

ANGA COM 2025 | Axians In-Booth Theater

Solving high-capacity challenge at the optical edge—bringing single-fiber access networks into the coherent DWDM era

Jon Baldry, Nokia





Solving the high-capacity challenge at the optical edge

Bringing single-fiber access networks into
the coherent DWDM era

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ANGA COM - 4th June 2025

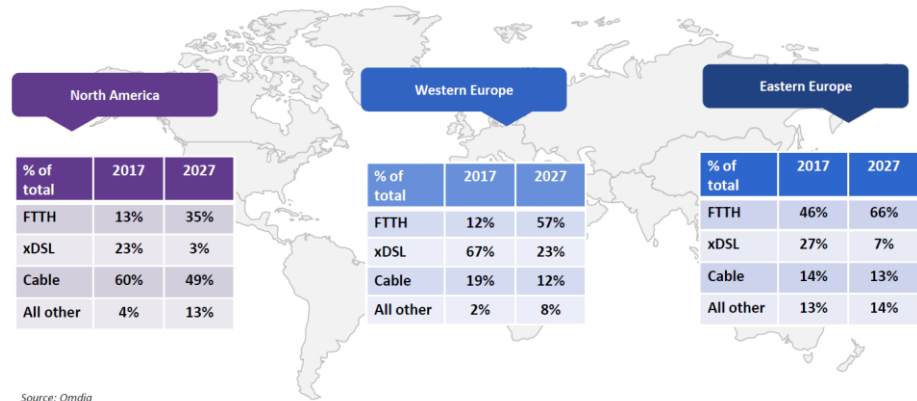


Market dynamics in last mile optical access networks

Last mile single fiber PON infrastructure is a massive investment and is here to stay!

- Large strategic government fiber investment programs, e.g. **\$42.5B** Broadband Equity, Access and Development (BEAD) program in USA
- PON-based FTTH rapidly becoming the predominant residential broadband technology in most regions
- PON deployment cost breakdown*:
 - 10% Active equipment
 - PON OLT & ONU
 - 90% Passive infrastructure
 - 35% Civil work
 - 55% ducts, cables, splitters, etc
- Large growth anticipated in 2022-27, driven mainly by XGS-PON**

Context – broadband subscriptions by technology for selected regions



Source: Omdia

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OMDIA

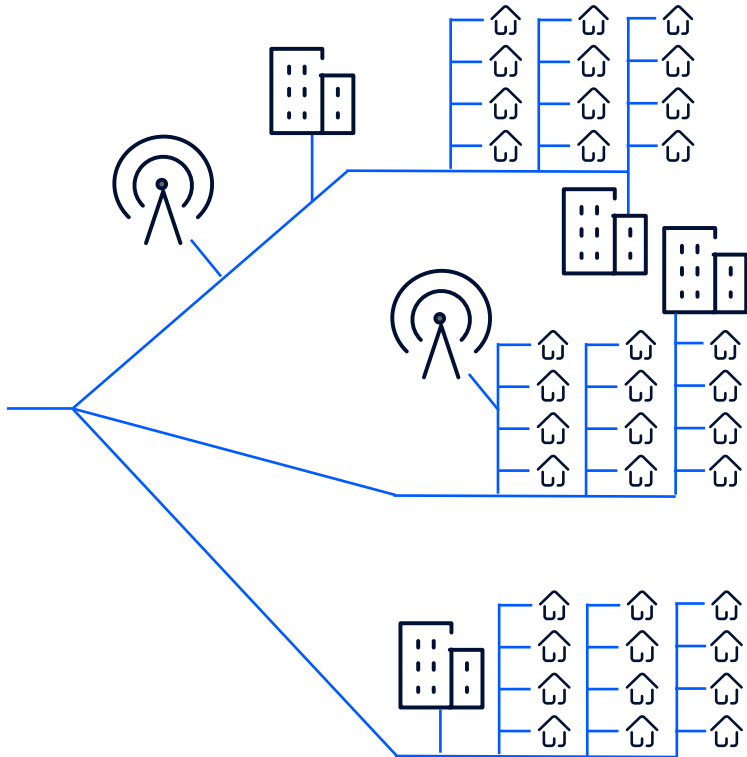
Source: OMDIA PON Webinar, Nov 2022

* Source: OMDIA PON Webinar - Orange presentation, Nov 2022

** Source: Dell'Oro Broadband report press release, Jan 2023

High-capacity services over single fiber working infrastructure

Can we leverage PON infrastructure for high-capacity enterprise and mobile services?



- We often don't live in totally residential blocks
- Residential driven PON infrastructure often overlaps with business parks and enterprise locations
- Mobile cell sites are also on-net or close by:
 - In some regions up to 50% of existing mobile macro sites are still backhauled on microwave due to lack of economic fiber availability
 - 5G will drive many more macro cell and small cell deployments close to where people live and work

