

# TRUNK-120

## Trunking

### Education Services

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# **Module 1**

## **Course Introduction**

**Education Services**

0318

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## Course Overview

- The purpose of this course is to explain trunking concepts in a Brocade Fibre Channel SAN

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## Course Objectives

- After completing this course, students should be able to explain how trunking works in a Fibre Channel SAN

## Course Prerequisites

- Although not required, having a basic knowledge of Fibre Channel and Fibre Channel SANs is useful
  - Suggest taking the following courses before taking this one
    - Fibre Channel Theory (FC-120)
    - Zoning concepts (Zone-120)
    - Fabric Shortest Path First (FSPF-120)

## Course Agenda

- Module 1: Course Introduction
- Module 2: Trunking
- Knowledge assessment quiz
- Optional material:
  - Demonstration

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## Assessment Quiz

- Each course provides the ability to assess your understanding of the content by taking an assessment quiz
  - The assessment quiz is included as one of the available learning objects
  - When a course is marked as completed<sup>1</sup> a **Certification of Completion** is made available to print

Price  
\$0.00

Available Languages  
English (US)

Subjects  
Storage Networking (SN) > Fibre Channel (FC)

Curriculum

- Modules and Assessment
  - FPI 220-WBT - M1: Course Introduction  
FPI 220-WBT M1: Course Introduction
  - FPI 220-WBT - M2: Fabric Performance Impact  
FPI 220-WBT - M2: Fabric Performance Impact
  - FPI-220 Assessment**  
Quiz for FPI 150 WBT course.
- Student Resources - Optional
  - FPI 220 - SDDQ Demo  
FPI 220 - SDDQ Demo
  - FPI 220-WBT Student Guide  
FPI 220-WBT Student Guide

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**Footnote 1:** For a course to be marked as **completed** all non-optional course elements must be completed

