Next Generation EPON Requirements and Architecture Considerations II

- ODN migration paths

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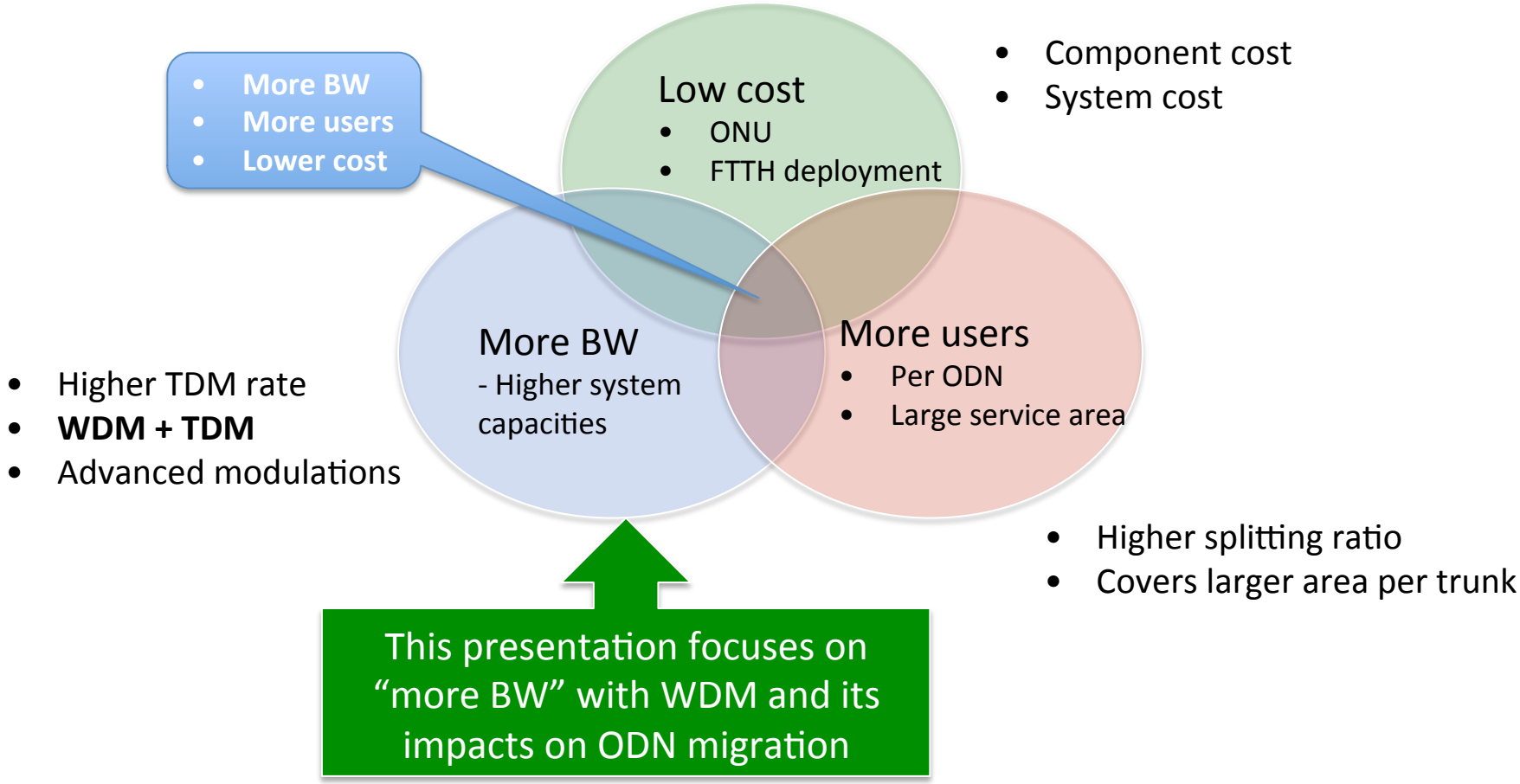
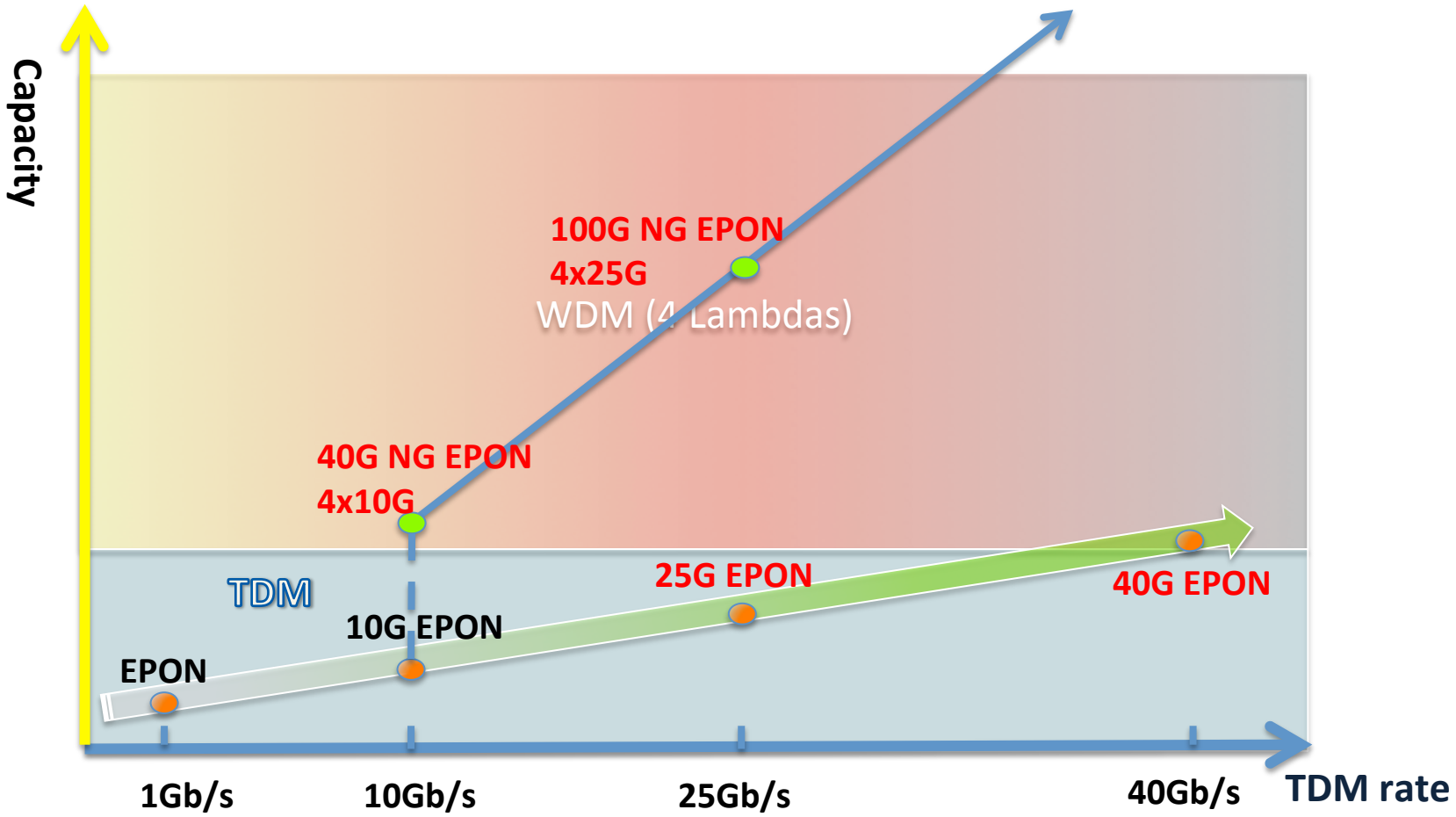
OUTLINE

