Next Generation EPON

- Requirement and Architecture Considerations

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Next Generation EPON Industry Connections

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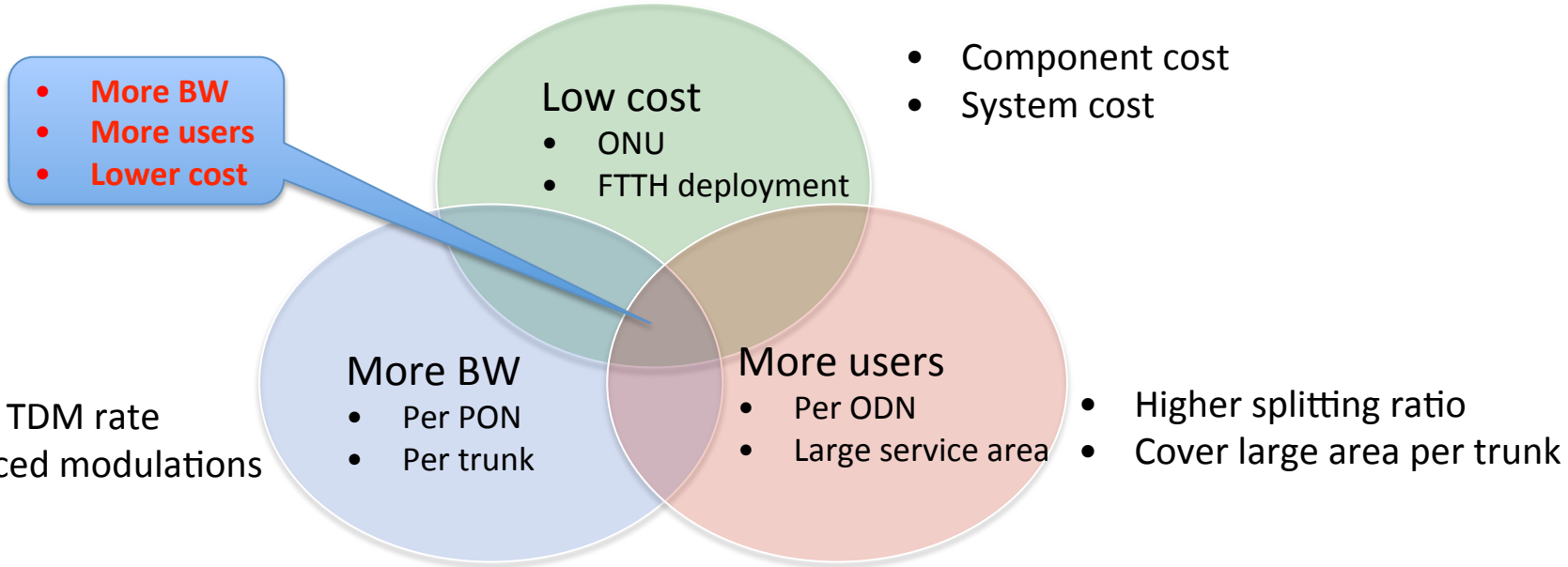
The goal of NG EPON: Seeking a common set…



… is not easy, or it may not always exist.

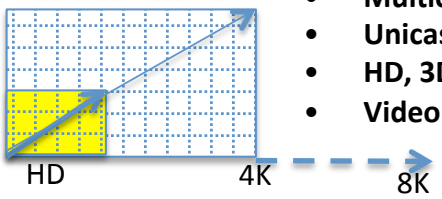
Greedy for bandwidth…

How much bandwidth is enough?

