Unified Wavelength Grid in 100G-EPON

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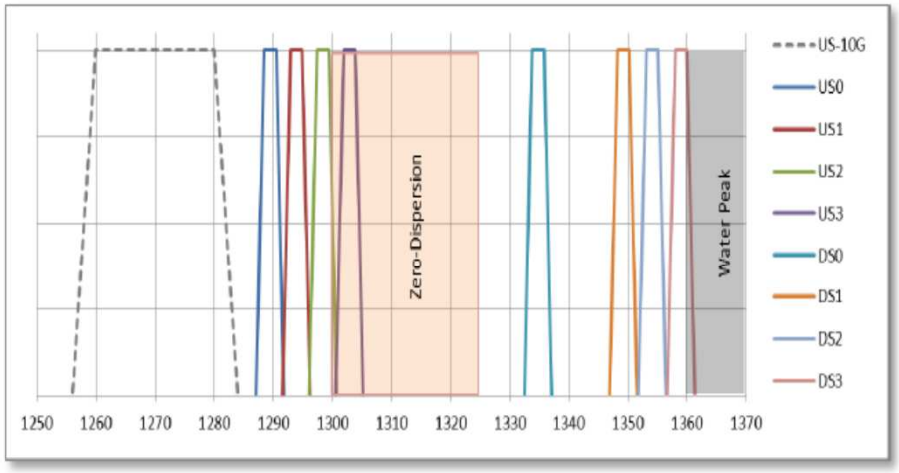
The Problem at Hand

There is an implementation difficulty in wavelength multiplexing/de-multiplexing for the wavelength plans of 100G-EPON that are currently under evaluation, e..g, Revised Plan A and Revised Plan B, because

- The wavelength channels may have different channel spacing values
- They may have different channel bandwidths
- They need to avoid the zero-dispersion window (1302nm~1322 nm)
- They need to avoid the water-absorption window (1360nm~1470nm)
- They need to be compatible with 10G-EPON upstream (1270±10nm)
- They need to be multiplexed and de-multiplexed in a cost-effective manner.

Revised Wavelength Plan A

In this wavelength plan, the wavelength channels may have different channel spacing values and different channel bandwidths, making it difficult for wavelength multiplexing and de-multiplexing for both downstream (DS) and upstream (US) channels.



Revised Plan A

- Shift US channels by +100GHz so US2 > 0.64nm from ZDF. Trade-off vs. smaller 10G/US0 gap.
- Increase DS0-DS1 spacing to 2.4 THz (12.4nm gap). Trade off vs. DS3 closer to 1360nm water peak region.

Reference: http://www.ieee802.org/3/ca/public/meeting_archive/2017/01/johnson_3ca_2_0117.pdf

Revised Wavelength Plan B

In this wavelength plan, the wavelength channels may have different channel spacing values and different channel bandwidths, making it difficult for wavelength multiplexing and de-multiplexing for both DS and US channels.

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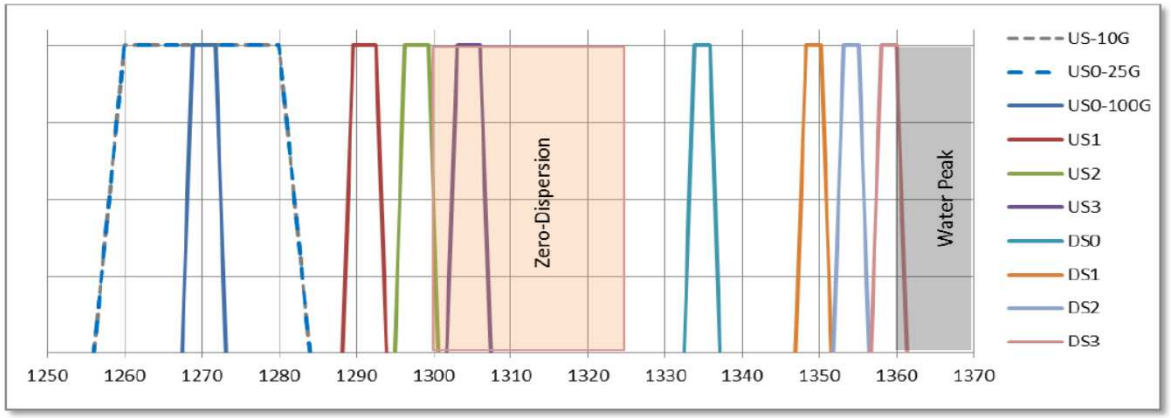
Details of revised Plan B channel plan



