Super-PON CFI

(preliminary version)

Scale Fully Passive Optical Access Networks to Longer Reaches and to a Significantly Higher Number of Subscribers

CFI Objectives

- Measure the interest in studying PMDs for DWDM in a long reach ODN
- We do not need to:
  - Fully explore the problem
  - Debate strengths and weaknesses of solutions
  - Choose a solution
  - Create a PAR or 5 Criteria
  - Create a standard
- Anyone in the room may vote or speak

Call For Interest

From 802.3ah (1G-EPON) to 802.3av (10G-EPON) to the current 802.3ca (25G/50G EPON), the IEEE 802.3 Working Group developed standards to scale the speed of Passive Optical Networks (PONs).

There is now the need to further scale the coverage and reach of PONs to cover more customers at higher distances from a Central Office. This means standardizing new EPON PMDs to exploit DWDM techniques in a long reach (i.e., optically amplified) PON.

This Call for Interest is to assess the support for the formation of a Study Group to explore the development of these new EPON PMDs.

Supporters

- …

Market Need

Super-PON: A Different Way to Scale

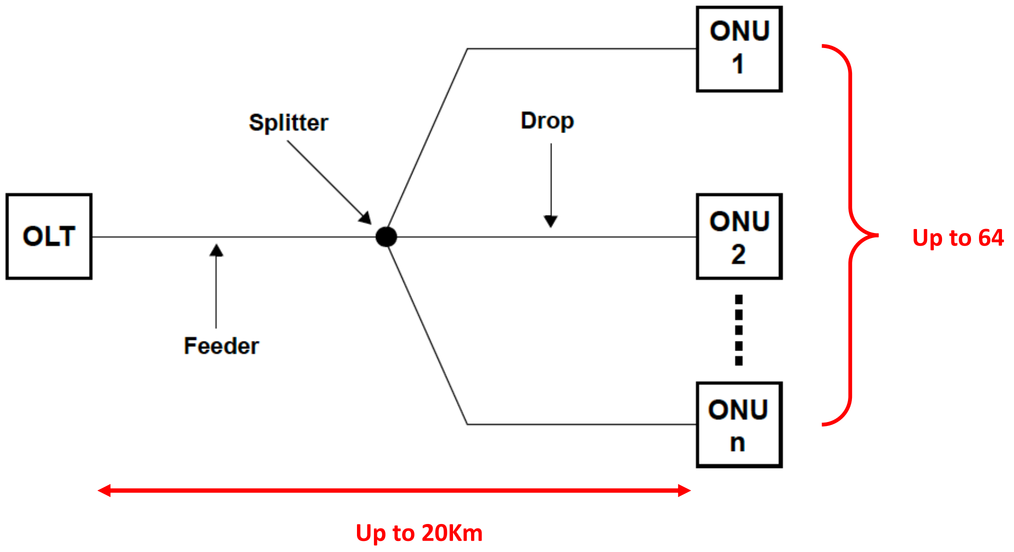
- Ethernet traditionally scaled (in speed) in powers of 10
- Then 802.3 recognized the need for different scaling factors for different markets/applications
  - And 40Gb/s, 25Gb/s, 50Gb/s, 2.5Gb/s, 5Gb/s, 200Gb/s, 400Gb/s came out
- Super-PON intends to study PON scalability in different dimensions to address different/complementary markets/applications
  - Not in speed (802.3ca is already doing that),
  - But in reach (from ~10-20Km to ~40-50Km) …
  - …and in number of subscribers for fiber strain (from ~64 to ~1024)
- Optimize OSP resources utilization – lower cost per customer

Why: Lower the OSP Building Cost

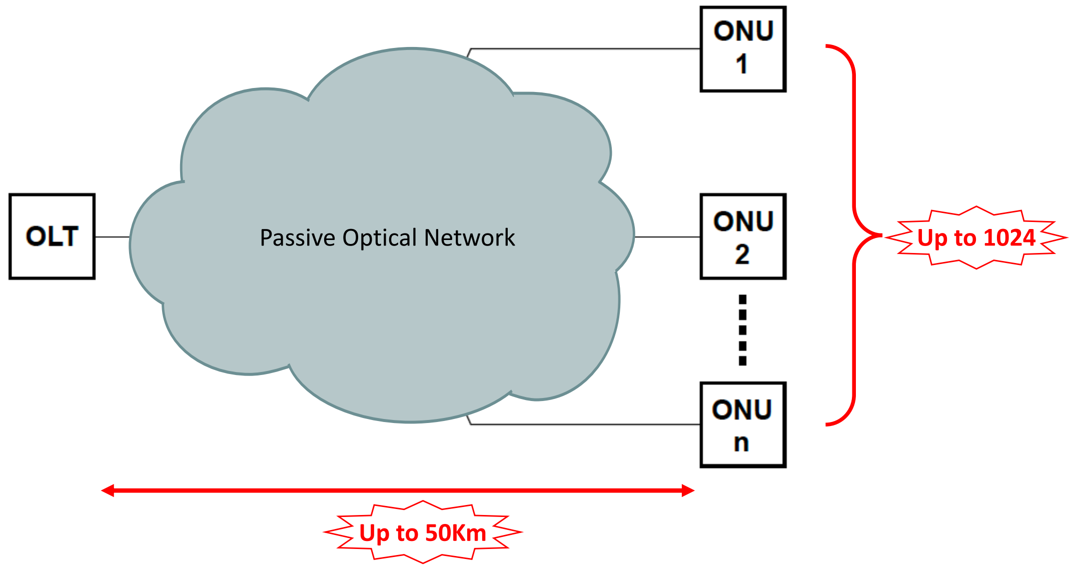
- To expand the OSP to support new residential developments
- For developing countries
  - E.g., India, Brazil
  - Reach rural areas
  - Potentially very large markets

