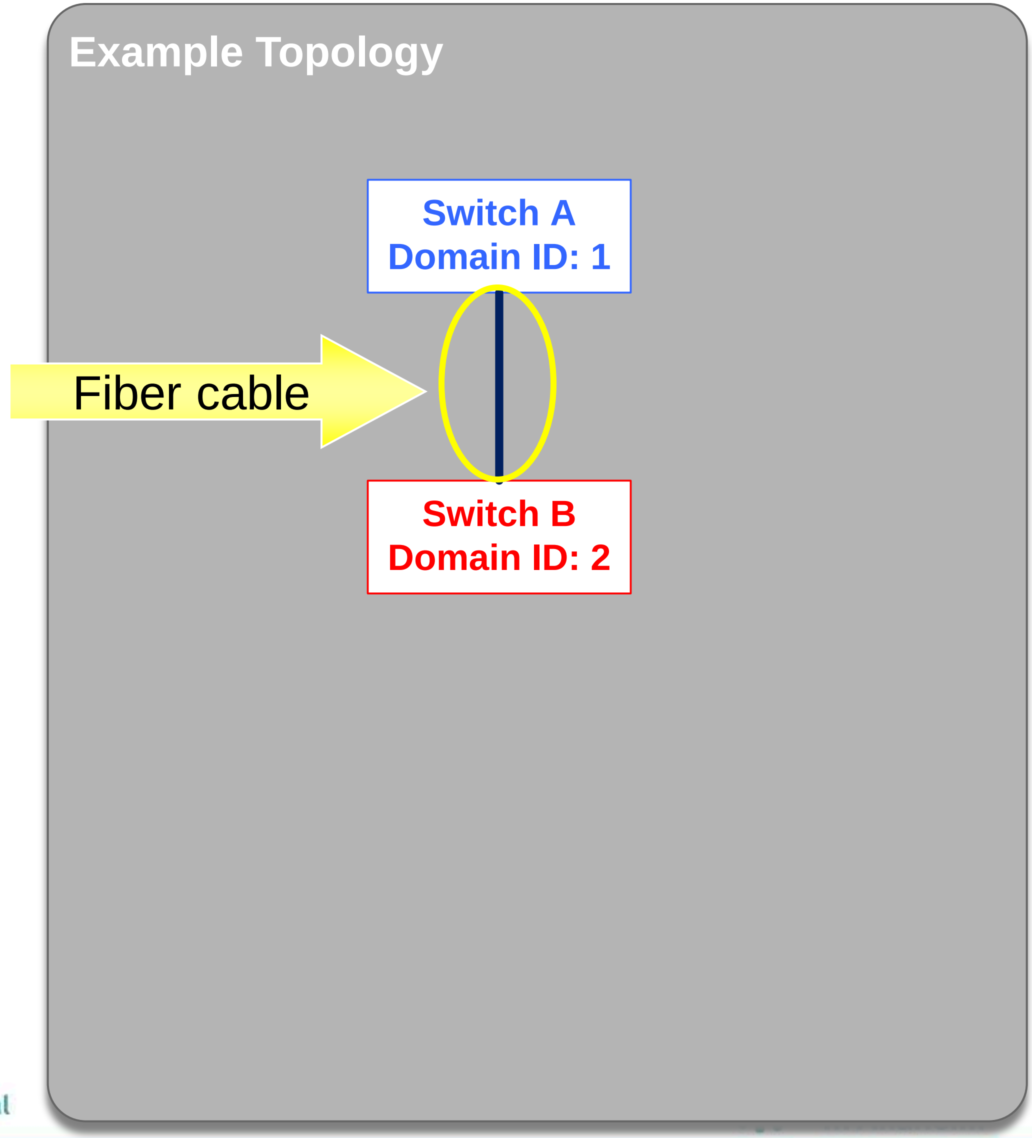
# This Section

- Very basic flow for the Build Fabric process and how Buffer Credits get initialized

# Build Fabric Process

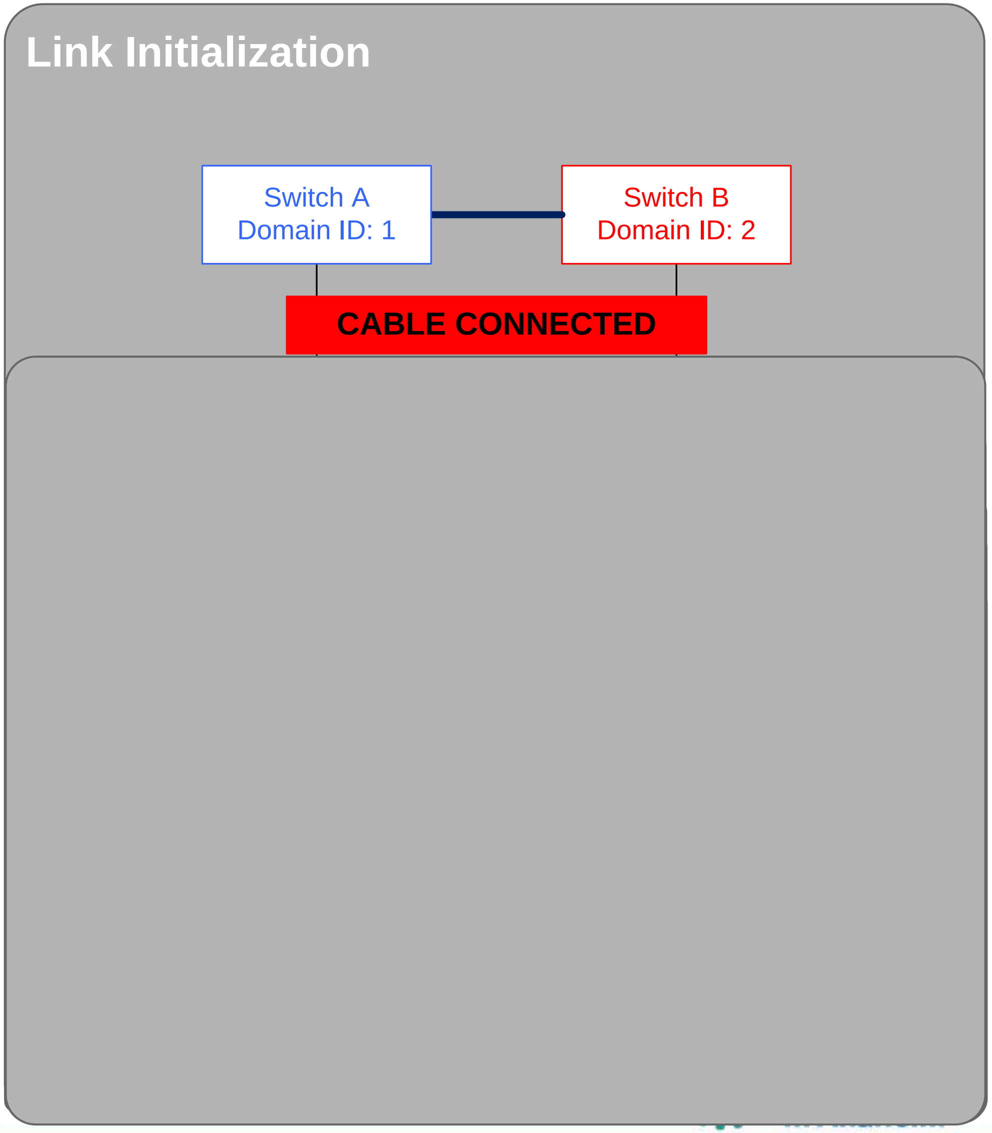
Assume

- A fiber cable will be attached between switch A and B
- This will create an ISL (E_Port) between these two devices



# Build Fabric Process

- **Cable connected**
- **Link Speed Auto-Negotiation**
- **Link is now in an Active state**
- **One credit is granted by default to allow the port logins to occur**
- **Exchange Link Parms (ELP)**
  - Contains the "requested" buffer credit information for the sender
  - Assume 8 credits are being granted for this example
- **Responder Accepts – then does its own ELP**
  - Contains the "requested" buffer credit information for the responder
  - Assume 8 credits are being granted for this example
- **Link becomes an E_Port**
- **Send Link Resets (LR)**
  - Initializes Sender credit values
- **Link Reset Response (LRR)**
  - Initializes Responder credit values



