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Solving high-c3pacity 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

Jon Baldry

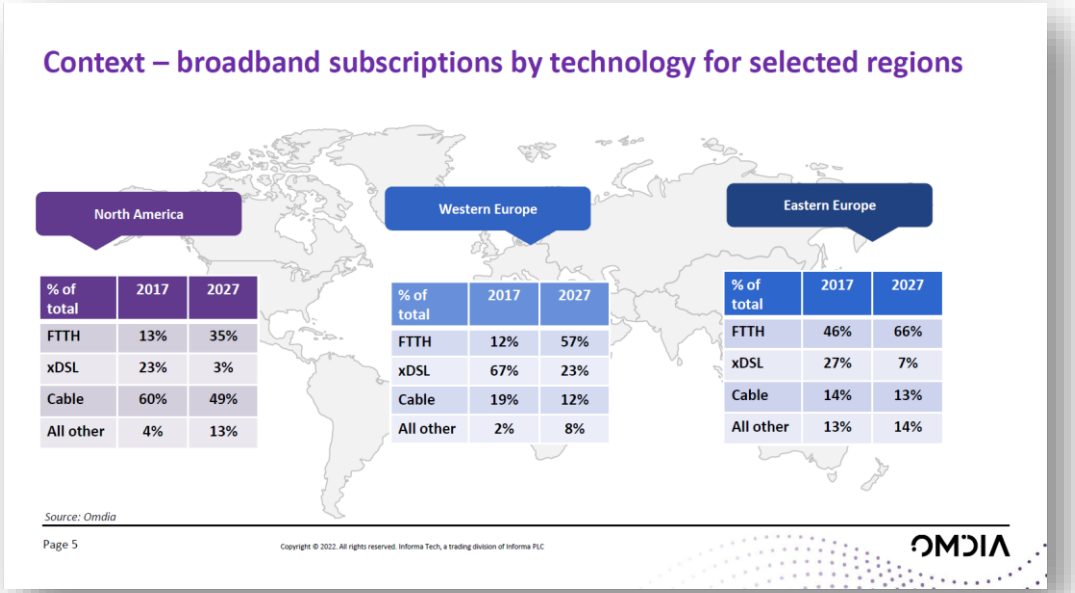
Senior Director Solutions Marketing

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**



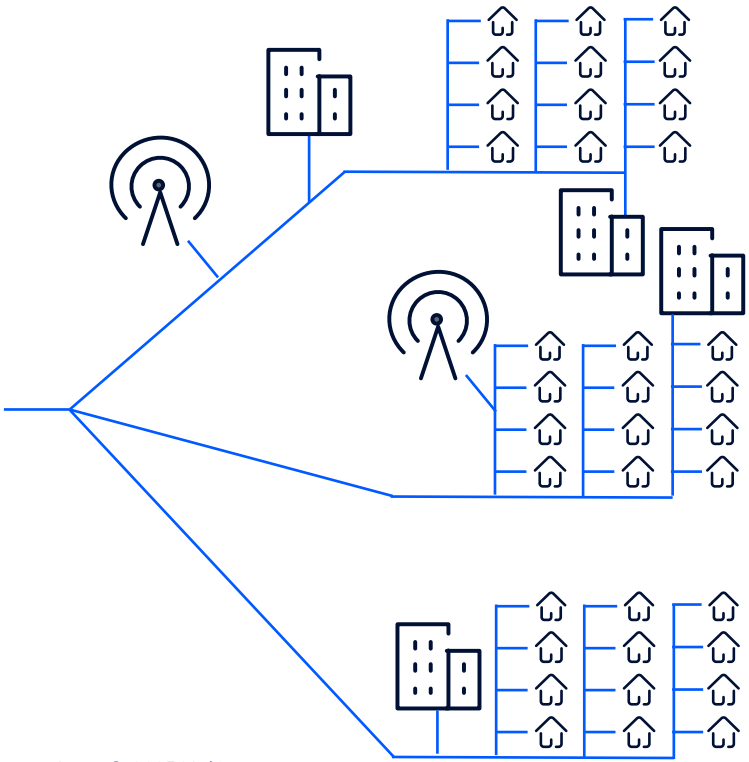
Source: OMDIA PON Webinar, Nov 2022

* 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?

