Super-PON Call For Interest

Consensus Deck

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CFI Objective

- Measure the interest in studying Ethernet Access (P2MP and P2P) PMDs leveraging wavelength division multiplexing over a common long reach optical distribution network (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

Supporters

Phil Miguelez (Comcast)

Maurizio Valvo (Telecom Italia)

Guangquan Wang (China Unicom)

Shikui Shen (China Unicom)

Curtis Knittle (CableLabs)

Frank Effenberger (Huawei)

Jun Shan Wey (ZTE)

Mark Laubach (Broadcom)

Glen Kramer (Broadcom)

Leo Lin (Finisar)

Vipul Bhatt (Finisar)

David Li (Hisense)

James Wang (Hisense)

Weiqing Zhang (Accelink)

Wanhui He (Accelink)

Karen Liu (Kaiam)

Henk Bulthuis (Kaiam)

Simin Cai (GoFoton)

Feng Tian (GoFoton)

Agenda

- Background Information
- Market Need
- Technical Approaches
- Why Now

Introduction

- 802.3 recognizes the need for different speeds for different markets/applications
  - E.g., 40Gb/s, 25Gb/s, 50Gb/s, 2.5Gb/s, 5Gb/s, 200Gb/s, 400Gb/s
- Super-PON intends to extend Ethernet Access to address different/additional markets/applications
  - Unify the ODN for Point-to-MultiPoint (P2MP) and Point-to-Point (P2P) operations
  - Extend the reach from ~10-20Km to ~40-50Km
  - Enlarge the number of subscribers per fiber strand from ~64 to ~1024
  - Independent from the higher speed definitions of 802.3ca
    - Possibly leverage them

Industry Trend

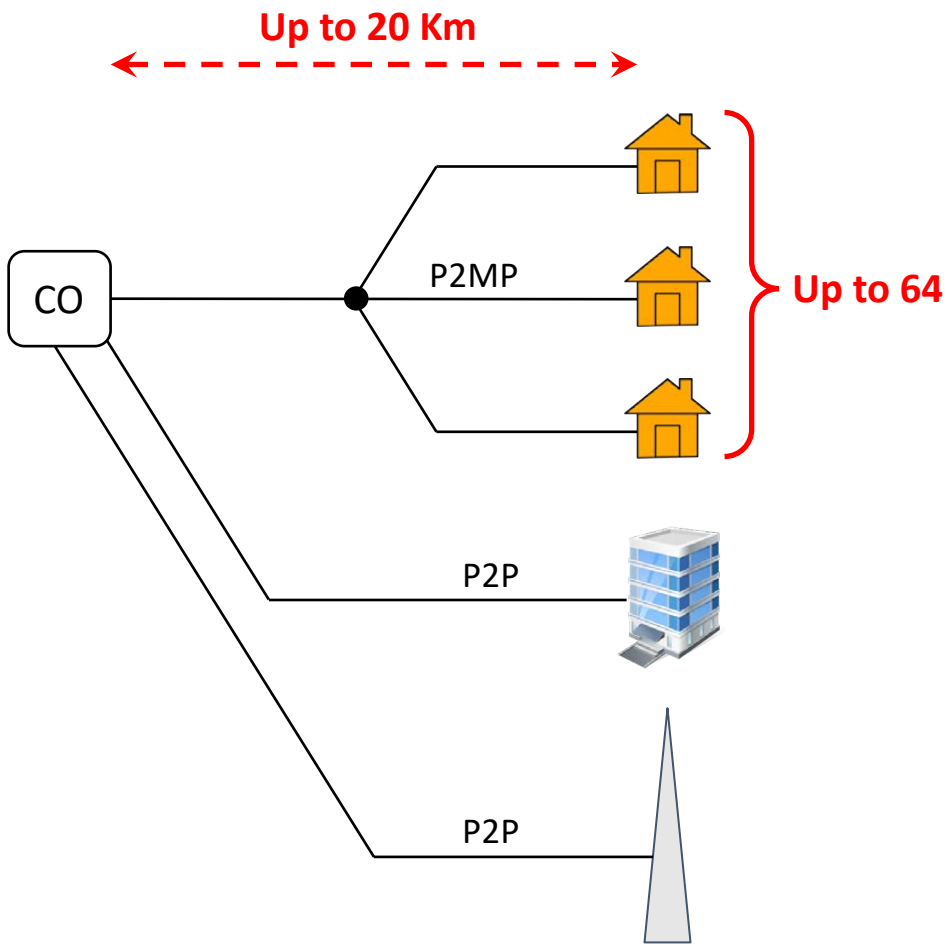
- Consolidation of local and regional offices and infrastructures is an on-going trend for telecommunication operators
- This brings new requirements to the network infrastructure
  - Support longer distances
  - Support multiple channels on the same ODN through wavelength division multiplexing
  - Support multiple P2MP and P2P operations over the same ODN
- Super-PON intends to satisfy these new requirements with a passive ODN
  - Advantageous for new ODN builds