Lane	Center Freq (THz)	Center WL (nm)
US0-25G	236.06	1270.00
US0-100G	236.00	1270.31
US1	232.20	1291.10
US2	231.00	1297.80
US3	229.80	1304.58
DS0	224.60	1334.78
DS1	222.20	1349.20
DS2	221.40	1354.08
DS3	220.60	1358.99

- Channel spacing: 800GHz (DS), 1200GHz (US)
- Laser accuracy: ±1nm (DS), ±1.5nm (100G US), ±10nm (25G US)
- DS-US gap (min): 53.8nm (25G), 27.7nm (100G)
- DS0-DS1 gap (min): 12.4nm
- US0-US1 gap (min): 9.6nm (uncooled US0)
- US2 to zero dispersion range (min): 0.7nm (124GHz)

Reference: http://www.ieee802.org/3/ca/public/meeting_archive/2017/01/johnson_3ca_2_0117.pdf

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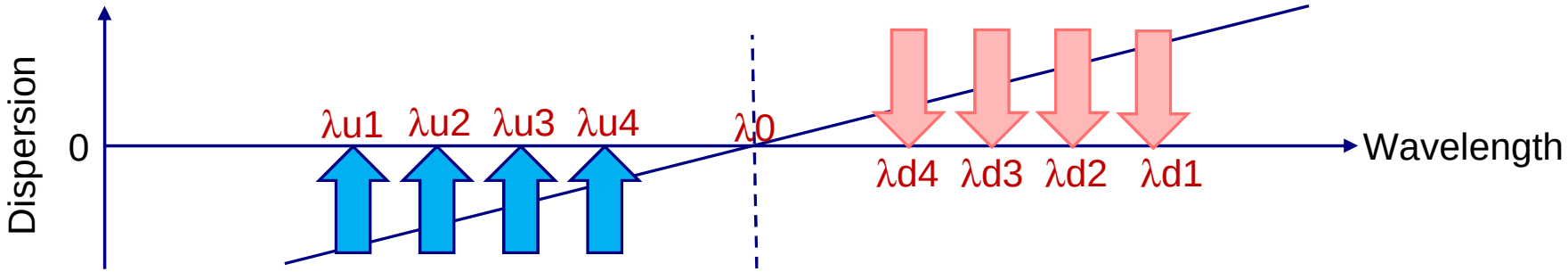
Symmetric Wavelength Plan A

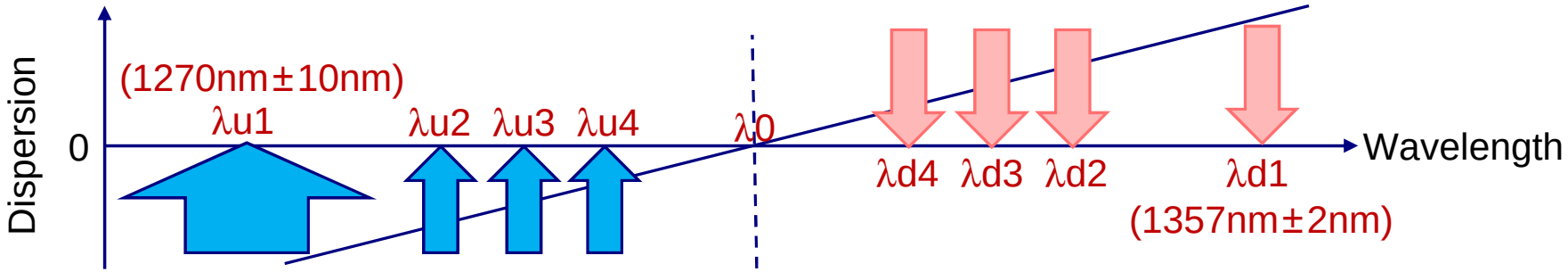
For Wavelength **Plan A**, all the four pairs of DS and US wavelengths are aggregated via wavelength-division multiplexing (WDM). To minimize the time synchronization error, it is preferred that we set each pair of DS and US wavelengths to be symmetric about the ZDW, as shown below.