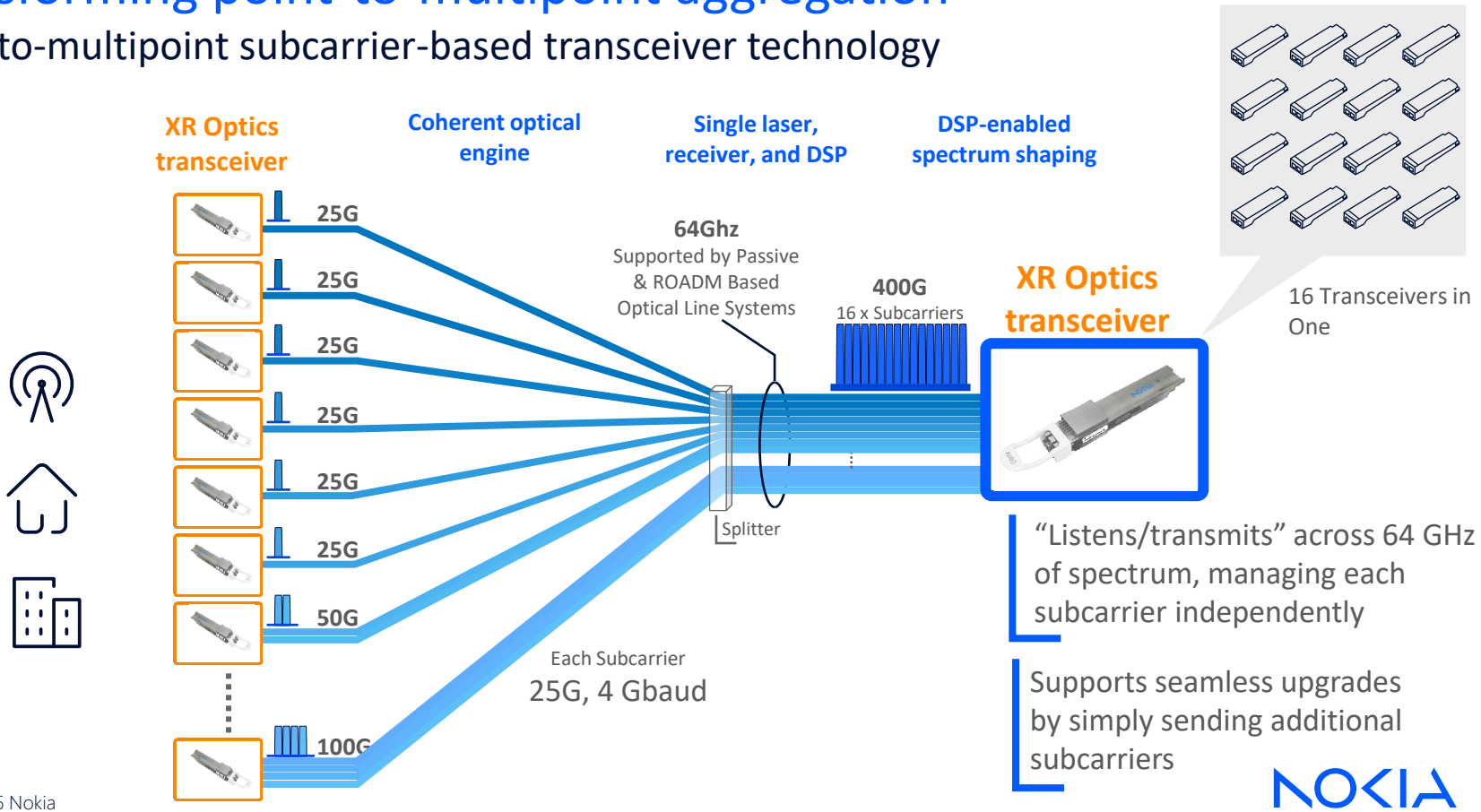


- We often don’t live in totally residential blocks
- Residential driven PON infrastructure often overlaps with business parks and enterprise locations
- Mobile cell sites are also on-net or close by:
  - In some regions up to 50% of existing mobile macro sites are still backhauled on microwave due to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

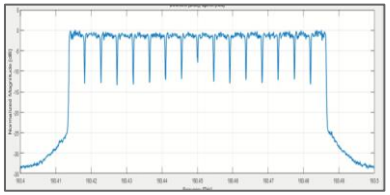
Introducing the XR Optics architecture

Transforming point-to-multipoint aggregation

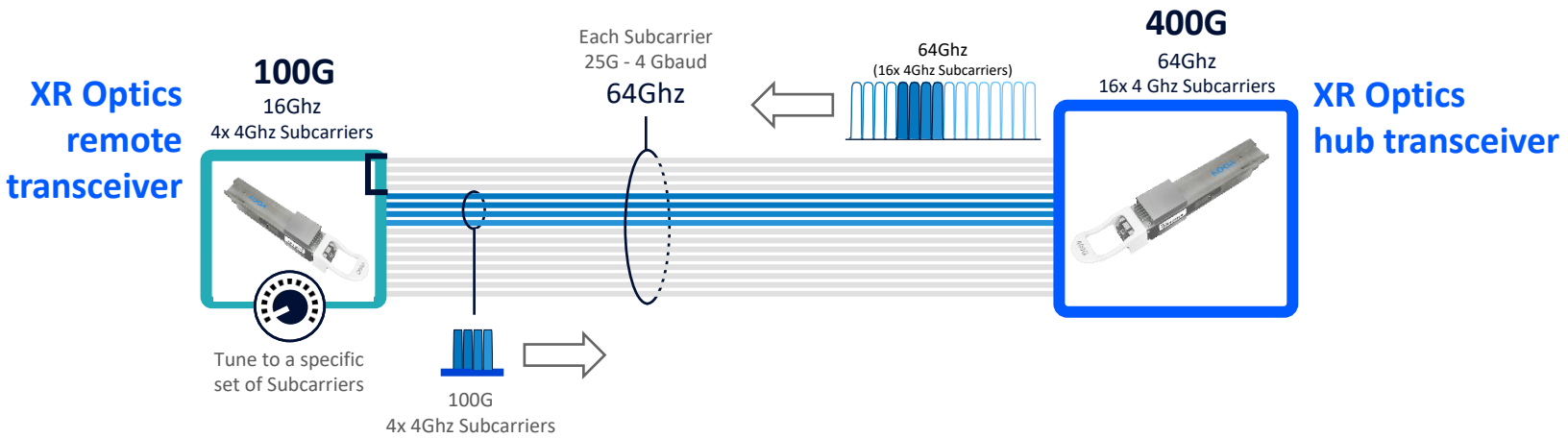
Point-to-multipoint subcarrier-based transceiver technology