# Build Fabric Process

- **Cable connected**
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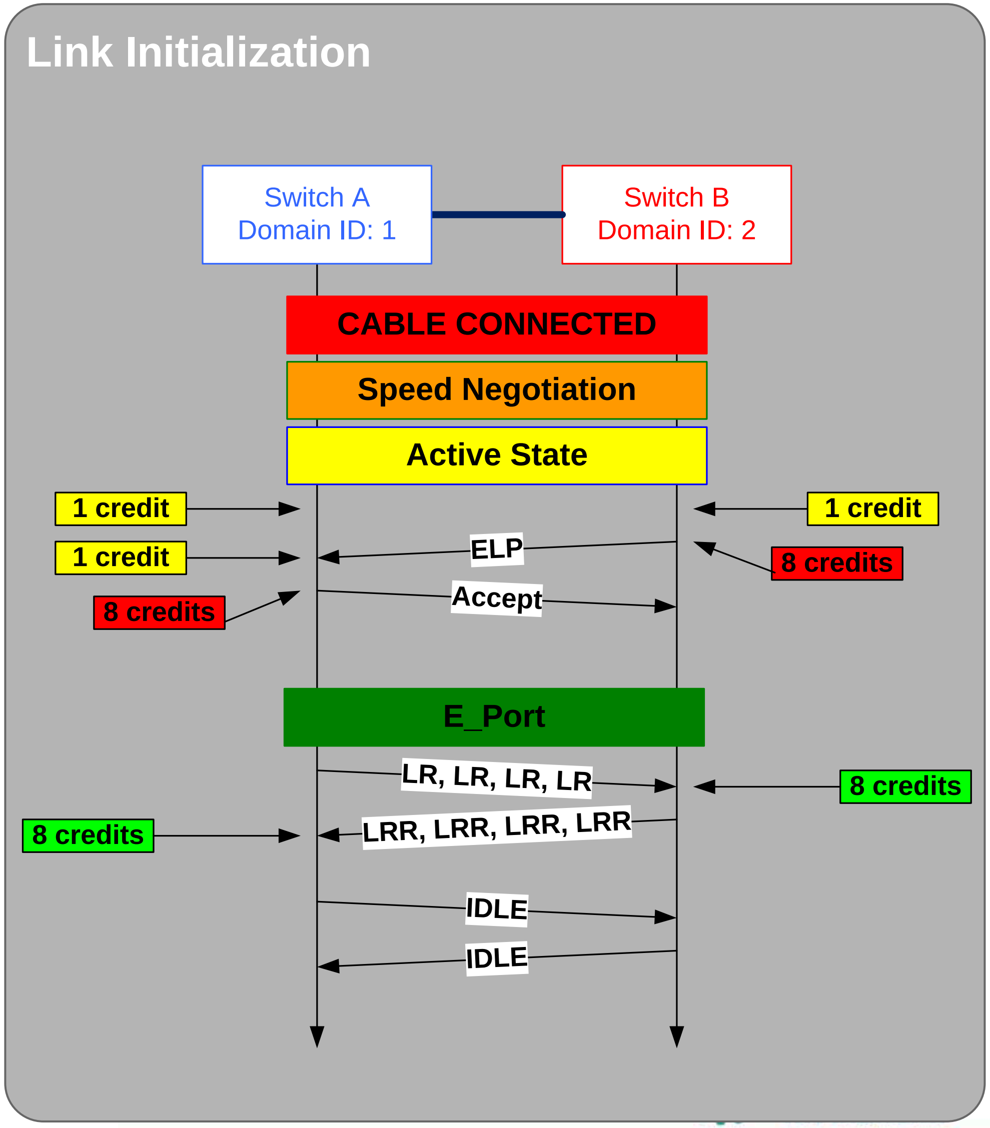
- **Link becomes an E_Port**
- **Send Link Resets (LR)**
  - Initializes Sender credit values
- **Link Reset Response (LRR)**
  - Initializes Responder credit values
- **Ready for I/O to start flowing**



# This Section

- How FICON uses Buffer-to-Buffer Credits

- Howard Johnson, BCAF and
  a Brocade FICON Engineer, will
  present an excellent session entitled,
  “Buffer-to-Buffer Credits, Exchanges,
  and Urban Legends” tomorrow at 8:00am

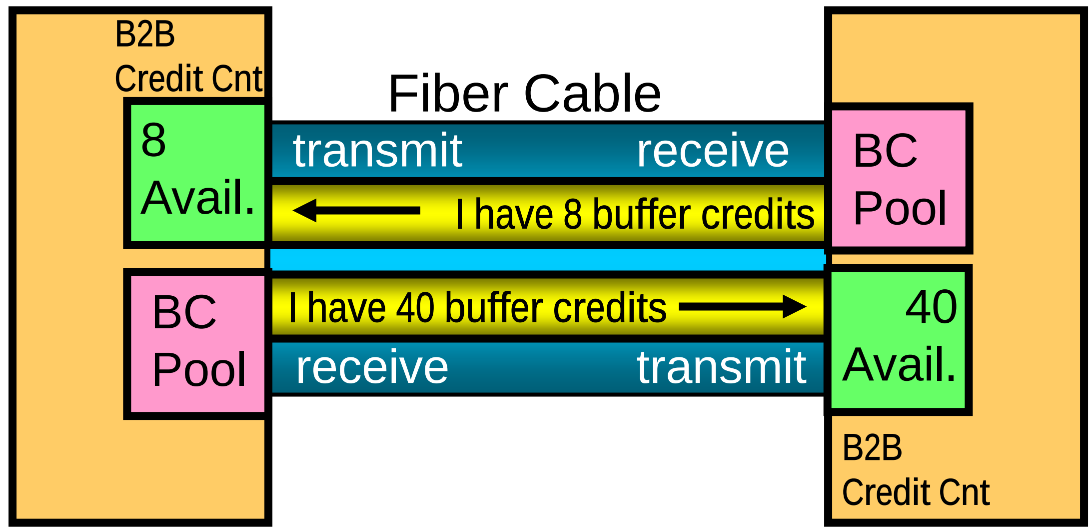
- I hope you’ll take the opportunity
  to hear it

# How Buffer Credits Work

- A Fiber channel link is a PAIR of paths
- A path from "this" transmitter to the "other" receiver and a path from the "other" transmitter to "this“ receiver
- The "buffer" resides on each receiver, and that receiver tells the linked transmitter how many BB_Credits are available
- Sending a frame through the transmitter decrements the B2B Credit Counter
- Receiving an R-Rdy or VC-Rdy through the receiver increments the B2B Credit Counter
- DCX family has a buffer credit recovery capability

**System z FICON X8/8S CHPID**

**Brocade Dir. Port**




Express = fixed 64 BC
Express2 = fixed 107 BC
Express4 = fixed 200 BC
Express8 = fixed 40 BC

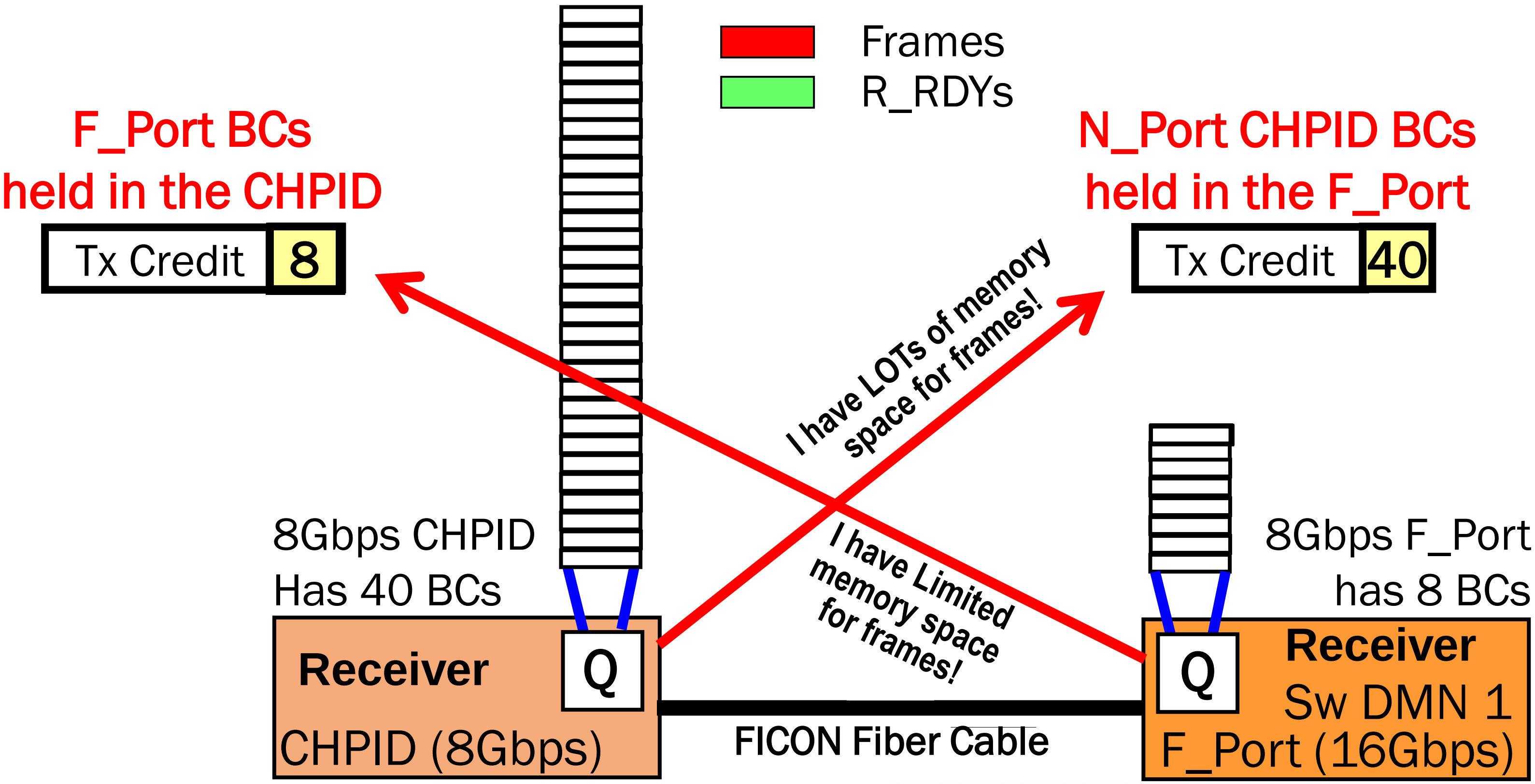
- Switch has variable BCs
- DASD has fixed BCs
- Old Tape had variable BCs