# Course Certificate



This is to certify that

**JANE DOE**

has completed a course of instruction in

**Introduction to Brocade Products**

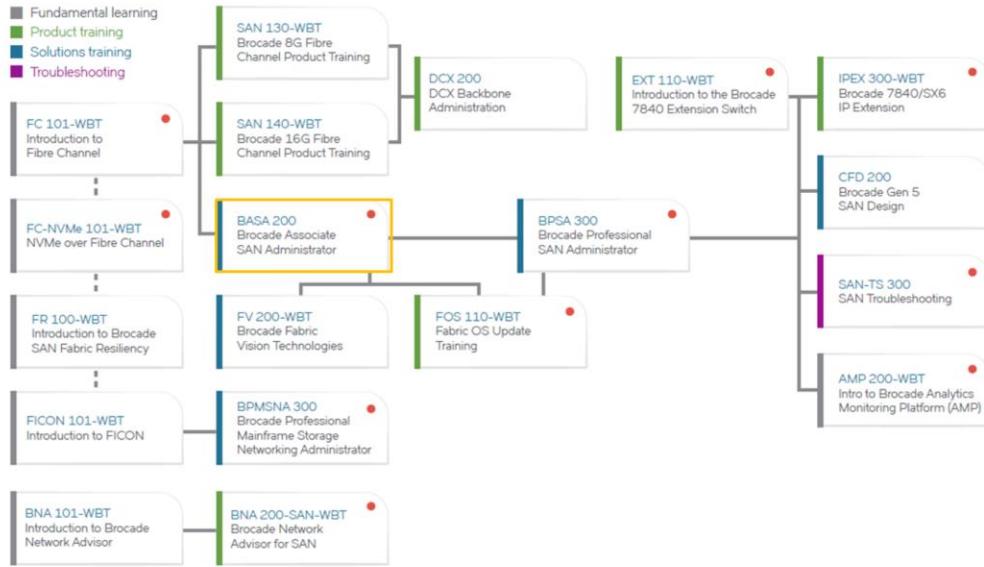
Date: February 1st, 2018

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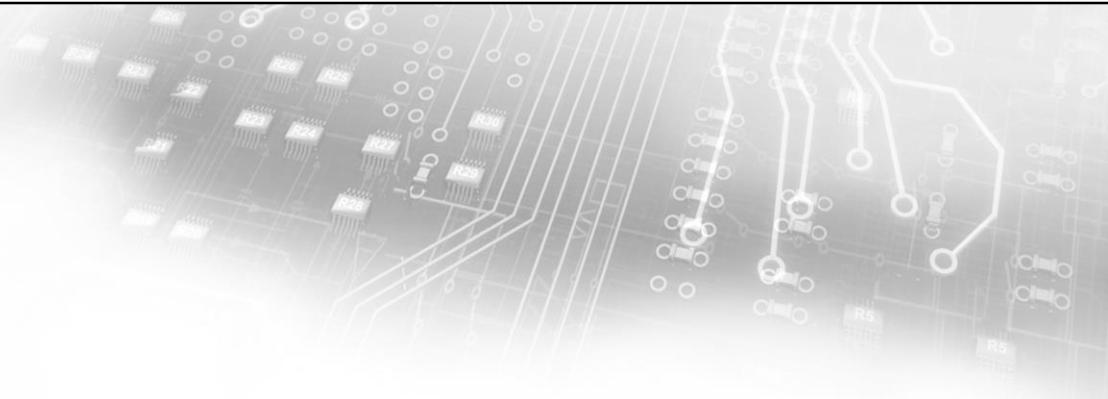
# Curriculum Paths

- Fundamental learning
- Product training
- Solutions training
- Troubleshooting



● Built-in assessments for these courses will be available by December 21st.  
All other courses will have assessments added in Q1, 2018

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# Thank You Trunk-120 Course Introduction

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## Education

For more information on Brocade training please contact  
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## Module 2

# ISL Trunking

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## Objectives

- After completing this module, attendees should be able to:
  - Manage Inter-Switch Link (ISL) functionally
  - Evaluate the trunking features of Brocade products

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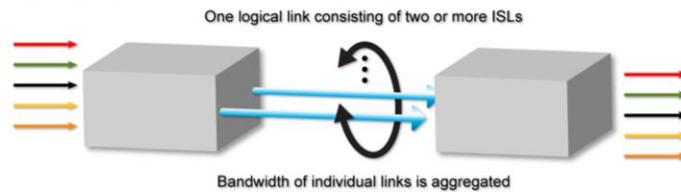


# Trunking

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## Brocade ISL Trunking Overview

- The Trunking feature optimizes the use of bandwidth by allowing a group of ISLs to merge into a single logical link
- Trunking goals:
  - Reduce individual ISL congestion
  - Form a fault-tolerant, high bandwidth, logical ISL (called a *trunk* or *trunk group*) that withstands the failure of individual ISLs
- Trunk group characteristics:
  - Frames are multiplexed across all ISLs in the trunk group
  - One port in the trunk group (the trunk master) represents the entire trunk in the routing database
  - ASICs preserve in-order delivery



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The routing database determines how frames are routed from input port to output port when going to the next destination. Fabric Shortest Path First (FSPF) puts available equal cost routes in the routing data base. One output port in the trunk group is put into the routing data base. When a communication between two end devices in a fabric is assigned a route through a trunk, the ASIC of the assigned trunk group port will be the same ASIC as all ports in the trunk group. This ASIC will multiplex frames across ISLs in the trunk group and maintain in-order delivery. The ASIC will send a frame down each link to determine the links latency. These individual link latency calculations will be used to maintain in-order delivery.

If some ports in a trunk group have QoS enabled and some ports have QoS disabled, the two different trunks are formed: one with QoS enabled and one with QoS disabled.

