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Coherent PON Poised to Become Cable's Next Long Term Evolution Access Platform

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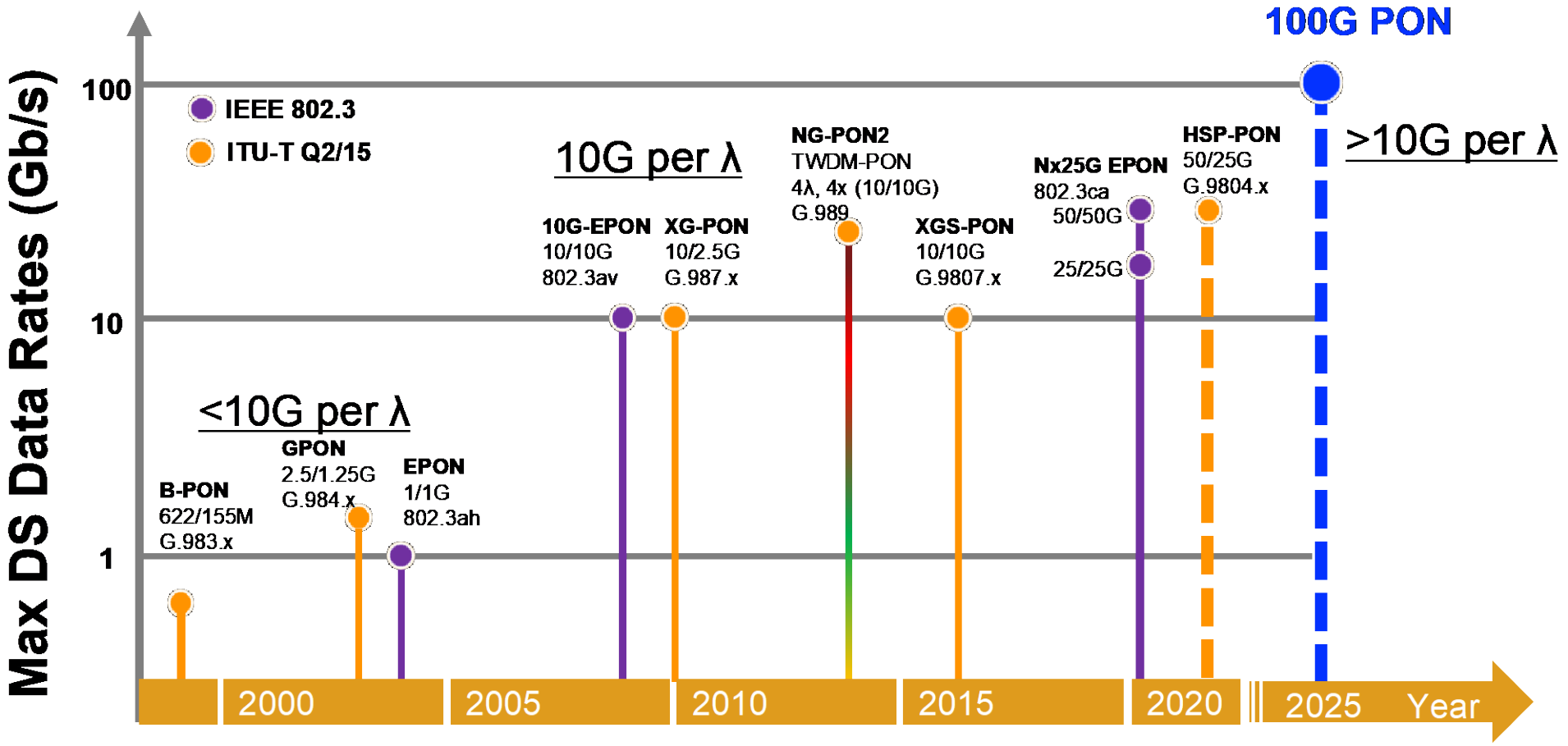
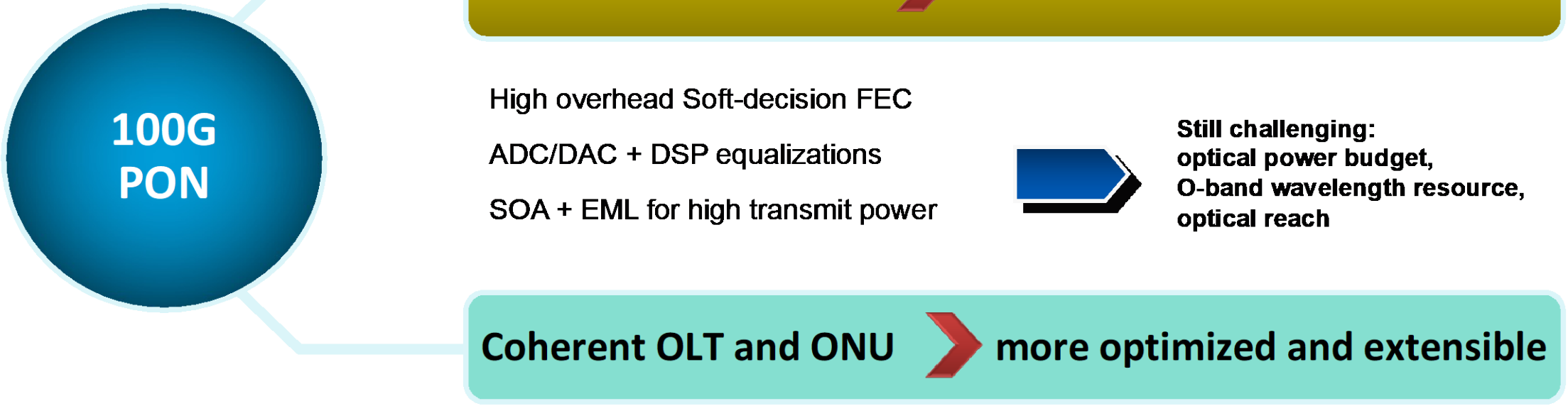
Outline

- Introduction and Motivation
  - Passive Optical Network Evolution
  - 100G PON
  - Coherent PON
- CPON Use Cases and Deployment Scenarios
- CPON Key Technology Development
- Introduction of CableLabs's CPON Program
- Conclutions

