



Extending EPON link budgets through *alternative new* PMD definitions

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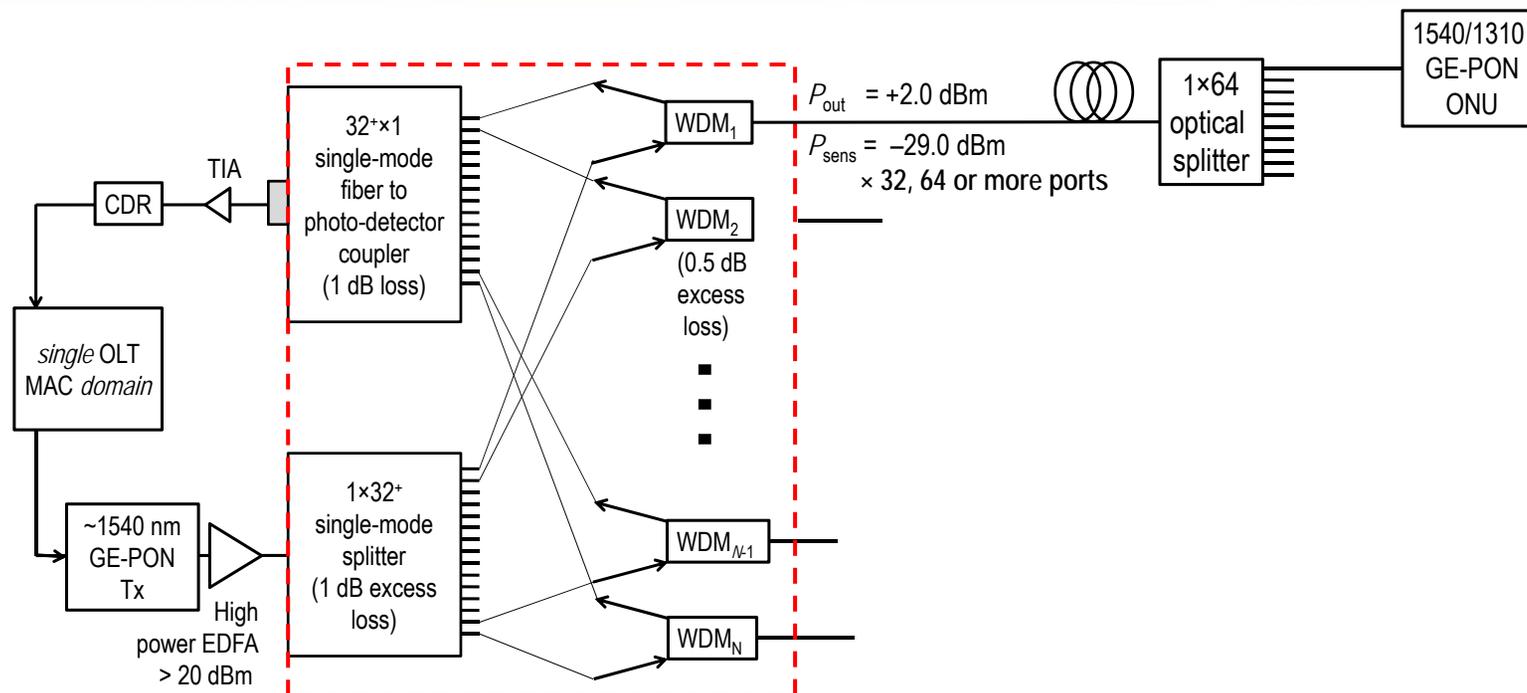
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- I show two situations where new PMD definitions can enable
  1. A very-low-cost, very-high split-ratio GE-PON to enable the copper → fiber transition (especially in developing-economy nations).
  2. Moving MCR-based extension systems near and into buildings enables very-high split-ratio EPONs and ultra-low-cost ONUs. This may be appropriate for dense urban environments, and also can speed the copper → fiber transition.

