Preparing Optical Spectrum Resources for 100G EPON

Eugene (Yuxin) DAI PhD

Cox Communications, Eugene.dai@cox.com

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Outline

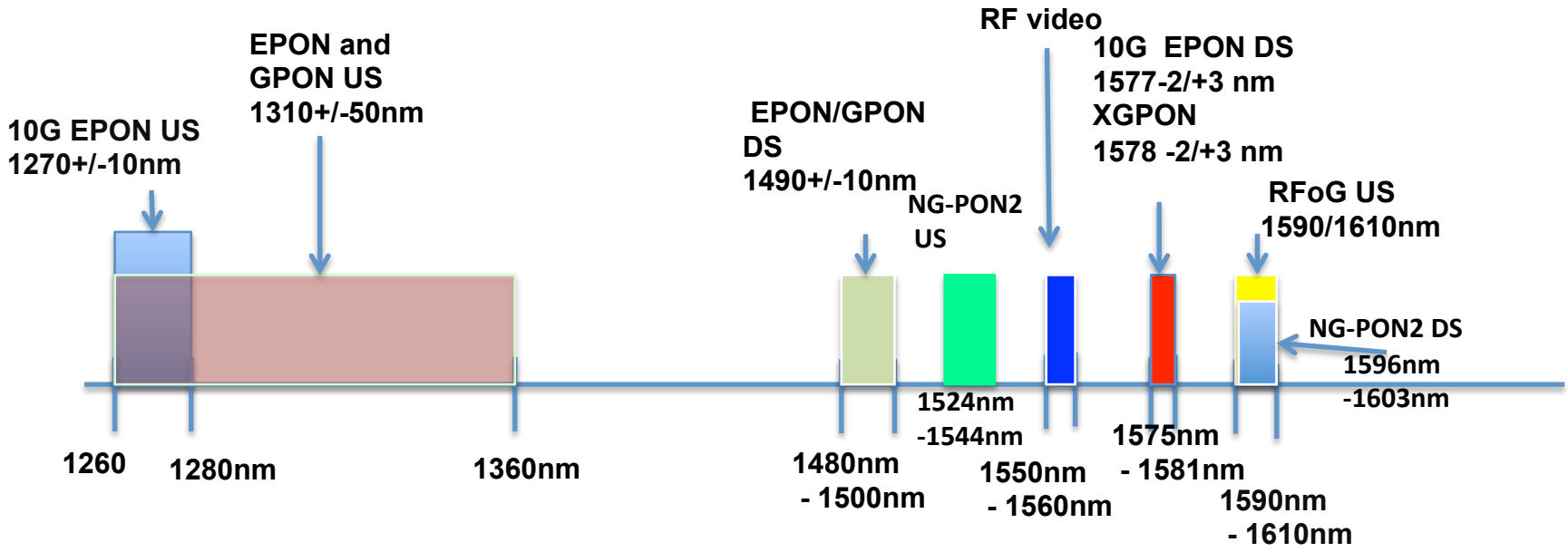
- 100 Gb/s EPON ONU wavelength range considerations
- Current wavelength allocation for PON
- Wavelength choices for 100 Gb/s EPON

100 Gb/s EPON ONU wavelength range – DWDM or CWDM?

- 25 Gb/s single channel EPON is the building block for 100 Gb/s EPON
- 25 Gb/s EPON will likely use 10G EPON optics with PAM-4 or duo-binary modulations
- 25 Gb/s EPON should adopt the wavelength range similar to that of the 10G EPON
  - Upstream 20nm range
  - Downstream 5nm range
- 100 Gb/s EPON is built with 4X25 Gb/s, there are two choices for the WDM wavelength plan
  - DWDM: using 100GHz or 200GHz channel spacing, similar to NG-PON2
  - CWDM, or specially defines WDM grade to accommodate the wider wavelength range

From the cost and reusing 10G EPON optics point of view, 100 Gb/s EPON should adopt coarser wavelength range

