Business Challenges at Mass Scale
Traditional economics are beginning to break

Revenue is Flat
0.3% CAGR (2017-2022)

$1 CAPEX in 2022
11X the work it did in 2012

$5 OPEX today for each $1 of CAPEX

CapEx

More Devices and Connections
18 Billion ➔ 28.5 Billion

More Busy-hour Traffic
2.8 PetaBytes ➔ 7.2 PetaBytes

890 MB per month

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Converged SDN Transport

**Automated Network Operations**

**Access**
- Wireless
- Cable, DSL
- Fixed, TDM, Ethernet

**Backbone**
- IP Routing
- Optical
  - Interconnects
  - ROADMs (network nodes)

Converge access services, simplifying management.

Converge IP and optical, increasing share in high-value segment.

Innovation across silicon, optics, software, and systems.

**Advantages**

- Simplifies operations and reduces network complexities
- Increases space, power and operational savings
- Reduces time-to-market for services
- Improves scalability while maintaining a consistent, superior customer experience
Innovation across multiple dimensions can shift the paradigm.

Strategy to Redefine the Economics of the Internet

New Possible Network Architectures
- Converged
- Cloud Enhanced
- Fabric Based

Delivering Unprecedented
- Cost & Power Efficiency
- Prioritized Operations
- Augmented Intelligence
Key drivers for 8000 and Silicon

- Requirements change
  - Increased focus on bandwidth and power
  - Hyperscale Cloud

- Underlying component technologies change
  - SerDes, SRAMs, DRAMs, Silicon processes, Optics

- ASIC architectures usually last around 10-15 years
  - Focused deployment
  - Feature parity – broader deployment
  - Iterative evolution
  - Maturity and investment protection
  - End of Sale/Maintenance/Life

- Adoption curve for chips and systems
Cisco Silicon One
Flexible Forwarding ASIC

One Unified Silicon Architecture
• Comprehensive routing with switching efficiency
• Multiple segments: web and service provider
• Multiple functions: system-on-a-chip, line card, and fabric
• Multiple form-factors: fixed or modular

Delivers Performance Without Compromise
• First routing silicon to break 10 Tbps barrier
• 2x bandwidth, 3x packets-per-second over current industry routing silicon
• 2x more power efficient
• Global route scale, deep buffering, P4 programmable
Cisco 8000 Routers
Service Provider scale and flexibility with Cisco Silicon ONE ASIC

Industry’s only platform optimized for 100G & 400G without compromising for High Availability

Cisco 8202  Cisco 8201

Cisco 8808  Cisco 8812  Cisco 8818

10.8 Tbps  115 Tbps  172 Tbps  260 Tbps  2 Pbps
Technology Evolution in Optics and Routing

**Optical Systems Evolution**

- Subsea 10,000
- LH 1,000s
- Metro 100s
- DCI 10s

**Routing Scale Evolution**

- NPU capacity > Projected Traffic Demand

**Chassis Based Solutions → Pluggables**

- Acacia (pending)
- Leaba
Converged SDN Transport

New Engines for Mass-scale

- **NCS 540**: 10/25/100 GE, 4.5x*, 300Gb System
- **ASR 9000**: 400 GE, 3.3x, 80Tb System
- **NCS 5700**: 400 GE, 2.7x, 153.6Tb System
- **CISCO 8000**: 400 GE, 16.3x**, 260Tb System

* vs. ASR 900
** vs. NCS 6000
Thank You!
Introducing Cisco QSFP DD Portfolio

- QSFP-DD MSA has very broad industry support
- MSA has over 60 member companies
- Port is backward compatible to QSFP+, QSFP28, QSFP56
  - Ease migration to 400G
- Leverages industry cost structure and production capability of QSFP
  - Over 70M QSFP ports have been deployed to date
  - Industry has invested in roughly 40M QSFP modules
- Support 2x100G designs
- QSFP-DD will support over 20W of power dissipation
  - Supports pluggable coherent modules (ZR & ZR+)
- Broad product offering from copper cable to coherent
- Evolving to 800G in future (QSFP-DD800 MSA)
Why is Backward Compatibility Important

40G QSFP+
100G QSFP28
2x 100G QSFP-DD
200G QSFP56
400G QSFPDD

Platform with QSFP-DD Ports

Allows customers to buy the latest platforms with the latest features while managing their speed migration over time on a per port basis
Recipe for Success – Why will QSFP-DD succeed?