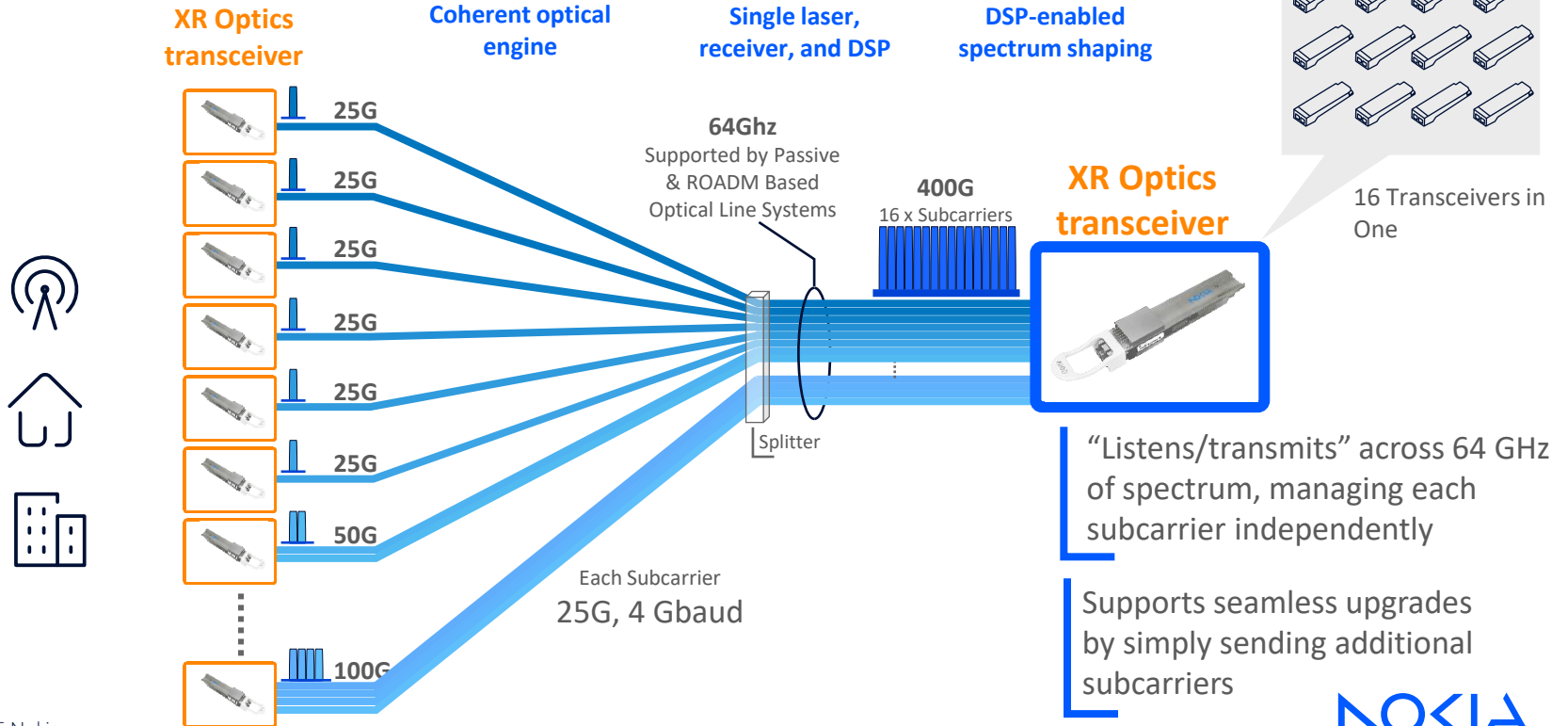


Introducing the XR Optics architecture

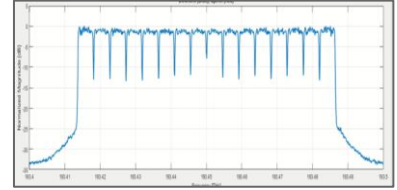
NOKIA

Transforming point-to-multipoint aggregation

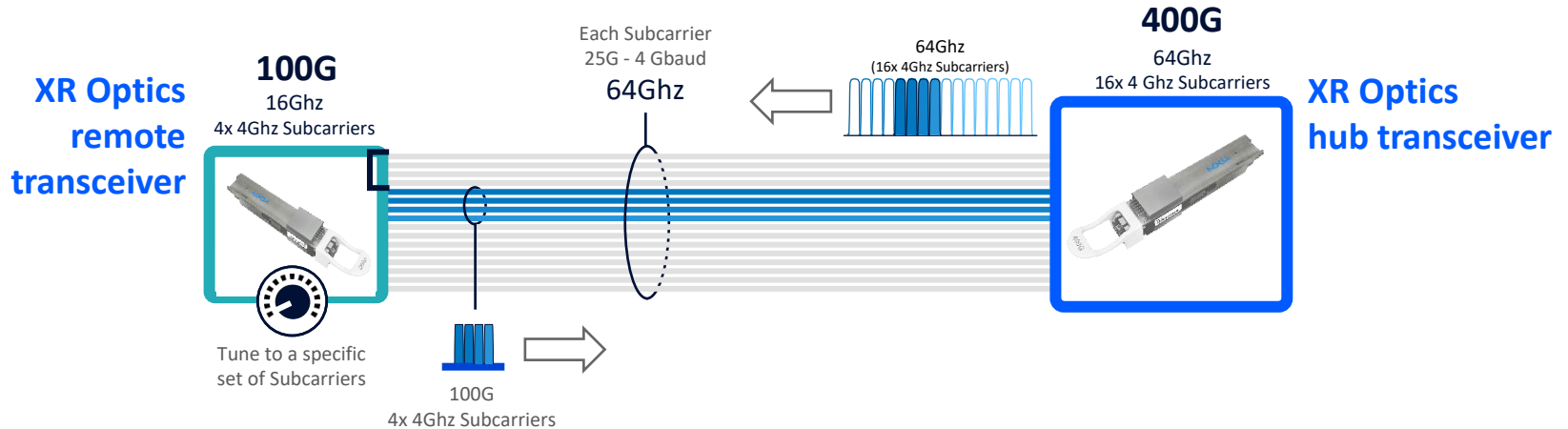
Point-to-multipoint subcarrier-based transceiver technology