## 4, 8, 10, 16, and 32 Gbps Trunking Overview

- Automatically aggregates up to eight ISLs when the switches are connected<sup>1</sup>
  - Condor3 ASICs provide up to 128 Gbps of aggregate bandwidth
  - Condor4 ASICs provide up to 256 Gbps of aggregate bandwidth
- All ports in a trunk group must operate at the same speed
  - Condor3 ASICs support multiple 2/4/8/10/16 Gbps trunks between same switches
  - Condor4 ASICs support multiple 4/8/10/16/32 Gbps trunks between switches

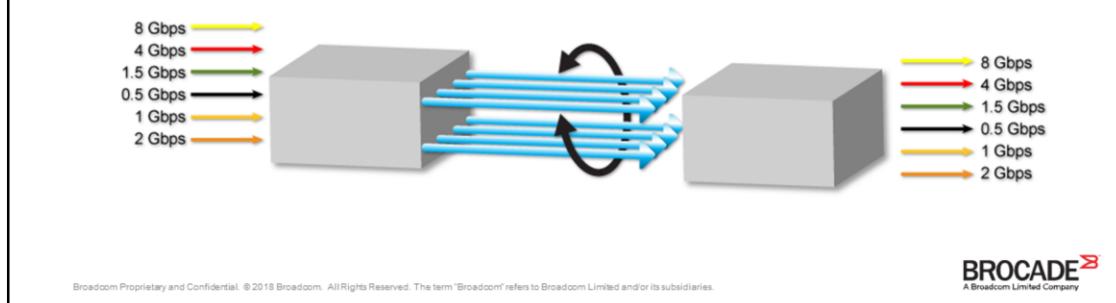
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**Footnote 1:** Automatically creates ISL trunks using from 2 to 8 ISLs when the switches are connected and all trunking requirements are met.

## Trunking Requirements

- A Trunking license is required for all switches participating in Trunking
  - Trunking is available when the license is installed and the ports are reinitialized
- Trunking is enabled by default
  - If it has been disabled, it must be re-enabled on the trunk ports using the `portcfgtrunkport` CLI command
- Trunk ports must operate at a common speed and long distance setting
- Trunk ports must originate and end in a valid port group
  - Trunking port groups include: ports 0-7, 8-15, and so on
- When trunking criteria is met, the trunk forms automatically



Switches are shipped with Trunking enabled on all ports. To use Trunking, you must first install the Brocade Trunking license. Trunking is enabled automatically when the Trunking license is activated and ports are reinitialized. Trunks are easily managed using either Fabric OS CLI commands or Web Tools.

Trunk port-groups are ASIC specific and are discussed in more detail in subsequent slides.

8, 16 and 32 Gbps port groups include: ports 0-7; 8-15; and so on

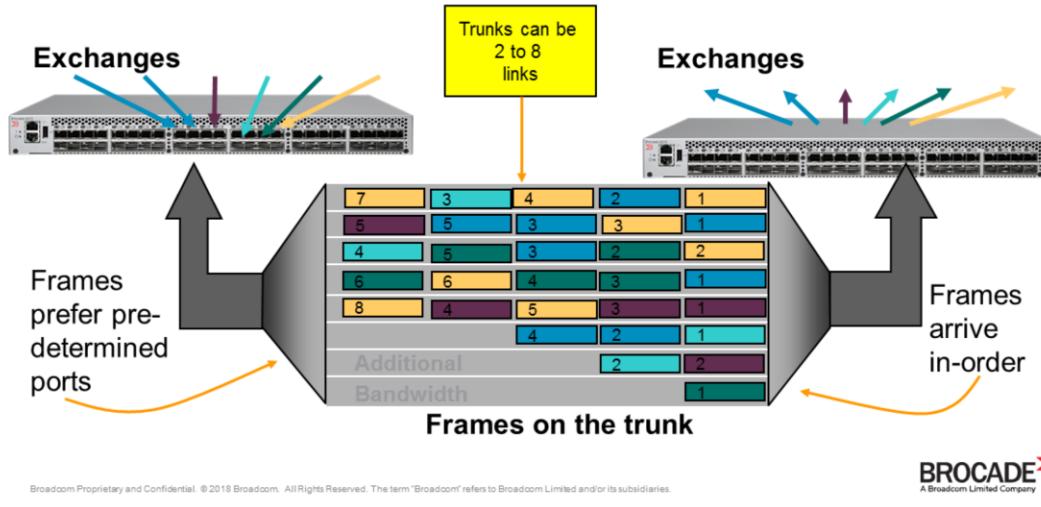
- The Condor4 ASIC is the foundation for the Brocade Gen6 32 Gbps Fibre Channel products, such as the X6-4 and X6-8 directors as well as the G620 switch
- The Condor 3 ASIC is the foundation for the Brocade Gen5 16 Gbps products, such as the DCX 8510-4 and DCX 8510-8 directors as well as the 6520, 6510 and 6505 switches.