Reference: Contribution to the IEEE 802.3ca 100G-EPON Task Force Meeting by Xiang Liu and Frank Effenberger, "Accurate Synchronization in 100G-EPON," March 14-16, 2017.

Symmetric Wavelength Plan B

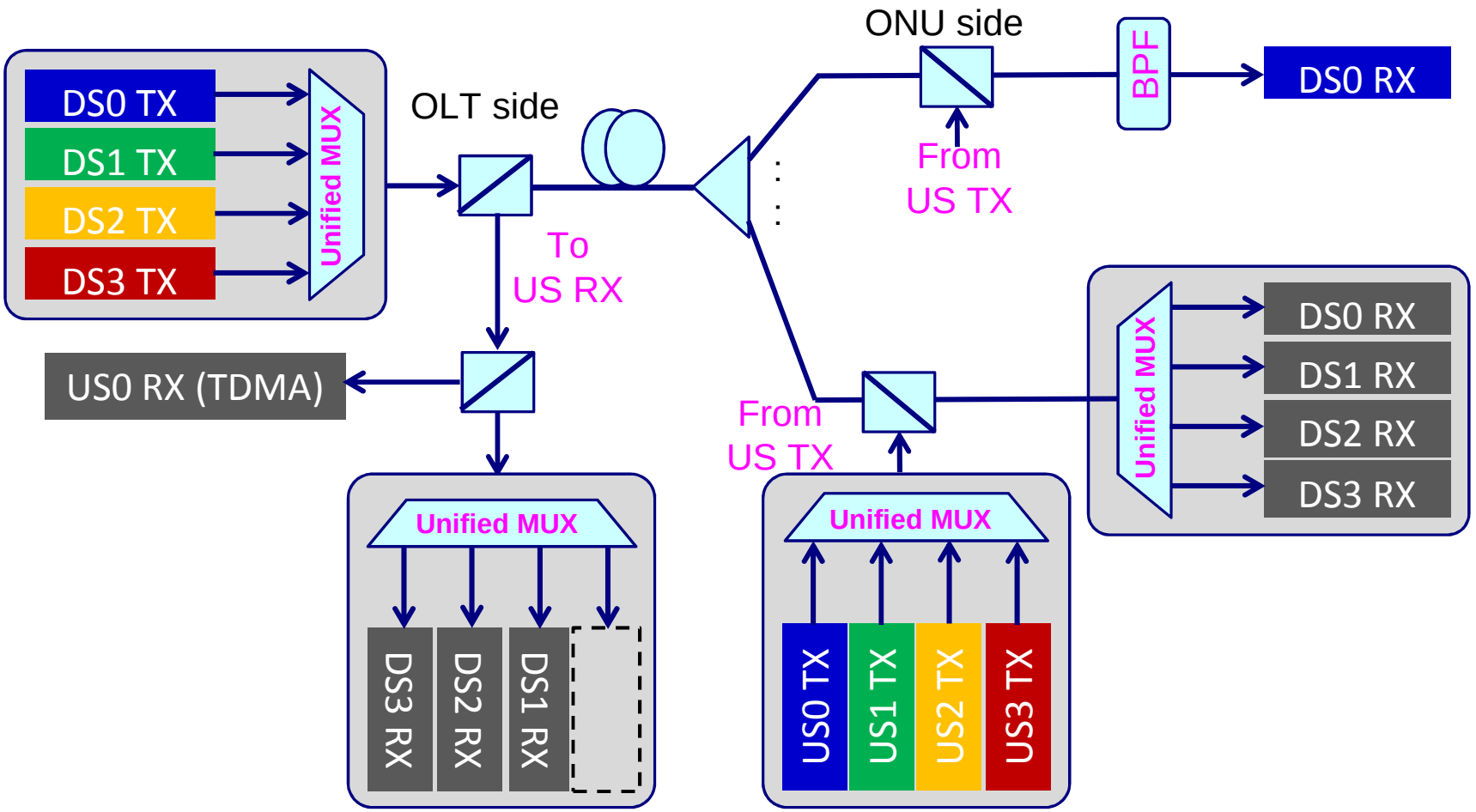
For Wavelength **Plan B**, the last three pairs of DS and US wavelengths are added via wavelength-division multiplexing (WDM). To minimize the time synchronization error, it is preferred that we set each pair of DS and US wavelengths to be symmetric about the ZDW, as shown below.