QSFP-DD positively checks out on all the 4 pillars necessary for a pluggable module to succeed

**Compatibility**
Alignment with ASIC IO (8x 50G PAM4 necessary)

**Investment Protection**
Backwards compatibility enables smooth network transition allowing reuse of the $9B investment the industry has already made in QSFP modules

**System Density**
Support network requirements for system density: 32 & 36 ports

**Superior Performance**
Support necessary thermal/SI for implementation
All optical and copper reaches supportable incl. 400ZR
## Current 400GbE Industry Activities – not just one place!

<table>
<thead>
<tr>
<th>Standards</th>
<th>MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IEEE 802.3bs</strong></td>
<td>OIF 400G ZR</td>
</tr>
<tr>
<td>400 GbE MAC &amp; Interfaces (AUI, 200G-FR/LR4, 400G-DR4/FR8/LR8)</td>
<td>400G Coherent 80/120km</td>
</tr>
<tr>
<td><strong>IEEE 802.3cd</strong></td>
<td>100G Lambda MSA</td>
</tr>
<tr>
<td>100G-DR, 50G-CR [Also 50GE SMF/MMF, 200GE MMF]</td>
<td>100G-FR, 100G-LR, 400G-FR4, 400G-LR4</td>
</tr>
<tr>
<td><strong>IEEE 802.3ck</strong></td>
<td>400G-BiDi MSA</td>
</tr>
<tr>
<td>100 Gb/s SERDES Task Force</td>
<td>400G-SR4.2 100m Parallel MMF</td>
</tr>
<tr>
<td><strong>IEEE 802.3cm</strong></td>
<td>QSFP-DD MSA</td>
</tr>
<tr>
<td>400 GbE MMF (400G-BiDi; and 400G-SR8)</td>
<td>400G Form factor</td>
</tr>
<tr>
<td><strong>IEEE 802.3cn</strong></td>
<td>OSFP MSA</td>
</tr>
<tr>
<td>50GBASE-ER/200BASE-ER4/400BASE-ER8 Duplex SMF 40km Reach</td>
<td>400G Form factor</td>
</tr>
<tr>
<td><strong>IEEE 802.3ct</strong></td>
<td>COBO</td>
</tr>
<tr>
<td>100/400Gb/s Duplex SMF 80km Reach DWDM (will align to OIF 400G-ZR)</td>
<td>Embedded 400G/800G module</td>
</tr>
<tr>
<td><strong>IEEE 802.3cw</strong></td>
<td>CWDM8 MSA</td>
</tr>
<tr>
<td>400Gb/s Duplex SMF 80km Reach DWDM (will align to OIF-400ZR)</td>
<td>400G MSA for 2km and 10km</td>
</tr>
<tr>
<td><strong>IEEE 802.3cu</strong></td>
<td>Open-Eye MSA</td>
</tr>
<tr>
<td>100G per Lambda Task Force (100G-FR/LR, 400G-FR4/LR4)</td>
<td>Alternative (Analog-only receivers) specs (non-interoperable)</td>
</tr>
<tr>
<td><strong>IEEE 802.3cp</strong></td>
<td>QSFP-DD800</td>
</tr>
<tr>
<td>10/25/50G BiDi 10/20/40km</td>
<td>800G version of QSFP-DD</td>
</tr>
</tbody>
</table>

* Multi-Source Agreements – new ones all the time. Not all get wide industry adoption

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Cisco Leadership
(Committee Chair)
QSFP56-DD 400G Roadmap

**CABLES**

- **400G Copper**
  - Available
  - FCS: CY21

- **8x50G Copper**
  - Roadmap
  - FCS: 2HCY20

- **400G Active Copper**
  - FCS: TBD

- **8x50G Active Copper**
  - FCS: TBD

- **4x100G Active Copper**
  - Roadmap
  - FCS: Q4CY20

**MULTIMODE OPTICS**

- **400G SR4-BD**
  - Plan
  - FCS: Q2CY21

- **400G SR8**
  - Plan
  - FCS: 2HCY21

**SINGLE MODE OPTICS**

- **400G DR4**
  - Available
  - 4x100G MPO (100G DR/FR interop)
  - FCS: Q1CY21

- **4x100G FR/LR**
  - Plan
  - 4x100G MPO (100G FR/LR)
  - FCS: Q1CY21

- **400G FR4**
  - Available
  - 400G LC (CWDM4 technology)
  - FCS: TBD

- **400G LR8**
  - Orderable
  - 400G LC (LAN WDM technology)
  - FCS: Q4CY20

- **400G LR4**
  - Roadmap
  - 400G LC (CWDM technology)
  - FCS: Q1CY21

- **400G ZR/ZR+**
  - Roadmap
  - 400G Coherent
  - FCS: Q1CY21

**AOC**

- **Available**
  - 400G AOC

**Parallel MMF**

- **Plan**
  - 400G FR/LR

- **Orderable**
  - 400G MPO (100G FR/LR)

