Scale-Out Architecture with Brocade® UltraScale Inter-Chassis Links

Design Guide

Table of Contents

Chapter 1: UltraScale ICL Overview

Brocade® UltraScale inter-chassis links (ICLs) are high-performance ports for interconnecting multiple Brocade X7, X6, and DCX 8510 Directors, enabling industry-leading scalability while preserving ports for server and storage connections. Brocade optical UltraScale ICLs—based on quad small form factor pluggable (QSFP) technology—connect the core routing blades between Brocade X7, X6, or DCX 8510 Director family chassis. Each QSFP-based UltraScale ICL port combines four links, providing up to 32 UltraScale ICL ports on the Brocade X7-8, X6-8, and DCX 8510-8 and up to 16 UltraScale ICL ports on the Brocade X7-4, X6-4, and DCX 8510-4.

The optical form factor of the Brocade QSFP-based UltraScale ICL technology offers several advantages over connecting multiple director platforms using inter-switch links (ISLs). The combination of four cables into a single QSFP provides a dramatic reduction in the number of ISL cables required—a four-to-one reduction compared to traditional SFP optic-based ISLs with the same amount of interconnection bandwidth. And because the QSFP-based UltraScale ICL connections reside on the core routing (CR) blades instead of consuming traditional ports on the port blades, up to 33% more FC ports are available for server and storage connectivity. Given that ICL ports reside on CR blades, frame switching avoids one hop (on each chassis) to egress port blades, resulting in improved (lower) latency. In addition, QSFP-based connectivity provides incredible flexibility for deploying a variety of different topologies, including a massive 9-chassis full-mesh design with only a single hop between any two points within the fabric and a 12-chassis core-edge design.

For the remainder of this paper, "8-slot director chassis" will be used to refer to the Brocade X7-8, X6-8, or DCX 8510-8, and "4-slot director chassis" will be used to refer to the Brocade X7-4, X6-4, or DCX 8510-4.

Chapter 2: UltraScale ICL Licensing

An ICL Ports on Demand (POD) license is applicable to the Gen 7, Gen 6, and Gen 5 director families. ICL POD licenses are unique for each product generation family and are supported only for that product generation.

2.1 Brocade X7 ICL POD Licensing and ICL Kit Offerings

For Gen 7 ICLs, the same ICL POD licenses are used on both Brocade X7-8 and X7-4 Directors, enabling 8 UltraScale ICL ports per POD license. For an X7-8 Director, a total of four ICL POD licenses are required to fully enable all 32 ICL ports. The first ICL POD license enables QSFP ports 0-1 and 8-9 on each core blade, and the second ICL POD license enables ports 2-3 and 10-11. The third ICL POD license enables ports 4-5 and 12-13, and the fourth ICL POD license enables the remaining ports 6-7 and 14-15. An X7-4 Director requires a total of two ICL POD licenses to enable all 16 ICL ports. The first ICL POD license enables QSFP ports 0-1 and 4-5 on each core blade, and the second ICL POD license enables the remaining ports 2-3 and 6-7. Three ICL kit offerings are currently available for the Brocade X7 Directors:

- **Gen 7 100m ICL kit (P/N BR-X7ICLKIT-100M-01)**: This kit includes one Gen 7 ICL POD license and eight 4 × Gen 7 100m ICL SWL QSFPs that support connectivity only between two Gen 7 chassis at a fixed speed. One POD license enables 4 QSFP ports on each CR blade or 8 QSFP ports per chassis. To enable all QSFP ICL ports on both CR blades, four kits are required for an 8-slot X7 chassis and two kits are required for a 4-slot X7 chassis.

- **Gen 7 2-km ICL kit (P/N BR-X7ICLKIT-2KM-01)**: This kit includes one Gen 7 ICL POD license and eight 4 × Gen 7 2-km ICL SWL QSFPs that support connectivity between two Gen 7 chassis at Gen 7 ICL speed. One POD license enables 4 QSFP ports on each CR blade or 8 QSFP ports per chassis. To enable all QSFP ICL ports on both CR blades, four kits are required for an 8-slot X7 chassis and two kits are required for a 4-slot X7 chassis. 2-km Gen 7 ICLs cannot be used to connect to an X6 Director unless it has been upgraded to Gen 7. Gen 7 2-km ICL optics require Fabric OS version 9.1.0 or later. Note that the Gen 7 2-km QSFP optics have a maximum air intake temperature rating of 40°C while operating at sea level only. From sea level up to 1500m elevation, the optics are rated at 35°C, and they are rated at 30°C from 1500m to 3000m.

- **Gen 6 100m ICL kit for the X7 chassis (P/N BR-X7GEN6ICLKIT-100M-1)**: This kit also includes one Gen 7 ICL POD license, but it includes eight 4×32G 100m ICL SWL QSFPs that allow connectivity to an X6 chassis at 32G or to a DCX 8510 chassis at 16G (manual configuration of the port speed is required on an X6 or X7 chassis). Port enablement via license installation is the same as the Gen 7 100m ICL kits.

NOTE: The POD license is the same in each of the ICL kits listed above. The only difference is the type of optics that are shipped as part of the kit. Ports that have been enabled can be populated with any of the supported optics. X7 Directors and X6 Directors that have been upgraded to Gen 7 require the use of secure optics. Once an X6 has been upgraded to Gen 7, 32G nonsecure QSFP optics (MPN 57-1000351-01 or 57-1000480-01) are no longer supported for use.

2.2 Brocade X6-8 ICL POD Licensing and ICL Kit Offerings

For Gen 6 ICLs, there are different ICL POD licenses for both the Brocade X6-8 and X6-4 Directors. For an X6-8 Director, a total of two POD licenses are required to fully enable all 32 ICL ports. A minimum of one ICL POD license is required on an 8-slot chassis. The first ICL POD license on the Brocade X6-8 enables a total of 16 QSFP UltraScale ICL ports per director chassis, enabling 8 ICL ports (0, 1, 2, 3, 8, 9, 10, and 11) on each core blade. A second ICL POD license enables the remaining 16 QSFP UltraScale ICL ports on the chassis, enabling the remaining 8 ICL ports (4, 5, 6, 7, 12, 13, 14, and 15) on each core blade; so all 32 QSFP ports across both core routing blades are enabled. These ICL POD licenses are bundled as part of the ICL kit offerings. Currently available ICL kit offerings for the Brocade X6-8 include the following:

- **Gen 6 100m 8-slot ICL kit (P/N BR-X68ICLKIT-100M-02)**: This kit includes one ICL POD license and sixteen 4×32G 100m SWL QSFPs. One POD license enables 8 QSFP ports on each CR blade (16 QSFP ports per chassis). To enable all QSFP ICL ports on both CR blades, two kits are required. This kit bundles XBR-000275 4×32G QSFPs supporting 4×32G or 4×16G speeds, supporting connectivity from X6-8 to X6 ICLs or X6-8 to DCX 8510 ICLs. This kit replaced the original kit offered for the X6-8, BR-X68ICLKIT-100M-01, which supported only 32G connectivity between X6s and has since been discontinued.

- **Gen 5 2-km 8-slot ICL kit for the X6-8 chassis (P/N BR-X68GEN5ICLKIT-2KM-01)**: This kit includes one ICL POD license and eight 4×16G 2-km QSFPs. This POD license enables 8 QSFP ports per CR blade (16 QSFP ports for the chassis). This kit is required for the Brocade X6-8 if the Brocade X6-8 is connected to a Gen 5 DCX 8510 chassis via 2-km ICLs at 4×16G speeds. Note that only eight 2-km 4×16G QSFPs are bundled with this option, although the license enables double that number of QSFP ports. The license included in this kit is the same as that for the Gen 6 ICL kit; the only difference is the bundled QSFPs. The remaining eight ports can be populated with ICL optics purchased individually supporting 100m or 2-km distances running at 32G or 16G.