- The paths towards NG EPON
- ODN migration considerations
  - TDM PON
  - Hybrid WDM-TDM PON

The goal of NG EPON



The paths towards higher capacities



TDM or WDM is a question…

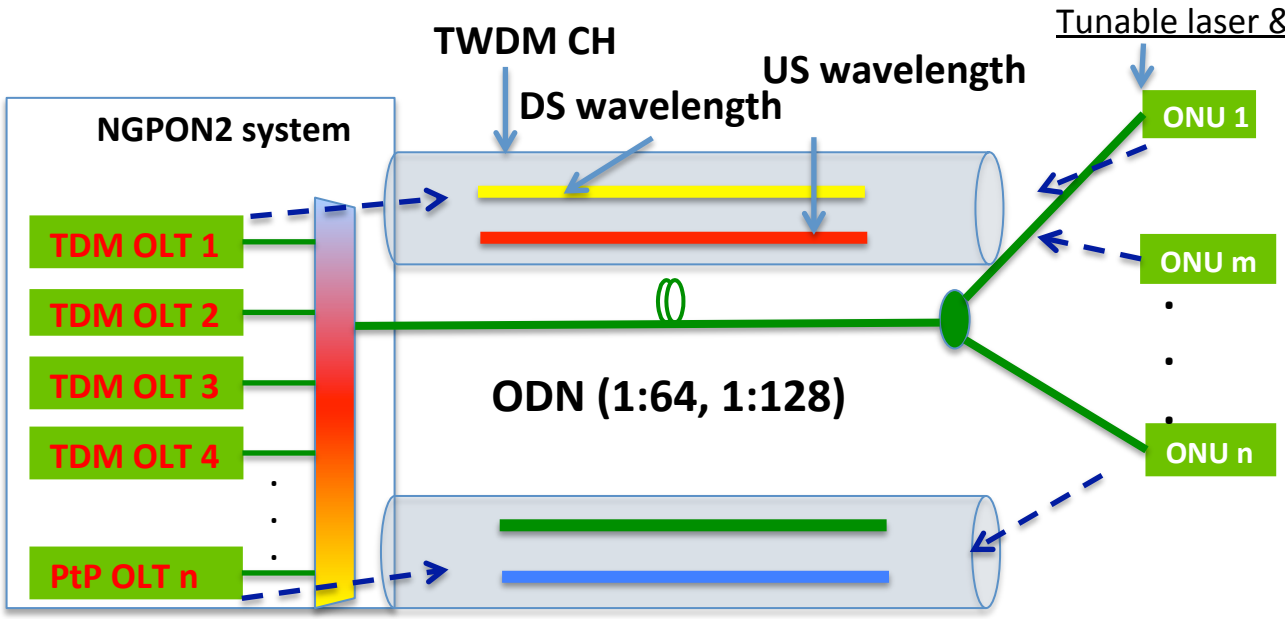
TDM or WDM is a tough question…

- Historically WDM has always been introduced whenever higher rate TDM faces technical difficulties at the time, or for cost saving reasons
- What is the most feasible highest TDM PON rate today?
  - Highest downstream rate?
    - 25 Gb/s or 40 Gb/s?
  - Highest upstream rate?
    - 25 Gb/s in burst mode?
  - What is the acceptable asymmetry?
  - All above require further study
- At what point should we move to a WDM + TDM solution?
  - Start with 10G EPON or…
  - go to a higher rate TDM first, such as 25Gb/s TDM PON, and then move to WDM?
- Do these choices impact the ODN planning and migration?
  - Is there a future proof ODN migration path?

ODN migration requirements

- TDM PONs deployed today, i.e. EPON, GPON and 10G EPON, use passive optical power splitters in the field
  - 1x32 couplers are most commonly used
- It is taken for granted that the NG PON keeps the ODN based upon optical power splitters unchanged
  - Does not touch the outside plant
  - NG-PON2 at FASN/ITU-T requires power splitter ODN
- This requirement is necessarily true if NG EPON is purely TDM
  - 25Gb/s, 40Gb/s
- What about if NG EPON adopts a hybrid WDM - TDM architecture like that of FSAN/ITU-T NG-PON2?