What: Super-PON Goal

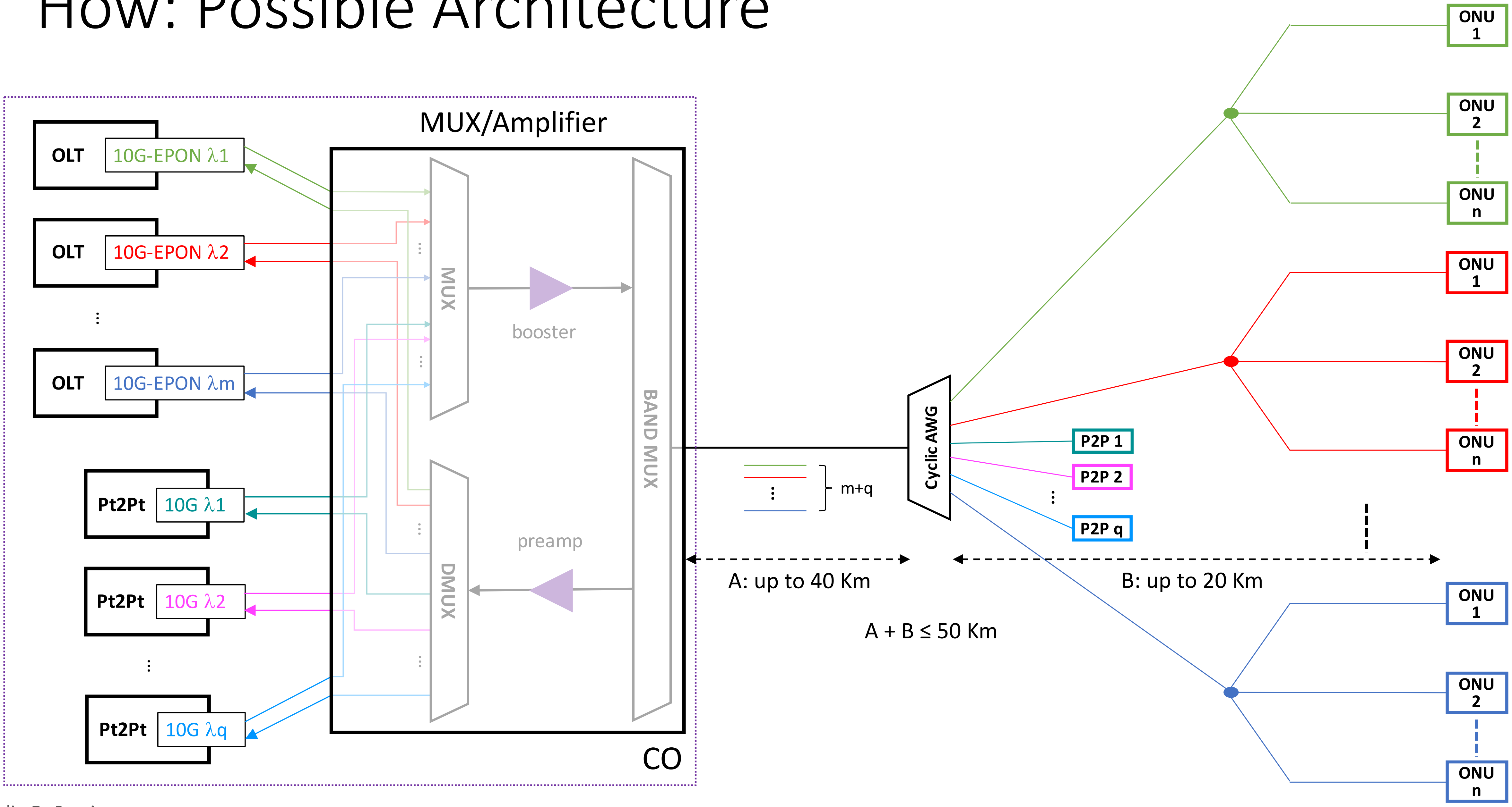
From here…



…to here



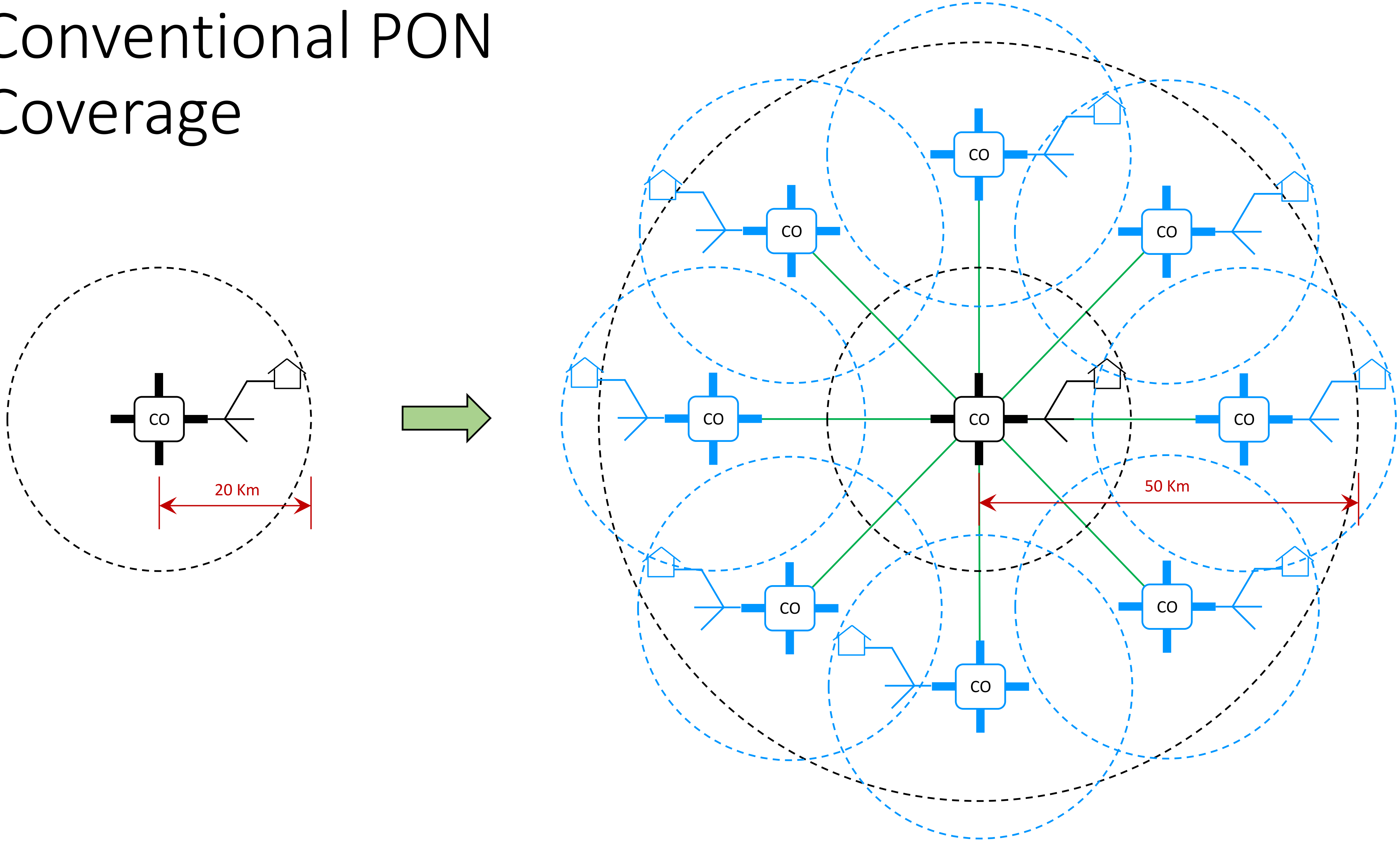
How: Possible Architecture



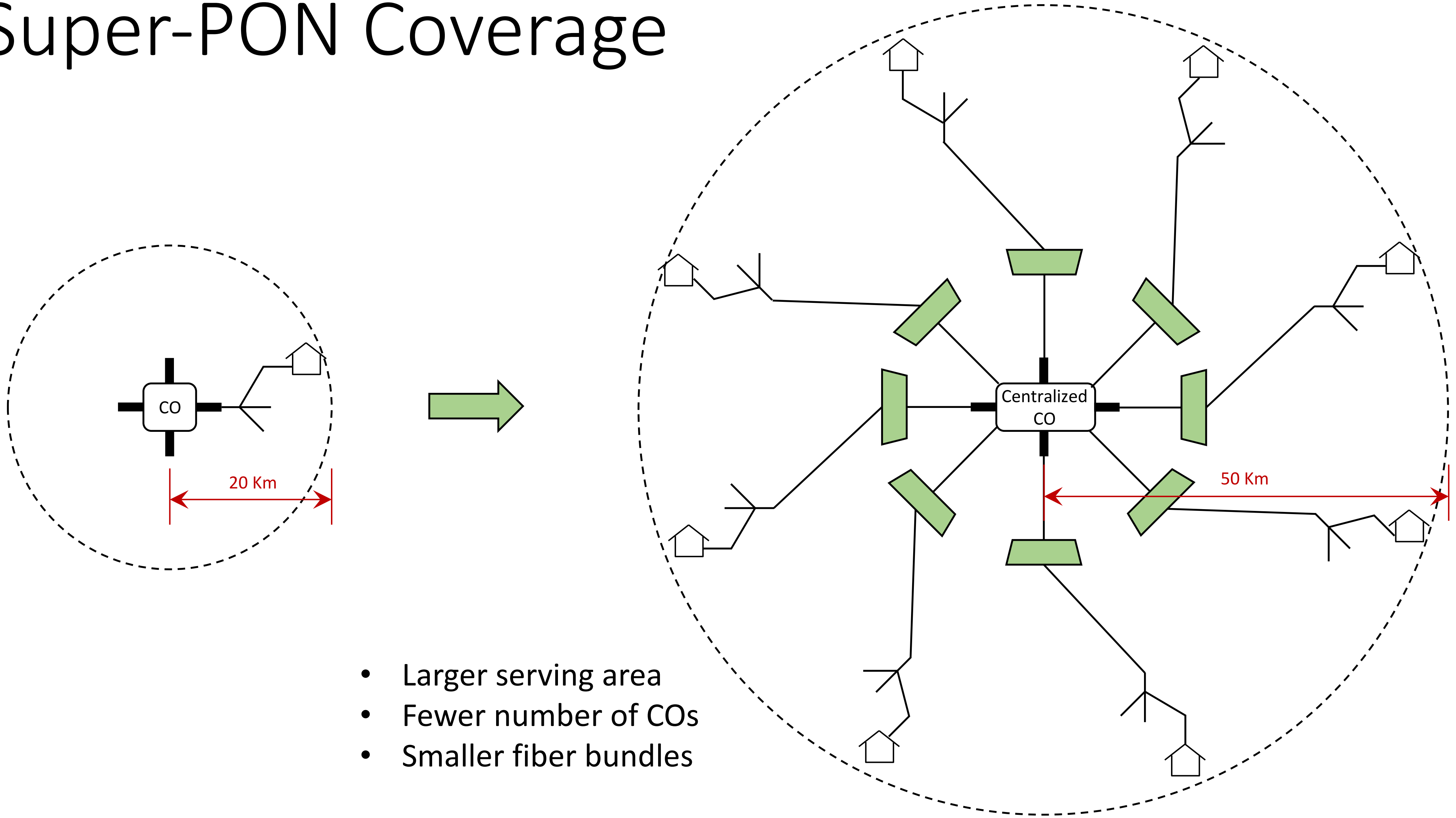
Desired Properties

- A DWDM system
  - Multiplexes multiple channels over a single feeder fiber
  - Separates the channels with a passive optical router (AWG) in the OSP
  - Supports more (customers) with less (fiber)
- An amplified system
  - Achieves long reach through amplification
  - Single amplifier for all channels to reduce the cost impact
- Supports different types of subscribers
  - Cost effective asymmetric ONUs for residential customers
  - Guaranteed performance symmetric ONUs for business customers

