25G and 50G EPON downstream wavelength plan

- Ed Harstead, Nokia
- John Johnson, Broadcom

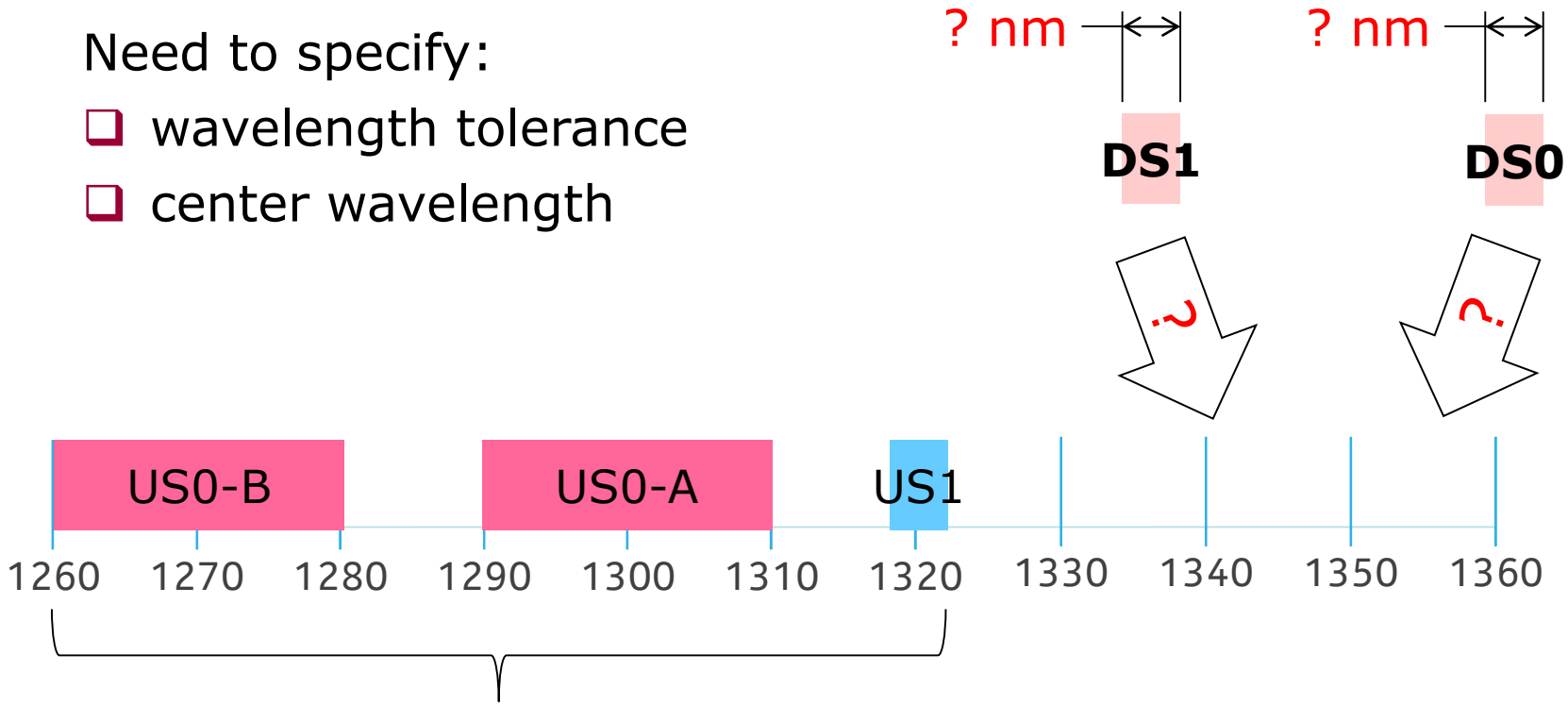
Supporters

- Wang Bo, China Telecom
- Dekun Liu, Huawei
- Phil Miguelez, Comcast
- Daisuke Umeda, Sumitomo Electric
- Ed Walter, AT&T
- Wey Jun Shan, ZTE

Specifying DS wavelengths

Need to specify:

- wavelength tolerance
- center wavelength



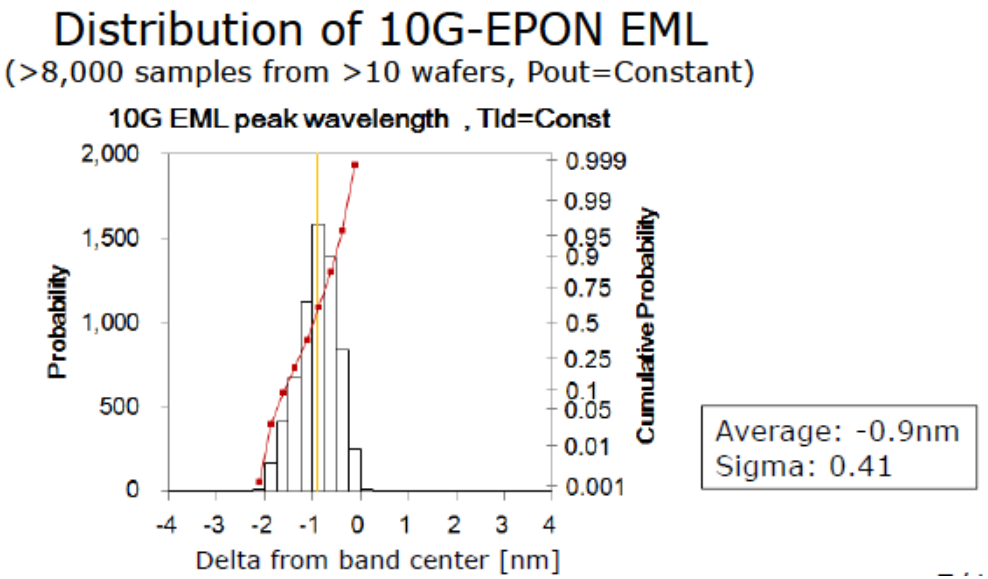
Upstream wavelength plan

- US0-B: 1270 +/- 10 nm
- US0-A: 1300 +/- 10 nm
- US1: 1320 +/- 2 nm

Per Motions 12 and 15, minutes_unapproved_3ca_0118.pdf

DS wavelength tolerance

- Assume EML implementation
- 4 nm is adequate for high yield



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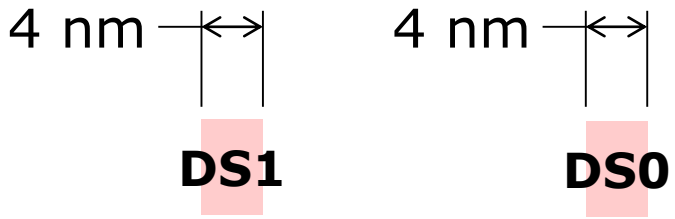
- Therefore choose 4nm for DS0 and DS1