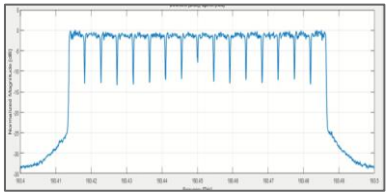
XR Optics in fiber pair applications



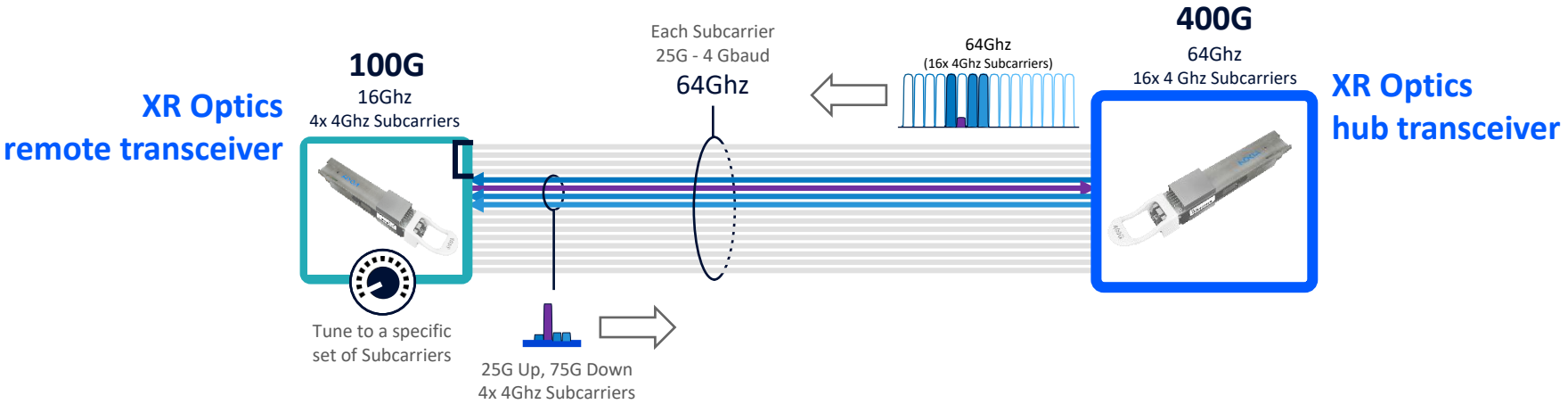
Nyquist subcarrier point-to-multipoint transceiver technology



XR Optics in single fiber applications

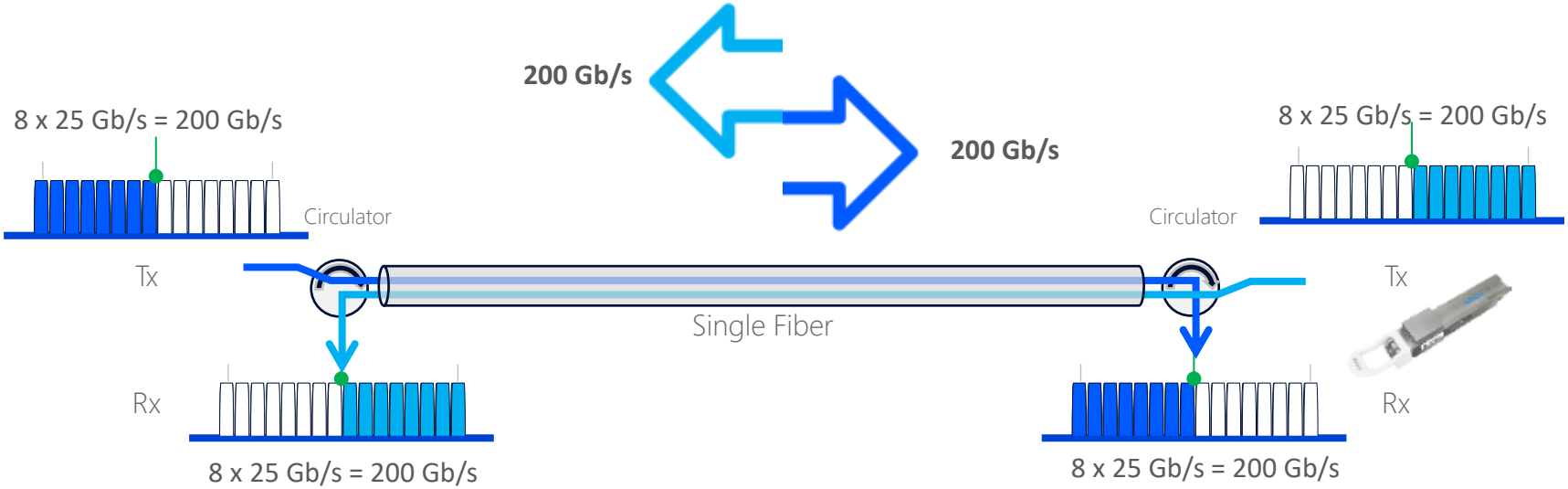


Nyquist subcarrier
Up-link and down-link allocation



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

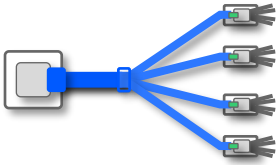
Manageability

3

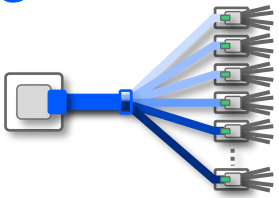
“A tool is ever only as good as your ability to use it”

