Cisco NCS 1010 Topologies

This appendix describes multidegree support on NCS 1010 and has examples of a few NCS 1010 topologies.

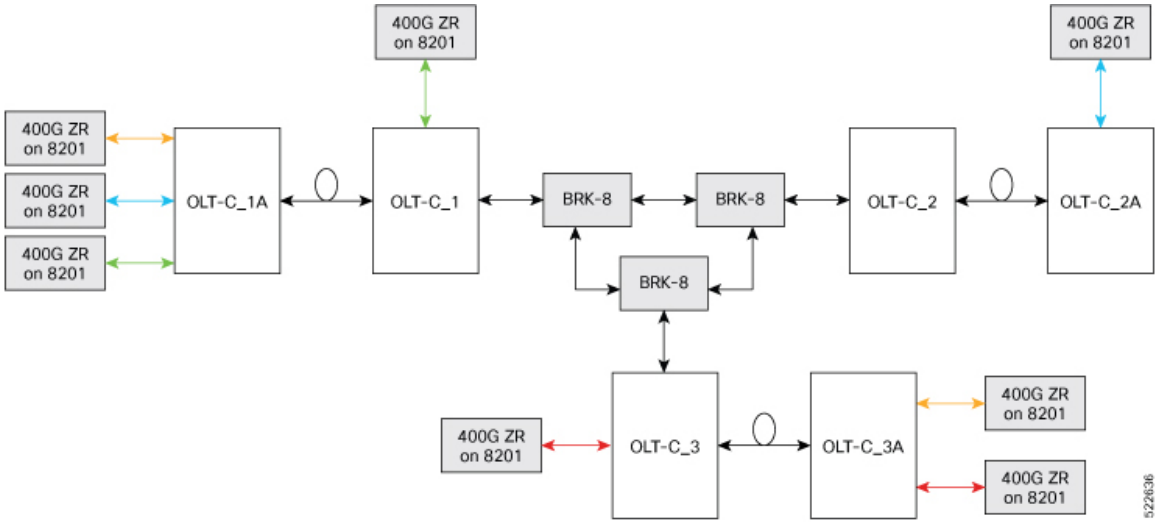
- Multidegree Support, on page 1
- Omnidirectional Support , on page 9
- Multidegree ROADM networks with NCS1010 OLT devices, on page 13
- Omnidirectional topologies , on page 21

Multidegree Support

NCS1010 OLT devices support up to 8 degrees of ROADM express. You can set up multidegree connections using NCS1K-BRK-8 modules. Use BRK-8 modules for MPO breakout for express interconnect. For a multidegree topology, you must use as many BRK-8 modules and OLT devices as there are degrees. The BRK-8 modules help NCS 1010 nodes to achieve multidegree capability.

The following diagram represents a sample 3-degree topology. The diagram represents three point-to-point multispan optical networks - OLT-C_1A to OLT-C_1, OLT-C_2A to OLT-C_2, and OLT-C_3A to OLT-C_3. These multispan networks can have ILA nodes between the OLT endpoints. We connect OLT-C_1, OLT-C_2, and OLT-C_3 to each other using three BRK-8 modules. Each BRK-8 module must have connections to each of the other BRK-8 modules. This express interconnect enables multidegree support. Configure the optical cross-connects on each OLT device such that the signal gets to the target OLT.

Figure 1: Typical 3-Degree Topology



NCS 1010 Sample Topologies

The following section describes three sample topologies of specific hardware deployments.

- Point-to-point topology
- Multidegree topology: Colored solution
- Multidegree topology: Colorless solution
- Multidegree topology: Hybrid solution

Point-to-point Topology

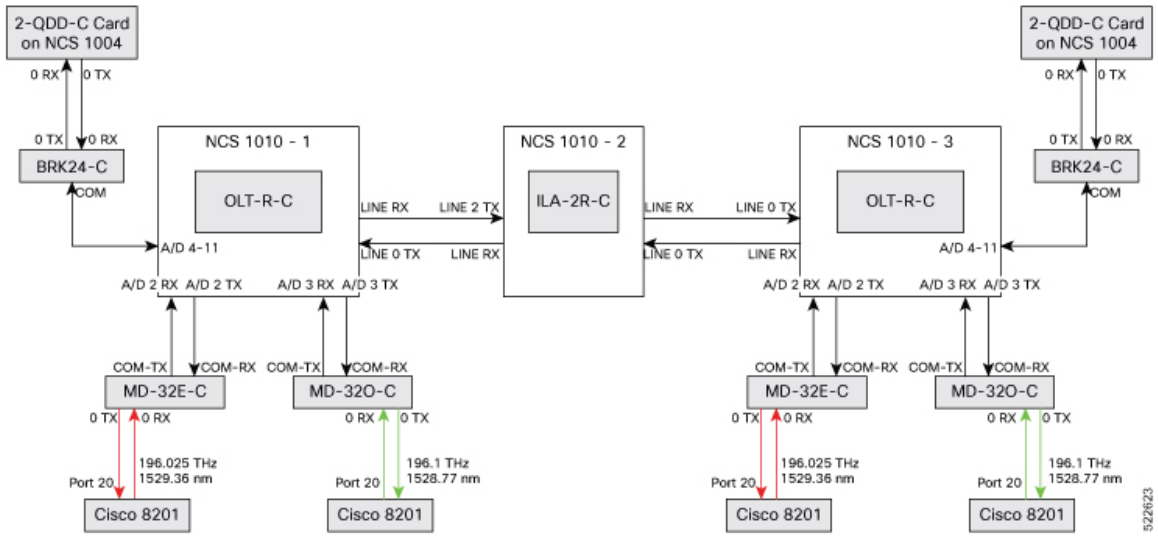
This sample topology is a simple point-to-point topology with no more than 2 degrees per site. You can use it for point-to-point optical links.

Topology Components

To build this topology, you need the following hardware:

- Cisco NCS 1010 devices
- NCS1K-MD32E-C modules
- NCS1K-MD32O-C modules
- NCS1K-BRK-24 modules
- QDD-400G-ZR-S transceiver
- LC/LC cables

Figure 2: Point-to-point Topology



Multidegree Topology: Colored Solution

This sample topology is a three-degree topology. You can use similar topologies for multidegree optical links that have:

- Optical channels from low TX power transponders like the ZR or ZR+ pluggable optical modules
- Optical channels with TX power spectral density between -21dBm/12.5GHz and -14dBm/12.5GHz

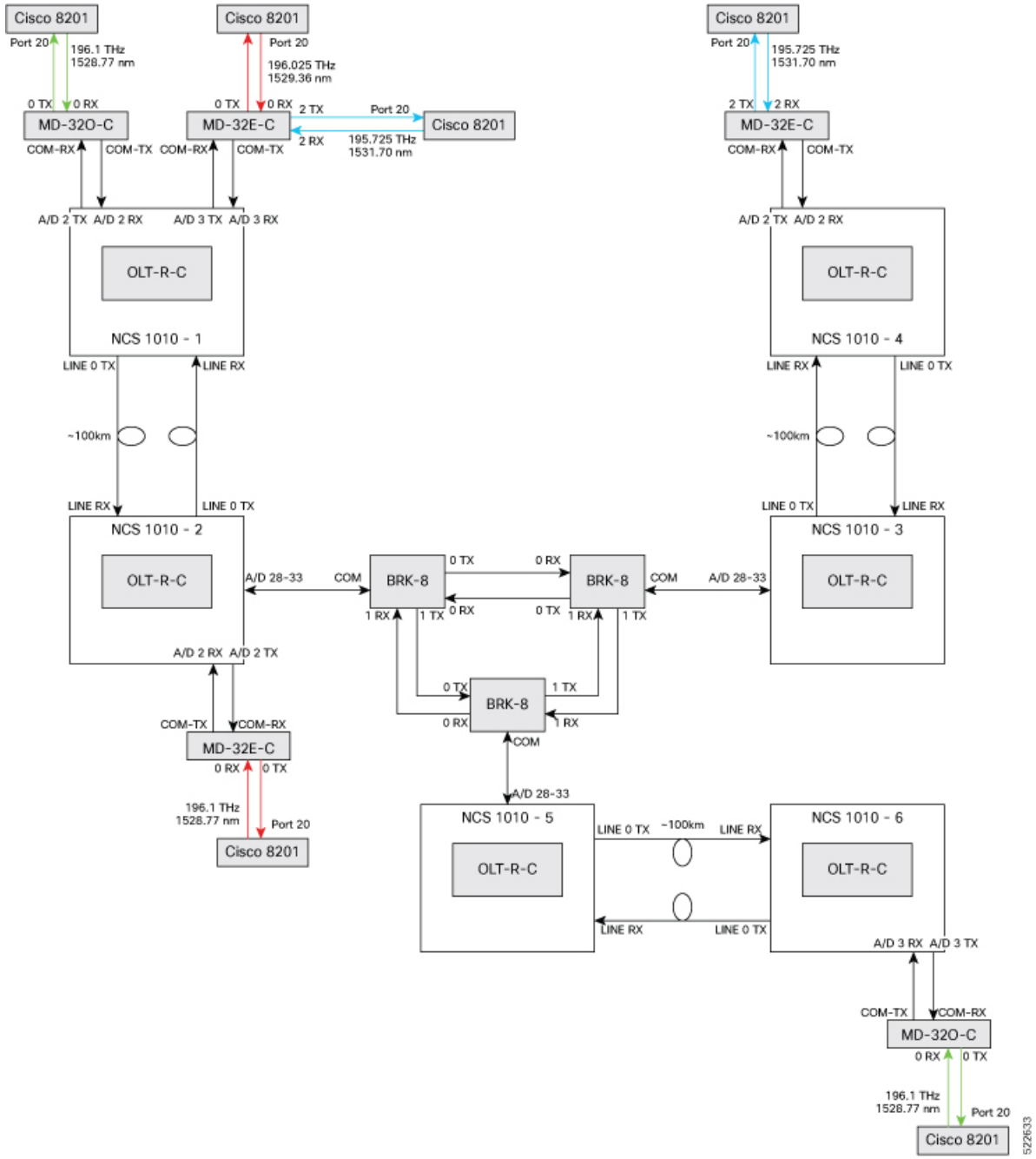
Topology Components

To build this topology, you need the following hardware:

- Cisco NCS 1010 devices
- NCS1K-MD32E-C modules
- NCS1K-MD32O-C modules
- NCS1K-BRK-8 modules
- Cisco 8201 routers
- QDD-400G-ZR-S transceivers
- LC/LC cables
- MPO cables

Cisco NCS 1010 Topologies

Figure 3: Colored Solution



Multidegree Topology: Colorless Solution

This sample topology is a three-degree topology. You can use similar topologies for multidegree optical links that have:

- Optical channels from high TX power transponders like 1.2T line card on NCS 1004 or line cards with CFP2-400G-DCO as the trunk interface.

- Optical channels with TX power spectral density not lower than -7dBm/12.5GHz

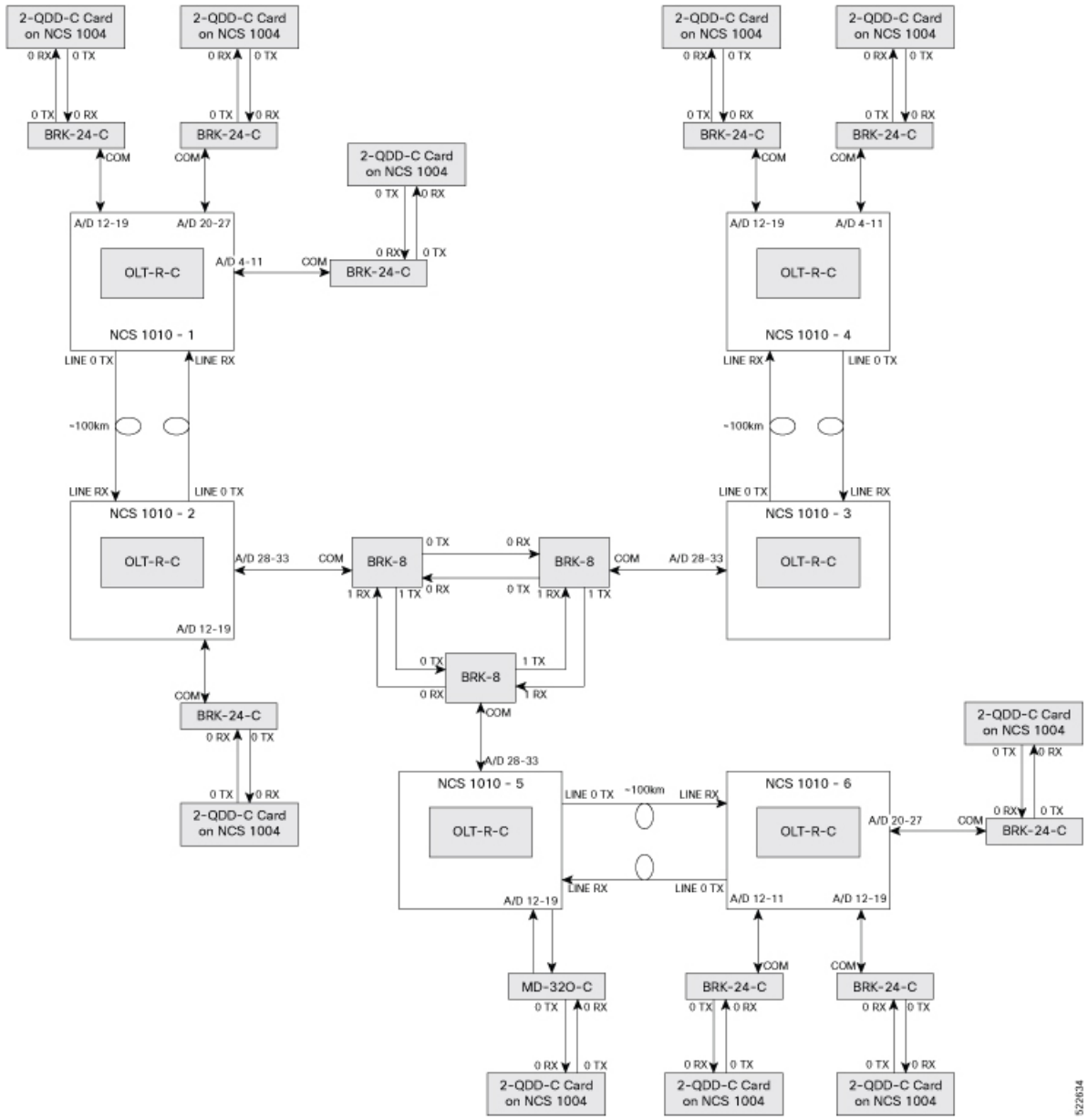
Topology Components

To build this topology, you need the following hardware:

- Cisco NCS 1010 devices
- NCS1K-BRK-8 modules
- NCS1K-BRK-24 modules
- CFP2-400G-DCO transceivers
- Cisco NCS 1004 devices
- NCS1K4-2-QDD-C-K9 line card
- LC/LC cables
- MPO cables

Cisco NCS 1010 Topologies

Figure 4: Colorless Solution



Multidegree Topology: Hybrid Solution

This sample topology is a three-degree topology. You can use similar topologies for multidegree optical links that have

- Optical channels from both high and low TX power transponders
- Optical channels with TX power spectral density that you use in both colored and colorless solutions

Topology Components

To build this topology, you need the following hardware:

- Cisco NCS 1010 devices
- NCS1K-MD32E-C modules
- NCS1K-MD32O-C modules
- NCS1K-BRK-8 modules
- NCS1K-BRK-24 modules
- Cisco 8201 routers
- QDD-400G-ZR-S transceivers
- CFP2-400G-DCO transceivers
- Cisco NCS 1004 devices
- NCS1K4-2-QDD-C-K9 line card
- LC/LC cables
- MPO cables

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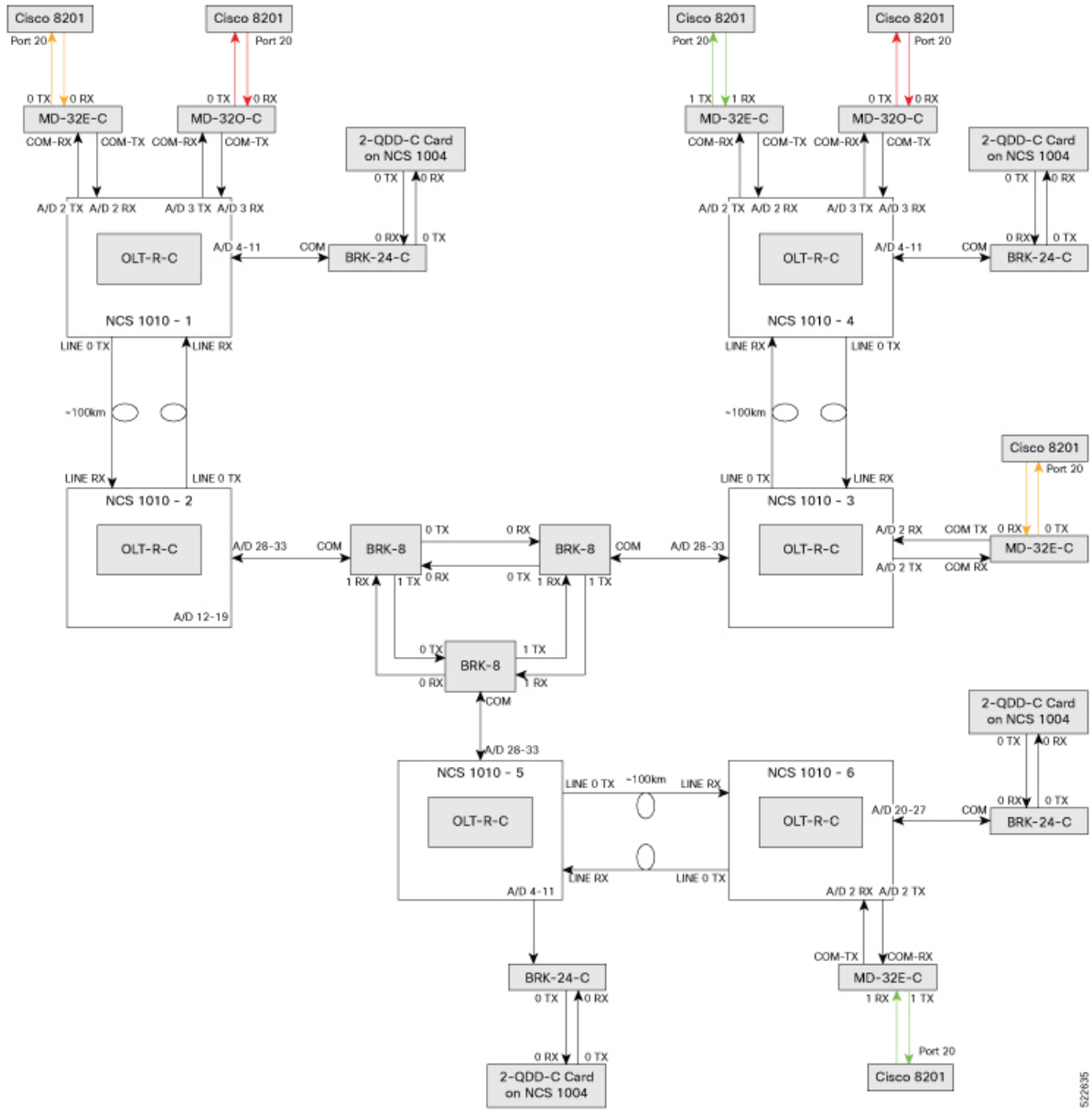
Figure 5: Colorless Solution