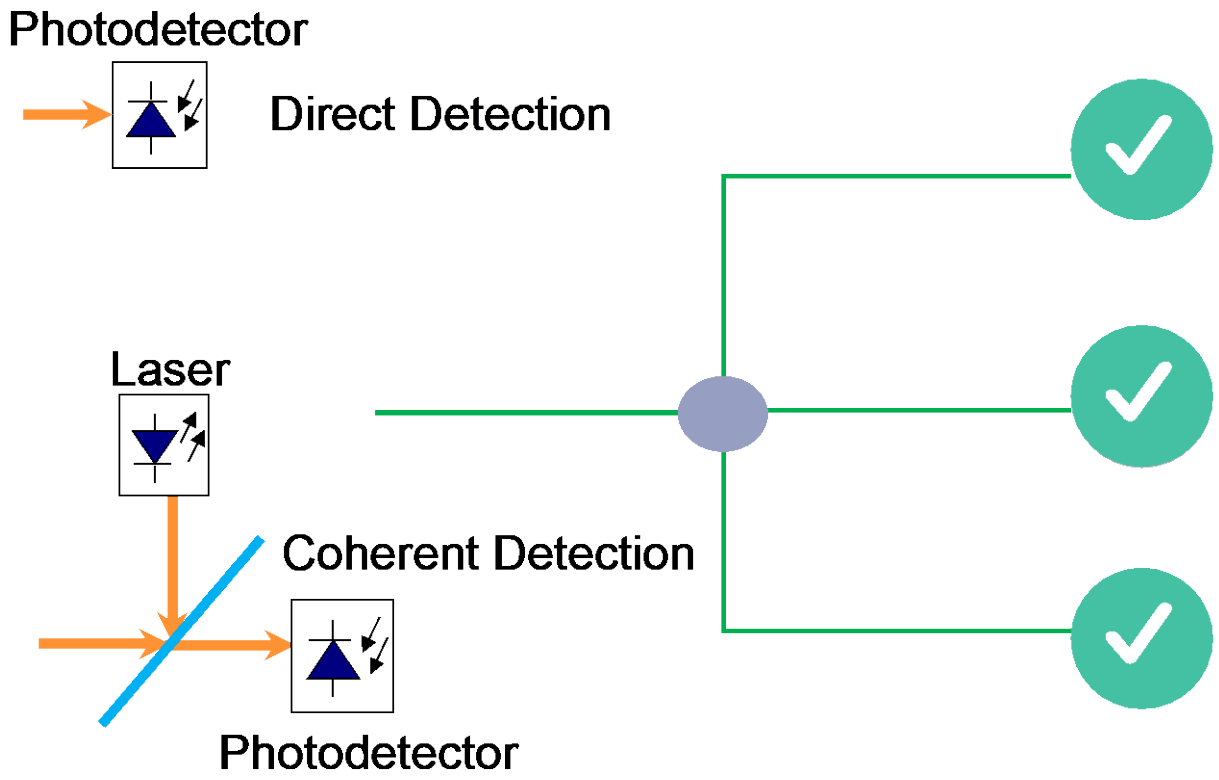
Evolution to 100G Passive Optical Network (PON)



100G PON Technology Options



Technology Comparison: Coherent Optics vs. IM-DD



Linear optical field conversion

Enabling modulation and detection for four independent degrees of freedom with **DSP**

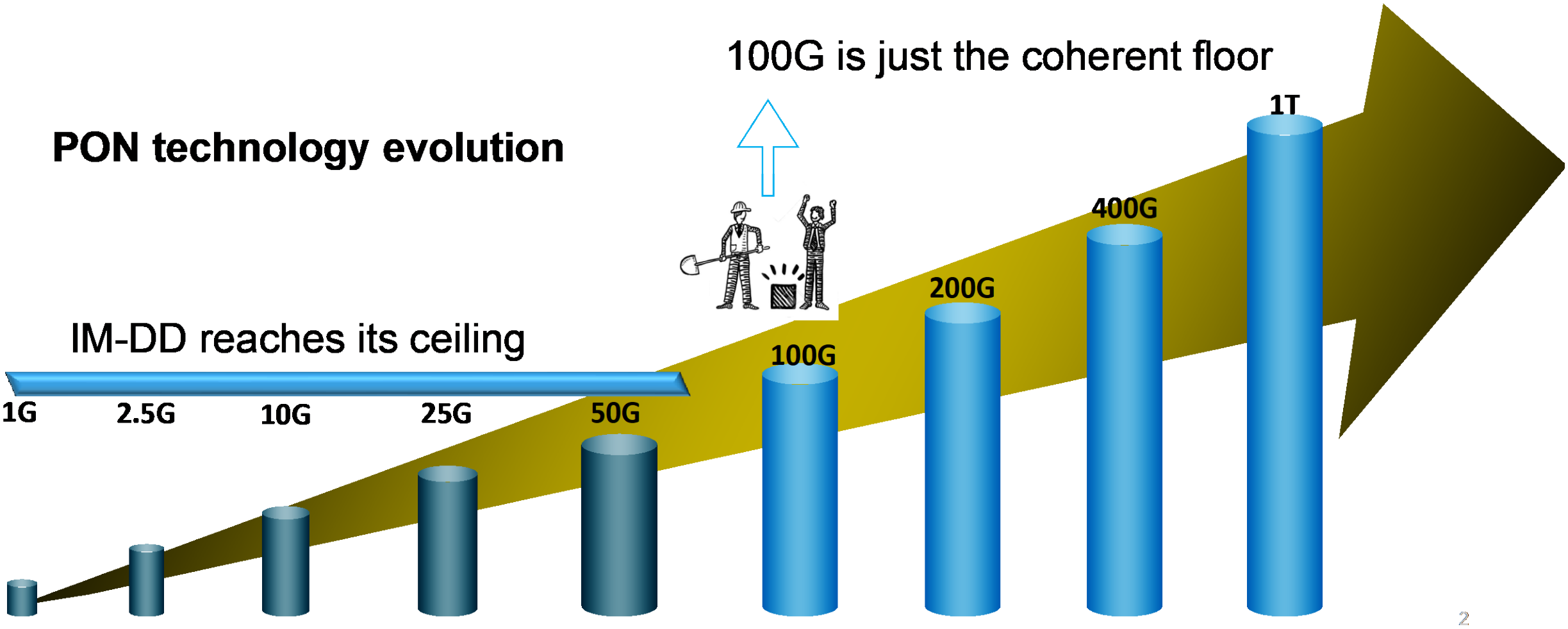
Inherent frequency selectivity

Local Oscillator serving as a clean signal amplifier and synchronizing the desired wavelength channel

Coherent gain for superior sensitivity

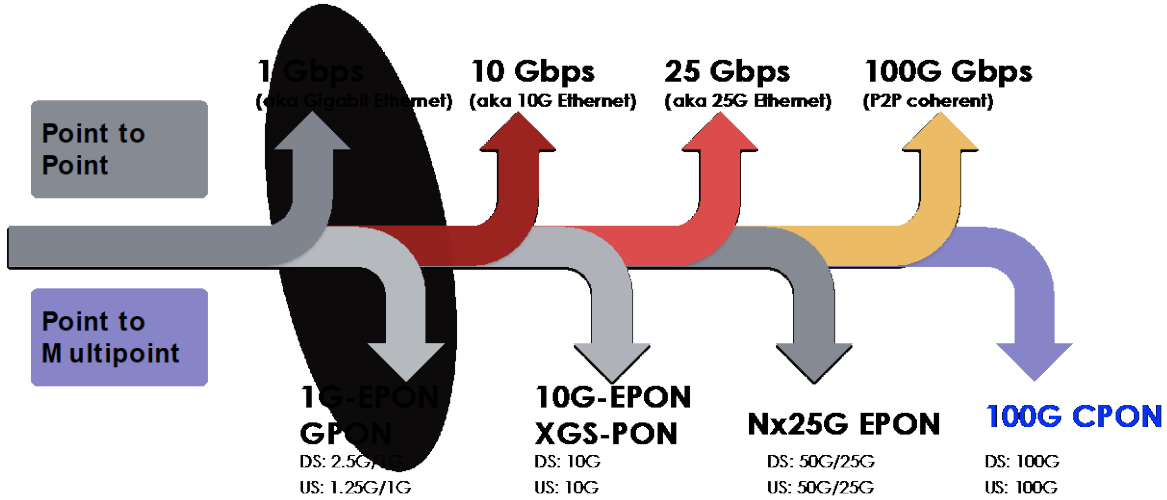
In demonstrated results, observing **>18 dB** difference between 100G DP-QPSK and IM-DD PAM4