NOTE: The underlying license is the same in the ICL kits listed above. The only difference is the number of optics that are shipped as part of the kit. Ports that have been enabled can be populated with any of the supported optics. X7 Directors and X6 Directors that have been upgraded to Gen 7 require the use of secure optics. Once an X6 has been upgraded to Gen 7, 32G nonsecure QSFP optics (MPN 57-1000351-01 or 57-1000480-01) are no longer supported for use.

2.3 Brocade X6-4 ICL POD Licensing and ICL Kit Offerings

For Gen 6 ICLs, there are different ICL POD licenses for the Brocade X6-8 and X6-4 Directors. For an X6-4 Director, a total of two POD licenses are required to enable all 16 ICL ports. A minimum of one ICL POD license is required on a 4-slot chassis. The first ICL POD license on the Brocade X6-4 enables a total of 8 QSFP UltraScale ICL ports per director chassis, enabling 4 ICL ports (0, 1, 4, 5) on each core blade. A second ICL POD license enables the remaining 8 QSFP UltraScale ICL ports on the director chassis, enabling the remaining 4 ICL ports (2, 3, 6, 7) on each core blade; so all 16 QSFP ports across both core routing blades are enabled. These ICL POD licenses are bundled as part of the ICL kit offerings. Currently available ICL kit offerings for the Brocade X6-4 include the following:

- **Gen 6 100m 4-slot ICL kit (P/N BR-X64ICLKIT-100M-02)**: This kit includes one ICL POD license and eight 4×32G 100m SWL QSFPs. One POD license enables 4 QSFP ports on each CR blade (8 QSFP ports per chassis). To enable all QSFP ICL ports on both CR blades, two kits are required. This kit bundles XBR-000275 4×32G QSFPs supporting 4×32G or 4×16G speeds, supporting connectivity from X6-4 to X6 ICLs or X6-4 to DCX 8510 ICLs. This kit replaced the original kit offered for the X6-4, BR-X64ICLKIT-100M-01, which supported only 32G connectivity between X6s and has since been discontinued.

- **Gen 5 2-km 4-slot ICL kit for the X6-4 chassis (P/N BR-X64GEN5ICLKIT-2KM-01)**: This kit includes one ICL POD license and eight 4×16G 2-km QSFPs. The POD license enables 4 QSFP ports per CR blade (8 QSFP ports per chassis). *This kit is required for the X6-4 if it is connected to a Gen 5 DCX 8510 chassis via 2-km ICLs at 4×16G speeds*. The license included in this kit is the same as that for the Gen 6 ICL kit; the only difference is the bundled QSFPs.

NOTE: The underlying license is the same in all listed ICL kits. The only difference is the type and number of optics that are shipped as part of the kit. The X6-4 POD license differs from the DCX 8510-4 ICL POD license. In the Brocade X6-4 chassis, the ICL POD license capacity is eight ports. Therefore, two ICL POD licenses (or two ICL kits) are required to fully enable all ICL ports on the Brocade X6-4. On the Brocade DCX 8510-4 chassis, one ICL POD license enables 16 ICL ports; thus only one ICL POD license (or one ICL kit) is required to fully enable all ICL ports on the Brocade DCX 8510-4. X7 Directors and X6 Directors that have been upgraded to Gen 7 require the use of secure optics. Once an X6 has been upgraded to Gen 7, 32G nonsecure QSFP optics (MPN 57-1000351-01 or 57-1000480-01) are no longer supported for use.

2.4 Brocade DCX 8510 ICL POD Licensing and ICL Kit Offerings

For Gen 5 ICLs, the same ICL POD licenses are used for both the Brocade DCX 8510-8 and DCX 8510-4 Directors. For a DCX 8510-8 Director, a total of two POD licenses are required to fully enable all 32 ICL ports. A minimum of one ICL POD license is required on an 8-slot chassis. The first ICL POD license on the Brocade DCX 8510-8 enables a total of 16 QSFP UltraScale ICL ports per director chassis, enabling 8 ports (0-7) on each core blade. The second ICL POD license enables the remaining 16 QSFP UltraScale ICL ports, enabling 8 ports (8-15) on each core blade; so all 32 QSFP ports across both core routing blades are enabled. For a DCX 8510-4 Director, only one POD license is required to fully enable all 16 UltraScale ICL ports on the two core blades. These ICL POD licenses are bundled as part of the ICL kit offerings. The ICL kit offerings for the DCX 8510 platforms include the following:

- **100m ICL kit (P/N BR-8510ICLKIT-01)**: This kit includes one ICL POD license and sixteen 4×16G SWL 100m QSFPs. One license enables 8 QSFP ports per CR blade (16 QSFP ports per chassis). To enable all QSFP ICL ports on both CR blades on the DCX 8510-8 chassis, two kits are required. A single kit enables all QSFP ICL ports on a DCX 8510-4 chassis.
- **2-km ICL kit (P/N BR-8510ICLKIT2KM-01)**: This kit includes one ICL POD license and eight 4×16G 2-km QSFPs. One POD license enables 8 QSFP ports per CR blade (16 QSFP ports per chassis). To enable all QSFP ICL ports on both CR blades on the DCX 8510-8 chassis, two such kits are required. Note that only eight 2-km 4×16G QSFPs are bundled with this option, although the license enables double the number of QSFP ports. The remaining eight ports can be populated with ICL optics purchased individually, supporting 100m or 2-km distances.

2.5 Enterprise ICL License

The Enterprise ICL (EICL) license is required on each Brocade DCX 8510 chassis that connects to four or more Brocade director chassis via UltraScale ICLs. This license requirement is not dependent on the total number of Brocade DCX 8510 chassis that exist in a fabric, but on the total number of chassis that are directly connected via ICLs. This license is in addition to the ICL POD license requirements noted previously, which enable the ICL ports themselves.

This license is applicable only to the Brocade DCX 8510 Director family and is not required for Brocade X6 or X7 Director chassis.