Omnidirectional Support

Table 1: Feature History

Feature Name	Release Information	Description
OLT Based Omnidirectional Add/Drop Topology	Cisco IOS XR Release 7.9.1	You can now set up pure OLT-based omnidirectional add/drop topology. This topology is supported over the C+L band and scalable beyond 4-degree nodes. Dual omnidirectional add/drop can be implemented on a node to provide redundancy or increased add/drop capacity. The omnidirectional setup provides the flexibility to the multidegree topology to route channels through any of the optical degrees during fiber cut without the need for physical fiber reconnections.

You can design multiple OLT-based omnidirectional add/drop stages. This configuration gives flexibility to the multidegree topology to route channels through any of the optical degrees during fiber cut without the need for changing the physical fiber connections.

NCS2K-MF-4x4-COFS Based Colorless Omnidirectional Topology

In Release 7.7.1, the omnidirectional add/drop stage is designed using the NCS 2000 passive module, 4x4 colorless omnidirectional flex spectrum (COFS) add/drop module (NCS2K-MF-4x4-COFS) and NCS2K-MF-MPO-8LC. The channels from different degrees are aggregated at the MF-MPO-8LC. The MF-4x4-COFS adds the channels. Similarly, the channels from the MF-4x4-COFS can be routed to any of the degree through the MF-MPO-8LC, thus achieving the omnidirectional functionality. This colorless omnidirectional topology gives flexibility to retune the frequency or wavelength of the channel coming from the transponder or muxponder without any physical changes.

Topology Components

To build this topology, you need the following hardware:

- NCS 1010 OLT devices
- NCS2K-MF-4x4-COFS modules
- NCS2K-MF-MPO-8LC modules
- NCS1K-BRK-8 modules

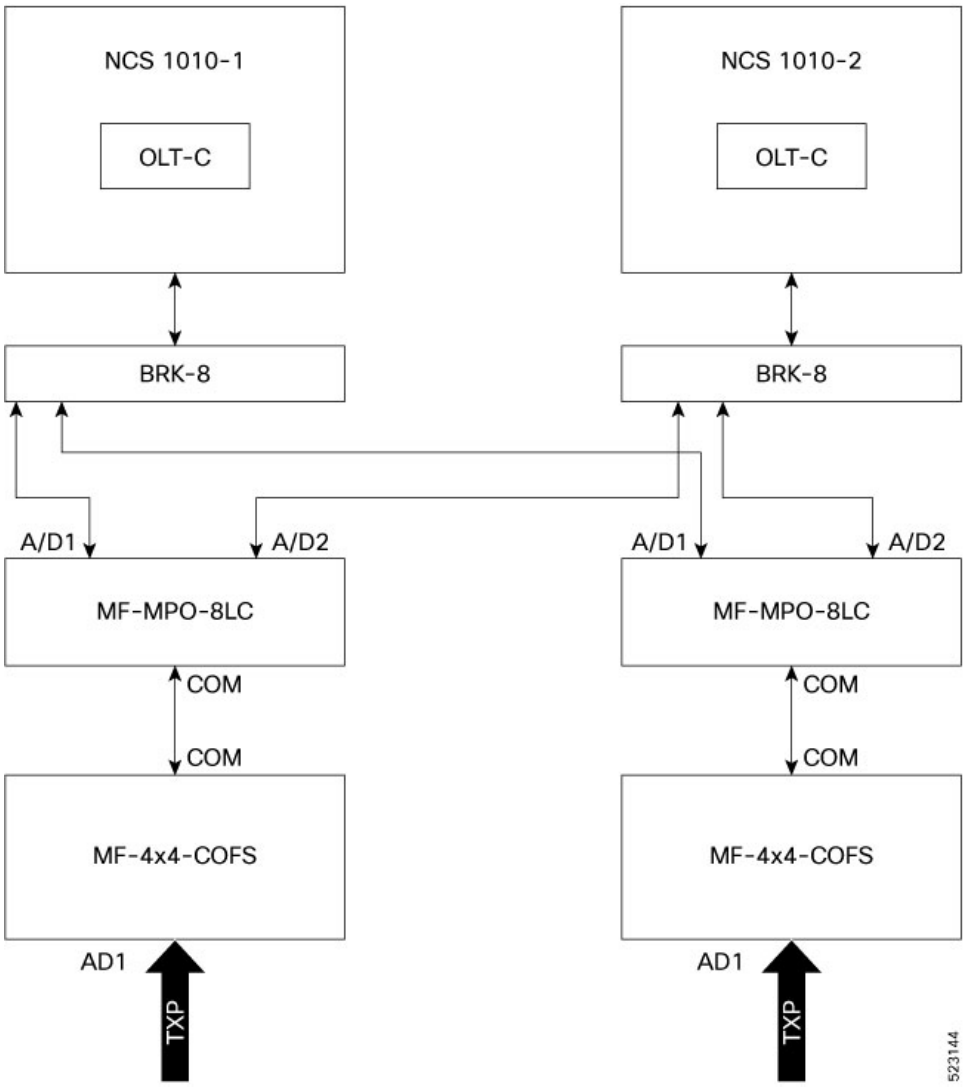
Following are the specific cable configurations for interconnecting the modules:

- The MF-4x4-COFS modules are interconnected using standard MPO 8 or 12 fibers (15454-MPO-MPO-x or ONS-12MPO-MPO-x)

Cisco NCS 1010 Topologies

- The MF-4x4-COFS modules and NCS1K-BRK-8 module are interconnected using standard LC-LC fibers.

Figure 6: MF-4x4-COFS Based Colorless Omnidirectional Topology



Limitations

- This configuration is supported only for C-band ROADM.
- This configuration is scalable only up to a maximum of 4 degrees. More OSNR penalty is induced by the MF-4x4-COFS as you add more degrees.
- One MF-4x4-COFS module can support up to only four channels. To scale up to 32 channels, you would require 8 MF-4x4-COFS modules.
- The terminal node in this configuration can be connected only to NCS 1004 line cards, line cards with CFP2-400G-DCO as a trunk interface, and DP04QSDD pluggable.

OLT Based Omnidirectional Add/Drop Topology

From the Release 7.9.1, the omnidirectional add/drop stage is implemented using two OLT-C nodes interconnected back-to-back at the LINE-TX/RX ports. You can have more than one omnidirectional add/drop stages in one ROADM site. You can also include OLT-L devices in this topology. Multiple transponders can be connected to the terminal OLT node including the low-power ZR+. There are no additional restrictions on the transponder or interface types that can be connected to the terminal OLT-C.

Topology Components

To build this topology, you need the following hardware:

- NCS 1010 OLT-C devices
- NCS 1010 OLT-L devices
- NCS1K-BRK-24 modules
- NCS1K-BRK-8 modules
- NCS1K-MD32-C modules

Following are the specific configurations and applications that are required for this configuration:

- The interconnection between the terminal OLT-C, where the traffic is terminated and the omnidirectional degree is managed as a 0dB span.
- OSC-C and OSC-L controllers can be used with unnumbered IP on OSC interfaces of the omni span.
- Link tuner and Gain estimator must be disabled on the Omni span.
- APC must be enabled on Omni span.
- ASE loading is enabled (both static and dynamic).
- Specific configuration for optical applications such as span length and fiber type are not required.
- To have the Preamplifier of OLT-C working in proper condition (minimum gain 12dB), the Line-Tx PSD must be set to –12.9 dBm/12.5 GHz (considering 80% CH_SD).