Reference: Contribution to the IEEE 802.3ca 100G-EPON Task Force Meeting by Xiang Liu and Frank Effenberger, "Accurate Synchronization in 100G-EPON," March 14-16, 2017.

Unified Wavelength Multiplexer (1)

It is beneficial to use a unified wavelength multiplexer for downstream (DS) and upstream (US) wavelength multiplexing (MUX) and de-multiplexing (DMUX), to save cost and ease management. The diagram below shows the case of TDMA coexistence with 10G-EPON.



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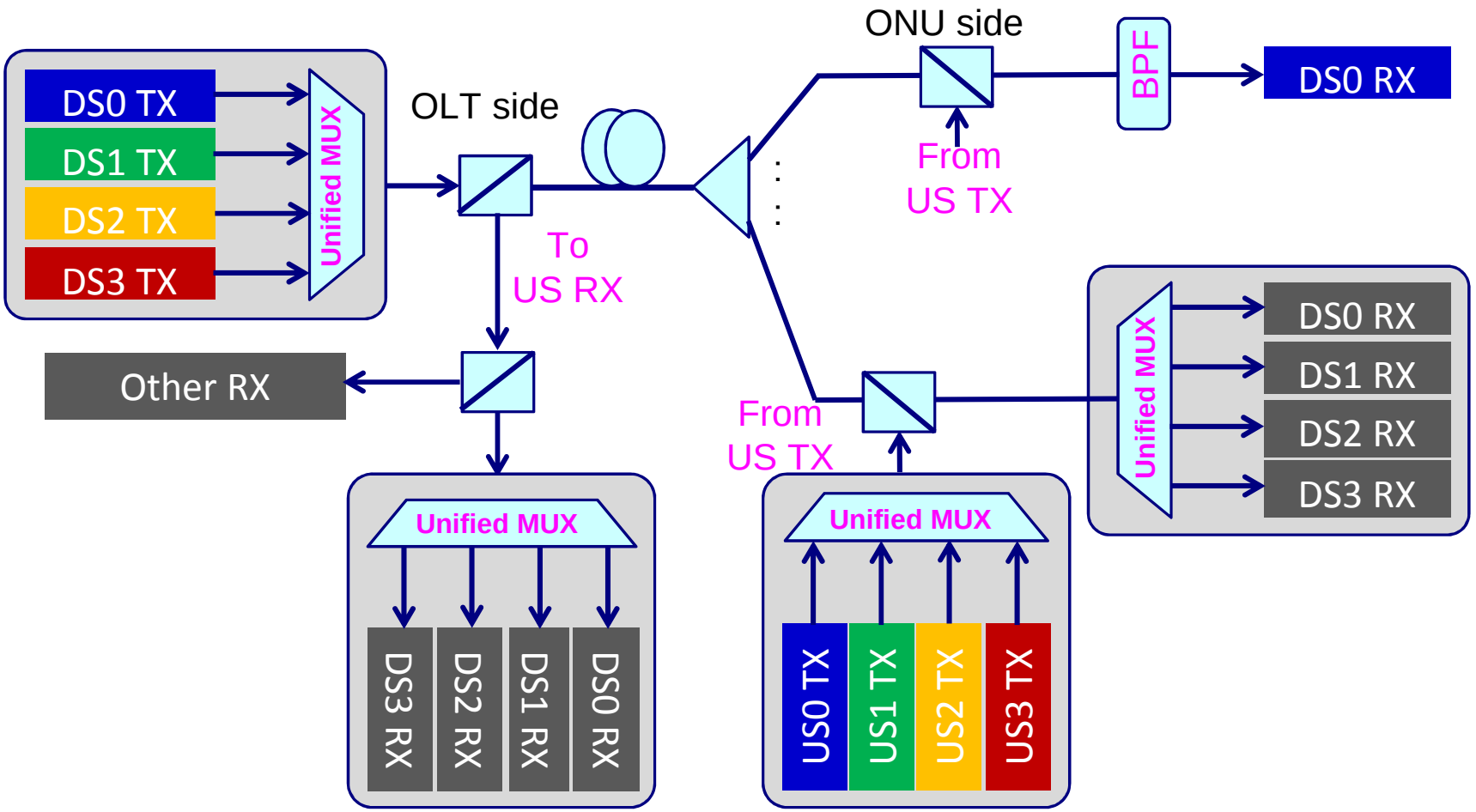
Unified Wavelength Multiplexer (2)