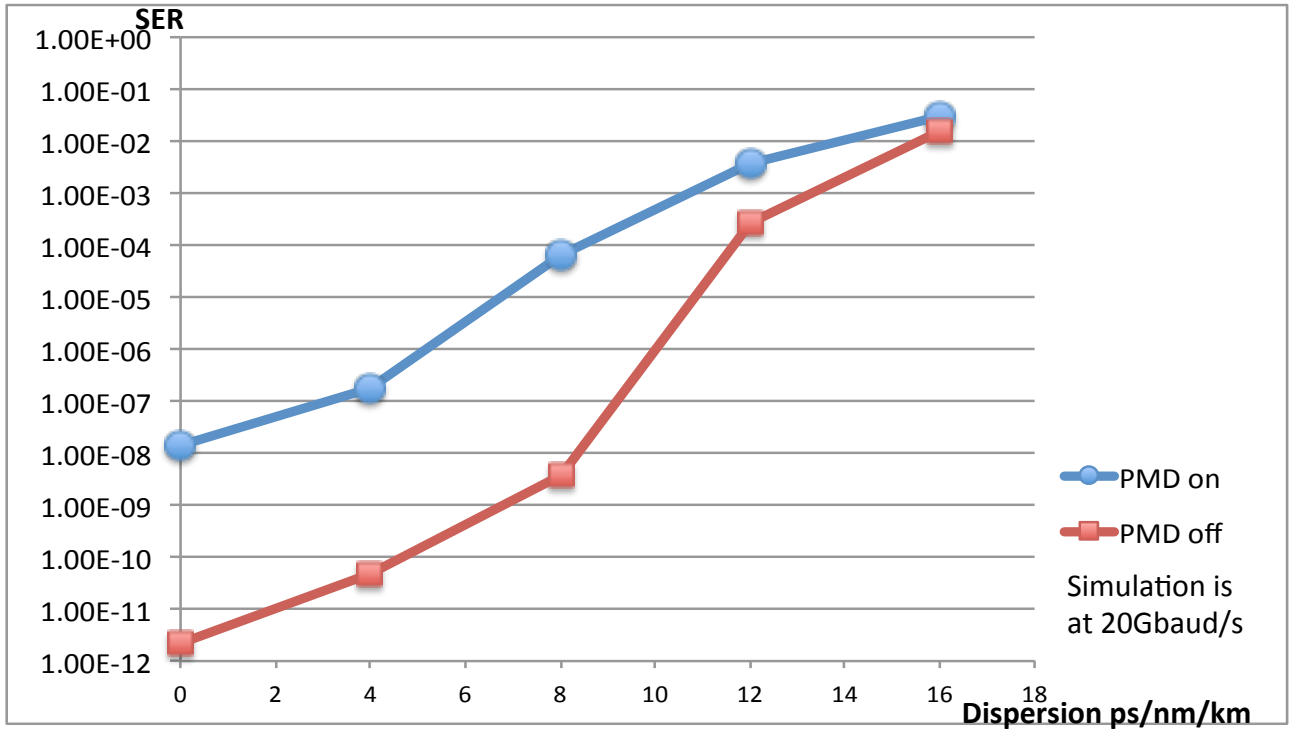
Current optical spectrum allocations



- The 100 nm in O band resource is used by legacy EPON/GPON.
- The 20 nm in lower L band resource is used by RFoG US and NG-PON2 DS
- The 20 nm C band resource is used by NG-PON2 US
- Have to keep 1550nm video overlay; and can not reuse 10G EPON wavelengths
- Coarse wavelength plan for 100 Gb/s EPON needs 80nm for US and 20nm for DS