ICE-X 400G: Multiple applications from one device

Point-to-point Applications

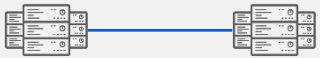


Coherent Breakout Applications



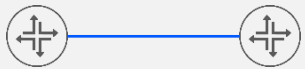
Point-to-multipoint Applications

Data Center Interconnect



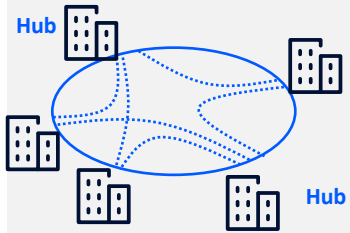
- Connect two or many data centers
- Distance from 40km to 1000s of km

IPoDWDM



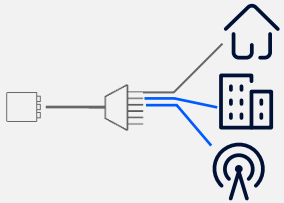
- Connect two or many routers (aggregation) over an open line system
- Distance from 40km to 1000s of km

Metro Aggregation



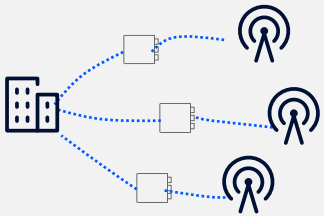
- Aggregate traffic from different metro end sites to one or two hubs over a ring or a horseshoe

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 challenges of single fiber working (SFW) for coherent optics

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

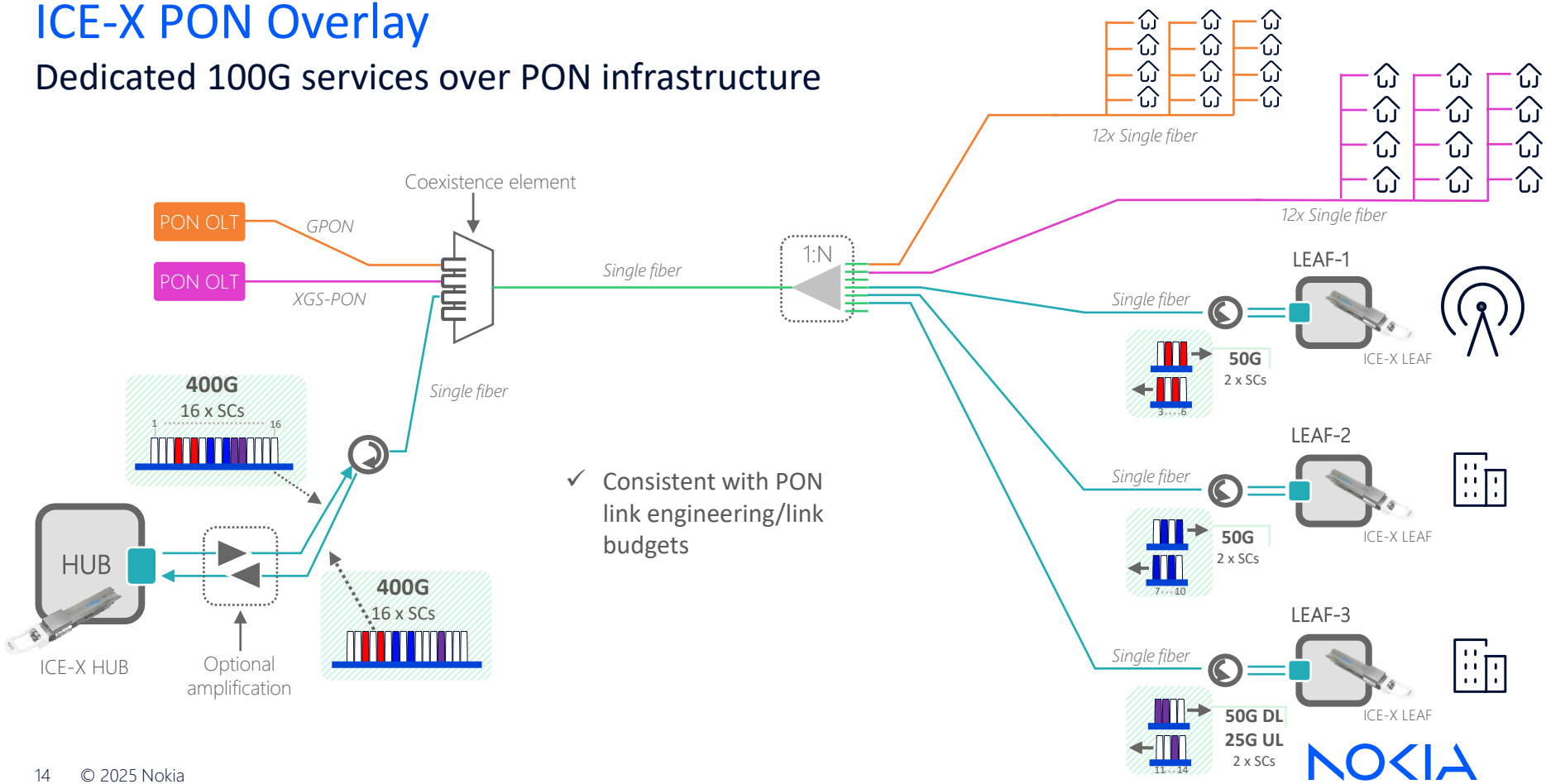
- Direct detect/OOK Optics
  - 10G OOK ok with bi-di optics
  - 25G OOK very limited
    - 15km with no intermediate filters
  - No long-term path for OOK