Long distance trunks must be set to the same distance.

See the *Brocade Fabric OS Administrators Guide* for additional information.

## Trunking Frame Allocation

- ASICs evenly distribute frames when bandwidth of trunk is fully utilized
- Frames at low bandwidth will not appear to be evenly distributed
- No interruption of traffic if the trunk master goes offline



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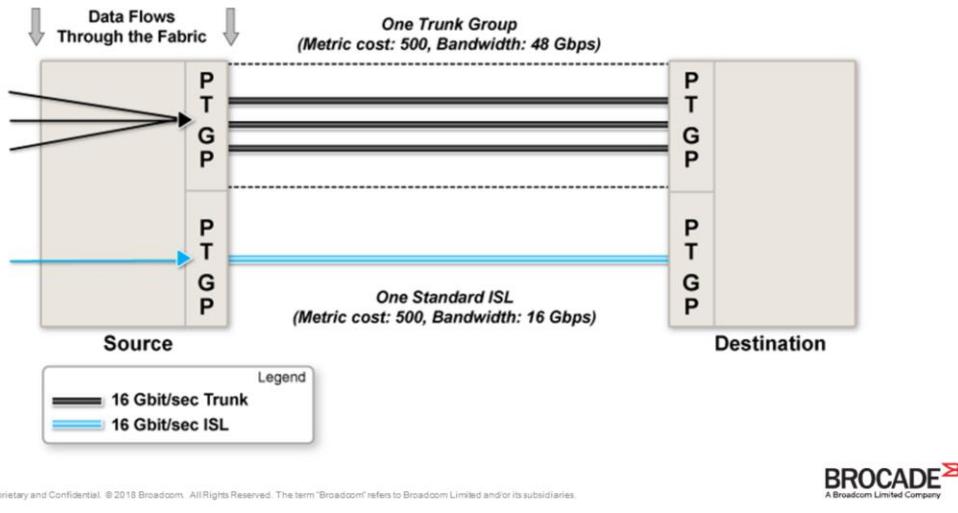
With ASIC trunking in effect, 8 ISLs are aggregated into a single logical ISL capable of up to 256 Gbps aggregate bandwidth. Frames entering the logical pipe are allocated to a predetermined port which happens to be the lowest back ASIC port in the port group. If that port is busy, they are allocated to another predetermined port. When the bandwidth of the pipe is fully utilized the frames are evenly distributed. When the aggregate bandwidth of the logical pipe is not fully utilized and the 1st predetermined port is free, the frames do not need to be evenly distributed. Calculated time differentials are needed to maintain in-order delivery of frames.

If traffic patterns involve large sequences of frames and high bandwidth utilization, then the frame allocation across the ISLs in the trunk begins to evenly distribute frames across the ISLs.

The predictable way frames are allocated to ASIC trunk groups enables non-disruptive loss of trunk master behavior which is also referred to as Pseudo-Master Trunking.

## Routing over Trunks

- A trunk group is considered one logical ISL, and is identified by the trunk master in the routing table
- The load assigned to a trunk group is based on the aggregate bandwidth of the trunk



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Dynamic Path Selection (DPS) is exchange-based routing where exchanges or communications between end devices in a fabric are assigned to egress ports in ratios proportional to the potential bandwidth of the ISL or trunk group.