Cisco NCS 1010 Topologies

Figure 7: Omnidirectional Configuration with OLTs

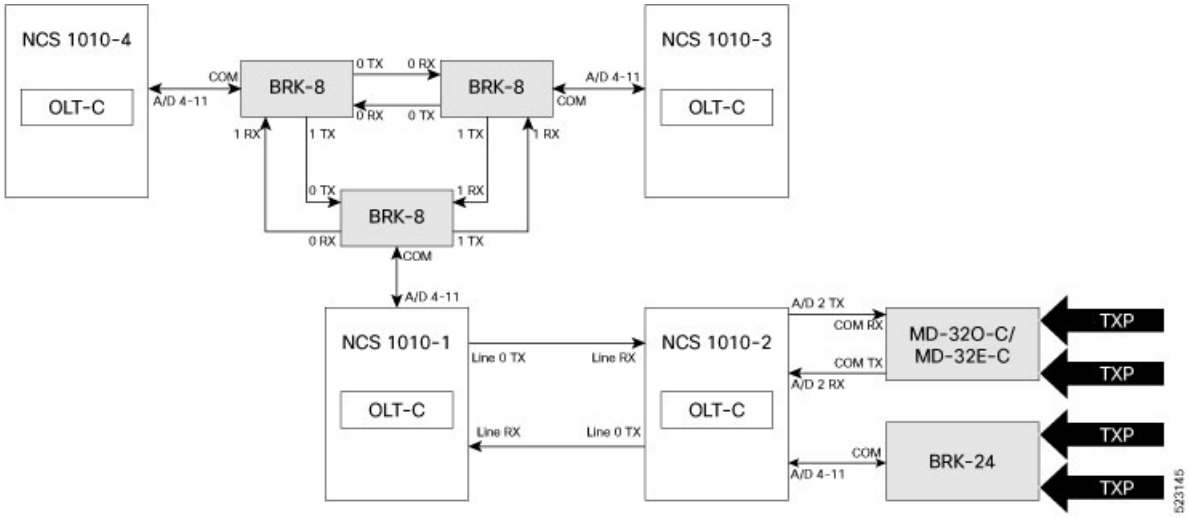


Figure 8: Dual Omnidirectional Configuration

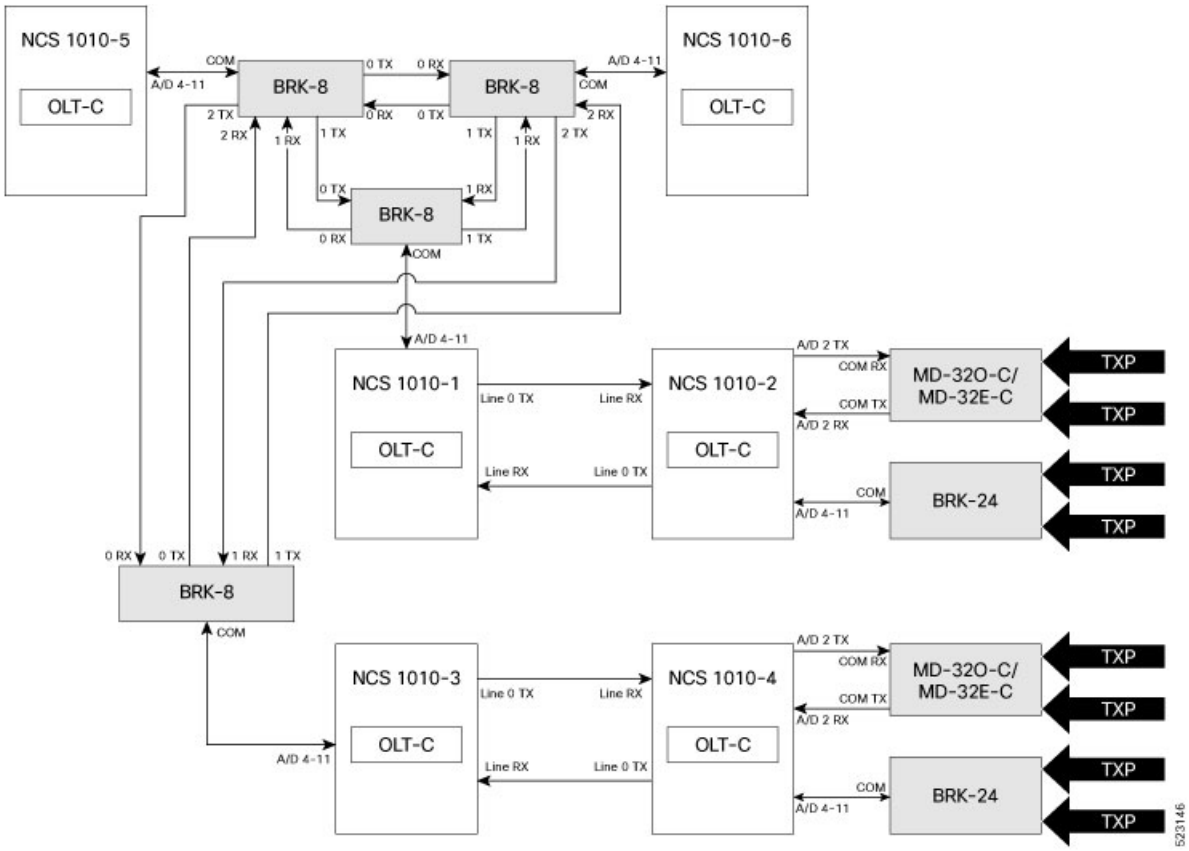
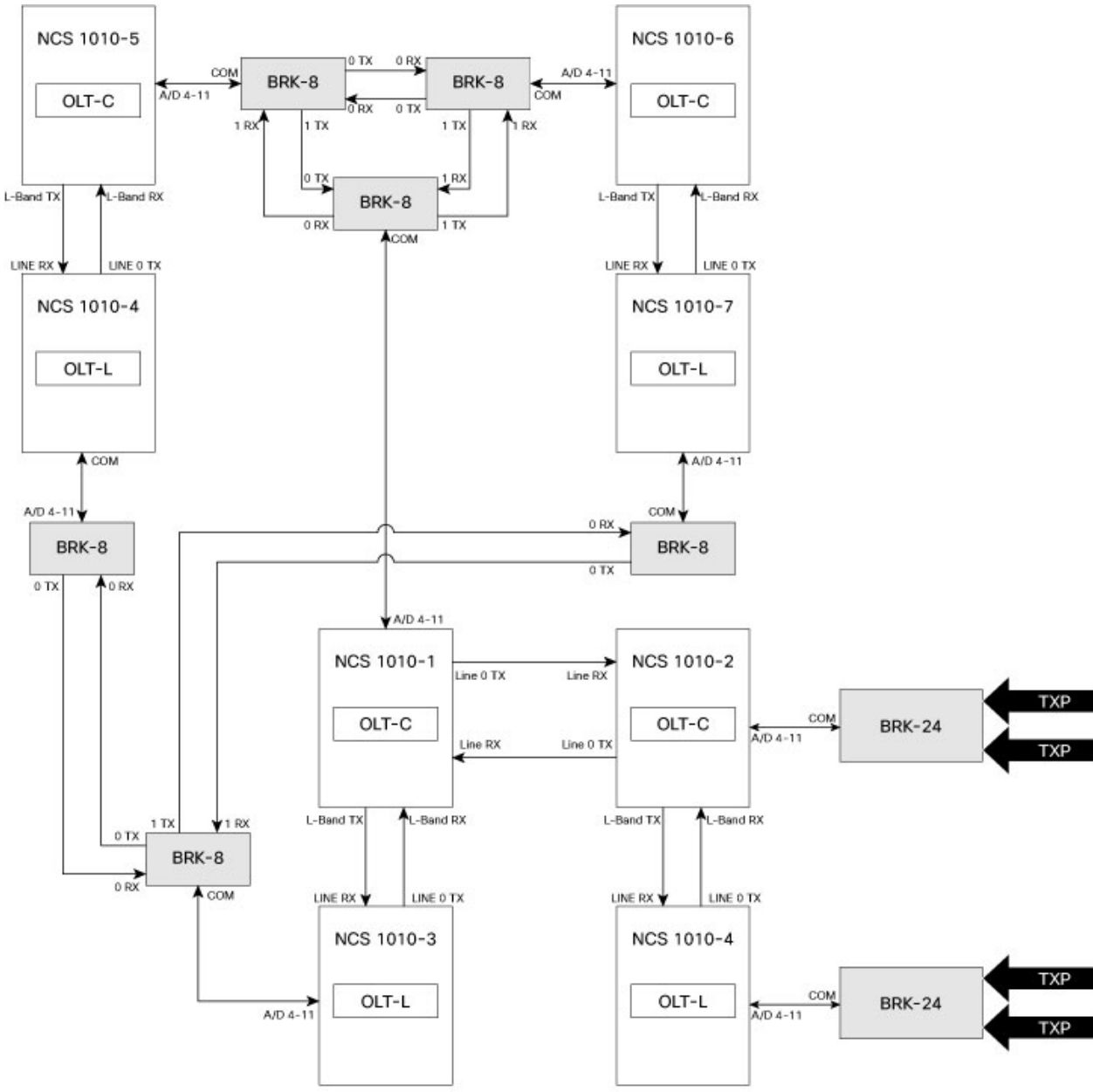


Figure 9: C+L Omnidirectional Configuration



Multidegree ROADM networks with NCS1010 OLT devices

A multidegree ROADM network is a network capability that enables a single ROADM node to establish more than two degrees of connection.

