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OCTOBER 11-14

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2021 Fall
Technical Forum
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Converged Networks and Mobility

Access Beyond 10G: Coherent Subcarrier Aggregation as Backhaul for Next-Generation R-OLT, RMD, and Wireless

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The logo consists of the text '10G' in a bold, sans-serif font. The '10' is white and the 'G' is red. Below the text are ten vertical bars of varying heights, transitioning from orange on the left to red on the right.

Q: How do I enable my network to deliver 10G services?

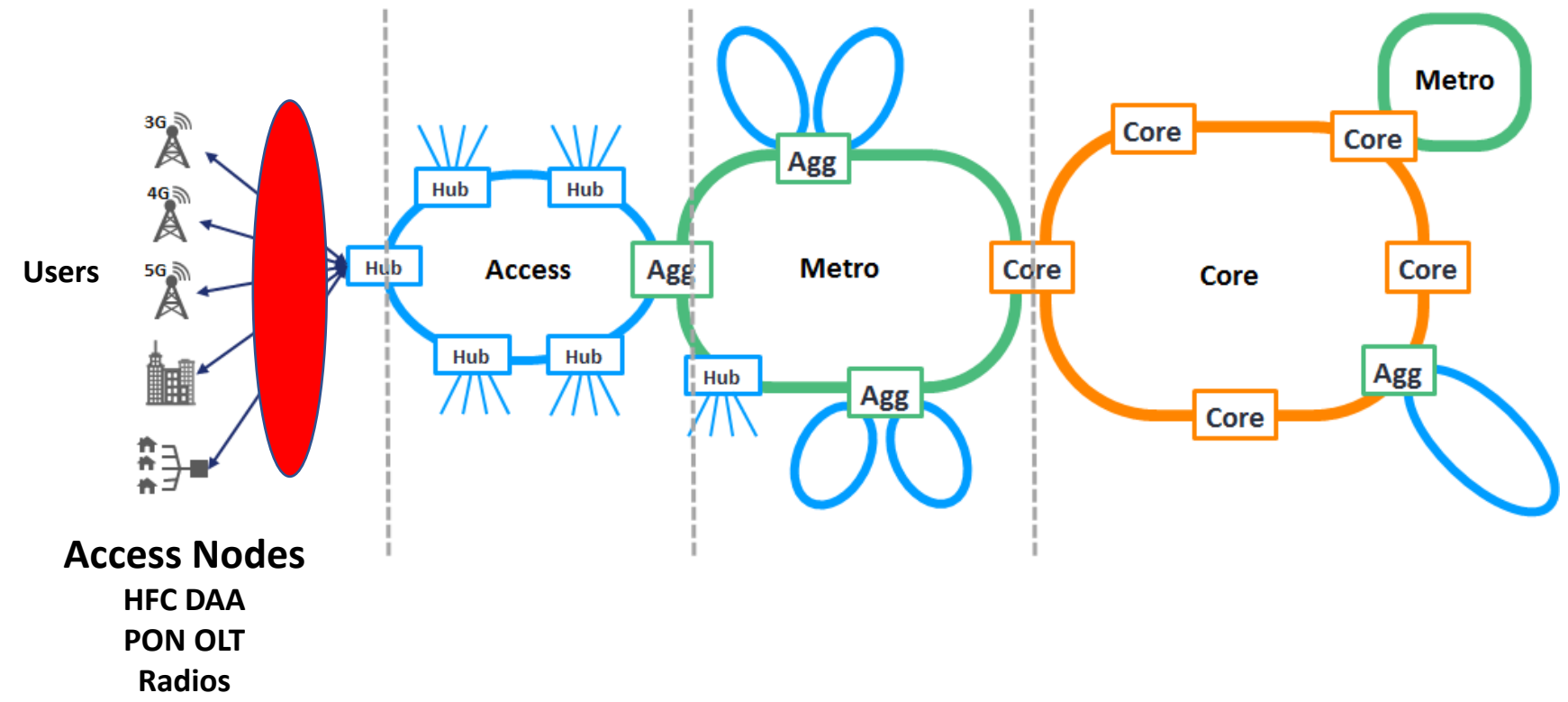
A: By going beyond 10G Optical Backhaul

Traffic Segments

Bandwidth IS needed everywhere, but link count is highest serving Access Nodes

Access Node Backhaul

- Generally <80km
- Typically served by 10G SFP+ today



Point-to-Point (P2P) vs. Point-to-Multipoint (P2MP)

Why are most optical backhaul networks still Point-to-Point?