- 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

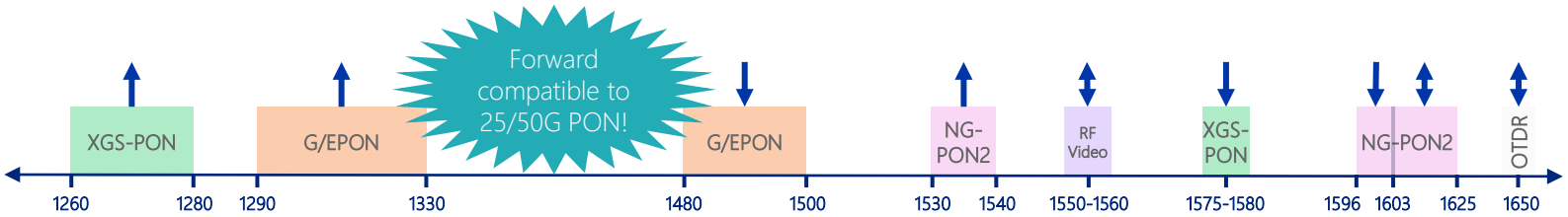
Dedicated 100G services over PON infrastructure



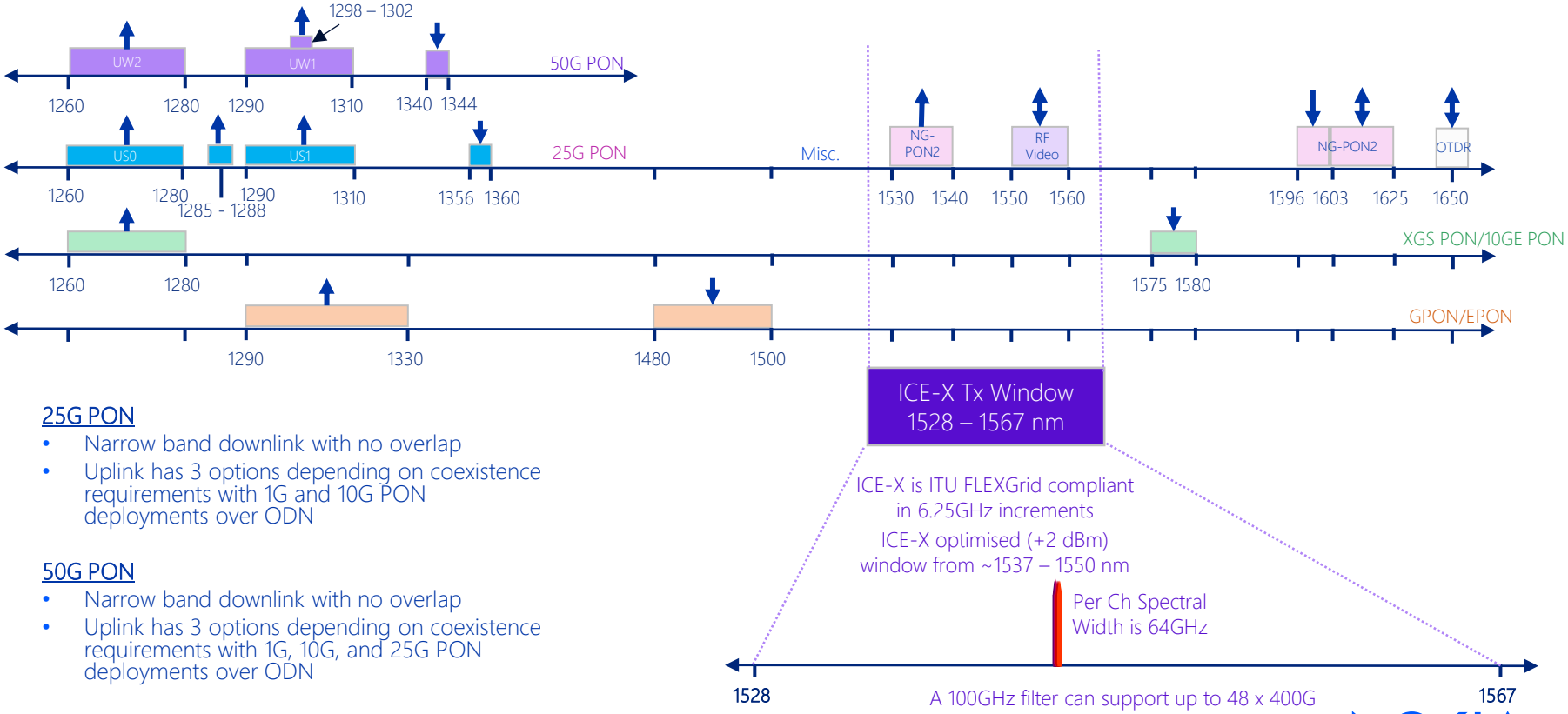
✓ Consistent with PON link engineering/link budgets