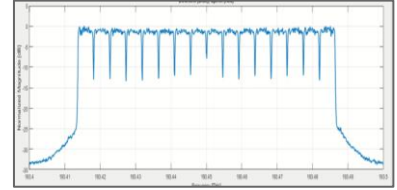
XR Optics in fiber pair applications



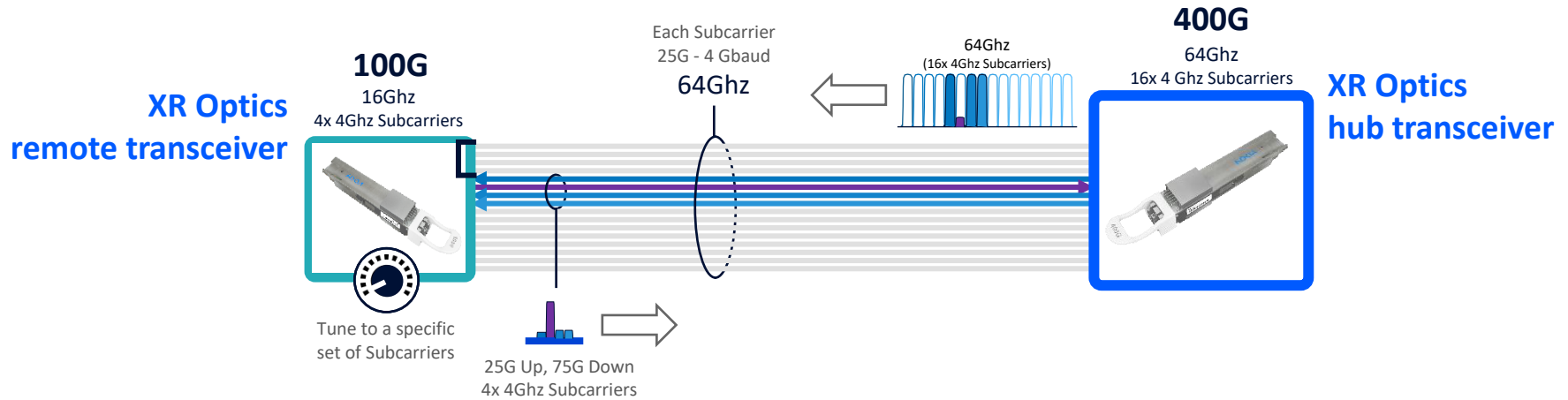
Nyquist subcarrier point-to-multipoint transceiver technology



XR Optics in single fiber applications

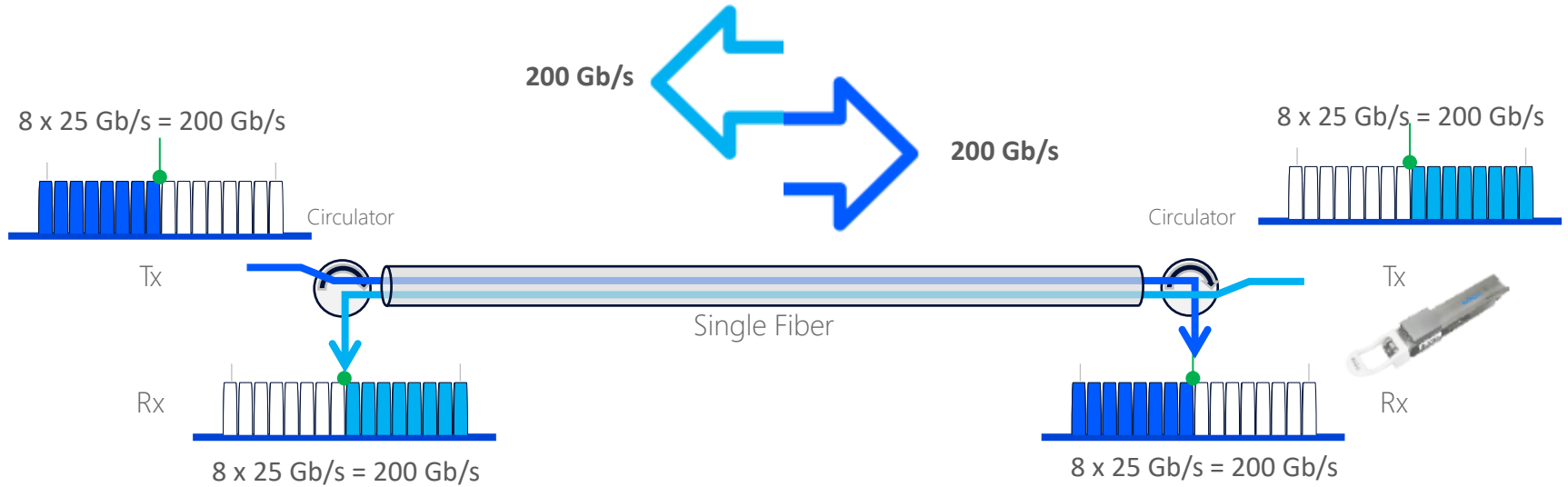


Nyquist subcarrier Up-link and down-link allocation



XR Optics enables single fiber deployments in the field

Coherent over single fiber (Bi-Di)



Implementing XR Optics with ICE-X 400G

Performance



1
Maximize resource utilization

Programmability

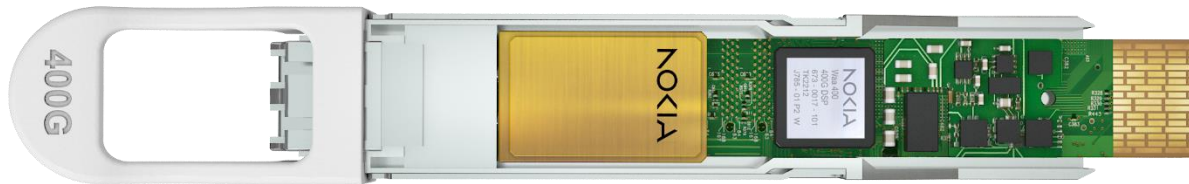


2
Maximize addressable applications

Manageability



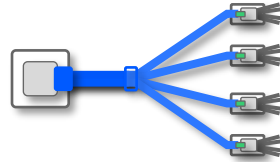
3
“A tool is ever only as good as your ability to use it”