Chapter 3: Supported ICL Topologies
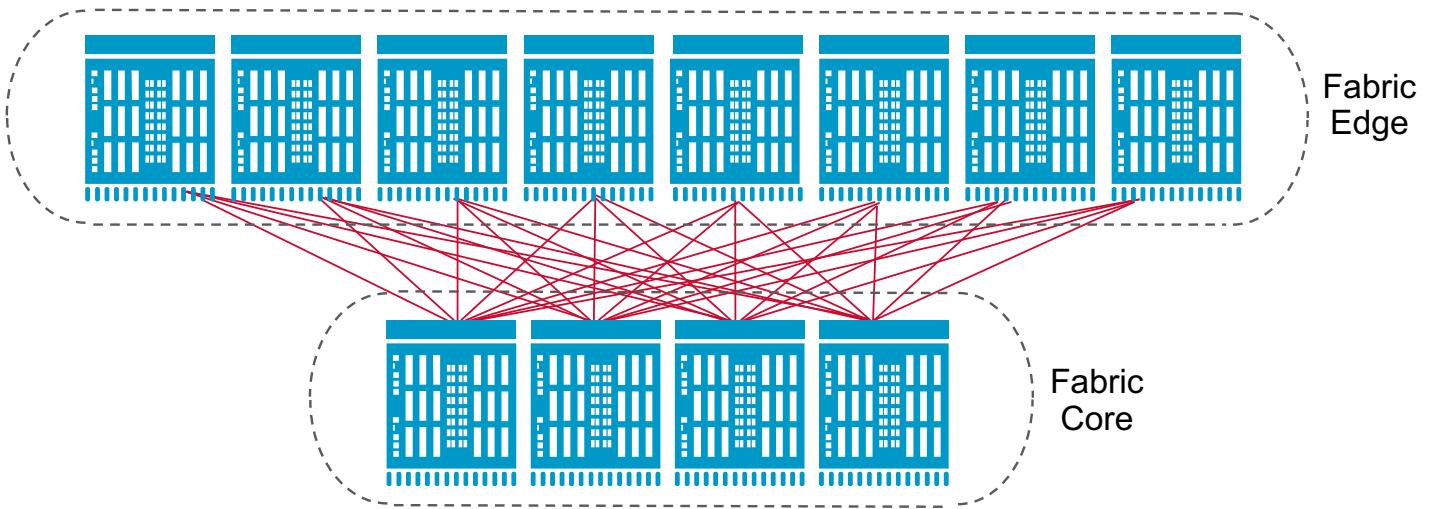
Two network topologies are supported with the Brocade director platforms and optical UltraScale ICLs: core/edge and mesh. Both topologies deliver unprecedented scalability while dramatically reducing ISL cables.

NOTE: Always refer to the *Brocade SAN Scalability Guidelines* for appropriate Brocade Fabric OS® versions for supported UltraScale ICL topology scalability limits.

3.1 Core/Edge Topology

A core/edge topology, also known as CE, is an evolution of the well-established and popular "star" topology often used in data networks. CE designs have dominated storage area network (SAN) architecture for many reasons, including the fact that they are well tested, well balanced, and economical. Figure 1 shows how a customer could deploy four Brocade X7 chassis and/or X6 chassis at the core and eight more directors at the edge, for a highly scalable, cost-effective topology. In most environments, servers are attached to the edge chassis, with storage being attached to the core. By connecting each edge chassis to each core, all hosts/targets are separated by a maximum of one hop, regardless of where they are attached in the fabric. (A variety of different CE designs can be implemented, with varying ratios of core versus edge chassis being used to meet the needs of any environment.)
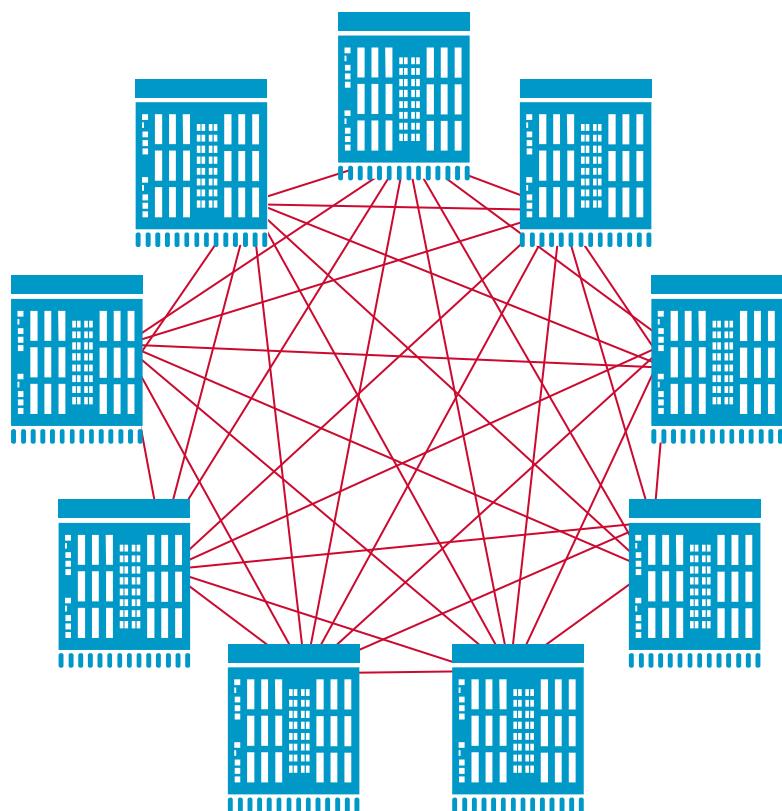
Figure 1: Twelve-Chassis Core/Edge Topology Supported with the Brocade X7, X6, and/or DCX 8510

3.2 Mesh Topology

A mesh topology was a common design philosophy when SAN fabrics were first being built, as these fabrics were simple and easy to manage. But as larger fabrics became more common, the cabling infrastructure to support such a topology became impossible to manage. Without direct connections between every pair of chassis, knowing where each storage and server port is located in order to provide ideal fabric routes can quickly become an operational nightmare. Brocade optical UltraScale ICL technology solves these issues by easily allowing each Brocade Gen 7, Gen 6, or Gen 5 director to connect directly to every other director in the fabric. This drastically simplifies design and operational issues associated with deployment. Figure 2 shows a nine-chassis active-active mesh topology using UltraScale ICLs.

Figure 2: Nine-Chassis Mesh Topology Supported with the Brocade X7, X6, and/or DCX 8510
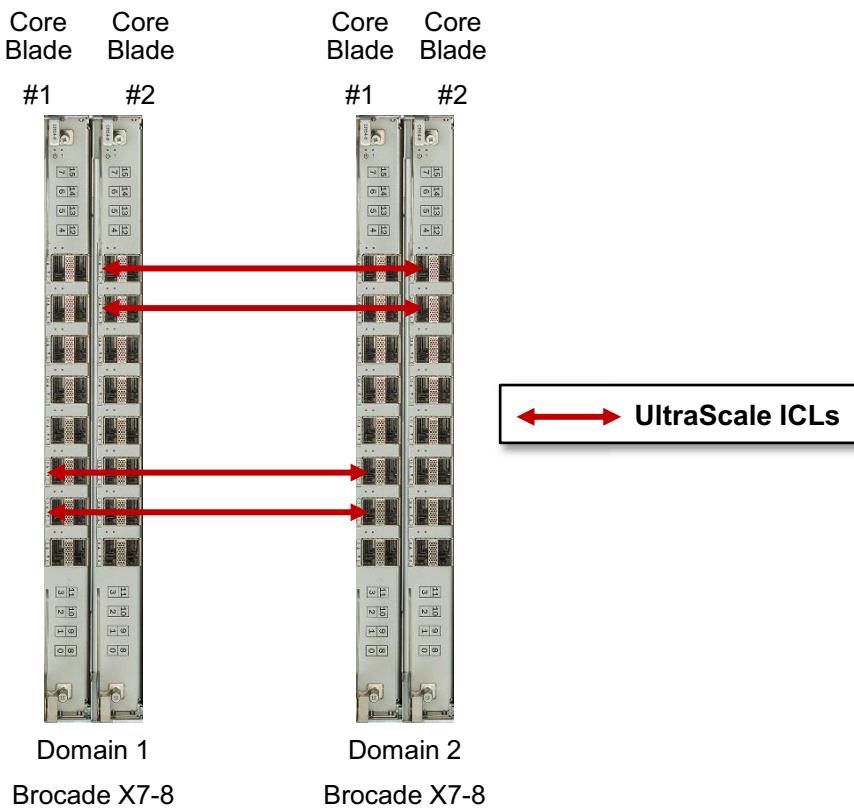
Chapter 4: QSFP-Based UltraScale ICL Connection Requirements

To connect multiple Brocade X7, X6, and DCX 8510 chassis via UltraScale ICLs, a minimum of four ICL ports (two on each core blade) must be connected between each chassis pair. The 32 UltraScale ICL ports available on the 8-slot director chassis (with all ICL POD licenses installed) support ICL connectivity with up to eight other chassis. Figure 3 shows the minimum connectivity between a pair of Brocade X7-8 chassis.