100G PON is the Starting Point for Coherent Optics



What is exactly Coherent PON (CPON)

- Coherent PON is like traditional PON:
  - Passive optical distribution network
  - Point-to-multipoint topology



- Yet, Coherent PON is different:
  - Uses coherent modulation and detection instead of IM-DD
  - Optimizes optical power distribution
  - Provides longer reach & higher split ratio with improved power budget
  - Enables 100 Gbps and beyond data rate (per lambda)
  - Multiple lambdas per fiber

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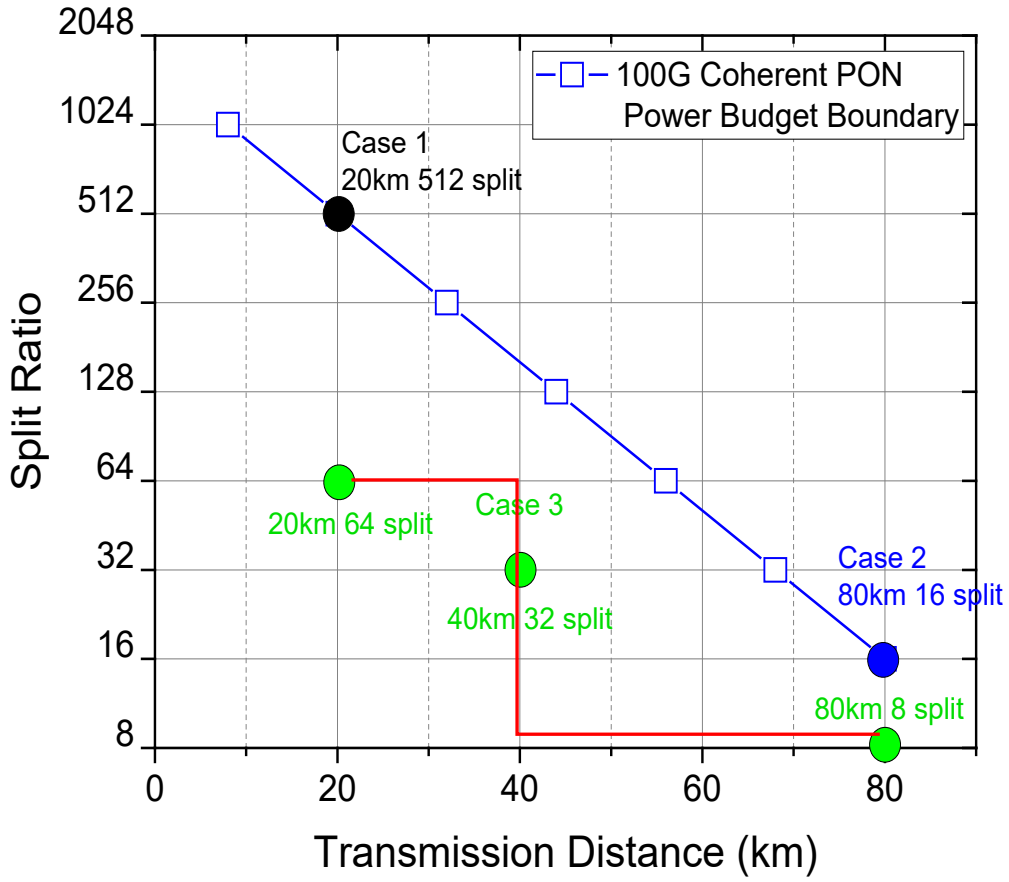
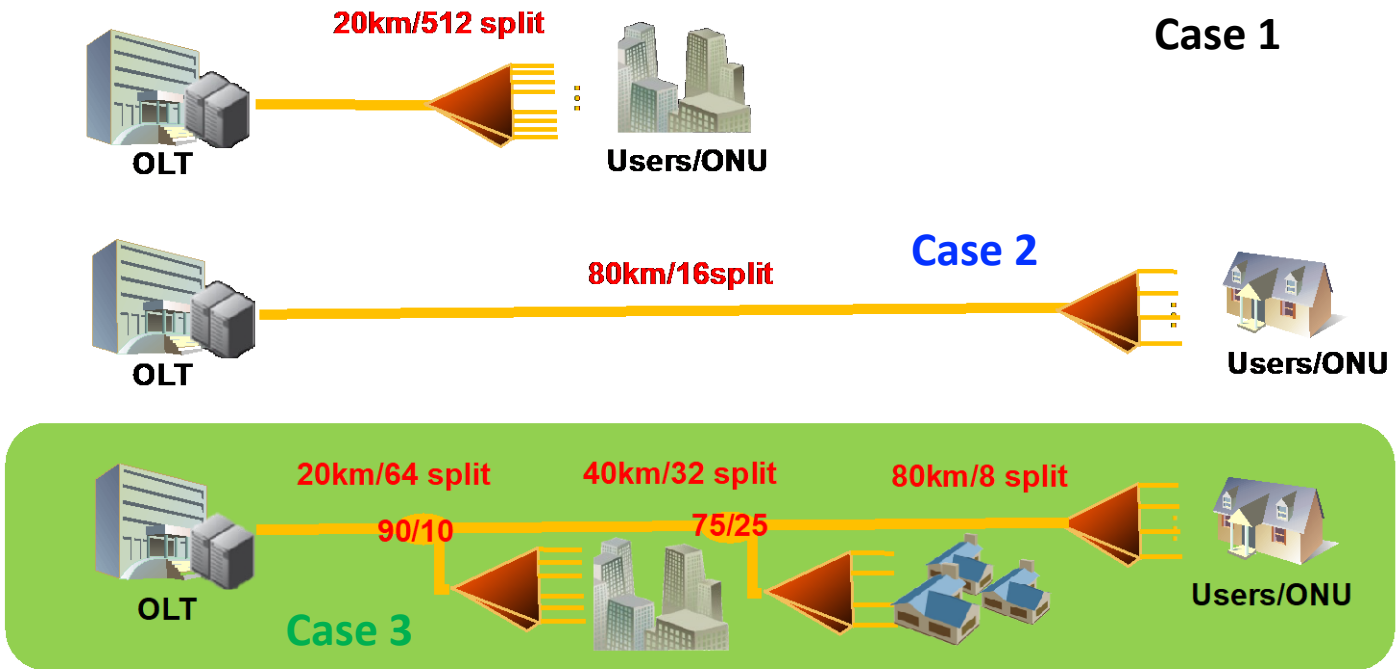
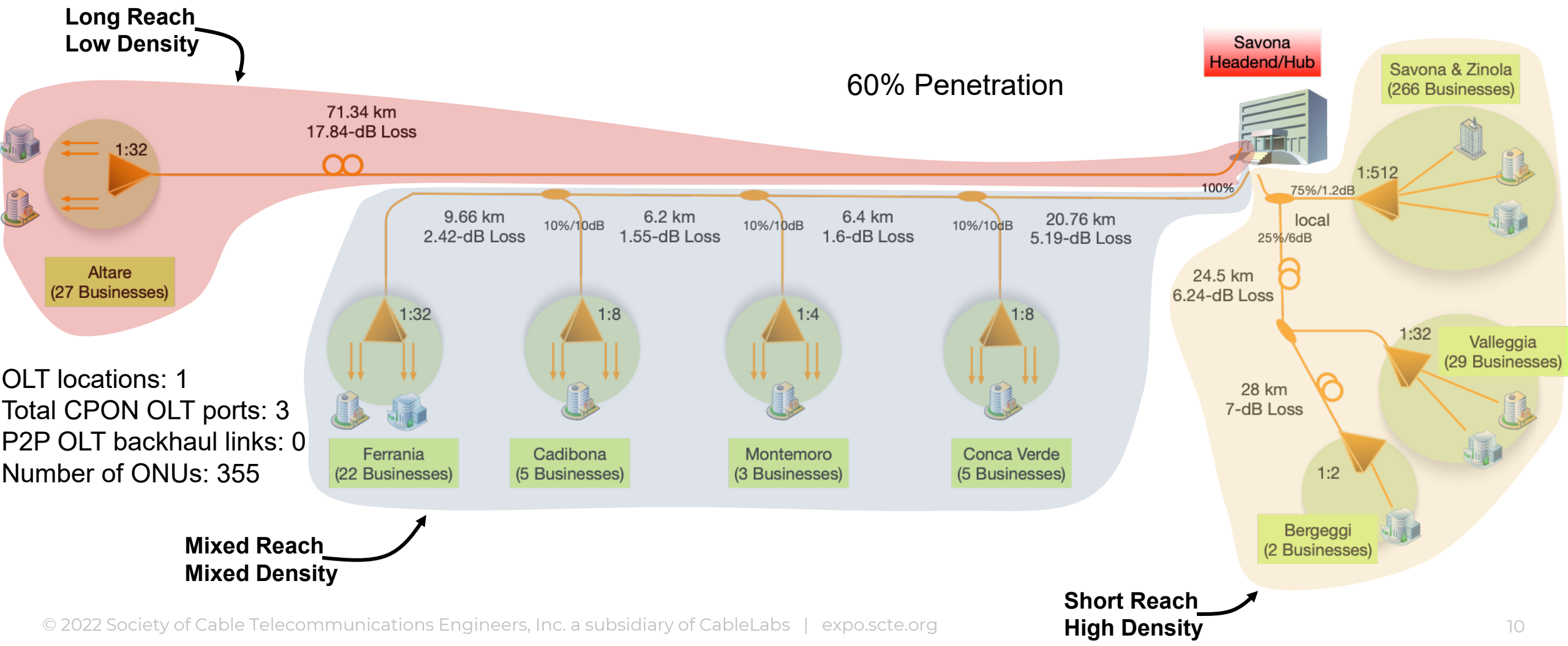
CPON Use Cases and Deployment Scenarios