Conventional PON Coverage



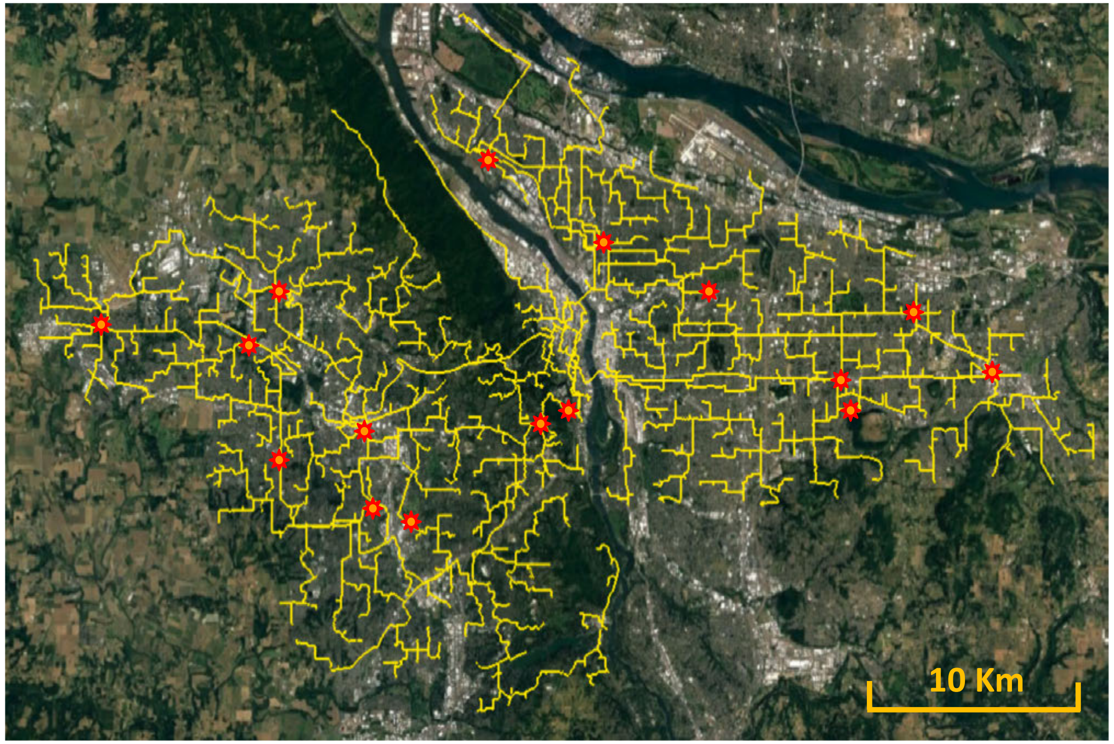
Super-PON Coverage



- Larger serving area
- Fewer number of COs
- Smaller fiber bundles

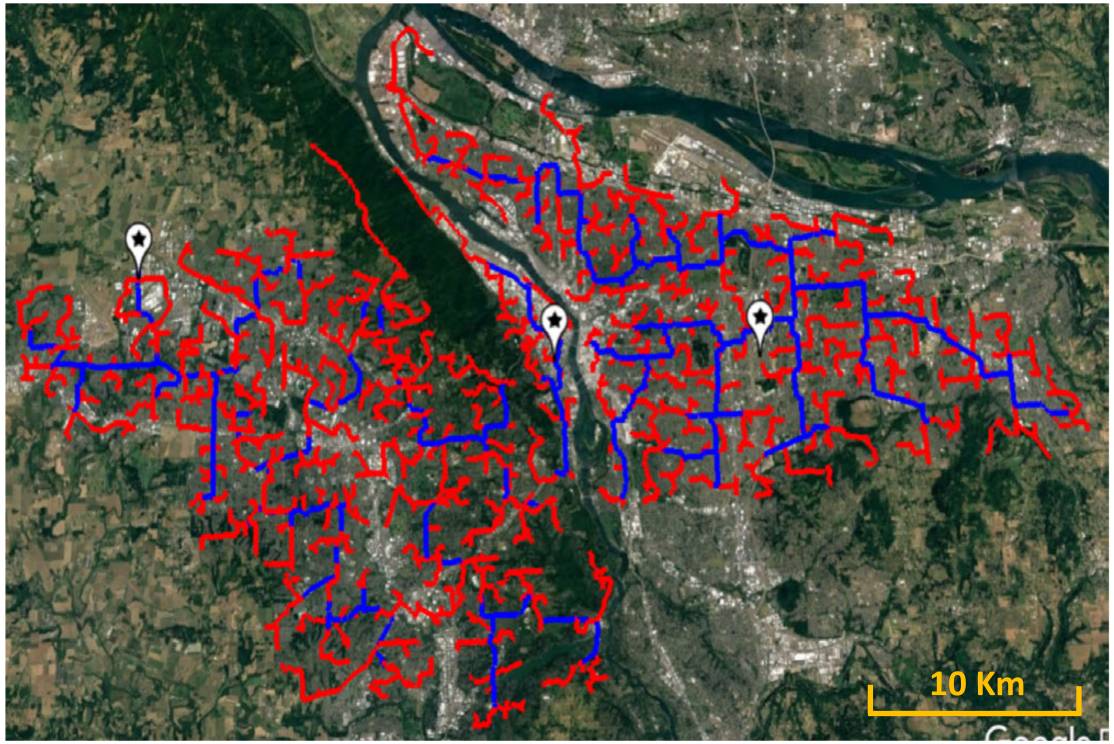
Super-PON OSP Example

Conventional PON: 16 COs



Feeder fiber

Super-PON: 3 COs



CAWG feeder fiber

Splitter feeder fiber

- Significantly smaller number of COs
- Better fiber utilization
  - Much less backbone and feeder fiber
  - Lower OSP building cost

Advantages

- Fewer fibers needed to support the same number of customers
  - Enables smaller/fewer cables
    - From 432-fiber cables to 12-48-fiber cables
- Easier OSP construction
  - Smaller cables can be longer and are easier to bend/handle
  - Allows use of micro-trenching techniques
  - Easier to repair
- CO consolidation
  - The same number of feeder fibers can serve a much greater area
  - Fewer COs → less OPEX

About Trenching…

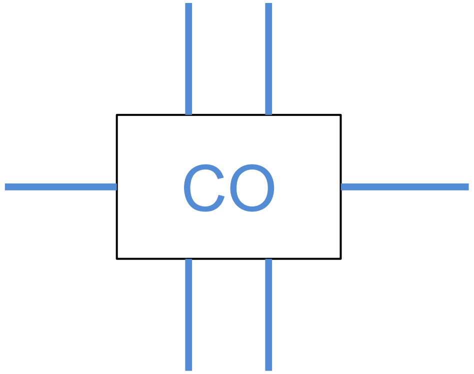
Traditional Trenching

Directional Boring

Micro Trenching

…and Repairs

6 feeder cables
(432-fiber)



A 432-fiber cable:

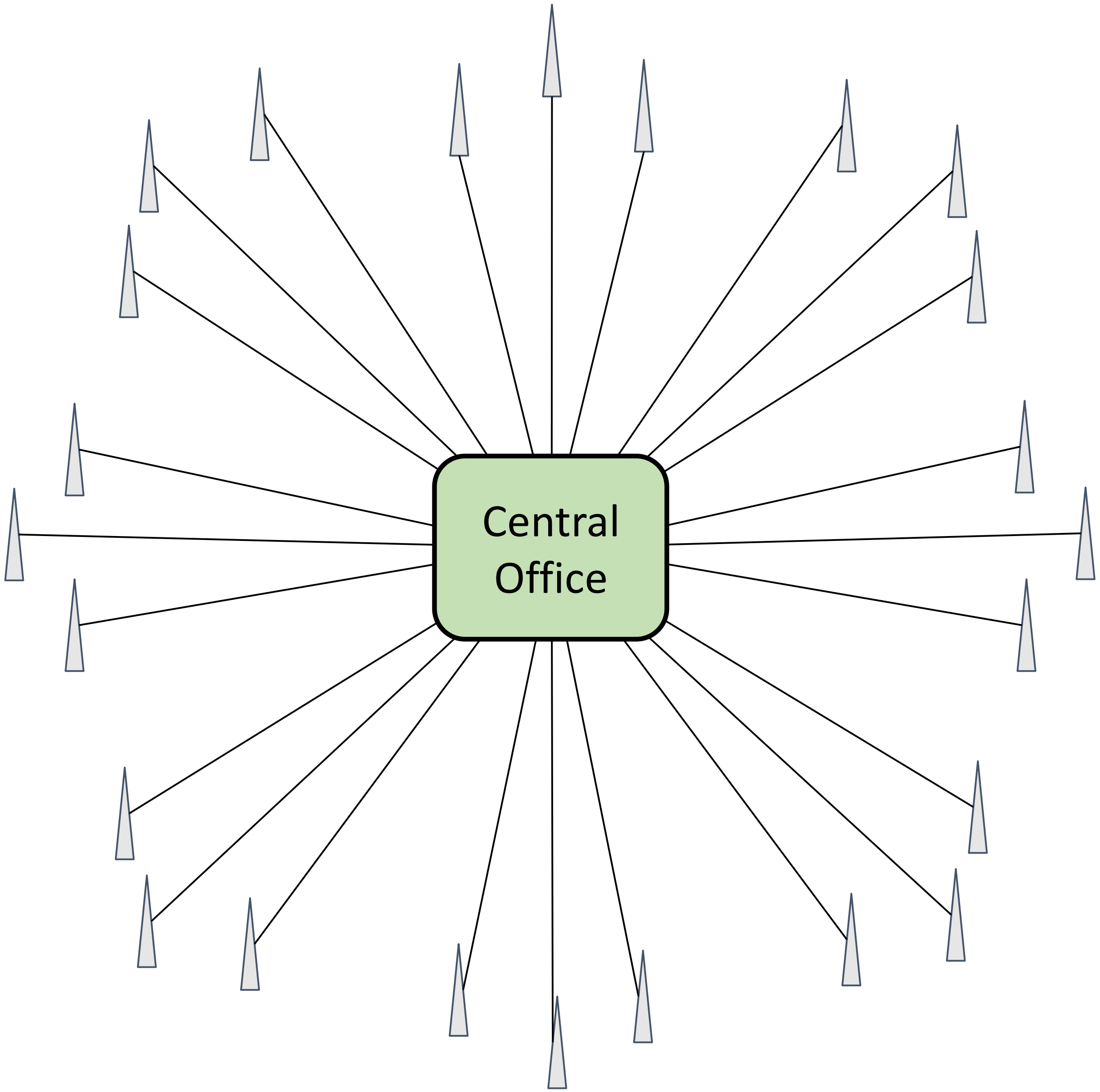
- Contains 36 ribbons of 12 fibers
- ~10 min to splice a ribbon
- ~6 hours total to splice a broken cable
- Additional ~2 hours for cable manipulation
- Average time to repair a cable damage: ~8 hours