FSAN/ITU-T NG-PON2 in a nutshell



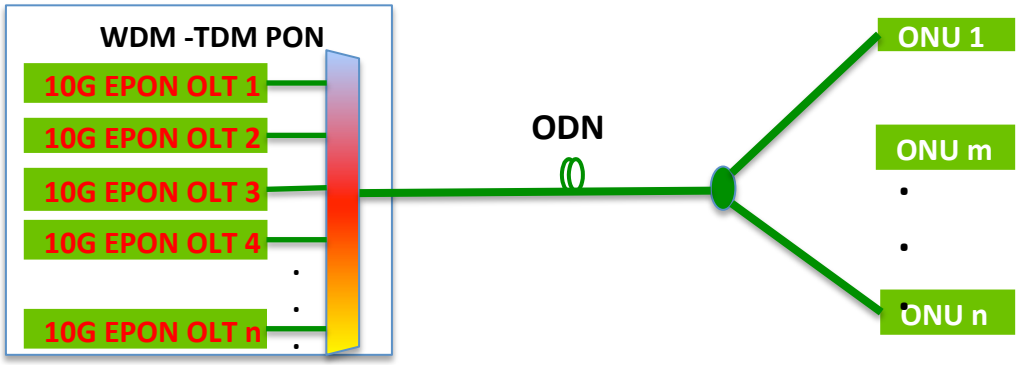
- NG-PON2 is developing at FSAN/ ITU-T, the terminology here is not necessarily aligned with that of the to be published standard

- NG-PON2 is hybrid TDM PON (10Gb/s) and WDM (TWDM)
  - 40 Gb/s system capacities with 4 lambdas
  - Could extend to 80 Gb/s system capacities with 8 lambdas
- NG-PON2 also supports PtP WDM
- The WDM filter is located at CO

NG PON2 assumes ODN based upon optical power splitter

An option for NG EPON: 10G EPONs WDM overlay

80 Gb/s SYS Capacities (8 lambdas)



- Assuming FSAN NG PON2 type of TWDM architecture
  - Power splitter ODN
- 8 lambdas with 10 G EPON gives a total of 80 Gb/s SYS capacities
- 1:32 ODN (32 users) will not be effective
- However, 1:128 splitter has ~ 21 dB splitting loss
  - Total ODN loss (4X1:32) with 20 km fiber is ~ 27 dB
- The maximum splitting ratio feasible is 1:128