- **Better be a lot of more…**

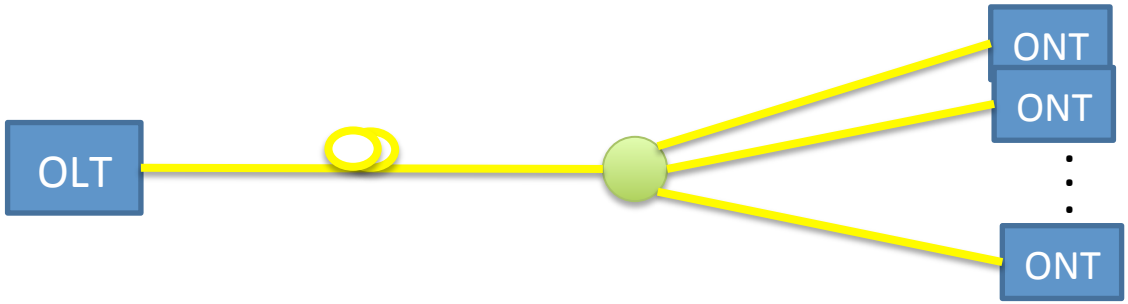
Reporter: How much money is enough?
The billionaire: just a little more…

Services drives



- **Multicast IP video**
- **Unicast IP video**
- **HD, 3D, 4K, 8k…**
- **Video calls, online gaming**

Fixed and mobile backhaul



The viewing habits are changing…, Netflix, OTT…, which has far-reaching impacts on PON

- **Decline of multicast IP video**
- **Increase of unicast IP video**

A P2MP PON is very efficient in multicast traffic and is inefficient in unicast traffic

- **Increase PON bandwidth is an inevitable response**
- **But access network providers do not necessarily get the revenue…**

Reduce total cost of ownership of PON based FTTH - 1

Total deployment cost = Equipment + outside plant +operation

The "price" of "colorless"

ONU type	Gray	Colored	Colorless
Laser	FP, DFB	ITU-T grid DFB	Tunable laser, Tunable filter, RSOA, injection-locking…
Cost	Low	Medium	High

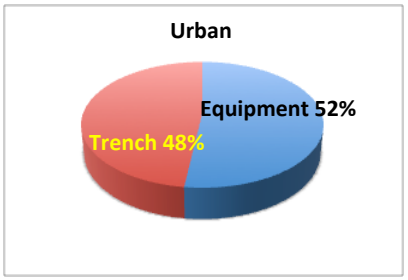
The "price" of advanced optical modulation

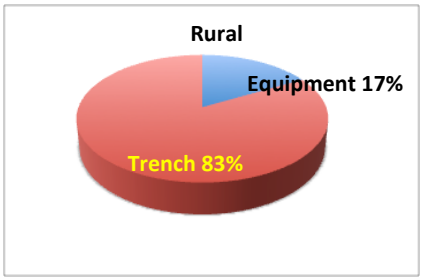
PON type	TDM	WDM	OFDM(A)
Laser/ Detection	Gray/DD	Colorless/ DD	Coherent/ DD
Cost	Low	High	Higher

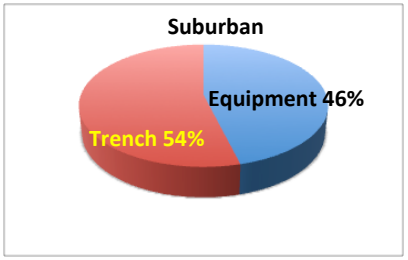
- "Colorless" becomes a presumption for WDM PON, however, "colorless" is at a (high) price
  - Q: Why "colorless"?
  - A: Inventory management
  - An innocent simple requirement creates a "huge" research topic with no good solution yet
- Advanced optical modulation is attractive
  - Feasible and successful in other areas such as long haul optical transport
  - But cost is prohibitory for access
- Balance the "cost" and the bandwidth requirement
- Enable low cost scalable expansion