*Each receiver on the fiber cable can state a different value!*

*Once established, it is transmit (write) connections that will typically run out of buffer credits*

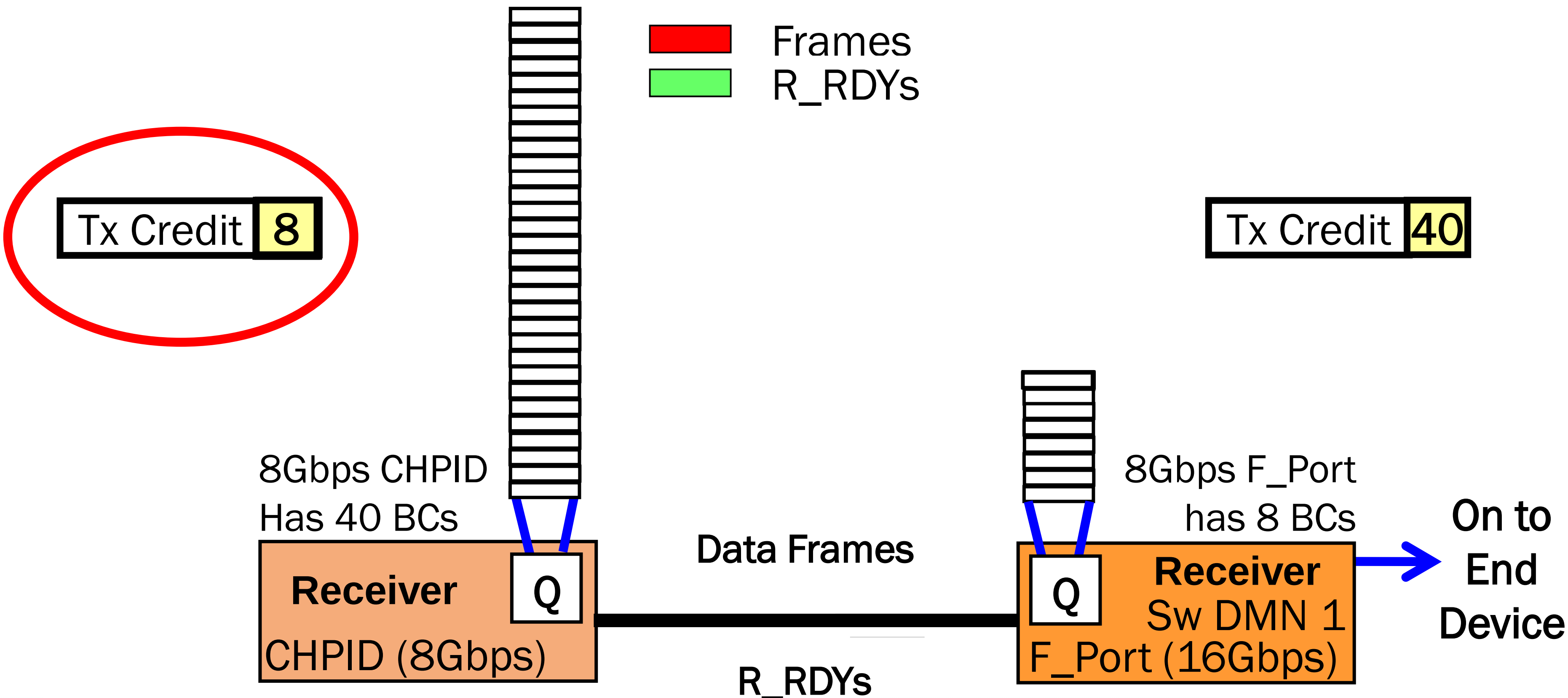
# Buffer-to-Buffer Credits
## Buffer-to-Buffer flow control

- After initialization, each port knows how many buffers are available in the queue **<u>at the other end of the link</u>**
  - This value is known as Transmit (Tx) Credit

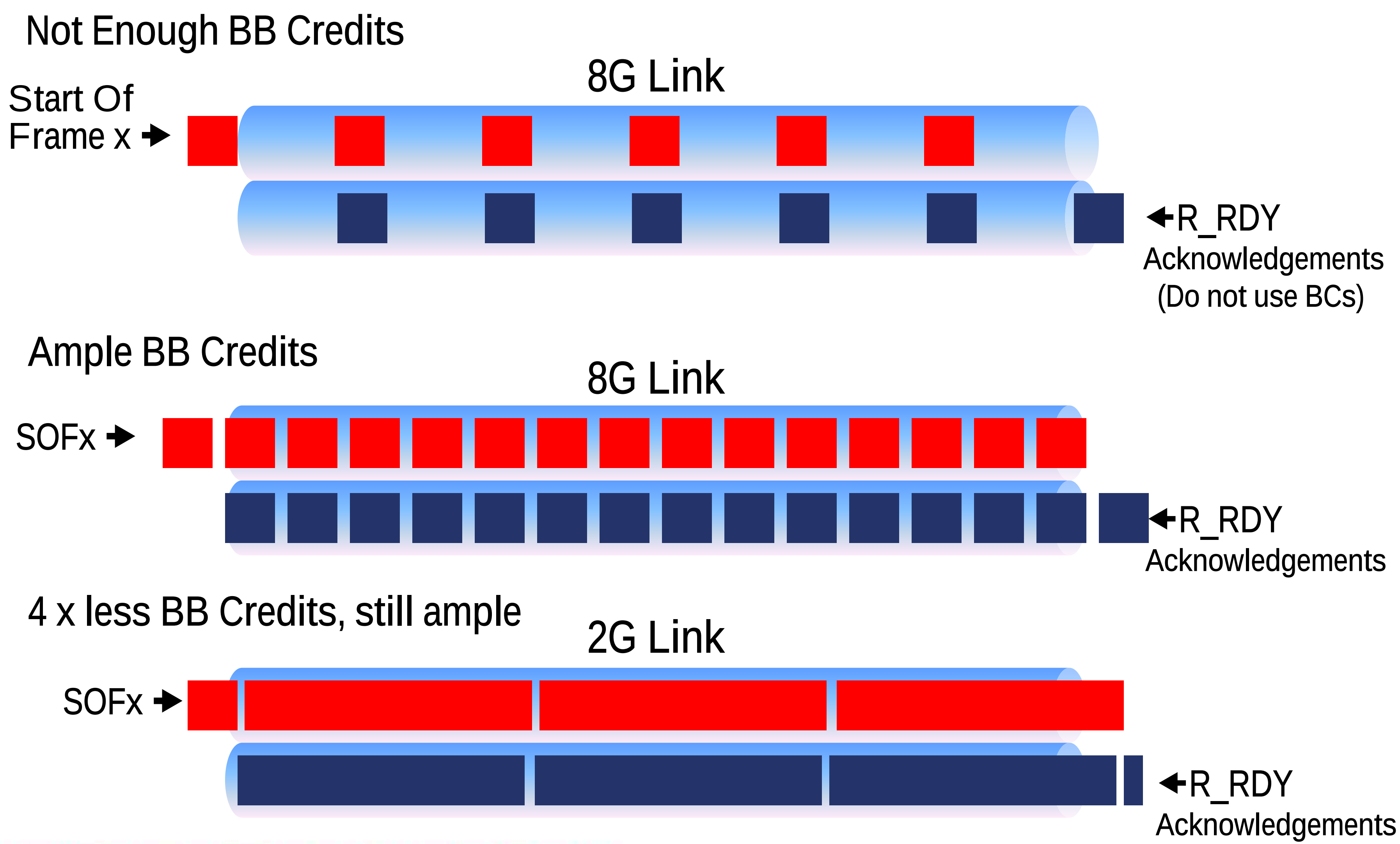


# Buffer-to-Buffer Credits
## Buffer-to-Buffer flow control Example

- Tx Credit is **decremented** by one for every frame sent from the CHPID
- No frames may be transmitted after Tx Credit reaches zero
- Tx Credit is **incremented** by one for each R_RDY received from F_Port