- In another presentations at this meeting([ExEPON\\_1109\\_piebler\\_2.pdf](#)), and elsewhere [1], I have shown how *a mode-coupling receiver (MCR) at the OLT can enable very-high [ $> 2,048$ ] split-ratios.*
- At this meeting([ExEPON\\_1109\\_piebler\\_2.pdf](#)), I have show an example of how *optical integration can significantly reduce the size and complexity of the integrated optical splitter / MCR.* We are developing products based on this technology at NeoPhotonics.
- I have shown elsewhere [1], that *the OLT cost-structure of an integrated optical splitter / MCR-based OLT transceiver is sub-linear as the split-ratio becomes large, if one can utilize a high-power EDFA to amplify the downstream signal.*
- Unfortunately, *no commercial EDFAs operate at the GE-PON downstream wavelength (1490 nm).* Under the present GE-PON PMD definition, the GE-PON cannot, economically provide very-high [ $> 2,048$ ] split-ratios.

- To date, fiber-to-the-home is seen as an expensive solution. DSL survives. Some carriers pursue fiber-to-the-curb / DSL-to-the-subscriber strategy.
- If the cost to send fiber to the subscriber were low-enough, even for customers using only narrow-band service, carriers would reap an OpEx benefit of operating a single network for all customers.
- Developing-economy nations have an even harder time justifying the cost to provide any fiber-based broadband (or narrow-band) services in rural areas.

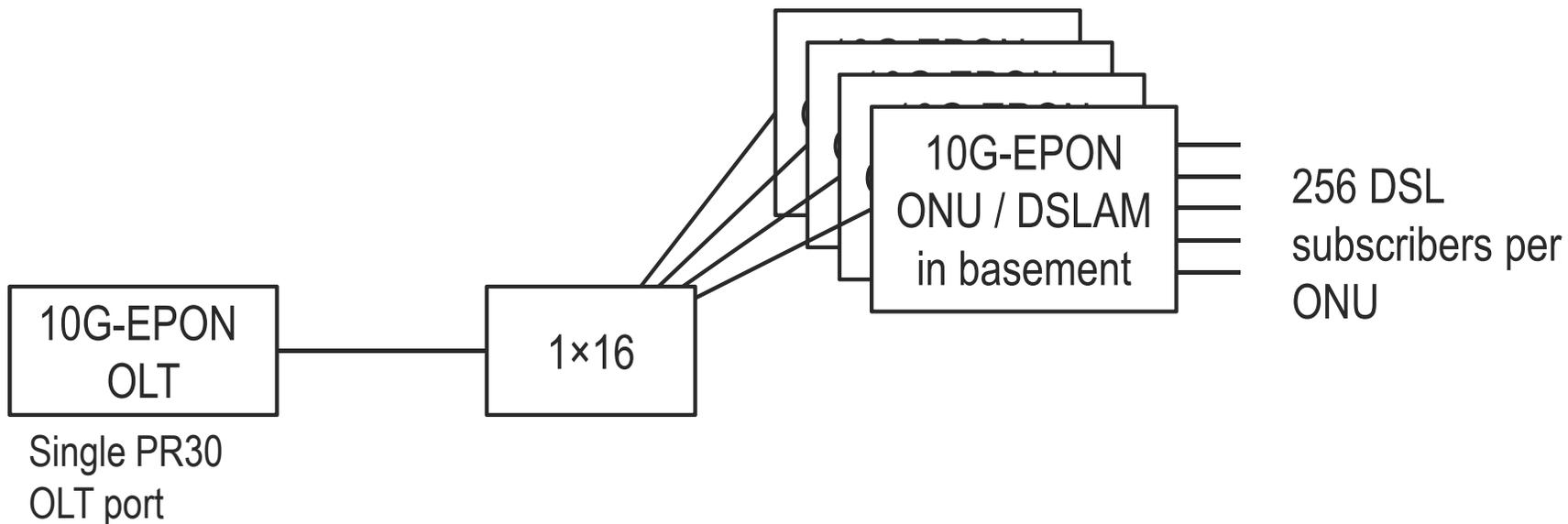
# Case 1 – proposed $PMD_{new}$ GE-PON OLT supports split ratio of 2,048 or more



- *GE-PON OLT transmitter wavelength moved to the C-band for very-high-split ratio / minimal bandwidth applications. There are **no technical road-blocks** for creating transceivers for this new PMD definition.*
- Single OLT MAC domain serves passes > 2,048+ residences.
- *At highest-split-ratios OLT costs are dominated by EDFA cost*
  - Required EDFA launch power ~100 mW per ~2000 residences passed =  $0.05 \text{ mW}_{EDFA}/\text{residence}$ 
    - *Comparison: Typical North American video overlay requires EDFA launch power of ~50 mW per 32 homes passed =  $1.56 \text{ mW}_{EDFA}/\text{residence}$ .*