Use Cases and Deployment Scenarios are Flexible

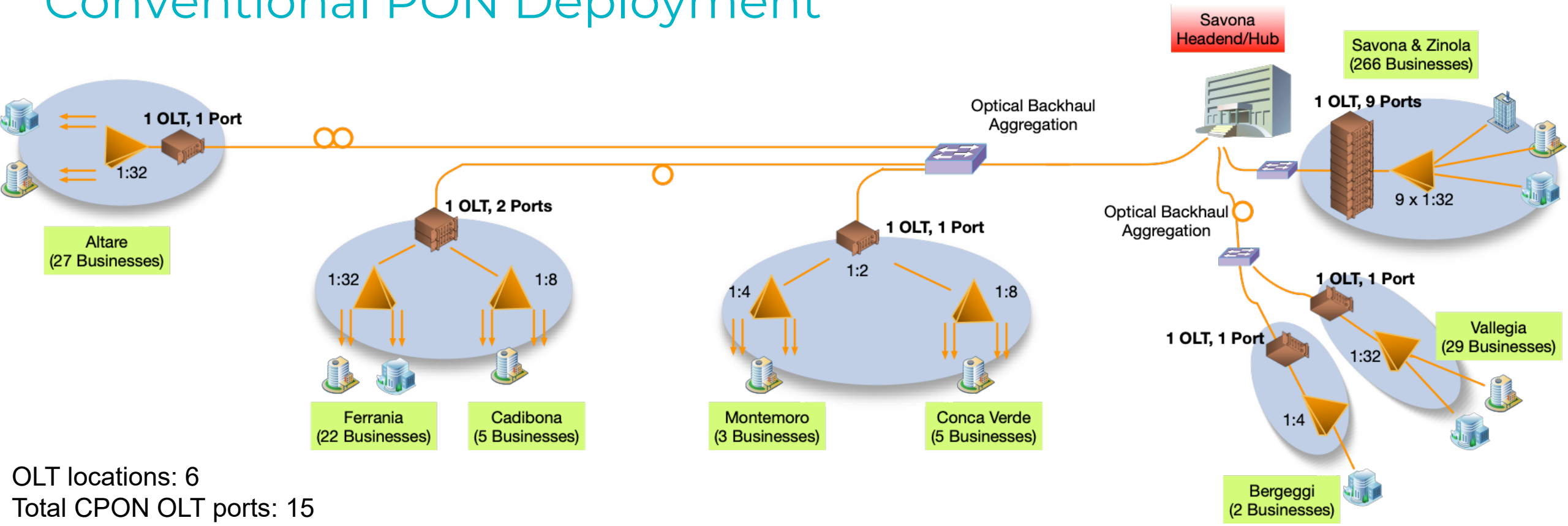




CPON Deployment Scenarios

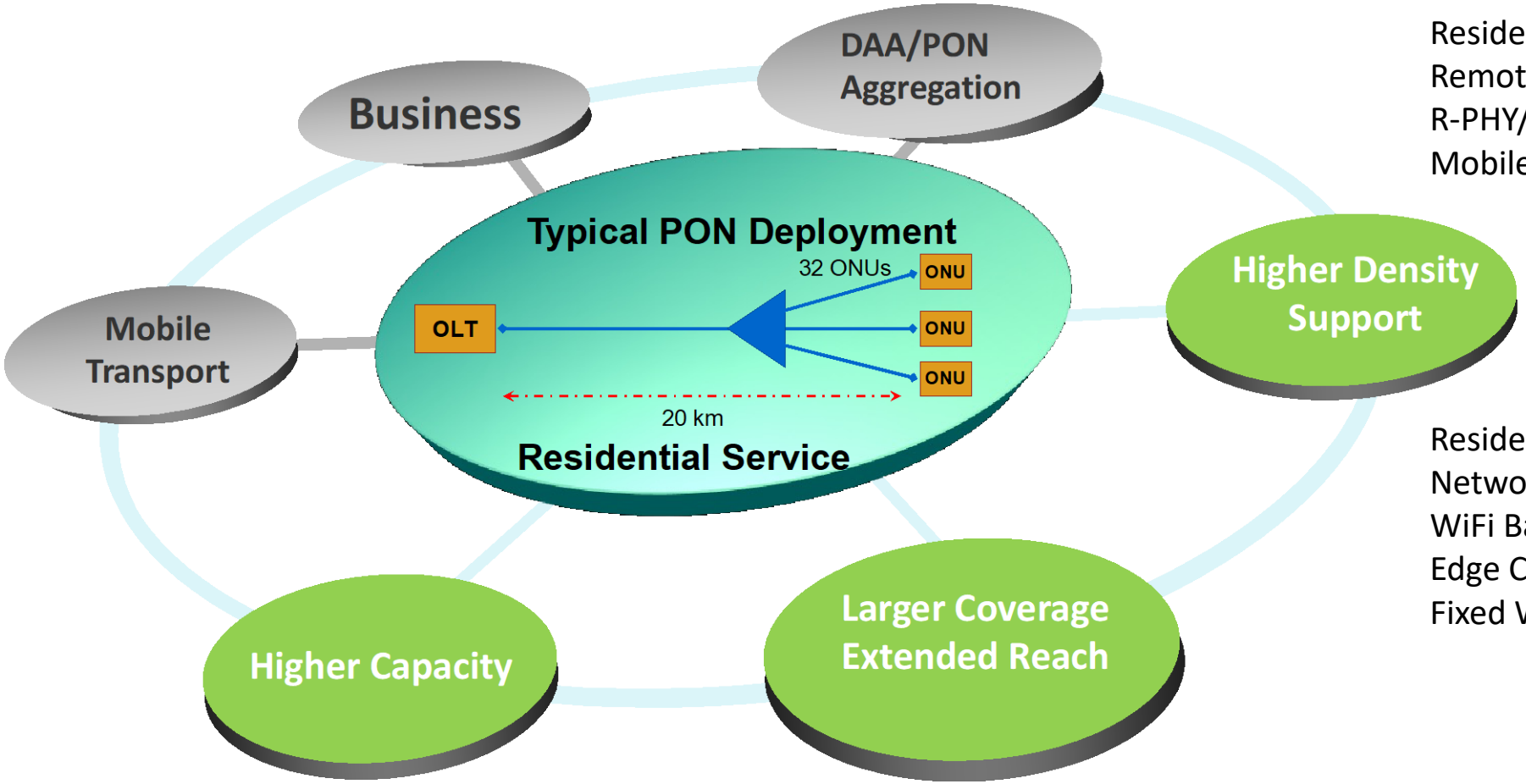


Conventional PON Deployment



OLT locations: 6
Total CPON OLT ports: 15
P2P OLT backhaul links: 5
Number of ONUs: 355