# BB Credit Droop

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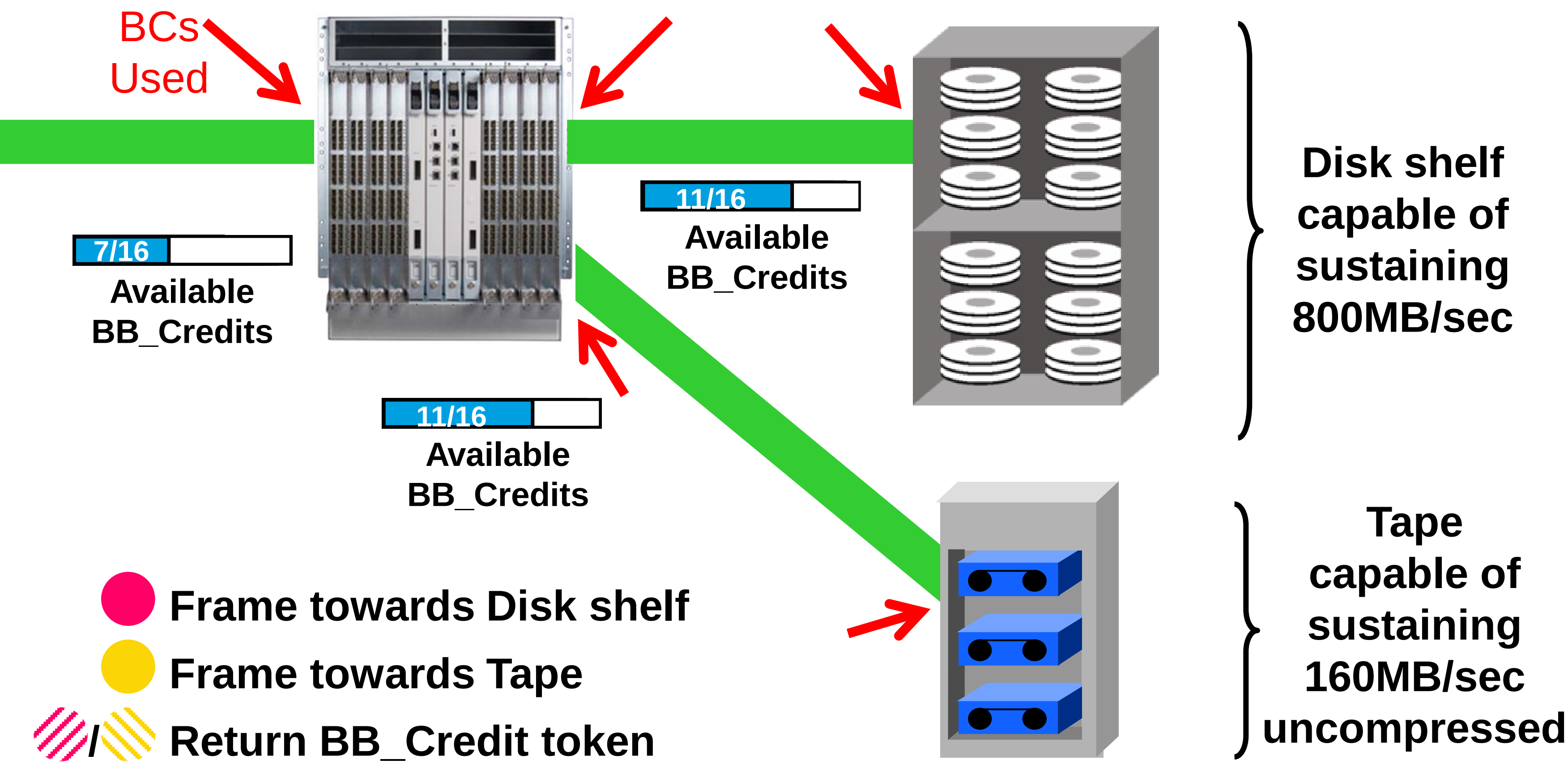
# Buffer Credits
# Working Ideally

Buffer Credits are a “Flow Control” mechanism to assure that frames are sent correctly (engineers call this “Frame Pacing”)

In an ideal FC network all devices can process frames at the same rate and negotiate equal levels of BB_Credits)



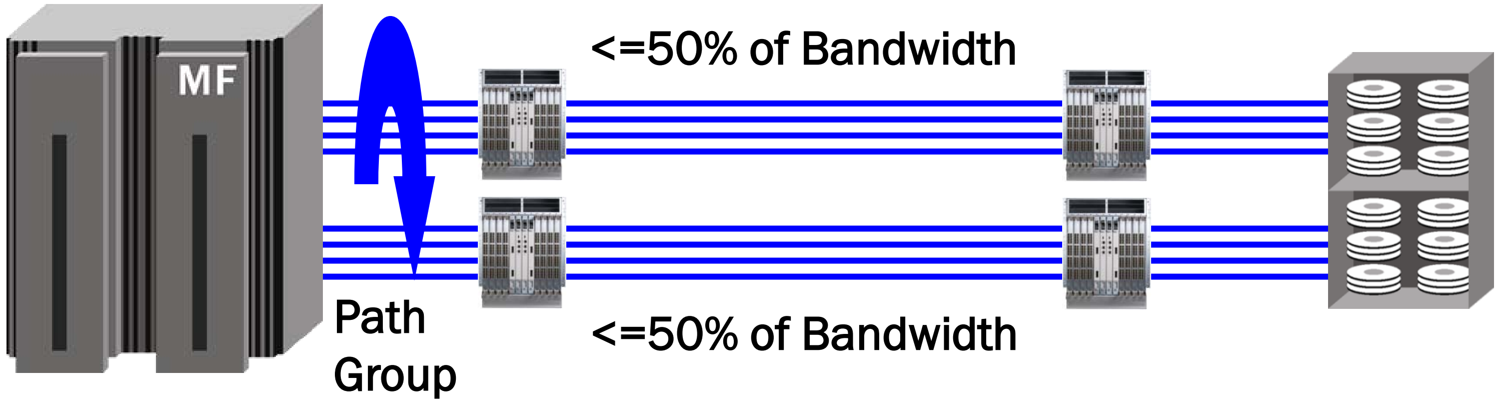
# This Section

- ISL Oversubscription

NOTE:
There is also fabric oversubscription and link oversubscription.
In this session I think that **ISL Oversubscription** will demonstrate how serious a concern that oversubscription really can be to the enterprise.

# ISL Oversubscription – Design Architecture

Provides a potential five-9's of availability environment




But each fabric really needs to run at no more than 45% busy so that if a failover occurs then the remaining fabric can pickup and handle the full workload

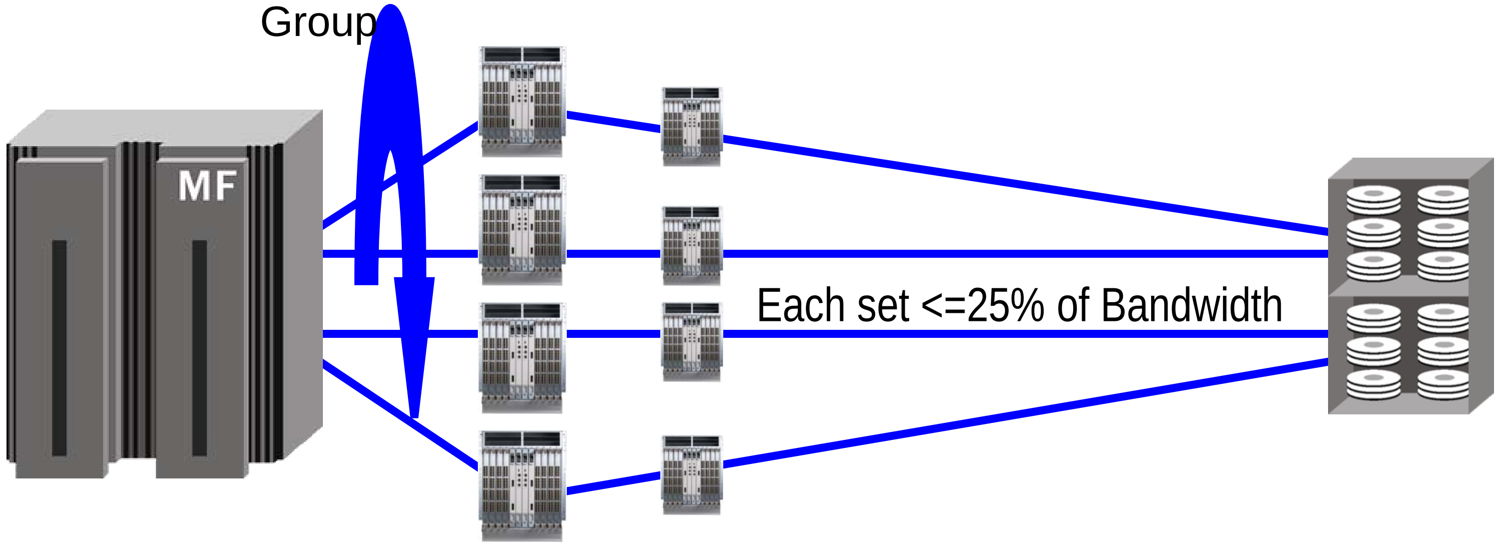
z/OS's IOS automatically load balances the FICON I/O across all of the paths in a Path Group (up to 8 channels in a PG)

- Although this *potentially* provides a five-9s environment, when a fabric does fail how devastating will it be to you in the event that another event occurs and the remaining fabric also fails ?
- Especially when humans get involved, multiple failures too often do occur!

# ISL Oversubscription – Design Architecture

Having 4 fabrics servicing a Path Group protects your enterprise's I/O availability!

