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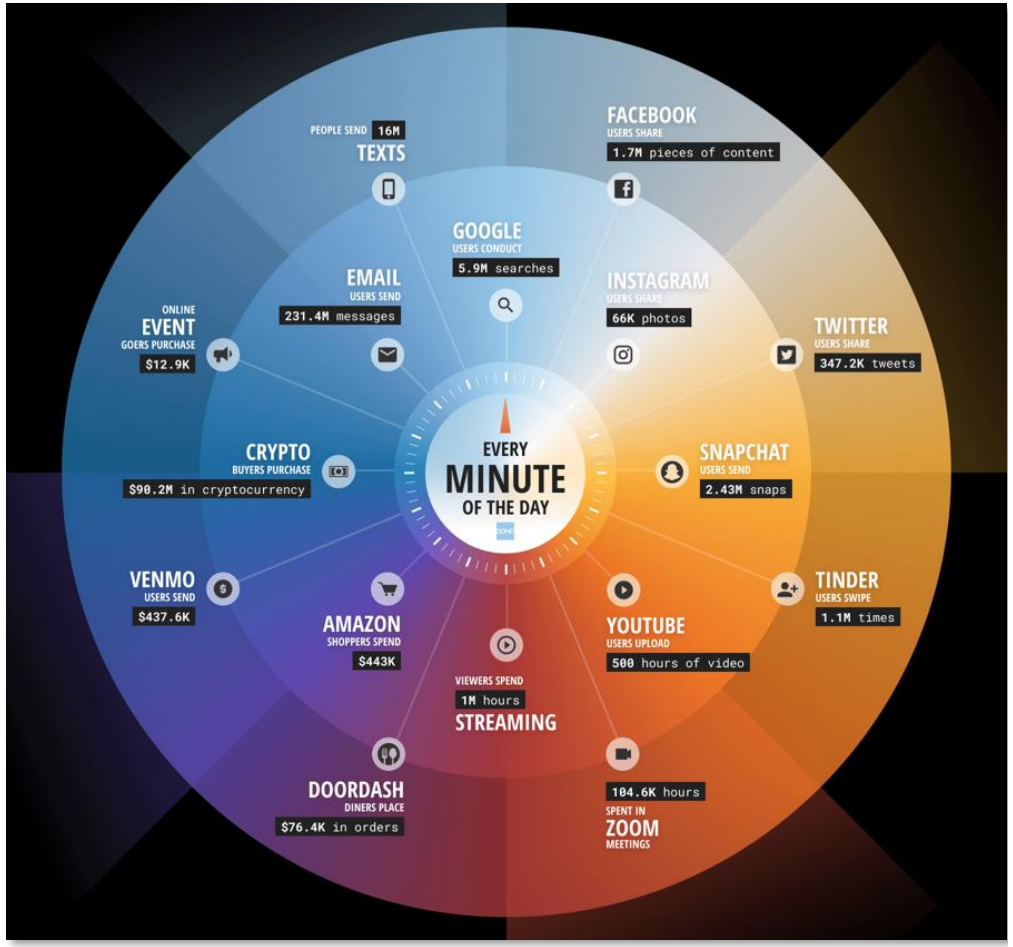
Products innovations in the access network

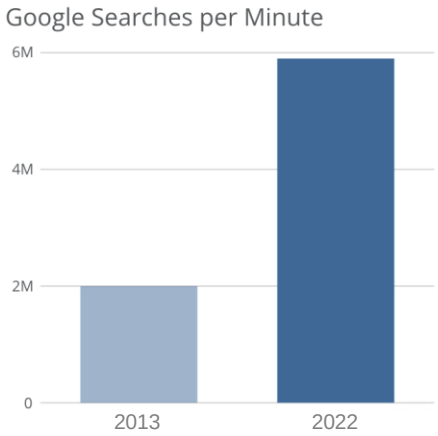
Building the network for 2030

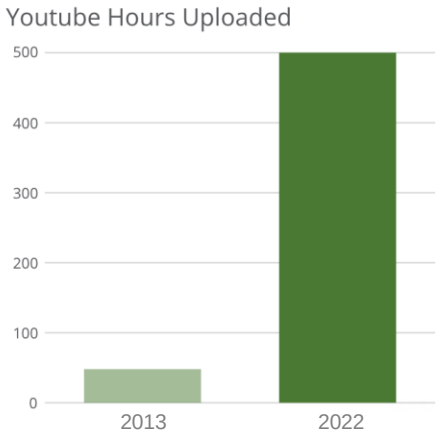
Sander Jansen, May 2023

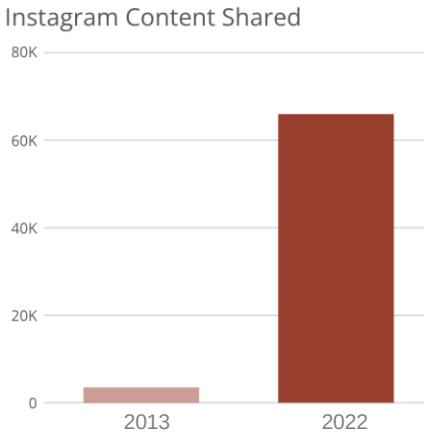
The Internet in 2023

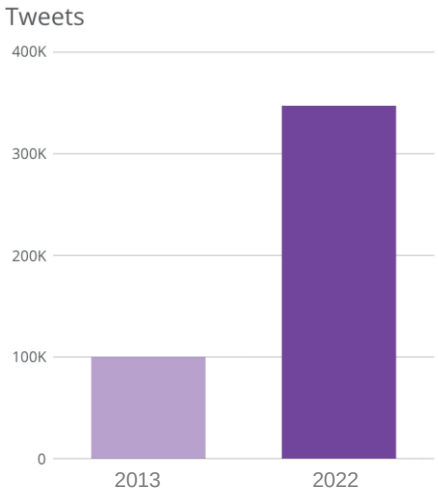
We're using (a lot of) data almost every minute of our day