NOTE: The physical location of UltraScale ICL connections may differ from what is shown in the figure. There must be at least two connections per core blade.

Figure 3: Minimum ICL Connections Needed Between a Pair of Chassis

The dual connections on each core blade must reside within the same UltraScale ICL trunk boundary on the core blades. UltraScale ICL trunk boundaries are described in detail in Chapter 5. If more than four UltraScale ICL connections are required between a pair of director chassis, additional UltraScale ICL connections must be added in pairs (one on each core blade).

A maximum of 16 UltraScale ICL connections or ICL trunk groups between any pair of director chassis is supported, unless they are deployed using Virtual Fabrics, where a maximum of 16 UltraScale ICL connections or trunks can be assigned to a single logical switch. This limitation is due to the maximum number of supported connections for Fabric Shortest Path First (FSPF) routing. Effectively, this means that there should never be more than 16 UltraScale ICL connections or trunks between a pair of director chassis, unless Virtual Fabrics is enabled, and the ICLs are assigned to two or more logical switches. The exception to this is if eight port trunks are created between a pair of directors. Details on this configuration are described in Chapter 5.

Combining QSFP-based UltraScale ICLs and traditional ISLs is not supported between a single pair of directors. All inter-chassis connectivity between any pair of director chassis must be done using either ISLs or UltraScale ICLs and at the same speed between any two directors. However, if Brocade Virtual Fabrics is enabled, simultaneous ICLs and ISLs can coexist between a pair of Brocade X7, X6, and/or Brocade DCX 8510 chassis if ICLs are in a different logical switch than the ISLs.
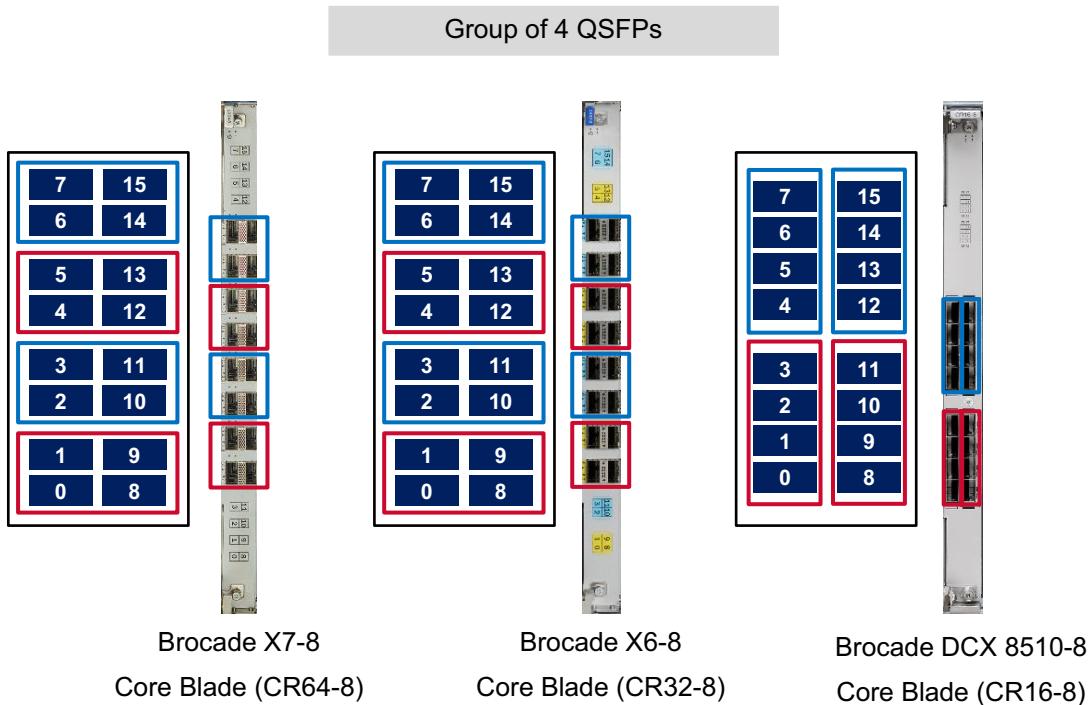
The final layout and design of UltraScale ICL interconnectivity are determined by the customer's unique requirements and needs, which dictate the ideal number and placement of ICL connections between each pair of director chassis in the fabric. Brocade Professional Services can assist in developing large-scale ICL-based designs.

Chapter 5: UltraScale ICL Trunking and Trunk Groups

Trunking involves taking multiple physical connections between a chassis or switch pair and forming a single "virtual" connection, aggregating the bandwidth for traffic to traverse. Brocade offers a number of hardware-based trunking solutions, including Brocade ISL Trunking for traditional ISLs, trunking for Integrated Routing (FCR connectivity), trunking for Access Gateway, and also trunking for UltraScale ICLs. This chapter describes the trunking capability used with the QSFP-based UltraScale ICL ports on the Brocade director platforms. (Note that trunking is enabled automatically for UltraScale ICL ports, and it cannot be disabled by the user.)

As previously described, each QSFP-based UltraScale ICL port actually has four independent links for the Brocade X7, X6, and DCX 8510, each of which terminates on one of four Condor switching ASICs on an 8-slot director core blade or on two ASICs on an 4-slot director core blade. Trunk groups can be formed using any of the ports that make up contiguous groups of eight links on each ASIC. Figure 4 shows that each core blade has groups of eight UltraScale ICL ports (indicated by the blue and red boxes around the groups of ports) that can participate in common trunk groups with links from the other ports in the group. A minimum of two QSFP ports within an ICL trunk boundary are required to form a trunk group to a neighboring domain. Each 8-slot director core blade has two groups of eight UltraScale ICL ports (that is, 16 per core blade and 32 per chassis) that form trunks across QSFPs.
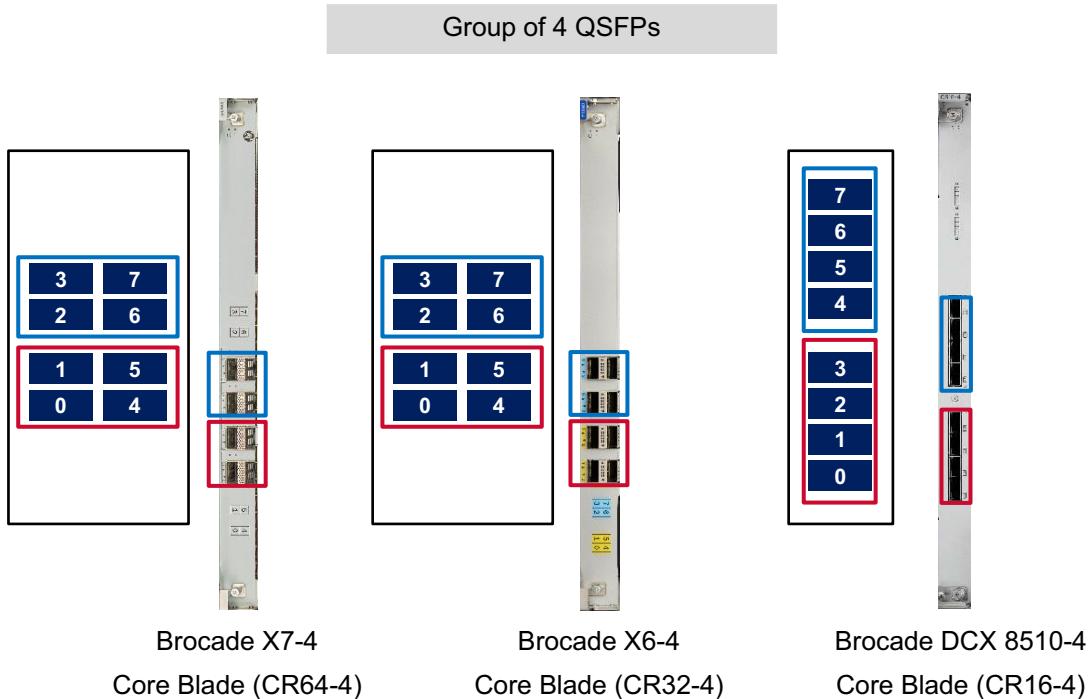
Figure 4: Core Blade Trunk Groups on an 8-Slot Director Core Blade

