100G EPON Downstream wavelength plan

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Motivations

- O-band wavelength plan was accepted at Huntington Beach meeting, but wavelength plans for downstream and upstream are still unsettled
- There are some considerations in deciding the downstream wavelength plan in cost aspect of ONU transceiver implementation
  1. US/DS GAP for single λ BOSA
  2. Channel bandwidth for wavelength blocking filter
  3. TDP of 25 Gb/s downstream signal
  4. Etc…
- It is clear that 25G ONU transceiver of first channel will use single λ BOSA to ensure cost effectiveness and convenience
- Adoption of single λ BOSA imposes two constraints on the wavelength plan
  1. US/DS GAP should be larger than 50 nm
  2. The bandwidth for first λ should be over 10 nm
- It is not clear that ONU transceivers for 100G ONU will use BOSA or not.
- Question: Is it inevitable to apply the single λ BOSA constraints to the other channels?

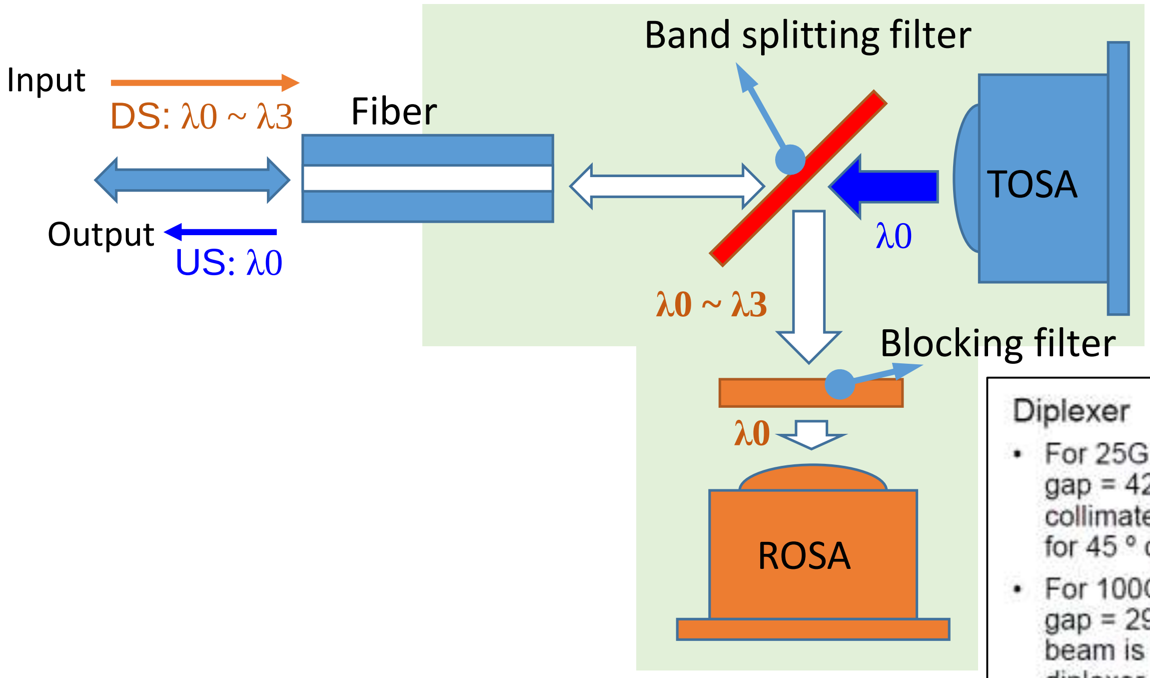
Single λ BOSA and US/DS GAP (ONU transceiver)

- Filter excess loss for focus beam coupling Bi-D, with margin

Assume US0 on 1290nm

	Item	45ns Gap (1335nm)	50nm Gap (1340nm)	60nm Gap (1350nm)	70nm Gap (1360nm)
DS	Filter excess loss to Rx [dB]	<0.5	<0.2	0	0
	Dispersion penalty increase [dB]	0 (reference)	0.1	0.2	0.3
US	Filter excess loss to Tx [dB]	<0.2	<0.1	0	0

