OPEN XR
OPTICS FORUM

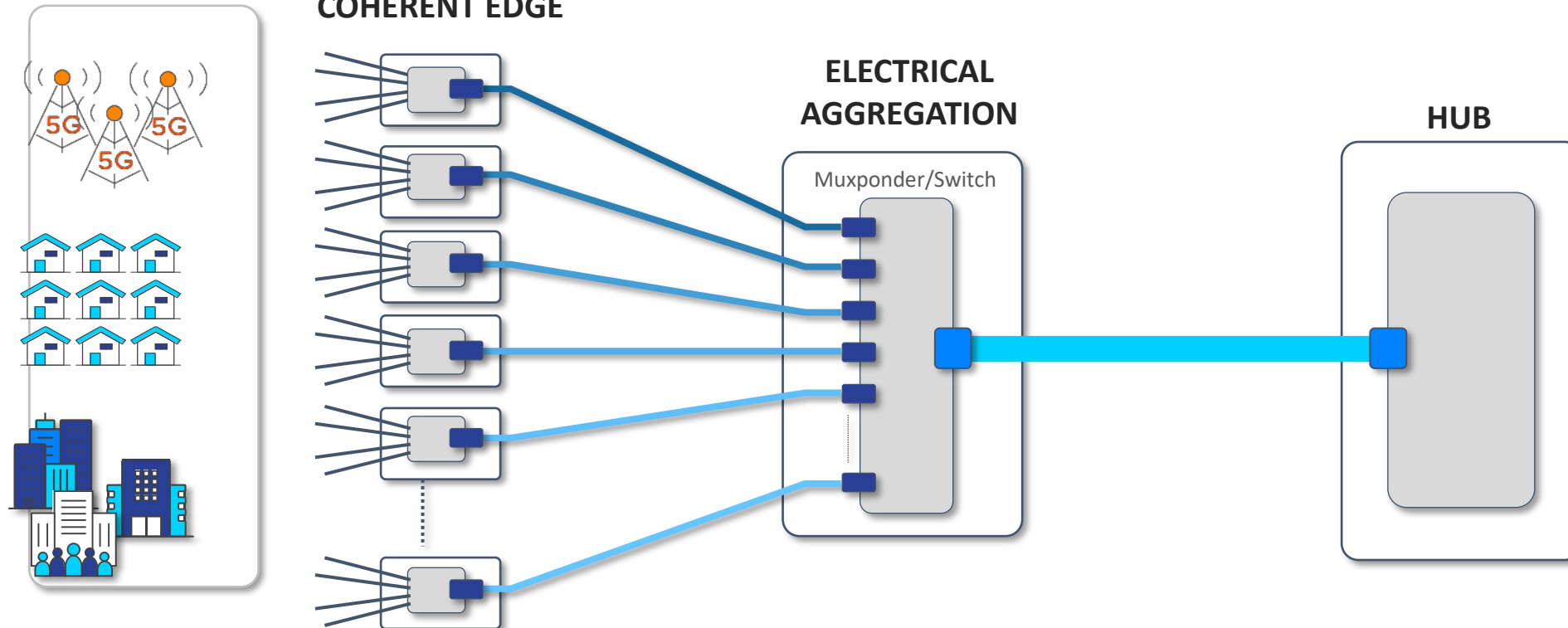Title — Standardization of Open XR Optics and Smart Coherent Transceivers

Date — March 26th, 2024

David Hillerkuss,
Director Open XR Optics Forum

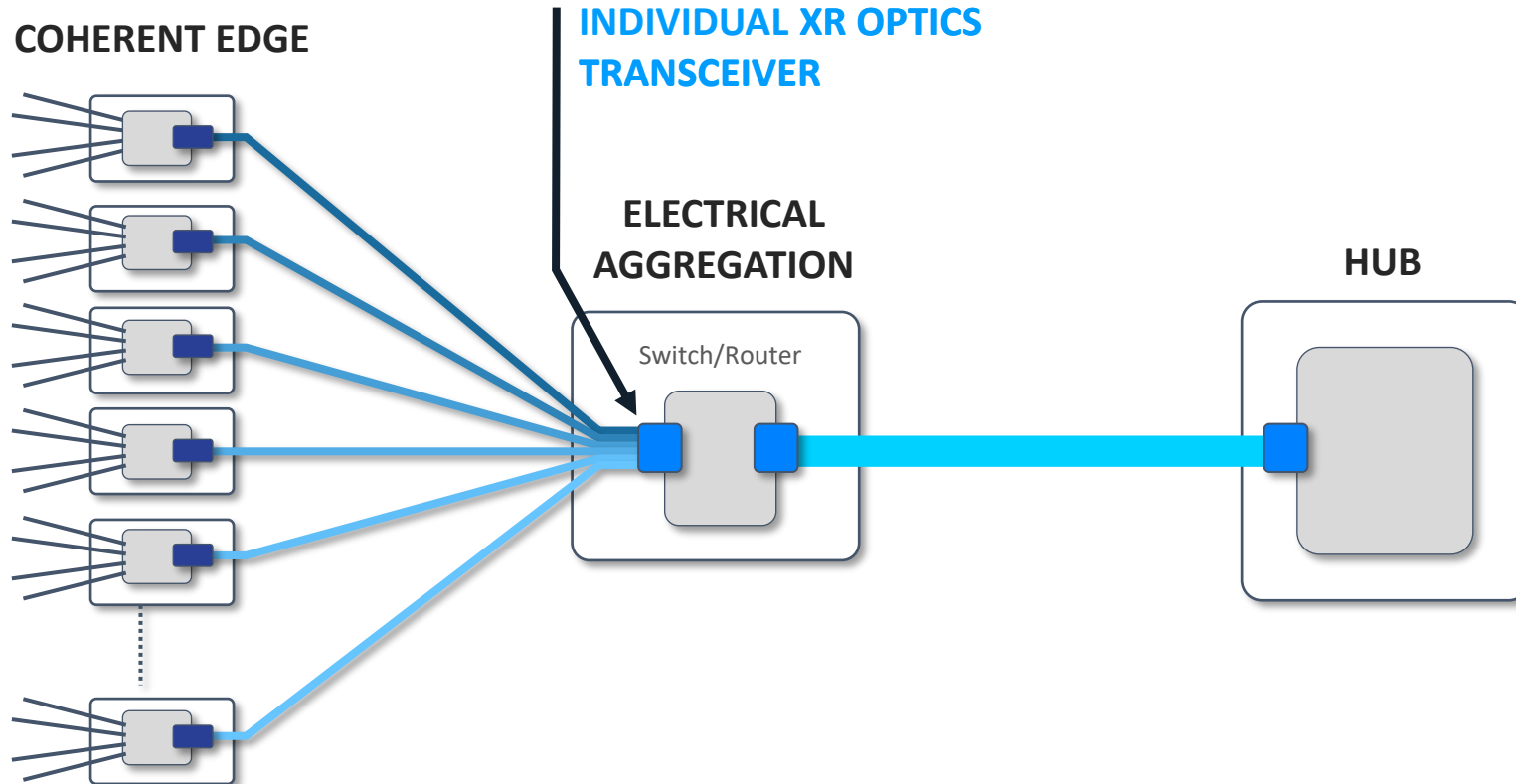# Aggregation Networks Using Pt-Pt Technology