Common ODN for Access Networks

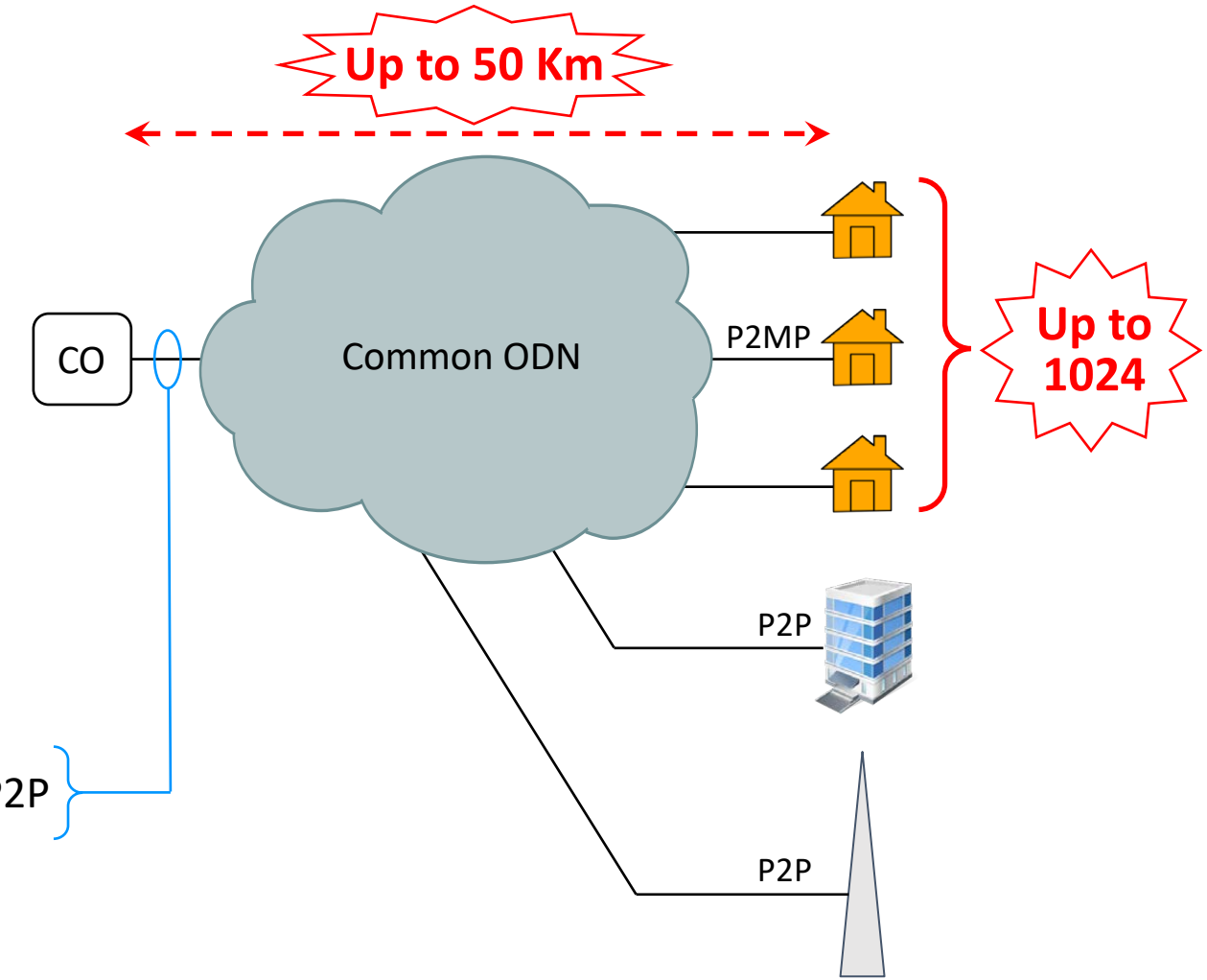
- Clause 56 defines Ethernet for subscriber access networks
  - Or Ethernet in the First Mile (EFM)
- Supports Point-to-Point (P2P) and Point-to-MultiPoint (P2MP)
  - 1G-EPON, 10/1G-EPON, and 10/10G-EPON P2MP (Clauses 60, 64, 65, 75, 76, 77)
  - 100BASE-X and 1000BASE-X P2P (Clauses 58, 59, 66)
  - 802.3ca is defining additional PHYs for P2MP
    - 25/10G-EPON, 25/25G-EPON, 50/10G-EPON, 50/25G-EPON, and 50/50G-EPON
  - The Bidirectional Optical Access PHY Study Group is studying additional PHYs for P2P
    - at 10Gb/s and 25Gb/s
- Assumes different ODNs for P2MP and P2P operations
- Super-PON intends to define P2MP and P2P operations over a common ODN