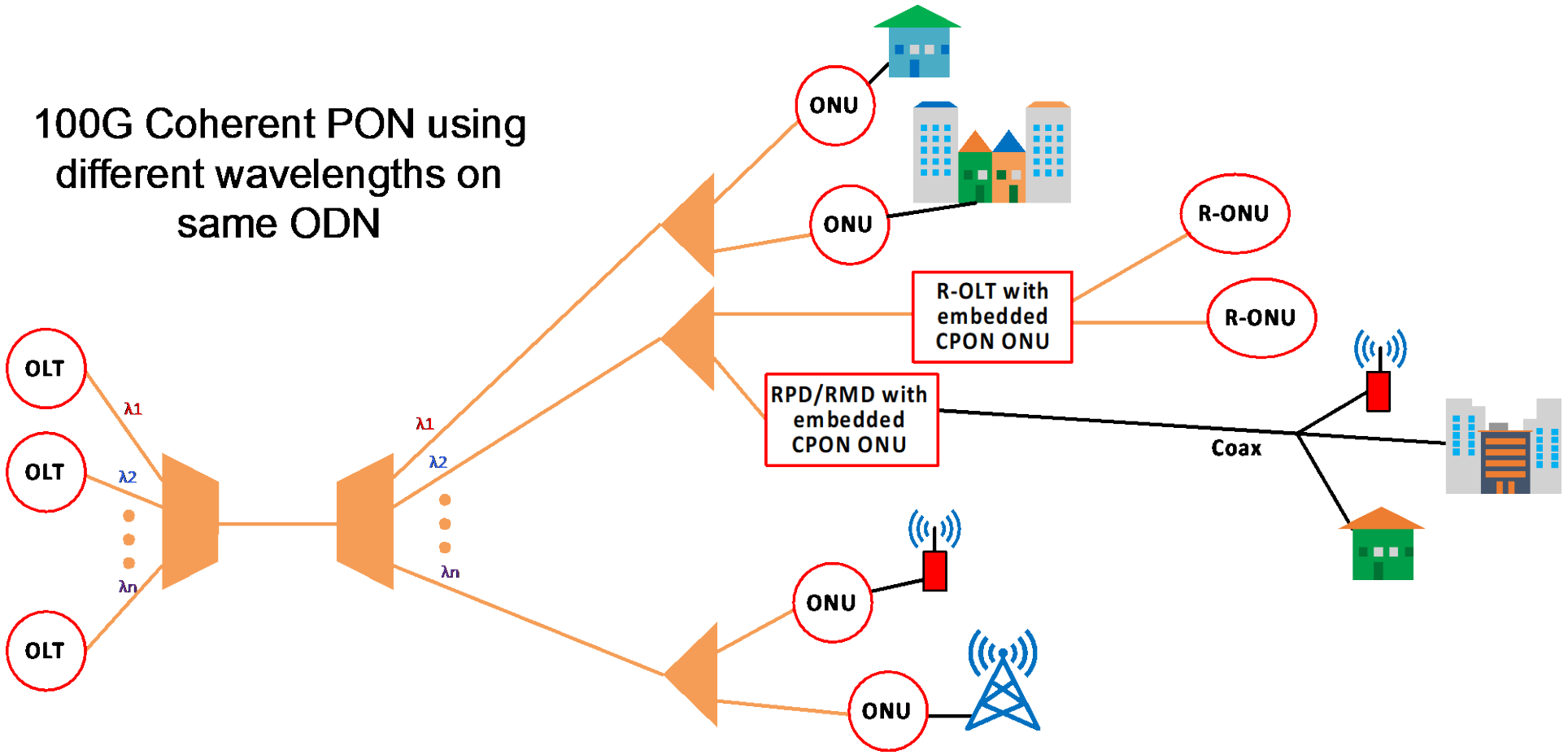
Extended PON Use Cases



Residential/FTTH MDU
Remote OLTs Connection & Backhaul
R-PHY/RMP Connection & Backhaul
Mobile Fronthaul & Backhaul

Residential/FTTH SFU
Network As A Platform
WiFi Backhaul
Edge Computing
Fixed Wireless Backhaul