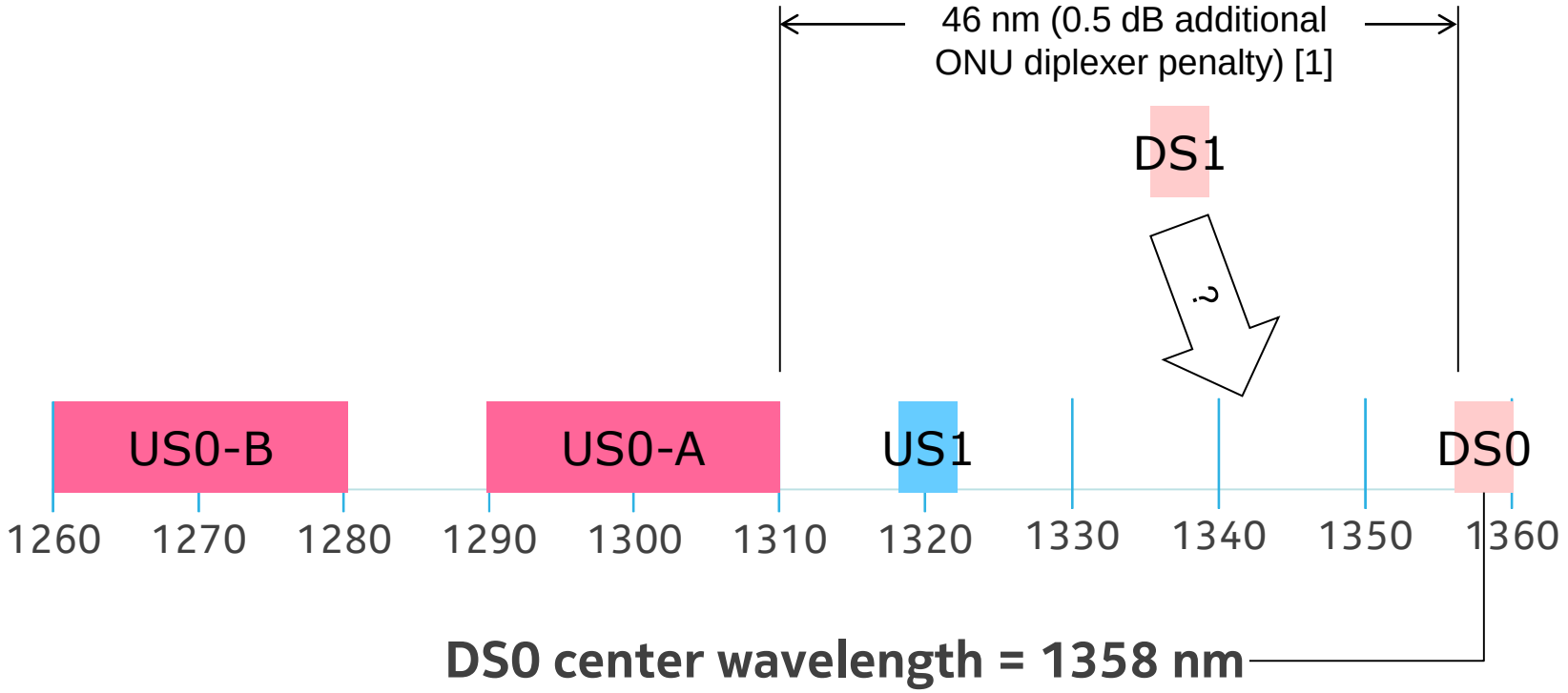


EML wavelength re-use?

- If EMLs already existed at wavelengths >1330 nm, there would be development cost savings if these wavelengths would be reused.
  - For example, CWDM at 1351 nm.
- However EMLs do not exist >1330 nm so this is not a consideration.

Minimizing 25G diplexer penalty for US0-A

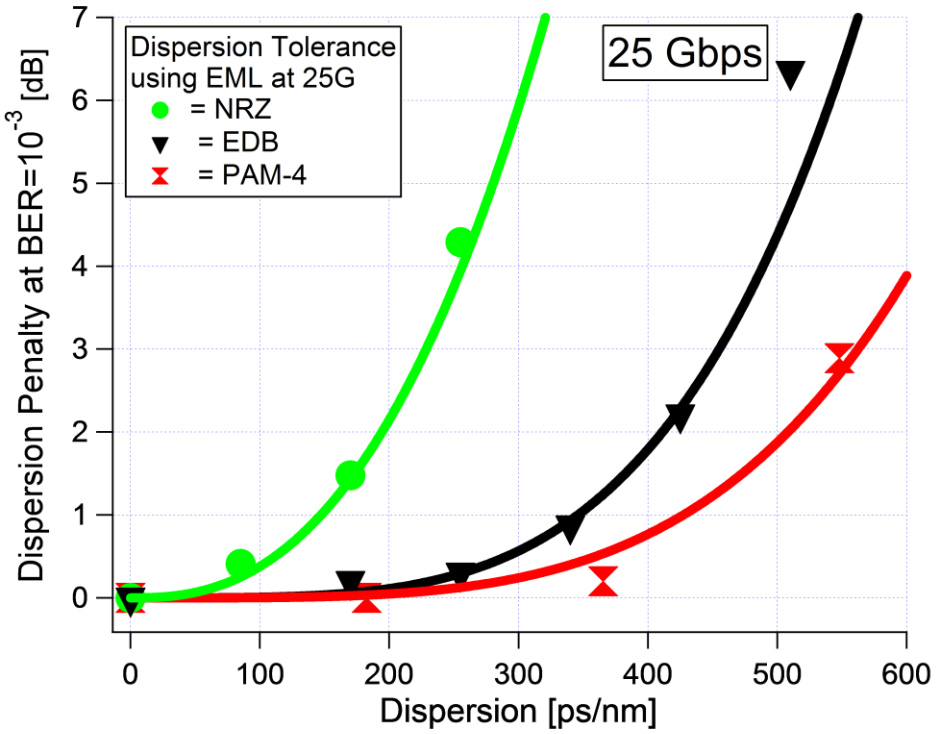
- DS0: move to the longest wavelength in the O-band to maximize the DS/US gap, thereby minimizing 25G diplexer penalty for US0-A
- Dispersion will be slightly higher there, but not a significant problem at 25G. It will be a bigger problem for future 50G.