Reduce total cost of ownership of PON based FTTH - 2

Total deployment cost = Equipment + outside plant + operation

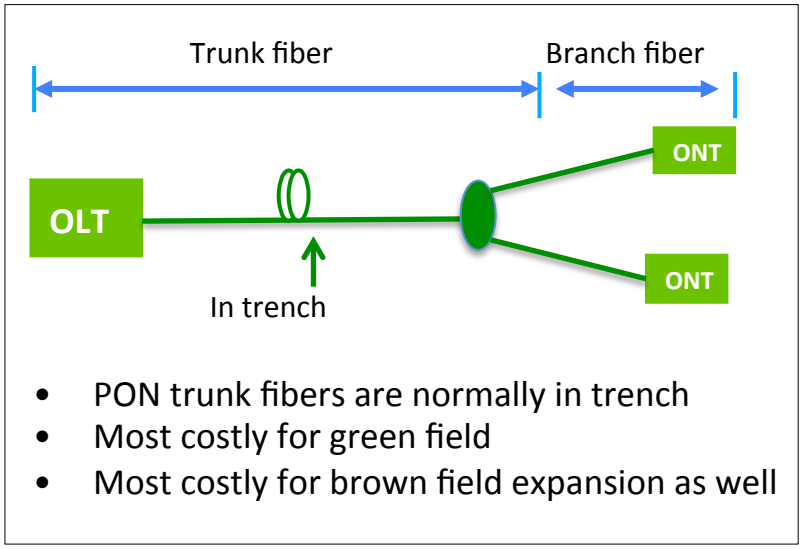






- **Urban and Suburban cost ratio: Trench/Equipment ~ 1:1**
- **Rural cost ratio Trench/Equipment ~ 4:1**

Data from BH Telecom Sarajevo, FTTH in Bosnia,

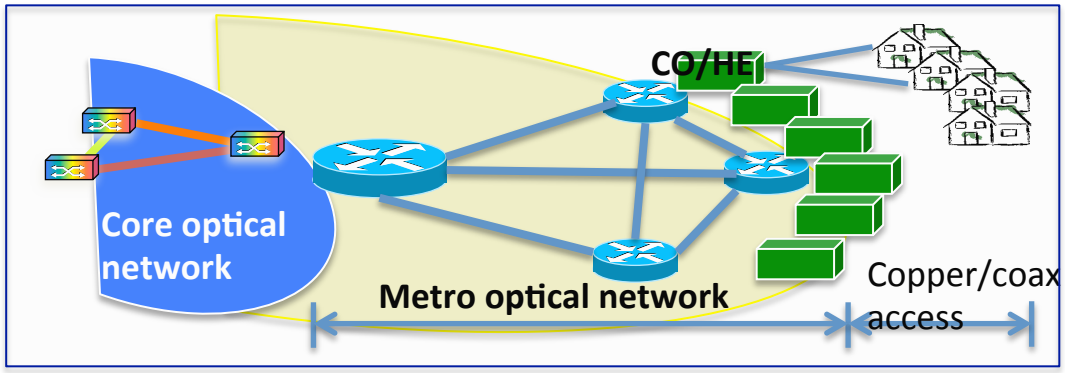


- PON trunk fibers are normally in trench
- Most costly for green field
- Most costly for brown field expansion as well

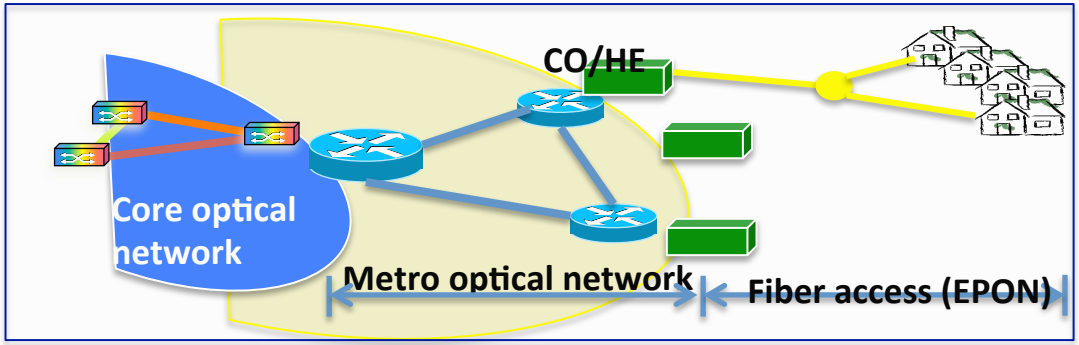
- **Large savings could be achieved by using existing trench structure for PON trunk fibers, especially for "brown field" FTTH**
- **Today's "green field" will become tomorrow's "brown field"**