When there are multiple routes to a destination, the input traffic will be distributed across the different routes in proportion to the bandwidth available on each of the routes. This improves utilization of the available routes, thus reducing possible congestion on the routes. Every time there is a change in the network (which changes the available routes), the input traffic can be redistributed across the available routes. This is a very easy and non-disruptive process when the Exchange-based Routing Policy is engaged.

Exchanges in the example depicted on this slide are allocated based on the primary criteria: link cost and secondary criteria: potential bandwidth. The potential bandwidth allocation depicted in this example yields flow allocations of 3:1.

## One Port Group with Multiple ISL Trunks

- One port group can simultaneously have different speed trunks

```
SW1:admin> switchshow
switchName:      SW1
switchType:      162.0
switchState:     Online
... <output truncated> ...
Index Port Address Media Speed State Proto
=====
 0   0   010000  id  N32  Online  FC  E-Port  (Trunk port, master is Port 4 )
 1   1   010100  id  N32  Online  FC  E-Port  (Trunk port, master is Port 4 )
 2   2   010200  id  N32  Online  FC  E-Port  (Trunk port, master is Port 4 )
 3   3   010300  id  N32  Online  FC  E-Port  (Trunk port, master is Port 4 )
 4   4   010400  id  N32  Online  FC  E-Port  10:00:00:05:33:93:69:3f "G620"
(upstream) (Trunk master)
 5   5   010500  id  N32  Online  FC  E-Port  (Trunk port, master is Port 4 )
 6   6   010600  id  N16  Online  FC  E-Port  (Trunk port, master is Port 7 )
 7   7   010700  id  N16  Online  FC  E-Port  10:00:00:05:33:93:69:3f "6510"
(downstream) ((Trunk master)

<output truncated>
```

**A six-ISL  
32 Gbps trunk group**

**A two-ISL  
16 Gbps trunk group**

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The `switchshow` command shows trunk groups associated with ports 0 – 5 and 6-7 with the master port of the individual trunk groups noted. The remaining ports in the trunk groups are the non-master ports. It should also be noted that only one trunk group represents the principal ISL path.

## Masterless Trunking

- Brocade uses masterless trunking to prevent disruption when the trunk master is offline
- There is no build fabric when the trunk master goes offline
- The `trunkshow` command displays the current master

```
SW1:admin> trunkshow
 1: 4 -> 8 10:00:c4:f5:7c:0e:d4:d8 2 deskew 1      MASTER
    0 -> 9 10:00:c4:f5:7c:0e:d4:d8 2 deskew 1
    1 -> 10 10:00:c4:f5:7c:0e:d4:d8 2 deskew 2
    5 -> 11 10:00:c4:f5:7c:0e:d4:d8 2 deskew 2
<truncated output>
```

- When the MASTER is offline, `trunkshow` displays the new master

```
SW1:admin> trunkshow
 1: 1 -> 10 10:00:c4:f5:7c:0e:d4:d8 2 deskew 2      MASTER
    5 -> 11 10:00:c4:f5:7c:0e:d4:d8 2 deskew 2
    0 -> 9 10:00:c4:f5:7c:0e:d4:d8 2 deskew 1
```



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When the Trunk Master is disabled another pre-determined port takes over the role without fabric disruption.

**Note** – Gen6 products use a starting deskew value of 1, Gen5 and older products use a starting deskew value of 15. Deskew value is discussed on the next slide.

Example from 6510 Gen5 switch:

```
6510_Edge:FID128:admin> trunkshow
 1: 9-> 9 10:00:c4:f5:7c:0e:c0:7c 2 deskew 15 MASTER
 8-> 8 10:00:c4:f5:7c:0e:c0:7c 2 deskew 16
```