[1] funada_3ca_1_0117

DS1: considering 1x50G PON

- 1x50G PON downstream: chromatic dispersion penalty (DP) becomes a concern, even in the O-band.
- Empirical dispersion tolerance values for NRZ, EDB and PAM4 modulations using EMLs, are available for 25G:

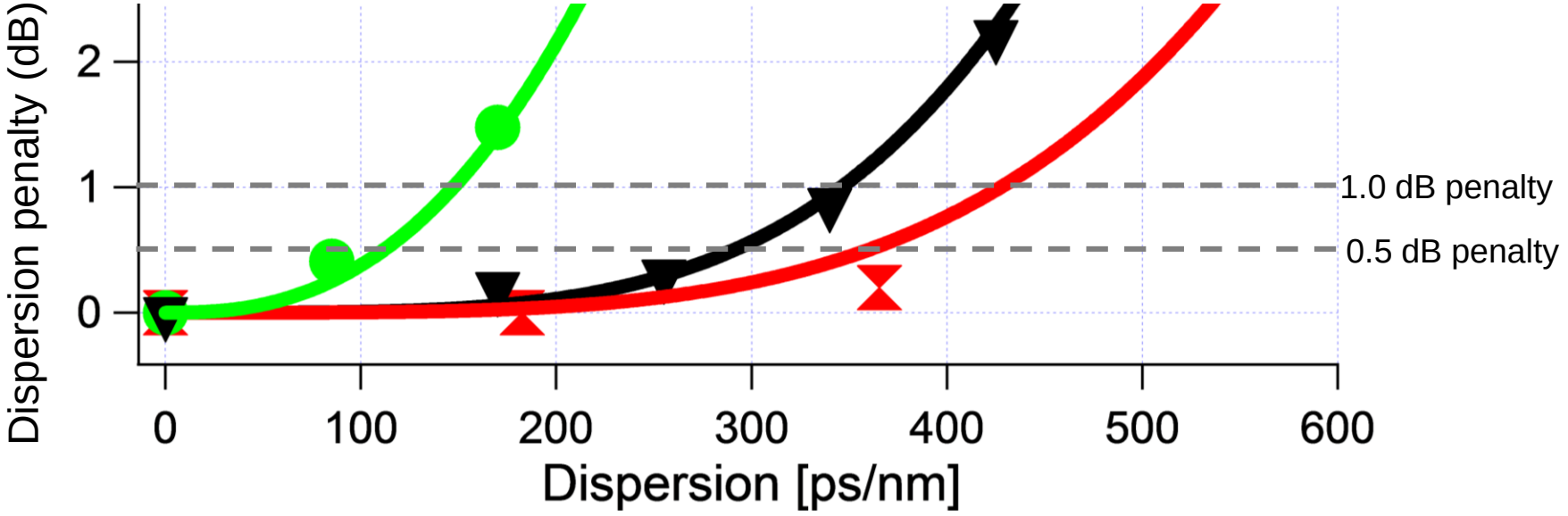


V. Houtsma, D. van Veen, "A Study of Options for High-Speed TDM-PON Beyond 10G", J. Lightwave Tech., Feb. 2015.

Notes:

1. No dispersion compensation
2. Penalties shown for 1e-3 BER. Should be very similar for 1e-2 BER

50G dispersion tolerance (DT)

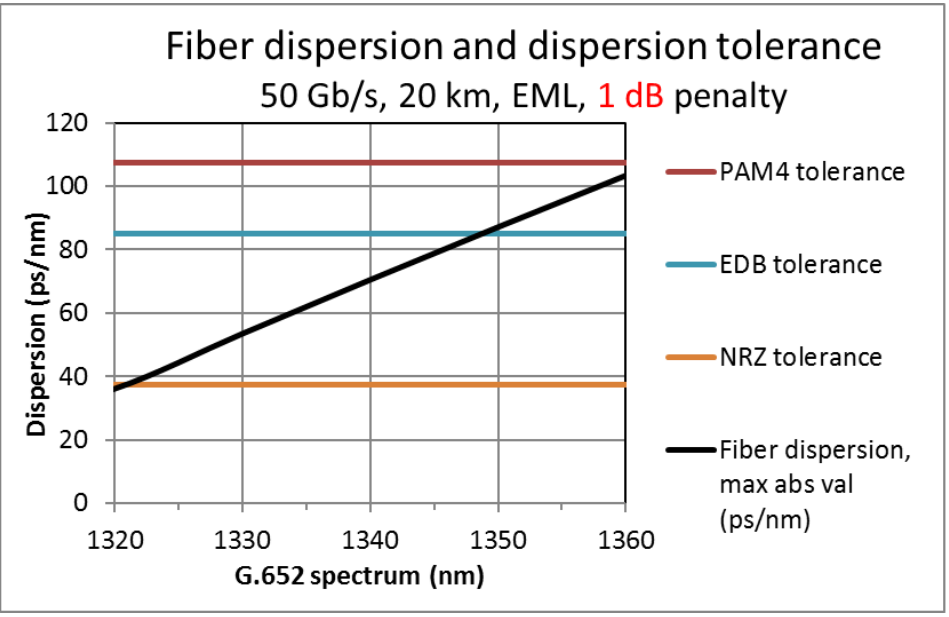


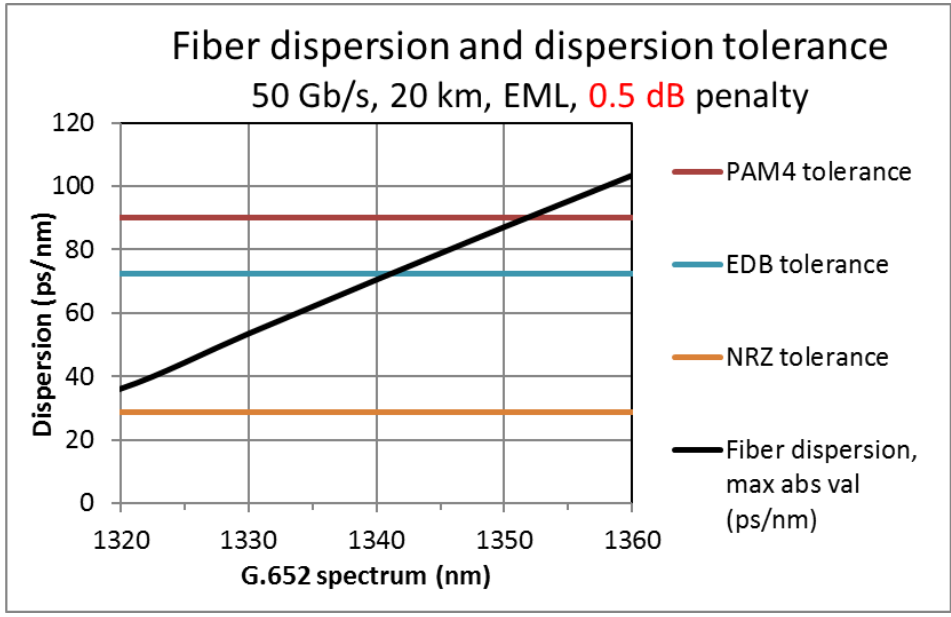
		Dispersion tolerance (ps/nm)		
DP	**Bit rate**	**NRZ**	**EDB**	**PAM4**
0.5 dB	25 Gb/s	115	290	360
1.0 dB	25 Gb/s	150	340	430
0.5 dB	**50 Gb/s**	**28**	**73**	**90**
1.0 dB	**50 Gb/s**	**38**	**85**	**108**