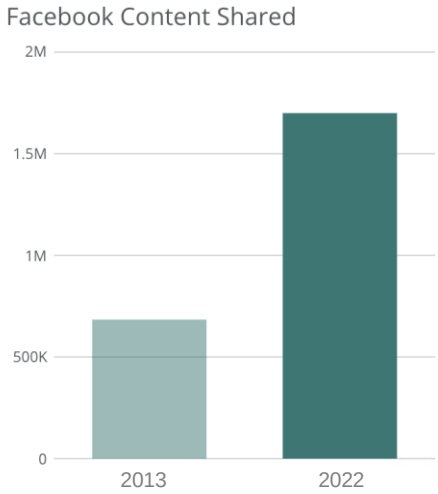


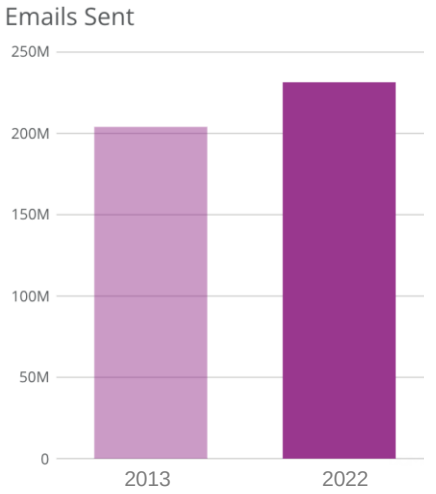






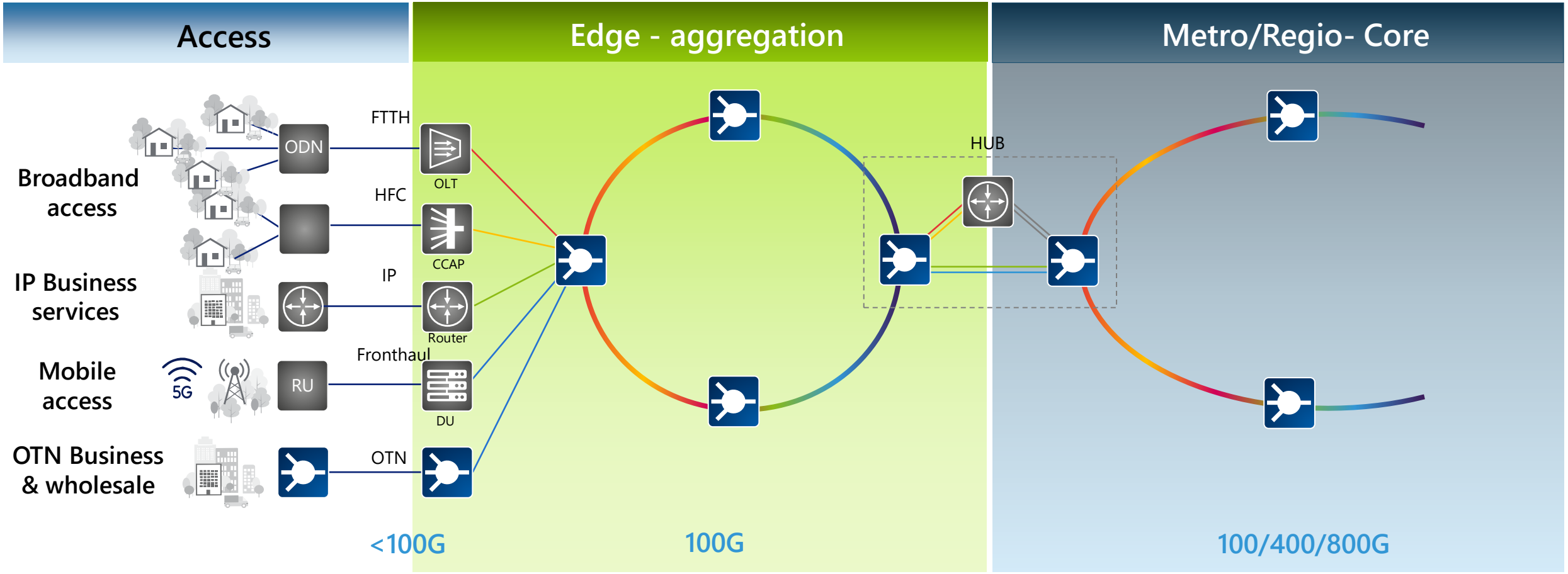






Source: https://www.domo.com/data-never-sleeps#data, November 2022

Technologies for the Edge & Core network



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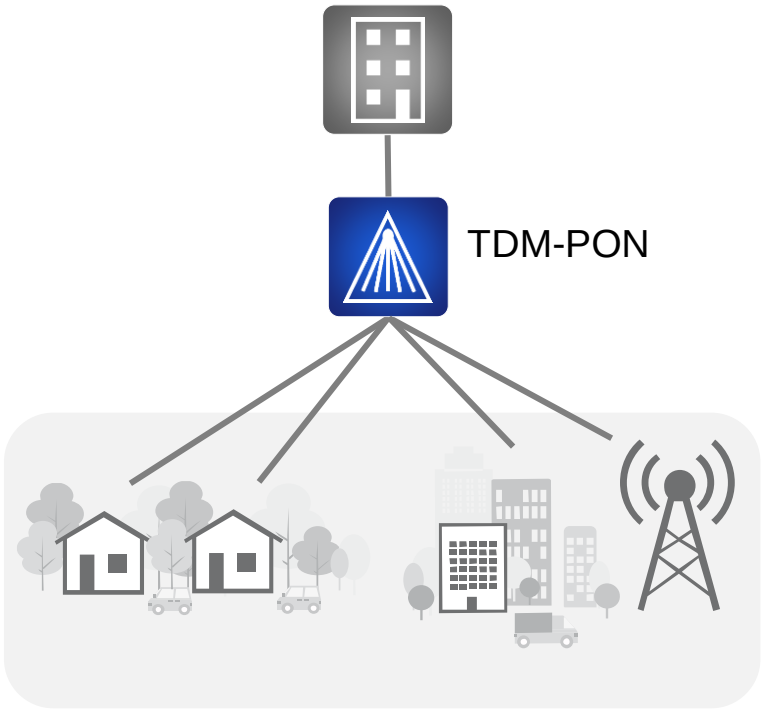
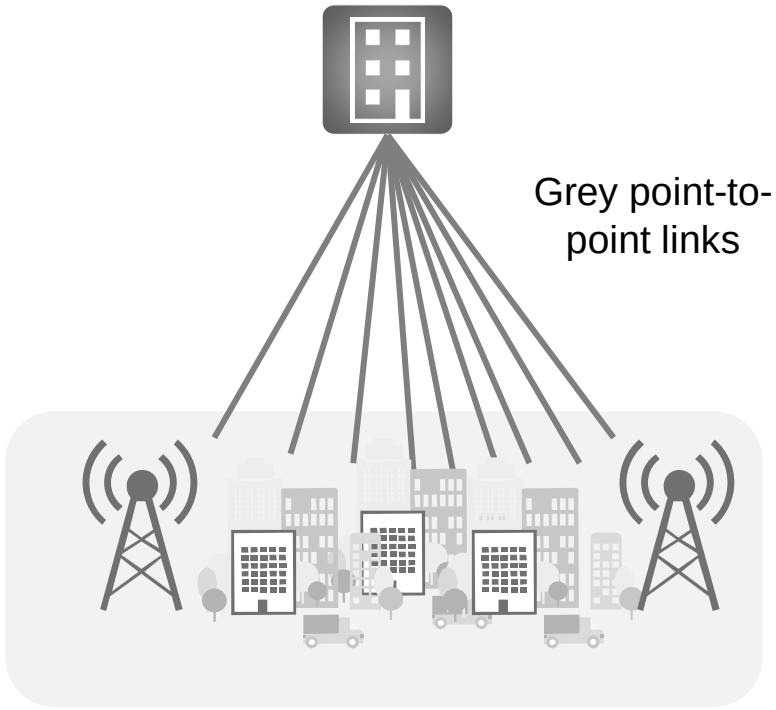
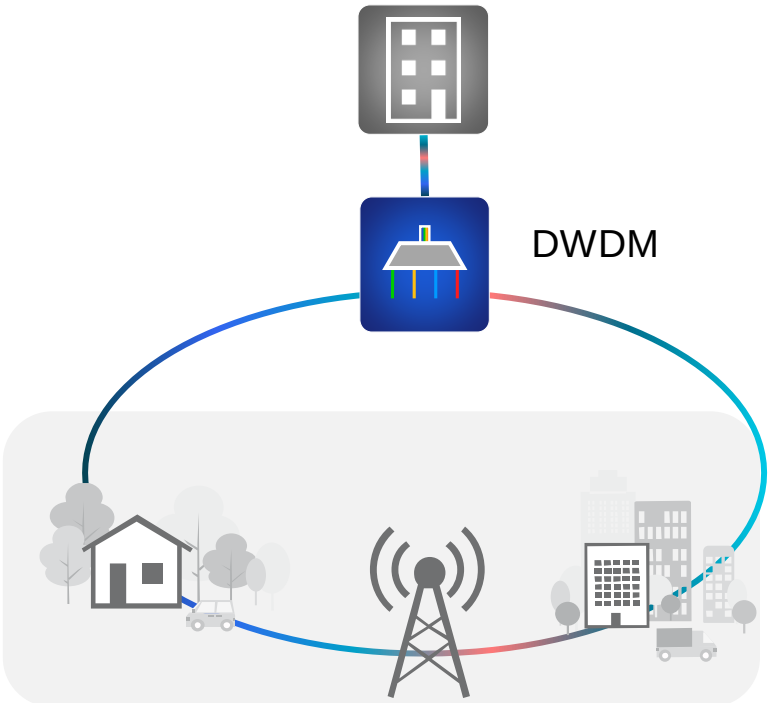
What are the optical layer options?



Best-effort traffic only



Best latency



Highest capacity per fiber and low latency

No silver bullet - Pragmatic approach is needed

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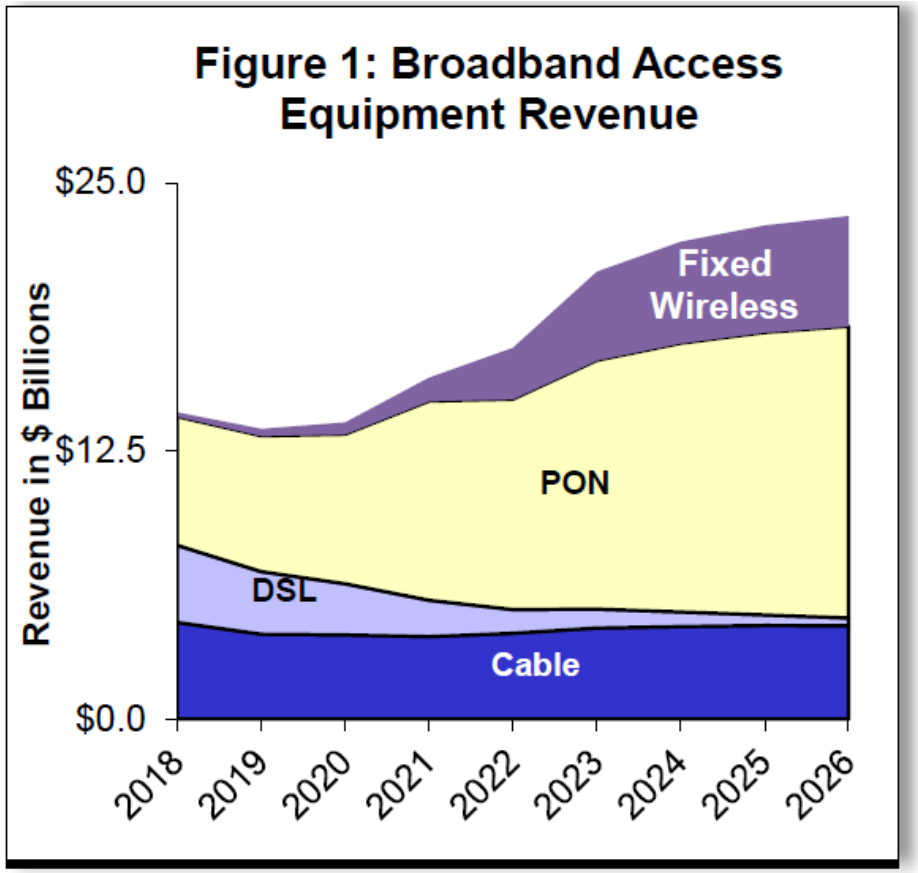
PON is becoming the dominant access technology

DSL rates are limited to about 50Mb/s
- Technology does not scale

Fixed wireless
- Good technology for fiber-poor areas

Cable
- Scaling beyond DOCSIS 3.1 requires a massive invest

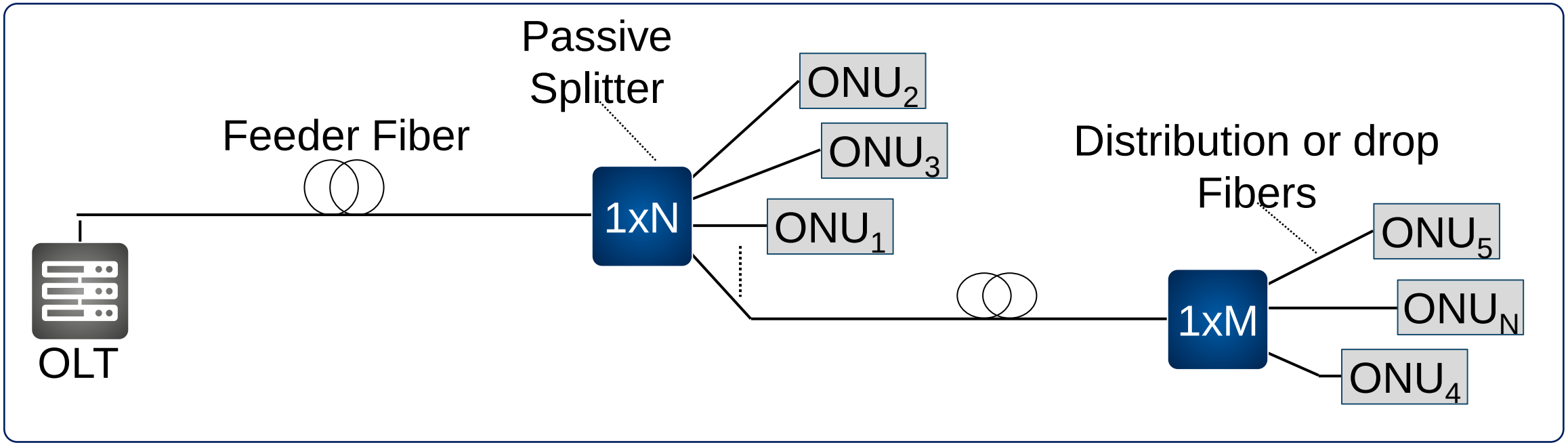
PON
- For most carriers the technology of choice