## The Deskew Counter

- Deskew values are used to maintain in-order delivery of frames and are set based on distance and link quality
  - Deskew units represent the time difference for traffic to travel over each ISL as compared to the shortest ISL in the group
  - The system automatically sets the minimum deskew value of the ISL with the least latency (shortest round-trip time) to 1 deskew units<sup>1</sup>
  - The deskew for the remaining ISLs is calculated in relation to the ISL with the least latency
- The deskew value is a representation of an ISLs transmission capabilities
  - Differences in deskew can be caused by signal degradation which affects the transmission time of frames through the link
  - Can also be caused by excessive differences in cable length
- Deskew values are displayed in the `trunkshow` command output

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**Footnote 1:** Gen6 products use 1 as the minimum deskew value, Gen5 and older products use 15. The difference in latency (typically due to cable length) between the ISLs in a trunk determines the deskew value. This is needed for timing purposes so that delivery of frames across the trunk can be ensured. The shortest ISL is selected as the base and is assigned a deskew value of 10 nanoseconds (ns) for Gen6 products and 150ns for Gen5 and older products. The deskew values are expressed (shown in all command displays) by dividing the time value by 10. Example: A deskew value of 10ns is shows as 1 (10/10) and a deskew value of 150ns is shown as 15 (150/10).

The first ISL in the trunk to initialize is selected as the trunk master. The length of the cable is not a consideration when selecting the master. The deskew values for the other ISLs in the trunk will be calculated from the base ISL and may have a higher value. Each switch connected by the ISL will have a deskew value since each has a separate transmit line to the other. Due to the signal quality/optical media, cables that are identified as the same length may have a different deskew value. For example, one cable may have a deskew value of 1 and a cable of the same length may calculate to be 3. This is not a problem since deskew is a true measurement of its transmission capabilities.

## Trunking and Cable Lengths

- The maximum supported difference in cable length between the shortest and the longest ISL in a trunk group is 400 meters
  - This is to help ensure in-order delivery of frames
  - Consider this when creating long distance trunks over WDMs
- A two meter difference is approximately equal to one deskew unit
  - Differences greater than 30 meters could introduce performance degradation
  - Since the shortest ISL is set to a deskew of 1, an ISL with a difference of 30 meters has a deskew of approximately  $16^1$ 
    - A 400 meter difference would yield a deskew value of 201

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**Footnote 1:** Light in a vacuum travels much faster, but in optical cable the rate is about 5 ns/meter. 5ns/meter multiplied by 30 meters is 150 ns.

A two meter difference is approximately equal to one (10ns) deskew unit.

Differences greater than 30 meters could introduce performance degradation

For Gen5 and older products, since the shortest ISL is set to a deskew of 15 (150ns), an ISL with a difference of 30 meters has a deskew of approximately 30

A 400 meter difference would yield a deskew value of 215.

## Trunking Related Commands – Overview

- Commands that display trunk information:
  - trunkshow
  - switchshow
  - islshow
  - portcfgshow
- Commands that configure trunk parameters:
  - portcfgtrunkport
  - switchcfgtrunk
- Command that allows the troubleshooting of trunks:
  - trunkdebug <start port> <end port>

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trunkshow

- Displays each trunk group
- Displays which local port is connected to which remote port
- Displays WWN of the other switch
- Displays deskew values and identifies the trunk master port

switchshow

- Displays the master port (trunk master) and each non-master port
- Displays the WWN of connected switch to trunked ports