From the chart

As a first approximation, 50G DT=25G DT/4

Optimizing DS1 for 50G dispersion (1/2)





For 1 dB DP:

- EDB requires DS1 <1348 nm.
- PAM4 OK to 1360 nm

For 0.5 dB DP:

- EDB requires DS1 <1341 nm.
- PAM4 requires DS1 <1352 nm.

Note: electronic dispersion compensation could provide some limited benefit:

- Enable NRZ for >1320 nm
- Further minimize dispersion penalty for EDB and PAM4

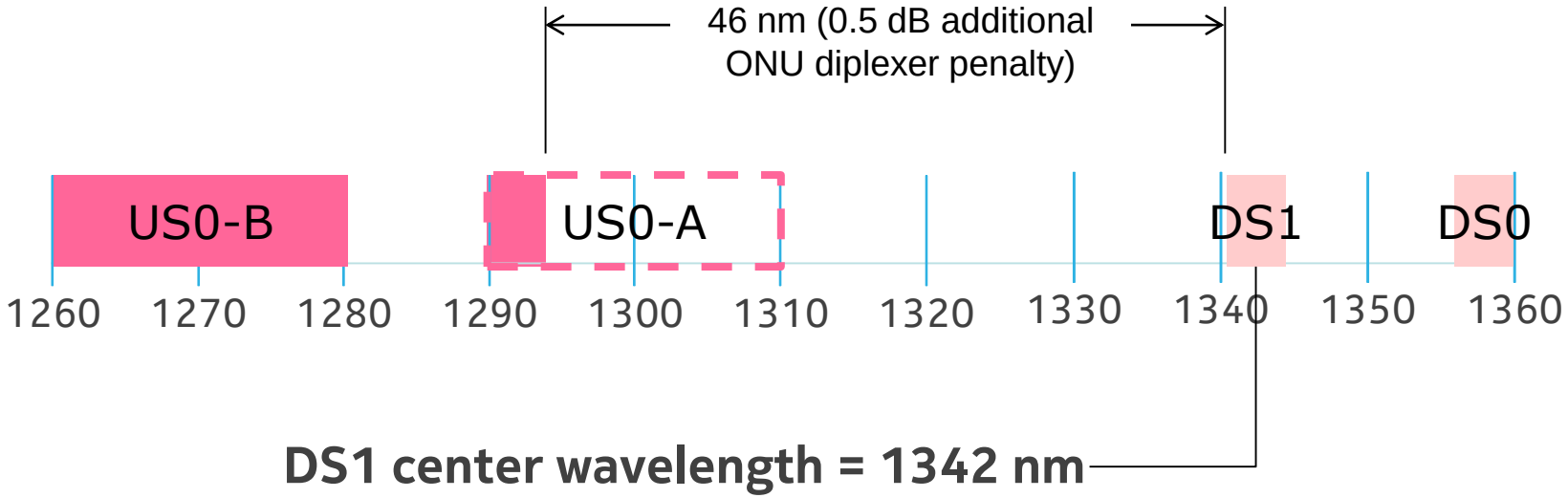
Optimizing DS1 for 50G dispersion (2/2)

Keeping in mind that these are first approximations, we can still draw these conclusions

- NRZ >1320 nm will only work if accept >1 dB dispersion penalty
- Minimizing the DS1 wavelength will reduce the dispersion penalty for 50G regardless of whether NRZ, EDB or PAM4 modulation is chosen.