Dominant traffic sources

- Managed/OTT video
- Internet services

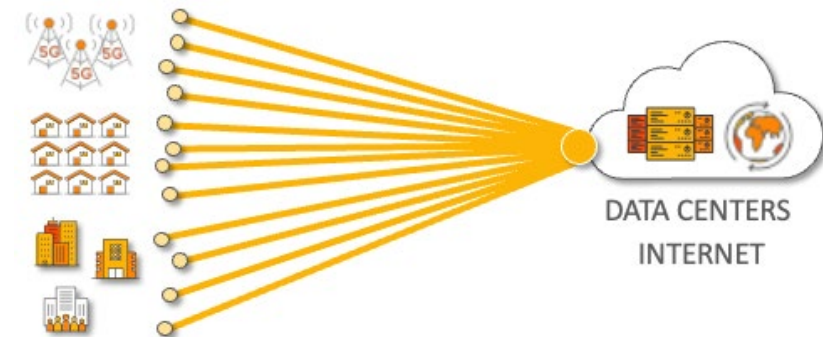
Resulting traffic pattern

- Hub (servers) and spoke (end users)

Point-to-Point Optics



Point-to-Multipoint Traffic

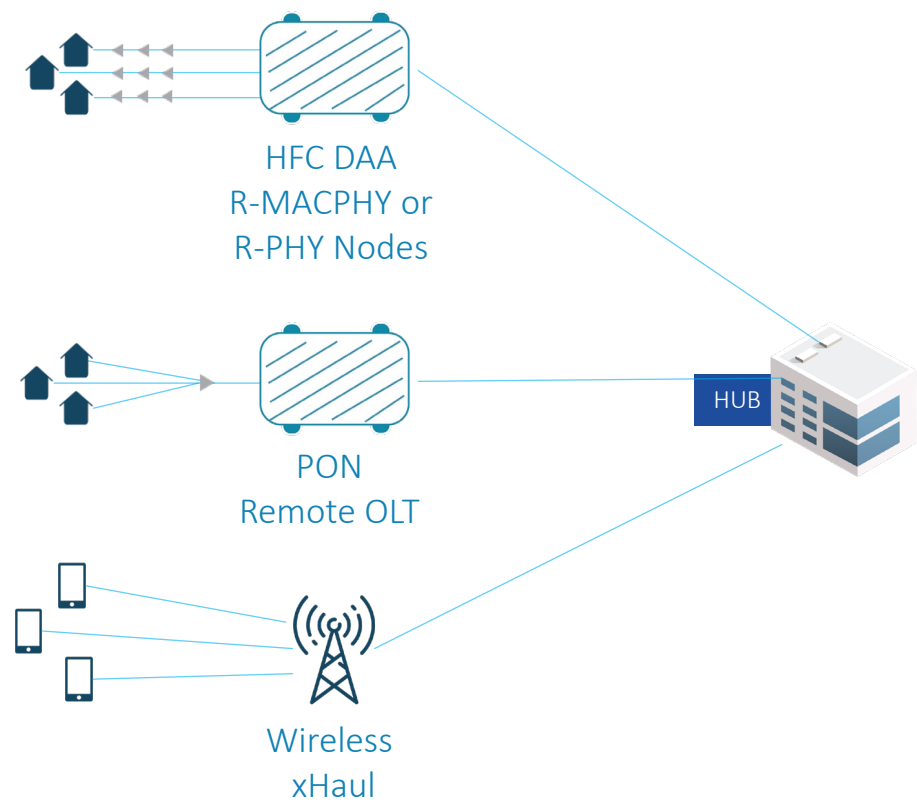


Why do we need to go Beyond 10G to deliver last mile access?