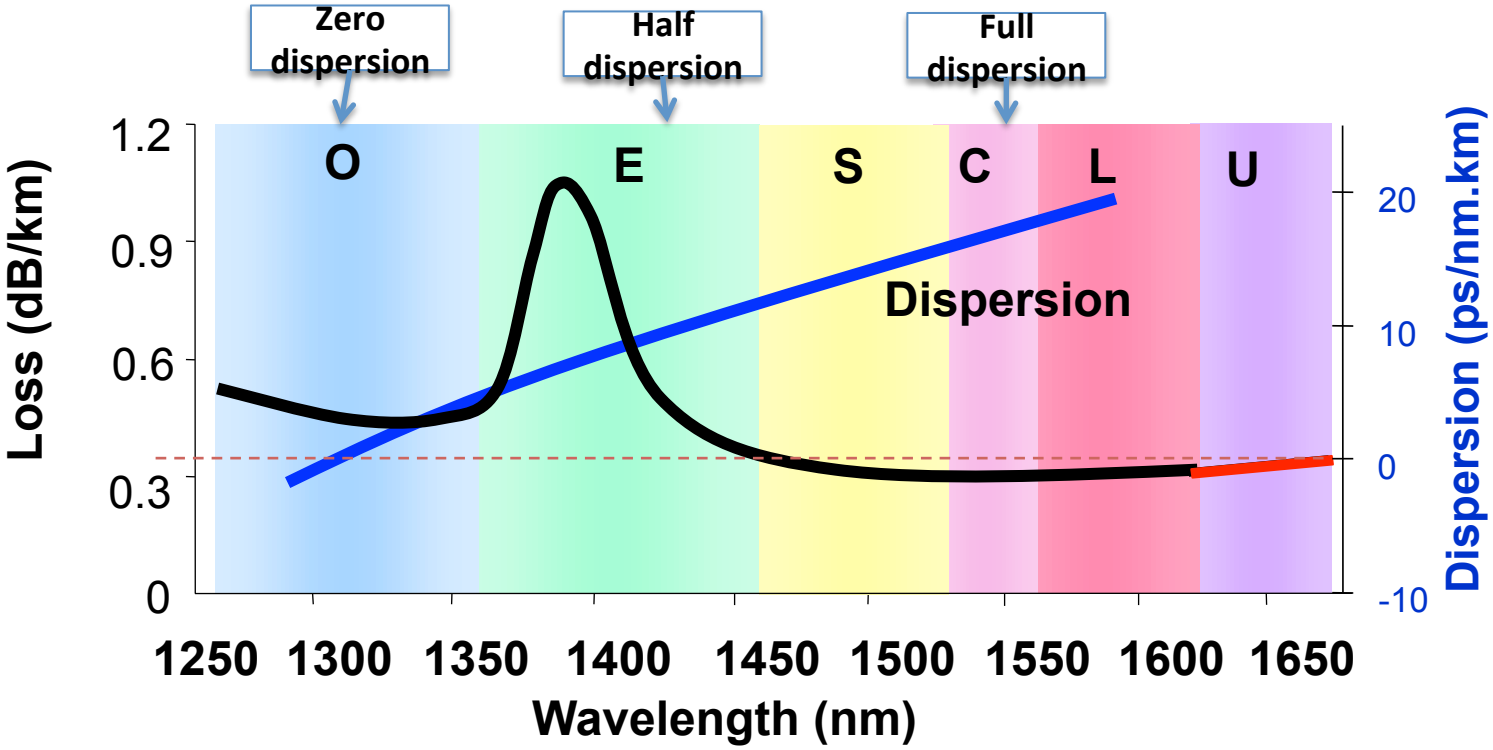
Reclaiming the EPON US and RFoG US wavelengths provides the resources needed for 100G EPON

Impacts of dispersions and PMD on PAM-4



Both dispersions and PMD affect symbol error rate. Zero or low region dispersion is preferred for PAM-4.

Choices of Wavelengths



- C band wavelengths experience higher dispersions, it could be a problem for PAM-4 or duo-binary modulations
- E band has higher optical attenuations under the water peak
- O band is the best choice for high-speed advanced modulations

L band and RFoG

- The 20 nm optical spectrum resources in L band from 1590 nm to 1610 nm are used by RFoG US and NG-PON2 DS
- It prevents operators from deploying NG-PON2 with RFoG
- The 20 nm spectra in L band are suitable for 100G EPON DS
  - Assuming the 5 nm spacing for 100G EPON
- Reclaiming the 20 nm L band spectrum resources will benefit operators who deploy NG-PON2 and/or 100G EPON.
- However, RFoG is considered to last for a fairly long time period during the migration
- We need to find a alternative way to backhaul RFoG signals and it will be discussed in a separate contribution
- Here, we assuming the 20 nm L band optical resources are available