CPON with Multi-Wavelength Stacking



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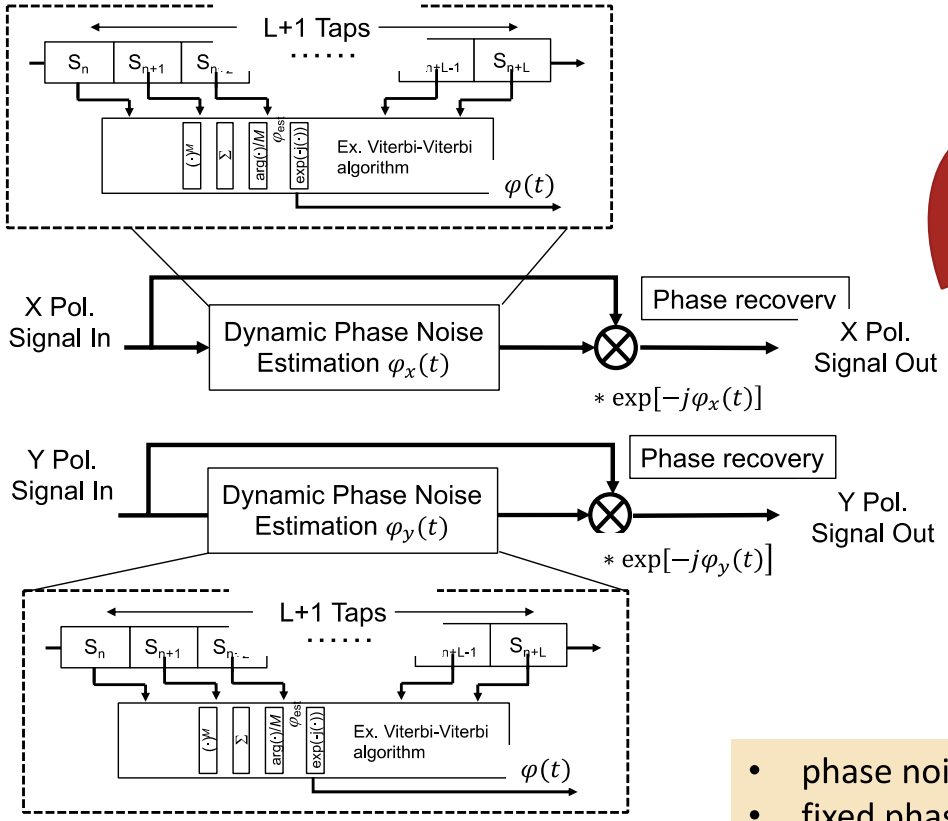
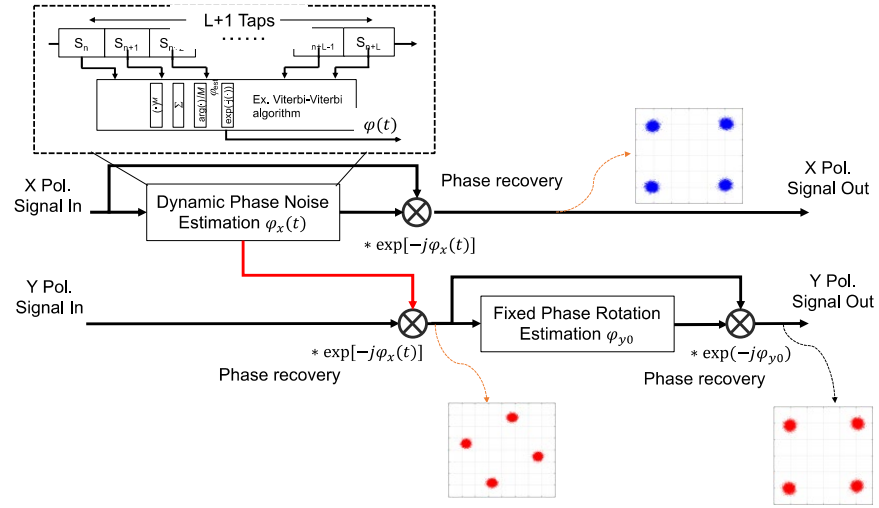
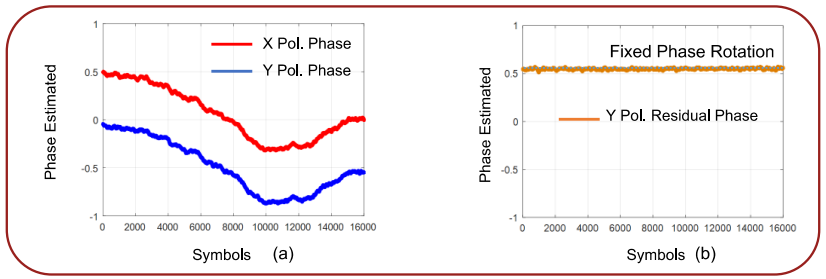
CPON Key Technologies

Optimization: Carrier Phase Recovery in DSP Flow

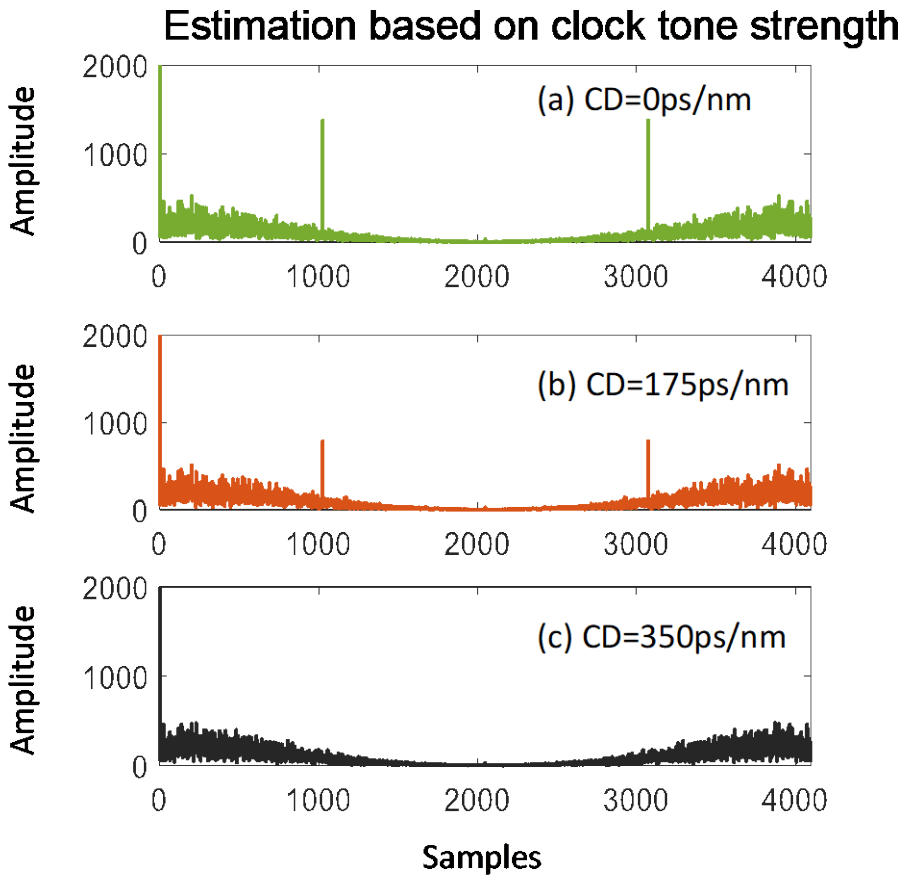






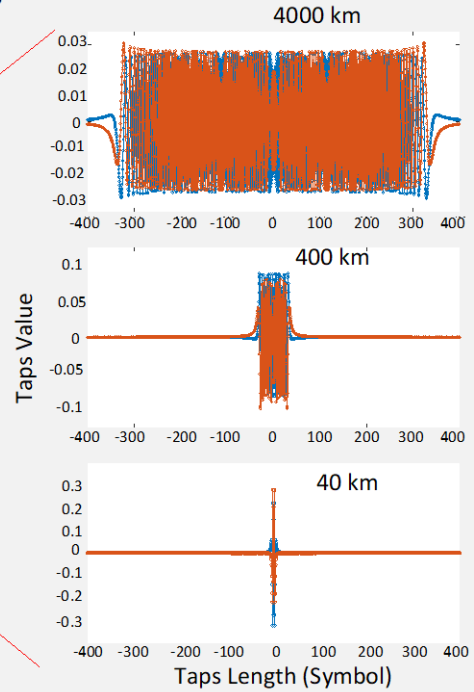
- phase noise estimation is firstly performed at only single polarization direction
- fixed phase rotation estimation & recovery of the second polarization signal

