100G EPON Wavelength Plan - Back to Fundamentals

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Background

- Since the formation of TF, the wavelength plan discussion has been carried on for ≥ 20 months, for every meeting
- Wavelength plans have been labeled from A, B to Z (although not all characters were used). Maybe soon we need to find a writing system that has more than 26 characters

This contribution first discusses different network application scenarios for asymmetric/symmetric 25G and 100G EPON, cost structures, coexistence, and then proposes a balanced wavelength plan

Outline

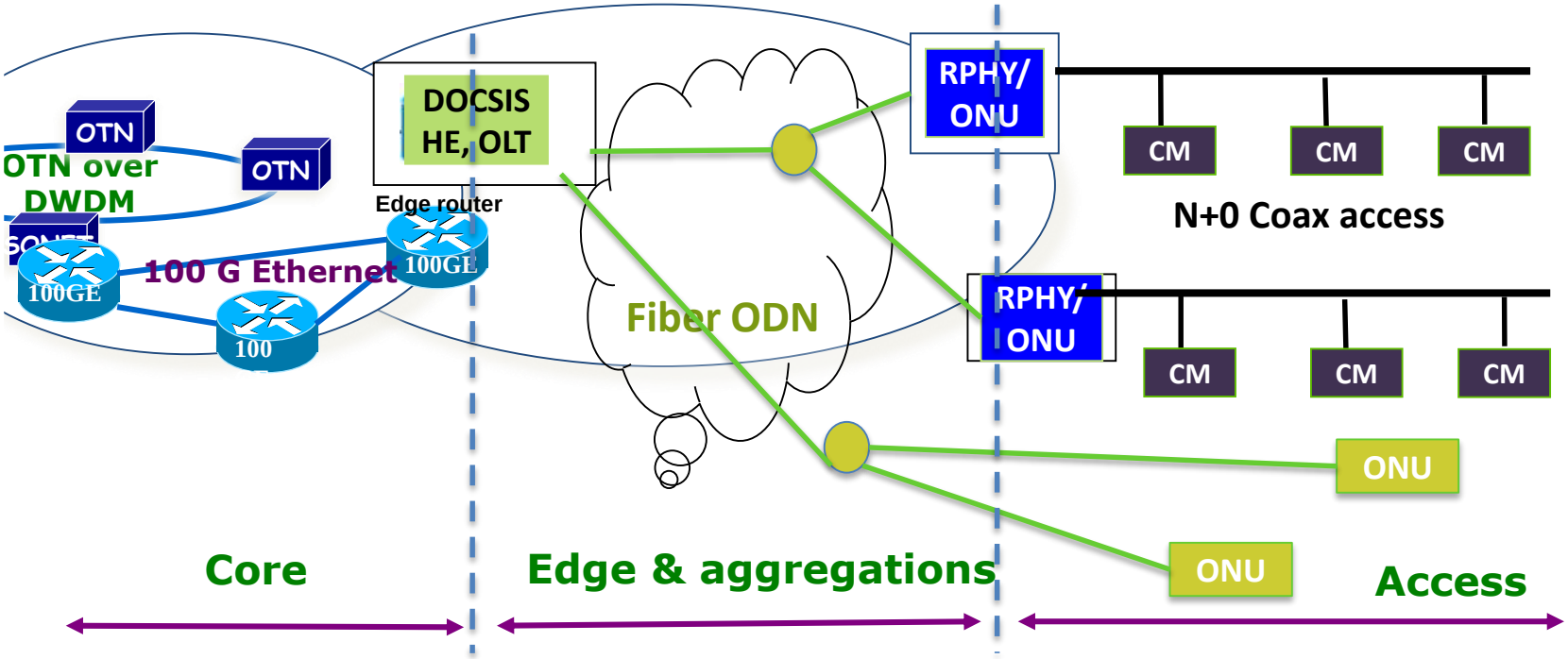
- 25G/100G EPON for last mile and network transport applications
- Cost structures and requirements
- A balanced wavelength plan

Applications for PON – today and tomorrow

- Traditional **last mile** applications for PON
  - Today, PONs have been viewed as last mile access technologies
  - PON is the main technology for FTTH
  - The driving forces behind seeking higher-speed PON are often assumed as various IP video related applications – HD, 4K,8k, DVR, and recently VR…
- Emerging **network transport** applications of PON
  - Mobile backhaul/fronthaul applications, RPHY backhaul applications
  - GPON has been used for mobile backhaul/fronthaul for years
  - Recently, 10G PON (XGS-PON, 10G EPON) and NG-PON2 are considered