A degree is a bidirectional physical fiber connection between two nodes in a network.

Cisco NCS 1010 Topologies

NCS 1010 multidegree ROADM express

ROADM express refers to the pass-through wavelengths that travel directly from one fiber degree to another inside a ROADM node, bypassing local add/drop without optical-electrical-optical (OEO) conversion.

NCS1010 OLT devices support up to eight degrees of ROADM express through NCS1K-BRK-8 (BRK-8) modules. The BRK-8 modules help in MPO breakout for express interconnect. For a multidegree network, use as many BRK-8 modules and OLT devices as there are degrees. The BRK-8 modules help NCS 1010 nodes to achieve multidegree capability.

BRK-8 modules are essential for scaling network degrees and supporting express interconnects in advanced optical networking scenarios.

Three-degree ROADM network using NCS 1010 devices

In this example, a three-degree ROADM network established an express interconnection among three different point-to-point multispan optical networks. The three point-to-point topologies are:

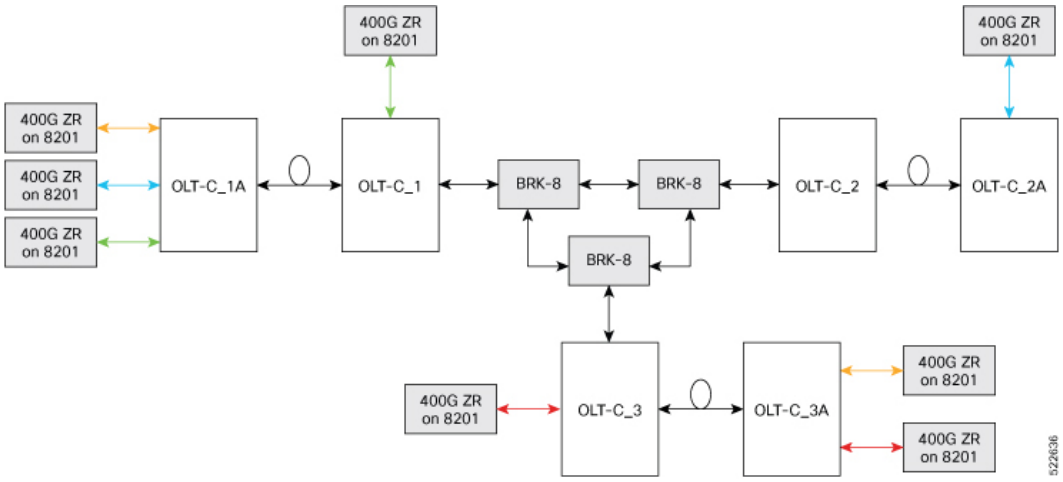
- OLT-C_1A to OLT-C_1
- OLT-C_2A to OLT-C_2
- OLT-C_3A to OLT-C_3

The three OLT nodes (OLT-C_1, OLT-C_2, OLT-C_3) are each connected using three BRK-8 modules. Each module must link to the other two, providing the necessary express interconnect. ptical cross-connects in each OLT ensure signals can traverse to any of the three endpoints, even across multiple spans including intermediate ILA nodes.

The three-degree ROAMD network with NCS 1010 devices contains

1. OLT-C_1, OLT-C_2, and OLT-C_3 nodes connected to each other using three BRK-8 modules.
2. Each BRK-8 module is connected to each of the other BRK-8 modules for express interconnect that enables multidegree support.
3. Each OLT device has optical cross-connection to each other to enable the signal to reach the target OLT.

Figure 10: Typical 3-Degree Topology



Types of NCS 1010 sample topologies

This section describes three sample topologies of specific hardware deployments.

Colored multidegree topologies

A colored multidegree topology is a network design pattern that

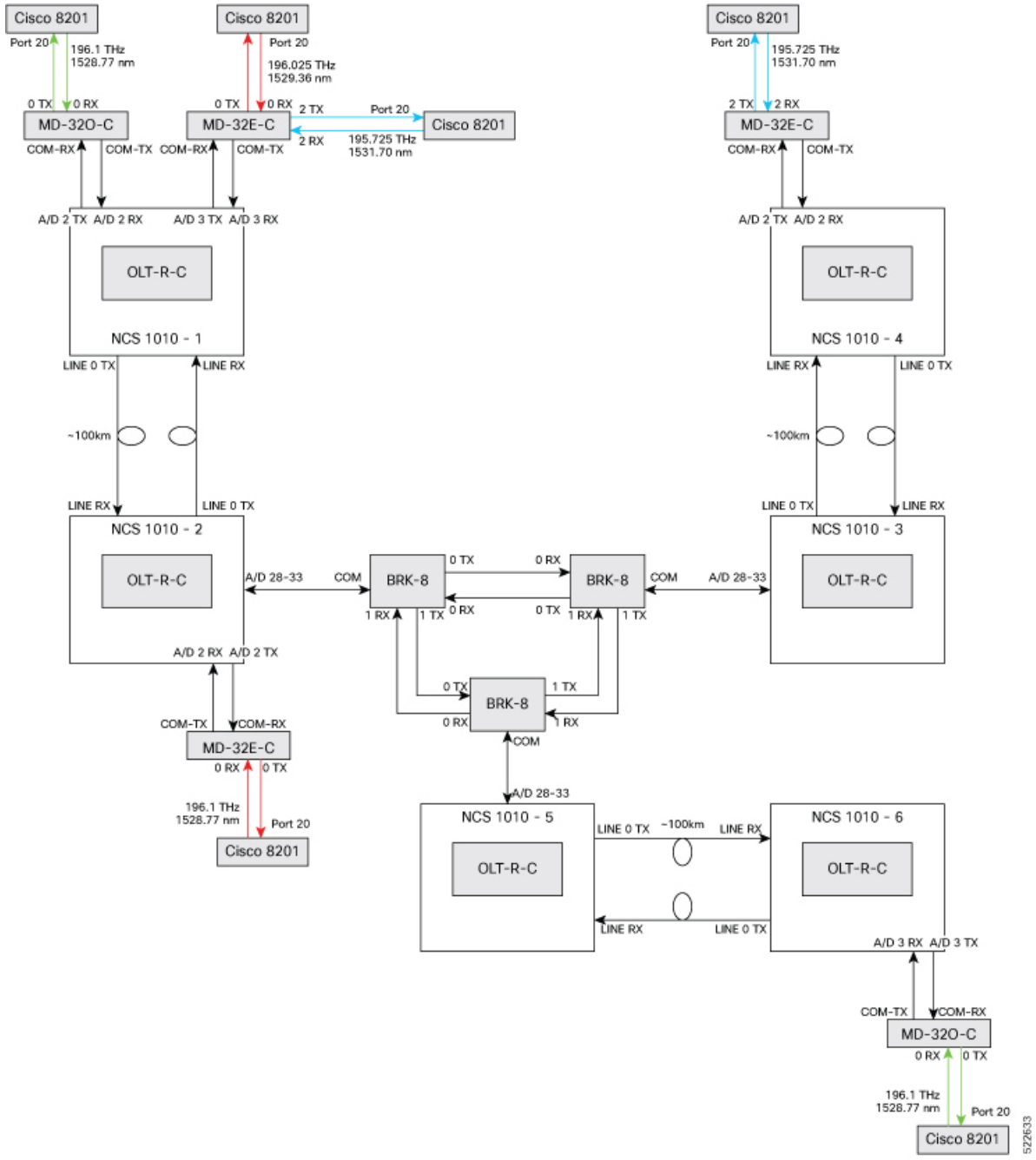
- interconnects sites using multiple optical degrees,
- supports optical channels from transponders with low transmit (TX) power such as ZR or ZR+ pluggable modules, and
- operates with channel TX power spectral density between -21 dBm/12.5 GHz and -14 dBm/12.5 GHz.

Topology components

This topology typically requires:

- Cisco NCS 1010 devices
- NCS1K-MD32E-C modules
- NCS1K-MD32O-C modules
- NCS1K-BRK-8 modules
- Cisco 8201 routers
- QDD-400G-ZR-S transceivers
- LC/LC cables
- MPO cables

Figure 11: Colored solution



Colorless multidegree topologies

A colorless multidegree topology is a network design pattern that

- uses multi-degree site interconnections with flexible wavelength assignment,
- supports optical channels from high TX power transponders like 1.2T line cards or CFP2-400G-DCO trunk interfaces, and