A 24-fiber cable:

- ~40 mins total to splice a broken cable
- Additional ~1 hour for cable manipulation
- Average time to repair a cable damage: ~1 hour 40’

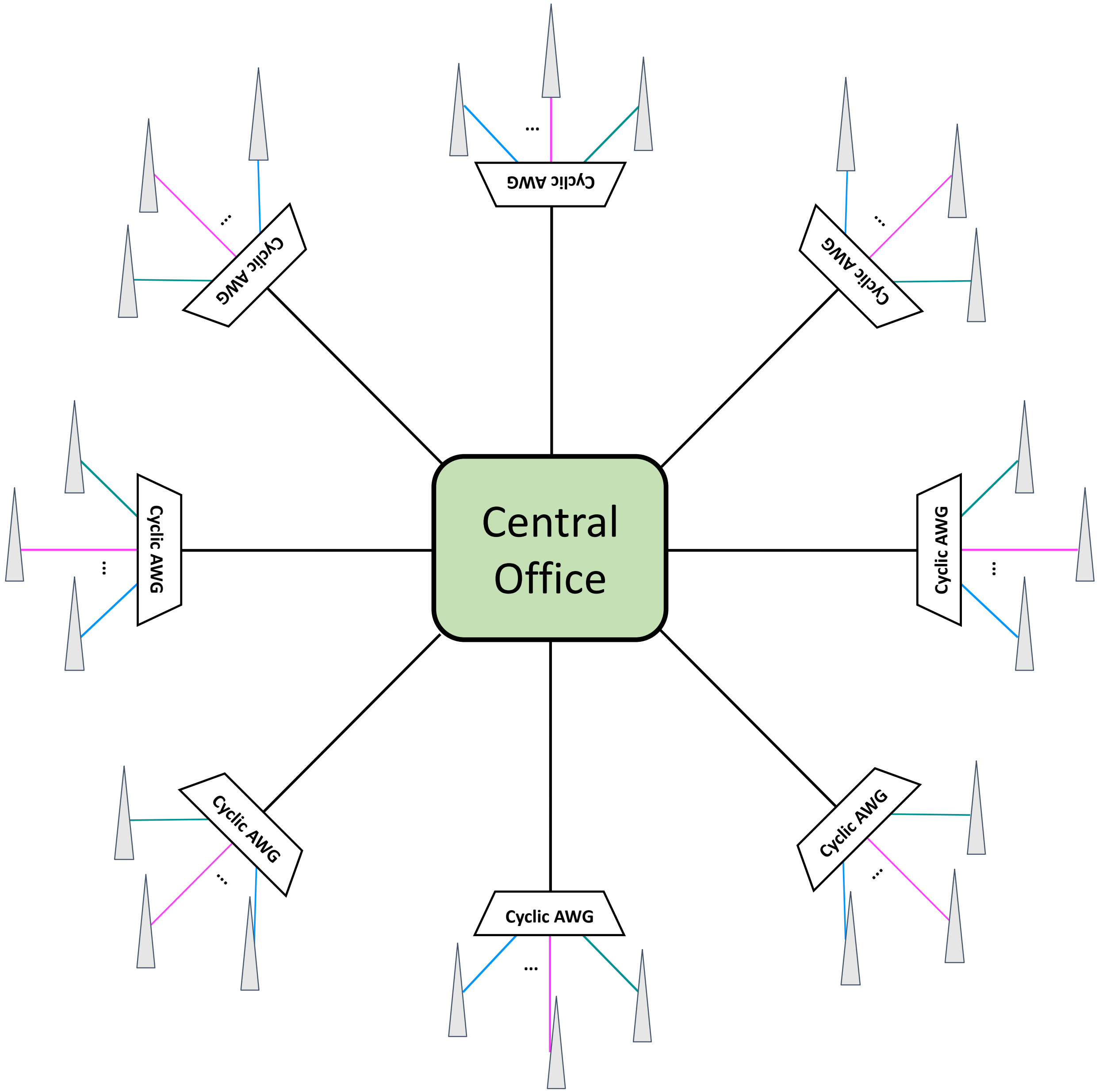
Cellular Support

- From here…
  - Each tower needs its own fiber from the central office