islshow

- Displays bandwidth information associated with each trunk group

switchcfgtrunk

- Used to configure trunking to be ON or OFF on all ports on switch

portcfgtrunkport

- Used to configure trunking per port as either ON or OFF, default is ON

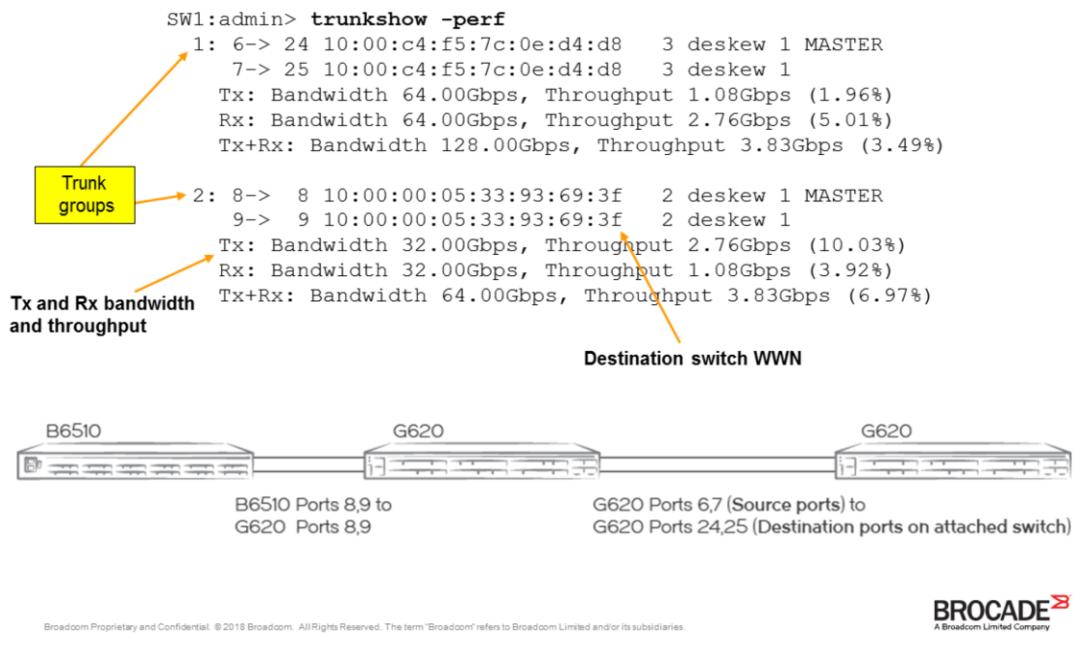
portcfgshow

- Displays port configuration information including trunk ON/OFF status

```
trunkdebug port1 port2
```

- Tests specified ports in trunk group and reports trunking status. Possible trunkdebug outputs include:
  - Switch does not support trunking
  - Trunking license required
  - port port\_id is not E\_Port
  - port port\_id trunking disabled
  - port port\_id speed is not 2G, 4G, 8G, 10G, or 16G
  - port port\_id and port port\_id are not in same port group
  - port port\_id and port port\_id connect to different switches
  - port port\_id and port port\_id connect to the switch WWN
  - port port\_id is not a trunking port due to: E\_Port being disabled, or trunking might be disabled at remote port
  - port port\_id and port port\_id cannot trunk, please check link length to make sure difference is less than 400 m

## trunkshow



Trunk master selection is not related to deskew.

Trunk master selection is based on the ASICs internal port values, it is predictable. It is dependent on distance and quality of the link and its associated connection points.

The switches in this example have multiple trunk groups between them. Notice that the trunk master is not always the lowest port number in the group nor is it related to the deskew value.

## islshow

- The `islshow` command displays
  - Speeds for each ISL in the trunk group
  - Aggregate bandwidth for the trunk group
  - WWN of the other switch
- In the example below note the following:
  - Each trunk group is represented by the trunk master of each trunk; port 8 of trunk group 1 points to port 9 of a trunk group on the attached switch
  - Port 15 is the trunk master of trunk group 2 on both of the switches

```
SW1:admin> islshow
 1: 8-> 9 10:00:00:05:33:93:69:3f    3 6510_Edge sp: 16.000G bw: 32.000G
TRUNK QOS CR_RECov FEC
 2: 15-> 15 10:00:c4:f5:7c:0e:d4:d8    2 G620_Edge sp: 32.000G bw: 64.000G
TRUNK QOS CR_RECov FEC
```

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## Portcfgtrunkport / portcfgshow

```
SW1:admin> portcfgtrunkport 8 0
SW1:admin> portcfgshow | more
```

	Ports of Slot 0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Octet Speed Combo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Speed	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	
AL_PA Offset 13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Trunk Port	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	
Long Distance	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
VC Link Init	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Locked L_Port	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Locked G_Port	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Disabled E_Port	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Locked E_Port	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
ISL R_RDY Mode	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
RSCN Suppressed	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Persistent Disable	ON	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
LOS TOV mode	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NPIV capability	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	
NPIV PP Limit	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	
NPIV FLOGI Logout	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
QOS Port	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	AE	

<output truncated>

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The **portcfgtrunkport** command is used to turn on or off trunking on one port, specified by port number. The last parameter indicates on or off (1 for on and 0 for off).