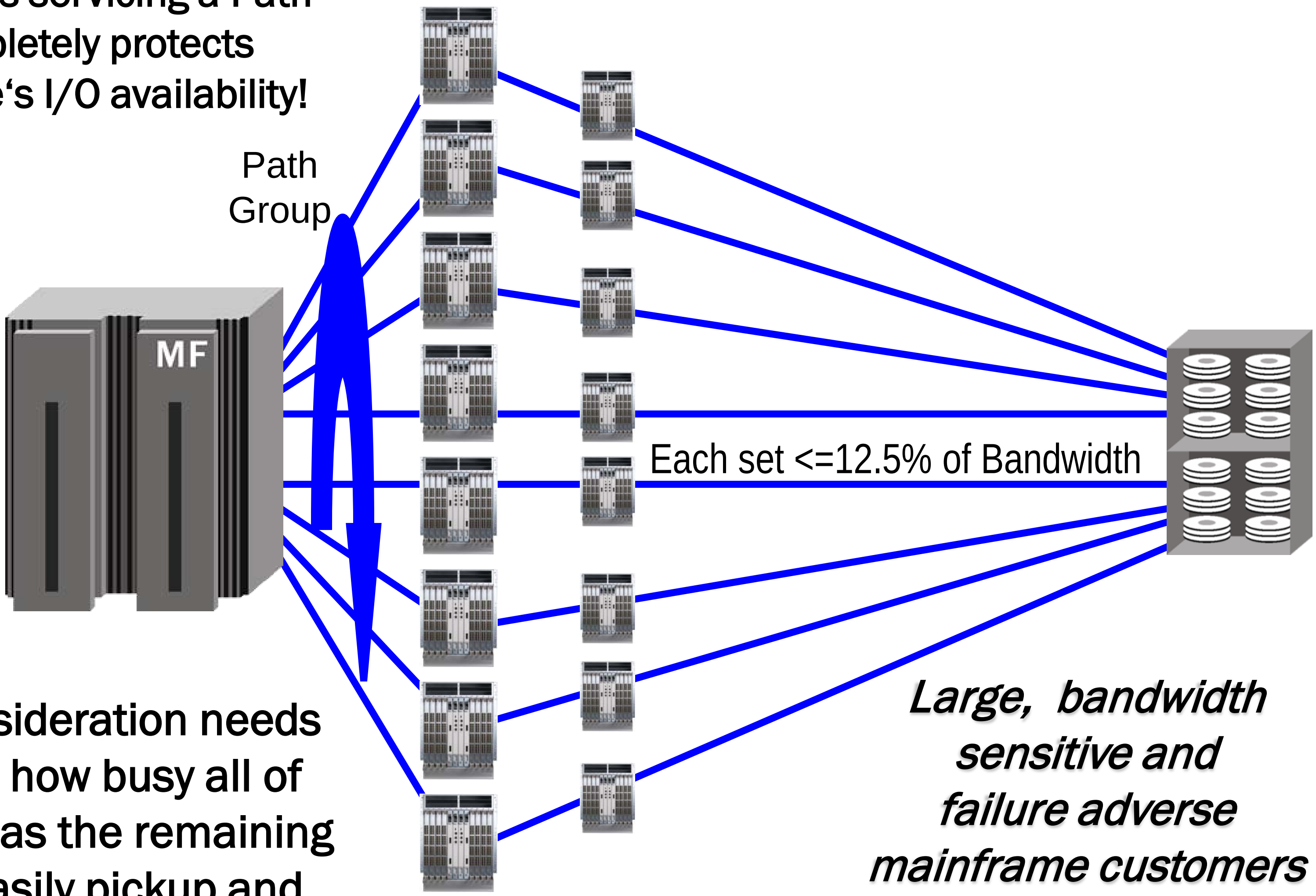
Provides a five-9's of availability environment




A little consideration needs to be given to how busy all of the fabrics are but the remaining fabrics should easily pickup and handle the full workload

# ISL Oversubscription – Design Architecture

Having 8 fabrics servicing a Path Group completely protects your enterprise's I/O availability!




Provides a five-9's of availability environment

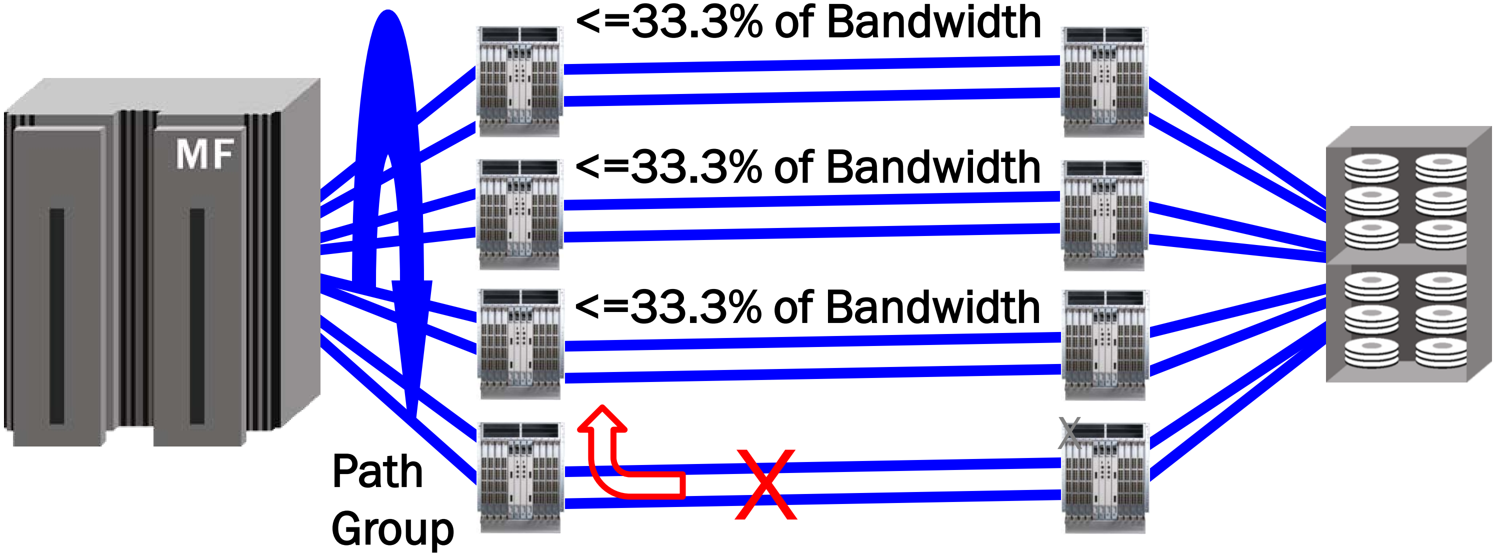
Not much consideration needs to be given to how busy all of the fabrics are as the remaining fabrics can easily pickup and handle the full workload

*Large, bandwidth sensitive and failure adverse mainframe customers might benefit from configurations like this!*

# ISL Oversubscription – Design Architecture

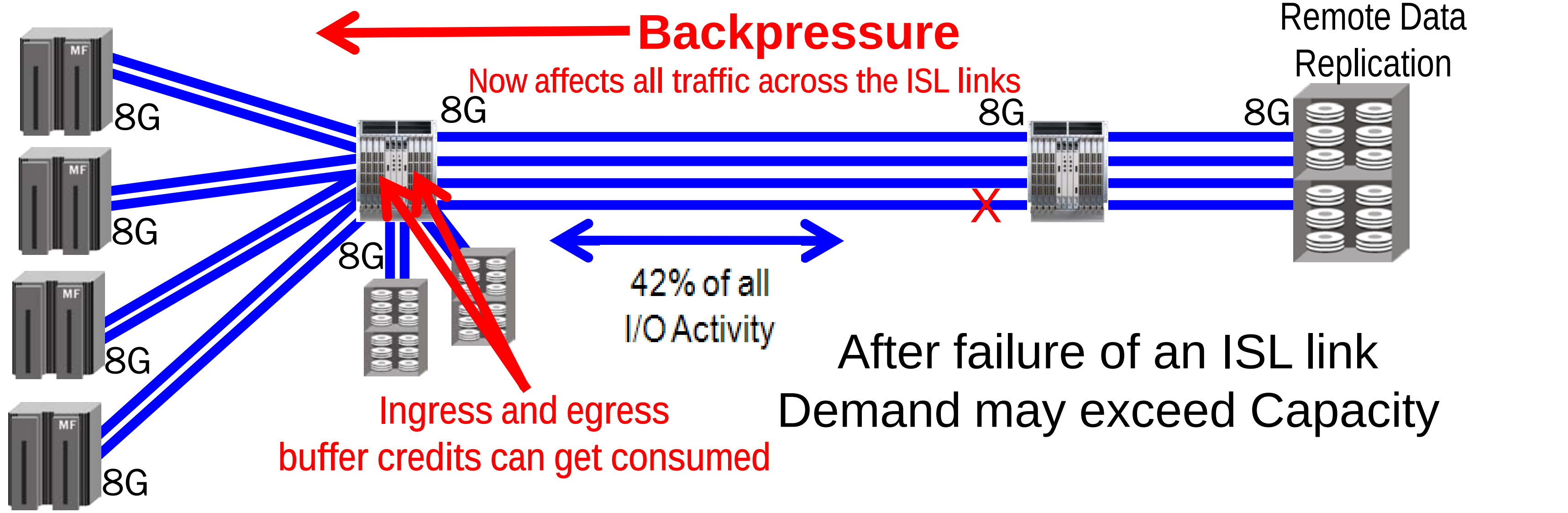

- Risk of Loss of Bandwidth is the motivator for deploying FICON fabrics like this
- In this case, 2 paths from an 8 path Path Group are deployed across four FICON fabrics to limit bandwidth loss to no more than 25% if a FICON fabric were to fail
- Each fabric needs to run at no more than ~50-60% busy so that if a failover occurs then the remaining fabrics can pickup and handle the full workload without over-utilization and with some extra utilization to spare per fabric
- If an ISL link in a single fabric fails then that fabric runs at only 50% capability

# ISL Oversubscription – After a Failure Demand may exceed capacity




- In this case if a switching device fails …or… if the long distance links in a fabric fails then the frame traffic that was traveling across the now broken links will be rerouted through the other fabrics to reach the storage device
- Those remaining fabrics must have enough reserve capacity in order to pick up all of the rerouted traffic while maintaining performance
- Congestion and potential back pressure could occur if all fabrics are running at high utilization levels – again, probably above 50% or 60% utilization
- Customers should manage their fabrics to allow for rerouted traffic