- **Some kind of WDM aggregation at the trunk could provide low cost & scalable FTTH expansion**
- **Does not necessarily mean WDM PON**
  - **WDM PON does not have the advantage in this area (such as overlay 2nd WDM PON)**

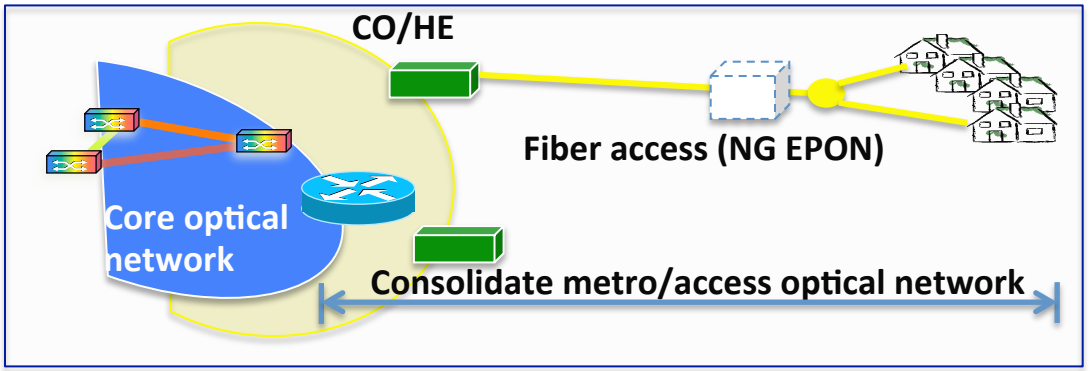
The meaning of long reach PON … not just distance…



Copper/coax access
- **Extended metro**
- **Short access**

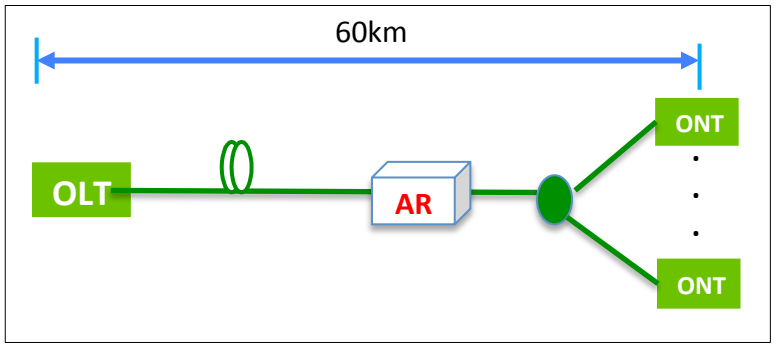


Fiber access (TDM PON)
- **Reduced metro**
- **Extended access**
- **CO/HE consolidations**



NG Fiber access
- **Further reduced metro**
- **Much larger access converge**
- **Consolidated metro/access**
- **Further CO/HE consolidations**