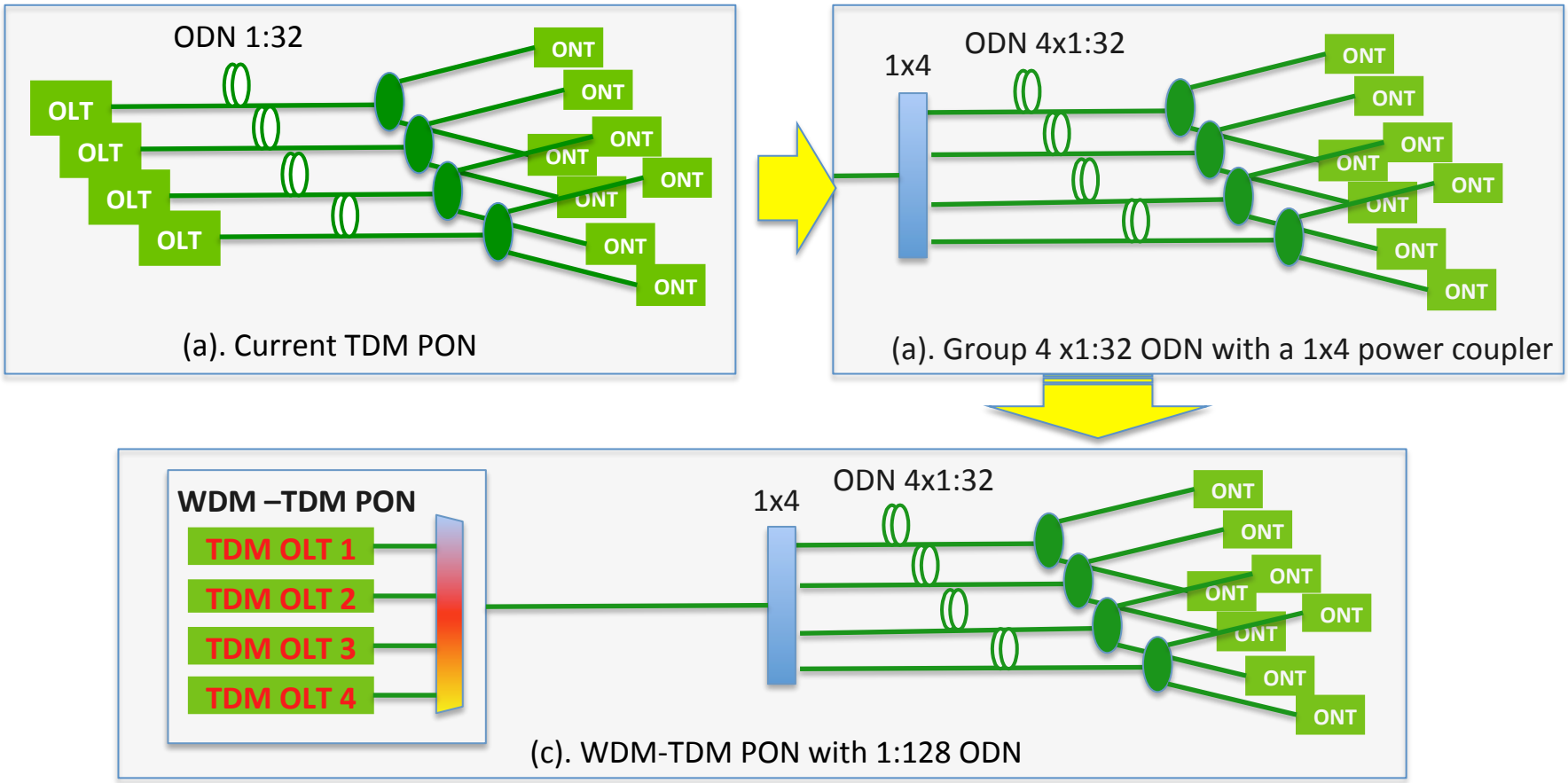
A scalability problem: The meaningful maximum WDM-TDM NG EPON system capacity is limited by the maximum possible ODN splitting ratio

How to scale WDM-TDM PON?

- In a WDM-TDM PON, n TDM OLTs share the same power splitter ODN
- For this WDM-TDM PON architecture to be effective, a large splitting ratio is needed
  - However, the scale of power splitter ODN is limited by the power budget
  - The highest feasible splitting ratio seems to be 1:128
- The scalability the WDM+TDM architecture is limited by splitter loss
- Today most common TDM PON deployments use 1:32 splitting ratio