N x 2 TRANSCEIVERS

INTERMEDIATE AGGREGATION

COHERENT EDGE

ELECTRICAL AGGREGATION

Muxponder/Switch

HUB

5G 5G 5G

The Solution: Open XR Optics P2MP Transceiver

N + 1
TRANSCEIVERS

INTERMEDIATE
AGGREGATION

COHERENT EDGE

INDIVIDUAL XR OPTICS TRANSCEIVER

ELECTRICAL AGGREGATION

HUB

Switch/Router
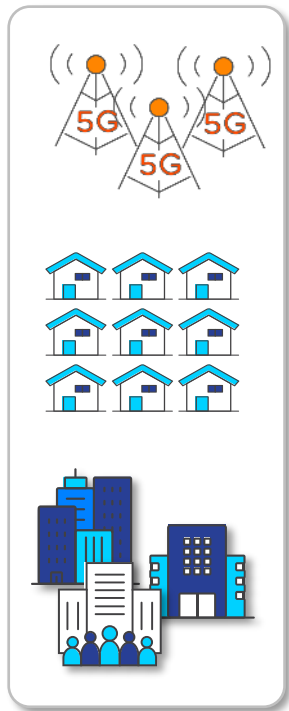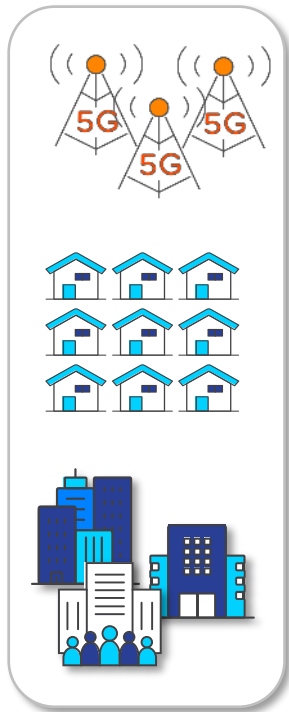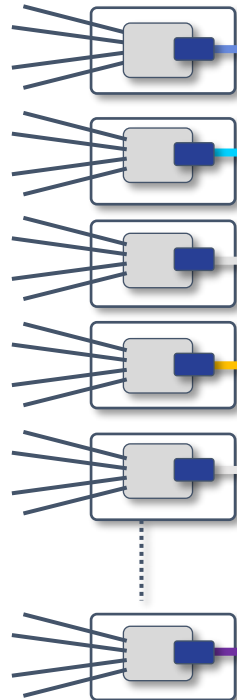
The Solution: Open XR Optics

N + 1 TRANSCEIVERS

OPTICAL AGGREGATION

COHERENT EDGE

XR OPTICS TRANSCEIVER

OPTICAL AGGREGATION

Optical Splitter/Combiner

HUB

5G
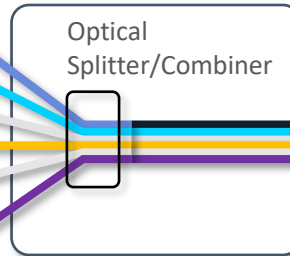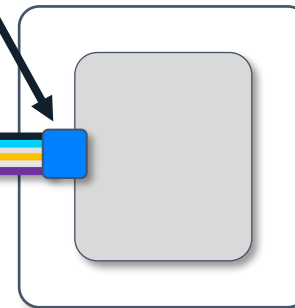
70+%
REDUCTION IN NETWORK COST

Open XR Optics – Open and Operator Driven

Applications and Requirements	Transceiver Specifications	Management Interfaces
• Applications, Use Cases, and requirements ✅ • Reference Implementations 🔜 • Management Interfaces Requirements 🔜	• Performance Specifications ✅ • Open XR Signal Specification 🔜 • Pluggable Form Factor Specifications ✅	• CMIS contributions ✅ • Open XR CMIS registers 🔜 • Open XR Module API(s) 🔜 • Controller API extensions 🔜

Open specifications available:
https://www.openxropticsforum.org/documents

5

Overall Principles in Open XR Efforts

- Operator driven
  - 21 operator members
  - 2 working groups on operator requirements for deployment

- Leverage existing Ecosystem
  - Comply with available standards and MSAs
  - Build on existing standards and MSAs
  - Contribute to other bodies where appropriate

- Create new Specifications where necessary
  - New work in ITU-T, OIF, IETF, IOWN, CableLabs, and other bodies
  - Open XR delta specifications where small extensions are needed
  - New specifications where no relevant prior work exists (subcarriers)