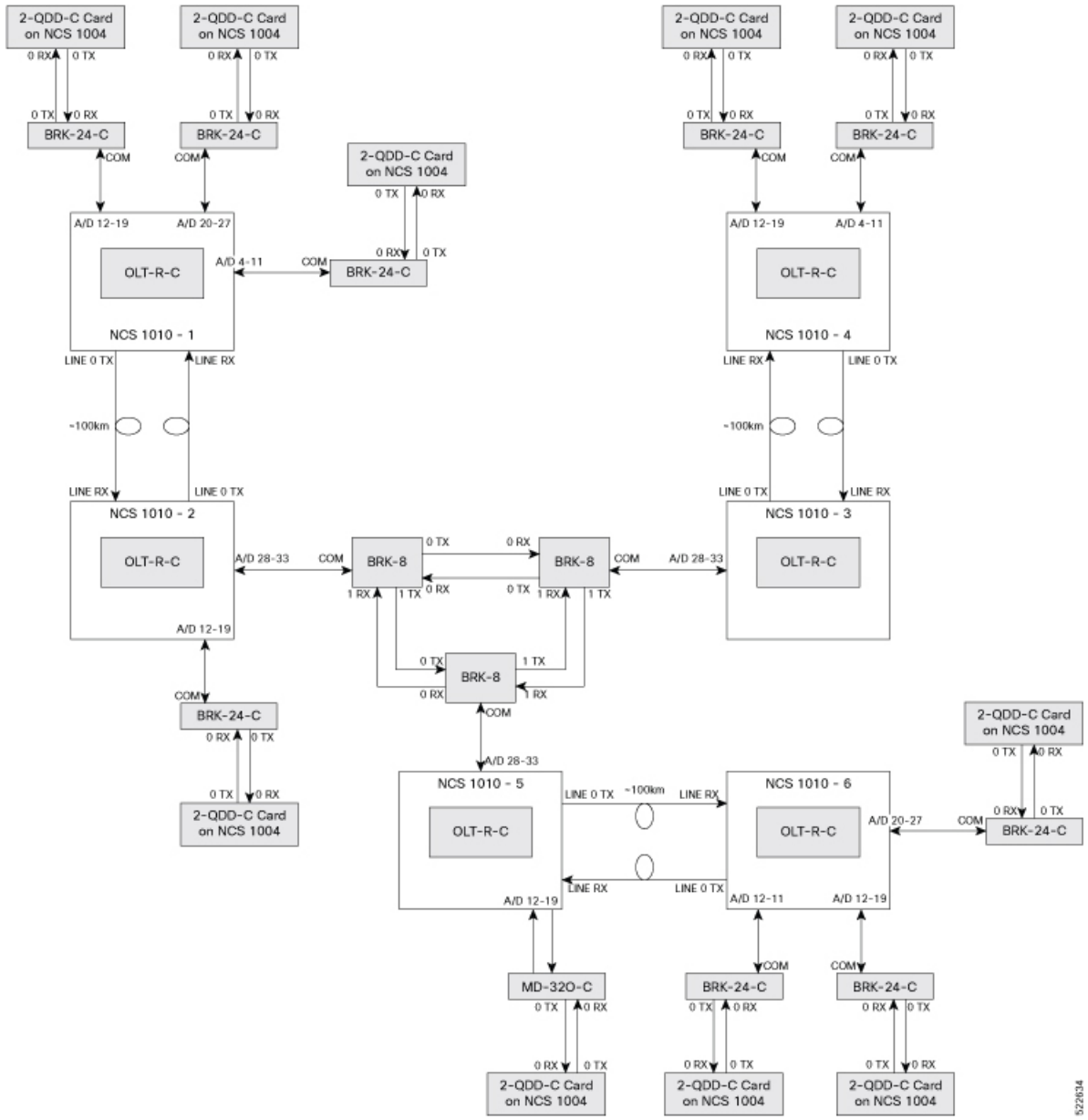
- requires channel TX power spectral density not lower than -7 dBm/12.5 GHz.

Components required

Deployment typically includes:

- Cisco NCS 1010 devices
- NCS1K-BRK-8 modules
- NCS1K-BRK-24 modules
- CFP2-400G-DCO transceivers
- Cisco NCS 1004 devices
- NCS1K4-2-QDD-C-K9 line card
- LC/LC cables
- MPO cables

Figure 12: Colorless solution



Hybrid multidegree topologies

A hybrid multidegree topology is a network design pattern that

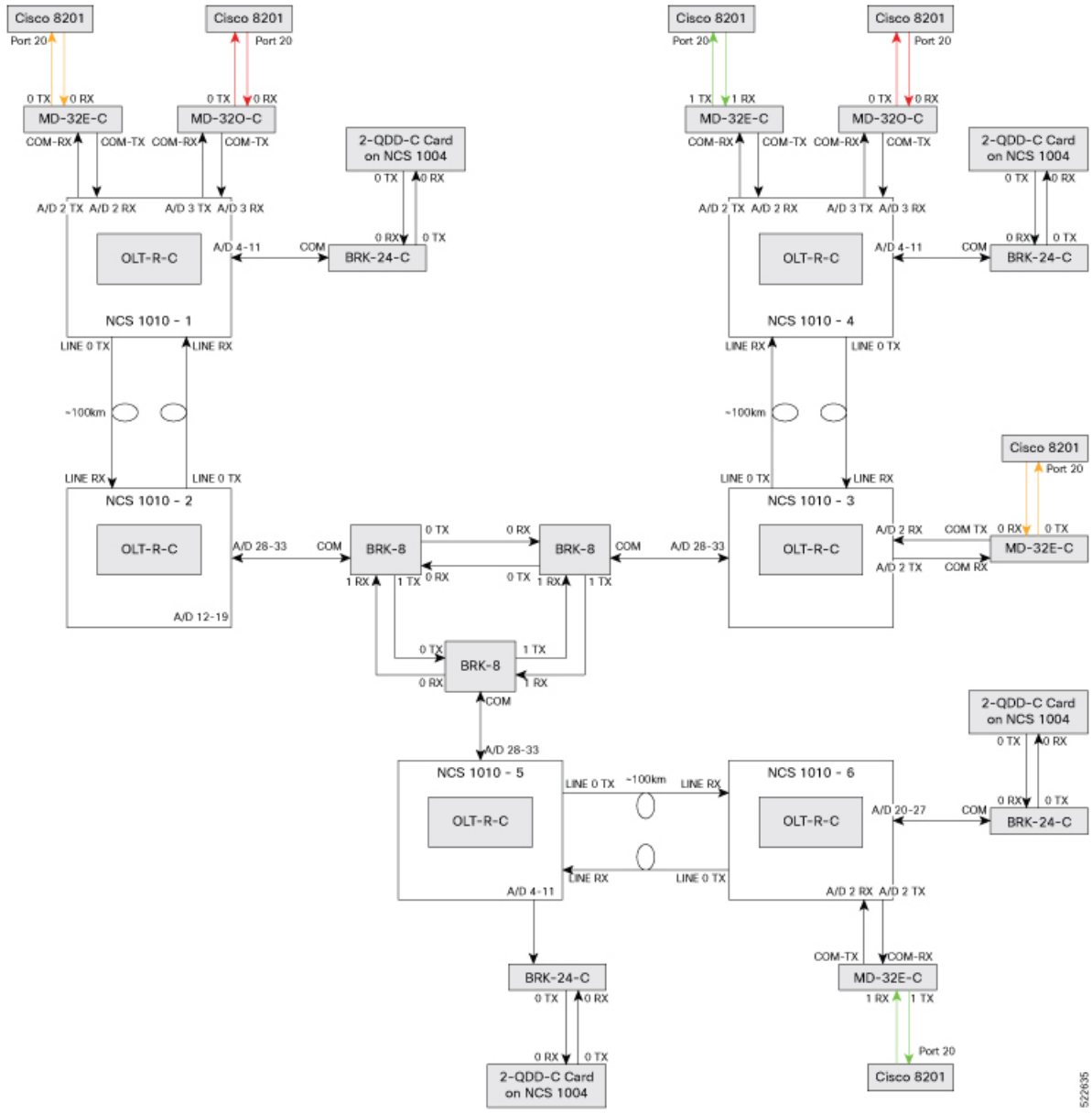
- interconnects sites using both colored and colorless optical channels,
- accommodates a mix of high- and low-TX power transponders within the same deployment, and
- leverages the channel TX power spectral density ranges required for both colored and colorless topologies.

Components required

Supported hardware includes:

- Cisco NCS 1010 devices
- NCS1K-MD32E-C modules
- NCS1K-MD32O-C modules
- NCS1K-BRK-8 modules
- NCS1K-BRK-24 modules
- Cisco 8201 routers
- QDD-400G-ZR-S transceivers
- CFP2-400G-DCO transceivers
- Cisco NCS 1004 devices
- NCS1K4-2-QDD-C-K9 line card
- LC/LC cables
- MPO cable

Figure 13: Colorless solution



Point-to-point topologies

A point-to-point topology is a network design pattern that

- connects two network sites directly using optical links,
- limits the number of degrees per site to two or fewer, and
- enables simple deployment with minimal hardware requirements.