**Parallel SMF**

- **Plan**
  - 400G FR/LR

- **Orderable**
  - 400G MPO (100G FR/LR)

**Duplex SMF**

- **Plan**
  - 400G FR/LR

- **Orderable**
  - 400G MPO (100G FR/LR)
QSFP28-DD 2x100G Programs

QSFP28-DD optics enables high-density 100G backward compatibility with current gen100G optics

MULTIMODE OPTICS

2x100G SR4
Available

SINGLE MODE OPTICS

2x100G CWDM4
Available

2x100G LR4
Roadmap

2x100G CWDM4, 2 x TX and 2 x RX fibers

2x100G LR4, 2x TX and 2 x RX fibers

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Cisco 400G Router Portfolio

- **NCS5500**
  - Jericho 2
  - NC57-24DD (24x400GE LC)
  - NC57-18DD-SE (18x400GE LC)

- **Series 8000**
  - Cisco Silicon One
    - 8201
      - (24x 400GE + 12x 100GE)
    - 8202
      - (12x 400GE + 60x 100GE)
    - 36x 400GE LC

- **ASR9K**
  - Cisco Light Speed Plus
    - A9K-20HG-FLEX-SE/TER
      - (5x 400GE + 15x 100G)
    - A9K-8HG-FLEX-SE/TR
      - (2x 400GE + 6x 100GE)

Redefining the Economics of the Internet
Cisco Nexus 400G Switch Portfolio

- **Nexus 3400-S**
  - Innovium Terralynx
  - 1RU 32p 400G Switch
  - 4RU 8-slot Switch

- **Nexus 9300 GX**
  - Cisco Cloud Scale GX
  - 1RU 16p 400G Switch
  - 1RU 28p 100G + 8p 400G Switch

- **Nexus 9500 GX**
  - Cisco Cloud Scale GX
  - 16p 400G Line Card
  - 8-slot GX 400G Fabric Module
  - 4-slot GX 400G Fabric Module

- **Nexus 9500 R Series**
  - Broadcom Jericho 2
  - 24p 400G Line Card
  - 8-slot R2 400G Fabric Module
  - 4-slot R2 400G Fabric Module

- **Nexus 9000 GX2, GX3**
  - Cisco Cloud Scale GX2 & GX3
  - 1 RU 32p 400G Switch**
  - 2RU 64p 400G Switch**
  - 4RU 400G & 100G (Expandable)**

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**ACI** – On Cisco Cloud Scale ASICs. **NXOS** – On Cisco Cloud Scale & Merchant ASICs.

**Roadmap, to be IC’ed**

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400GBASE-DR4 & 4x100G to 100GBASE-DR/FR/LR Breakout

- 400GBASE-DR4/(4x100G-DR/FR/LR) provides 4 lanes of 1λ-100G-PAM4 (100GBASE-DR/FR/LR) optical signal with a reach of 500m /2km/10km
- 4x 100G-FR provides 4 lanes of 1λ-100G-PAM4 (100G-FR) optical signal extended to 2km and 10km version as well
- Module will use an MPO-12 SMF connector
- 400GBASE-DR4 can be used for high density 100G interface with breakout QSFP-100G-DR/FR/LR module
- QSFP-100G-DR/FR/LR will provide low cost 100G to any QSFP28 port
- QSFP-DD provides the industry’s highest density 100G interface
400G MMF Solution
(IEEE 400GBASE-SR4.2, 400G BiDi MSA)

QDD-400G-SR4-BD
- Provides 400G connectivity over 4 prs. of MMF
  - Can be used for platform speed migration from 100G to 400G
  - Same cable infrastructure as 100G-SR4
- Reach target is 100m
- Can also for 100G breakout to QSFP-40/100G-SRBD

*Wavelengths indicated are nominal to indicate VCSEL based PMD

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2X100G QSFP-DD to 100G QSFP28 Breakout

- QSFP-DD 2X100G Modules provide the ability to connect legacy 100G modules to QSFP-DD ports
- Available in 2X 100G-LR4, 2X 100G-CWDM4, 2X 100G-PSM4 or 2X 100G-SR4 modules