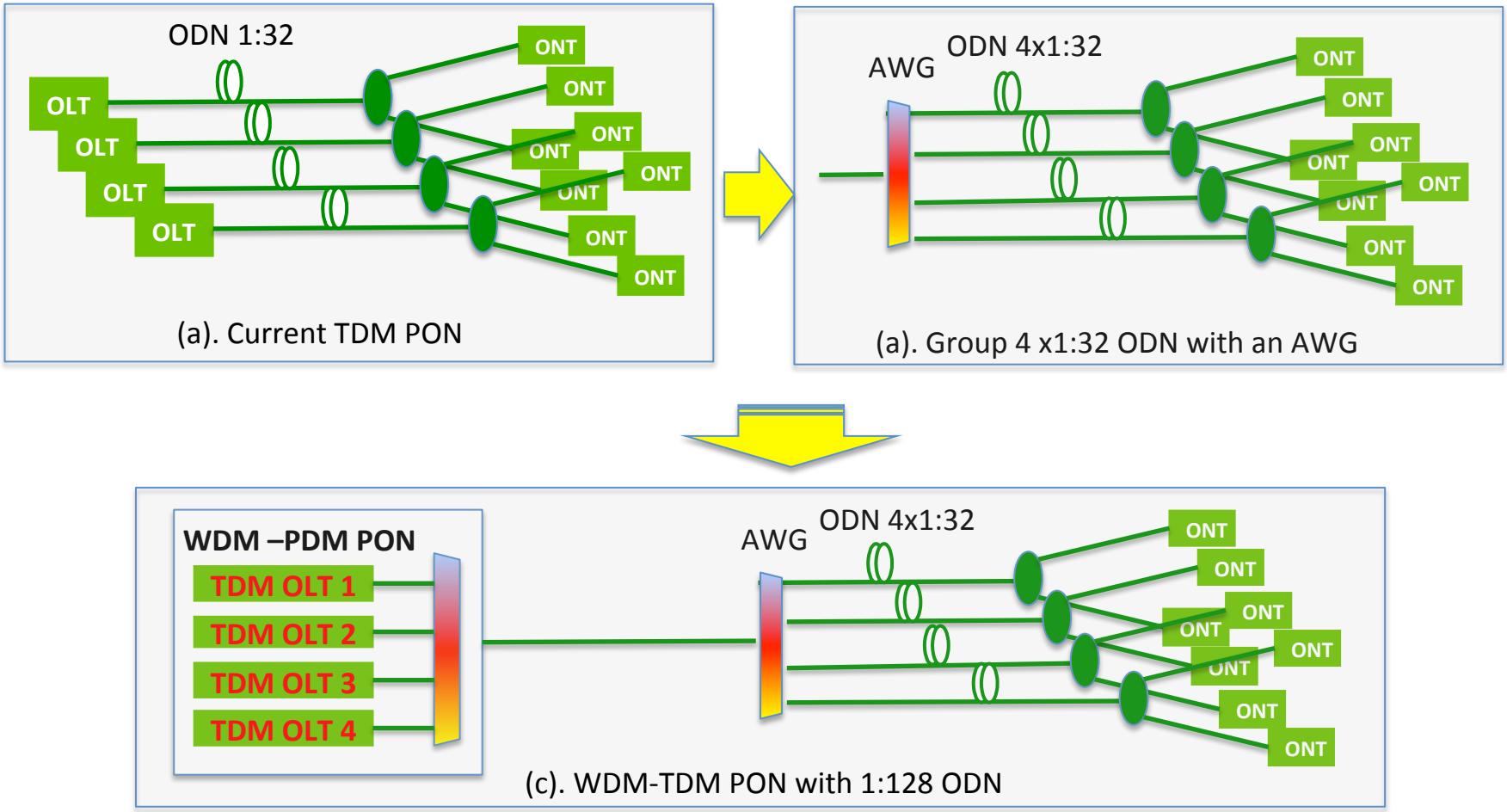
- **In order to achieve a reasonable high splitting ratio (1:64 or 1:128), rearranging the ODN is inevitable**
- **AWG could be used instead of power splitters to aggregate ODN**

Touch ODN or not … is not a question



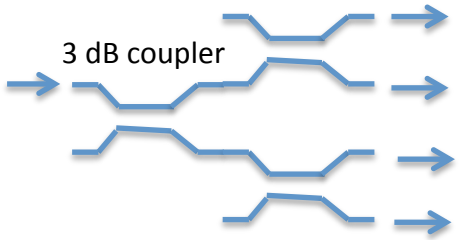
ODN migration for WDM-TDM PON with power splitter

ODN migration for WDM-TDM PON with AWG



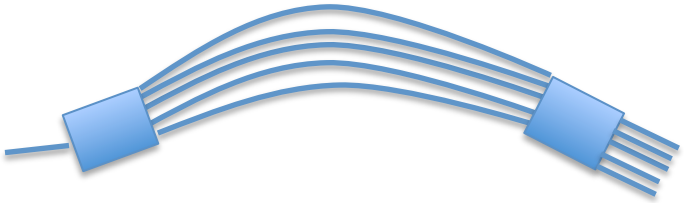
Why AWG ?