Active Reach PON

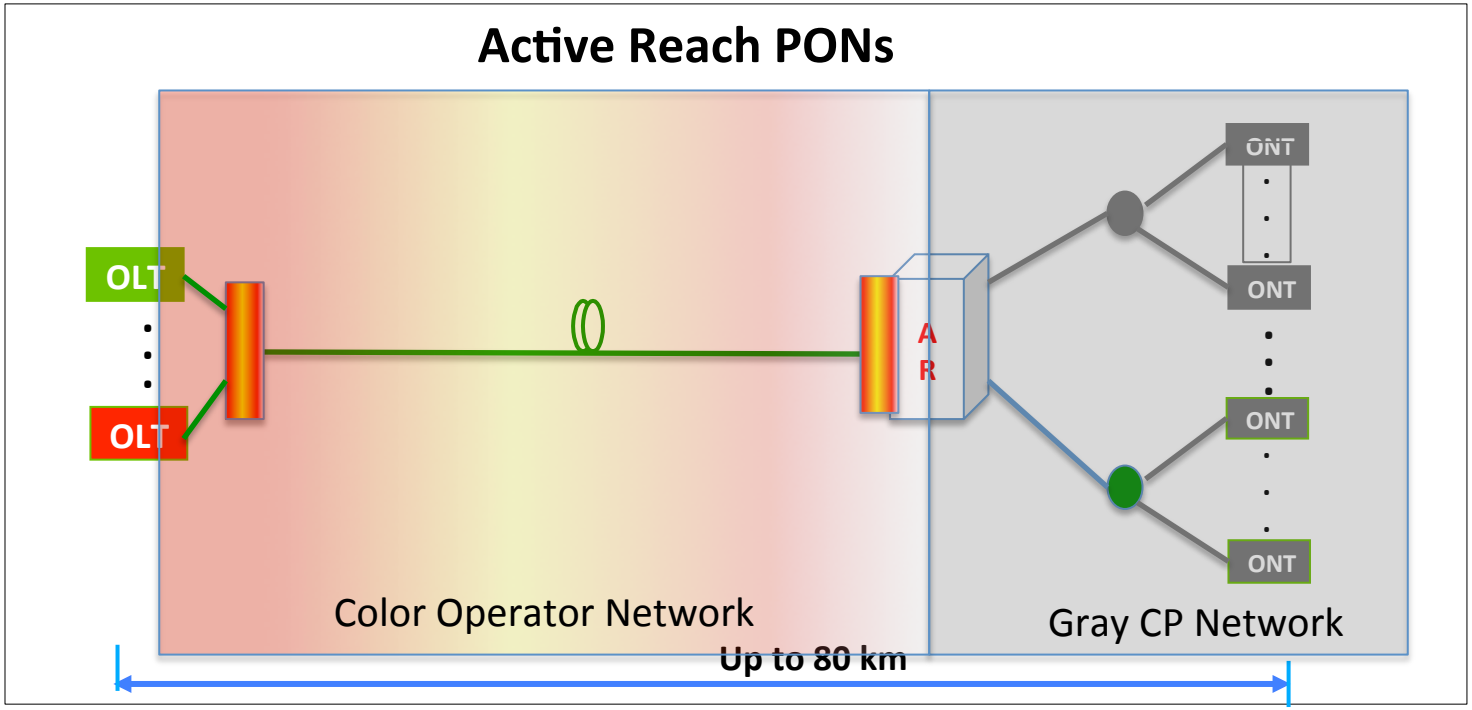


- NG PON2 has "passive reach" and "active reach" requirements
  - Passive reach: up to 40km,
  - Active reach: >40km (mid-span RE)
- G.984.6 defined GPON reach extender
- IEEE 802.3bk defined 10G EPON extender

Can we extend the concept to "Active Reach PONs?"
Will it make a difference?

- When the rate of single PON goes beyond 10 Gb/s, its functions may go beyond the traditional "access network" boundary
- Aggregated capacities of PONs – use WDM to provide "aggregated" capacities, save trunk fibers, and provide scalable growth
- NG EPON should enable CO/HE consolidation to save network operational costs
- AR PON could provide high aggregated capacities without adding trunk fiber, save operational costs, and results in CO/HE consolidations with low cost

A common set … Active Reach PONs



- **An example of common set:**
  - **Low cost Gray optics in CP facing network**
  - **Relative low cost Color DWDM optical optics in operator network for high capacity**
  - **Avoided high cost "colorless" optics and all the issues associated with it**
- **More bandwidth, more users with low cost**

Summary: NG EPON requirement considerations

Capacity requirements

- Single lambda rate >= 10Gb/s
- Aggregated capacity >= 40Gb/s (single or multiple lambdas)

Operational requirements

- Low deployment cost
- Low operational cost
- Scalable
  - "pay as you go"

System requirements

- Active Reach NG EPONs
  - Reach: up to 80 km
  - No "colorless" optics
  - Minimum 4 lambdas
- Passive Reach NG EPON
  - Reach >= 20 km

Compatibility requirements

- Compatible with 10G EPON
- Compatible with DWDM in operator facing network for AR NG EPONs
- Compatible with power splitter

Thanks

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