Funada_3ca_1_0117.pdf



johnson_3ca_1a_0916.pdf

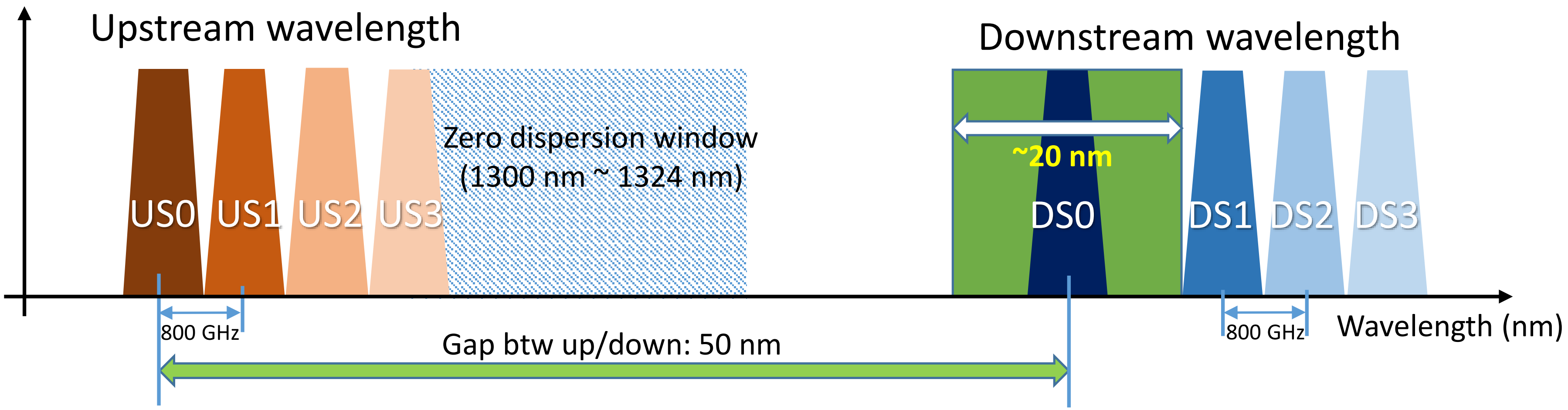
Diplexer

- For 25G ONU, DS0-US0 gap = 42.8nm. Use of non-collimated beam is difficult for 45 ° diplexer.
- For 100G ONU, DS0-US3 gap = 29.3nm. Collimated beam is needed for 45 ° diplexer.

25G Blocking filter

- Wide 1.6THz spacing between DS0 and DS1
- For ±1nm laser tolerance, guardband > 10nm.
- Compatible with low-cost focusing beam optics (liu_3ca_3_0716) for 0 ° blocking filter.