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



25G PON

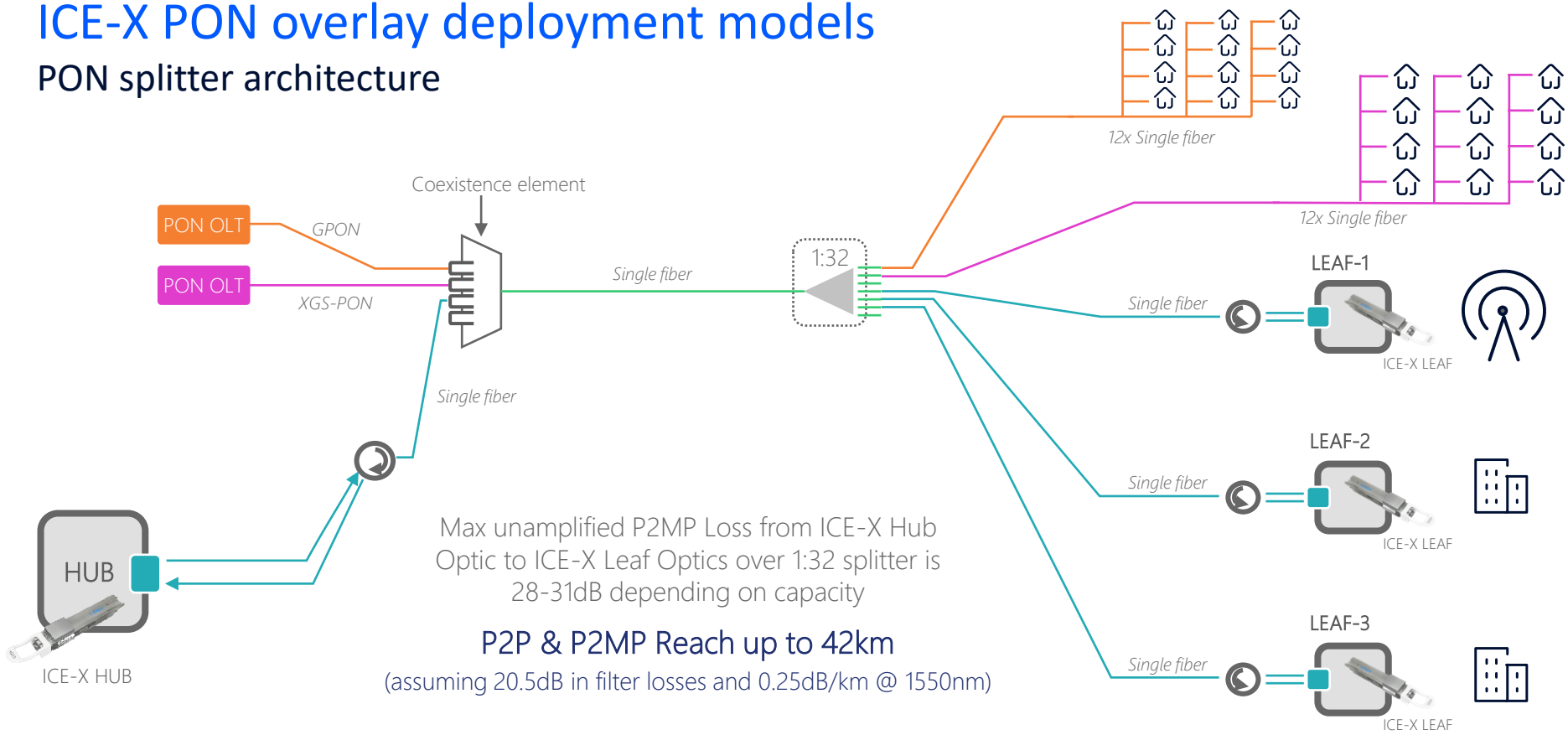
- Narrow band downlink with no overlap
- Uplink has 3 options depending on coexistence requirements with 1G and 10G PON deployments over ODN