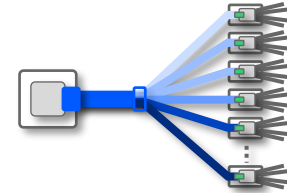
ICE-X 400G: Multiple applications from one device



Point-to-point Applications

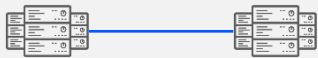


Coherent Breakout Applications



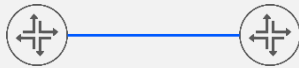
Point-to-multipoint Applications

Data Center Interconnect



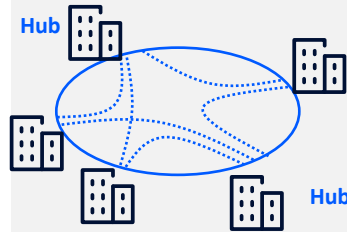
- Connect two or many data centers
- Distance from 40km to 1000s of km

IPoDWDM



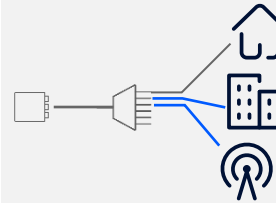
- Connect two or many routers (aggregation) over an open line system
- Distance from 40km to 1000s of km

Metro Aggregation



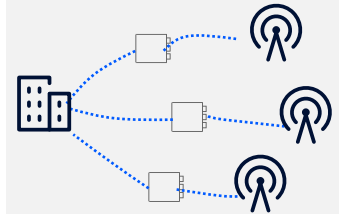
- Aggregate traffic from different metro end sites to one or two hubs over a ring or a horseshoe

Dedicated 100G Services over PON



- Deliver high-capacity business and PON/5G backhaul services over existing PON infrastructure by leveraging single fiber infrastructure

5G xHaul



- Backhaul 5G traffic to central office over fiber pair or single fiber.
- Topologies can be linear, ring or horseshoe

Applications Deployable Over Dual or Single Fiber Networks

ICE-X in single fiber PON networks

The Nokia logo is a large, stylized blue chevron shape pointing to the left, which serves as a background for the word "NOKIA".

NOKIA

The challenges of single fiber working (SFW) for coherent optics

XR Optics and ICE-X 400G can address this challenge!



• Direct detect/OOK Optics

- 10G OOK ok with bi-di optics
- 25G OOK very limited
 - 15km with no intermediate filters
- No long-term path for OOK