Simplification: CD Estimation and Compensation

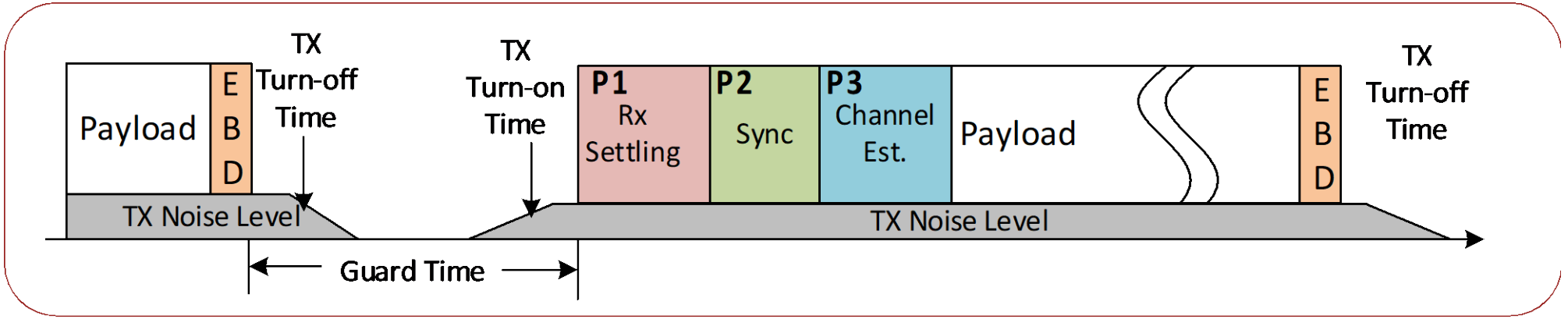


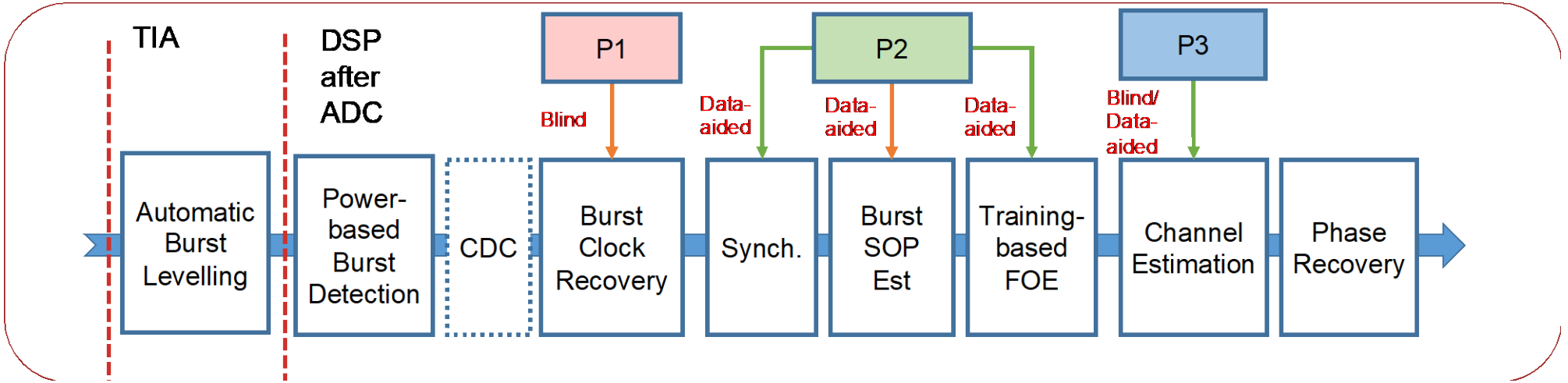
Example: number of digital filter taps for different distance introduced chromatic dispersion