Open XR Optics Forum Members (41) March 2024

Network Operators 21	verizon	BT	LUMEN	LIBERTY GLOBAL	WINDSTREAM
	colt	zayo	Telefónica	AT&T	AMERICAN TOWER CORPORATION
	TIM	CROWN CASTLE	KDDI	viettel	Inligo NETWORKS / COMCAST
	MIDCO	MobiCom	Tier 1 MSO	NEXTLINK INTERNET & PHONE	elisa
Equipment Providers 15	JUNIPER NETWORKS	SUMITOMO ELECTRIC	DELL Technologies	ufiSpace	ARRCUS NETWORK DIFFERENT
	FURUKAWA ELECTRIC GROUP	DZS	DRIVENETS	LightRiver TECHNOLOGIES	ARISTA
	altice labs	APRESIA	ribbon	Edge-core NETWORKS	FONEX
Component Manufacturers 5	Infinera	INNOLIGHT	Hisense Broadband	LUMENTUM	PICadvanced

Specification Roadmap

Status	Specification
Done	
	Management Architecture – Open XR Network Management Specification*
	Open XR Transceiver(s):Optical and Client Interface Specification
	Open XR Transceiver(s):400G Optical Module Form Factor Hardware Specifications
In Progress	
	Attachment Points for Subcarriers in CMIS 5.3*
	Open XR Transceiver(s): Management Specification (Open XR CMIS Registers)
	Link Budgets, Pt-Pt, P2MP, PON Overlay, Spectrum Allocation for PON overlay
	Management Interfaces Requirements
	Open XR Signal Format White Paper
	Open XR Controller Northbound Interface Definition (to Orchestrator or OSS)*
	Open XR Signal Format Specification: Mid Span Meet
To Do	
	Communication Agent Specification*
	Open XR Controller Southbound Interface Definition (NB from module)*

Specification Roadmap
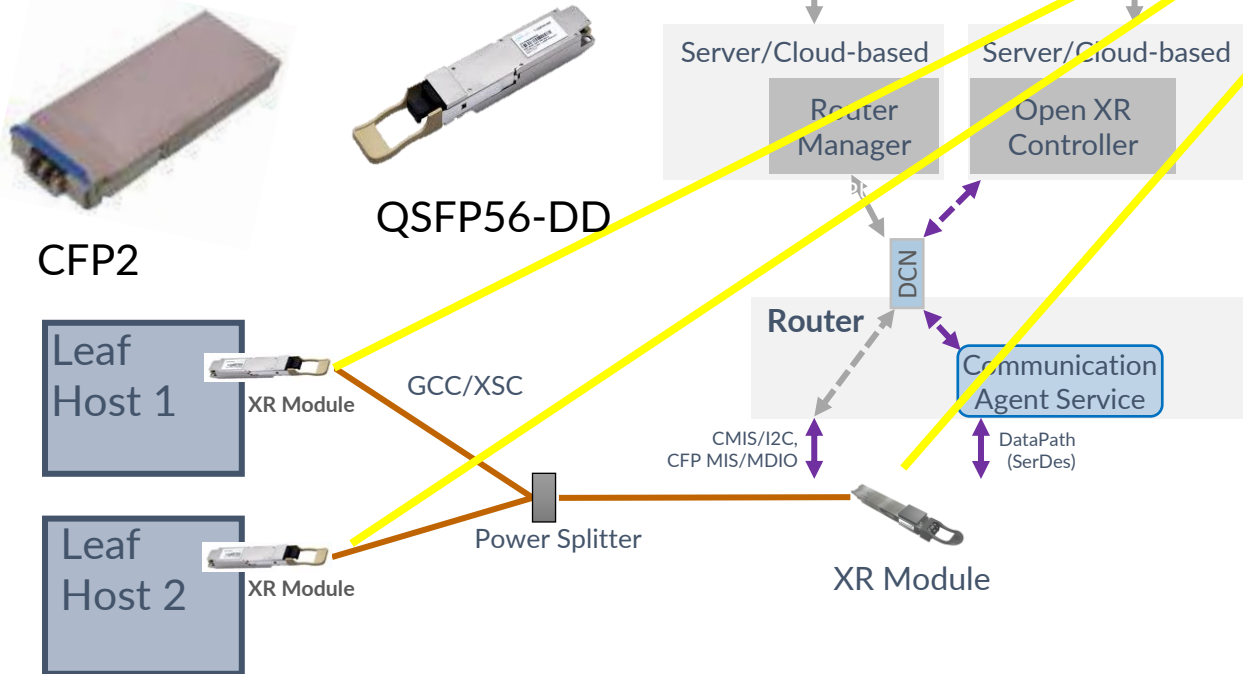
Available through Open XR Forum website
https://www.openxrforum.org/documents

Server / Cloud-based

Back Office OSS

North Bound
Interface

L2/L3   Transport

Server/Cloud-based   Server/Cloud-based

Router Manager   Open XR Controller

Path 1   **Path 2**

Pt

DCN

Router

Communication Agent Service

Leaf Host 1

XR Module

GCC/XSC

CMIS/I2C, CFP MIS/MDIO   DataPath (SerDes)