Power splitter or AWG ?



(a). Power splitter

1:32 power splitter Loss ~ 16 dB

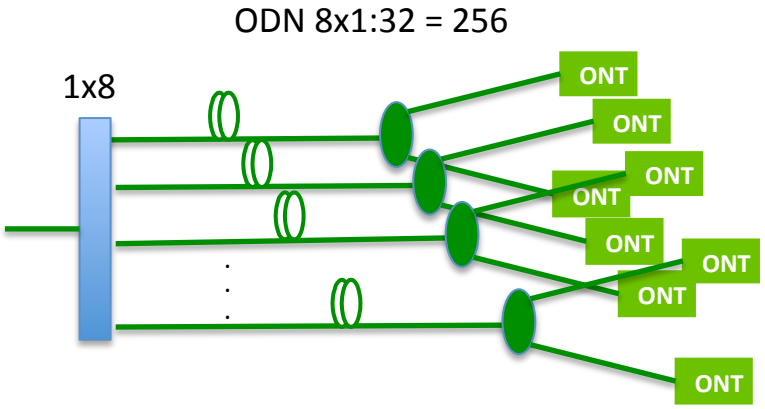


(b). AWG

AWG Insertion loss (IL):
Maximum 2.5 dB (product)
Minimum 0.7 dB (literature)

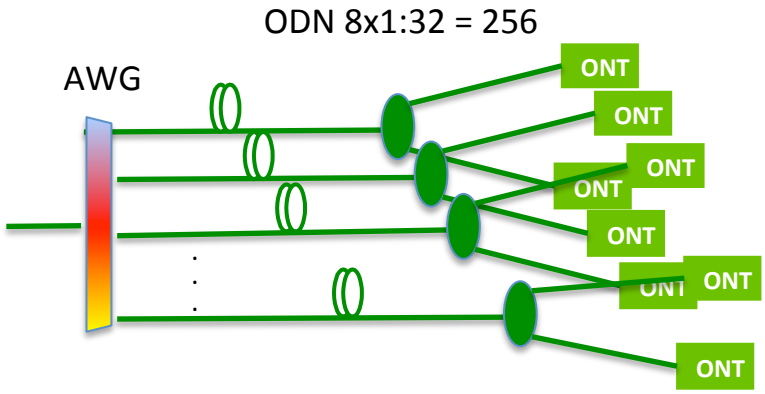
- **The IL of AWG is much lower than that of the power coupler**
- **The AWG IL is independent from the total number of ports**
- **The AWG scales much better than the power coupler**