Super-PON Goal

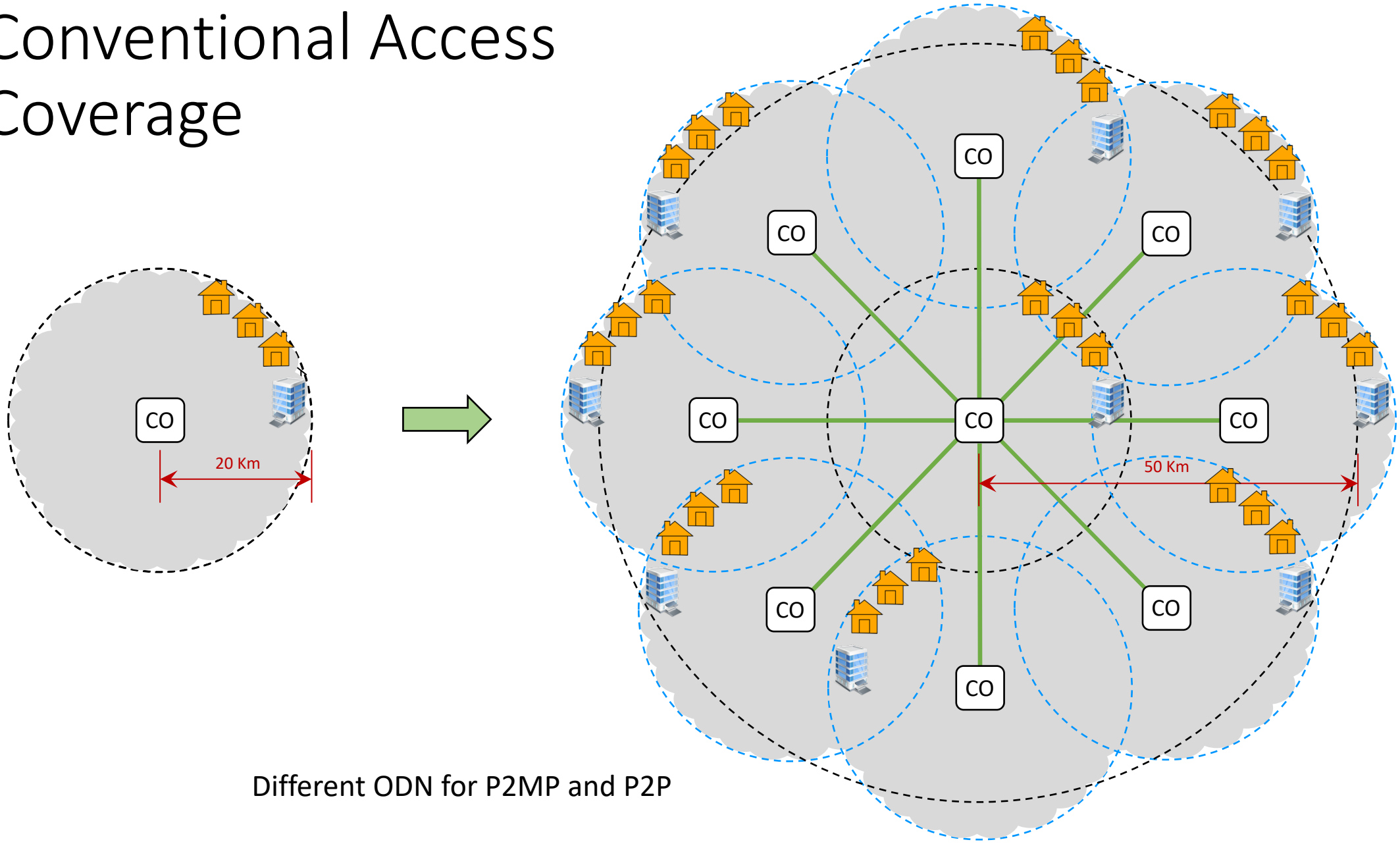
From here…



…to here

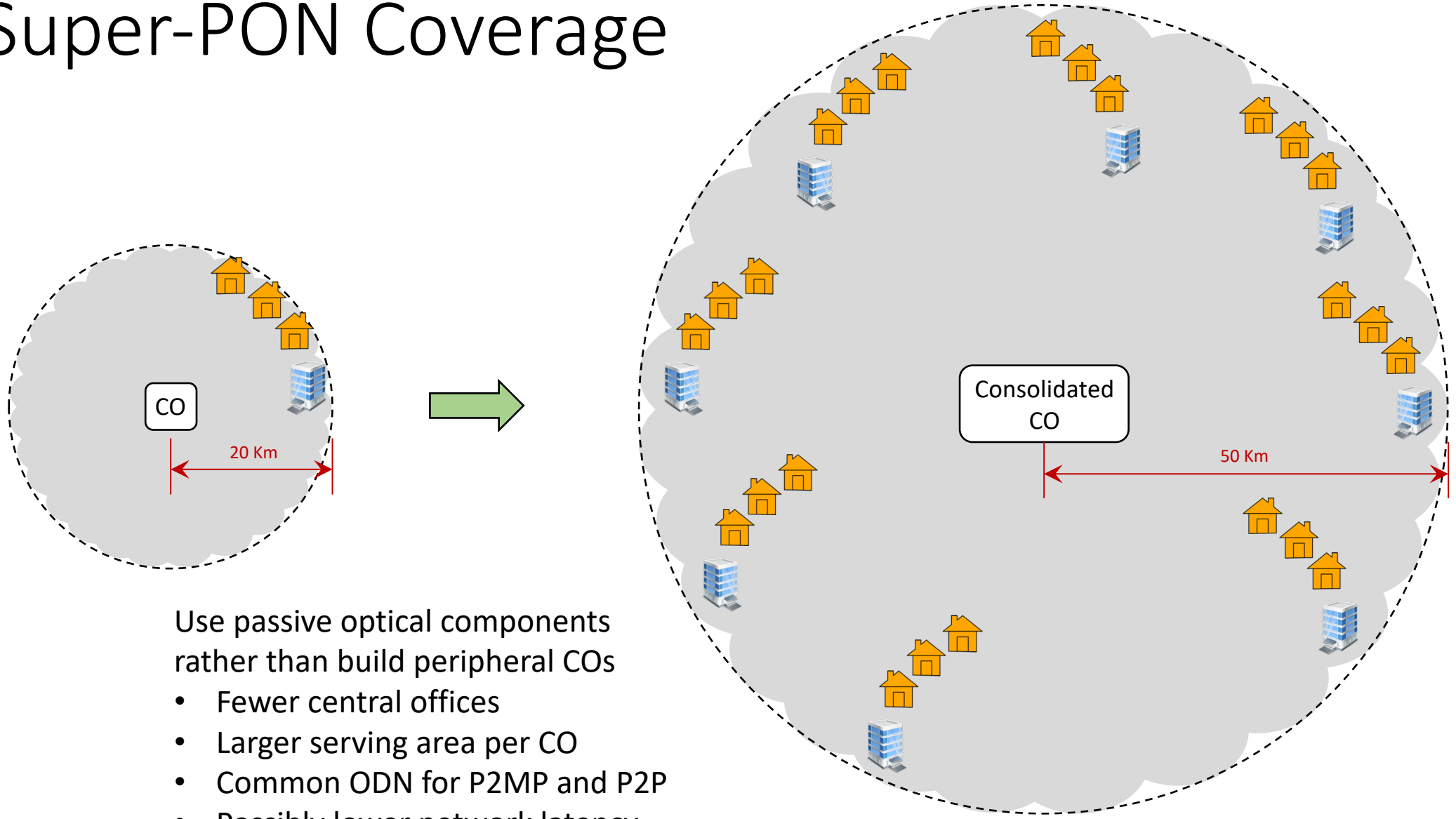


Conventional Access Coverage



Different ODN for P2MP and P2P

Super-PON Coverage

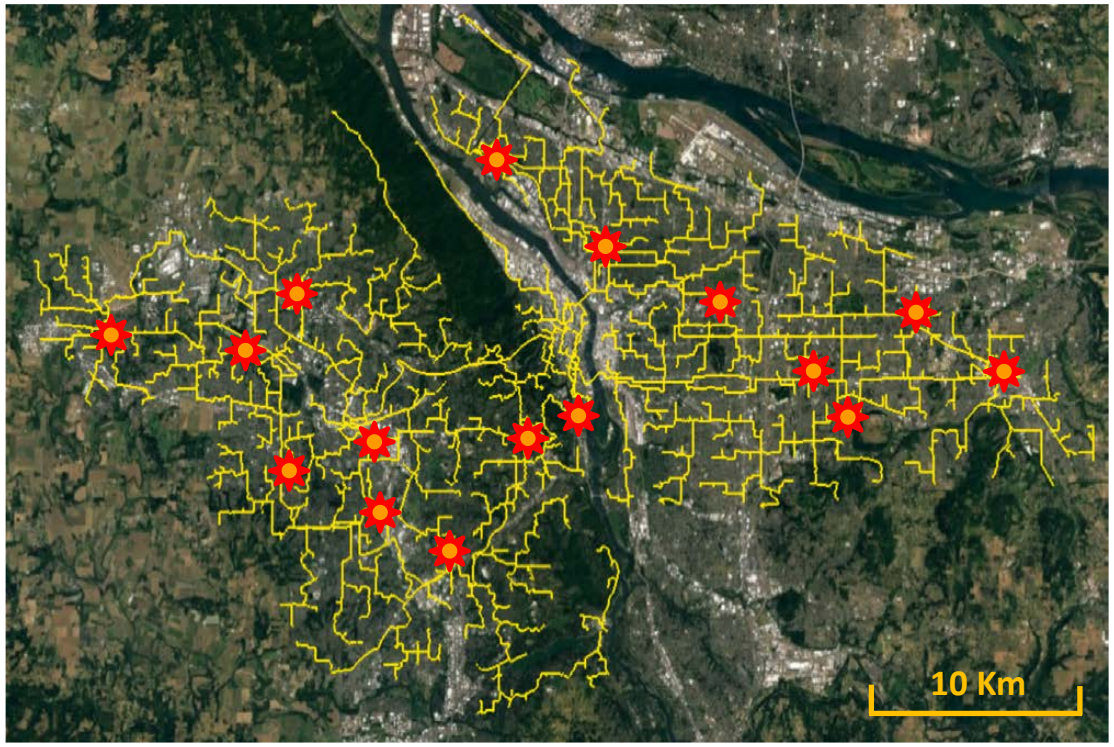


Use passive optical components rather than build peripheral COs

- Fewer central offices
- Larger serving area per CO
- Common ODN for P2MP and P2P
- Possibly lower network latency
- Lower cost by reducing active electronics in the field