Leaf Host 2

XR Module

Power Splitter

XR Module

XR Module

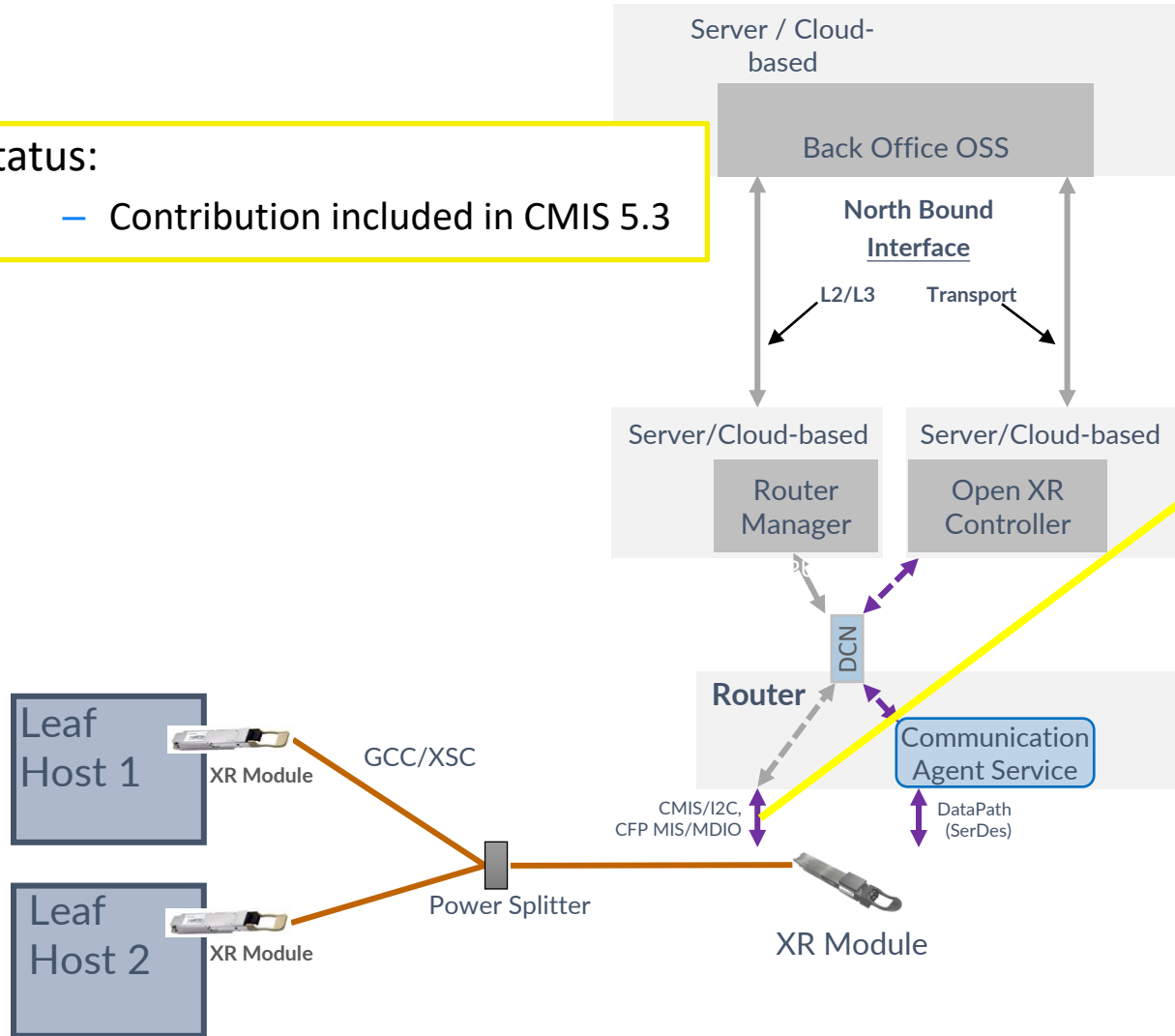| Status	Specification
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Specification Roadmap

Transceiver Spec. Working Group:
- Active working group
  - 10 companies
  - 24 participants
- Two documents published in February 2024 https://www.openxrforum.org/documents
- Additional work in progress

CFP2

QSFP56-DD

Server / Cloud-based

Back Office OSS

North Bound Interface

L2/L3   Transport

Server/Cloud-based
Router Manager

Server/Cloud-based
Open XR Controller

DCN

Router

Communication Agent Service

CMIS/I2C, CFP MIS/MDIO

DataPath (SerDes)

Leaf Host 1

XR Module

GCC/XSC

Leaf Host 2

XR Module

Power Splitter

XR Module

Status	Specification
Done	
	Management Architecture – Open XR Network Management Specification* ✓
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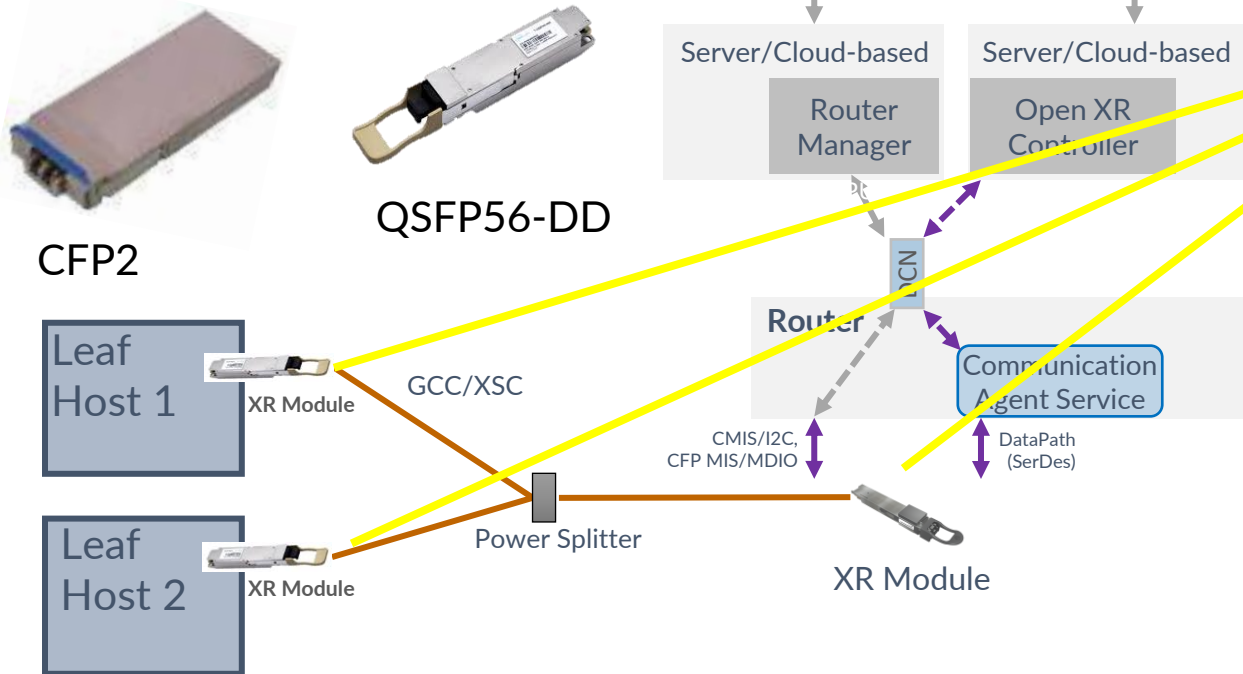# Specification Roadmap