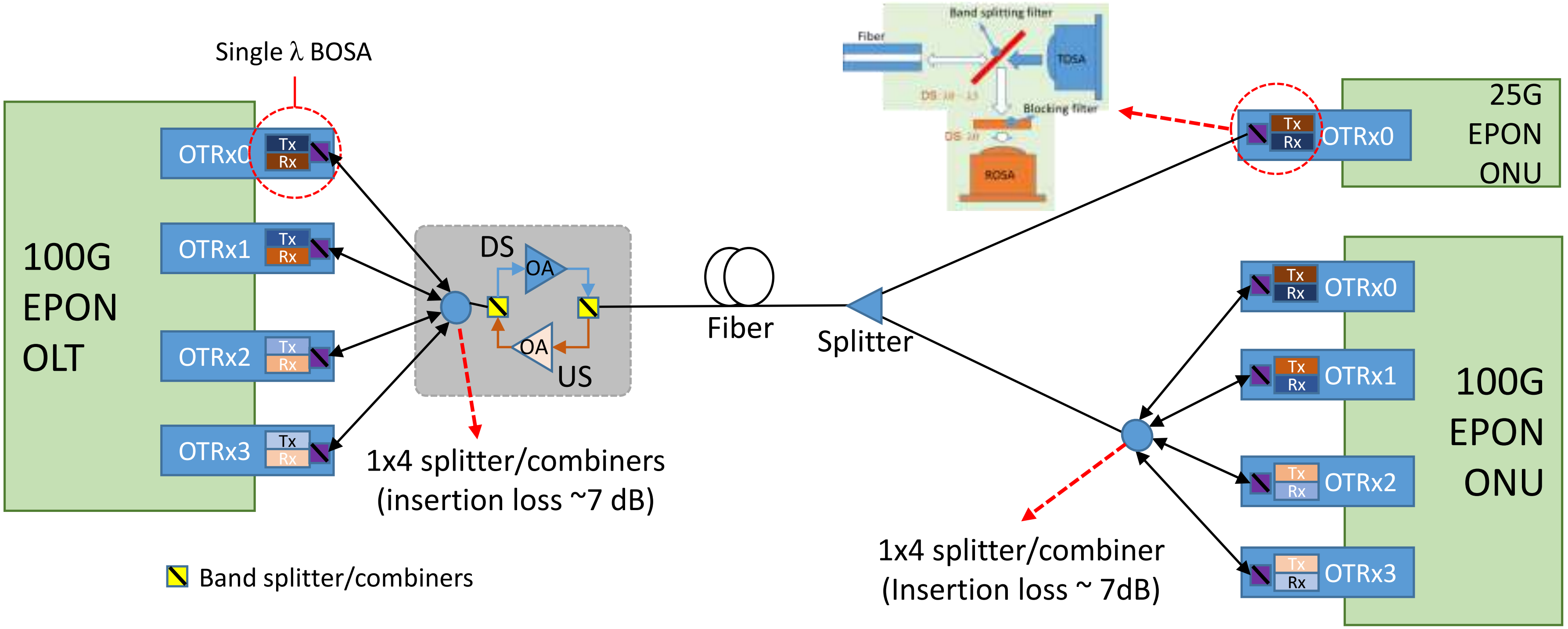
US/DS wavelength plan I



	Ch0	Ch1	Ch2	Ch3	Note
Upstream (nm)	1289.71	1294.16	1298.65	1303.16	800 GHz channel spacing
Downstream (nm)	1339.85	1351.94	1356.83	1361.76	800 GHz channel spacing for Ch1, Ch2, and Ch3
Gap (nm)	50.15	57.78	58.19	58.60	
TDP (dB)	0.5	0.7	0.7	0.8	umeda_3ca_1_0316

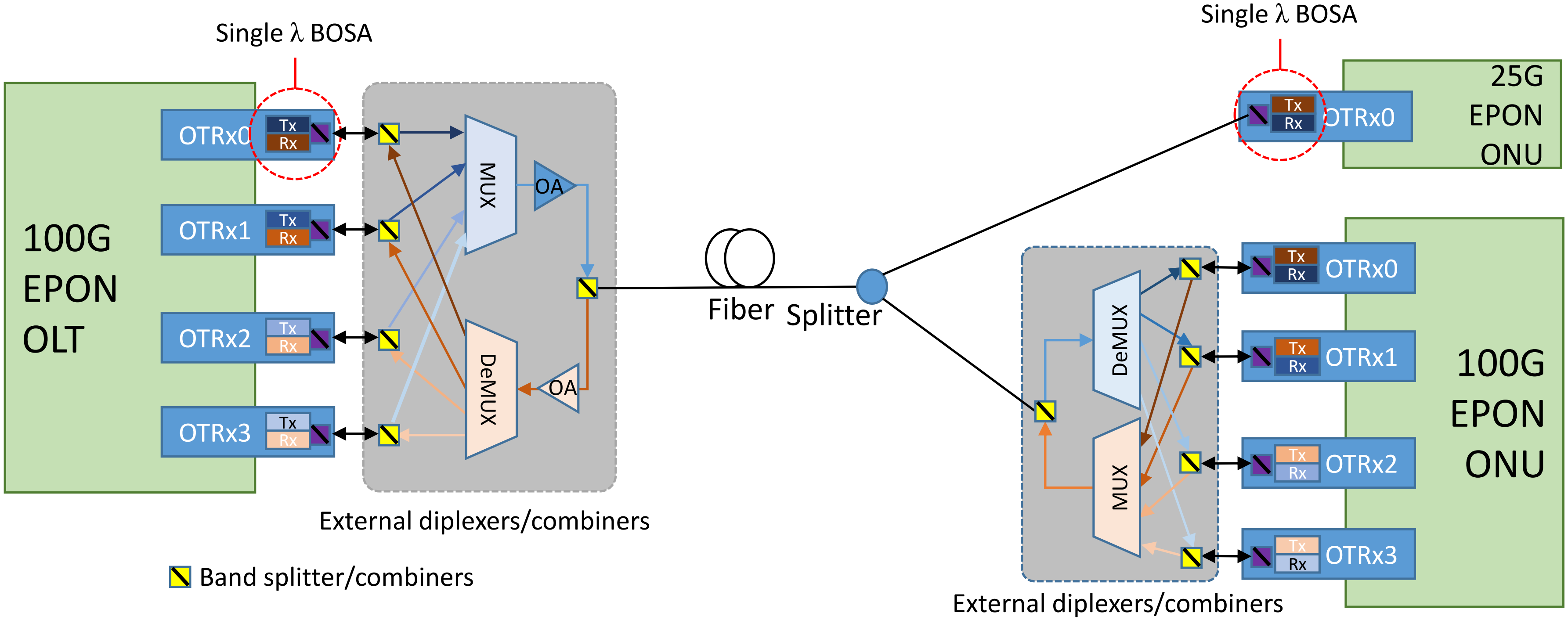
- All ONU transceivers use BOSAs with 50 nm GAP btw US and DS
- Bandwidth of the first DS signal(DS0) is 20 nm for relaxed ONU blocking filter
- The last DS signal wavelength is longer than the upper limit of O-band ("Original" O-band, 1260 nm to 1360 nm)