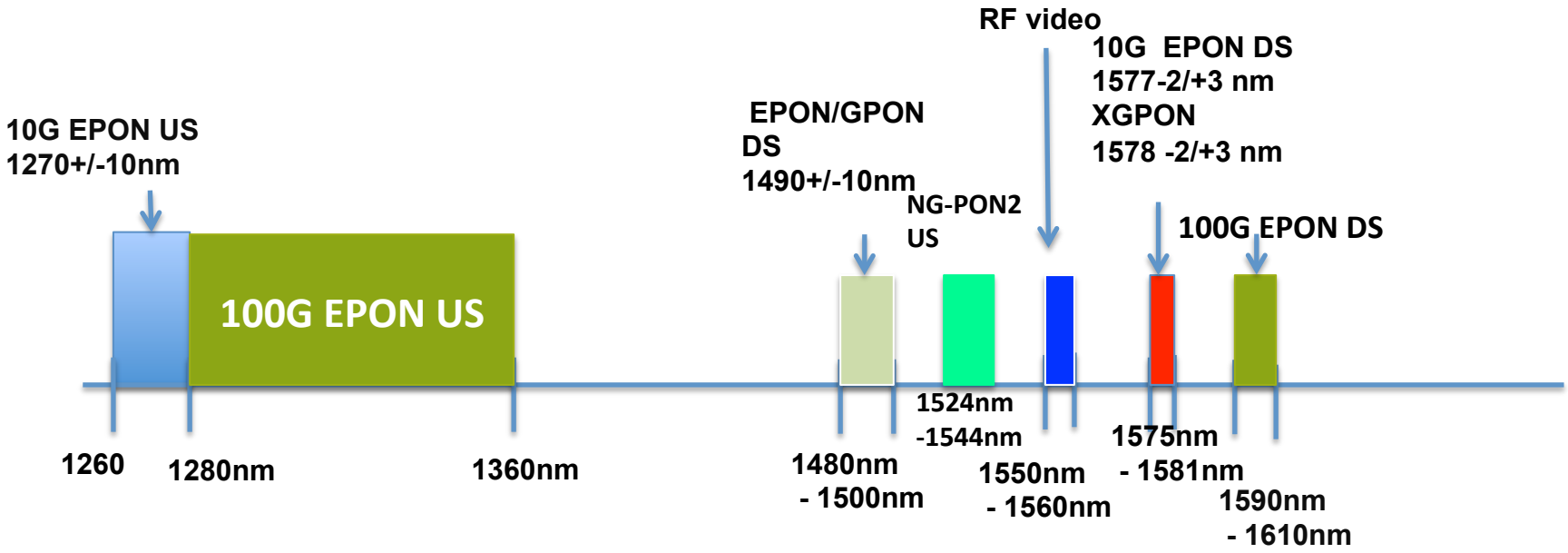
O Band and Coexist considerations

- **O band is the best choice for high-speed advanced modulations**
- **We have agreed to consider coexisting with the closest generation**
  - Only coexistence with 10G EPON will be considered
- **O band spectrum resources in the range from 1280nm to 1360nm can be released for 25G and 100G EPON**
- **25 Gb/s EPON could coexist with 10G EPON in WDM fashion, or**
- **25 Gb/s EPON could coexist with 10G EPON in TDM fashion in upstream**
  - Similar to the co-existence of 10G EPON and EPON
  - 25 Gb/s EPON upstream wavelength therefore is 1270 nm
  - Only need to find a downstream wavelength for 25 Gb/s EPON

S band and C band

- S band and C band are used for DWDM applications
  - Prefer to reserve them for DWDM
- C band does not have enough spectrum resources for 4 channels coarser then WDM for 100G EPON
- Lower S band channels are too close to wave peak
- The dispersion in C band is too high for 100G EPON upstream
- Using C band for 100G EPON US will force a much narrower wavelength range, such as 100GHz or 200GHz as in NG-PON2
- Will not have the cost benefits from using coarser 10G EPON optical spec