The number of required digital taps increases with the transmission distance

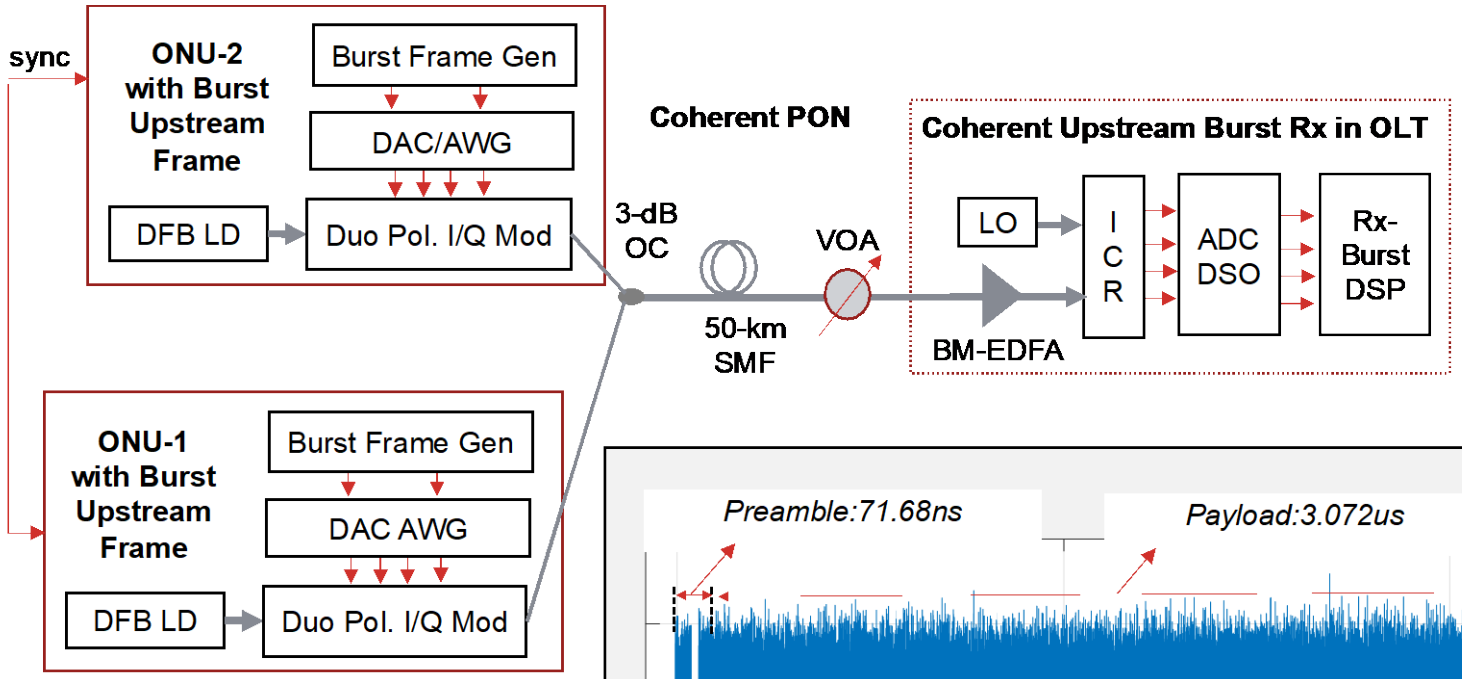


Coherent Burst Signal Design and Processing

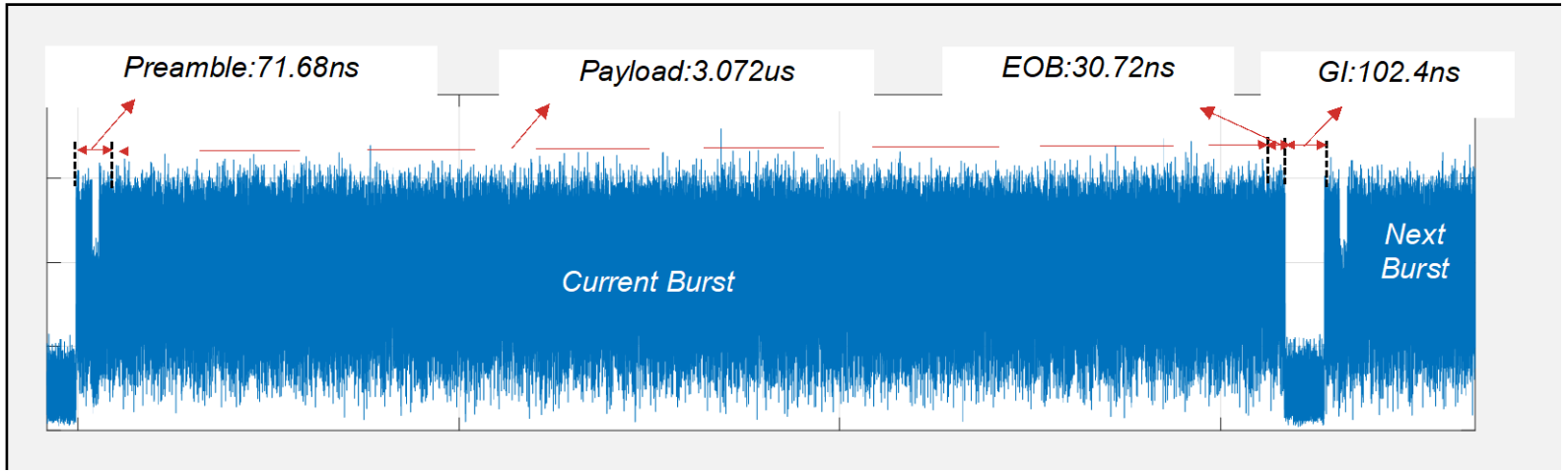




Experimental Verification: Coherent Burst System



Preamble	Length (Symbols)	Functions
P1	1024	Burst Clock Recovery
P2	512	Frame Sync, Pol DeMux, FOE
P3	256	Channel Estimation



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CableLabs' CPON Program

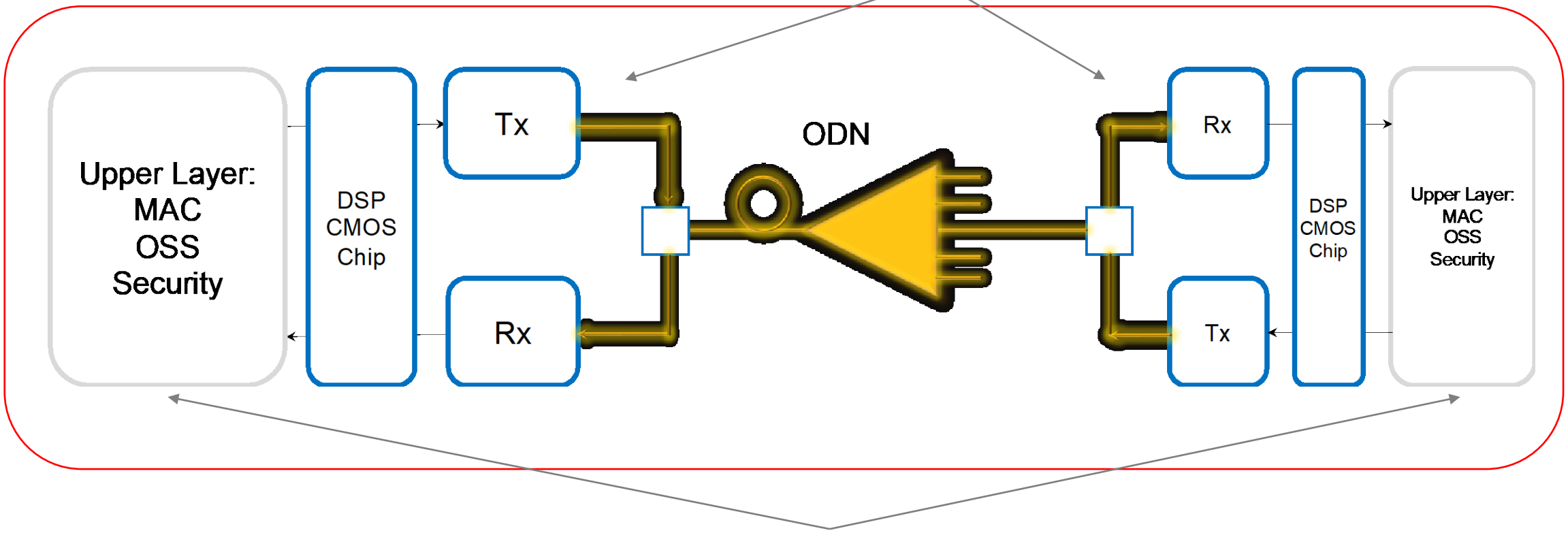
CPON Program - Objective

- Define business and technology requirements of 100G CPON for point-to-multipoint connection in operators' access networks
- Develop specifications for CPON systems and devices that:
  - Are multi-vendor interoperable
  - Can be developed and deployed at scale at reasonable cost
  - Support a wide range of applications and use cases, including cable operators and others such as mobile operators, telcos, etc.
  - Coexist with existing infrastructure

CPON Program - Specifications

Architecture Specification

PHY Specification



Upper Layer Specs

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Summary

Conclusions

- 100G PON is coming
  - Expand beyond traditional residential deployment to support convergence needs at the network edge, from DAA aggregation, mobile x-haul, optical LAN, all the way to future fiber to the MDU and home.
  - IM-DD technology faces many challenges in terms of transmit power, receiver sensitivity, and optical transmission penalty.
- Coherent optics as a long-term evolution strategy – transition from P2P to P2MP
  - 100G is just the coherent floor
  - Re-engineering coherent optics is need for PON applications
- CableLabs is actively working on CPON specifications
  - Send email to workinggroups@cablelabs.com if you'd like to participate the working group or you have any questions related to this activity.

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Thank You!

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