It is beneficial to use a unified wavelength multiplexer for downstream (DS) and upstream (US) wavelength multiplexing (MUX) and de-multiplexing (DMUX), to save cost and ease management. The diagram below shows the case of WDM coexistence with 10G-EPON.



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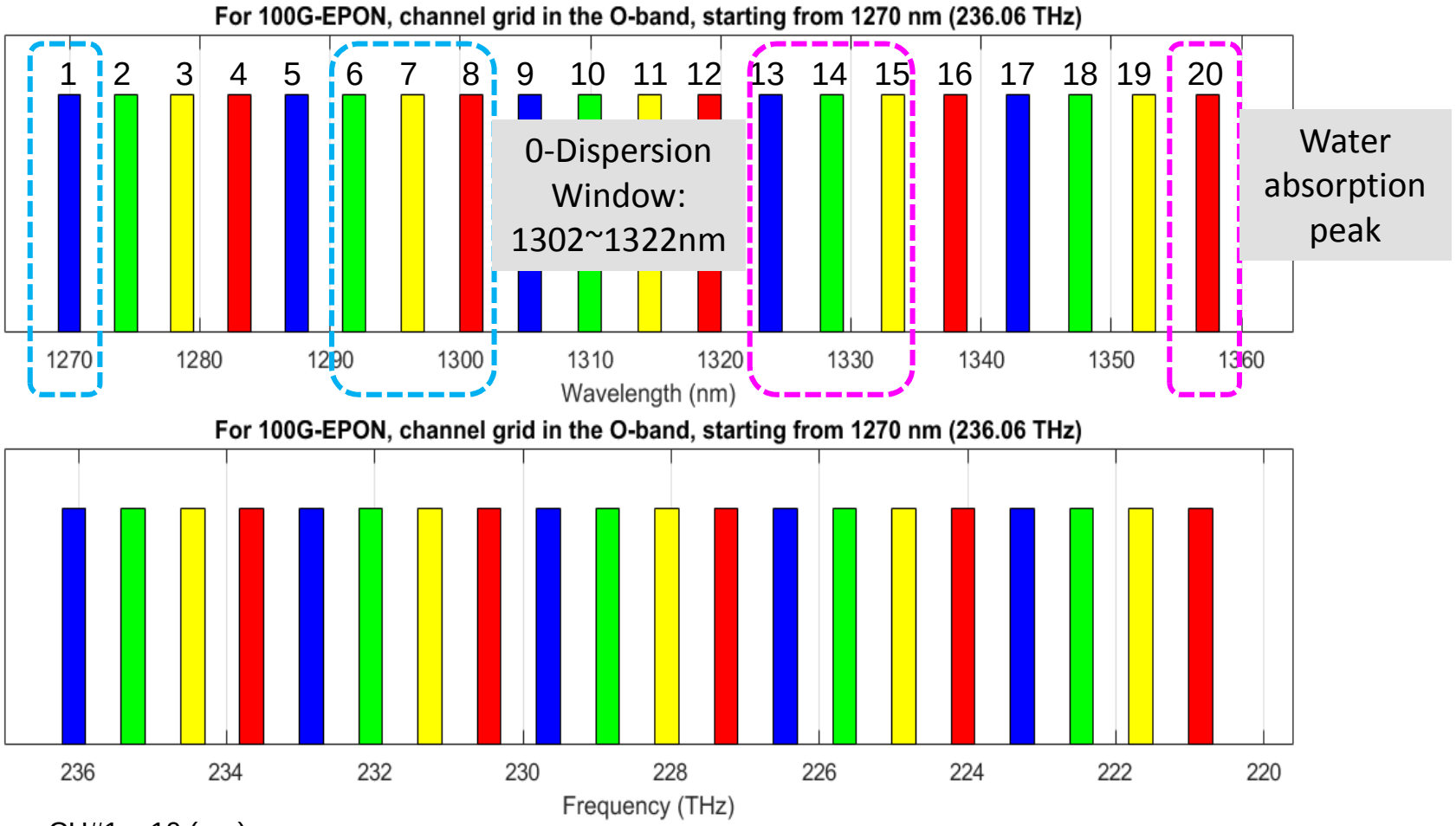
Unified Wavelength Grid - 800GHz Spacing