Brocade X7-8
Core Blade (CR64-8)

Brocade X6-8
Core Blade (CR32-8)

Brocade DCX 8510-8
Core Blade (CR16-8)

NOTE: Members of trunk boundaries are the same on the Brocade X7-8 and X6-8 but are different on the DCX 8510-8. Regardless, the connectivity requirements and principles are the same between all three generations of products.

Similarly, for 4-slot director chassis, each core blade has two groups of four UltraScale ICL ports with a total of 8 ICL ports per core blade and 16 per chassis. Figure 5 shows trunk boundaries on a 4-slot director core blade.

Figure 5: Core Blade Trunk Groups on a 4-Slot Director Core Blade

Brocade X7-4
Core Blade (CR64-4)

Brocade X6-4
Core Blade (CR32-4)

Brocade DCX 8510-4
Core Blade (CR16-4)

NOTE: Members of trunk boundaries are the same on the Brocade X7-8 and X6-8 but are different on the DCX 8510-8. Regardless, the connectivity requirements and principles are the same between all three generations of products.
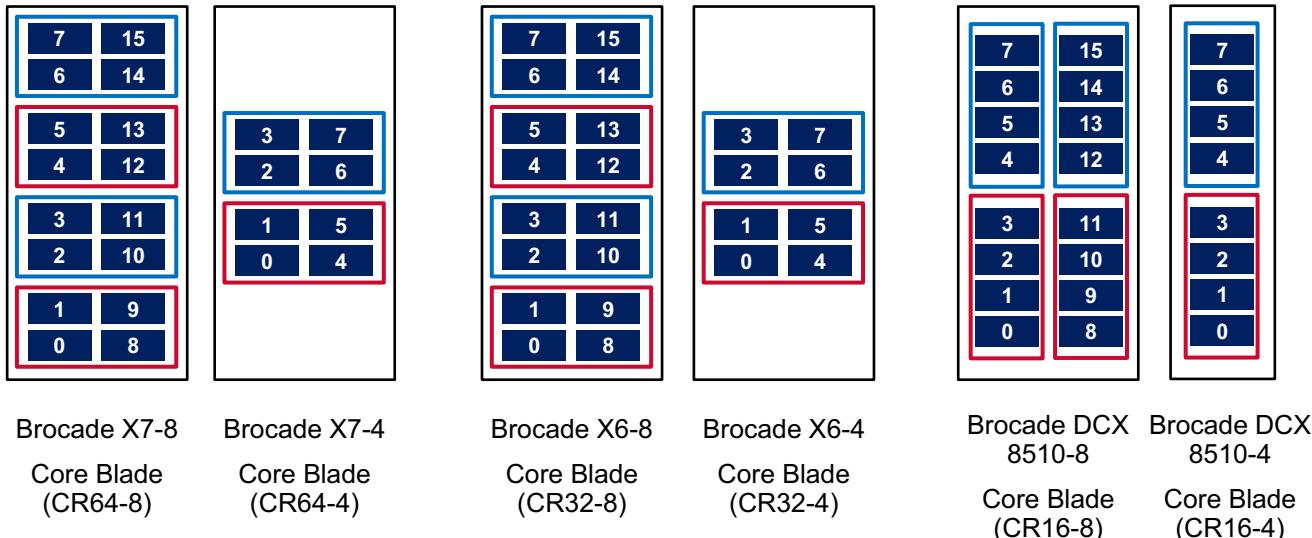
Because there are four separate links for each QSFP-based UltraScale ICL connection, each individual link of the ICL port is part of a separate trunk, with up to eight links in each trunk.

A trunk can never be formed by links within the same QSFP ICL port. This is because each of the four links within the ICL port terminates on a different ASIC for the 8-slot director core blade or on either different ASICs or different trunk groups within the same ASIC for the 4-slot director core blade. Thus, each of the four links from an individual ICL is always part of independent trunk groups.

When connecting UltraScale ICLs between an 8-slot director chassis and a 4-slot director chassis, the maximum number of links in a single trunk group is four. This is due to the different number of ASICs on each model's core blades, as well as the mapping of the ICL links to the ASIC trunk groups. To form trunks between two 4-slot chassis or two 8-slot chassis with up to eight links, UltraScale ICL ports must be deployed within the trunk group boundaries indicated in Figure 4 and Figure 5 (note that 8 QSFP ports in both blue or red trunk boundaries will form an 8-port trunk on an 8-slot chassis); and 8-port trunks can be created only when deploying ICLs between a pair of 8-slot chassis or 4-slot chassis. It is not possible to create trunks with more than four links when connecting UltraScale ICLs between an 8-slot chassis and a 4-slot chassis.

As a best practice, deploy trunk groups in groups of up to four links by ensuring that the UltraScale ICL ports intended to form trunks all reside within the groups indicated by the red and blue boxes in Figure 6.

Figure 6: Recommended Core Blade Trunk Groups

Brocade X7-8 Core Blade (CR64-8)

Brocade X7-4 Core Blade (CR64-4)

Brocade X6-8 Core Blade (CR32-8)

Brocade X6-4 Core Blade (CR32-4)

Brocade DCX 8510-8 Core Blade (CR16-8)

Brocade DCX 8510-4 Core Blade (CR16-4)

By following this best practice, trunks can be easily formed using UltraScale ICL ports, whether you are connecting two 8-slot chassis, two 4-slot chassis, or an 8-slot chassis and a 4-slot chassis.

When additional UltraScale ICL connections are added to a chassis, they should be added in pairs by including at least one additional UltraScale ICL on each core blade. Also, trunks on a core blade should always have an equal number of links, and connections should be deployed in an identical fashion on both core blades within a chassis. For example, if you deploy two UltraScale ICLs within a group of four ICL ports in one of the red trunk groups in Figure 6, you can add a single additional ICL to an existing trunk in the same red trunk group, or you can add a pair of ICLs to any of the other trunk groups on the core blade. This ensures that no trunks are formed that have a different total bandwidth from other trunks on the same blade. Deploying a single additional UltraScale ICL to another blue trunk group could result in mismatched trunked port capacity between the pair (4 × 2 port trunks in the red group and 4 × 1 port trunks in the blue group).

The port mapping information shown in Table 1 and Table 2 also indicates the recommended UltraScale ICL trunk groups by showing ports in the same recommended trunk group with the same color.