Dell Oro - Broadband_Access_Forecast_Summary – July 2022

Share of PON networks is rapidly expanding

PON Architecture (splitter based)



Typical network parameters

- Single passive splitter of 1x32 or 1x64
- Optical power budget of 28dB to 32dB
- 20km Feeder Fiber and 1km Drop Fiber

Sometimes ONU is referred to as “ONT”

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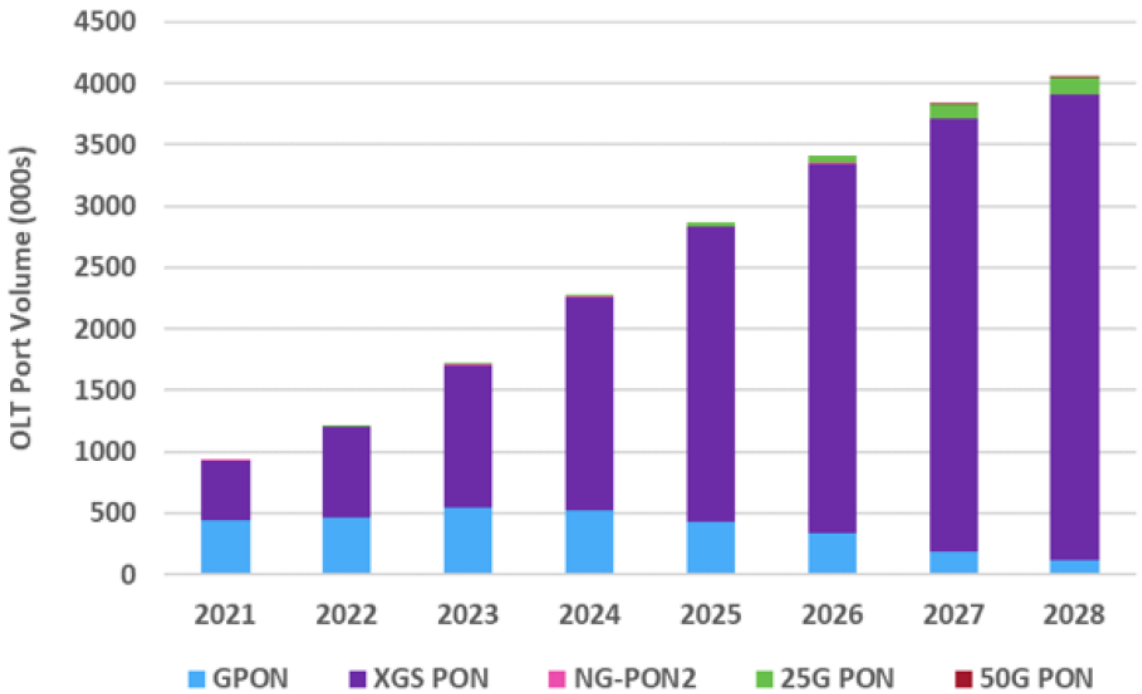
GPON OLT Port Forecast – by type - selected regions

North America:

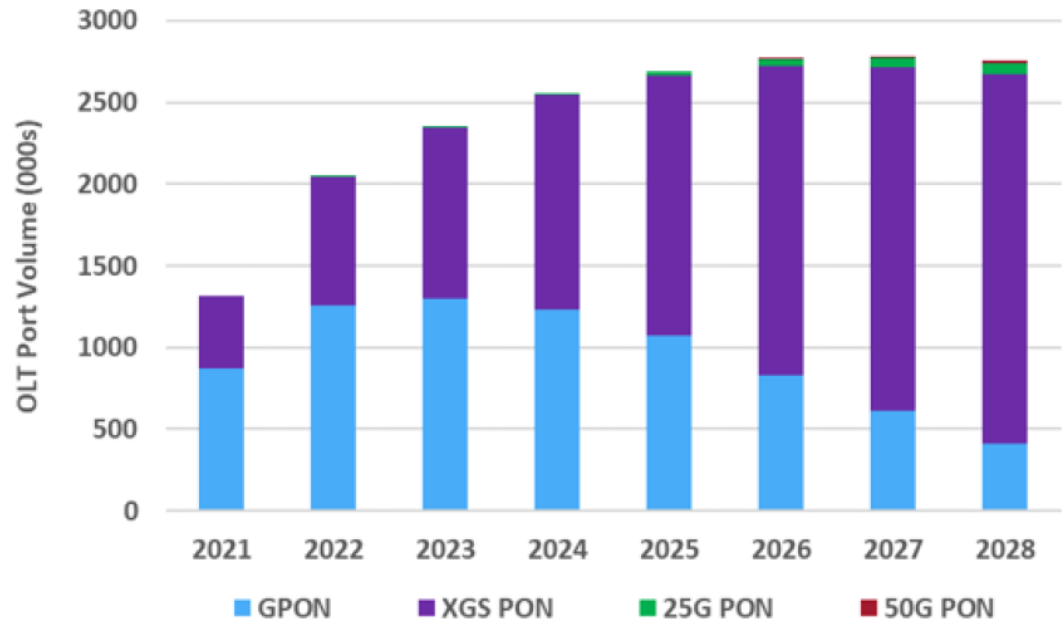
- Rapid adoption of XGS beginning in 2ndH 2021.
- 4X downstream and 8X upstream for less than 4X the cost.
- Growth throughout forecast years but supply constrained.
- Use of PON for beyond residential.



Source: Omdia

Western Europe:

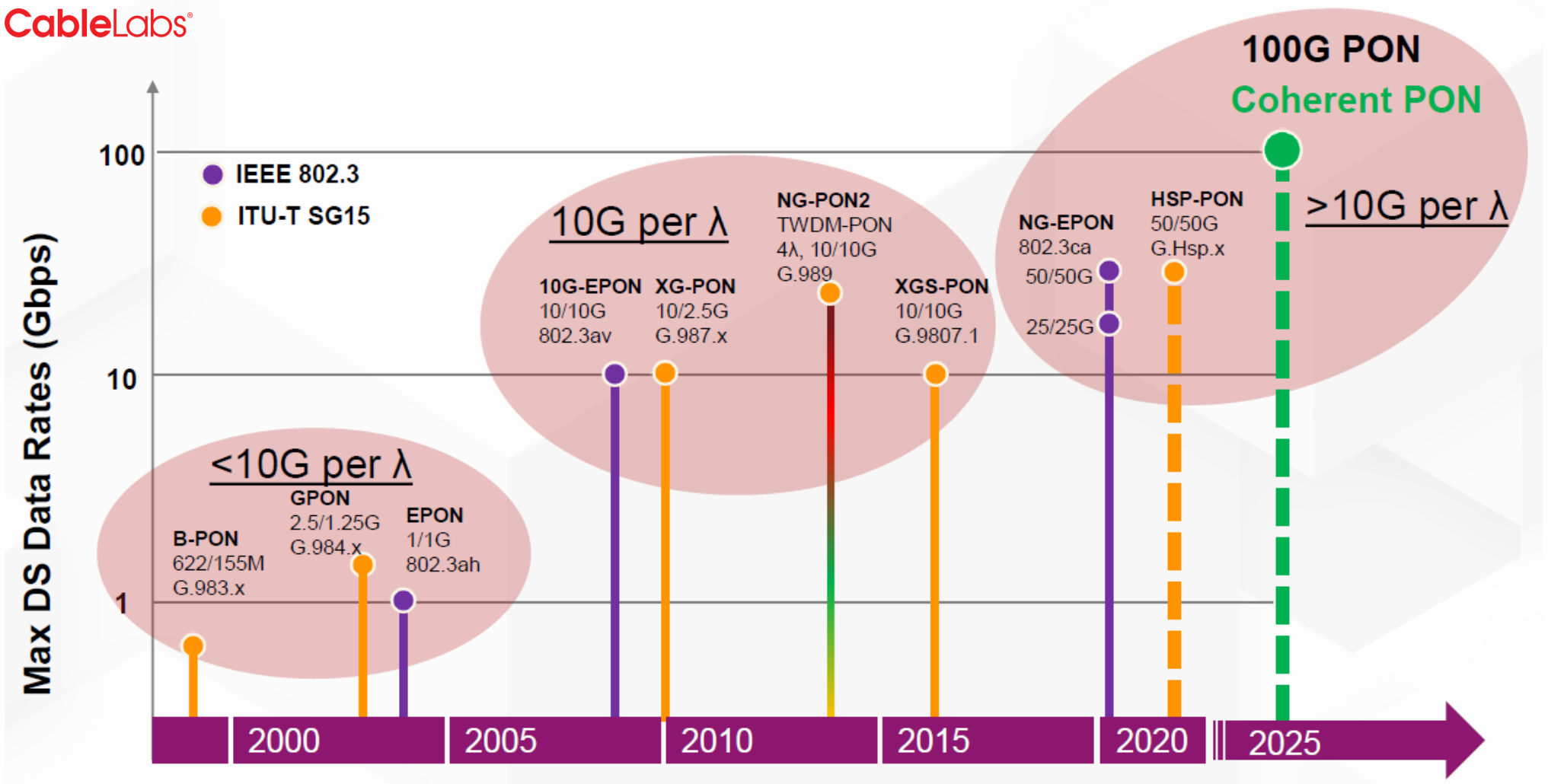
- XGS will exceed GPON in 2024.
- Bandwidth consumption is less in WE countries than in NA. Tariffs are lower too.
- AltNets are creating competitive environment in several countries.