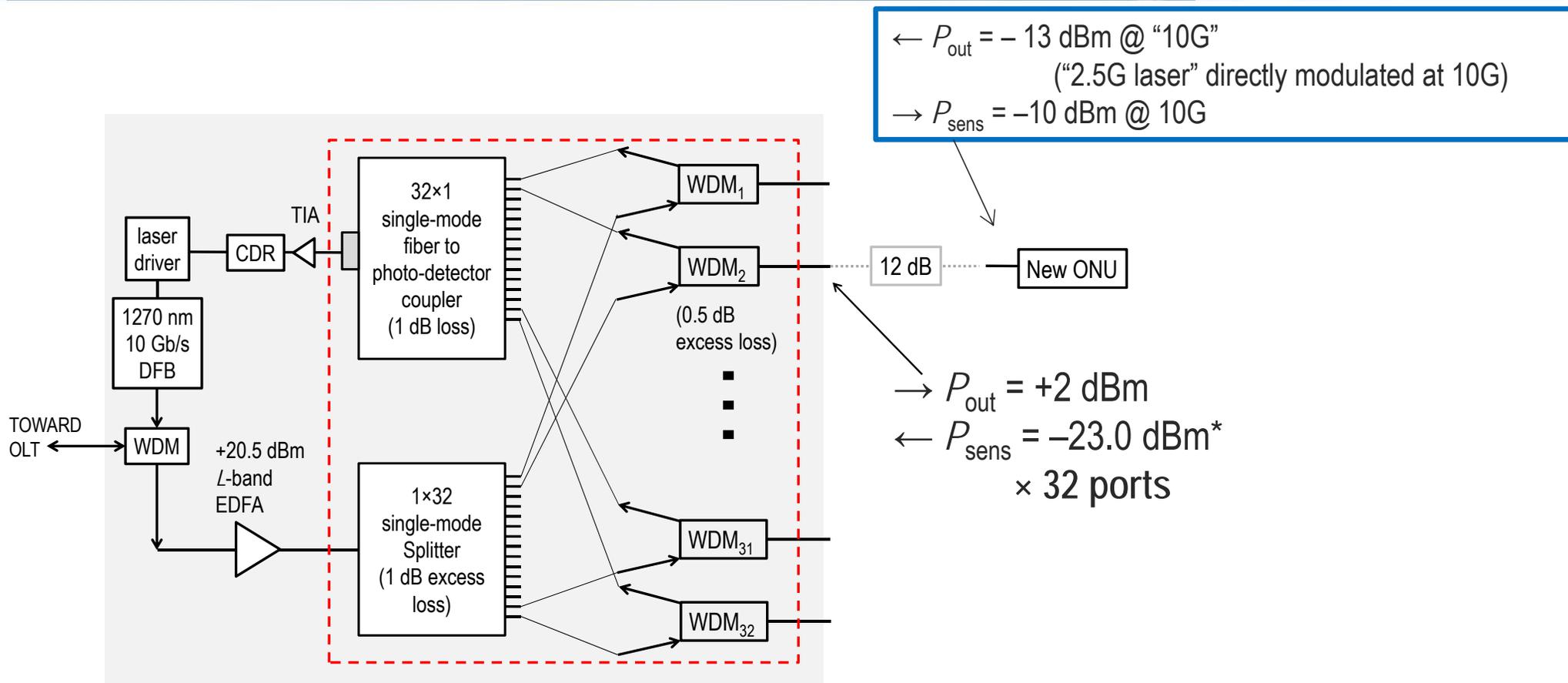
## Case 2 – problem

- Carrier supports heterogeneous EPON / DSL network.
- 10G-EPON ONUs located in basement co-located with DSLAM supporting 256 subscribers.
- 10G-EPON OLT port supports 4,096 DSL subscribers



- Shift to all-fiber network
- Requires cost effective 10G-EPON ONU
- Requires cost-effective PON extension system in basement.

# Case 2 – proposed $\text{PMD}_{\text{new}}$ for ultra-low-cost ONU.



- PON extender is based a PIC-based embodiment of the items in red box.
- A 12-dB from each port is supported ( a  $\sim 1 \times 8$  split over short distances).
- \*"2.5G optics" directly-modulated at 10G are used in the ONU and the lower OLT sensitivity (\*) reflects this.
- The optical output power and receiver sensitivity are relaxed by > an order of magnitude over existing PMDs.