<table>
<thead>
<tr>
<th>Module Type</th>
<th>Optical Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>2X 100G-LR4</td>
<td>Dual Duplex CS Connector</td>
</tr>
<tr>
<td>2X 100G-CWDM4</td>
<td>Dual Duplex CS Connector</td>
</tr>
<tr>
<td>2X 100G-SR4</td>
<td>MMF MPO-24 Connector</td>
</tr>
</tbody>
</table>

Optical breakout cable or breakout thru a patch panel

2X 100G-LR4 Breakout Example
**400G ZR**

**QDD-400G-ZR-S**
- OIF 400G-ZR compliant
- Mapping to 400GZR Frame
- 400G 16QAM
- C-FEC 15%
- 2400ps/nm (80 km)
- C-Band tunability
- Pout: -10dBm min
- Muxponder capable
- <18W
- Q1CY21

**QDD-400G-ER1-S**
- OIF 400G-ZR compliant
- Mapping to 400GZR Frame
- 400G 16QAM
- C-FEC 15%
- CD 1200ps/nm (40km)
- Fixed wavelength
- Pout: -9dBm min
- Muxponder capable
- <18W
- 2ndHCY20

<table>
<thead>
<tr>
<th>PID</th>
<th>Mode</th>
<th>Sym Rate</th>
<th>Dispersion (ps/nm)</th>
<th>OSNR Sensitivity</th>
<th>FEC</th>
<th>Pout</th>
<th>Target Power Disp (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QDD-400G-ZR-S</td>
<td>402ZR</td>
<td>16QAM</td>
<td>60</td>
<td>2400</td>
<td>C-FEC</td>
<td>-10</td>
<td>&lt;16</td>
</tr>
<tr>
<td>QDD-400G-ER1-S</td>
<td>402ZR</td>
<td>16QAM</td>
<td>60</td>
<td>1200</td>
<td>N/A</td>
<td>-9</td>
<td>&lt;16</td>
</tr>
</tbody>
</table>

* Engineered Link
400G ZR+

QDD-400G-ZRP-S
- OIF 400G-ZR compliant
  - Mapping to 400GZR
  - 400G 16QAM
  - O-FEC 15%
  - C-Band tunability
  - Pout: -10dBm min
  - Muxponder capable
    - 2x200G
    - 4x100G
  - <21W
- Q1CY21

<table>
<thead>
<tr>
<th>PID</th>
<th>Mode</th>
<th>Sym Rate (GB)</th>
<th>Dispersion (ps/nm)</th>
<th>OSNR Sensitivity (dB)</th>
<th>FEC</th>
<th>Pout (dBm)</th>
<th>Target Power Disp (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QDD-400G-ZRP-S</td>
<td>400G ZR+ 16QAM</td>
<td>60</td>
<td>26,000</td>
<td>22</td>
<td>O-FEC</td>
<td>-10</td>
<td>&lt;20</td>
</tr>
<tr>
<td>QDD-400G-ZRP-S</td>
<td>300G ZR+ 8QAM</td>
<td>60</td>
<td>50,000</td>
<td>18</td>
<td>O-FEC</td>
<td>-10</td>
<td>&lt;19</td>
</tr>
<tr>
<td>QDD-400G-ZRP-S</td>
<td>200G ZR+ QPSK</td>
<td>60</td>
<td>50,000</td>
<td>14</td>
<td>O-FEC</td>
<td>-10</td>
<td>&lt;18</td>
</tr>
<tr>
<td>QDD-400G-ZRP-S</td>
<td>100G ZR+ QPSK</td>
<td>30</td>
<td>80,000</td>
<td>11</td>
<td>O-FEC</td>
<td>-6</td>
<td>&lt;14</td>
</tr>
</tbody>
</table>
# How to Transition from 100G to 400G Optics

<table>
<thead>
<tr>
<th>Reach</th>
<th>Optic today</th>
<th>Next Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>100m MMF</td>
<td>100G SR4</td>
<td>400G SR4.2 Parallel fiber; breakout</td>
</tr>
<tr>
<td>500m SMF</td>
<td>100G PSM4</td>
<td>400G DR4 (500m) Parallel fiber; breakout</td>
</tr>
<tr>
<td>500m/2km SMF</td>
<td>100G SM-SR</td>
<td>400G FR4 Duplex fiber, no breakout</td>
</tr>
<tr>
<td>10G CWDM4</td>
<td>100G CWDM4</td>
<td>400G FR4 Duplex fiber, no breakout</td>
</tr>
<tr>
<td>10km SMF</td>
<td>100G LR4</td>
<td>400G LR4 Duplex fiber, no breakout</td>
</tr>
<tr>
<td>80km SMF</td>
<td>100G DCO</td>
<td>400G ZR Duplex fiber, no breakout</td>
</tr>
<tr>
<td>&lt;30m</td>
<td>100G AOC</td>
<td>400G AOC</td>
</tr>
<tr>
<td>&lt;3m</td>
<td>100G DAC</td>
<td>400G DAC</td>
</tr>
</tbody>
</table>