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

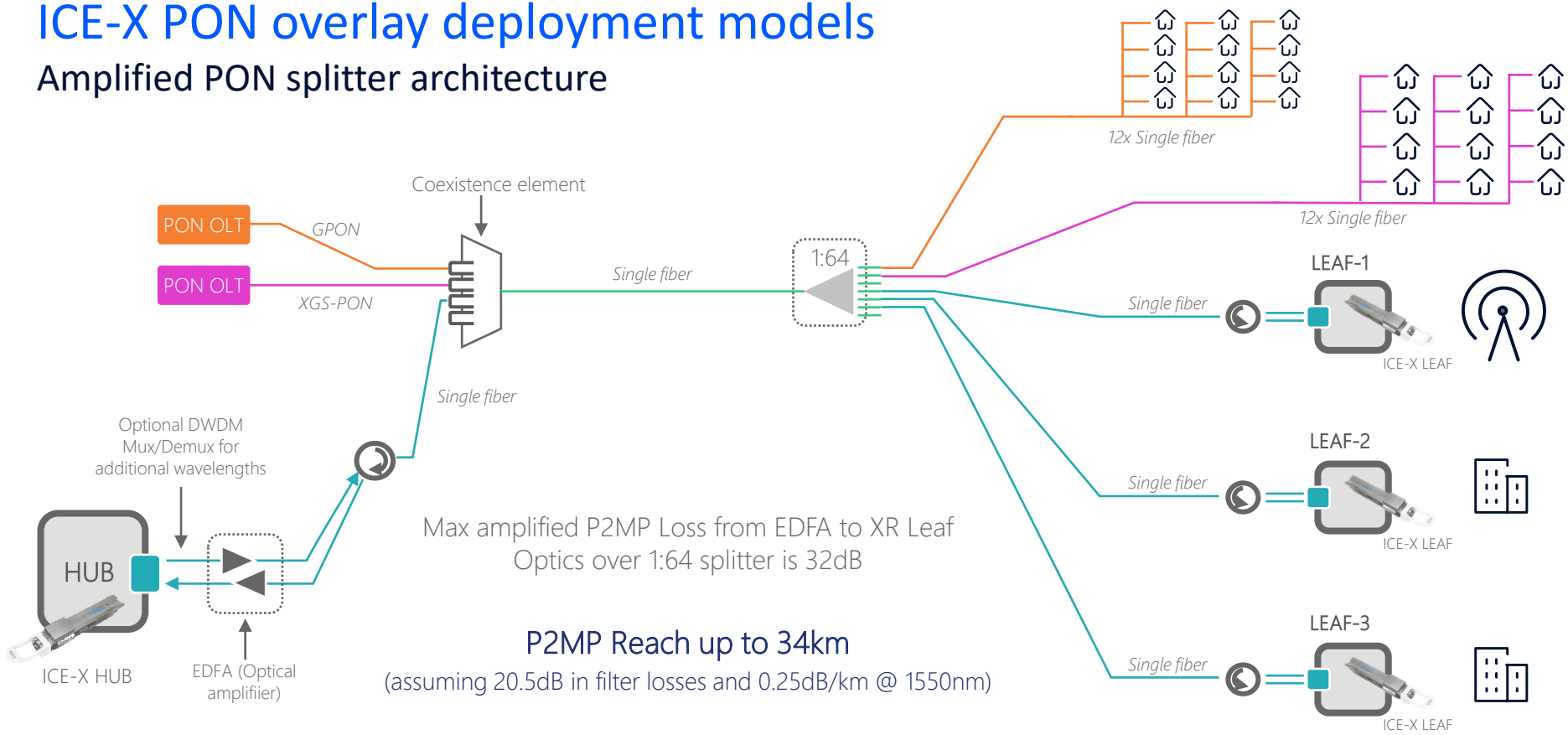
ICE-X PON overlay deployment models

PON splitter architecture

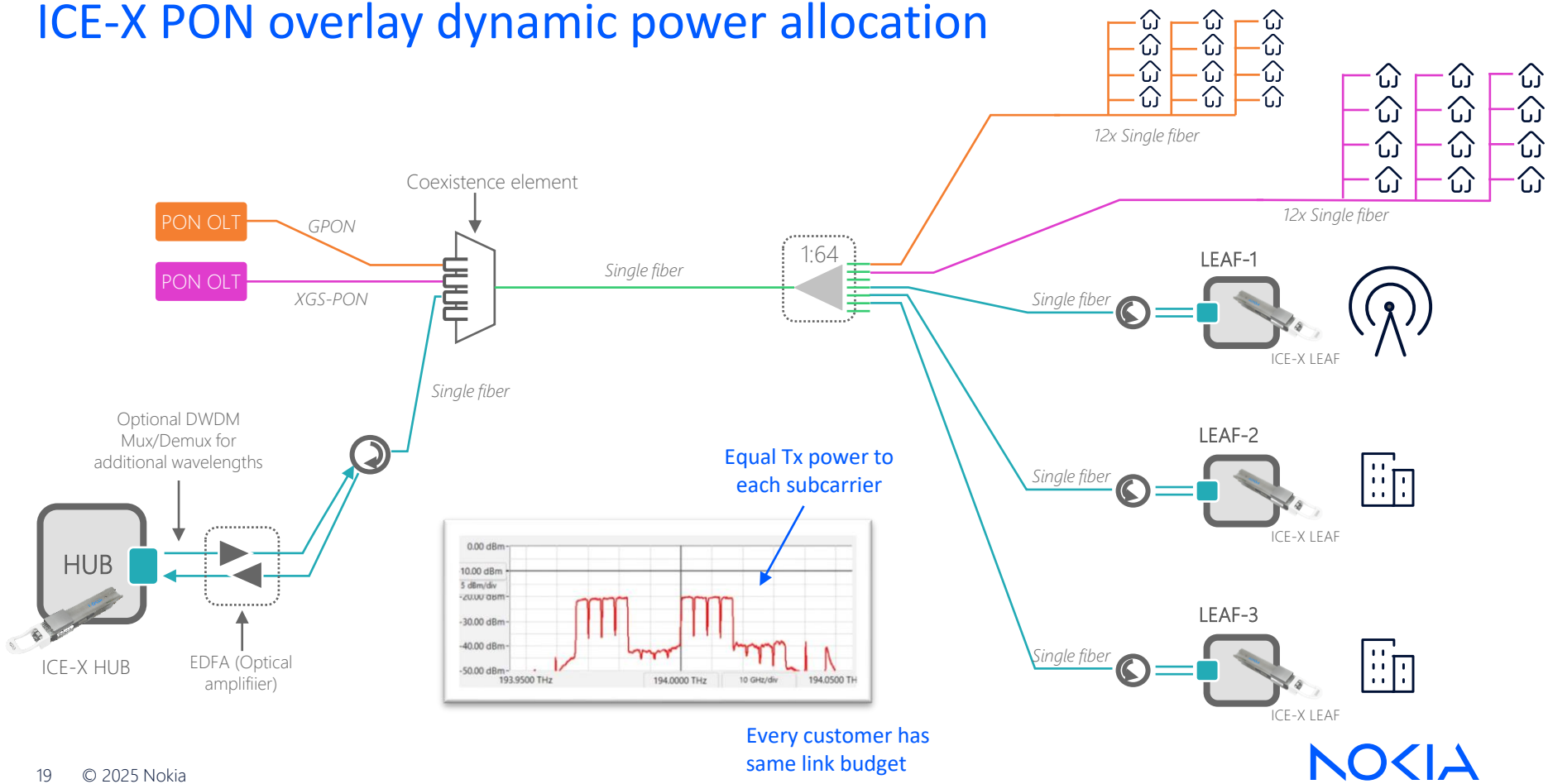


ICE-X PON overlay deployment models

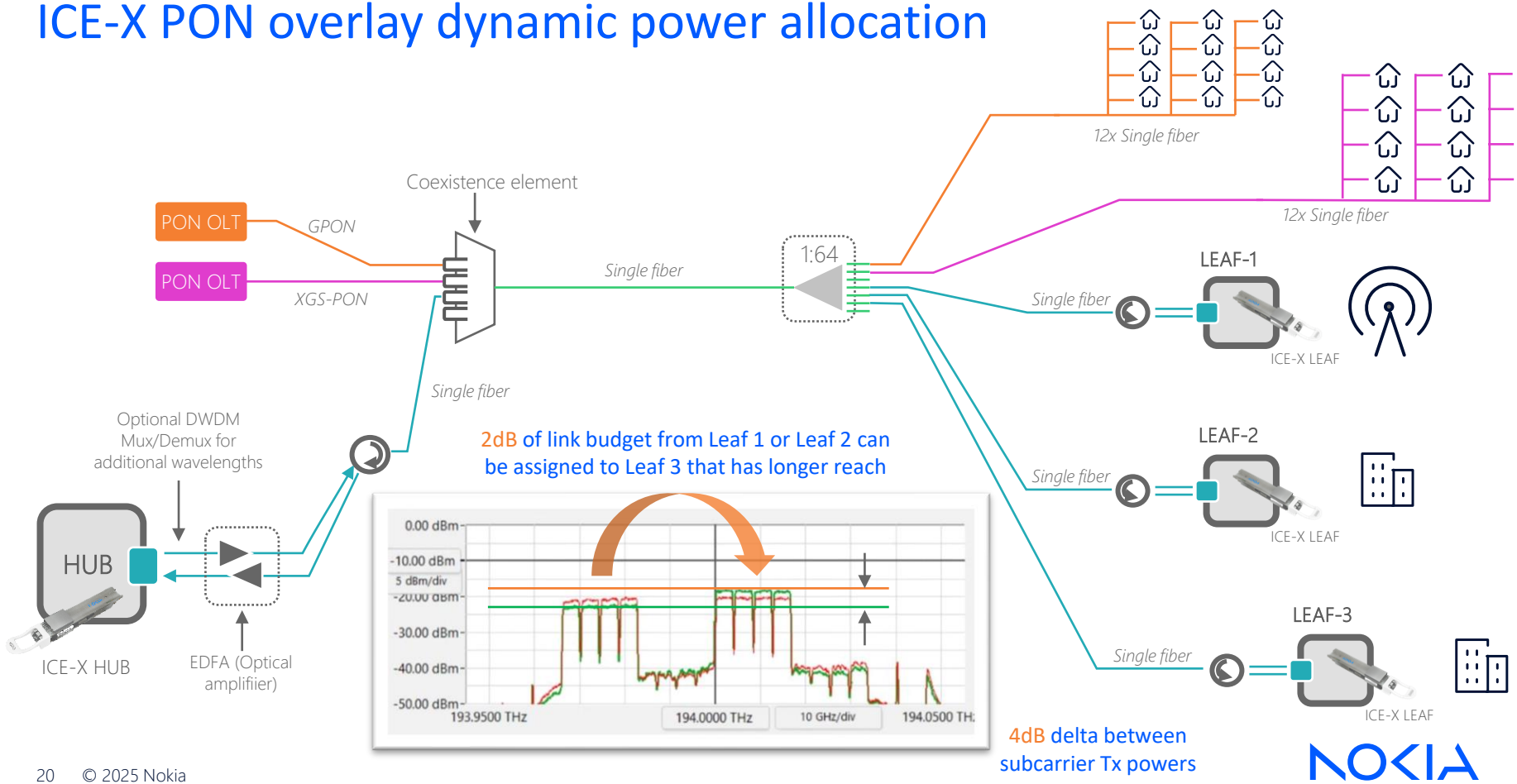
Amplified PON splitter architecture



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 PROGRAMABLE

Highly flexible with advanced system level features, all remotely configurable

STANDARD/MSA BASED

Thank You
For Listening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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