DS1 wavelength selection for 1x50G EPON

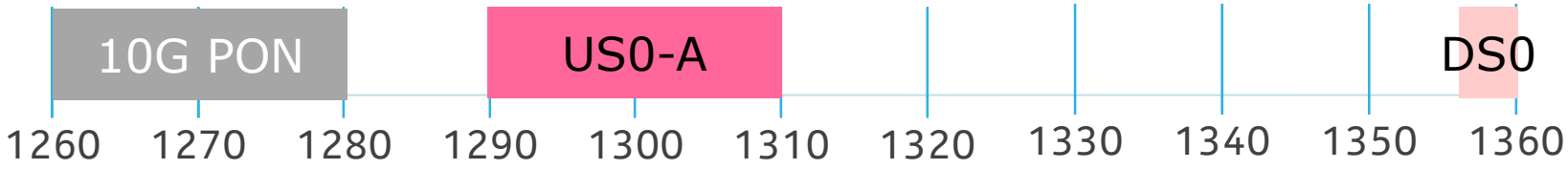
- 50G DS1 should be >~45nm away from 50G US0-A to allow 45deg ONU diplexers and minimizing diplexer penalty
- Not possible for DS1 if US0-A is 1290-1310 nm. But if 50G US0-A is restricted to 1290-1294nm (cooled laser), then DS1 >1340 nm can work.



- DS1 at 1342 +/-2 nm corresponds to <1 dB DP for EDB and ~0.5 dB DP for PAM4. These are manageable penalties.