Case A1: All transceivers use single λ BOSA



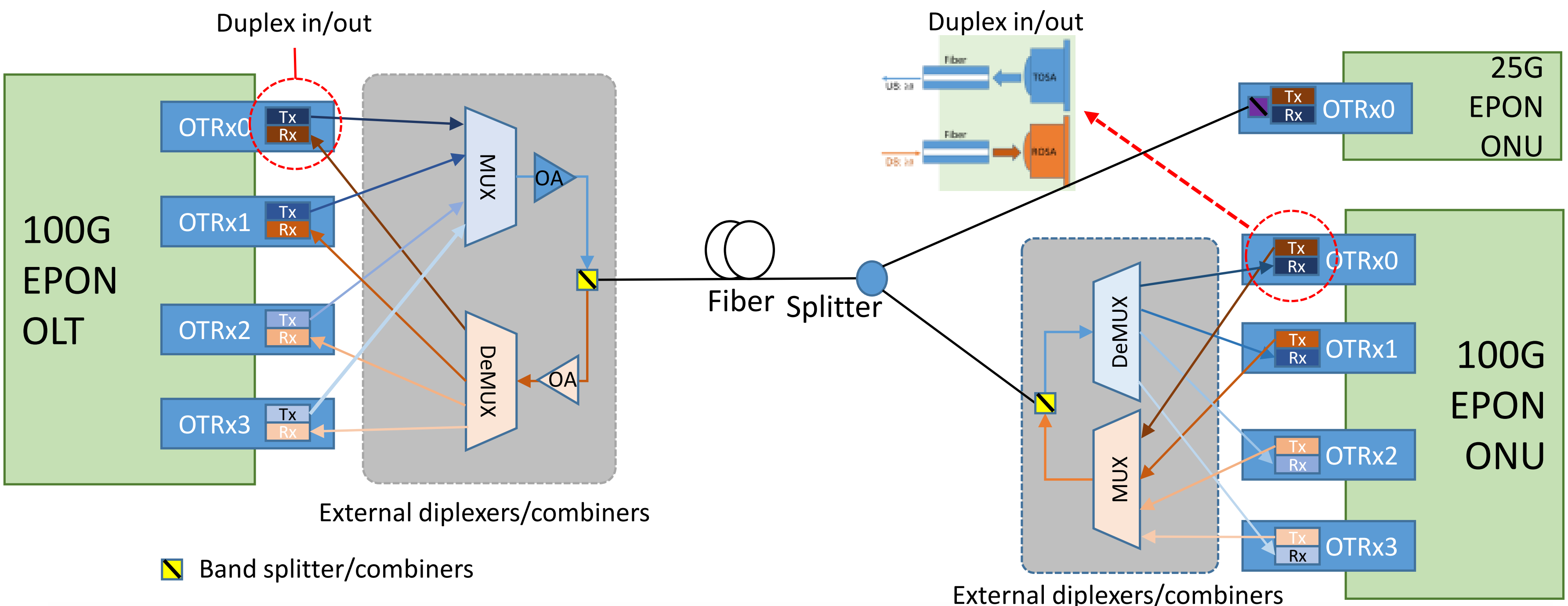
- All ONU transceivers are implemented with Single λ BOSAs
  - 1x4 splitters are used to multiplex and demultiplex DS and US signals
  - Extra insertion loss is ~ 14 dB from two 1x4 splitter/combiners
  - Optical amplifiers can compensate the extra loss but an launched downstream power/ channel to the fiber should be over + 11 dBm considering 29-dB link budget, 7-dB 1x4 combiner loss and -24.2 dBm of ONU receiver sensitivity