- One DOCSIS 3.1 service group is ~10 Gbps full capacity (not today)
- Segmentable D3.1 nodes – 2 SG past 10 Gbps and 20 Gbps full
- D4.0 ESD exceeds 13 Gbps full capacity in 1 SG

- 10G-EPON/XGS-PON ~9 Gbps, 1 uplink (10G) to each PON segment
- R-OLT typically 4 PON segments
- 25GS-PON and 25G-EPON coming
- Save fiber/wavelengths and hub switch ports by aggregating in R-OLT

- Highly variable depending on CU/DU/RU split
- Backhaul/midhaul – generally less than 10G (user bandwidth)
- Fronthaul – RU only, typical in vRAN: 14 Gbps for 20 MHz, 3 sectors and 82 Gbps for 400 MHz, 4 layers 64T/64R Massive MIMO mm-wave



Existing Point-Point Transmission Technologies

Direct Detection and Coherent, Paired Optics

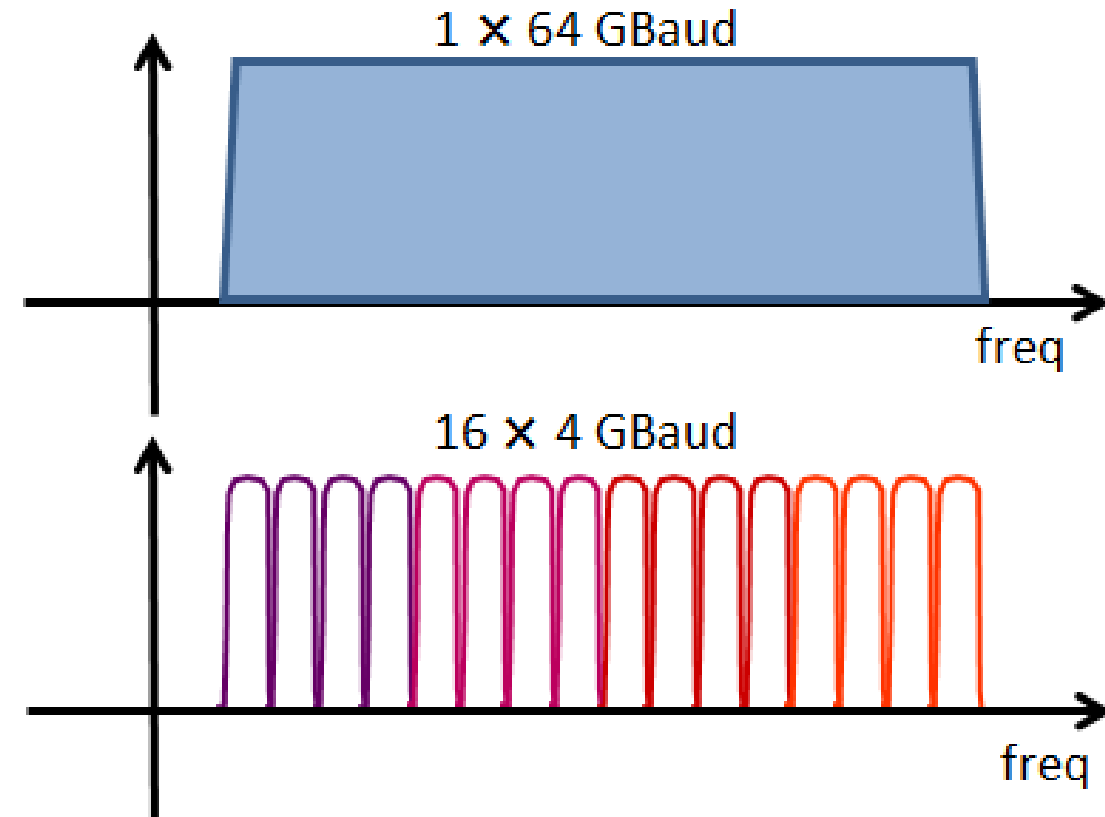
- Today for HFC and R-OLT – SFP+
 - 10Gbps mix of LR/ER/ZR,DWDM
- Beyond 10G: SFP28 w/25G IM-DD
 - Limited reach, FEC needed
- Coherent point-point w/interop
 - CFP2 for node integration
 - CableLabs 100G/200G work
 - IEEE 802.3ct 100G

Type	Loss Budget (dB)	Distance (km)	Speed (Gbps)	Fiber Count
10GBASE-ZR	25	80	10	2
25GBASE-ER	20	40	25	2
25GBASE-LR	18	10	25	2
10GBASE-ER	14	40	10	2
10GBASE-LR	8	10	10	2
50GBASE-LR	12	10	50	2
50GBASE-ER	15	40	50	2
100GBASE-FR1	4	2	100	2
100GBASE-LR1	8	10	100	2
Coherent 100	18	80	100	1
Coherent 200	18	80	200	1
10GBASE-PR	30	20	10	1