Channel center frequencies: f(n)=236.06-(n-1)*0.8 (THz), for n=1:20

US0, 1/2/3 at CH#1, CH#6/7/8; DS0, 1/2/3 at CH#20, CH#15/14/13



CH#1 ~10 (μm):	1.2700	1.2743	1.2787	1.2830	1.2874	1.2919	1.2963	1.3008	1.3054	1.3099
CH#11~20 (μm):	1.3145	1.3192	1.3238	1.3285	1.3332	1.3380	1.3428	1.3476	1.3525	1.3574

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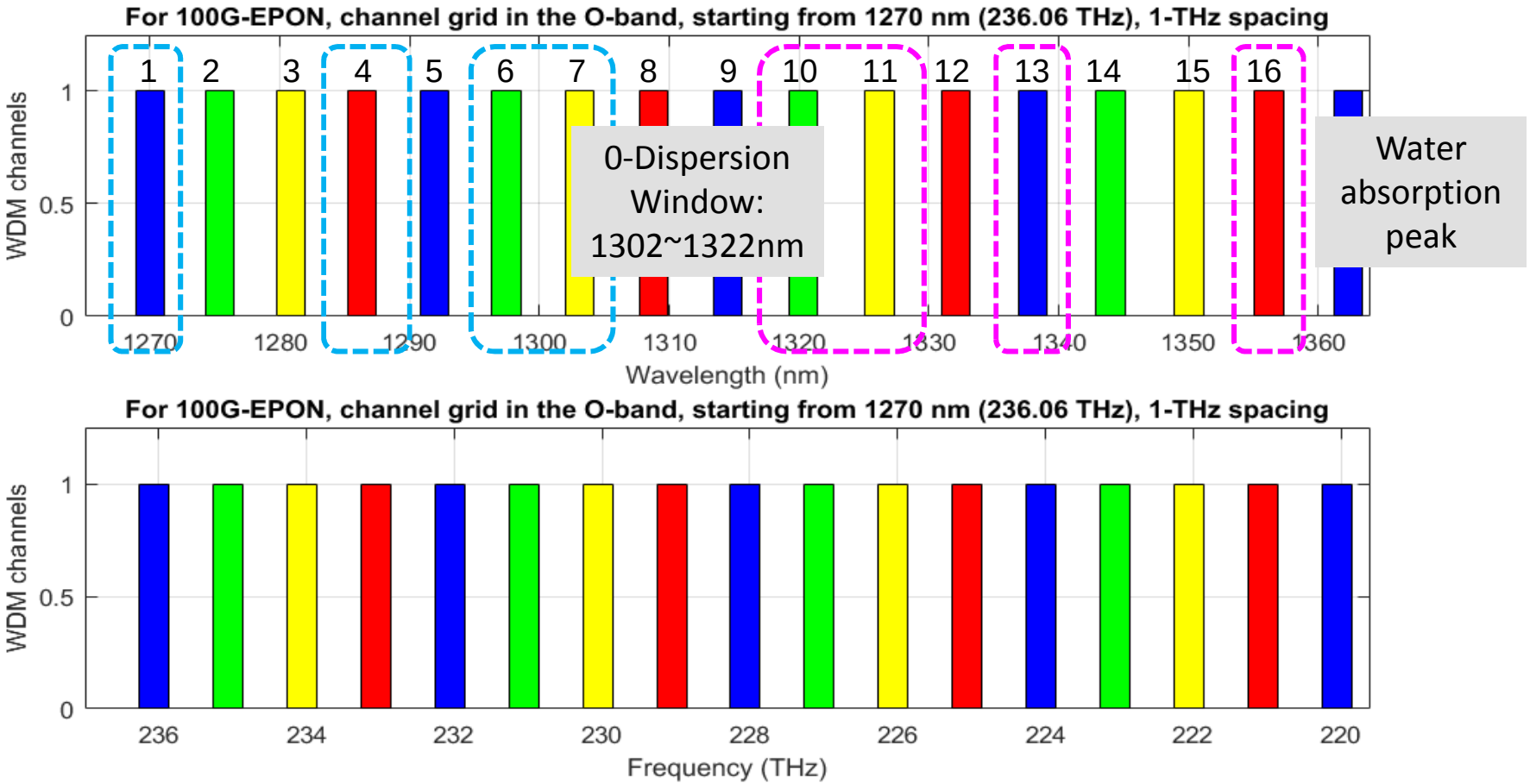
Unified Wavelength Grid – 1THz Spacing

Channel center frequencies: f(n)=236.06-(n-1)*1 (THz), for n=1:16

US0, 1/2/3 at CH#1, CH#4/6/7; DS0, 1/2/3 at CH#16, CH#13/11/10



CH#1~ 8 (μm):	1.2700	1.2754	1.2808	1.2863	1.2919	1.2975	1.3031	1.3088
CH#9~16 (μm):	1.3145	1.3203	1.3262	1.3321	1.3380	1.3440	1.3501	1.3562