Chapter 6: Port Numbering Layout on 8-Slot Chassis Core Blades

Table 1 and Table 2 show the layout of ports 0 to 15 on the 8-slot director chassis core blade (Table 1 for both the Brocade X6-8 CR32-8 and X7-8 CR64-8 core blades and Table 2 for the Brocade DCX 8510-8 core blade). You can also see what the `switchshow` output would be if you issued a `switchshow` command using the Brocade Fabric OS CLI.

The colored groups of external UltraScale ICL ports indicate those ports that belong to common recommended trunk groups. For example, for the X6-8 or X7-8, ICL ports 0, 1, 8, and 9 (shown in gray in Table 1) form four trunk groups, with one link being added to each trunk group from each of the four external ICL ports. For the 8-slot director chassis, you can create up to 16 trunk groups of 4 links each on each of the two core blades.

Table 1: Brocade X6-8 CR32-8 and X7-8 CR64-8 Core Blades: External UltraScale ICL Port Numbering to "switchshow" (Internal) Port Numbering

External ICL Port No.	switchshow Port No.	External ICL Port No.	switchshow Port No.
7	28–31	15	60–63
6	24–27	14	56–59
5	20–23	13	52–55
4	16–19	12	48–51
3	12–15	11	44–47
2	8–11	10	40–43
1	4–7	9	36–39
0	0–3	8	32–35

The first ICL POD license on the Brocade X7-8 enables a total of 8 QSFP UltraScale ICL ports on the director chassis, enabling 4 ICL ports on each core blade (QSFP ports 0, 1, 8, and 9) that are part of the bottom two 4-port trunk groups in Table 1. A second ICL POD license enables an additional 8 QSFP UltraScale ICL ports on the director chassis, enabling QSFP ports 2, 3, 10, and 11 on both core blades that are part of the upper two 4-port trunk groups in Table 1. A third ICL POD license enables QSFP ports 4, 5, 12, and 13 on both core blades, corresponding to the two 4-port trunk groups in Table 1. And the fourth ICL POD license enables the last eight QSFP ports 6, 7, 14, and 15 on both core blades.

The first ICL POD license on the Brocade X6-8 enables a total of 16 QSFP UltraScale ICL ports on the director chassis, enabling 8 ICL ports on each core blade (QSFP ports 0, 1, 8, 9, 2, 3, 10, and 11) that are part of the bottom two 4-port trunk groups in Table 1. A second ICL POD license enables the remaining 16 QSFP UltraScale ICL ports on the director chassis, enabling QSFP ports 4, 5, 12, 13, 6, 7, 14, and 15 on both core blades that are part of the upper two 4-port trunk groups in Table 1.

Similarly for the DCX 8510-8, the colored groups of external UltraScale ICL ports indicate those ports that belong to common recommended trunk groups. For example, ICL ports 0, 1, 2, and 3 (shown in gray in Table 2) form four trunk groups, with one link being added to each trunk group from each of the four external ICL ports. For this 8-slot director chassis, you can create up to 16 trunk groups of 4 links each on each of the two core blades.

Table 2: Brocade DCX 8510-8 CR16-8 Core Blade: External UltraScale ICL Port Numbering to "switchshow" (Internal) Port Numbering

External ICL Port No.	switchshow Port No.	External ICL Port No.	switchshow Port No.
7	28–31	15	60–63
6	24–27	14	56–59
5	20–23	13	52–55
4	16–19	12	48–51
3	12–15	11	44–47
2	8–11	10	40–43
1	4–7	9	36–39
0	0–3	8	32–35

The first ICL POD license enables ICL ports 0 to 7 that are part of the left two trunk groups. Adding a second ICL POD license enables the remaining eight ICL ports, ports 8 to 15, which are the right two trunk groups on the port blade. This applies to ports on both core blades.

NOTE: To disable ICL port 0, you must issue the `portdisable` command on all four "internal" ports associated with that ICL port.

Chapter 7: Port Numbering Layout on 4-Slot Chassis Core Blades

Table 3 shows the layout of ports 0 to 7 on the Brocade X6-4 CR32-4 or Brocade X7-4 CR64-4 core blades. You can also see what the `switchshow` output would be if you issued a `switchshow` command using the Brocade Fabric OS CLI.

The colored groups of external UltraScale ICL ports indicate those ports that belong to a common recommended trunk group. For example, for the X7-4 or the X6-4, ICL ports 0, 1, 4, and 5 (shown in gray in Table 3) form four trunk groups, with one link being added to each trunk group from each of the four external ICL ports.

Table 3: Brocade X6-4 CR32-4/X7-4 CR64-4 Core Blades: External UltraScale ICL Port Numbering to "switchshow" (Internal) Port Numbering

External ICL Port No.	switchshow Port No.	External ICL Port No.	switchshow Port No.
3	12–15	7	28–31
2	8–11	6	24–27
1	4–7	5	20–23
0	0–3	4	16–19

Similarly, Table 4 shows the layout of ports 0 to 7 on the Brocade DCX 8510-4 CR16-4 core blade. You can also see what the `switchshow` output would be if you issued a `switchshow` command using the Brocade Fabric OS CLI.

The colored groups of external UltraScale ICL ports indicate those ports that belong to a common recommended trunk group. For example, for the DCX 8510-4, ICL ports 0, 1, 2, and 3 (shown in gray in Table 4) form four trunk groups, with one link being added to each trunk group from each of the four external ICL ports.

Table 4: Brocade DCX 8510-4 CR16-4 Core Blade: External UltraScale ICL Port Numbering to "switchshow" (Internal) Port Numbering

External ICL Port No.	switchshow Port No.
7	28–31
6	24–27
5	20–23
4	16–19
3	12–15
2	8–11
1	4–7
0	0–3

NOTE: To disable ICL port 0, you must issue the `portdisable` command on all four "internal" ports associated with that ICL port.

For the 4-slot director chassis (X7-4, X6-4, or DCX 8510-4), you can create up to eight trunk groups on each of the two core blades.

Licensing is the same on the Brocade X7-4 and X6-4 chassis, but it is different on the Brocade DCX 8510-4 chassis. On the Brocade X7-4 and X6-4, the first ICL POD license enables ICL ports 0, 1, 4, and 5 on both core blades that are part of the bottom trunk group in Table 3. Adding a second ICL POD license enables the remaining eight ICL ports, QSFP ports 2, 3, 6, and 7 on both core blades that are part of the upper trunking group in Table 3. For the Brocade DCX 8510-4, a single ICL POD license enables all eight ICL ports on both Brocade DCX 8510-4 core blades.
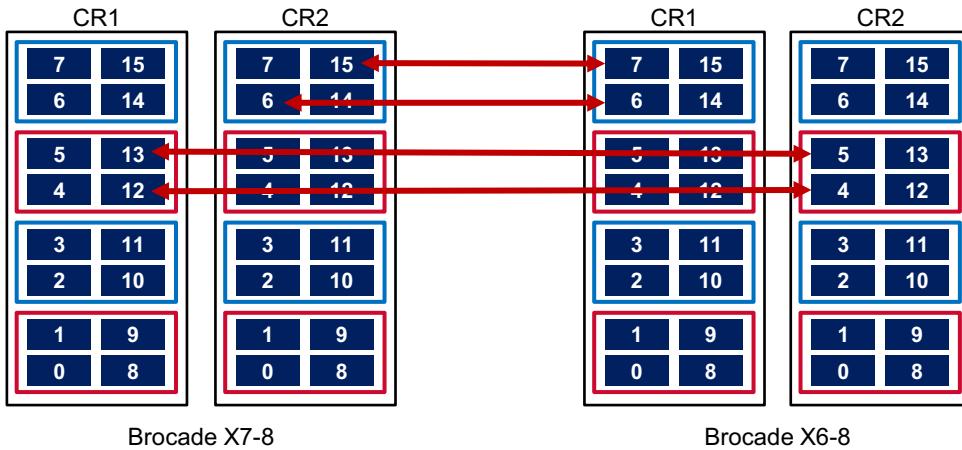
Chapter 8: Connecting Brocade Directors Using ICLs

To connect multiple Brocade X7, X6, and/or DCX 8510 Director family chassis via UltraScale ICLs, a minimum of four ICL ports (two on each core blade) must be connected between each chassis pair. The 32 UltraScale ICL ports available on the 8-slot chassis support ICL connectivity with up to 8 other chassis in a mesh topology (for a total of 9 in a fabric) and 11 other chassis in a core/edge topology (for a total of 12 in a fabric).