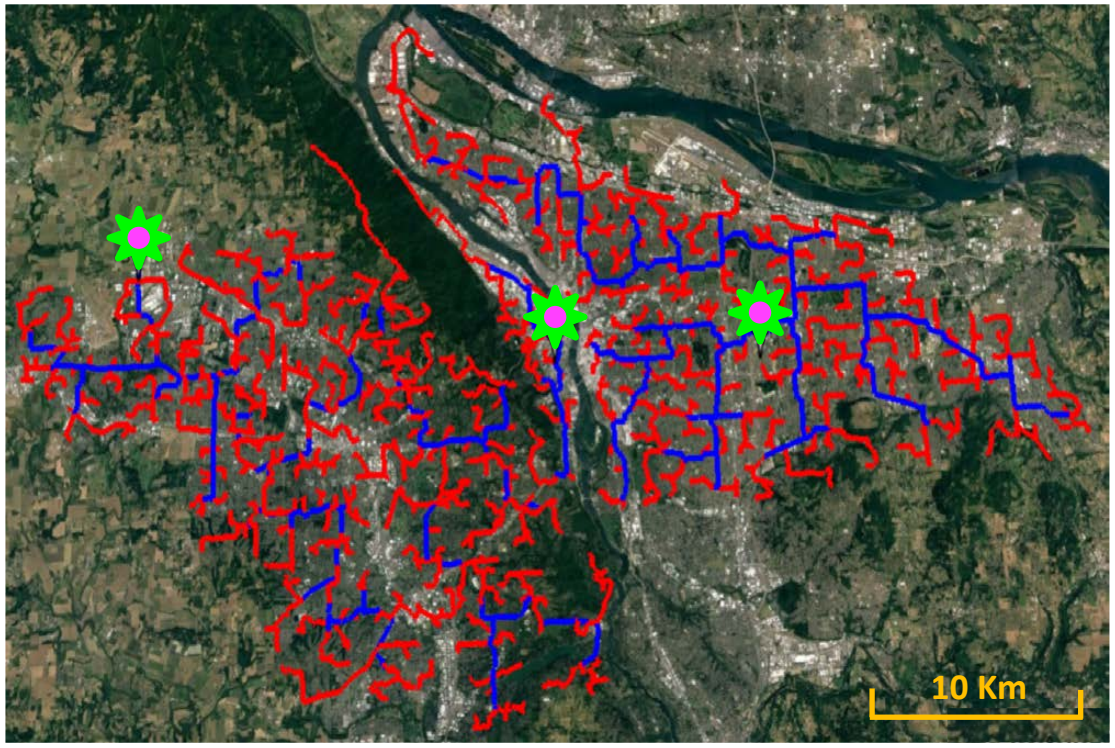
ODN Build Example

Conventional PON: 16 COs



Feeder fiber

Super-PON: 3 COs



CAWG feeder fiber

Splitter feeder fiber

- Fewer central offices
- Lower-count fiber cables
- Less backbone and feeder fiber
- Lower ODN building cost

Reducing Cables Size

Traditional Trenching

Directional Boring

Micro Trenching

Market Opportunity (1)

- PMDs for new ODN builds for developing countries
  - Long reach for rural areas
  - Many countries have government sponsored/funded projects aimed at developing large scale broadband connectivity
    - E.g., Brazil, Indonesia, Thailand, Vietnam, South Africa, Morocco, Kenia, Philippines
  - Example: India's BharatNet project (http://bbnl.nic.in/)
    - Aims to provide broadband connectivity to 250,000 Gram Panchayats
    - Goal: increase India's Internet connectivity to 600 million broadband subscribers
    - Specifically tailored to improve telecom services in rural and remote areas of the country
      - E.g., fiber-to-the-home in Telangana (http://it.telangana.gov.in/telangana-fiber-grid-t-fiber/)
      - ~ 8M households to connect
  - A window of opportunity for Ethernet of several millions PMDs

Market Opportunity (2)

- PMDs for ODN expansion for new residential developments
  - Long reach and broad coverage enable reducing active electronics in the field
- PMDs for ODN expansion to rural areas
  - Rural areas are difficult to serve not just in developing countries