Source: Omdia

Evolution of passive optical network (PON)

From 100 Mbps to 100 Gbps



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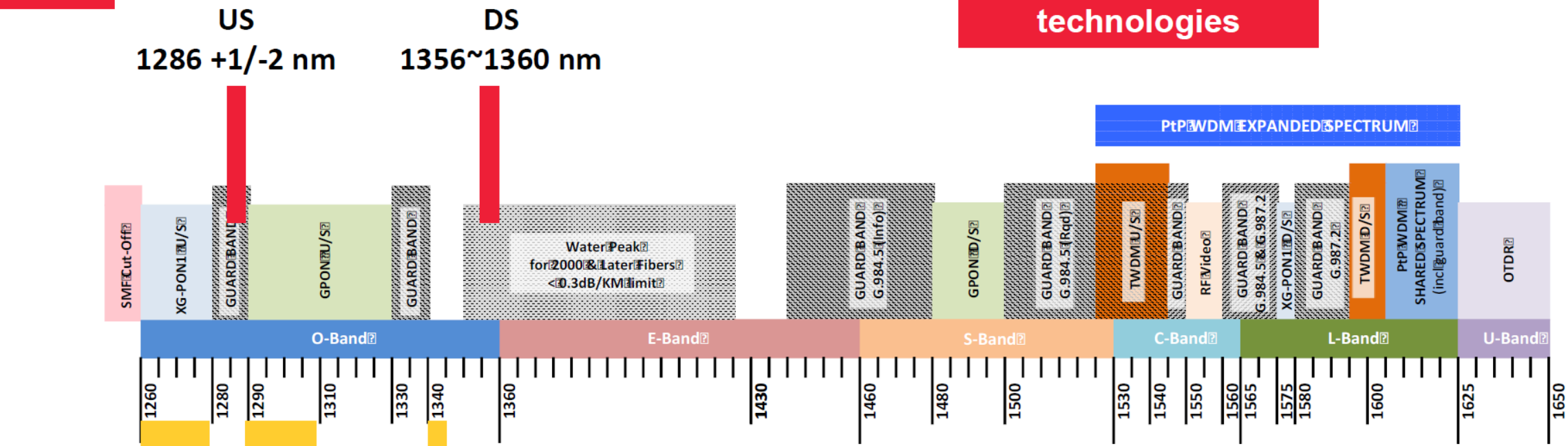
25GS-PON vs 50G-PON

25GS-PON MSA



Coexist with legacy technologies

50G-PON ITU-

US
1260~1280 nm

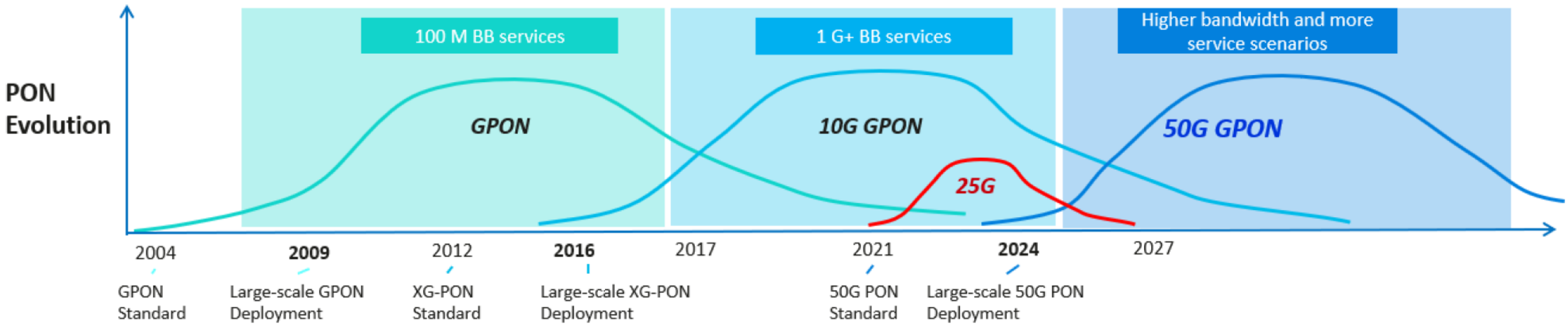
US
1290~1310 nm

DS
1340~1344 nm

Coexist with one of the legacy

Slide from Pic Advanced – presented at the Broadband Forum 2022

The access network upgrade cadence

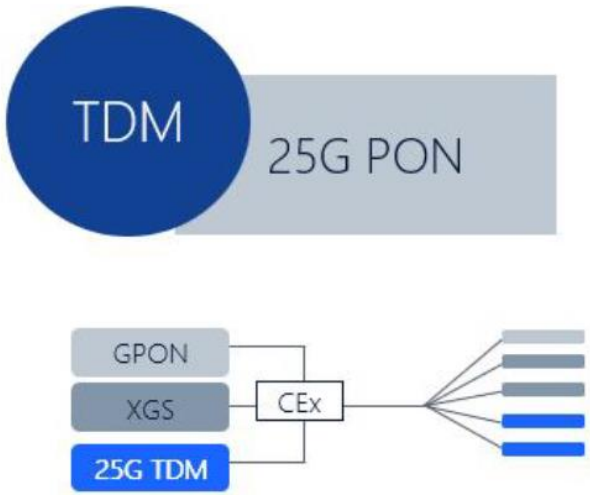


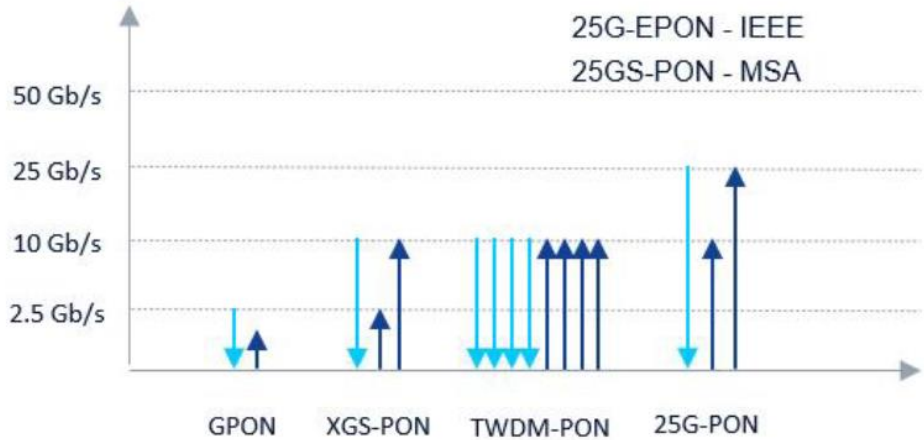
- The operators that deployed most of the PON in the world have clear requirements
  - Access network deployment pace is 8 to 10 years. Going any faster cannot be supported economically or operationally
  - Bandwidth must be upgraded by at least 4 times. Anything less than this is not worth the cost and effort
- 50G-PON is technically achievable in the required time
  - Majority system will be 50G down / 25G up
  - The introduction of DSP and soft FEC brings large improvements
  - Given the ~4 years before significant volume, we have the time

FUTUREWEI Technologies

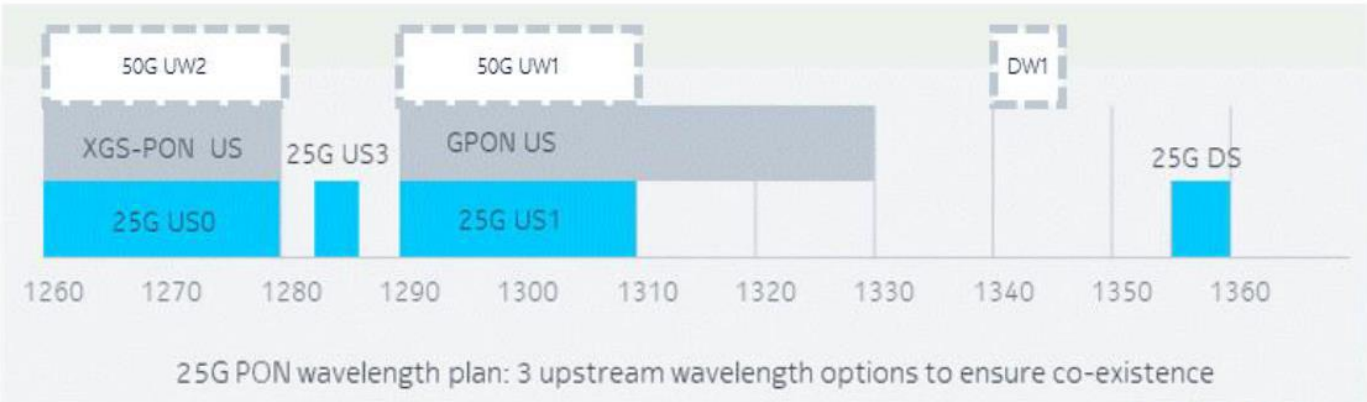
Slide from FutureWei – presented at the Broadband Forum 2022

Next step for PON: 25G PON aims for simplicity and cost-efficiency





- Leverage the existing mature eco-system
- Simple technology – no tunable lasers
- Co-existence with GPON, XGS-PON or both
  And future coexistence with G.HSP (50G)
- Matches 25G physical interfaces in radio units
- Bitrate tiers up to 20Gb/s