Status:
- Contribution included in CMIS 5.3

Status	Specification
Done	
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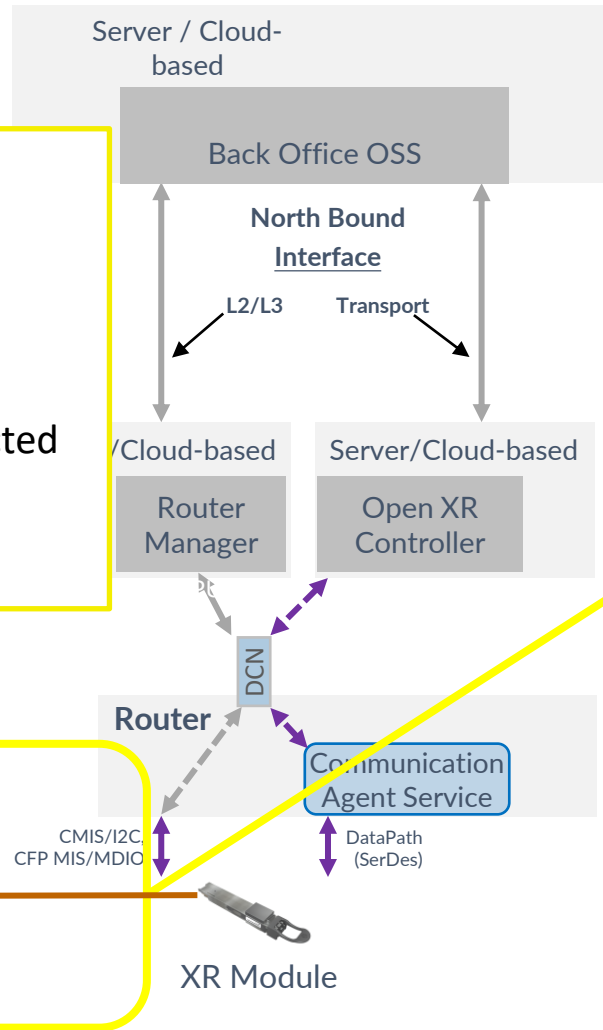- Two documents published in February 2024 **https://www.openxrforum.org/documents**
- Additional work in progress

CFP2

QSFP56-DD

Server / Cloud-based

Back Office OSS

North Bound Interface

L2/L3   Transport

Server/Cloud-based
Router Manager

Server/Cloud-based
Open XR Controller

Router

LCN

Communication Agent Service

Leaf Host 1

XR Module

GCC/XSC

CMIS/I2C, CFP MIS/MDIO

DataPath (SerDes)

Leaf Host 2

XR Module

Power Splitter

XR Module

Status	Specification
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To Do	
	Communication Agent Specification*
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Specification Roadmap

Link Budgets Working Group:

- Active working group
  - 12 companies
  - 23 participants
- Key applications identified
- Common requirements collected
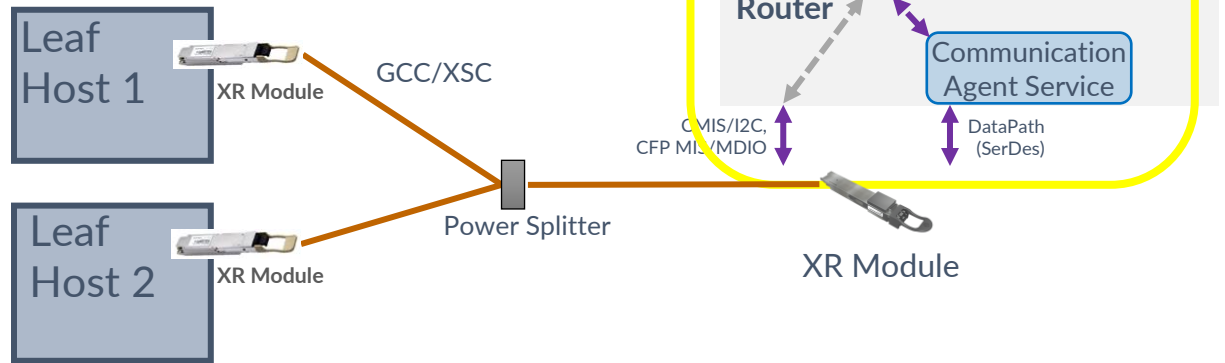- Reference link budgets being discussed

Status	Specification
Done	
	Management Architecture – Open XR Network Management Specification* ✓
	Open XR Transceiver(s):Optical and Client Interface Specification ✓
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In Progress	
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Specification Roadmap

Status:
- White Paper Being Prepared
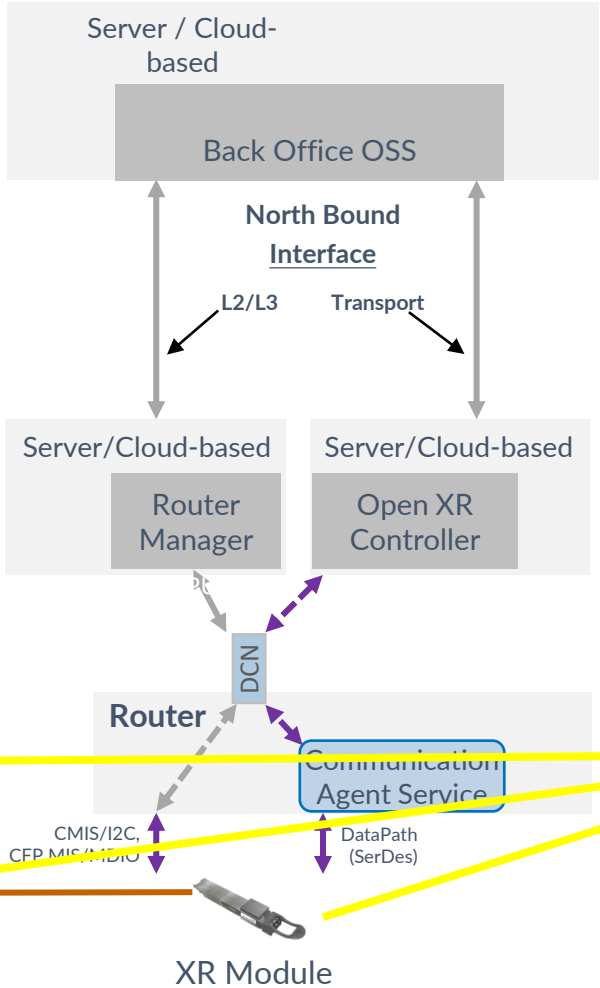- 16 companies
- 21 participants