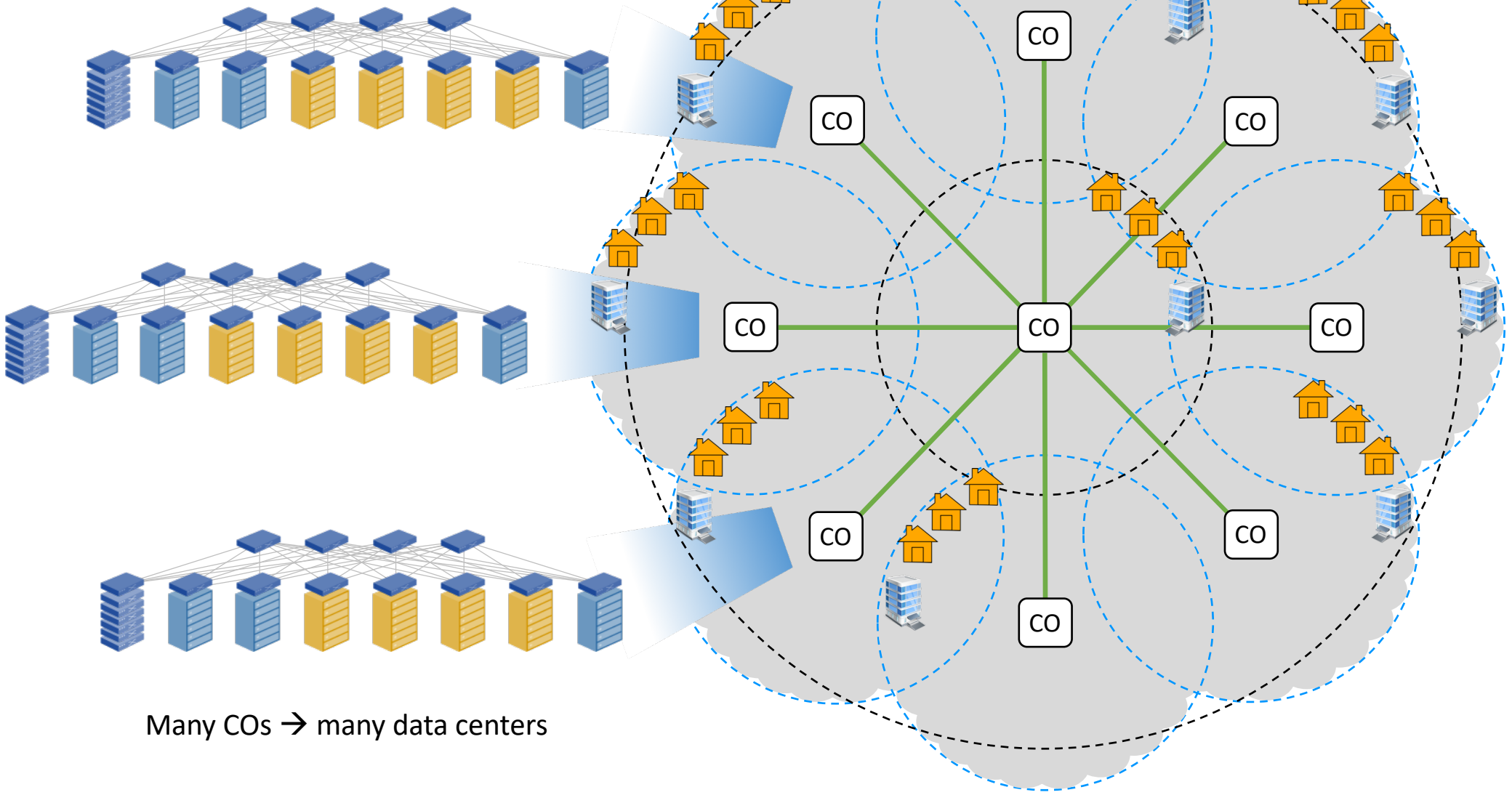
Market Opportunity (3)

- PMDs for ODN optimization for (5G) cellular deployments
  - Potentially a major application of Super-PON P2P PMDs
- Potential market
  - 3B people / (100 people / RU) / 10 year rollout = 3M P2P PMDs / year
  - Customers willingness to pay is significantly higher for P2P PMDs (i.e., business customers) than for P2MP PMDs (i.e., residential customers)

Market Opportunity (4)

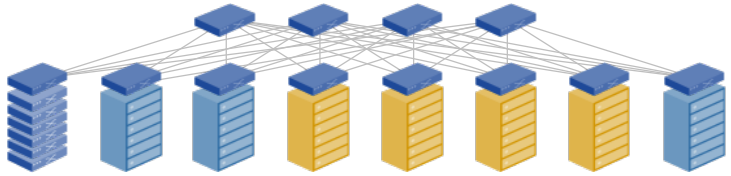
- PMDs for ODN optimization for central office redesign as data center
  - Consolidation of local and regional offices
- Multiple efforts are on-going to re-implement the central office functionalities as a data center
  - Not cost effective with many COs
  - More viable by consolidating COs or by building ODNs with fewer COs