Figure 7 shows the minimum connectivity between a pair of X7-8 or X6-8 chassis.
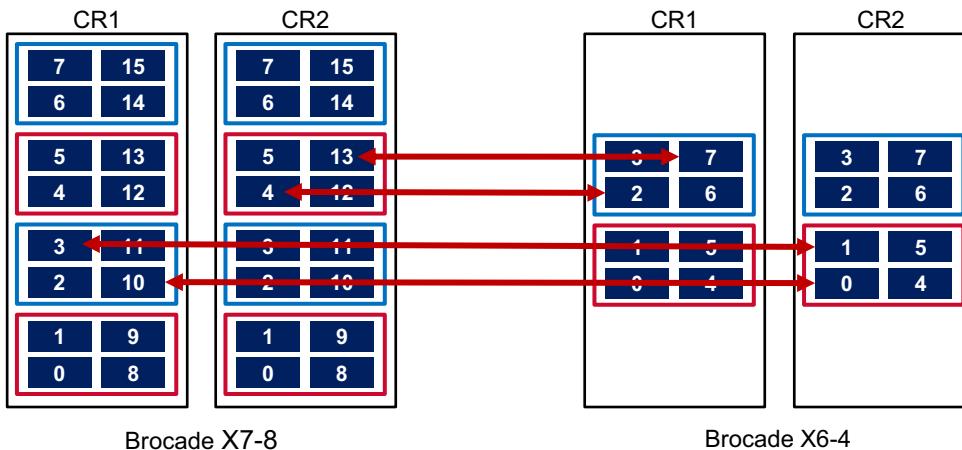
NOTE: The physical location of the UltraScale ICL connections may differ from what is shown in the figure. There must be at least two connections per core blade, and those connections must be from within the same ICL trunk boundary.

Figure 7: X7-8 to X6-8 ICL Connectivity

Figure 8 shows the minimum ICL connectivity between an X6-8 chassis and an X6-4 chassis.

**Figure 8: X7-8 to X6-4 ICL Connectivity**
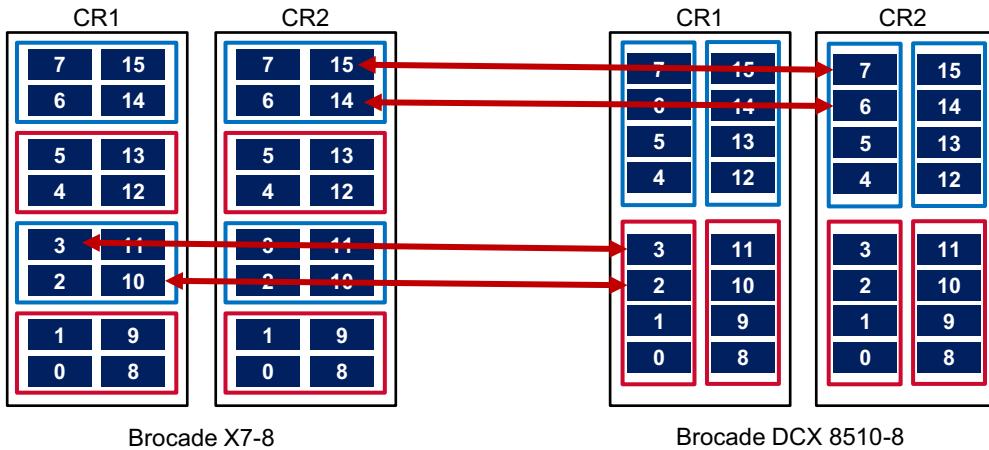
The dual connections on each core blade must reside within the same UltraScale ICL trunk boundary on the core blades. If more than four UltraScale ICL connections are required between a pair of Brocade director chassis, additional UltraScale ICL connections must be added in pairs (one on each core blade).

NOTE: Optics bundled in the BR-X68ICLKIT-100M-02/BR-X64ICLKIT-100M-02 kits support interoperability with any of the supported Gen 5 4×16G optics when connecting an X6 or X7 to a DCX 8510 via ICLs. *The only requirement is that the speed must be manually configured as fixed 4×16G on X6/X7 ICL ports when connecting to a DCX 8510.*

Before the availability of the BR-X68ICLKIT-100M-02/BR-X64ICLKIT-100M-02 kits, Brocade offered BR-X68GEN5ICLKIT-01/BR-X64GEN5ICLKIT-01, bundling Gen 5 4×16G QSFPs to connect an X6 chassis to a DCX 8510 chassis via ICLs. The 4×16G QSFP supported on the X6 chassis to connect to the DCX 8510 chassis via ICLs is part number XBR-000245 (MPN 57-1000294-02). The QSFP on the DCX 8510 CR blade to connect to the X6 via ICLs can be any of the supported revisions.

Figure 9 shows the minimum ICL connectivity between an X6-8 or X7-8 Director and a DCX 8510-8 Director.

Figure 9: X7-8 to DCX 8510-8 ICL Connectivity

Brocade X7-8   Brocade DCX 8510-8

The preceding figures demonstrate minimum ICL connectivity. The maximum number of ICLs between any two directors is 16. (The maximum number of ICL connections between two X7-8/X6-8/DCX 8510-8 chassis is 32. However, FSPF uses only the first 16 trunk groups to come online. With Virtual Fabrics, multiple logical switches can be defined with up to 16 ICLs in each.)

Chapter 9: UltraScale ICL Diagnostics

Brocade Fabric OS provides ClearLink® diagnostic port (D_Port) support for UltraScale ICLs, helping administrators quickly identify and isolate ICL optics and cable problems. ClearLink diagnostics on UltraScale ICLs measures link latency, link distance, and signal power, and it also performs link traffic tests. Gen 5 4×16G QSFPs, first-generation Gen 6 4×32G QSFPs, and Gen 7 QSFPs skip the electrical loopback and optical loopback tests because they do not support these functions. The second generation of the 4×32G SWL QSFP does support electrical and optical loopback functions; however these functions are not supported in ICL use cases. Use port decommissioning of the ICL ports prior to performing ClearLink diagnostics to ensure a graceful and lossless shut down of the ports prior to taking the ports offline for diagnostics. In addition, configuring the directors with Dynamic D_Port greatly simplifies ClearLink operations; to ensure that ClearLink is not mistakenly invoked on ports with Dynamic D_Port enabled, the ports must be provisioned prior to performing a diagnostics test. Details on ClearLink diagnostics port configuration and usage can be found in the *Brocade Fabric OS Troubleshooting and Diagnostics Reference Manual*.

Chapter 10: UltraScale ICL Routing

For environments enabled with Virtual Fabrics, Fabric OS provides the ability to configure EX_Ports on the UltraScale ICLs, utilizing the ICL bandwidth to route traffic across different fabrics. This capability allows users to build high-performance inter-fabric links (IFLs) using UltraScale ICLs, while simplifying cabling.