# ISL Oversubscription
# Creating Backpressure Problems on an ISL




- In This Example:
  - 8G CHPIDs and ISLs are capable of 760MBps send/receive (800 * .95=760)
  - Two CHPIDs per mainframe (1520MBps) and 4 mainframes (6080MBps)
  - About 42% of I/O activity is across the ISLs and requires **2550MBps**
  - Four ISLs provides 3040MBps – (760MBps * 4) – and a little extra
  - Then one ISL fails leaving only **2280MBps** – (760MBps * 3) – not enough redundancy
  - 2280MBps / 2550MBps = 89% of what is required (**Congestion Will Occur**)
  - Each CHPID experiences backpressure as the remaining 3 ISLs become congested and unable to handle all of the I/O traffic

# Some of my favorite photos

## In Technical Sessions, Your Brain Should Be Allowed To Take A Break!

Bryce Canyon, USA

Big Sur - California

Lock Lomond Scotland from Lock Lomond Castle

Alesund, Norway

**Brain Interlude Is Over….**

**Back to Work!**

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# This Section

- Slow Draining Devices

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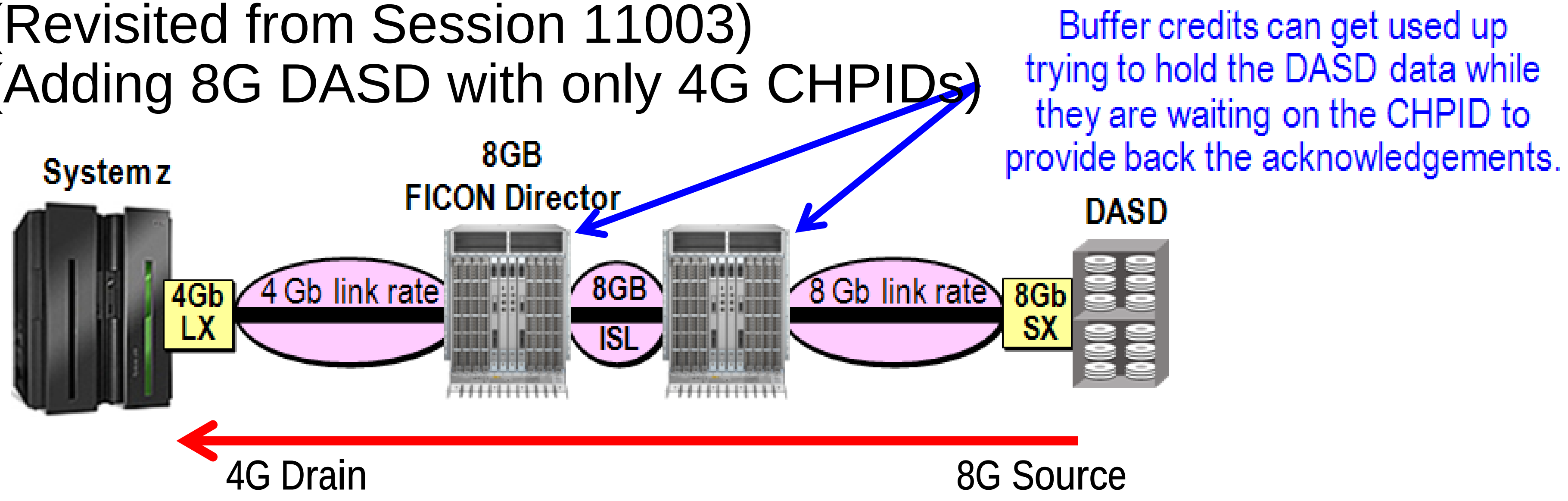
# Slow Draining Devices

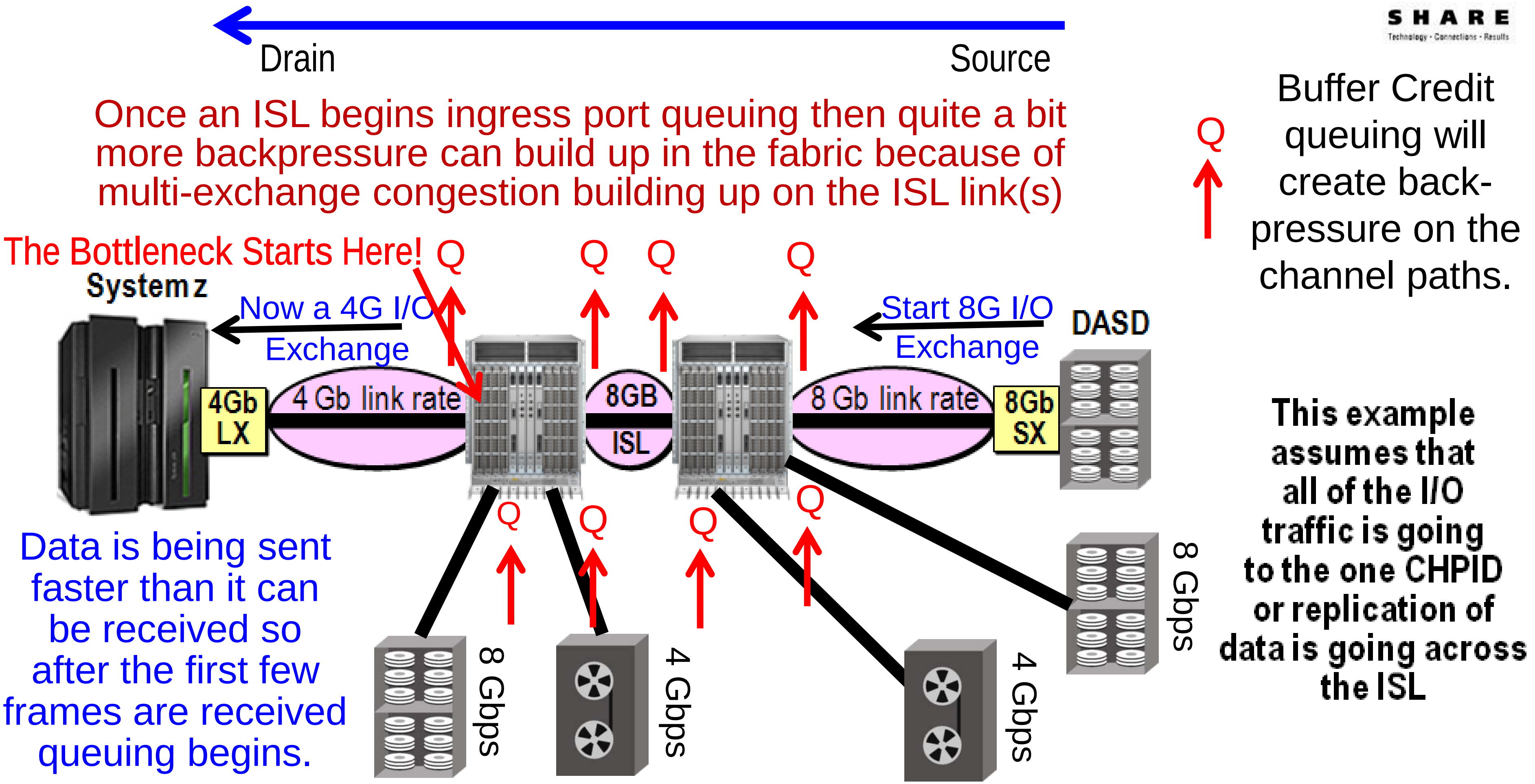
- Slow draining devices are **receiving ports** that have more data flowing to them than they can consume.
  - This causes external frame flow mechanisms to back up their frame queues and potentially deplete their buffer credits.
- A slow draining device can exist at any link utilization level
- It's very important to note that it can spread into the fabric and can slow down unrelated flows in the fabric.
- What causes slow draining devices?
- The most common cause is within the storage device or the server itself. That happens often because a target port has a slower link rate then the I/O source ports(s) or the Fan-In from the rest of the environment overwhelms the target port.

# Slow Draining Devices – DASD
(Revisited from Session 11003)
(Adding 8G DASD with only 4G CHPIDs)



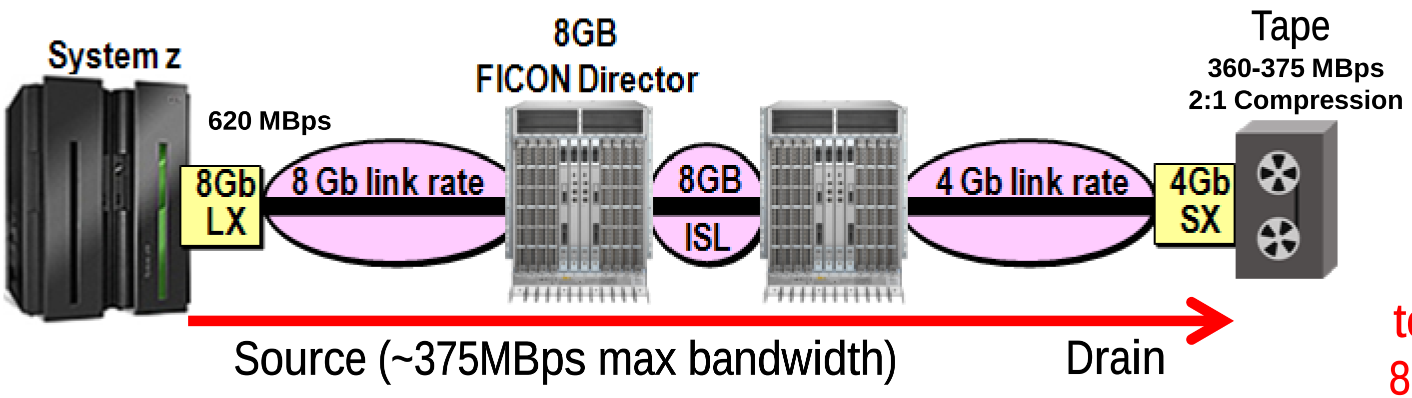

- This is potentially a very poor performing, infrastructure!
- DASD is about 90% read, 10% write. So, in this case the "drain" of the pipe is the 4Gb CHPID and the "source" of the pipe is the 8Gb storage port.
- The Source can out perform the Drain!
- This can cause congestion and back pressure towards the CHPID. The switch port leading to the CHPID becomes a slow draining device.