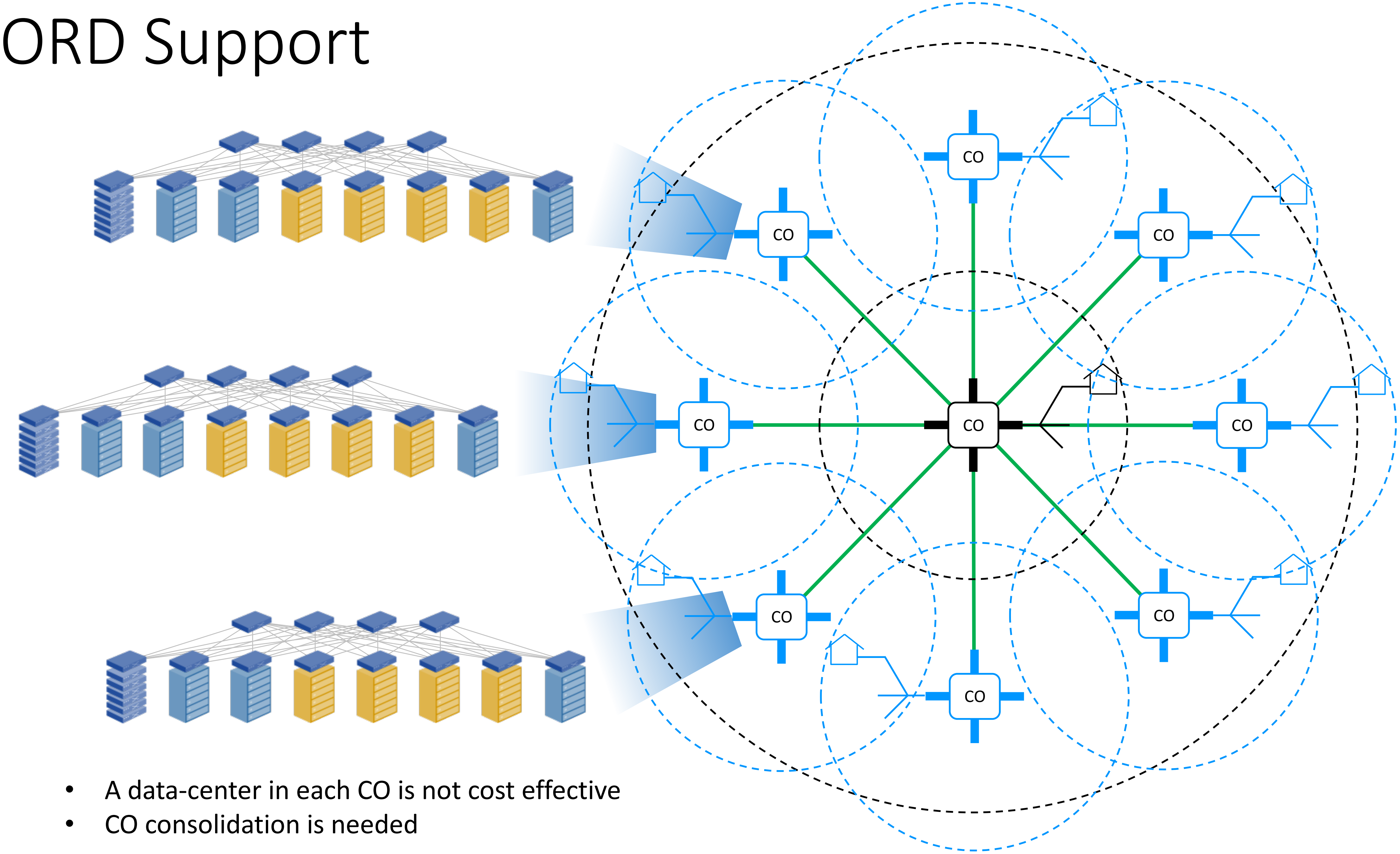


Cellular Support

- …to here
  - Leverage DWDM to carry multiple channels over one fiber

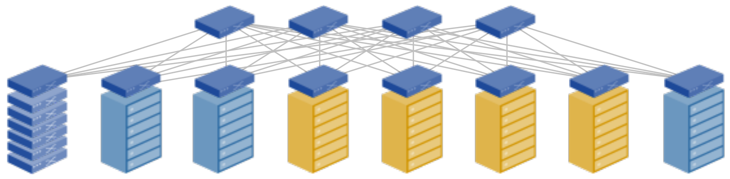


CORD Support

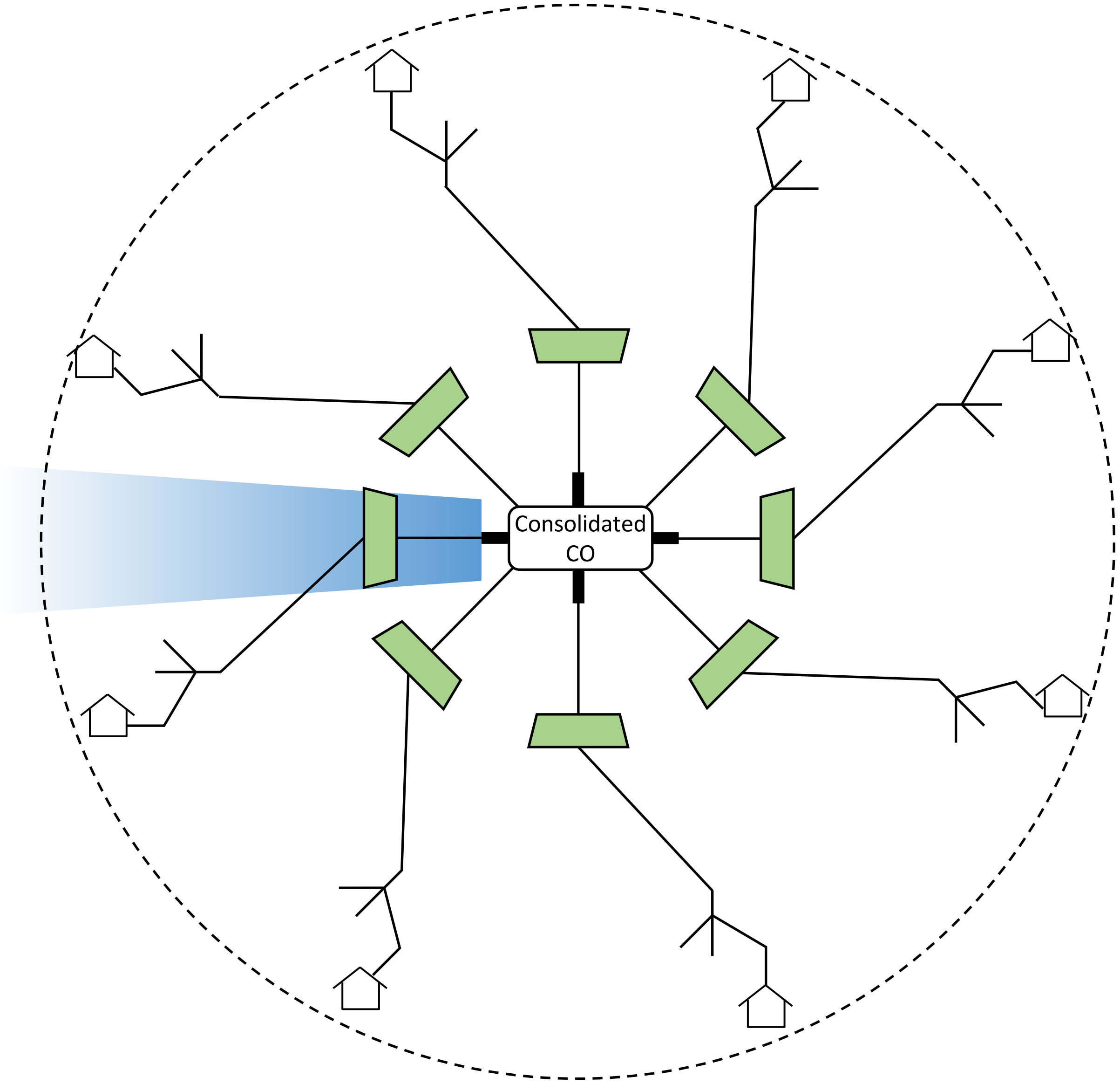