A new PON standard such as 25G/100G EPON should be optimized for both last mile and network transport

PON for last mile and transport



PON as last mile or for network transport has different cost structures and requirements

Requirements for PON as last mile and as network transport

- **PON for last mile:**
  - Residential and small/median business customers
  - Traffics in upstream and downstream are asymmetric
- **PON for network transport:**
  - Mobile backhaul/fronthaul, RPHY backhaul, small data center interconnections …
  - Traffics are approximately symmetric
- **Cost structures**
  - Last-mile: very sensitive to cost, need the lowest cost solution
  - Network transport: less sensitive to cost

- **Asymmetric 25G be optimized for last mile**
- **Symmetric 25G/100 be optimized for network transport**

The role of asymmetric 25G

- From the technology point of view
  - The 25G burst mode receiver may be difficulty
  - The cost for symmetric 25G may be too high
- From last-mile FTTH point of view
- The asymmetric of 10G/25G PON (1:2.5) is very close to that of GPON (1:2), but with about 10 times more bandwidth
- The residential traffics are asymmetric with relatively large asymmetric ratios
  - The asymmetric 25G EPON is very attractive for residential and small/medium business applications in the consideration that GPON is still been deployed for the same markets today

Low cost asymmetric 25G will be the first 25G PON to the market

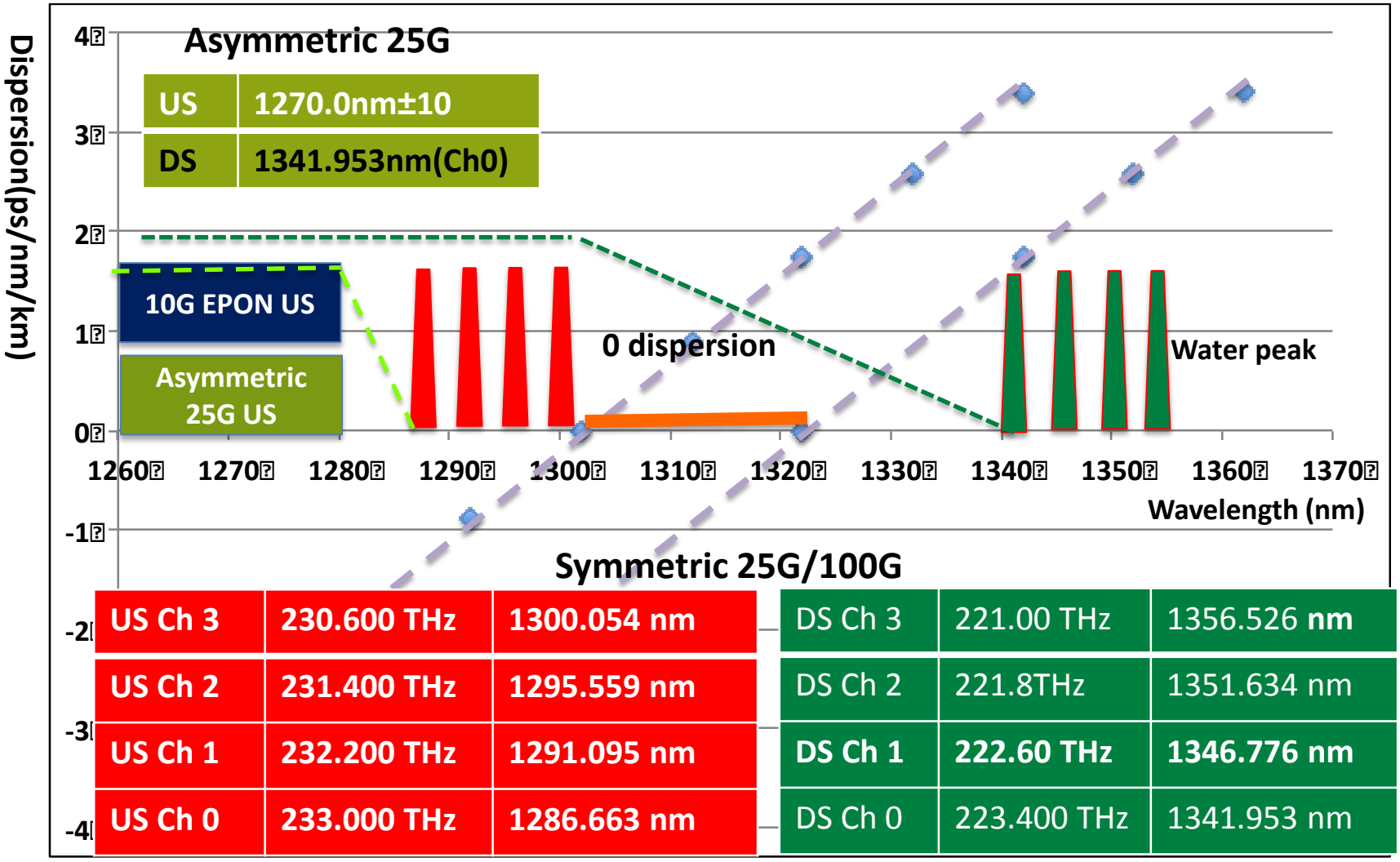
The cost structures of 25G and 100G EPON and wavelength plans