Server / Cloud-based

Back Office OSS

North Bound Interface

L2/L3   Transport

Server/Cloud-based   Server/Cloud-based

Router Manager   Open XR Controller

DCN

Router

Communication Agent Service

CMIS/I2C, CFP MDI/MDIO

DataPath (SerDes)

XR Module

Leaf Host 1

XR Module

GCC/XSC

Leaf Host 2

XR Module

Power Splitter

Status	Specification
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	Management Architecture – Open XR Network Management Specification* ✓
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Specification Roadmap

Status:

- Full DSP Specification and White Paper
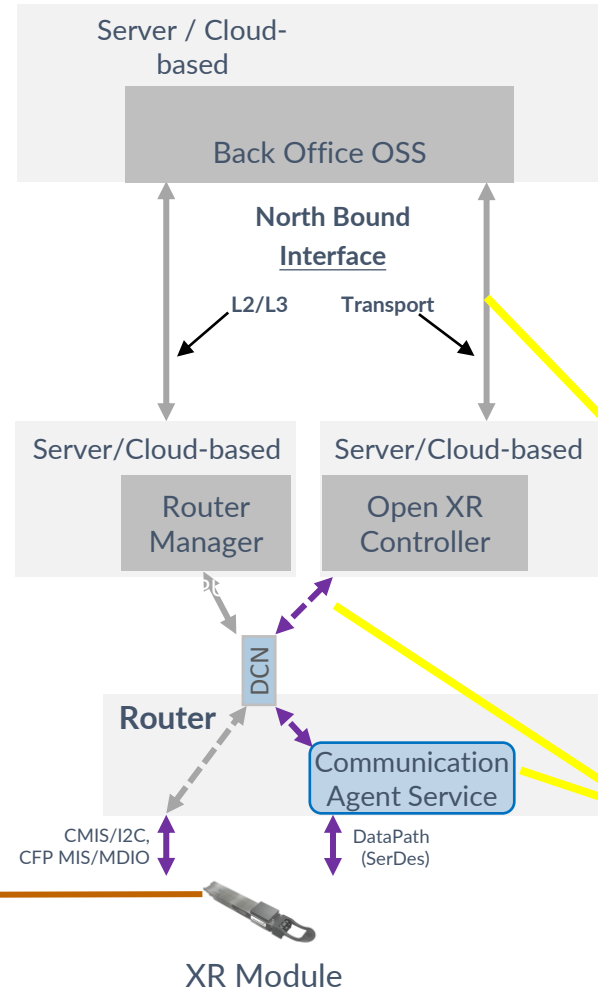- Specification draft under review
- To be published 2024

Server / Cloud-based

Back Office OSS

North Bound Interface

L2/L3   Transport

Server/Cloud-based   Server/Cloud-based

Router Manager   Open XR Controller

Pt

DCN

Router

Communication Agent Service

CMIS/I2C, CFP MIS/MDIO

DataPath (SerDes)

Leaf Host 1

XR Module

GCC/XSC

Leaf Host 2

XR Module

Power Splitter

XR Module

Status	Specification
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Specification Roadmap

Status: Management Interfaces Specifications
- Driven by management interfaces requirements
- Contributions to different standardization bodies under preparation

Server / Cloud-based

Back Office OSS

North Bound Interface

L2/L3   Transport

Server/Cloud-based — Router Manager

Server/Cloud-based — Open XR Controller

DCN

Router

Communication Agent Service

CMIS/I2C, CFP MIS/MDIO

DataPath (SerDes)

Leaf Host 1 — XR Module

GCC/XSC

Leaf Host 2 — XR Module

Power Splitter

XR Module

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Open XR Specifications and Whitepapers

Specifications

- Open XR Management Architecture Specification – Published ✅
- Open XR Optics 400G Optical Module Form Factor Hardware Specifications – Published ✅
- Open XR Optics Transceiver Optical and Client Interface Specifications – Published ✅
- Open XR Signal Format Specifications: Mid Span Meet – In Progress 🔜
- Open XR Transceiver Management Specification (CMIS registers) – In Progress 🔜

Whitepapers

- Open XR Concept Introductory White Paper – Published ✅
- Introduction to Applications of XR Optics to Coherent Optical Communication Networks – Published ✅
- Open XR Signal Format White Paper – In Progress 🔜
- Open XR Management Interfaces Requirements White Paper – In Progress 🔜

Published Open XR Documents available at:
https://www.openxropticsforum.org/documents

Tier 1 MSO

Relevant Activities in Other Forums

OIF — Management White Paper & Contributions to CMIS 5.3

IOWN GLOBAL FORUM™ — IOWN APN Functional Architecture 2.0 includes subcarrier multiplexing

CableLabs® — Subcarrier track in CPON

ITU — Subcarrier technology has been introduced in FSAN and several study groups

IETF® — Discussions on Management of next generation pluggable transceivers

Open XR Optics Forum POCs

Legend

✓	Completed
🏃	Running

✓ **P2P Performance and Host Independent Management**
- P2P performance trials
- Dual Management