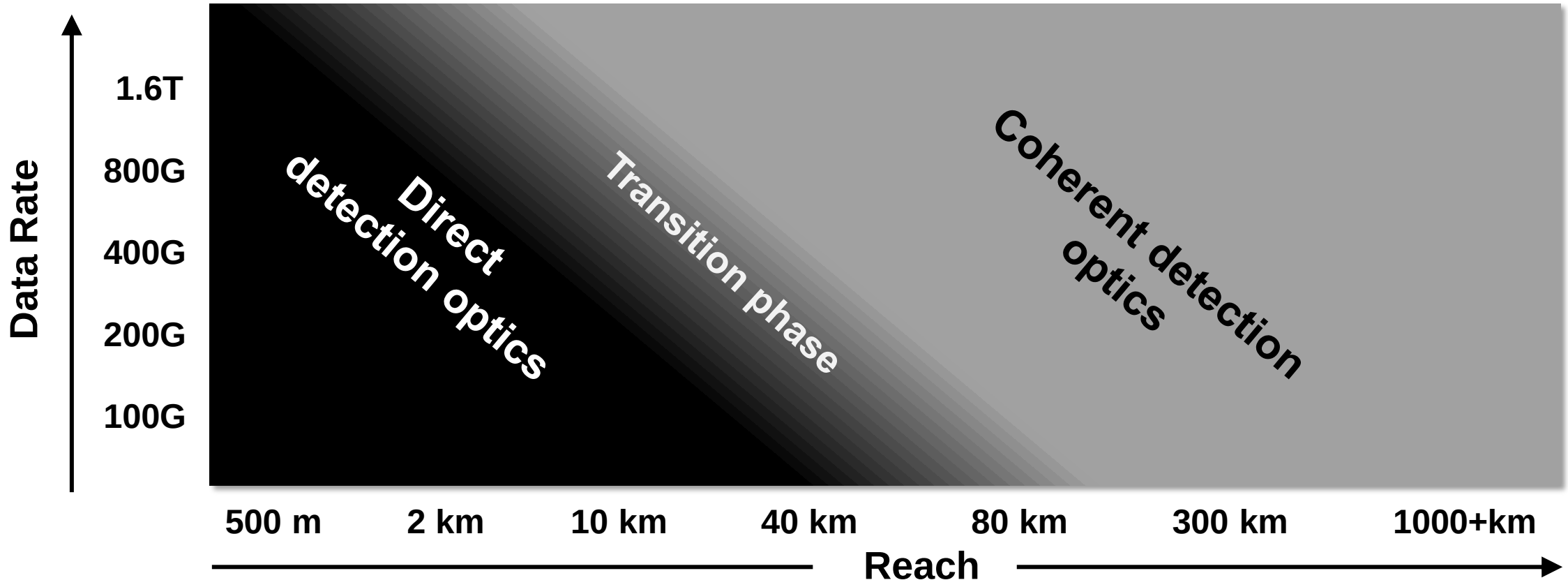


NOKIA

Slide from Nokia – presented at the Broadband Forum 2022

Coherent vs. Direct-Detection Optics

Technology evolution

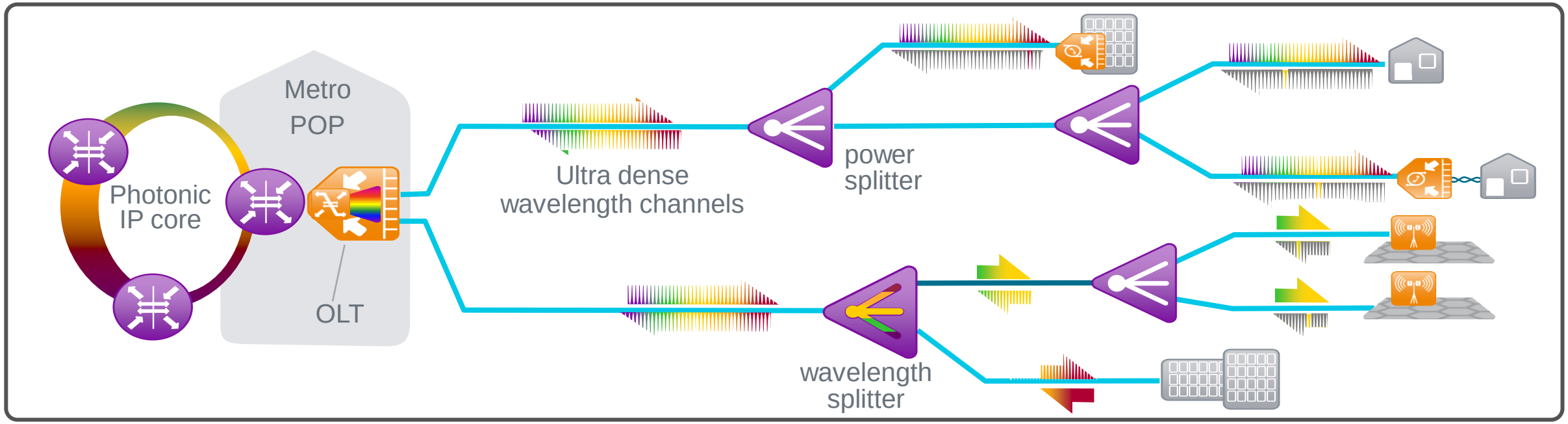


Direct-detect and coherent optics are converging more and more with increasing data rates

Coherent PON – original concept

Nokia Siemens Networks

Slide contributed by Harald Rohde



Capacity
- 1 λ per user (DS & US)
- Symmetric 1 Gbps/ user
- 3 GHz channel spacing
- Up to 1000 λ in C-band*

Passive reach
- 43 dB power budget
- Up to 100 km*

Coexistence & migration
- Support legacy ODN
- Coexist with G/XGPON/RF video
- Spectrum flexibility

Applications & services
- Residential
- Business
- Mobile backhaul

* Depending on choice of cascaded splitter / filter design

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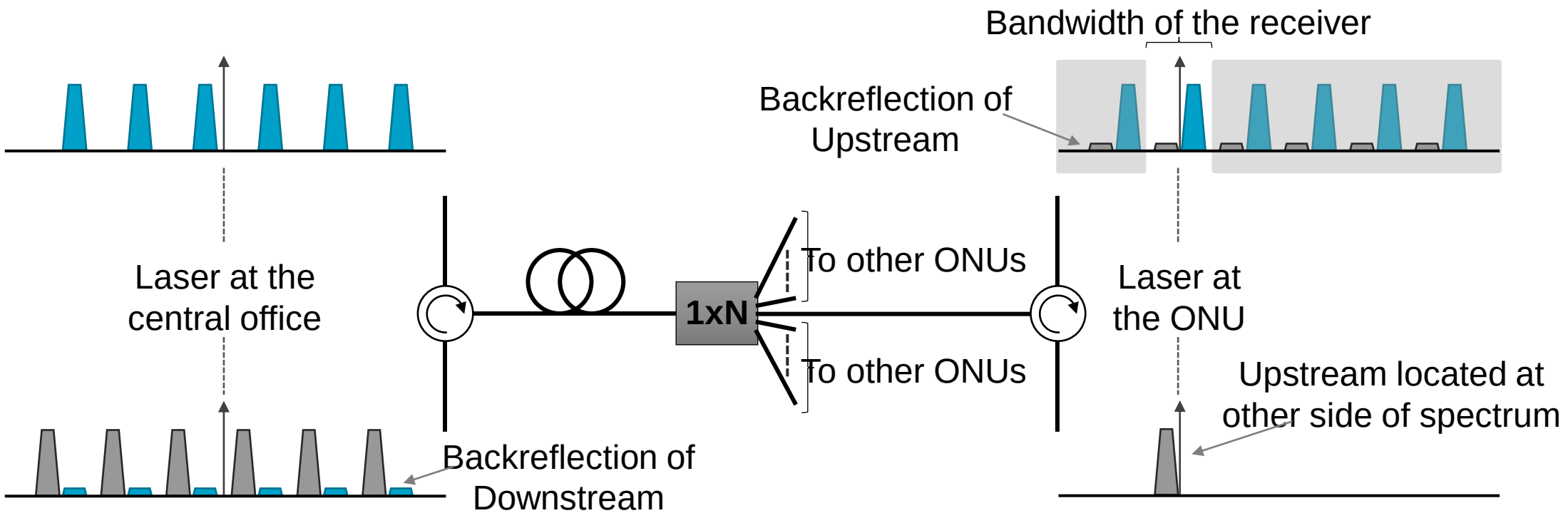
Wavelength allocation for PON operation

Central Office:
One laser is used to generate many subcarriers at once (6 in this example)

PON Network:
All ONUs receive the same spectrum with all subcarriers

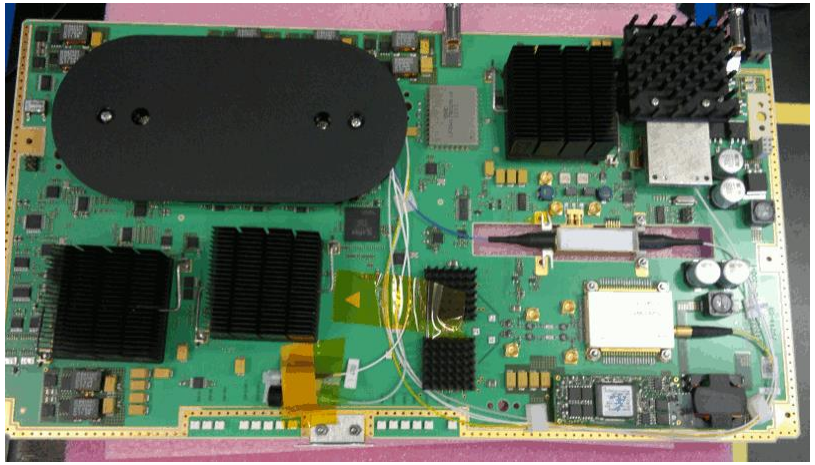
ONU Receiver:
The ONU tunes the laser to the subcarrier that is to be received