Cisco’s portfolio of QSFP-DD modules makes it easy to upgrade to 400G in many cases with the current fiber infrastructure.
Upgrading only one end of the link to QSFP-DD?

QSFP-DD breakout options provide backwards optical compatibility to QSFP28

<table>
<thead>
<tr>
<th>Distance</th>
<th>Interface</th>
<th>Bandwidth</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>100m MMF</td>
<td>100G SR4</td>
<td>2x100G SR4</td>
<td>Connect up to TWO 100G-SR4 modules to a QSFP-DD port with a QDD-2X100-SR4-S module</td>
</tr>
<tr>
<td>2km SMF</td>
<td>100G CWDM4</td>
<td>2x100G CWDM4</td>
<td>Connect up to TWO 100G-CWDM4 modules to a QSFP-DD port with QDD-2X100-CWDM4-S modules</td>
</tr>
<tr>
<td>10km SMF</td>
<td>100G LR4</td>
<td>2x100G LR4</td>
<td>Connect up TWO 100G-LR4 modules to a QSFP-DD port with QDD-2X100-LR4-S modules</td>
</tr>
<tr>
<td>2km SMF</td>
<td>100G FR</td>
<td>400G DR4 (500m) 4x100G FR (2km)</td>
<td>Connect up to FOUR 100G-FR modules to a QSFP-DD port with QDD-400G-DR4-S or QDD-4x100G-FR-S modules</td>
</tr>
<tr>
<td>10km SMF</td>
<td>100G LR</td>
<td>4x100G LR</td>
<td>Connect up to FOUR 100G-LR modules to a QSFP-DD port with QDD-4x100G-LR-S modules</td>
</tr>
<tr>
<td>100m MMF</td>
<td>100G BiDi</td>
<td>400G SR4.2</td>
<td>Connect up to FOUR 100G-BiDi modules to a QSFP-DD port with QDD-400G-SR4-BD</td>
</tr>
</tbody>
</table>

Cisco’s portfolio of QSFP-DD modules provides efficient connectivity solutions between platforms for almost any interface.
The Cisco difference

Breadth of portfolio
QSFP-DD solutions to easily migrate to 400G

Unmatched Optics Expertise
Cisco optics set the standard that all others will be measured by

Technical expertise & Industry thought leadership
Switch, Router, Optics, Silicon photonics and leadership with SR, EVPN etc. technologies.

End-to-End Architecture
Cisco optics for all networking applications

World class service
Renown Cisco TAC experience

Innovative Business Model
Subscription based SIA, RTU Licenses
How to leverage 400G DWDM
Right form factor for the right application

Maurizio Gazzola
Sr. PLM MIG
Jul 8th 2020
What is a DCO transceiver?  
DCO = Digital Coherent Optic

Cisco 100G Transponder line card for 300x300mm layouts

Discrete Photonic Elements

Digital Signal Processor

Moore’s Law

Silicon Photonics Integration Advanced packaging Integration

150W → 15W

28nm

7nm

QSFP-DD 400G DCO
Coherent 400G Product variants

- 3 Mechanical format will be available on the market:
  - CFP2 DCO
  - QSFP-DD
  - O-SFP
- CFP2 DCO is a larger form factor that allows to integrate a Mini-EDFA in the Optical Frontend. CFP2 DCO key different will be Tx Power about 0dBm that will allow full compatibility with current MCS Optical Add/Drop structure
- QSFP-DD and OSFP shows smaller footprint but QSFP-DD is smaller providing moreover full back-compatibility with QSFP+ and QSFP28.
- Cisco will productize QSFP-DD and CFP2-DCO
- Cisco proved that QSFP-DD, even with small power envelop can support maximum scale number in term of ports per RU
400G-ZR can disrupt the networking industry

- Grey optics = DWDM
- OIF driven DWDM I/F specification:
  - Multivendor interoperability
- QSFP-DD Pluggable DCO
  - Standard hardware
- Campus and metro applications
  - Data Center Interconnect
  - Peering, Core, Edge, Aggregation networks
  - Enterprise, Wireline, Mobile and Cable markets
What are the Cisco 400G DCO variants?