- **Reducing the cost of ONU is the key; the cost of OLT is not as sensitive as that of ONU**
- **Wavelength plans affects the cost of ONU**
  - Wider channel range is required for uncooled DFB
  - Low dispersion O band is traditionally preferred (except NG-PON2) for PON upstream
- **Wavelength plan also affect the cost of OLT, but**
  - Cooled DFB and temperature control environment enable OLT to use narrower channel range
  - PAM 4 modulation can be used to mitigate dispersion (the topic will not be expended in this contribution)
- **Asymmetric 10G/25G ONU has to have the lowest cost**
  - Enabled by using uncooled DFB with 20nm channel
- **Symmetric 25G/100G could use 800GHz channel spacing**

Wavelength considerations

- Asymmetric 25G PON/channel uses wide 20nm US channel enabling uncooled DFB laser and reusing 10G EPON PR 30 optics for lowest cost ONU
- Asymmetric 25G EPON TDMA coexists with 10G/10G EPON
  - With dual-format burst mode receiver
- Asymmetric 25G PON WDMA coexists with symmetric 25G and 100G EPON
- Symmetric 25G/100G EPON uses 800 GHz channel spacing
  - May need cooled DFB laser for ONU.
  - Mainly for network transport applications and high-end business customers that are not as cost sensitive as residential customers
- Exclude the SFM zero dispersion zone (~1302nm to 1324nm)