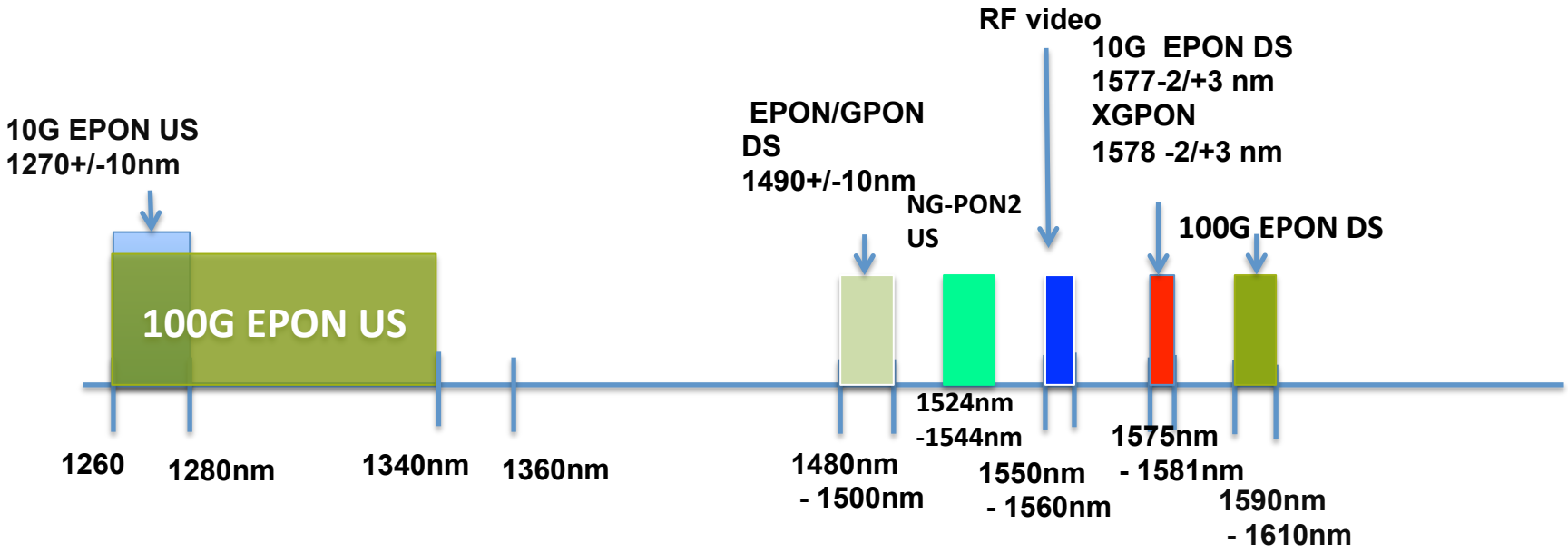
100G EPON wavelength allocation option A



- 100G EPON US: 1280 nm to 1360 nm with 20nm spacing
- 100G EPON DS: 1590nm to 1610 nm with 5 nm spacing

Option A is for WDM coexistence of 25G EPON with 10G EPON.

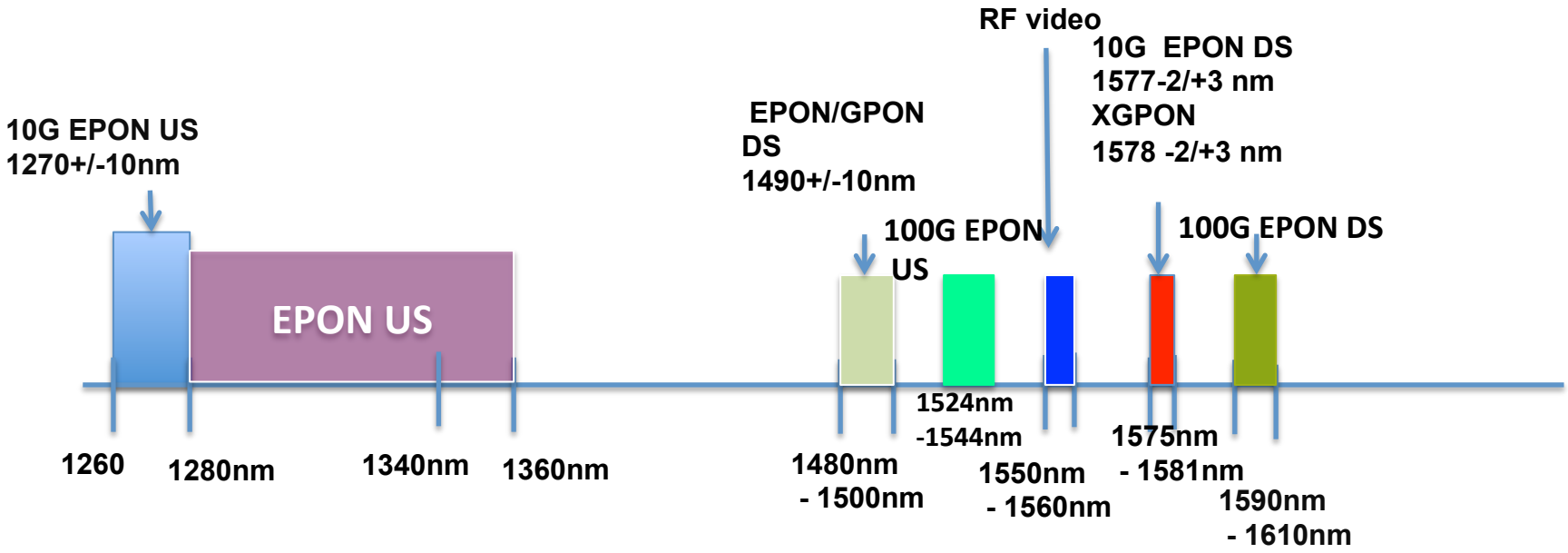
100G EPON wavelength allocation option B



- 100G EPON US: 1260 nm to 1340 nm with 20 nm spacing
- 100G EPON DS: 1590nm to 1610 nm with 5 nm spacing

Option B is for TDM coexistence of 25G EPON with 10G EPON.