- A data-center in each CO is not cost effective
- CO consolidation is needed

Consolidated CO

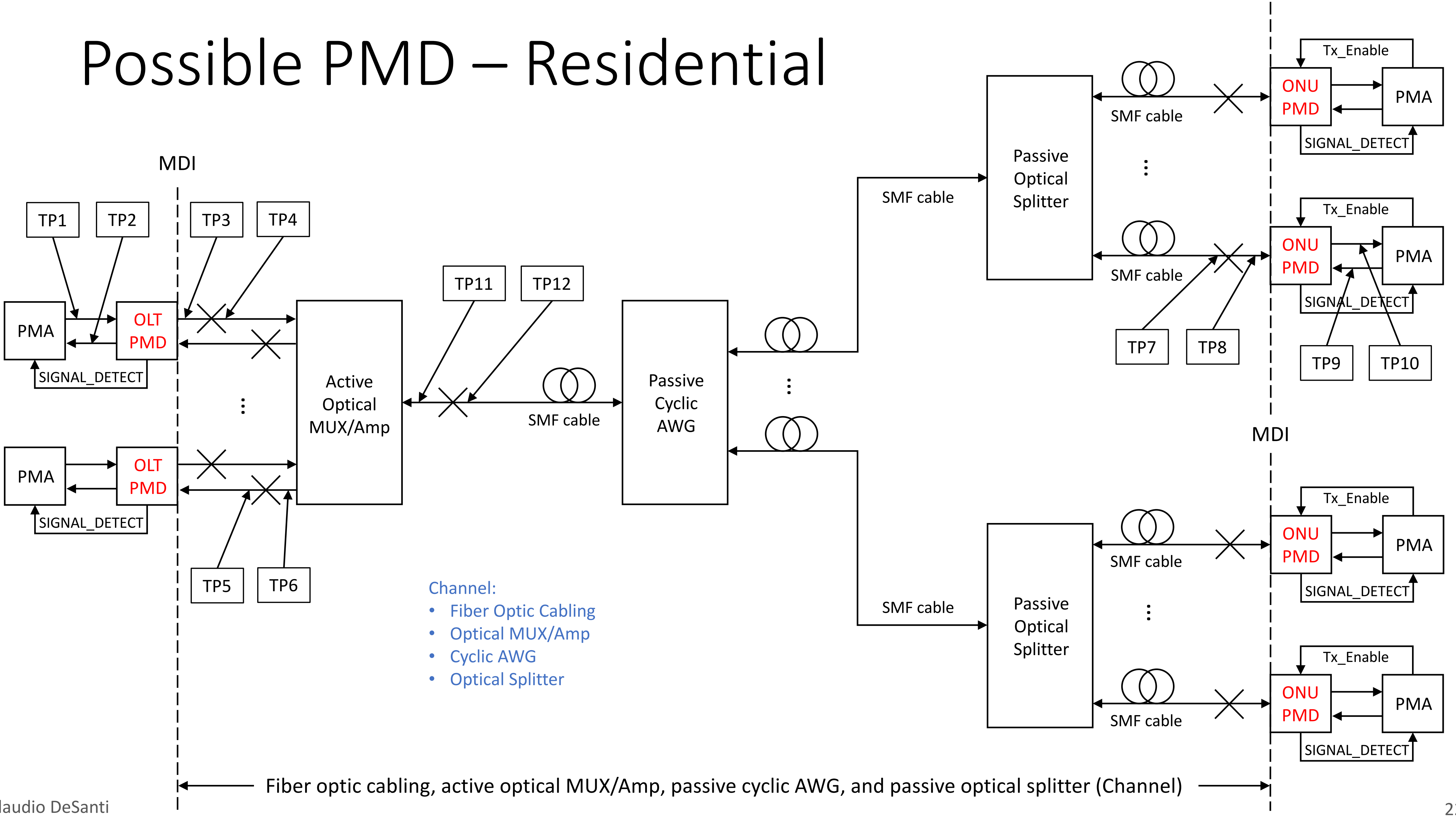


CORD is now cost effective



Technical Feasibility

Possible PMD – Residential

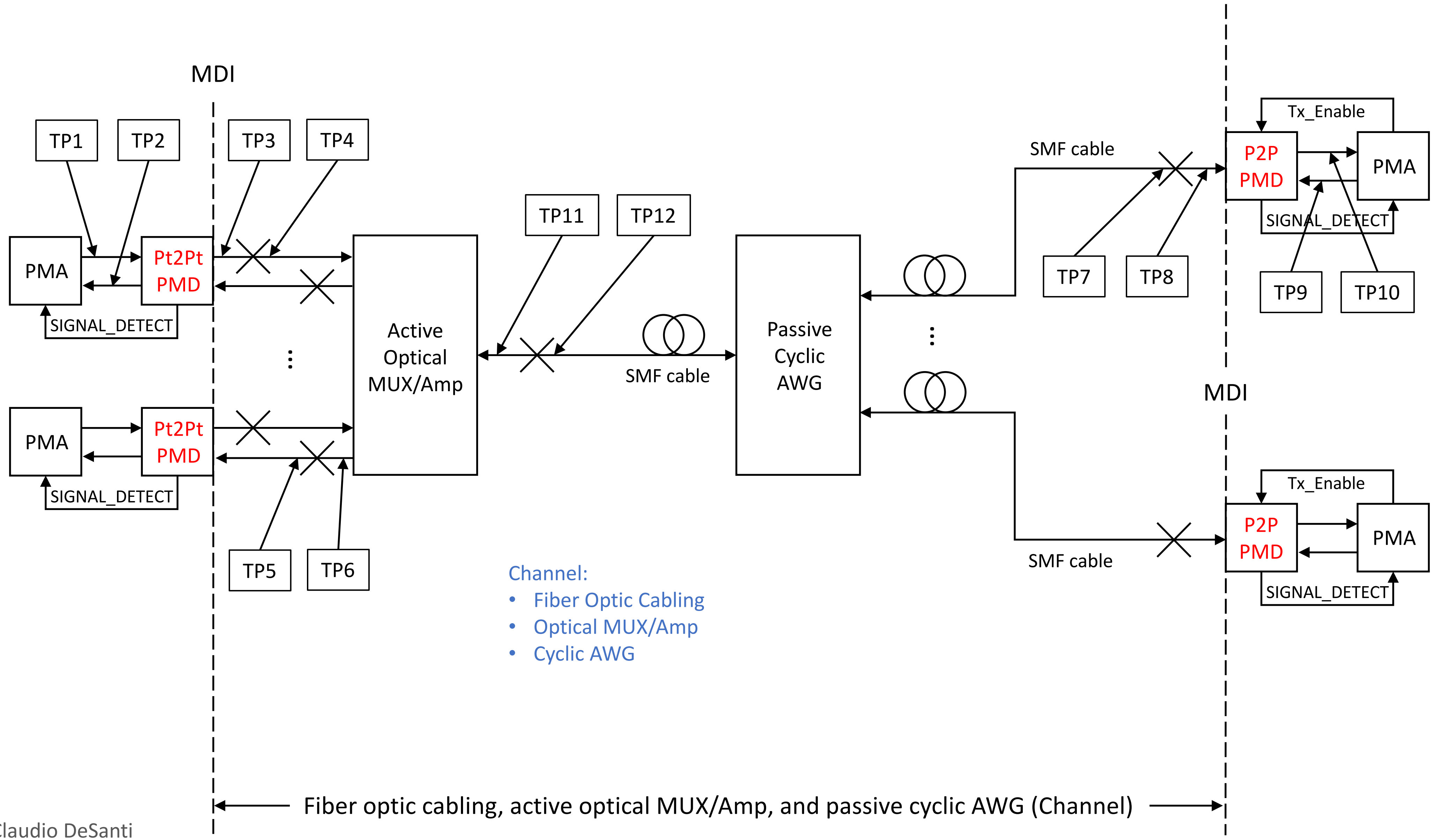


Channel:

- Fiber Optic Cabling
- Optical MUX/Amp
- Cyclic AWG
- Optical Splitter

Fiber optic cabling, active optical MUX/Amp, passive cyclic AWG, and passive optical splitter (Channel)

Possible PMD – Point to Point

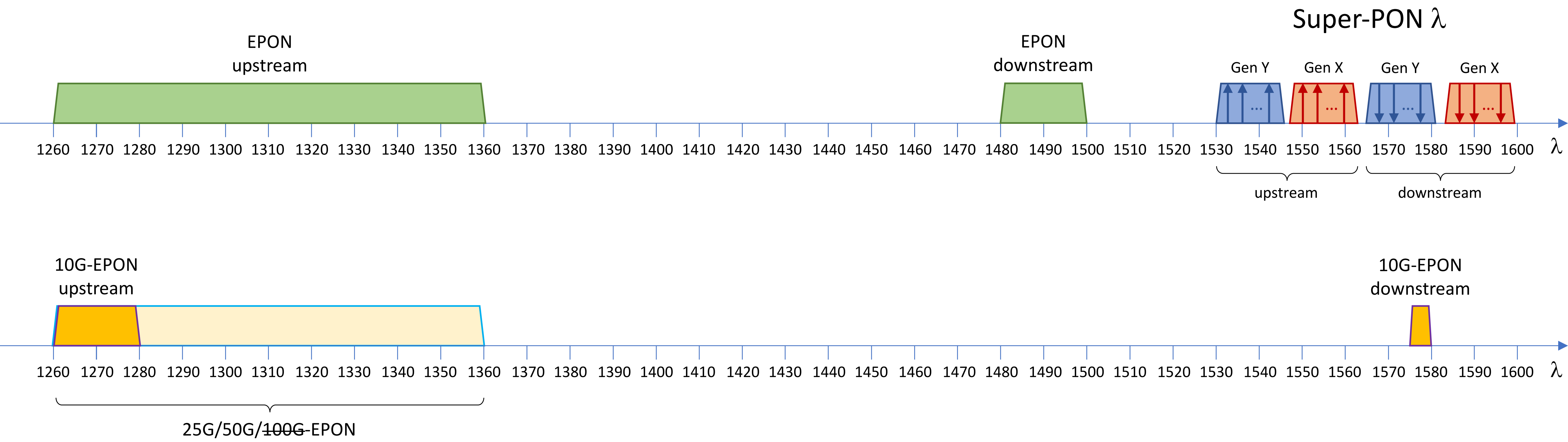


Channel:
- Fiber Optic Cabling
- Optical MUX/Amp
- Cyclic AWG

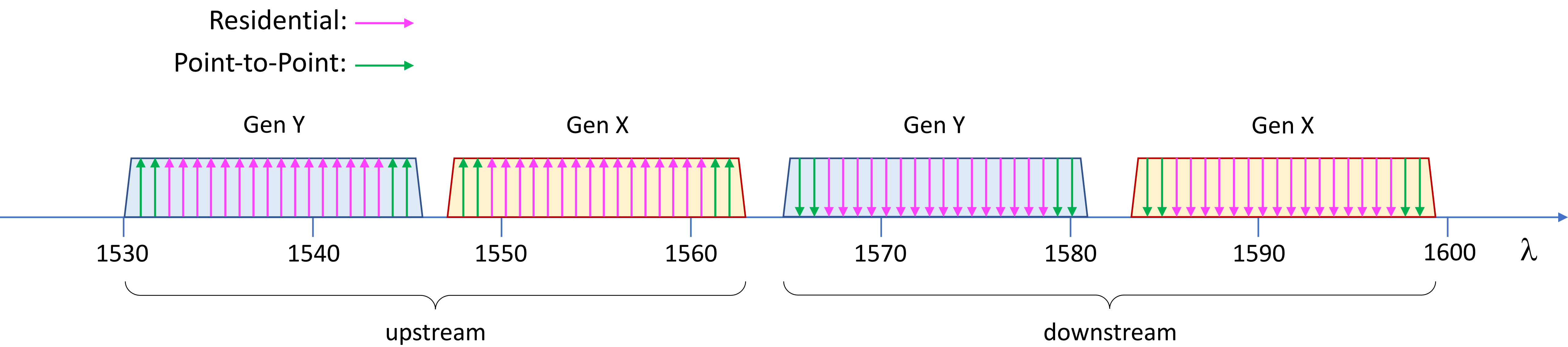
Defining the Optical Parameters

- Using EDFAs as amplifiers implies using the C- and L-bands for wavelengths
  - C-band: 1530 .. 1565 nm, upstream
  - L-band: 1565 .. 1625 nm, downstream
- Split the bands in two ~equally sized ranges to support speed upgrades
  - Gen X upstream: ~1530 .. 1546 nm
  - Gen Y upstream: ~1547 .. 1563 nm
  - Gen X downstream: ~1565 .. 1581 nm
  - Gen Y downstream: ~1583 .. 1599 nm
- These ranges define the FSRs of the cyclic AWG
- Within each range, define a set of wavelengths to use for DWDM transmission
  - 20 channels using a nominal channel spacing of 100 GHz

Wavelength Plan



Example of Residential and Point-to-Point λ



- Which wavelengths are for what can be deployment/implementation specific
- Need wavelength-stabilized and possibly tunable lasers

More on Lasers

- …

Why Now?

Why Now?

- Desire to lower the OSP building cost
  - For OSP expansion in new residential developments
  - For large developing countries
- The Software Defined Central Office is getting real
  - CORD is an example
  - Requires CO consolidation to be cost effective
  - Super-PON PMDs allow in the access network the consolidation made possible in compute and services by CORD
- Integrated point-to-point support helps upcoming 5G cellular deployments
- Technology advancements made cooled lasers and tunable cooled lasers more affordable than before
  - Enables narrow DWDM channel bands

Straw Polls

- Should a study group be formed?
- Would I participate in such a Study Group?
- Would my company support participation in such a Study Group?

Thank you