LUMEN® | Infinera®

✓ **P2MP network configurations and Dual Management PoC**
- Disaggregation of Hosts & Line Systems
- Dual Management

LIBERTY GLOBAL | JUNIPER NETWORKS | ufiSpace | DRIVENETS | Infinera®

🏃 **Metro and Access Network Convergence**
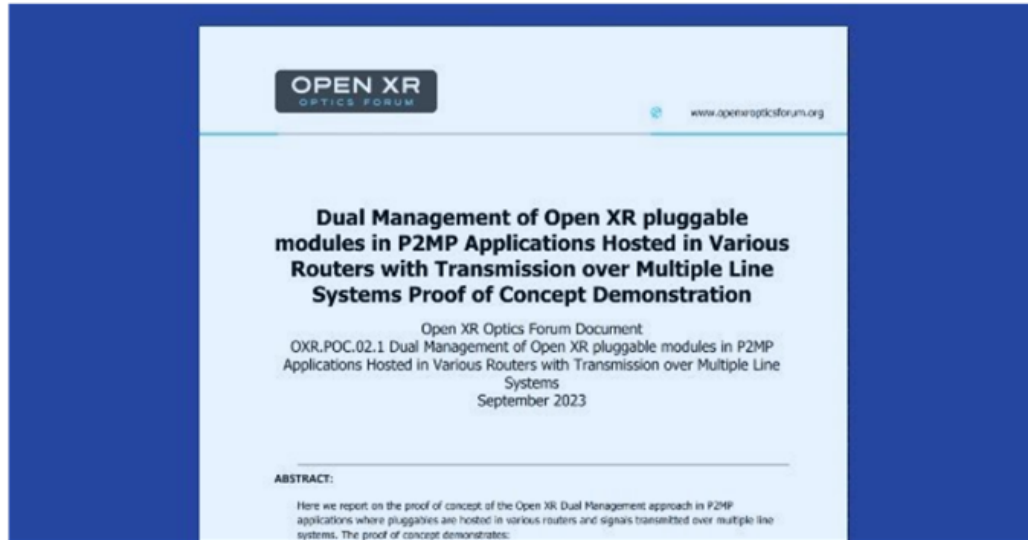- P2MP aggregation
- Central Office consolidation

TIM | DZS | Infinera®

🏃 **Flexible and Energy Efficient IP/MPLS Networks**
- Disaggregated transport networks
- Convergent IPoWDM infrastructure

Telefónica | ttc Centre Tecnològic de Telecomunicacions de Catalunya | Infinera®

Reports available at: https://www.openxropticsforum.org/documents

Open XR PoC Report
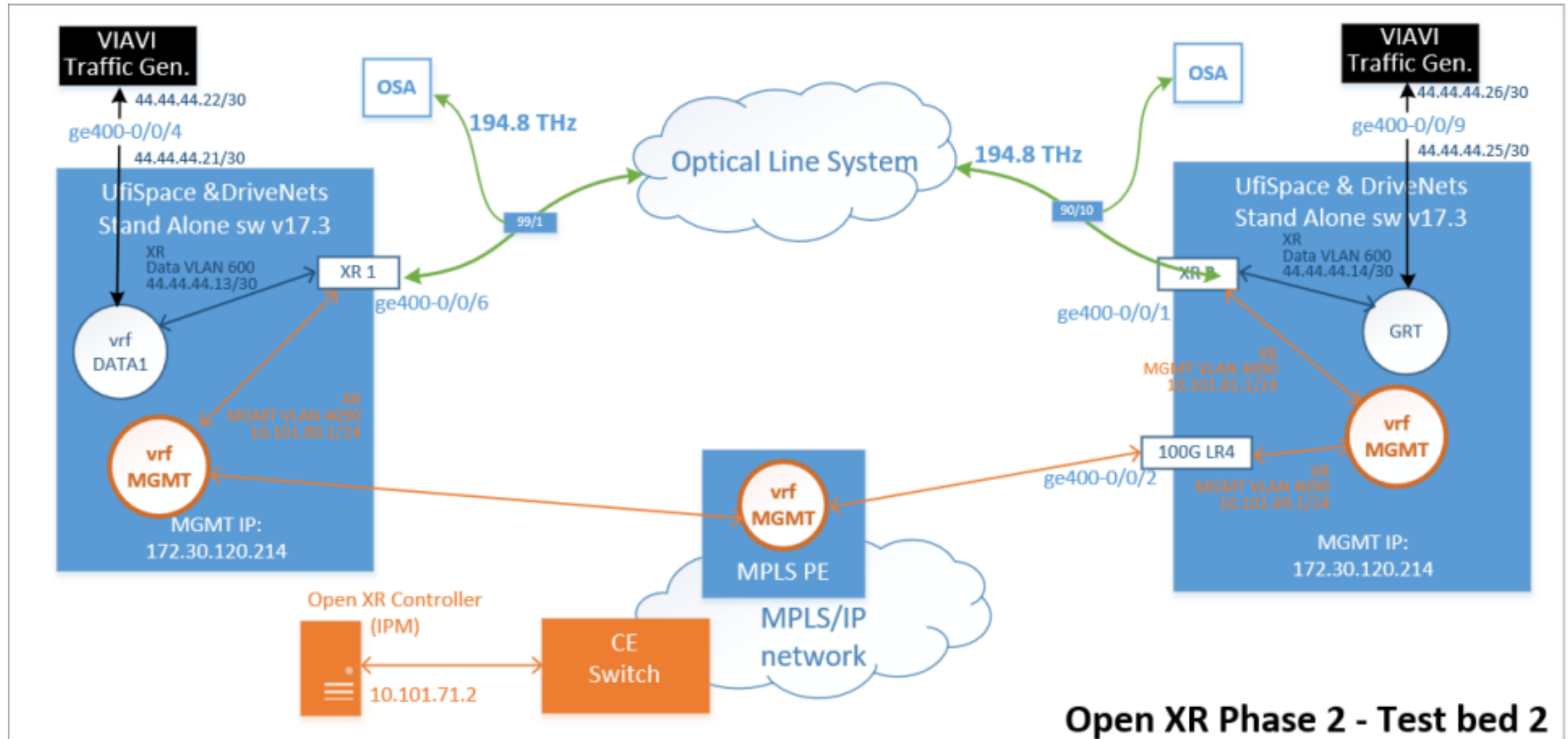
https://openxropticsforum.org/documents