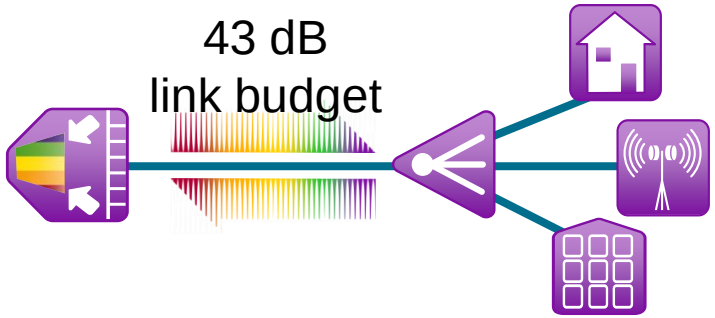


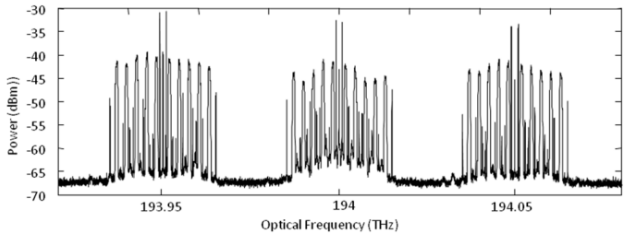
Proof of concept realization (2014)

Nokia Siemens Networks

Slide contributed by Harald Rohde







OLT

- Single board
- 10 channel Tx based on DAC
- 1 channel Rx based on commercial ADC
- Discrete off the shelve optical components

ONU

- 1Gb/s data rate
- Single board
- Integrated optical module
- Full scan and lock mechanism

Technology was well ahead of it's time…

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CableLabs CPON

Coherent PON – re-engaged

CPON Working Group

Members	Industry Groups
Charter	CableLabs
Cogeco	SCTE
Comcast	
Cox	
GCI	
Izzi	
Liberty Global	
Mediacom	
Midco	
Rogers	
Shaw	
Sparklight	
Videotron	
Vodafone	

Technology Vendor
ADVA
Antronix
Broadcom
Calix
Ciena
CIG Tech
Cisco
CommScope
Hisense
Huber + Suhner
Infinera
MACOM
Marvell
NEL-America
Tibit
Vecima

CableLabs

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CableLabs Webinar, 100G CPON - Use Cases, Technology and Specification Development, 2022

What is Coherent PON (CPON)

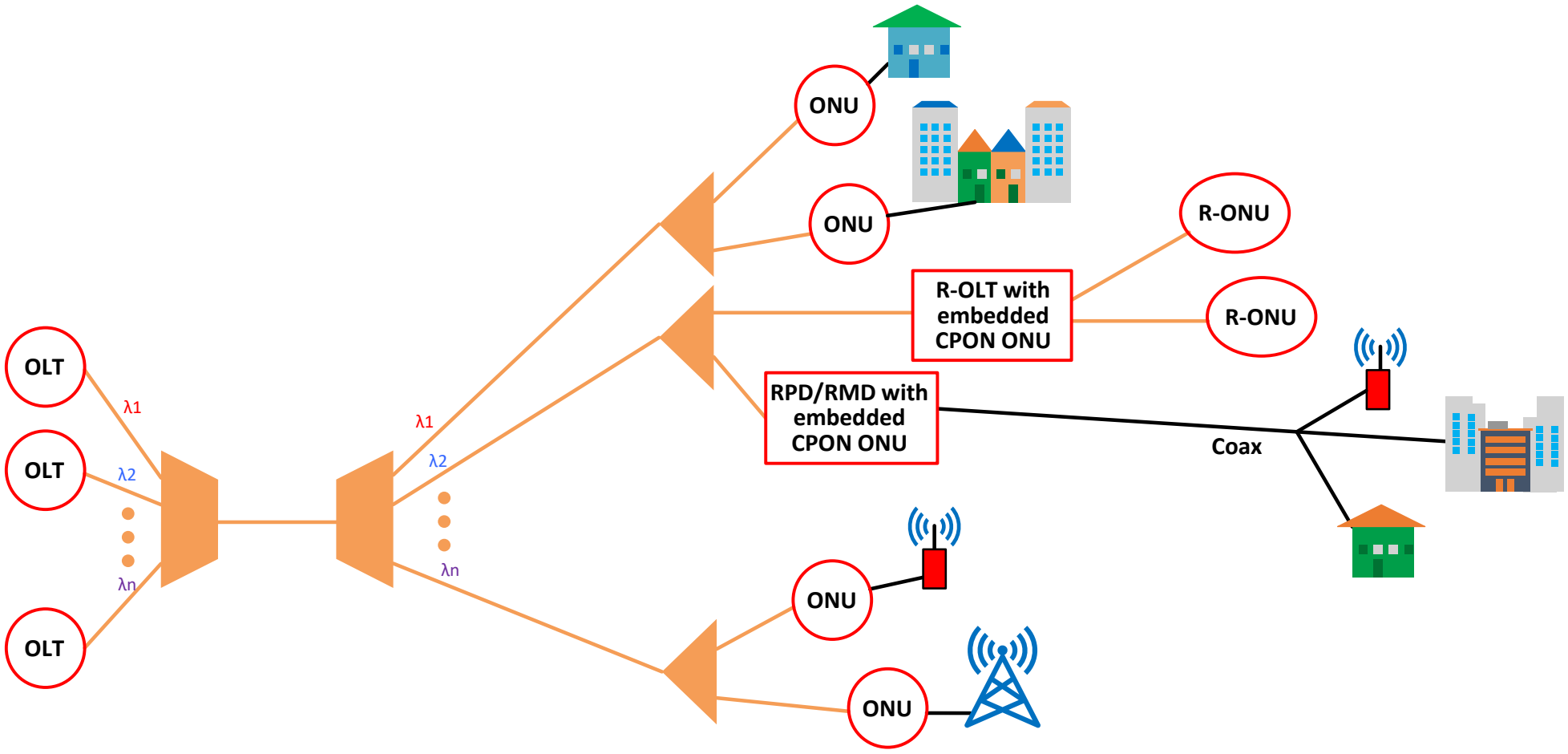
Like traditional PON

- Access applications
- Passive optical distribution network
  - Power splitter based
- Point-to-multipoint topology
- Shared capacity

- Coherent modulation and detection
- Enabling 100 Gbps and beyond
- Longer reach and higher split ratio
- Wavelength multiplexing capability
- Optimized optical power distribution
- …

Yet, many differences

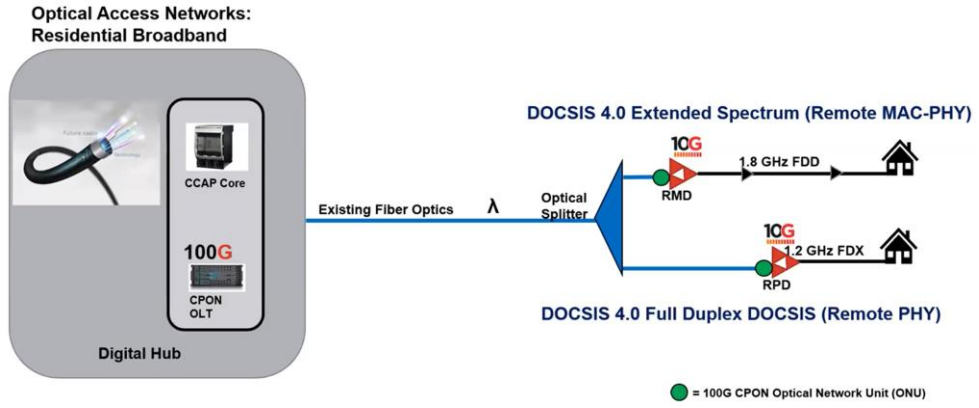
CPON scope



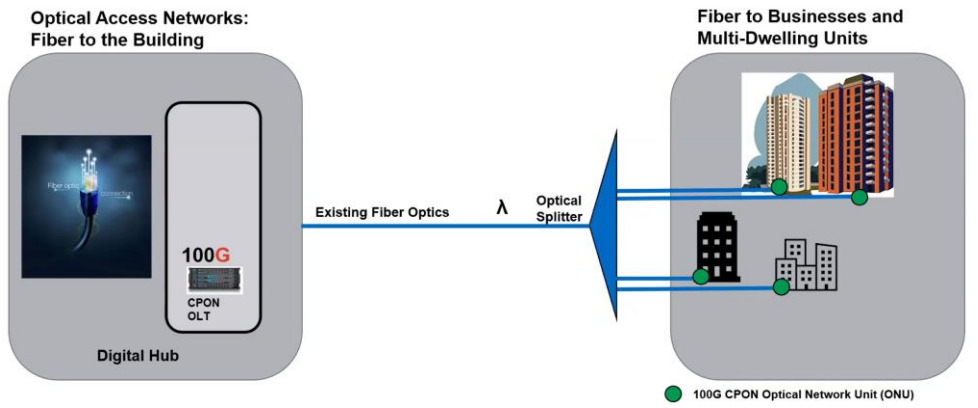
CPON with WDM supporting various applications