**400GE, 4x100GE**
- OpenZR+ Improved FEC performance
- Passive Fixed Filter
- P2P metro line system
- 120km

**400GE, 4x100GE**
- 100G/200G/300G/400G
- -10dBm Passive Fixed Filter
- P2P line system for long haul
- 1500km

**400GE, 4x 100GE/OTU4, 40x 10GE/OTU2/OTU2e/STM64/16GFC**
- OpenROADM Improved FEC performance
- Contention-less Direction-less
- Brown-field line system
- 1500km
Demo
Sruthi Pendam
400G CFP2 DCO
NCS 1004 CFP2-DCO

- NCS1004 Supports OTN-XP LineCard which has 2x CFP2 DCO WDM for high performance (w/ optional Encryption) Trunks supporting 200G, 300G and 400G Trunk rate and OTU4 with Standard FEC.

- Demo shows 400G Traffic on CFP2-DCO and End-to-End Client Traffic on OTN-XP LC.

Benefits of OTN-XP and CFP2-DCO

- Single Line Card capable to support 2x 4x100GE Muxponder or 2x 400GE Transponder application
- Up to 1.6Tbps of OTN aggregation switching functionality to efficiently optimize bandwidth
- DCO CFP2 WDM pluggability allows a pays as you grow strategy
Router Interconnect

• How can I Interconnect remote router at 400G?
• Symmetric and Asymmetric solutions
Remote Routers – Symmetric solution

- In case of symmetric 400G routers interconnect multiple option can be considered:
- Assuming a WDM system in the middle 3 major use cases are possible

1. WDM ZR/ZR+ optics embedded on the router
   a) Sub case 1: Cisco WDM system
   b) Sub case 2: Third part WDM system

2. 400GE Interconnection with a 400GE capable TXP

3. 4x100GE fan out with a 100GE capable TXP
Remote Routers – Asymmetric solution

- The best option to interconnect a 400G router to a legacy 100G router is leverage on 400G ZR+ optics embedded in the router (also ZR is OK if distance is less than 120km)
- Router 400G port is configured as 4x 100G fanout mode as ZR+ pluggable will transport those 100GE streams onto a single wavelength at 400G
- On the remote location an interoperable Muxponder will break out 4 individual 100G interfaces to the 100G router

Two Muxponder solution are planned to be interoperable with ZR+:
1. NCS 2000 1.2T Muxponder Line Card (Titano6 program) – Q2CY2021 Rel 12.2
2. NCS 1004 OTN-Xponder Line card (Bo program)
   1. Q1CY2021 IOS-XR 7.3.x (ZR)
   2. Q3CY2021 IOS-XR 7.4.x (ZR+)
QDD vs. CFP2 vs. TXP

- Is the Transponder still useful?
- What about CFP2 DCO vs. QDD DCO?
- What Add/drop structure do I need to use?
DCO vs. TXP

• If the Routers supports DCO capable the choice is intuitively to use the pluggables in place of a TXP
  • Much better Density (no need of external TXP shelf)
  • Better power consumption
  • Cost optimized solution (no need of 2 client optics, the connection cable, the transponder electronics etc.)

BUT.....
TXPs use cases

- There are still use cases when TXPs will be needed:
  - Submarine Applications
  - ULH network where there is no space for regeneration
  - The flexibility and the performance benefits that high-end optics mounted on the TXPs can not be matched by the DCO pluggable due to the power constraint driven by specific real-estate
- A second case is when there is not a match between the router capacity and the lambda capacity on the WDM system
  - Typical use case when one router has 400G WDM DCO and the router on the other side is 100G capable
  - A Muxponder on one side interoperating with direct wavelength from the router is expected
What about QDD vs CFP2

The 10dB of delta Tx Power will have a deep implication about which Add/Drop structure can be supported:

- Unamplified passive coupler, MCS and CCOFS:
  - They require high input power and so CFP2 DCO shall be used
  - CFP2 DCO is compatible with any existing ADD/drop config

- Amplified Passive coupler, Passive AWG
  - System can tolerate low Input Power and so QDD DCO shall be used

TX Power Range:
- -10 dBm, (ZR or ZR+ w/o Nyquist Shaping)
- ~13dBm (ZR+ w/Nyquist shaping)