DUAL MANAGEMENT OF OPEN XR PLUGGABLE MODULES PROOF OF CONCEPT DEMONSTRATION

1. Compatibility of XR signals with a variety of line systems in
   a. Point-to-point configuration and
   b. Point-to-multipoint configuration
2. Compatibility of XR pluggable transceivers with a variety of host systems (Juniper, DriveNets & Ufispace, SONiC & Edgecore, Infinera TM301, and Infinera NDU)
3. Advanced management functionality of smart pluggable transceivers, demonstrating the capability of modern routers to seamlessly support remote management of pluggable transceivers through the Open XR Management Architecture.

Remote Management of Pluggables

VIAVI Traffic Gen.
44.44.44.22/30
ge400-0/0/4
44.44.44.21/30

UfiSpace &DriveNets Stand Alone sw v17.3
XR Data VLAN 600
44.44.44.13/30

XR 1
ge400-0/0/6

vrf DATA1

XR MGMT VLAN 4090 10.101.80.1/24

vrf MGMT

MGMT IP: 172.30.120.214

OSA
194.8 THz

Optical Line System

99/1

90/10

194.8 THz

OSA

VIAVI Traffic Gen.
44.44.44.26/30
ge400-0/0/9
44.44.44.25/30

UfiSpace & DriveNets Stand Alone sw v17.3
XR Data VLAN 600
44.44.44.14/30

XR 2
ge400-0/0/1

GRT

XR MGMT VLAN 4090 10.101.81.1/24

vrf MGMT

XR MGMT VLAN 4090 10.101.69.1/24

MGMT IP: 172.30.120.214

100G LR4
ge400-0/0/2

MPLS PE

vrf MGMT

MPLS/IP network

Open XR Controller (IPM)

10.101.71.2

CE Switch

Open XR Phase 2 - Test bed 2

A new operational paradigm for IPoDWDM networks

Steven J. Hand[1], David F. Welch[1], (Fellow, IEEE), Vasudha Bhaskara[1], Dharmendra Naik[1], Anders Wikman[2], Mika Silvola[3], Hao Su[1], Teresa Monteiro[4], Fabio Marques[4], Paulo Santos[4], Norman Swenson[1], (Senior Member, IEEE), Antonio Napoli[5], David Hillerkuss[5], Harald Bock[5], (Member, IEEE),

[1] Infinera, San Jose, USA (e-mail: shand@infinera.com)
[2] Infinera, Stockholm, Sweden (e-mail: anders.wikman@infinera.com)
[3] Infinera, Espoo, Finland (e-mail: msilvola@infinera.com)
[4] Infinera, Lisbon, Portugal (e-mail: tmonteiro@infinera.com)
[5] Infinera, Munich, Germany (e-mail: dhillerkuss@infinera.com)

Corresponding author: Antonio Napoli (e-mail: anapoli@infinera.com).

Accepted for publication in IEEE Access, will be available in the next few weeks
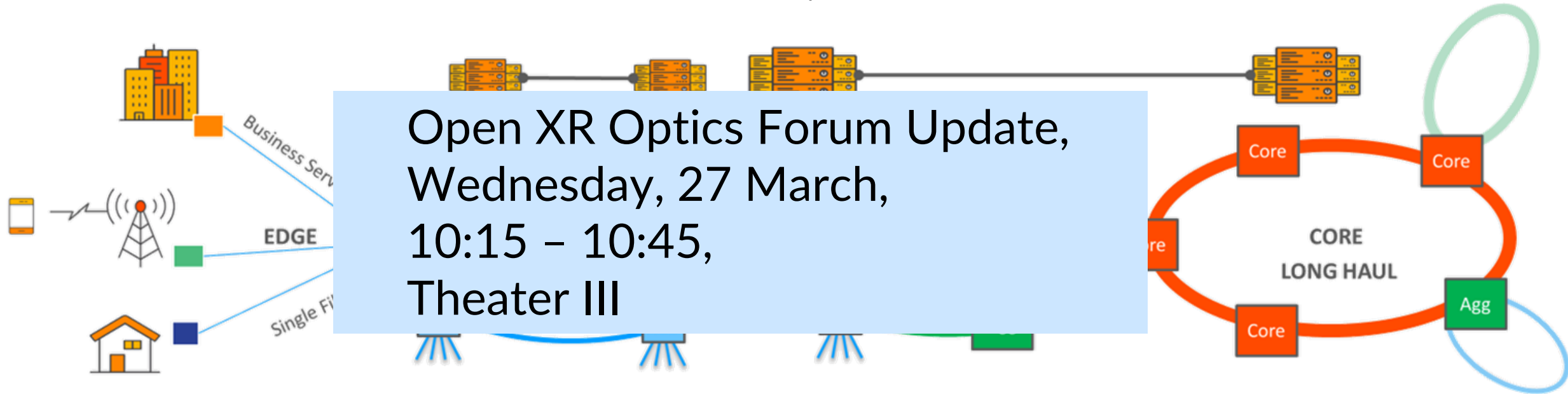
Open XR Optics Forum Update at OFC 2024

Andrew Lord

BT Fellow

Venk Mutalik

Comcast Fellow

Oscar González de Dios

Expert Telefonica CTIO

Dave Welch

Founder Infinera

Open XR Optics Forum Update,
Wednesday, 27 March,
10:15 – 10:45,
Theater III

Applications

- High-Capacity Overlay
- Any to any Host (CFP2, QSFP-DD)
- Dynamic Bandwidth Upgrade

Key Technical Benefits

- Single Laser BiDi
- Coherent Breakout
- Nyquist Subcarriers
- Dispersion Tolerance

Flexible Management

- Managed by Host & independent monitoring
- Host independent & remote management