Appendix A: ICL POD Kit Reference Table

The following tables are not official support matrices, but they can be used as a reference. Always check the latest release notes and documentation.

Table 5: X7 – ICL POD Kit Reference Table

X7	SWL/LWL	Product	Licenses per Chassis	QSFP Ports per Chassis per License	FC Ports per Chassis per License	QSFPs per Kit	Connector	Connectivity	Distance
Gen 7 100m ICL kit (P/N BR-X7ICLKIT-100M-01): X7 ICL POD KIT, enables 8 ICL ports, 8x GEN 7 ICL QSFPs 100m Optics: XBR-000420	SWL	X7-4	1 or 2	8 or 16	32 or 64	8	MTP	X7 - X7	OM3 70m OM4 100m
		X7-8	1, 2, 3, or 4	8, 16, 24, or 32	32, 64, 96, or 128				
Gen 7 2-km ICL kit (P/N BR-X7ICLKIT-2KM-01): X7 ICL POD KIT, enables 8 ICL ports, 8x GEN 7 ICL QSFPs 2 km Optics: XBR-000476	LWL	X7-4	1 or 2	8 or 16	32 or 64	8	LC	X7 - X7	2 km
		X7-8	1, 2, 3, or 4	8, 16, 24, or 32	32, 64, 96, or 128				
Gen 6 100m ICL kit for the X7 chassis (P/N BR-X7GEN6ICLKIT-100M-1): X7 32G ICL POD KIT, enables 8 ICL ports, 8x 32G QSFPs 100m Optics: XBR-000475	SWL	X7-4	1 or 2	8 or 16	32 or 64	8	MTP	X7 - X7 (32Gb/s) X7 - X6 (32Gb/s) X7 – DCX 8510 (16Gb/s)	OM3 70m OM4 100m
		X7-8	1, 2, 3, or 4	8, 16, 24, or 32	32, 64, 96, or 128				
Gen 6 2-km ICL kit for the X7 chassis (P/N BR-X7GEN6ICLKIT-2KM-01):[a] X7 32G ICL POD KIT, enables 8 ICL ports, 8x 32G QSFPs 2 km Optics: XBR-000285	LWL	X7-4	1 or 2	8 or 16	32 or 64	8	LC	X7 - X7 (32Gb/s) X7 - X6 (32Gb/s)	2 km
		X7-8	1, 2, 3, or 4	8, 16, 24, or 32	32, 64, 96, or 128				

a. The Gen 6 2-km ICL POD kit for the X7 is no longer available for purchase.

Table 6: X6 – ICL POD Kit Reference Table

X6-8	SWL/LWL	Product	Licenses per Chassis	QSFP Ports per Chassis per License	FC Ports per Chassis per License	QSFPs per Kit	Connector	Connectivity	Distance
Gen 6 100m ICL kit (P/N BR-X68ICLKIT-100M-02): X6 32G ICL POD KIT, enables 16 ICL ports, 16x 32G QSFPs 100m Optics: XBR-000475, XBR-000275	SWL	X6-8	1 or 2	16 or 32	64 or 128	16	MTP	X6 - X6 (16/32G) X6 - DCX 8510 (16G)	OM3 70m OM4 100m
Gen 6 2-km ICL kit (P/N BR-X68ICLKIT-2KM-01): X6 32G ICL POD KIT, enables 16 ICL ports, 8x 32G QSFPs 2 km Optics: XBR-000285	LWL	X6-8	1 or 2	16 or 32	64 or 128	8	LC	X6 - X6 (32 G)	2 km
Gen 5 2-km ICL kit for the X6-8 chassis (P/N BR-X68GEN5ICLKIT-2KM-01): X6 32G ICL POD KIT, enables 16 ICL ports, 8x 16G QSFPs 2 km Optics: XBR-000255	LWL	X6-8	1 or 2	16 or 32	64 or 128	8	MTP 3m pigtail APC	X6 - DCX 8510 (16G)	2 km
X6-4	**SWL/LWL**	**Product**	**Licenses per Chassis**	**QSFP Ports per Chassis per License**	**FC Ports per Chassis per License**	**QSFPs per Kit**	**Connector**	**Connectivity**	**Distance**
Gen 6 100m ICL kit (P/N BR-X64ICLKIT-100M-02): X6 32G ICL POD KIT, enables 8 ICL ports, 16x 32G QSFPs 100m Optics: XBR-000475, XBR-000275	SWL	X6-4	1 or 2	8 or 16	32 or 64	8	MTP	X6 - X6 (16/32G X6 - DCX 8510 (16G)	OM3 70m OM4 100m
Gen 6 2-km ICL kit (P/N BR-X64ICLKIT-2KM-01): X6 32G ICL POD KIT, enables 8 ICL ports, 8x 32G QSFPs 2 km Optics: XBR-000285	LWL	X6-4	1 or 2	8 or 16	32 or 64	8	LC	X6 - X6 (32G)	2 km
Gen 5 2-km ICL kit for the X6-4 chassis (P/N BR-X64GEN5ICLKIT-2KM-01): X6 32G ICL POD KIT, enables 8 ICL ports, 8x 16G QSFPs 2 km Optics: XBR-000255	LWL	X6-4	1 or 2	8 or 16	32 or 64	8	MTP 3m pigtail APC	X6 - DCX 8510 (16G)	2 km

Table 7: DCX 8510 – ICL POD Kit Reference Table

DCX 8510	SWL/LWL	Product	Licenses per Chassis	QSFP Ports per Chassis per License	FC Ports per Chassis per License	QSFPs per Kit	Connector	Connectivity	Distance
Gen 5 100m ICL kit (P/N BR-8510ICLKIT-01): DCX 8510 16G ICL POD KIT, enables 16 ICL ports, 16x 16G QSFPs 100m Optics: XBR-000245	SWL	8510-4	1	16	64	16	MTP	DCX 8510 - DCX 8510 (16G)	OM3 70m OM4 100m
		8510-8	1 or 2	16 or 32	64 or 128				
Gen 5 2-km ICL kit (P/N BR-8510ICLKIT2KM-01): DCX 8510 16G ICL POD KIT, enables 16 ICL ports, 8x 16G QSFPs 2 km Optics: XBR-000255	LWL	8510-4	1	16	64	8	MTP 3m pigtail APC	DCX 8510 - DCX 8510 (16G)	2 km
		8510-8	1 or 2	16 or 32	64 or 128				

Revision History

Scale-Out-ICLs-DG105; September 6, 2022

Deleted the Gen 6 2-km ICL kits from the list of available offerings. Deleted the two-kit minimum requirement for the X7-8.

Scale-Out-ICLs-DG104; February 23, 2022

Added the Gen 7 2-km ICL kit to the X7 ICL POD licensing and ICL kit offerings. Also added Appendix A: ICL POD Kit Reference Table.

Scale-Out-ICLs-DG103; March 29, 2021

Added the 32G 2-km ICL kit to the X7 ICL POD licensing and ICL kit offerings.

Scale-Out-ICLs-DG102; November 6, 2020

Clarified the explanation of ICL trunk groups.

Scale-Out-ICLs-DG101; September 9, 2020

Corrected ICL POD license information.

Scale-Out-ICLs-DG100; September 1, 2020

Initial version to cover new Gen 7 ICL kit offerings. Gen 7 ICLs support 4 × Gen 7 ICL speeds and are interoperable with Gen 5 and Gen 6 ICLs.