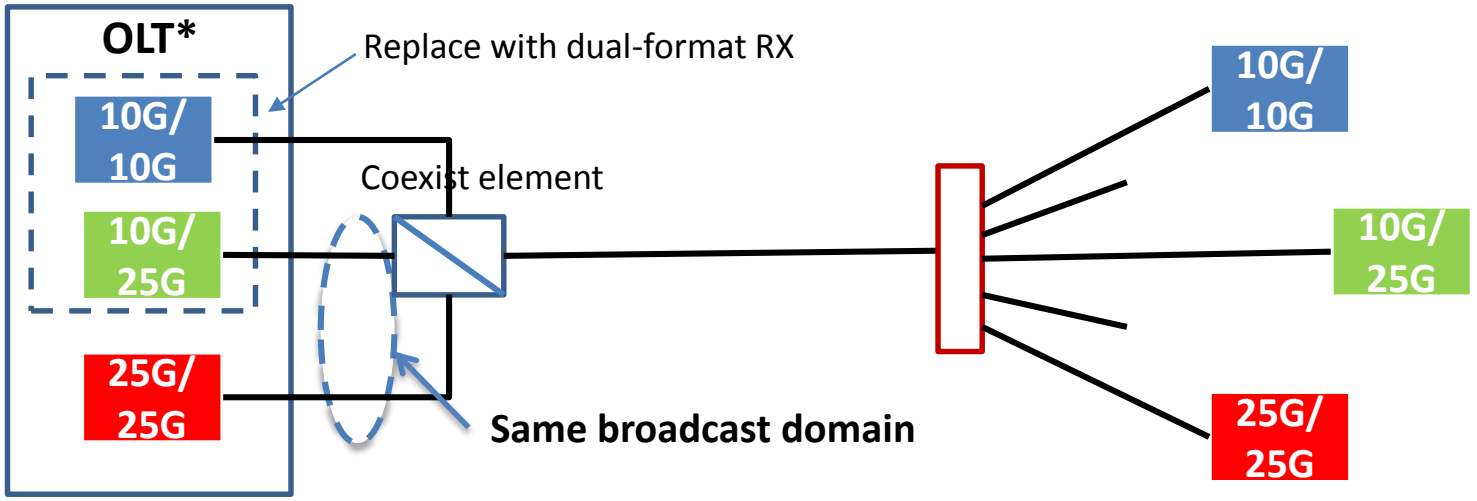
Wavelength Plan



Symmetric 25G/100G

US Ch 3	230.600 THz	1300.054 nm	DS Ch 3	221.00 THz	1356.526 **nm**
US Ch 2	231.400 THz	1295.559 nm	DS Ch 2	221.8THz	1351.634 nm
US Ch 1	232.200 THz	1291.095 nm	**DS Ch 1**	**222.60 THz**	**1346.776 nm**
US Ch 0	233.000 THz	1286.663 nm	DS Ch 0	223.400 THz	1341.953 nm

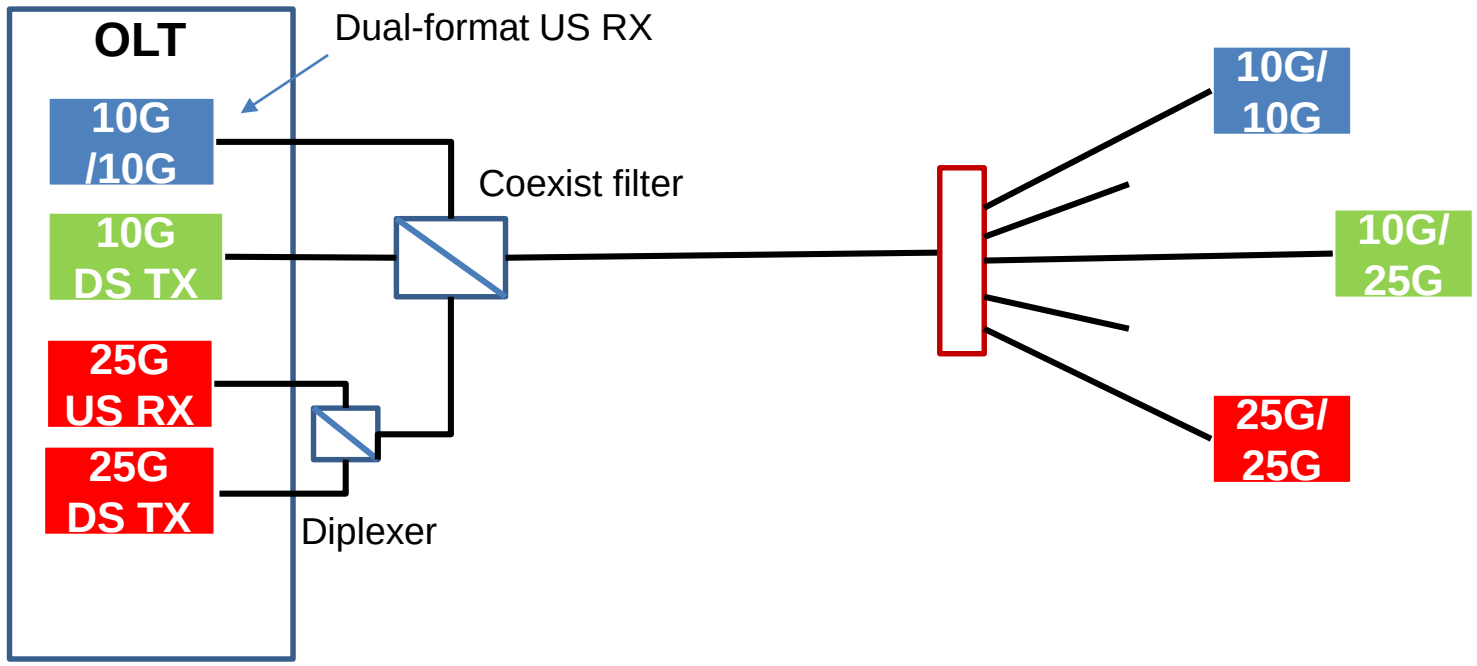
Coexistence of asymmetric, symmetric 25G with 10G/10G EPON



* Illustrates logical OLT migration, replace OLT is needed.