# The Affects Of Link Rates (watch out for ISLs!)




- The is a simple representation of a single CHPID connection
- Of course that won’t be true in a real configuration and the results could be much worse and more dire for configuration performance

# Slow Draining Devices – Real Tape




BUT…
If 8G Tape runs
at 375MBps (2X)
it will take 750MBps
to feed it and the best
8G CHPID <=620MBps

- 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 (@ 2:1 compression) is about 360MBps for Oracle (T1000C) and about 375MBps for IBM (TS1140)
- A FICON Express8S CHPID in Command Mode FICON can do about 620MBps
- A 4G Tape channel can carry about 380MBps (400 * .95 = 380MBps)
- So a single CHPID attached to a 4G tape interface:
  - Can run a single IBM tape drive (620 / 375 = 1.65)
  - Can run a single Oracle (STK) tape drive (620 / 360 = 1.72)

# This Section

- Determining Buffer Credits Required
- RMF Reports for Switched-FICON
- Brocade’s Buffer Credit Calculation Spreadsheet

Complete your sessions evaluation online at SHARE.org/AnaheimEval

# Buffer Credits
# Why FICON Never Averages a Full Frame Size

- There are three things that are required to determine the number of buffer credits required across a long distance link
  - The speed of the link
  - The cable distance of the link
  - The average frame size
- Average frame size is the hardest to obtain
  - Use the RMF 74-7 records report “FICON Director Activity Report”
  - You will find that FICON just never averages full frame size
  - Below is a simple FICON 4K write that demonstrates average frame size

Control — 76 — **Prefix command, etc.**

Write — 2084 (-64 FICON DB) — 2148 — 72

Status Accept — 68

**4K will not fit into 2 BCs because of headers for FC as well as SB3 protocol that is used and the 64 byte FICON header that is placed into the payload field of the 1st frame of every FICON exchange.**

Average = (76+2084+2148+72+68) / 5 = 890 Bytes

# Buffer Credits for Long Distance
## The Impact of Average Frame Size on Buffer Credits

| A distance of 20KM with 100% link utilization | | | | 2Gbps | 4Gbps | 8Gbps | 10Gbps | 16Gbps |
|---|---|---|---|---|---|---|---|---|
| SOF, Header, CRC, EOF | Payload | Total Frame Bytes | Smaller than full frame by xx% | Buffer Credis Required 8b10b | Buffer Credis Required 8b10b | Buffer Credis Required 8b10b | Buffer Credis Required 64b66b | Buffer Credis Required 64b66b |
| 36 | 2112 | 2148 | 0.00% | 20 | 40 | 80 | 99 | 159 |
| 36 | 1966 | 2002 | 6.80% | 22 | 43 | 85 | 107 | 170 |
| 36 | 1824 | 1860 | 13.41% | 23 | 46 | 92 | 115 | 183 |
| 36 | 1682 | 1718 | 20.02% | 25 | 50 | 99 | 124 | 198 |
| 36 | 1540 | 1576 | 26.63% | 27 | 54 | 108 | 135 | 216 |
| 36 | 1398 | 1434 | 33.24% | 30 | 60 | 119 | 149 | 238 |
| 36 | 1256 | 1292 | 39.85% | 33 | 66 | 132 | 165 | 264 |
| 36 | 1114 | 1150 | 46.46% | 37 | 74 | 148 | 185 | 296 |
| 36 | 972 | 1008 | 53.07% | 43 | 85 | 169 | 211 | 338 |
| 36 | 830 | 866 | 59.68% | 50 | 99 | 197 | 246 | 393 |
| 36 | 688 | 724 | 66.29% | 59 | 118 | 235 | 294 | 470 |
| 36 | 546 | 582 | 72.91% | 74 | 147 | 293 | 366 | 585 |
| 36 | 404 | 440 | 79.52% | 97 | 194 | 387 | 484 | 773 |
| 36 | 262 | 298 | 86.13% | 143 | 286 | 571 | 714 | 1142 |
| 36 | 120 | 156 | 92.74% | 273 | 545 | 1090 | 1363 | 2180 |
| 36 | 36 | 72 | 96.65% | 591 | 1181 | 2362 | 2952 | 4724 |

Created by using Brocades Buffer Credit Calculator

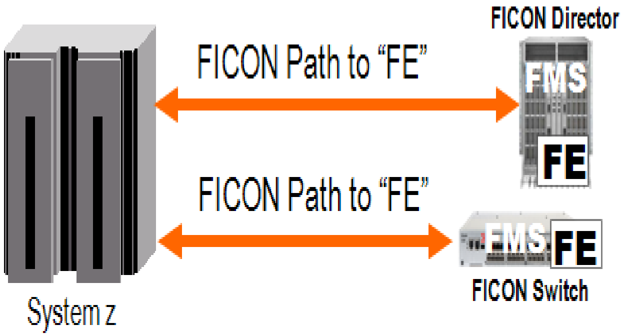
# Buffer Credit Starvation
# Why not just saturate each port with BCs?

- If a malfunction occurs in the fabric ….. or….
- If a CHPID or device is having a problem…
- It is certainly possible that some or all of the I/O will time out
- If ANY I/O does time out then:
  - All frames and buffers for that I/O (buffer credits) must be discarded
  - All frames and buffers for subsequently issued I/Os (frames and buffer credits) in that exchange must be discarded
    - Remember queued I/O will often drive exchanges ahead of time
  - The failing I/O must be re-driven
  - Subsequent I/O must be re-driven
- The recovery effort for the timed out I/O gets more and more complex – and more prone to also failing – when an over abundance of buffer credits are used on ports

# Buffer Credit Starvation
# Detecting Problems with FICON BCs

Produce the FICON Director Activity Report by creating the RMF 74-7 records – but this is only available when utilizing switched-FICON!

- A FICON Management Server (FMS) license per switching device enables the switch's Control Unit Port (CUP) – always FE – to provide information back to RMF at its request




- Analyze the column labeled AVG FRAME PACING for non-zero numbers. Each of these represents the number of times a frame was waiting for 2.5 microseconds or longer but BC count was at zero so the frame could not be sent

F I C O N   D I R E C T O R   A C T I V I T Y

PAGE 1

z/OS V1R8 | SYSTEM ID PRD1 | START 04/12/2009-04.30.00 | INTERVAL 000.15.00

RPT VERSION V1R8 RMF | END 04/12/2009-04.45.00 | CYCLE 1.000 SECONDS

IODF = A2   CR-DATE: 03/27/2009   CR-TIME: 16.43.51   ACT: ACTIVATE

SWITCH DEVICE: 032B   SWITCH ID: 2B   TYPE: 006140   MODEL: 001   MAN: MCD   PLANT: 01   SERIAL: 00000131656G

| PORT ADDR | -CONNECTION- UNIT | ID | AVG FRAME PACING | AVG FRAME SIZE READ | AVG FRAME SIZE WRITE | PORT BANDWIDTH (MB/SEC) -- READ -- | PORT BANDWIDTH (MB/SEC) -- WRITE -- | ERROR COUNT |
|---|---|---|---|---|---|---|---|---|
| 05 | CHP | 05 | 0 | 849 | 1436 | 8.63 | 17.34 | 0 |
| 07 | CHP-H | 6B | 0 | 1681 | 1395 | 0.87 | 0.32 | 0 |
| 09 | CHP | 15 | 7 | 833 | 1429 | 11.96 | 20.49 | 0 |
| 0C | CHP-H | 64 | 0 | 939 | 1099 | 0.39 | 0.50 | 0 |
| 0D | CHP | 6B | 1 | 1328 | 1823 | 3.56 | 12.73 | 0 |
| 0F | CHP-H | 66 | 0 | 1496 | 1675 | 1.85 | 2.61 | 0 |
| 10 | CHP | 64 | 0 | 644 | 1380 | 0.03 | 0.13 | 0 |
| 13 | CHP-H | 19 | 0 | 907 | 885 | 0.58 | 0.45 | 0 |
| 16 | CHP | 12 | 0 | 1241 | 1738 | 0.97 | 1.72 | 0 |
| 17 | CHP | 0B | 0 | 685 | 1688 | 0.10 | 0.82 | 0 |
| 1A | CHP | 15 | 0 | 1144 | 1664 | 0.65 | 1.18 | 0 |
| 1B | CHP | 0D | 0 | 510 | 1759 | 0.12 | 1.72 | 0 |
| 1E | CHP-H | 05 | 0 | 918 | 894 | 0.59 | 0.45 | 0 |
| 1F | CHP | 21 | 0 | 1243 | 1736 | 0.97 | 1.70 | 0 |
| 20 | CU | E900 | 0 | 1429 | 849 | 17.66 | 8.85 | 0 |
| | CU | E800 | | | | | | |
| | CU | E700 | | | | | | |
| 22 | CHP | 10 | 0 | 923 | 1753 | 0.55 | 2.78 | 0 |
| 23 | CHP | 54 | 0 | 1805 | 69 | 0.80 | 0.00 | 0 |
| 24 | CHP | 64 | 0 | 89 | 1345 | 0.00 | 0.00 | 0 |
| 27 | CHP | 6B | 0 | 1619 | 82 | 0.01 | 0.00 | 0 |
| 28 | CHP | 95 | 27 | 918 | 1589 | 10.32 | 30.56 | 0 |
| 2B | CHP | 70 | 0 | 69 | 2022 | 0.00 | 0.71 | 0 |