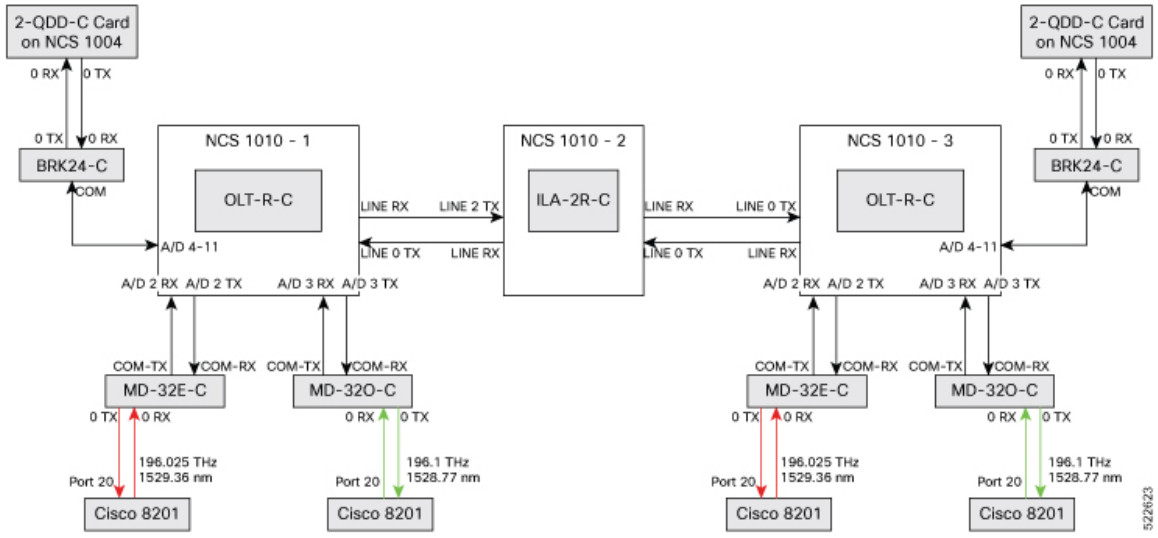
Components for point-to-point topology

To build this topology, you need these hardware components.

- Cisco NCS 1010 devices: OLT-R-C for and ILA-2R-C for inline amplication
- NCS1K-MD32E-C modules: Multiplex and demultiplex C-band signals in even channels.
- NCS1K-MD32O-C modules: Multiplex and demultiplex C-band signals in odd channels.
- NCS1K-BRK-24 modules: 24-degree MPO breakout modules for express interconnection.
- QDD-400G-ZR-S transceiver: QSFP-DD transceiver module, coherent DCO, 400G-ZR for transmiting 400G payload at 16QAM modulation
- MPO/MPO cables: Used for fiber-optic connectivity between NCS 1010 devices and BRK-24 modules.
- LC/LC cables: Used for fiber-optic connectivity between BRK-24 and mux/demux modules.

This image shows the point-to-point topology.

Figure 14: Point-to-point topology



Omnidirectional topologies

An omnidirectional topology is a network architecture that

- enables each optical channel to be dynamically routed through any available degree of a multidegree node,
- allows channel rerouting after fiber cuts without requiring physical fiber reconnections, and

- supports flexible and scalable add/drop configurations for redundancy or increased capacity.

Omnidirectional topologies are often implemented in optical networks using open-line terminal (OLT) hardware and compatible passive modules. They are supported over C+L bands and can scale beyond four network degrees. Dual omnidirectional add/drop configurations provide increased reliability and add/drop bandwidth.

NCS2K-MF-4x4-COFS based colorless omnidirectional topologies

A colorless omnidirectional topology is an optical network configuration that

- uses colorless modules to add or drop channels without wavelength constraints,
- aggregates and routes channels from multiple degrees using compatible passive hardware assemblies, and
- enables retuning of channel frequencies or wavelengths from connected transponders or muxponders without physical cabling changes.

Topology Components

To build this topology, you need the following hardware:

- NCS 1010 OLT devices
- NCS2K-MF-4x4-COFS modules
- NCS2K-MF-MPO-8LC modules
- NCS1K-BRK-8 modules

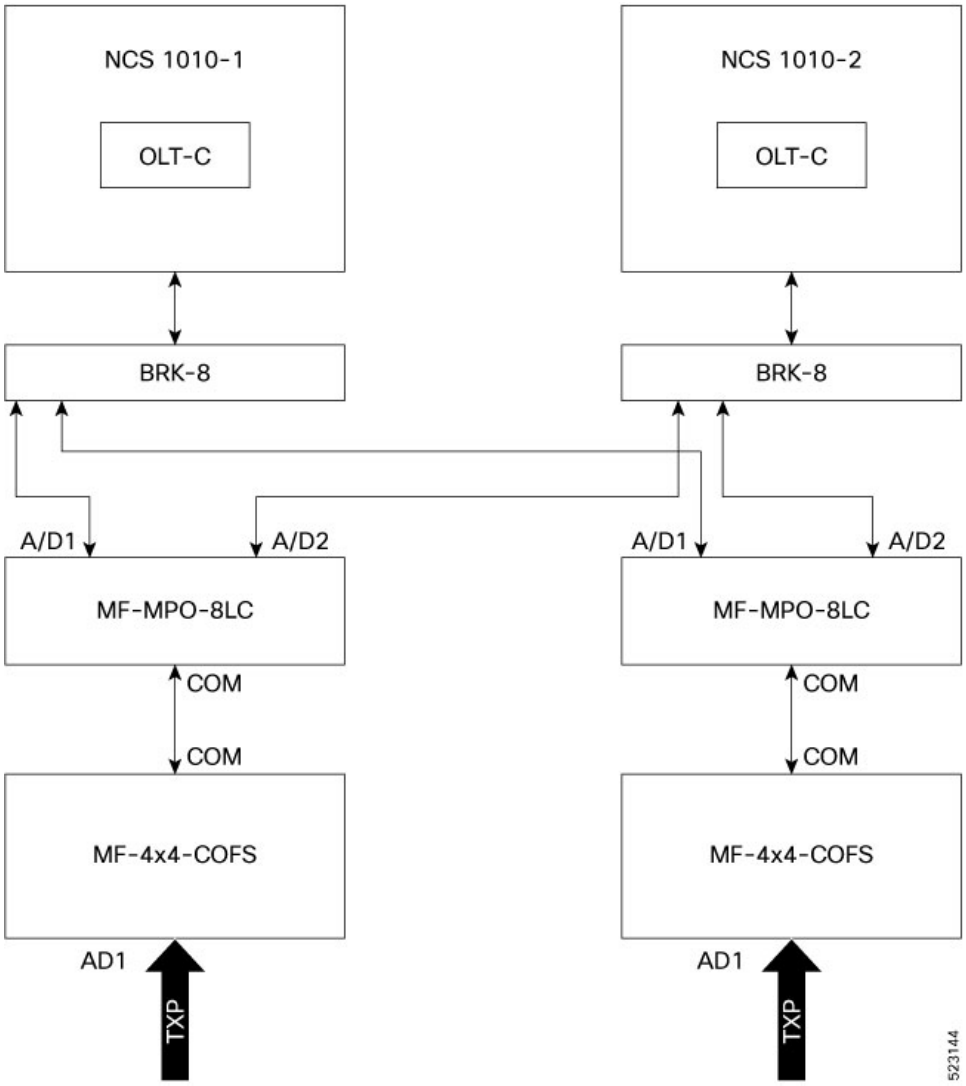
Specific cable configurations for interconnecting the modules:

- The MF-4x4-COFS modules are interconnected using standard MPO 8 or 12 fibers (15454-MPO-MPO-x or ONS-12MPO-MPO-x)
- The MF-4x4-COFS modules and NCS1K-BRK-8 module are interconnected using standard LC-LC fibers.

This image shows the COFS-based colorless omnidirectional topology

Cisco NCS 1010 Topologies

Figure 15: MF-4x4-COFS based colorless omnidirectional topology



Limitations

- This configuration is supported only for C-band ROADM.
- This configuration is scalable only up to a maximum of 4 degrees. More OSNR penalty is induced by the MF-4x4-COFS as you add more degrees.
- One MF-4x4-COFS module can support up to only four channels. To scale up to 32 channels, you would require 8 MF-4x4-COFS modules.
- The terminal node in this configuration can be connected only to NCS 1004 line cards, line cards with CFP2-400G-DCO as a trunk interface, and DP04QSDD pluggable.

OLT-based omnidirectional add/drop topologies

OLT-based omnidirectional add/drop topologies are optical network designs that

- implement omnidirectional routing by interconnecting OLT devices such as OLT-C and OLT-L back-to-back,
- enable multiple add/drop stages within a single ROADM site, improving flexibility and scalability, and
- support integration with a variety of transponders and trunk interfaces without major restrictions.

Topology components

To build this topology, you need the following hardware:

- NCS 1010 OLT-C devices
- NCS 1010 OLT-L devices
- NCS1K-BRK-24 modules
- NCS1K-BRK-8 modules
- NCS1K-MD32-C modules

Specific configurations and applications that are required for this configuration:

- The interconnection between the terminal OLT-C, where the traffic is terminated and the omnidirectional degree is managed as a 0dB span.
- OSC-C and OSC-L controllers can be used with unnumbered IP on OSC interfaces of the omni span.
- Link tuner and Gain estimator must be disabled on the Omni span.
- APC must be enabled on Omni span.
- ASE loading is enabled (both static and dynamic).
- Specific configuration for optical applications such as span length and fiber type are not required.
- To have the Preamplifier of OLT-C working in proper condition (minimum gain 12dB), the Line-Tx PSD must be set to –12.9 dBm/12.5 GHz (considering 80% CH_SD).