Envisaged use cases

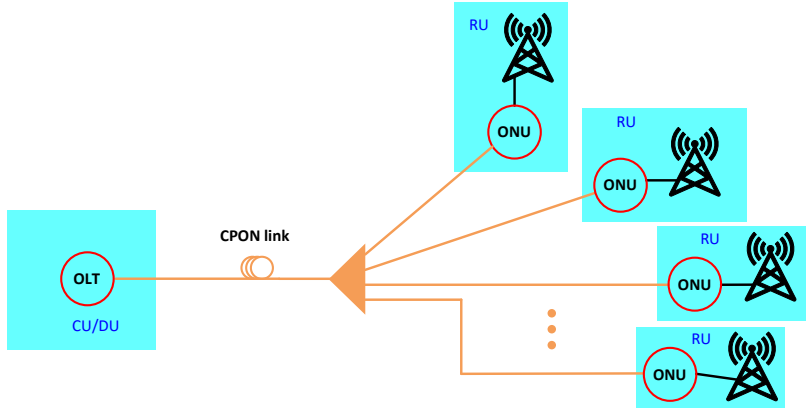
Residential cable broadband



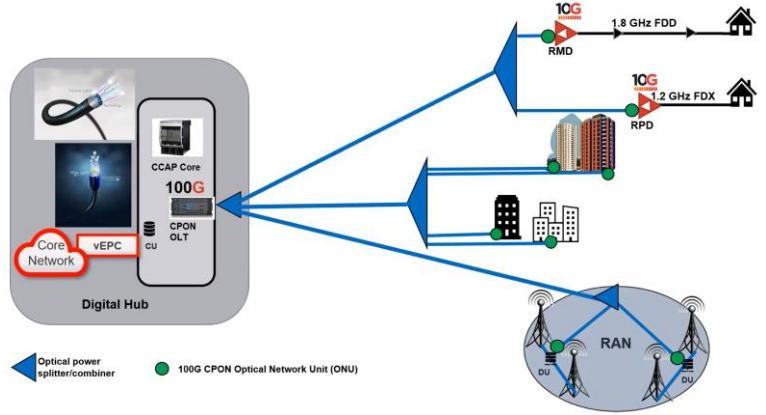
Fiber to the building



RAN transport: mid- & fronthaul



100G aggregation (mixed use)



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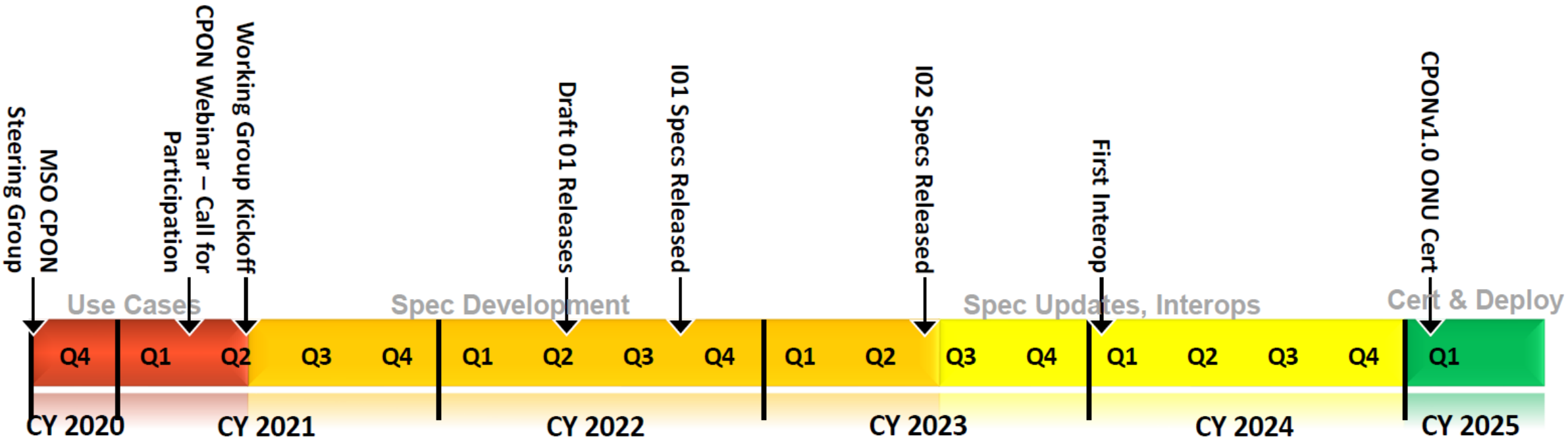
CPON project schedule

CableLabs®



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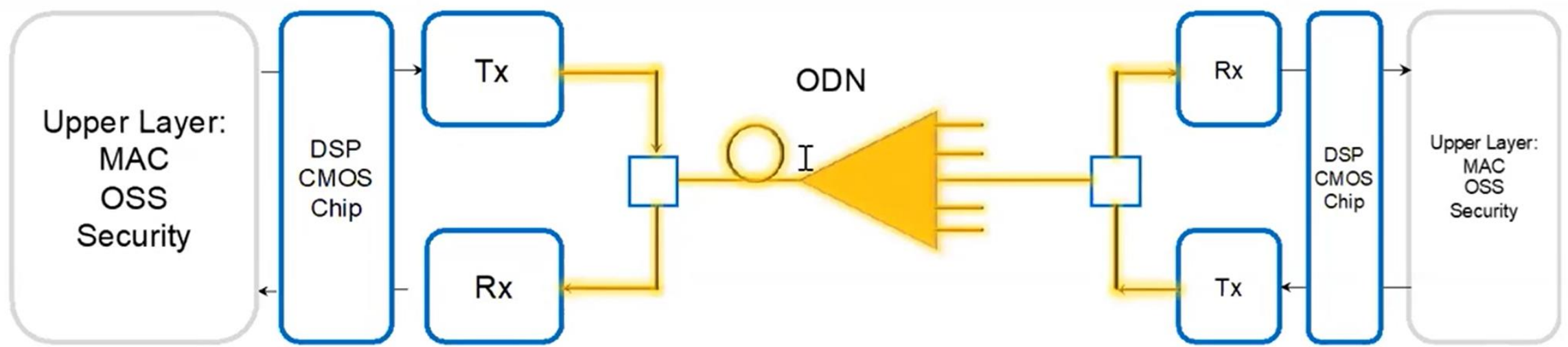
CPON architecture (draft)

Introducing coherent optics for PON

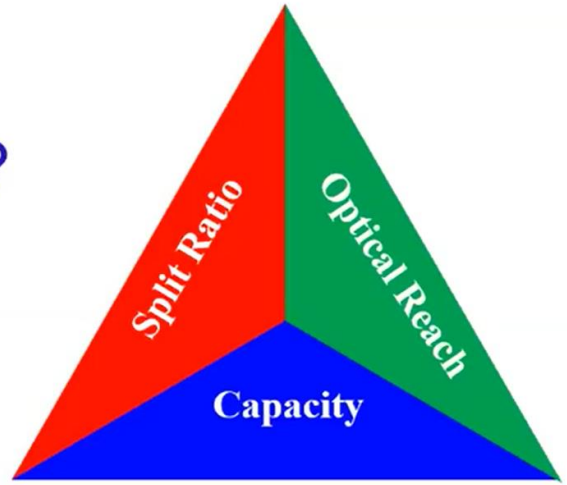


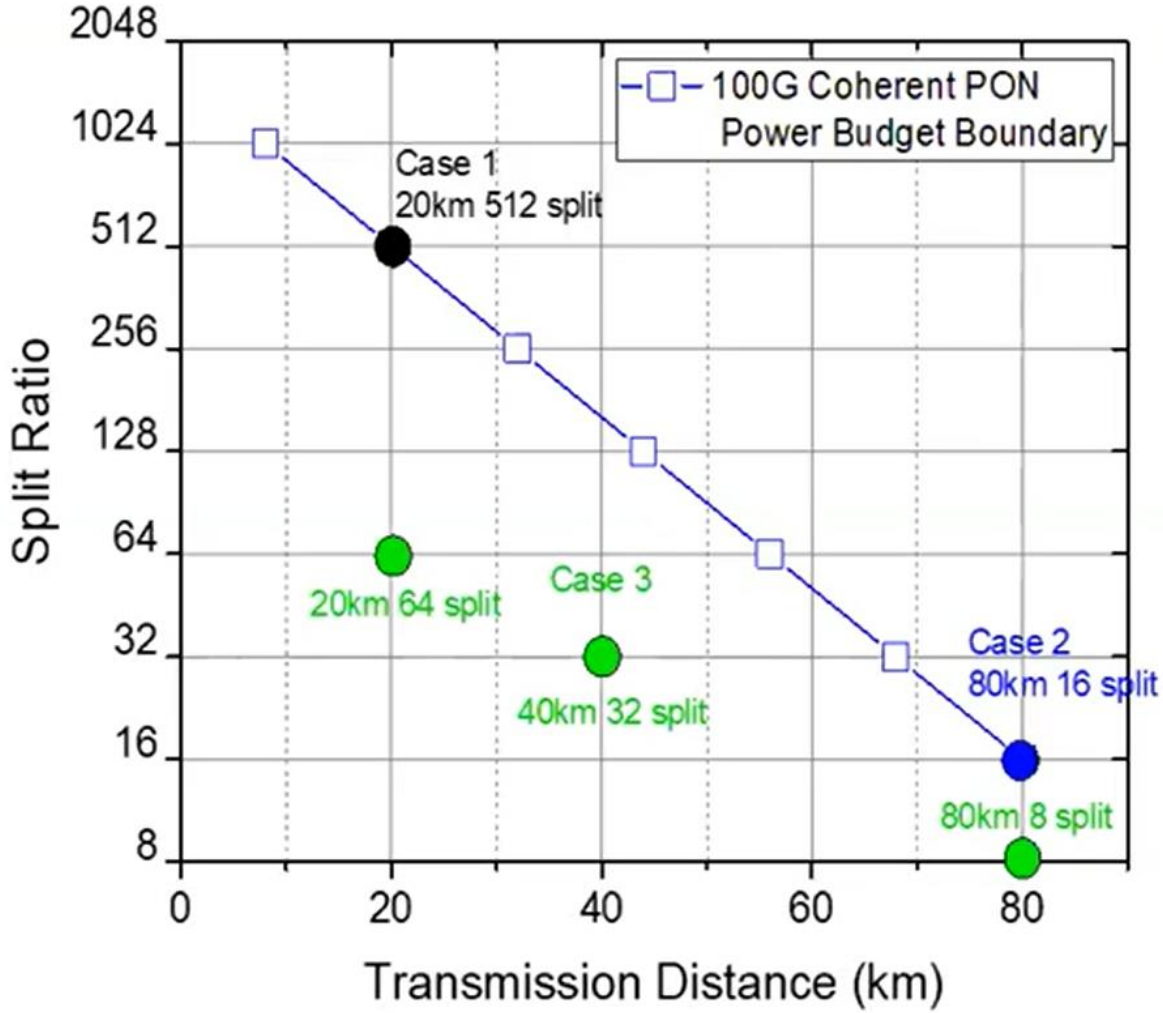
- System requirements
  - Power budget, coexistence and migration, reliability, …
- MAC and upper layers
- PHY layer optical interface
  - Modulation, line rate, coding, power level, wavelength grid,