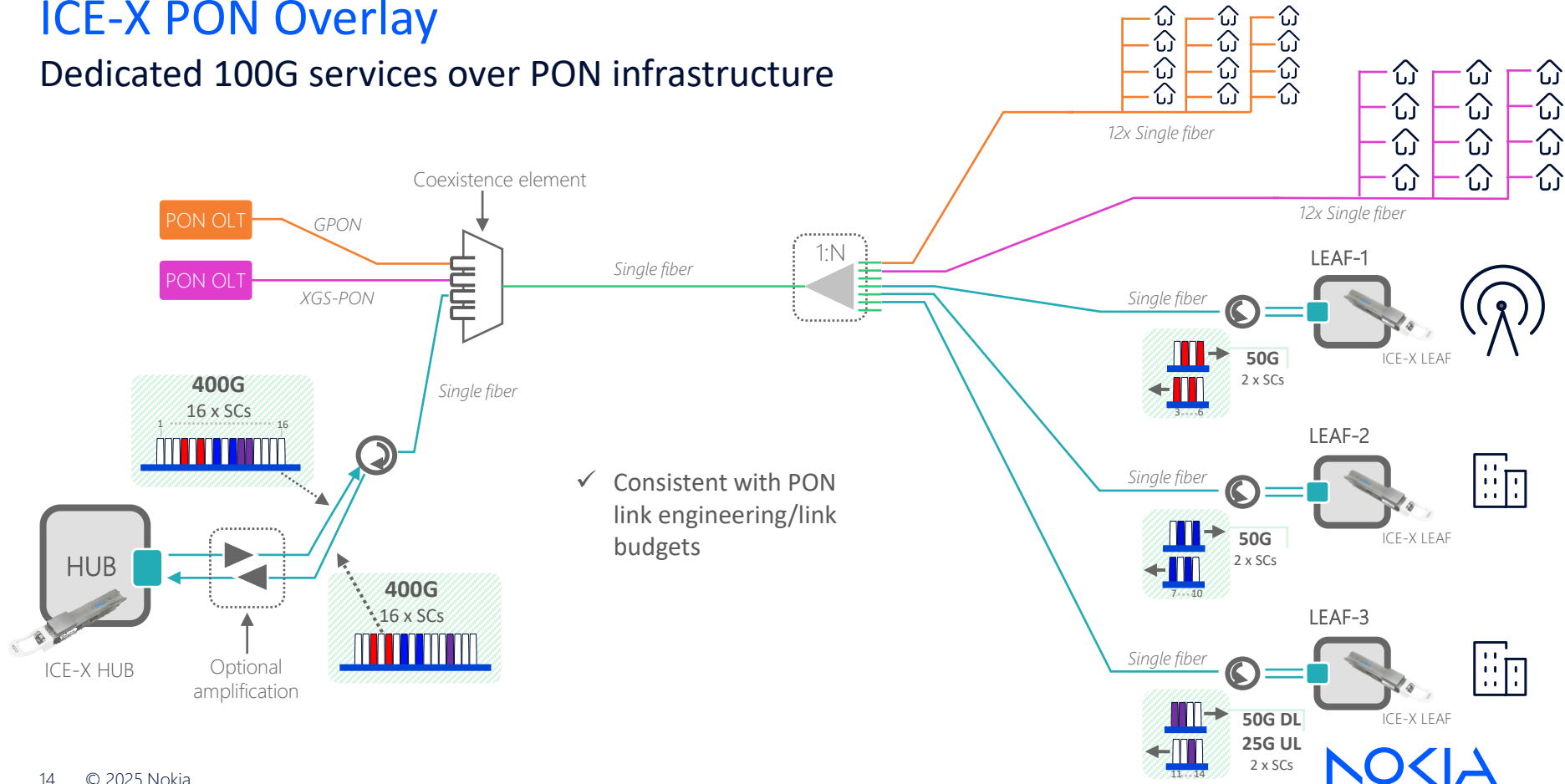
• High-speed Coherent Optics*

- Uses local tx laser as rx reference – locks tx and rx to same wavelength
 - Very challenging for SFW
 - Some short distances may be supported for P2P but needs careful reflections management
- Not capable of supporting PON infrastructure

* Some dual-laser lower speed (100G) coherent optics modules are available but at a higher cost due to the additional laser and lower reach performance

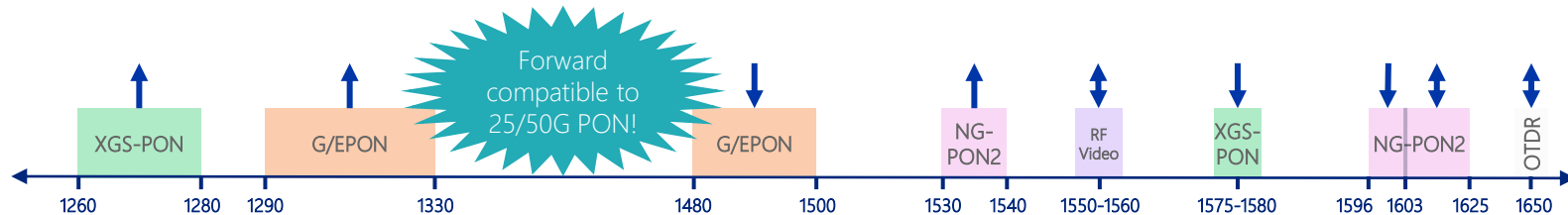
ICE-X PON Overlay

Dedicated 100G services over PON infrastructure

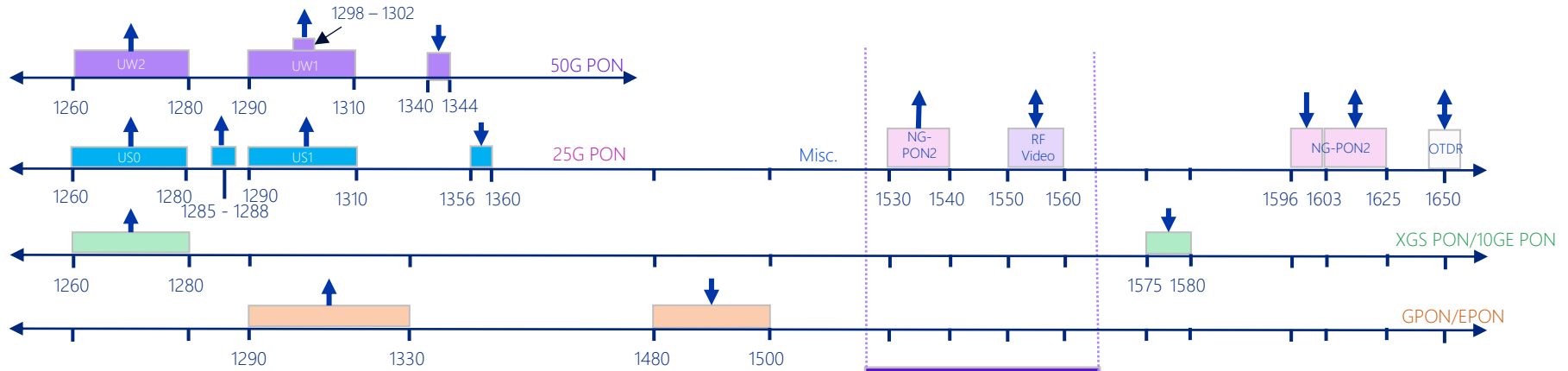


High-capacity PON overlay technical requirements

- Services over 10G require single fiber coherent DWDM
 - 25G OOK does not have the reach budget for PON overlay
 - Standard coherent optics don't support single fiber working!
- Temperature hardened I-Temp optics supporting -40°C (-40°F) to +85°C (185°F) case temperature
 - Note, hosting system temperature range is typically -40°C to +65/70°C
- DWDM C-band tuneability for coexistence with multiple PON technologies
 - ICE-X PON optimised range supports 17 wavelengths with **272x 25G** subcarriers
 - Full ICE-X C-band tuneability across 64 wavelengths supporting 100s of subcarriers
- PON optical distribution network (ODN) optical budget requirements
 - Must support existing PON network architectures



ICE-X and PON standardised spectrum



ICE-X Tx Window
1528 – 1567 nm

ICE-X is ITU FLEXGrid compliant
in 6.25GHz increments
ICE-X optimised (+2 dBm)
window from ~1537 – 1550 nm