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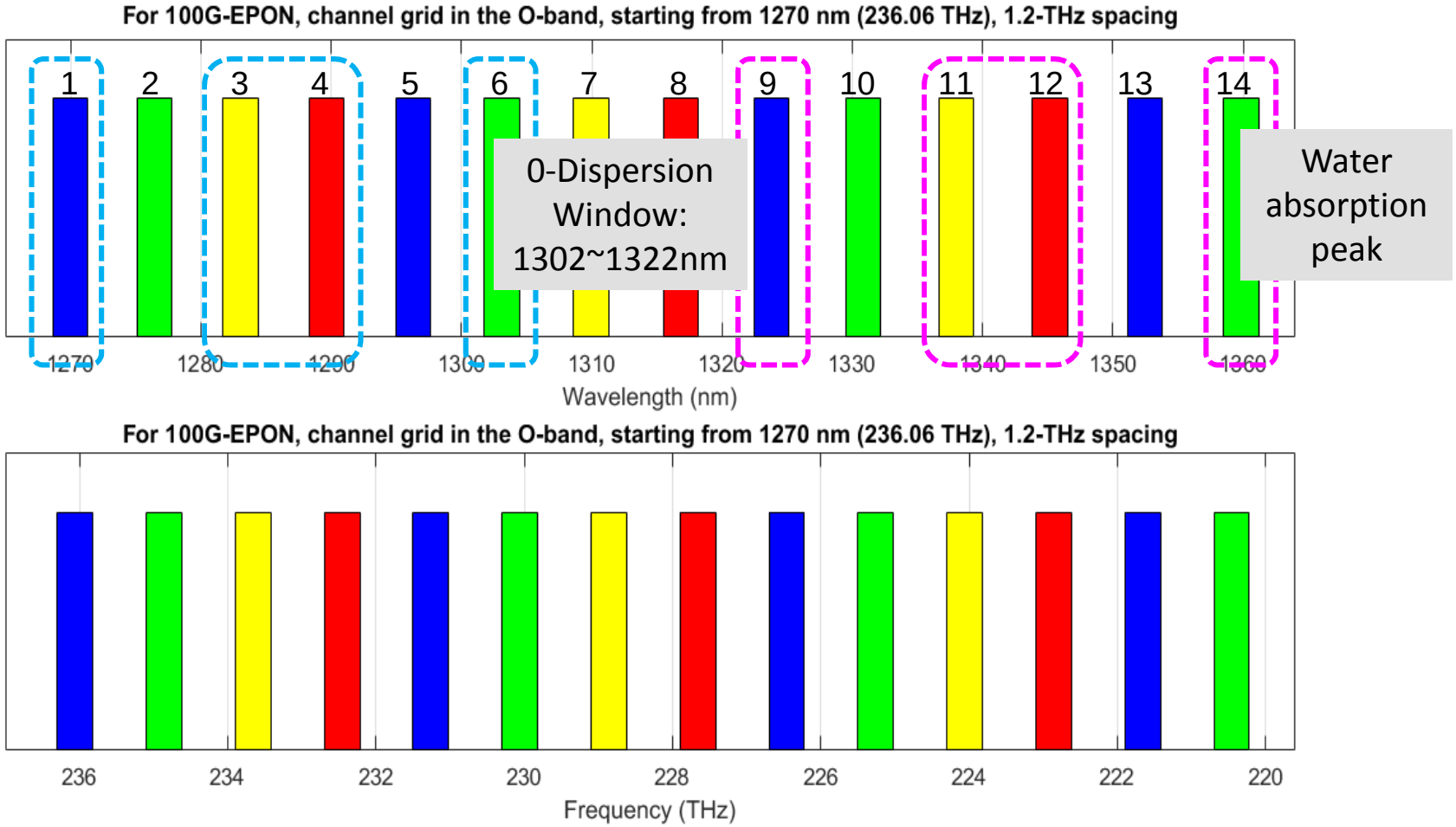
Unified Wavelength Grid – 1.2THz Spacing

Channel center frequencies: f(n)=236.06-(n-1)*1.2 (THz), for n=1:14

US0, 1/2/3 at CH#1, CH#3/4/6; DS0, 1/2/3 at CH#14, CH#12/11/9



CH#1~ 7 (μm):	1.2700	1.2765	1.2830	1.2897	1.2963	1.3031	1.3099
CH#8~14 (μm):	1.3168	1.3238	1.3309	1.3380	1.3452	1.3525	1.3598

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Summary

- When defining the wavelength plan of 100G-EPON, it is beneficial to consider a unified wavelength grid (or frequency grid) to make wavelength multiplexing and de-multiplexing cost-effective and easy to manage.
- Based on the analysis presented in this contribution, it is feasible to define such a unified wavelength grid (or frequency grid).
  - The frequency spacing can be 800 GHz, 1 THz, or 1.2 THz.
  - Certain wavelength channels can be chosen from the unified wavelength grid to meet the various requirements of 100G-EPON, such as the avoidance of the zero-dispersion window and the ease of filtering out the first pair of DS and US channels.
- The task force is thus recommended to consider the use of a unified wavelength grid or frequency grid to accommodate both DS and US wavelength channels.

Thank you

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