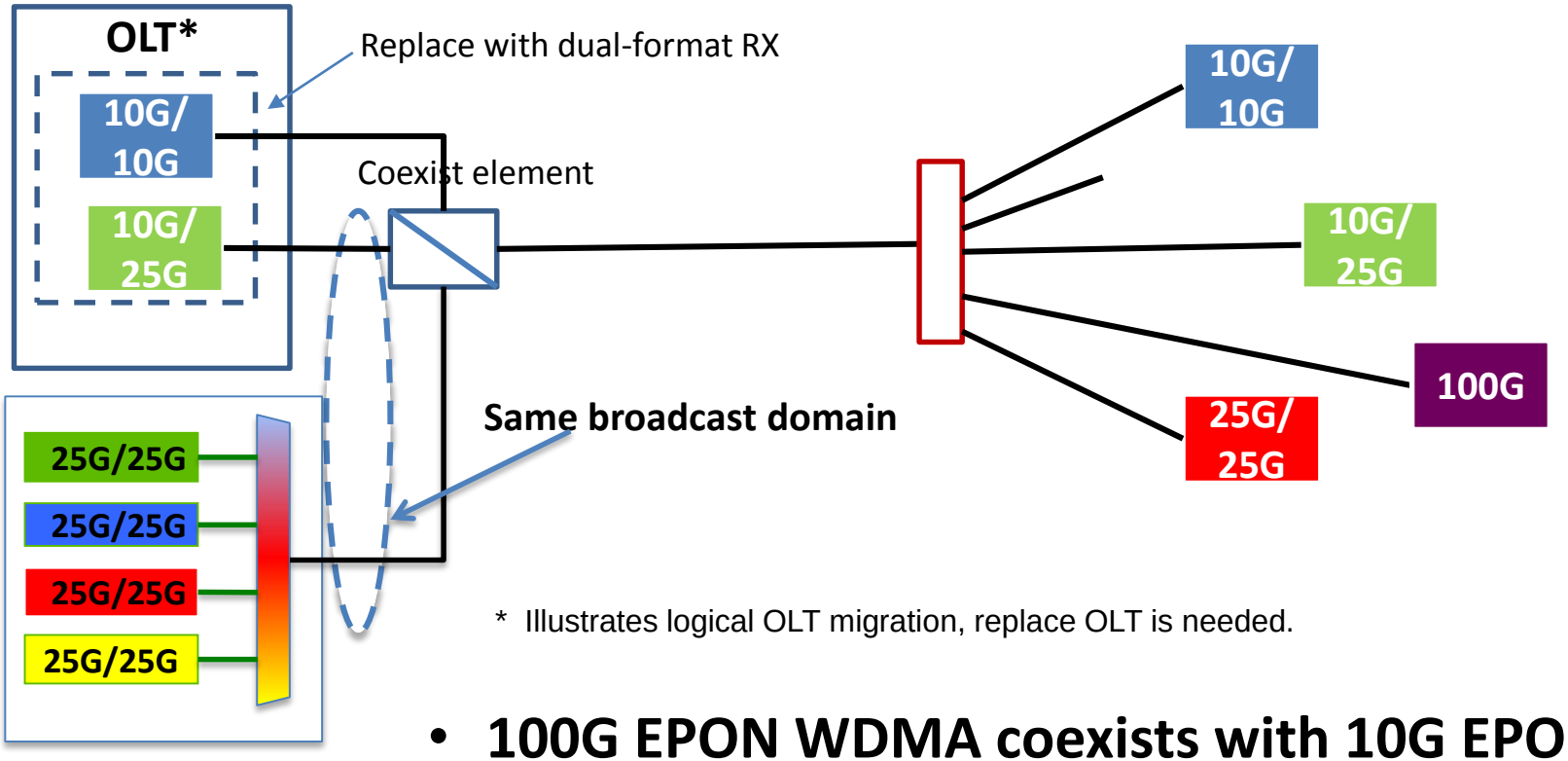
- **10G/25G TDMA coexists with 10G/10 EPON via dual-format receiver**
- **Asymmetric and symmetric 25G WDMA coexist**
- **Asymmetric and symmetric 25G are in one broadcast domain**