Per Ch Spectral
Width is 64GHz



25G PON

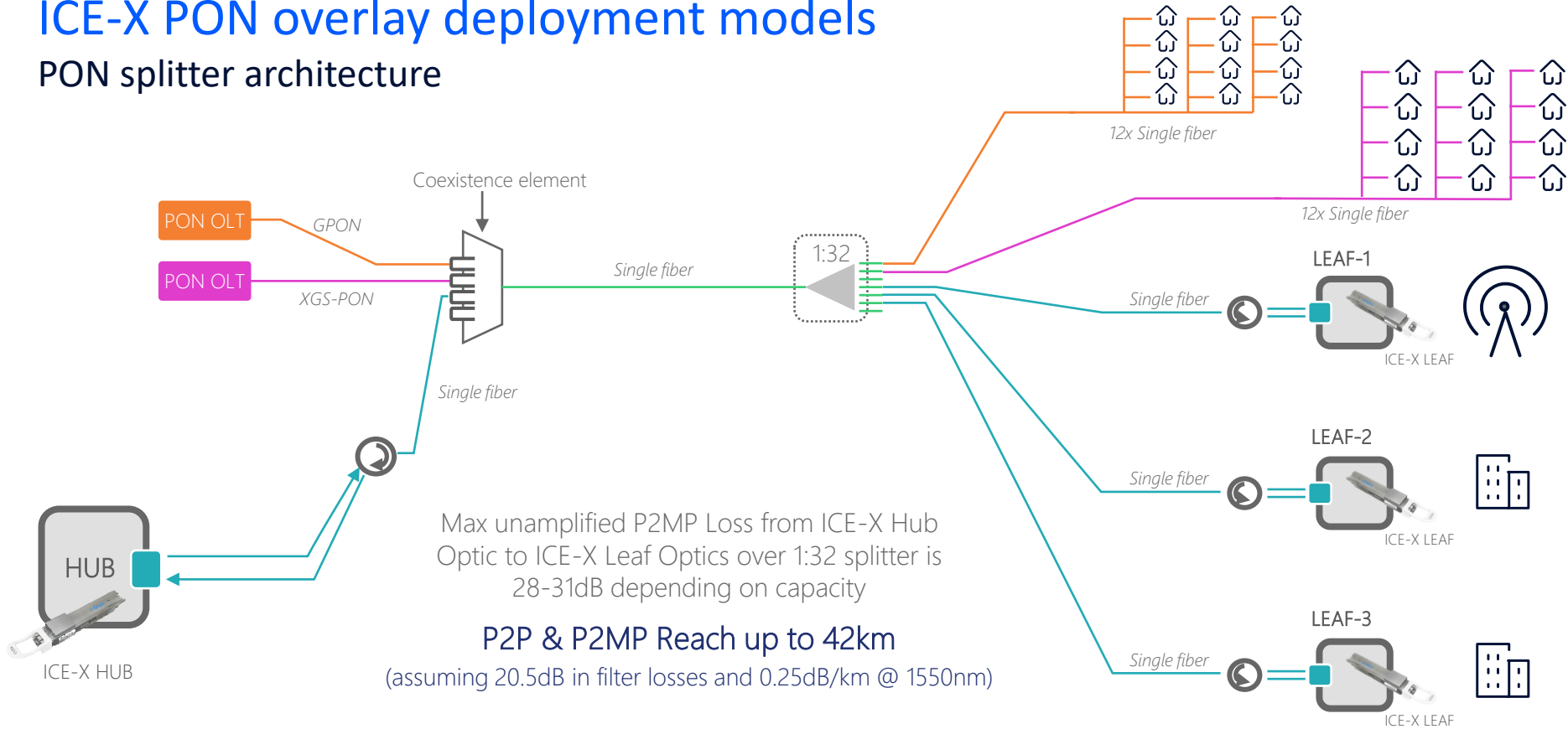
- Narrow band downlink with no overlap
- Uplink has 3 options depending on coexistence requirements with 1G and 10G PON deployments over ODN

50G PON

- Narrow band downlink with no overlap
- Uplink has 3 options depending on coexistence requirements with 1G, 10G, and 25G PON deployments over ODN