Case A2: All transceiver use single λ BOSA



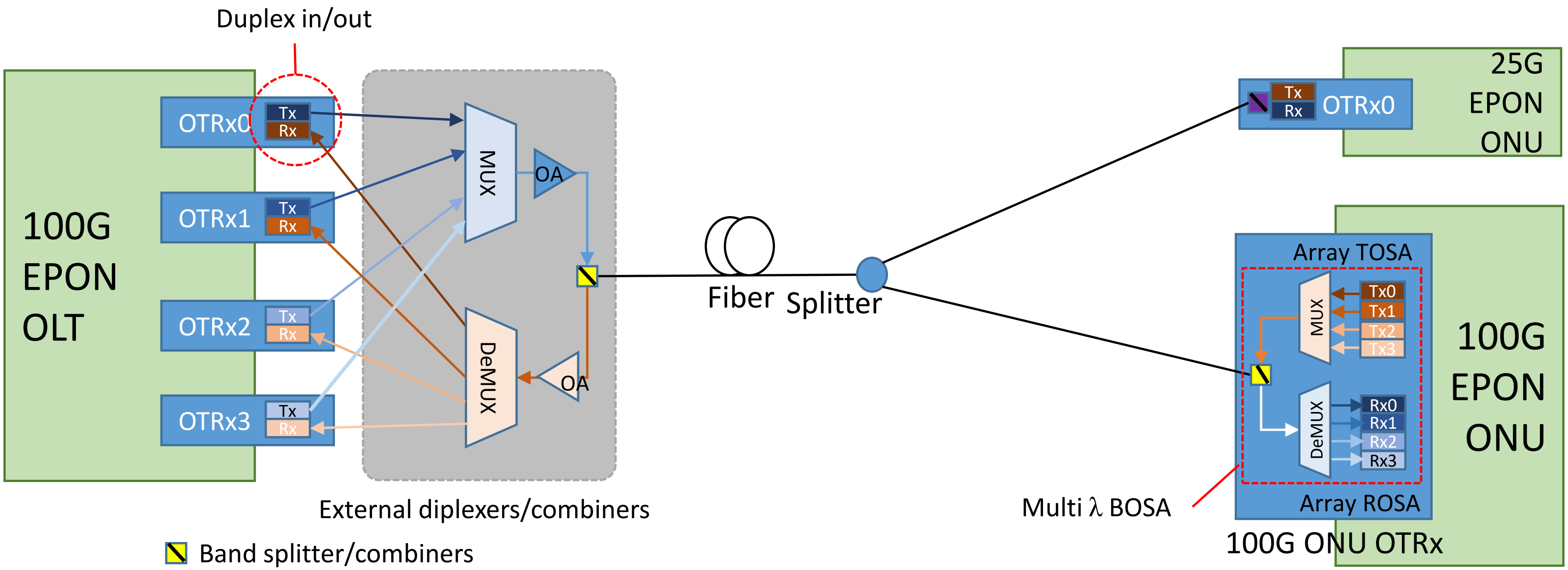
- All ONU transceivers are implemented with Single λ BOSAs
  - ➢ External band splitter/combiners are needed to separate downstream and upstream signal after each transceiver at both OLT and ONU
  - ➢ This will make the BOSA's role unclear