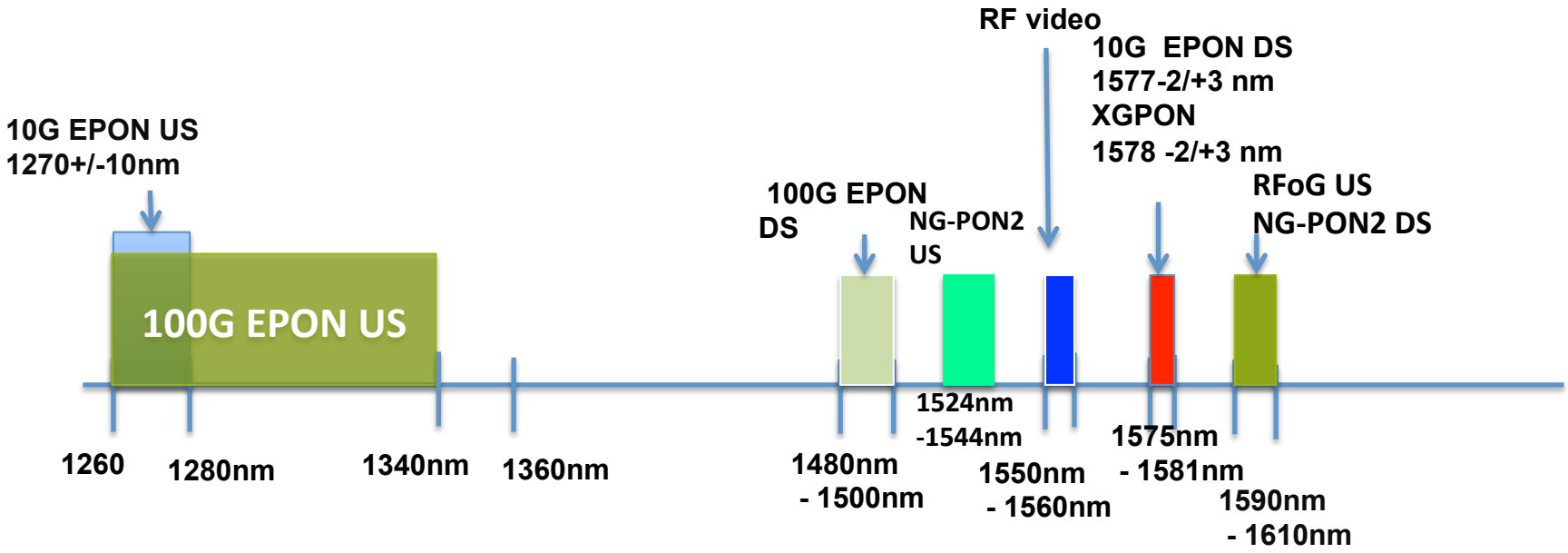
100G EPON wavelength allocation option C



- 100G EPON US: 1524 nm to 1544 nm with 5 nm spacing
- 100G EPON DS: 1590nm to 1610 nm with 5 nm spacing

Option C uses C band for 100G EPON upstream. Due to the limitation in C band spectrum resources, a tighter wavelength range (DWDM) is needed for ONU upstream.

100G EPON wavelength allocation option D



- 100G EPON US: 1260 nm to 1340 nm with 20 nm spacing
- 100G EPON DS: 1480 nm to 1500 nm with 5 nm spacing

Option D uses S band for 100G EPON downstream. Although S band is preferred for DWDM, it could be used for 100G EPON DS if coarse multiple channel optics are available

Conclusions

- Options A & B are preferred (different in coexist scenario)
- O band is the best choice for high-speed advanced modulations, especially for 100G EPON upstream
- Since only coexistence with 10G EPON will be considered, the 80 nm O band spectrum resources could be reclaimed for 100G EPON
- Assuming an alternative can be found to backhaul RFoG signal, the 20 nm L band optical resources can be reclaimed for 100G EPON downstream
- If coarse multiple channel optics are available in S band, option D could be the choice after options A&B.

Thanks

Eugene.dai@cox.com