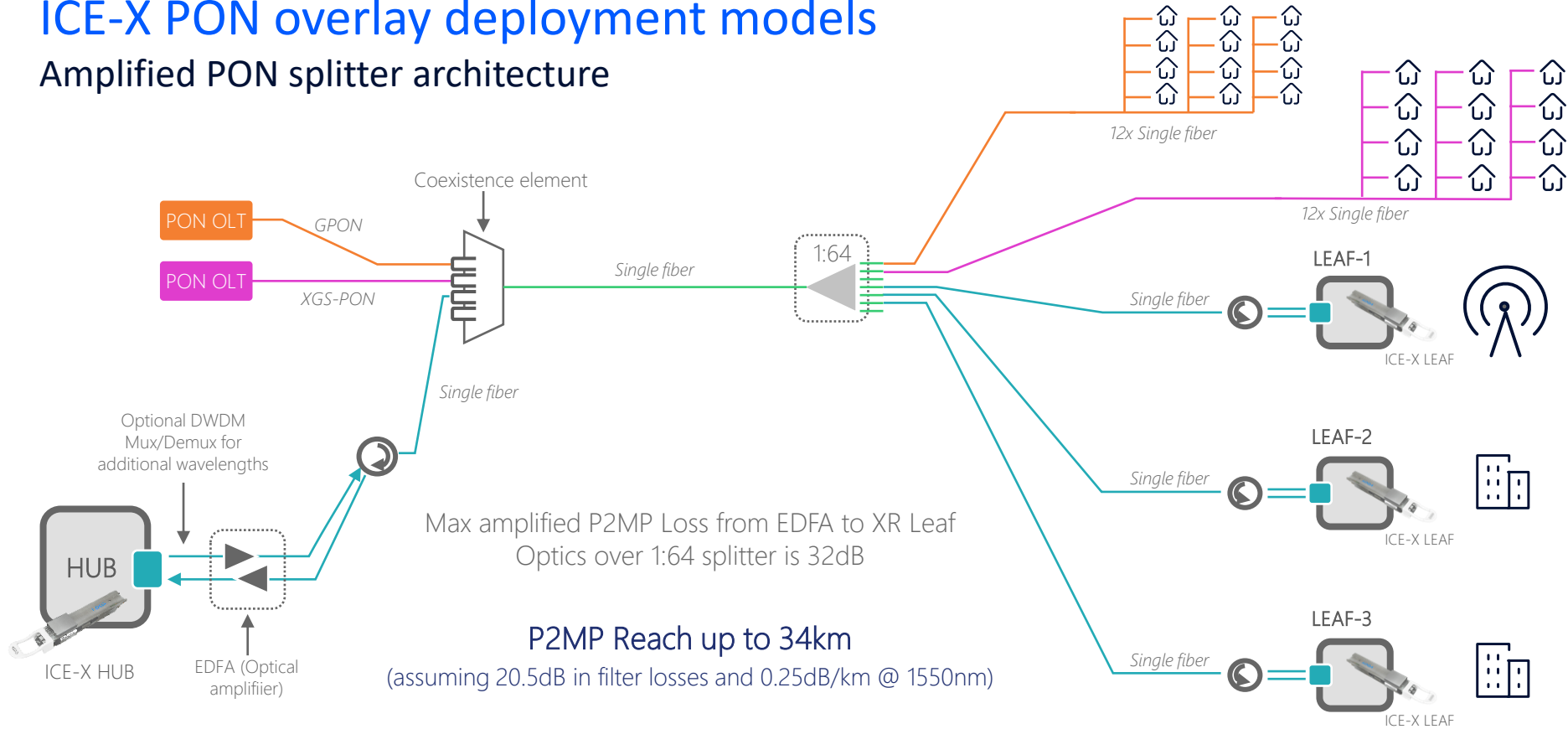
ICE-X PON overlay deployment models

PON splitter architecture

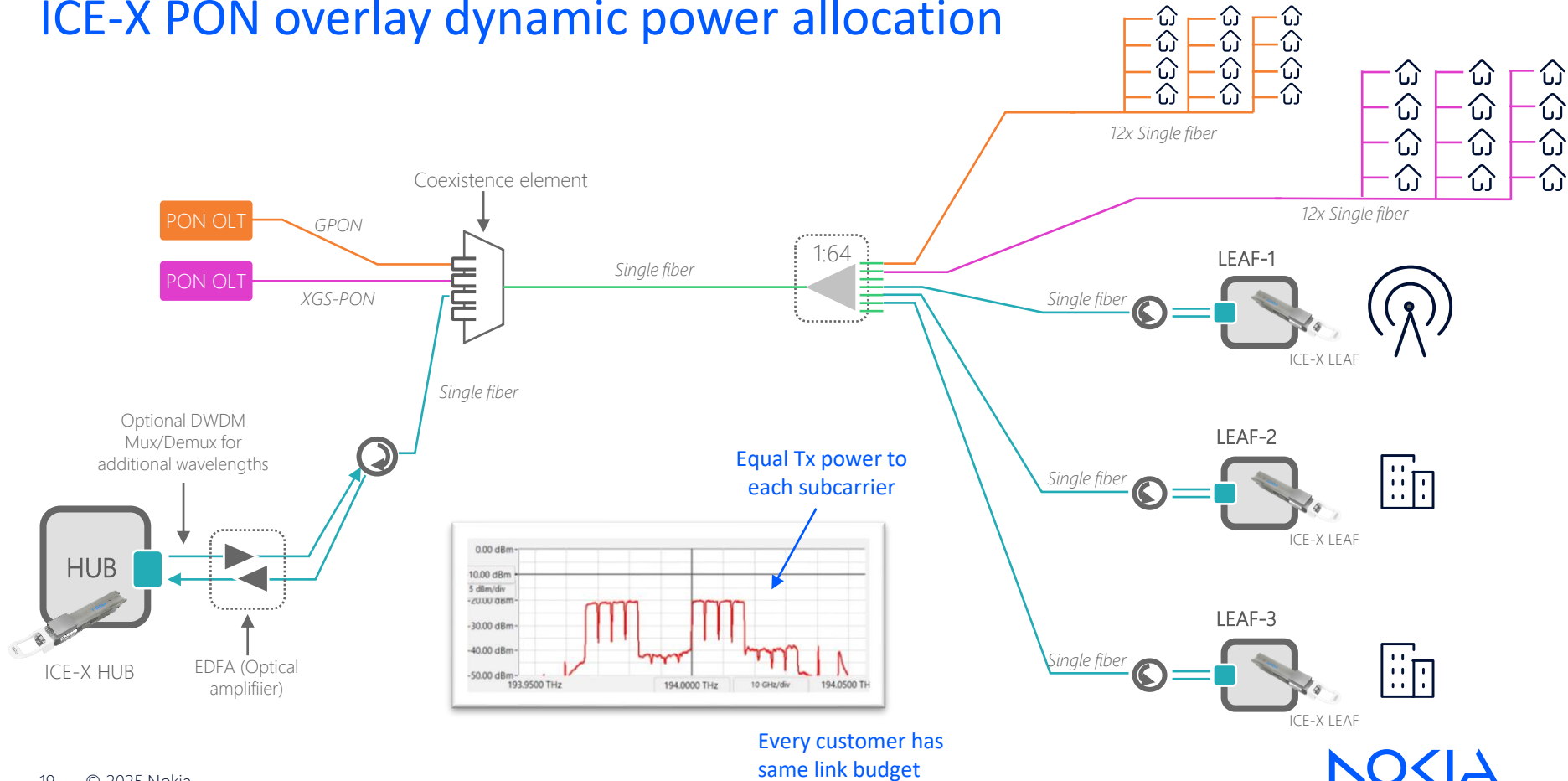


ICE-X PON overlay deployment models

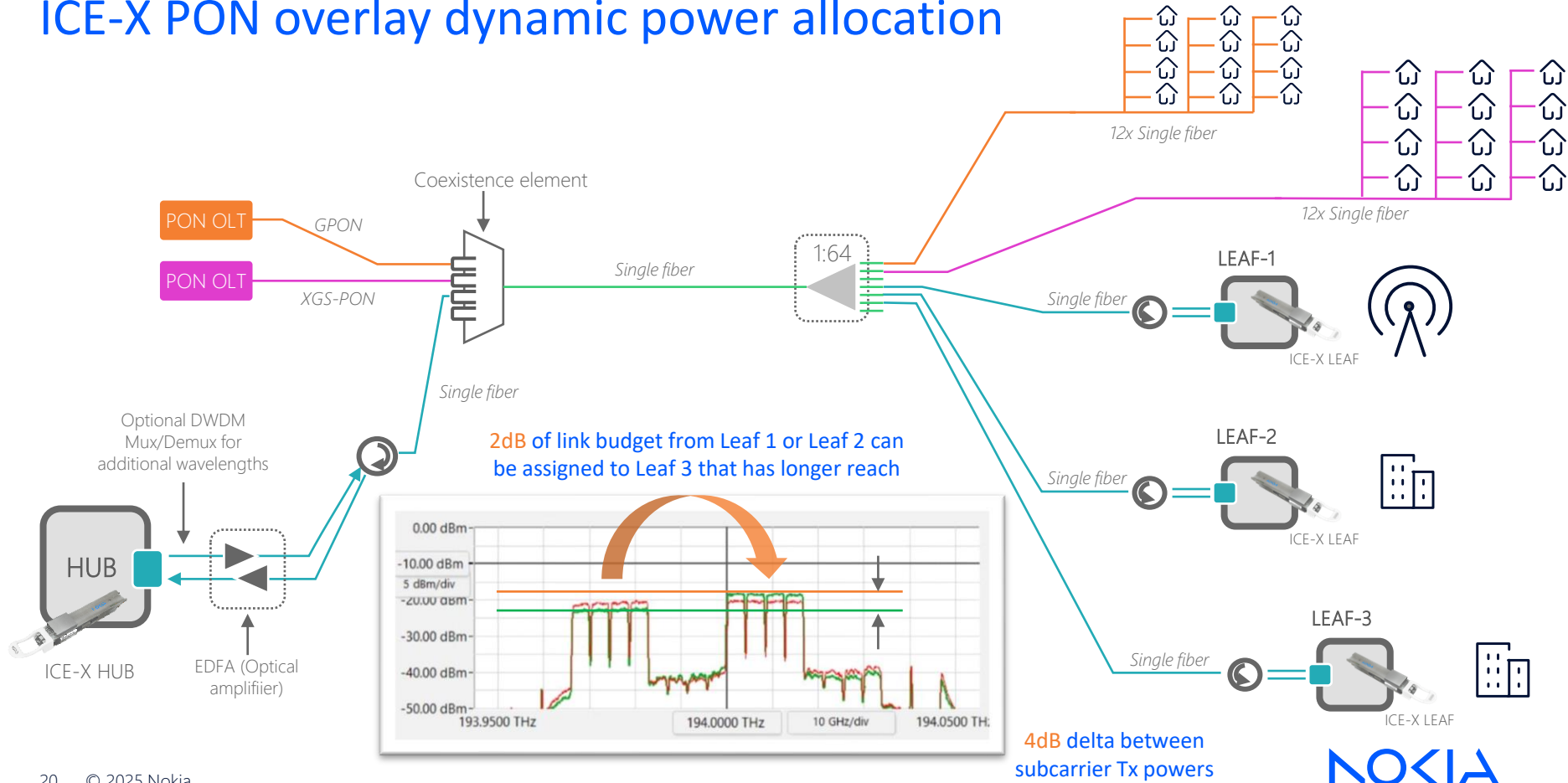
Amplified PON splitter architecture



ICE-X PON overlay dynamic power allocation



ICE-X PON overlay dynamic power allocation



ICE-X PON overlay applications

Summary and benefits

NO UPFRONT COSTS



Only deploy ICE-X over residential PON once high-capacity services are sold

NETWORK CAPEX/OPEX REDUCTION



Significantly lower TCO than alternative approaches for high-capacity services

COMPATIBILITY WITH EXISTING INFRASTRUCTURE



Operates over existing PON infrastructure

P2P, P2MP, HYBRID



Same intelligent pluggable for many configurations

SOFTWARE CONFIGURABLE



On-the-fly capacity allocation, change

HIGHLY PROGRAMMABLE



Highly flexible with advanced system level features, all remotely configurable



STANDARD/MSA BASED

Thank You
For Listening

NOKIA

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**Vielen Dank
für Ihren Besuch!**

**Wie hat Ihnen der
Vortrag gefallen?**

Titel: High-capacity challenge at
optical edge Referent: Jon Baldry,
Nokia



Jetzt abstimmen