25G EPON

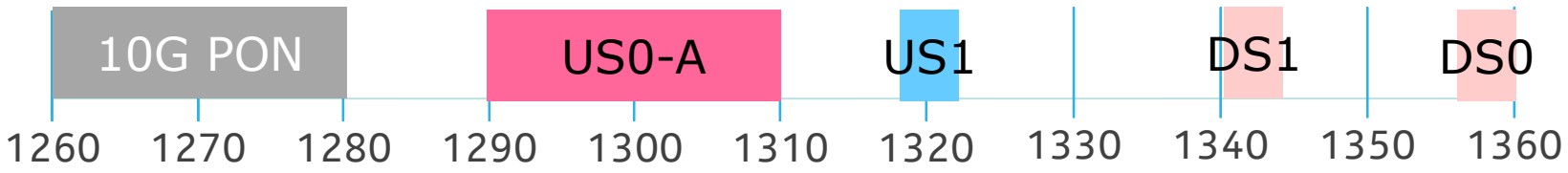
- Option 1



- Option 2

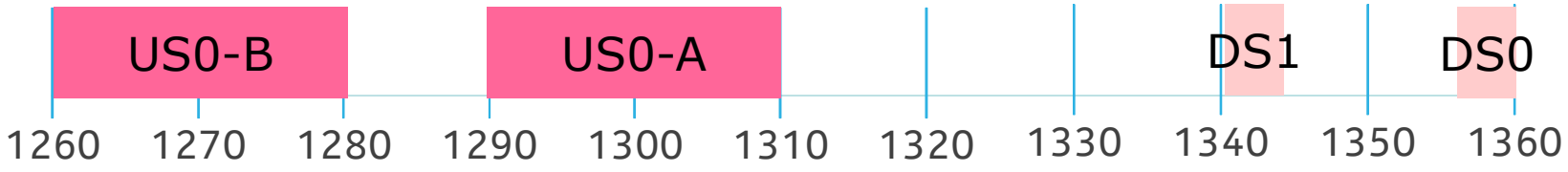
2x25G EPON

- Option 1

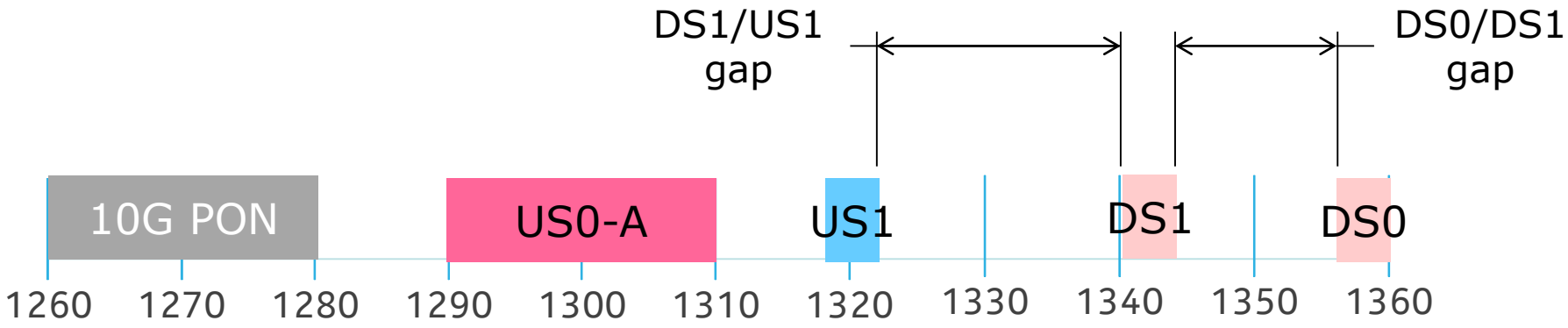


- Option 2a

- Option 2b (per liu_3ca_1_0118)



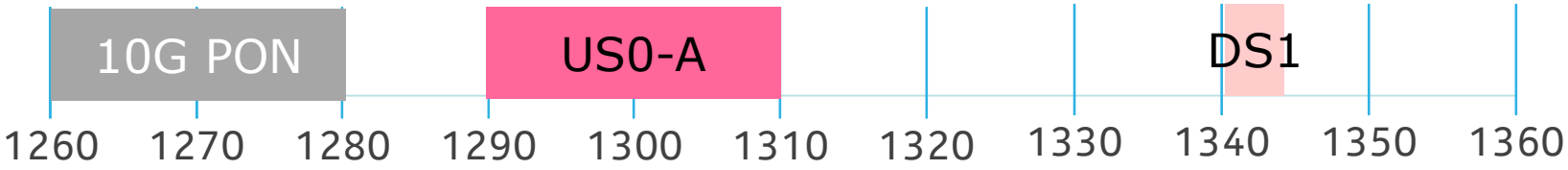
Check 2x25G filtering



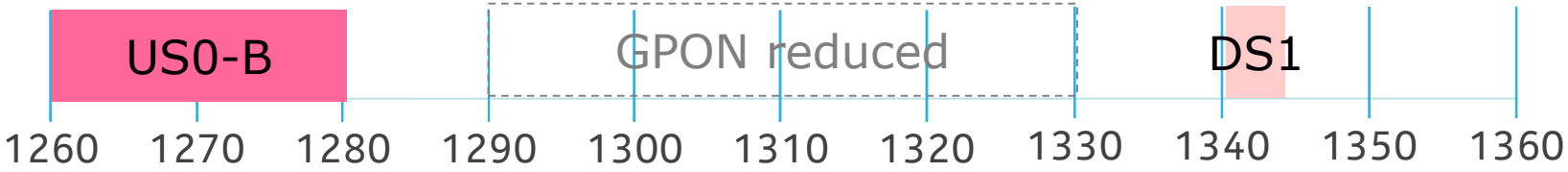
- DS1/US1 gap = 18 nm
- DS0/DS1 gap = 12 nm
- D. Umeda: For a 2x25G transceiver, 45 deg filters are not required and these gaps are enough for a narrower angle filter.

1x50G EPON

- Option 1



- Option 2



Summary: DS wavelength plan

- The two downstream wavelengths, DS0 and DS1, should have 4 nm wavelength tolerance, for high EML yield
- One DS wavelength, DS0, should be optimized for 25G EPON: minimize diplexer penalty in a low cost BOSA package
- The other DS wavelength, DS1, should be optimized for 1x50G EPON: minimize dispersion penalty. But still allow for possible low cost BOSA package.
- Proposed DS wavelength plan
  - DS0: 1358 +/- 2 nm
  - DS1: 1342 +/- 2 nm
- 25G EPON will use DS0. 2x25G EPON will use DS0 and DS1. 1x50G EPON will use DS1.

Motion #3

Adopt the following downstream wavelength plan:

- DS0: 1358 +/- 2 nm
- DS1: 1342 +/- 2 nm

25G-EPON shall use DS0, and update the draft accordingly.

Moved: Ed Harstead

Seconded: Glen Kramer

Technical motion >= 75%

For: 26

Against: 0

Abstain: 0