The ODN losses do matter



(a). Group 8 x1:32 ODN with a 1x8 power splitter

ODN loss* ~ 31 dB



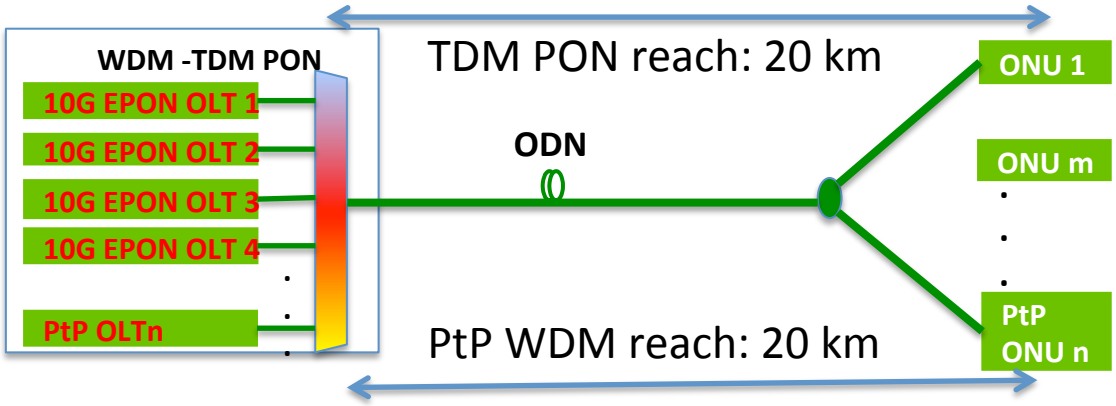
(b). Group 8 x1:32 ODN with an AWG

ODN loss* ~ 23 dB

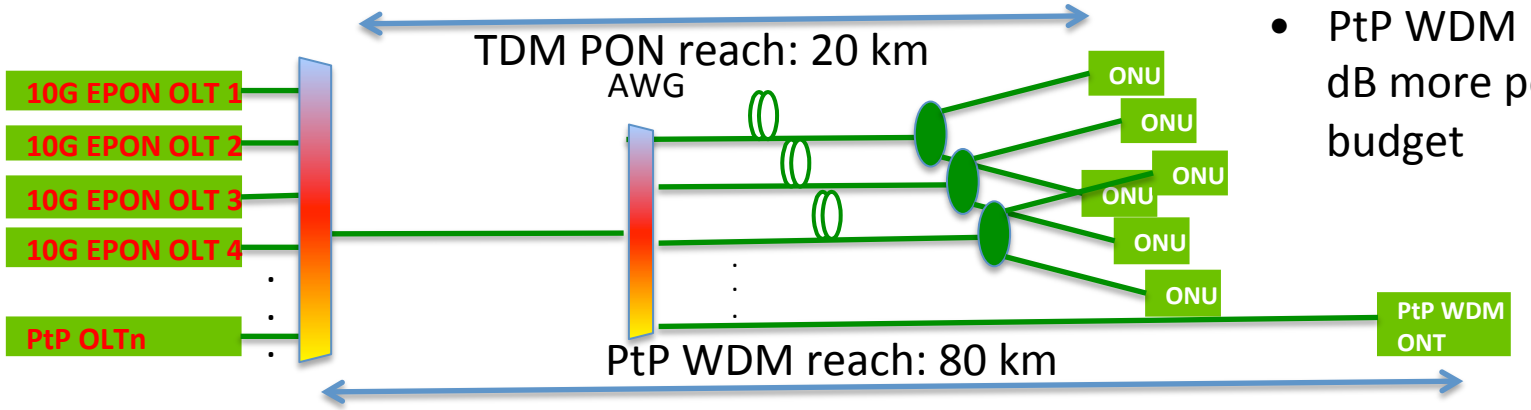
* 20 km SMF

- **Rearranging ODNs is necessary for WDM + TDM PON**
- **For WDM-TDM NG EPON, using AWG to rearrange ODN has significant advantages over using power splitters**
- **Scales to more wavelength, 4, 8, 16, 32…, lambdas**
- **Scales to much higher system capacities, 40G, 80G, 160G (assuming 10G EPON)…**
- **More effectively uses the high capacities of WDM-TDM NG EPON**

A path towards migrating to WDM PON



- PtP WDM suffer from unnecessary splitting loss



- PtP WDM has 10 dB more power budget

- **PtP WDM links have much longer reach in AWG-Power splitter ODN**
- **Hybrid AWG-Power Splitter ODN provides a migration path to WDM PON**

Conclusions

- **Assuming NG EPON adapts a higher rate TDM, such as 25 Gb/s, or 40 Gb/s, the ODN should remain as is today – based upon power splitters**
- **Assuming NG EPON adapts a WDM – TMD architecture, rearranging the outside plant ODN is unavoidable**
- **Aggregate current power splitter ODN with optical filters has significant advantages**
- **A hybrid AWG + power splitter ODN also provides a migration path to WDM PON in the future**

Thanks

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