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Figure 16: Omnidirectional configuration with OLTs

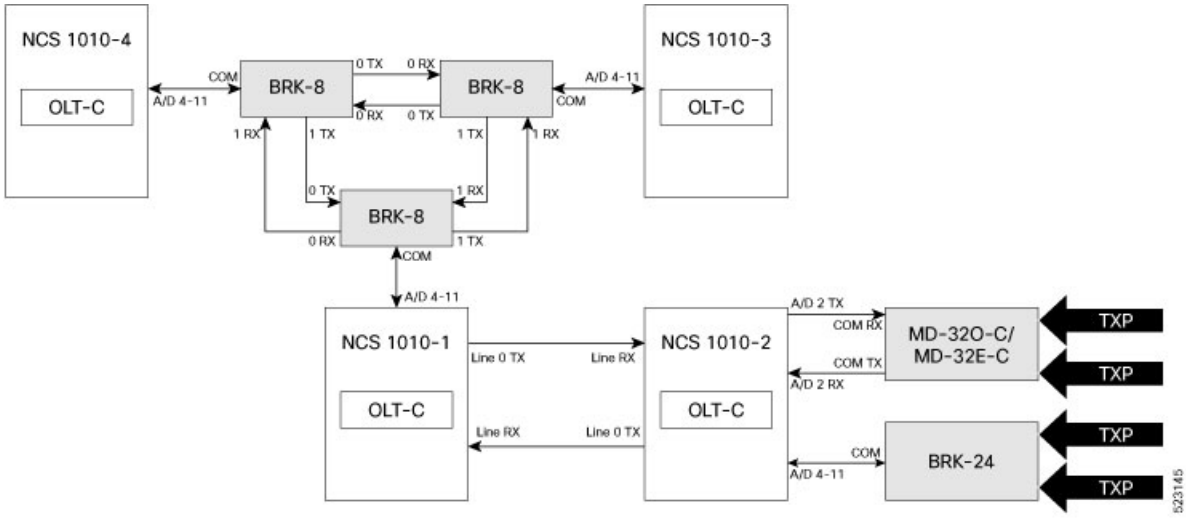

Figure 17: Dual omnidirectional configuration

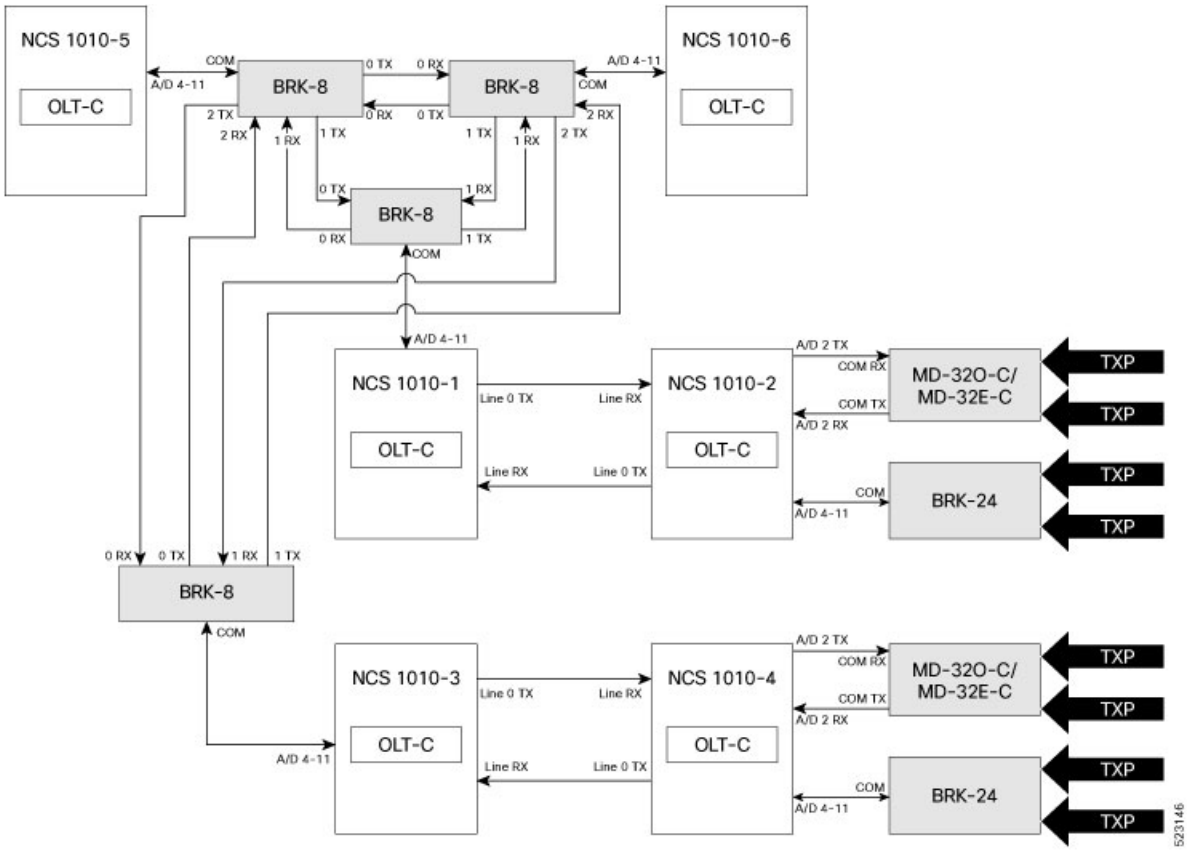

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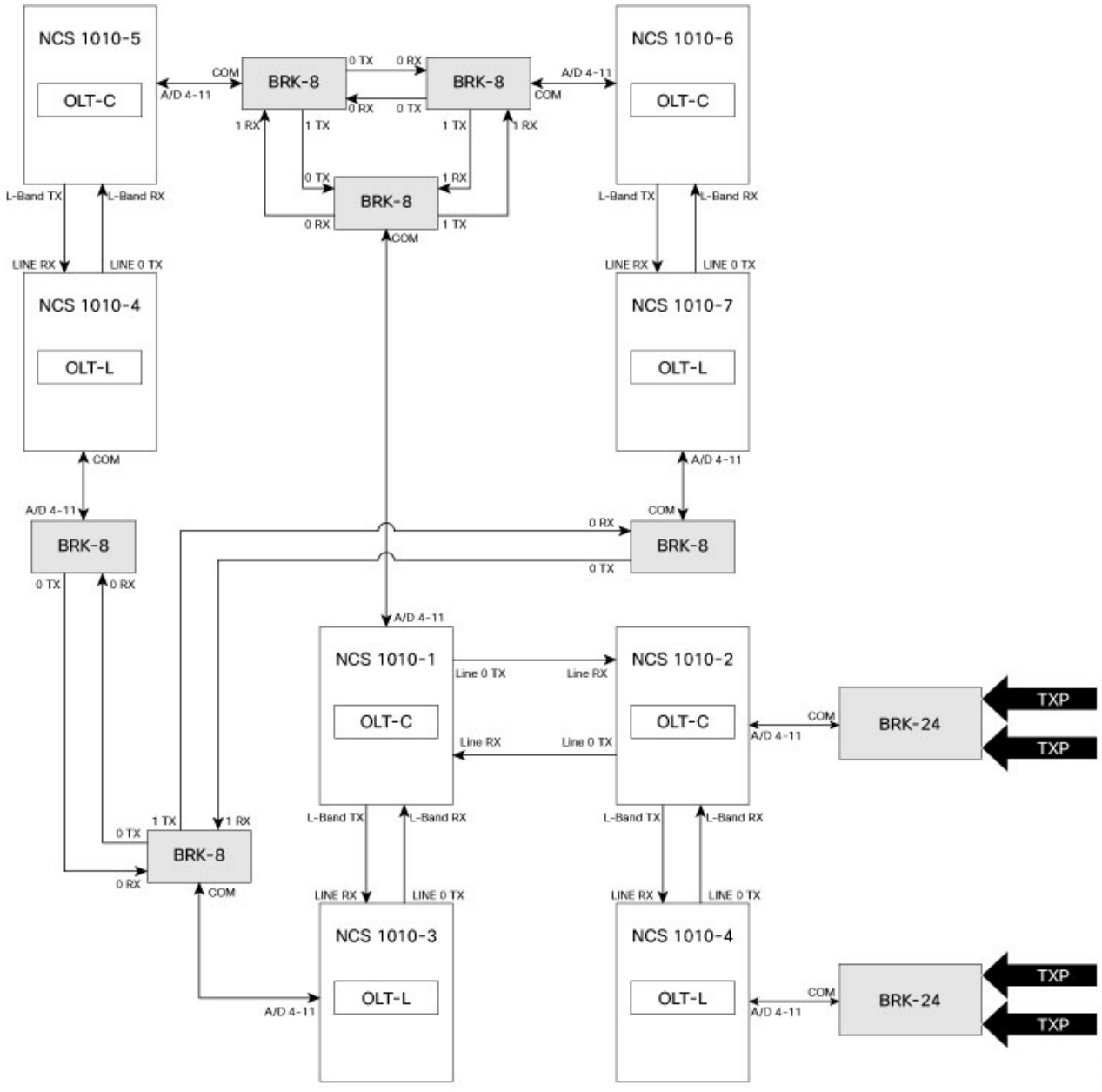
Figure 18: C+L omnidirectional configuration



Limitations

- Link tuner and gain estimator features must be disabled on Omni spans.
- Proper functioning of terminal OLT-C preamplifiers requires precise power spectral density (PSD) settings.
- Optical supervisory channel controllers (OSC-C and OSC-L) can be used with unnumbered IP addressing.