TDM or FDM, …

Operator's vision (Vodafone)

100 Gbps Capacity?
80 KM Reach?
512:1 Split Ratio?





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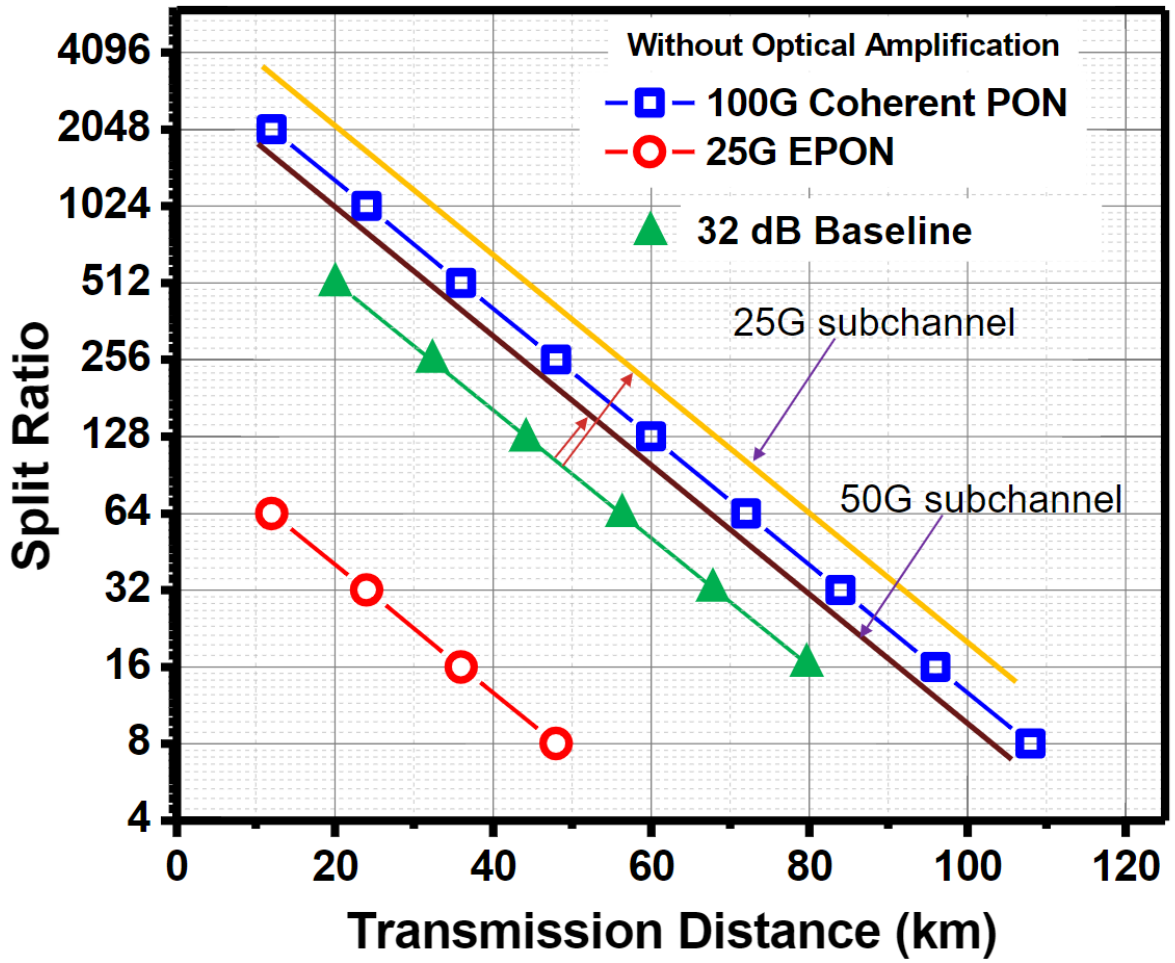
Current “hot topics”

CPON Downrating



CableLabs

- Proposed feature: the ability to reduce an ONU’s operating spectrum below nominal spectrum for 100G capability
- By halving spectrum (burgundy line):
  - Reduce available capacity to 50G
  - Increase link budget by 3 dB to baseline
- By halving spectrum again (gold line):
  - Reduce available capacity to 25G
  - Increase link budget by 6 dB to baseline
- At same split ratio, could represent 12-24 km of additional reach
- At same distance, can increase split ratio

5 5

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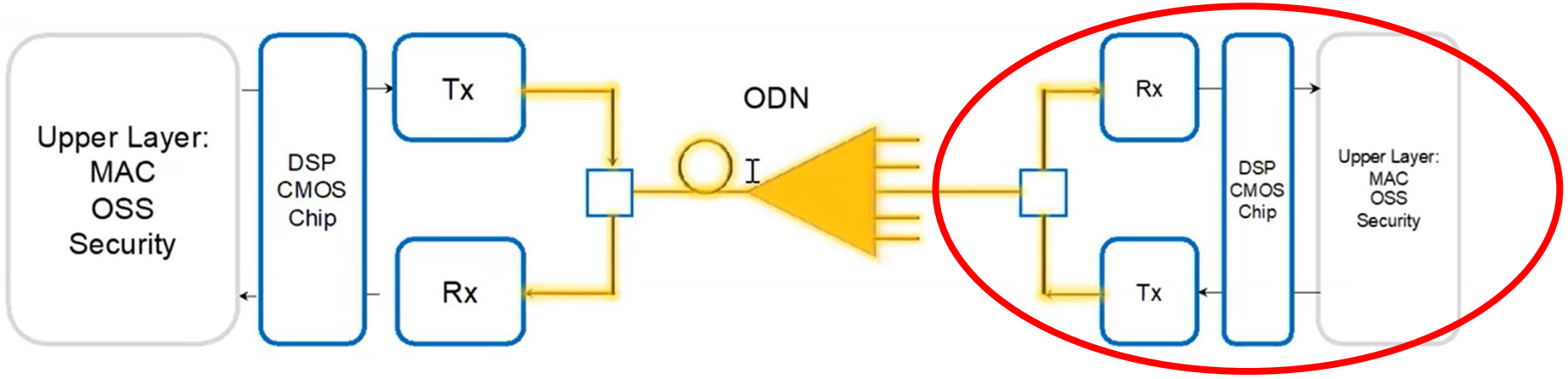
The Elephant in the room

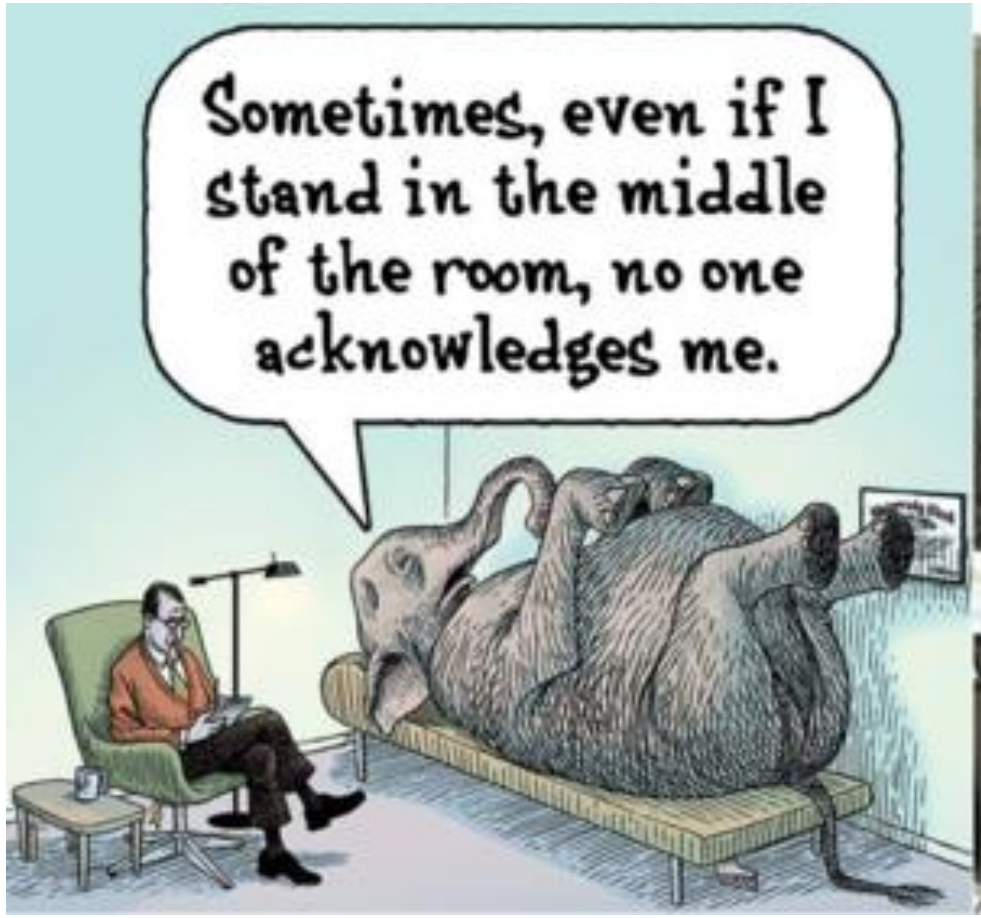
Will it be overseen (again) this time?



Low phase-noise laser
Tunable?

Coherent TX/RX
(IC-TROSA)

ASIC for DSP
Power dissipation



Thank you for your attention

Thank you

sjansen@adva.com