# FICON Director Activity Report With Frame Delay

Using Buffer Credits is how FC does Flow Control, also called "Frame Pacing"

F I C O N   D I R E C T O R   A C T I V I T Y

PAGE 1

z/OS V1R8 SYSTEM ID ABCD START 04/12/2009-04.30.00 INTERVAL 000.15.00
RPT VERSION V1R8 RMF END 04/12/2009-04.45.00 CYCLE 1.000 SECONDS

IODF = A2 CR-DATE: 03/27/2009 CR-TIME: 18.43.51 ACT: ACTIVATE
SWITCH DEVICE: 032B SWITCH ID: 2B TYPE: 006140 MODEL: 001 MAN: MCD PLANT: 01 SERIAL: 0000HIJKLMN

| PORT | -CONNECTION- | | AVG FRAME | AVG FRAME SIZE | | PORT BANDWIDTH (MB/SEC) | | ERROR |
|---|---|---|---|---|---|---|---|---|
| ADDR | UNIT | ID | PACING | READ | WRITE | -- READ -- | -- WRITE -- | COUNT |
| 05 | CHP-H | 05 | 0 | 849 | 1436 | 8.63 | 17.34 | 0 |
| 07 | CHP | 6B | 1 | 1681 | 1395 | 50.87 | 10.32 | 0 |
| 09 | CHP | 15 | 0 | 833 | 1429 | 11.96 | 20.49 | 0 |
| 0C | CHP-H | 64 | 0 | 939 | 1099 | 0.39 | 0.50 | 0 |
| 0D | CHP | 6B | 0 | 1328 | 1823 | 3.56 | 12.73 | 0 |
| 0F | CHP-H | 66 | 0 | 1496 | 1675 | 1.85 | 2.61 | 0 |
| 10 | CHP | 64 | 0 | 644 | 1380 | 0.03 | 0.13 | 0 |
| 13 | CHP-H | 19 | 0 | 907 | 885 | 0.58 | 0.45 | 0 |
| 16 | CU | C800 | 0 | 1241 | 738 | 20.97 | 5.72 | 0 |
| | CU | CA00 | | | | 70.10 | 3.82 | 0 |
| 1A | CHP | 15 | 0 | 1144 | 1664 | 0.65 | 1.18 | 0 |
| 1B | CHP | 0D | 0 | 510 | 1759 | 0.12 | 1.72 | 0 |
| 1E | CHP-H | 05 | 0 | 918 | 894 | 0.59 | 0.45 | 0 |
| 1F | CHP | 21 | 0 | 1243 | 1736 | 0.97 | 1.70 | 0 |
| 20 | CU | E900 | 0 | 1429 | 849 | 17.66 | 8.85 | 0 |
| | CU | E800 | | | | | | |
| | CU | E700 | | | | | | |
| 22 | CHP | 10 | 0 | 923 | 1753 | 0.55 | 2.78 | 0 |
| 23 | CHP | 54 | 0 | 1805 | 69 | 20.80 | 7.30 | 0 |
| 24 | CHP | 64 | 0 | 89 | 1345 | 0.00 | 0.00 | 0 |
| 27 | CHP | 6B | 0 | 1619 | 82 | 0.01 | 0.00 | 0 |
| 28 | SWITCH | 95 | 270 | [illegible] | 789 | 50.32 | 10.56 | 0 |
| 2B | CHP | 70 | 0 | 69 | 2022 | 0.00 | 0.71 | 0 |

In the last 15 minutes

This port had a frame to send but did not have any Buffer Credits left to use to send them.

And this happened 270 times during the interval.

**And this is an ISL Link!**

## Indicators of Buffer Credit Starvation

**Fabric with zHPF Enabled**

SHARE in Anaheim 2012

# We have a BC Calculator that you can use!

## Brocade's Buffer Credit Calculation for Fibre Channel (FICON and/or SAN)

| | | Link Speed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 Gbps | 2 Gbps | 4 Gbps | 8 Gbps | 10 Gbps | 16 Gbps | 32 Gbps | 40 Gbps | 100 Gbps |
| | | 1.0625E-09 | 2.1250E-09 | 4.2500E-09 | 8.5000E-09 | 1.0625E-08 | 3.4000E-08 | 1.3600E-07 | 3.4000E-07 | 1.0625E-06 |
| **Parameter** | | | | | | | | | | |
| Velocity of light in fibre | 200000km/s | 5.00E-06 | 5.00E-06 | 5.00E-06 | 5.00E-06 | 5.00E-06 | 5.00E-06 | 5.00E-06 | 5.00E-06 | 5.00E-06 |
| Nano seconds per byte | | 9.41E-09 | 4.71E-09 | 2.35E-09 | 1.18E-09 | 9.41E-10 | 5.88E-10 | 2.94E-10 | 2.35E-10 | 9.41E-11 |
| Framelength in seconds (dependent on cell i19) | | 8.05E-06 | 4.02E-06 | 2.01E-06 | 1.01E-06 | 8.05E-07 | 5.03E-07 | 2.51E-07 | 2.01E-07 | 8.05E-08 |
| Framelength in km (dependent on cell i19) | | 1.61 | 0.80 | 0.40 | 0.20 | 0.16 | 0.10 | 0.05 | 0.04 | 0.02 |

10 Gig has 64b/66B en/decoding and therefore a better performance

### Buffer Credit Calculation

To determine kilometers from miles, type miles into cell D15:
(1 mile = 1.609344 kilometer) **15** Miles Equals **24** Kilometers rounded to the nearest integer

To Calculate the proper number of buffer credits that you will need to keep the ISL link 100% utilized - especially over long distances:

Type in the frame "Payload" size in Bytes (in cell D19)=======> **819** Payload bytes and 36 overhead bytes equals a total frame size of **855** Bytes

Type in the total kilometers of the wire run (in cell D20)=====>
(Use the calculated kilometers from cell F15 if required) **24** Kilometers

| Description | 1 Gbps | 2 Gbps | 4 Gbps | 8 Gbps | 10 Gbps | 16 Gbps | 32 Gbps | 40 Gbps | 100 Gbps |
|---|---|---|---|---|---|---|---|---|---|
| Framelength takes up this many kilometers on the wire (calculated from frame size in cell I19) | 1.61 | 0.80 | 0.40 | 0.20 | 0.16 | 0.10 | 0.05 | 0.04 | 0.02 |
| *Buffercredits @ 100% B/W Utilization raw calculation.* | 29.83 | 59.66 | 119.32 | 238.64 | 298.30 | 477.28 | 954.56 | 1193.21 | 2983.02 |
| *Buffercredits @ 100% B/W Utilization rounded up.* | **30** | **60** | **120** | **239** | **299** | **478** | **955** | **1194** | **2984** |



Splash | B2B Calucator

**Ask your local Brocade SE to provide this to you free of charge!**

# Brocade Proudly Presents…
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*Brocade FICON Certification*

**Brocade Certified Architect for FICON**

Certification for Brocade Mainframe-centric Customers – Available since Sept 2008

For people who do or will work in FICON environments

Brocade provides a free on-site or in area 2-day class (Brocade Design and Implementation for FICON Environments – FCAF200), to assist customers in obtaining the knowledge to pass this certification examination – ask your local sales team about this training – also look at www.brocade.com under Education

Certification tests a person's ability to understand IBM System z I/O concepts, and demonstrate knowledge of Brocade FICON Director and switching fabric components

After the class a participant should be able to design, install, configure, maintain, manage, and troubleshoot Brocade hardware and software products for local and metro distance (100 km) environments

Check the following website for complete information:

- http://www.brocade.com/education/certification-accreditation/certified-architect-ficon/index.page

# Industry Recognized Professional Certification

## Brocade FICON Certification

**Brocade Certified Architect for FICON**

- Certification for Brocade Mainframe-centric Customers
- Available since September 2008
- Updated for 8Gbps in June 2010
- Slated for 16Gbps update in September 2012
- This certification tests the attendee's ability to understand IBM System z I/O concepts, and demonstrate knowledge of Brocade FICON Director and switching infrastructure components
- ***Brocade would be glad to provide a free 2-day BCAF certification class for Your Company or in Your City!***
- Ask me how to make that happen for you!

# SAN Sessions at SHARE this week

## Wednesday:

**Time-Session**

**0800 - 12076: Buffer-to-Buffer Credits, Exchanges, and Urban Legends**

**1500 - 12075: zSeries FICON and FCP Fabrics - Intermixing Best Practices**

## Thursday:

**Time-Session**

**1630 - 12084: Buzz Fibrechannel - To 16G and Beyond**

# Mainframe Resources For You To Use

**Visit Brocade's Mainframe Blog Page at:**

http://community.brocade.com/community/brocadeblogs/mainframe

**Also Visit Brocade's New Mainframe Communities Page at:**

http://community.brocade.com/community/forums/products_and_solutions/mainframe_solutions

# Please Fill Out Your Evaluation Forms!!

## This was session: 12071

**And Please Indicate On Those Forms If There Are Other Presentations That You Would Like To See In This SAN Track At The Next SHARE.**

QR Code