Coexistence of 25G/25G with10G/20G and 10G/15G



- Coexistence scenarios can be as options when design 25G OLT

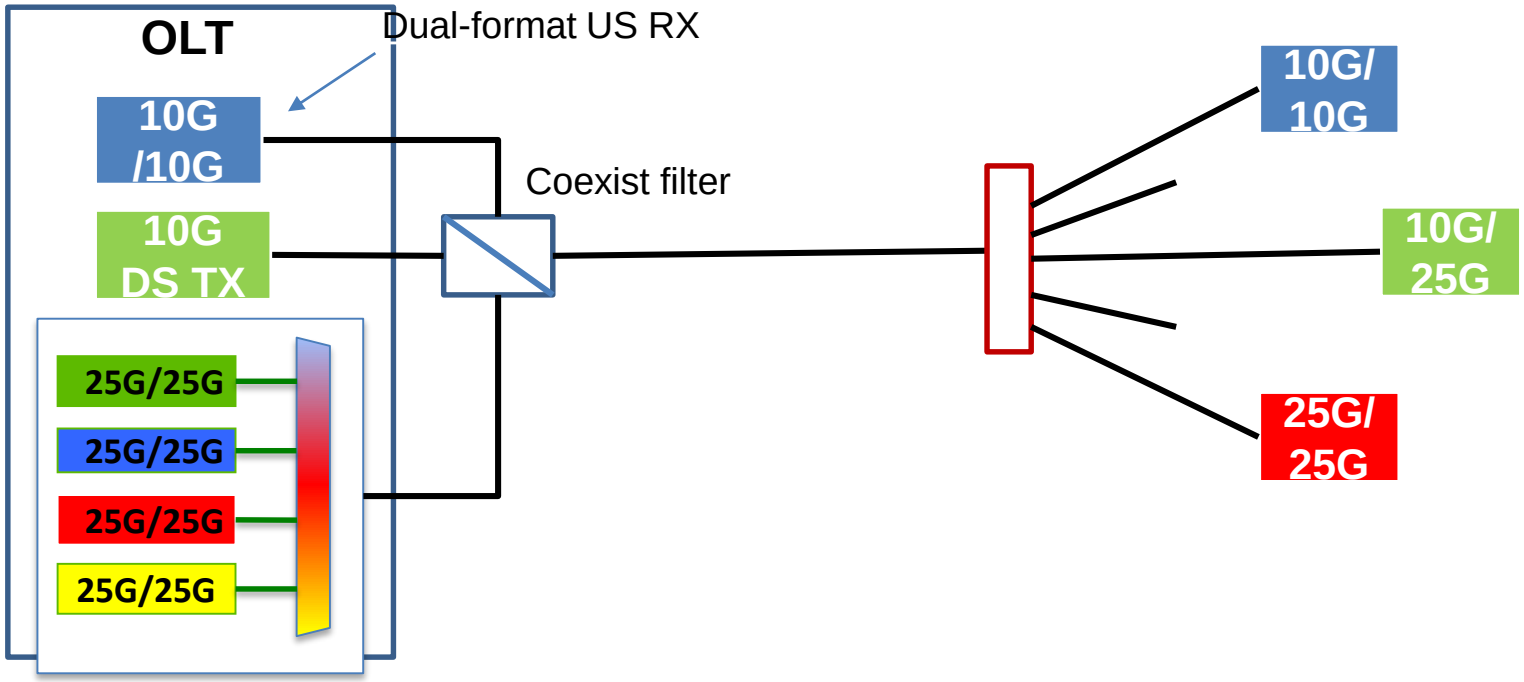
Coexistance of 100G, 25G with 10G/10G EPON



* Illustrates logical OLT migration, replace OLT is needed.

- **100G EPON WDMA coexists with 10G EPON asymmetric and symmetric 25G EPON**
- **Asymmetric 25G EPON and 100G EPON are in the same broadcast domain**

Coexistence of 100G with10G/20G and 10G/15G



- Coexistence scenarios can be as options when design 100G OLT

The characteristics of the wavelength plan

- Wide upstream channel for asymmetric 25G that enables uncooled DFB laser and reuses PR30 10G optics
- No new wavelength is allocated for asymmetric 25G
- Symmetric 25G channels have same channel spacing
  - Works better with SOA, easier to be integrated to 100G
  - Similar optical characteristics is a benefit for network design
- Asymmetric 25G EPON/channel may not need amplifiers
  - Solves the SOA performance problem of a 20nm wider channel with 3 other 800GHz channels
- The asymmetric 25G and 100G could be in one broadcast domain – closely integrated for service layer point of view

Conclusions

- **A balanced wavelength plan is proposed**
- **It allows reusing 10G EPON PR30 optics for asymmetric 25G EPON/channel.**
- **No new wavelength is needed for the lowest cost asymmetric 25G EPON**
- **The asymmetric 25G and 100G are in the same broadcast domain.**
- **The balance of the lowest cost asymmetric 25G EPON and the integrity of 100G EPON is achieved (optimized for both)**

Thanks

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