Case B1: 25G ONU transceiver uses single λ BOSA



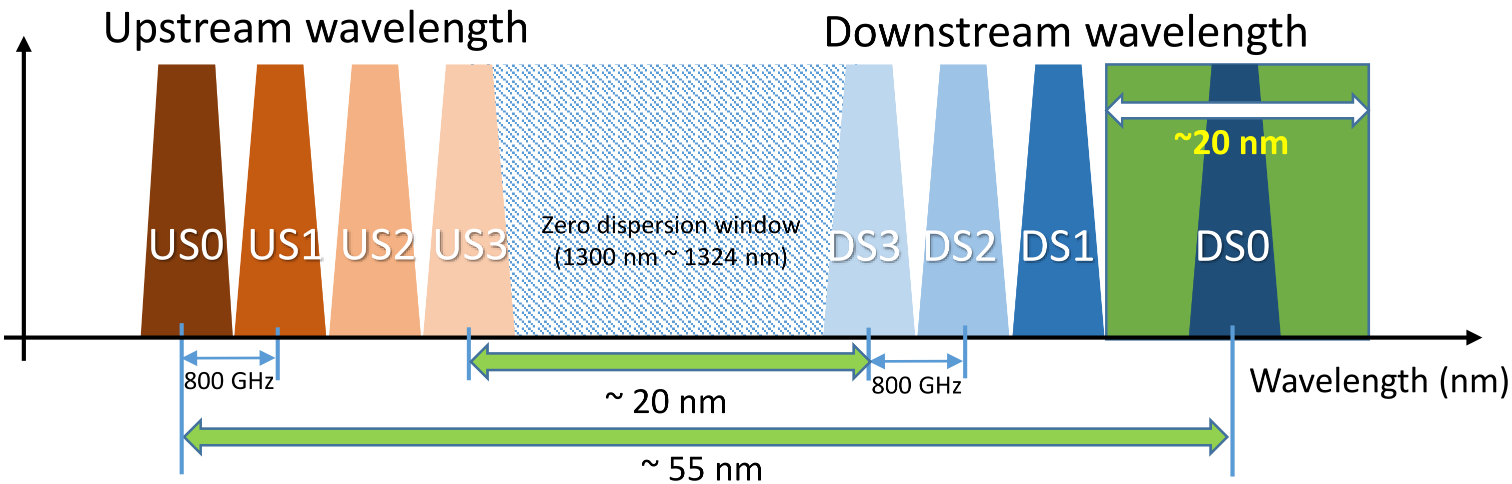
- 25G ONU transceiver uses a single λ BOSA
- Each 25G ONU transceiver for 100G ONU uses duplex in/out configuration rather than BOSA configuration in order to reduce redundant band splitters/combiners and insertion loss
- The external band splitters are implemented by a thin film filter and optical collimators. So, GAP can be relaxed from 50 nm to 20 nm

Case B2: 100G ONU transceiver uses multi λ BOSA



- 25G ONU transceiver uses a single λ BOSA
- 100G ONU transceiver use multi λ BOSA to simplify PMD configuration
- It is the simplest implementation case, but array optical / electrical components are required
- The external band splitters are implemented by a thin film filter and optical collimators. So, GAP can be relaxed from 50 nm to 20 nm

US/DS wavelength plan II for case B1 and B2



	Ch0	Ch1	Ch2	Ch3	Note
Upstream (nm)	1289.71	1294.16	1298.65	1303.16	800 GHz channel spacing
Downstream (nm)	1344.36	1332.41	1327.69	1323.00	800 GHz channel spacing for Ch1, Ch2, and Ch3
Gap	54.65	38.25	29.04	19.84	
TDP (dB)	0.6	0.4	0.4	0.3	umeda_3ca_1_0316

- The first downstream channel (DS0) has 20-nm channel bandwidth for relaxed 25G ONU blocking filter and maximum GAP is 55 nm between DS0 and US0 which will minimize Rx excess loss (ref. Funada_3ca_1_0117.pdf)
- Minimum GAP is set to 20 nm between DS3 and US3
- This plan will minimize TDPs of 25 Gb/s downstream signals

Conclusions

- Wavelength plans are discussed as considerable implementation scenarios of transceivers for 25G ONU and 100G ONU
- If all 25G ONU transceivers use BOSA then redundant optical components will be required and also extra loss will be added
- To reduce redundancy, it seems that transceivers for 100G ONU do not need to use single λ BOSA
  - ➢ Duplex configuration is simpler than BOSA configuration in transceiver implementation
- Wavelength plan II will be better than wavelength plan I in terms of TDP