Digital Subcarrier Multiplexing (DSCM)

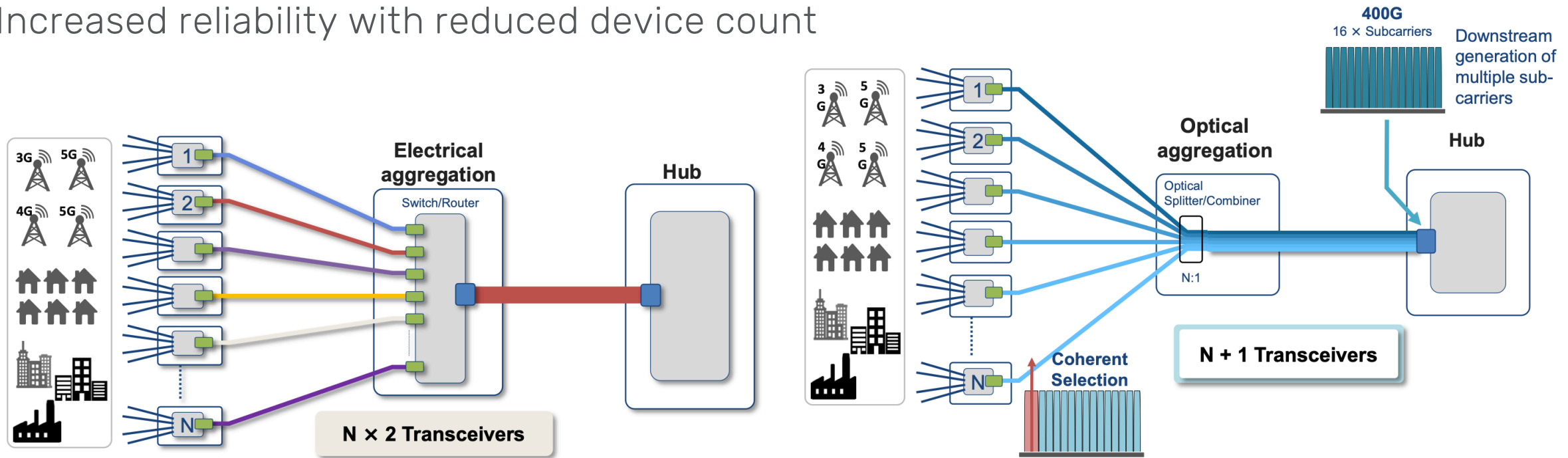
- Split single channel into several digital subcarriers
- Continuous mode transmission on both ends “no burst”
- Lower power by matching transmission to traffic
- Power control loop to balance per-SC differences

- Enables Frequency Division Multiplexing
 - Single “hub” module with N subcarriers
 - 1 to N dedicated subcarriers per endpoint
 - Static and dynamic endpoint scaling: 25G-400G to suit use cases and help reduce cost



DSCM Benefits – Simplification and Reductions

- Enables P2MP operation to allow optical split vs. L1/L2 electrical aggregation
- Significant reductions in transceivers, space, power
- Universal applicability – 25G to 400G endpoints
- Increased reliability with reduced device count



Beyond 10G Solution Comparison

Criteria	IM-DD 25G	Single-Carrier Coherent 100G/200G+	DSCM 25G-400G
Aggregate Module Capex	+	-- - with Electrical Agg	-
Scalability	-	Neutral + with Electrical Agg	++
Reach	-	+	+
Node Integration	+	Neutral	Neutral
Service Convergence	Neutral	+	+
Hub Space/Power	Neutral	-	+
HFC DAA Suitability	+	- Neutral with Elec Agg	Neutral
PON R-OLT Suitability	Neutral	Neutral	+
Wireless xHaul Suitability	Neutral	Neutral	+
Deployment Lifespan	-	+	+
Operational Simplification	Neutral	-	+

Conclusions and What's Next

- Solutions Beyond 10G in optical backhaul will be required to deliver 10G in the last mile
- Digital Subcarrier Multiplexing provides a powerful solution for this use case
 - Coherent optical performance and reach
 - P2MP operation to reduce total number of transceivers and allow optical passive splitting/combining instead of electrical aggregation
- Further interoperability and standardization to come – exciting times in Beyond 10G!
 - OpenXR Forum for DSCM
 - CableLabs 100G Coherent PON (CPON)



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Thank You!

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