Enabling Central Offices as Data Centers

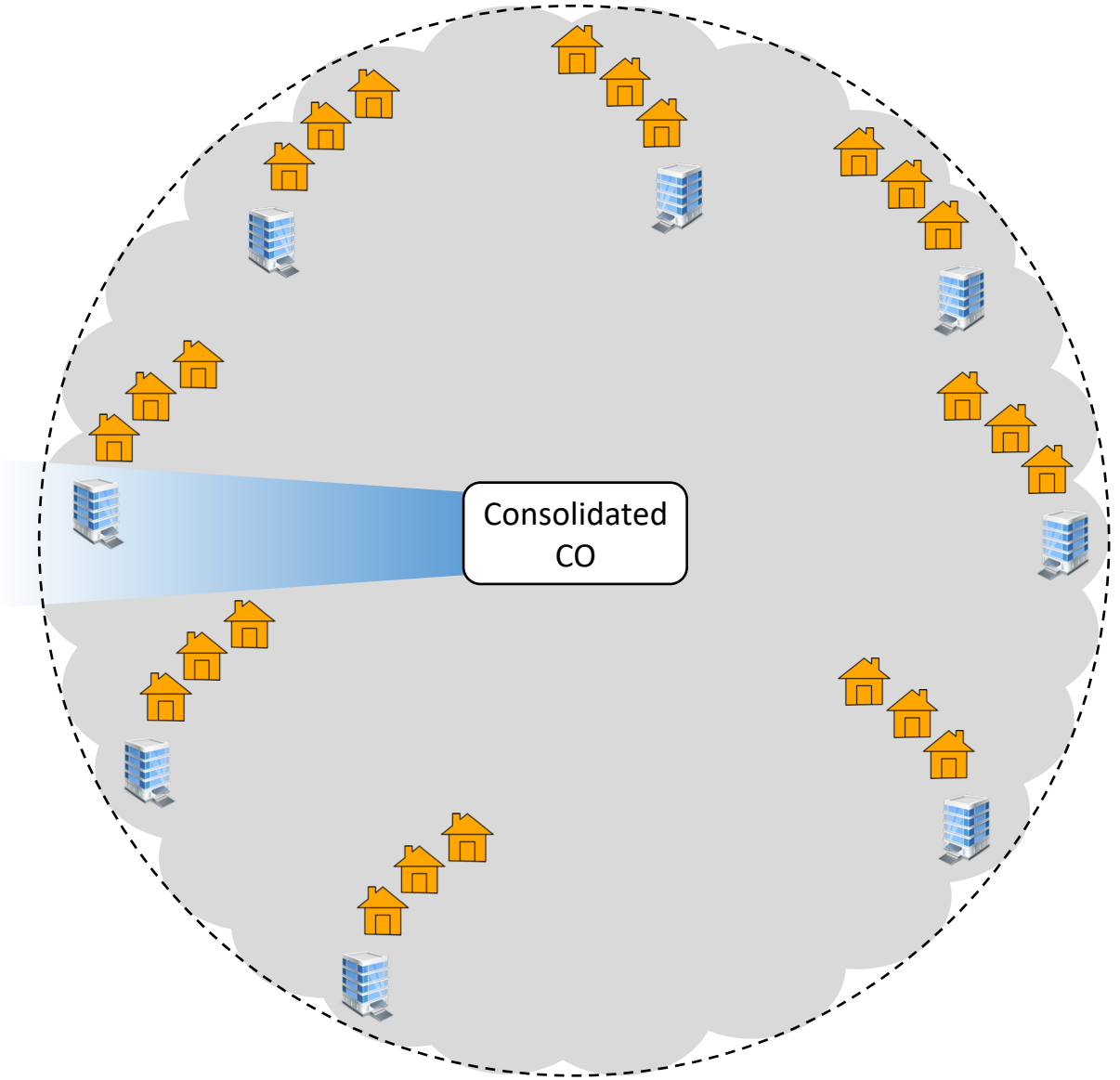


Many COs → many data centers

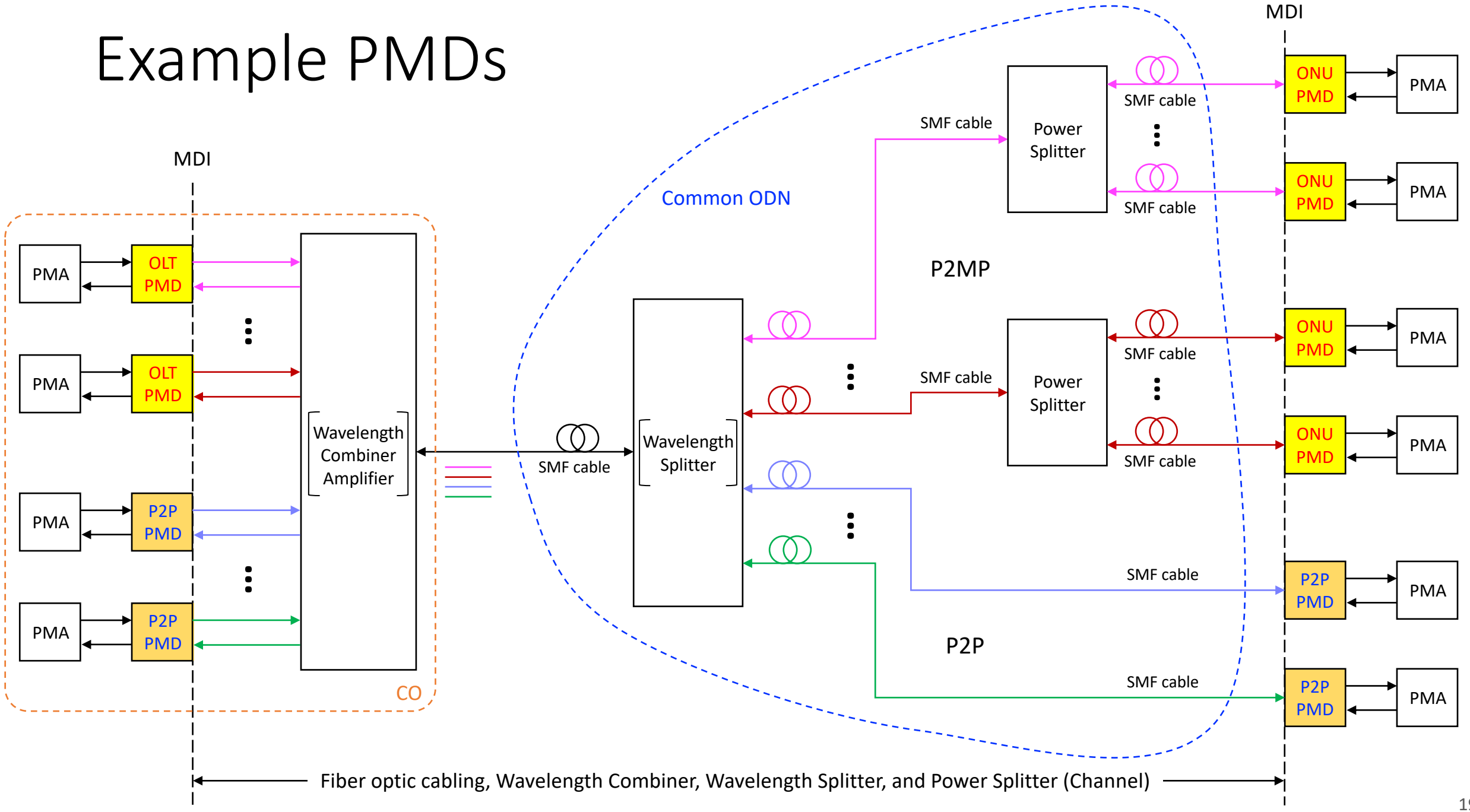
Data Center in Consolidated CO



Consolidated CO data center



Example PMDs



Possible Solution Components

- Wavelength division multiplexing
  - Multiplex multiple channels over a single feeder fiber
  - Separate the channels in the ODN
- Amplification in the central office
  - Long reach
  - Shared amplifier for all channels to reduce the cost
- Common ODN for P2MP and P2P operations
  - Wavelengths can carry P2MP or P2P channels
    - P2MP for cost effective ONUs for residential customers
    - P2P for high performance ONUs for business/specialized customers

Speed Support

- Goal: leverage the already defined PCS and PMA sublayers for both P2MP and P2P applications
  - i.e., DO NOT define new PCS and/or PMA
  - A PMD-only study group
- Support the already defined speeds
  - e.g., 10G-EPON, 25G-EPON for P2MP (upstream and downstream)
  - e.g., 10GBASE-R, 25GBASE-R for P2P
- Possible exception: a 2.5Gb/s upstream EPON speed
  - Because preliminary investigations show a 10G/2.5G asymmetric ONU could be very cost effective for residential use
  - A downclock of already defined higher speed PCS and PMA
  - The study group will decide

Why Now?

- Infrastructure is growing significantly in developing countries
  - A window of opportunity for Ethernet of several millions PMDs
- The need for broadband requires ODN expansion and optimization for emerging applications
  - 5G cellular field trials are underway
  - COs are beginning to migrate to data center architectures
  - New residential developments need to be served
  - Rural areas are still underserved
- Existing standard interfaces do not provide the needed reach and aggregation over a common ODN for both P2MP and P2P operations
  - E.g., Ethernet 1G-EPON, 10G-EPON, 25G-EPON, 50G-EPON, 100BASE-X, 1000BASE-X
  - E.g., XG(S)-PON, NG-PON2

Thank you

Straw Poll (1)

- Should a study group be formed?
  - Y:
  - N:
  - Abs:

Straw Poll (2)

- Would I participate in such a Study Group?
  - Y:
  - N:
  - Abs:

Straw Poll (3)

- Would my company support participation in such a Study Group?
  - Y:
  - N:
  - Abs:

Thank you