**Usage:** portCfgTrunkPort [SlotNumber/]PortNumber Mode

**Mode:** 1 - Configure port to be Trunking capable  
0 - Configure port to be Trunking incapable

The **switchcfgtrunk** command is used to turn on or off trunking capability for the whole switch:

**Usage:** switchCfgTrunk Mode

**Mode:** 0 - Configure ports to be Trunking incapable  
1 - Configure ports to be Trunking capable

## trunkdebug

- Used to debug a trunk link failure
- The command reports one of the following:
  - Switch does not support trunking
  - Trunking license required
  - port port\_id is not E\_Port
  - port port\_id trunking disabled
  - port port\_id speed is not 2G, 4G, 8G, 10G, 16G, or 32
  - port port\_id and port port\_id are not in same port group
  - port port\_id and port port\_id connect to different switches
  - port port\_id and port port\_id connect to the switch WWN
  - port port\_id is not a trunking port due to: E\_Port being disabled, or trunking might be disabled at remote port
  - port port\_id and port port\_id cannot trunk, please check link length to make sure difference is less than 400 m

```
SW1:admin> trunkdebug 7, 8  
local or remote ports are not in the same port group
```

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This command has the following operands:

**port1** Specify the port index number of port 1. Use the `switchshow` command to view the index numbers for a port. This operand is required.

**port2** Specify the port index number of port 2. Use the `switchshow` command to view the index numbers for a port. This operand is required.

Example of debugging a trunk connection:

```
switch:admin> trunkdebug 43 44  
Switch does not support trunking  
switch:admin> trunkdebug 62 63  
port 62 and 63 are trunked together
```

Director command syntax:

```
trunkdebug: area_number1 area_number2
```

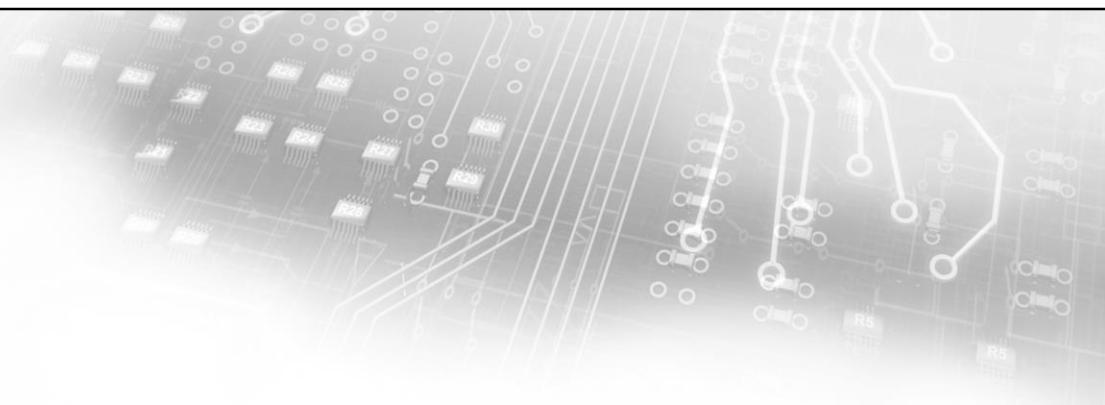
## Summary

- ISLs are used to connect multiple switches together into a single fabric
- ISLs can be trunked together for increased bandwidth and high availability

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# Thank You Trunk-120 Trunking

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## Education

For more information on Brocade training please contact  
[education@brocade.com](mailto:education@brocade.com)

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