25G/50G/100G EPON wavelength plan: if all wavelengths in O-band

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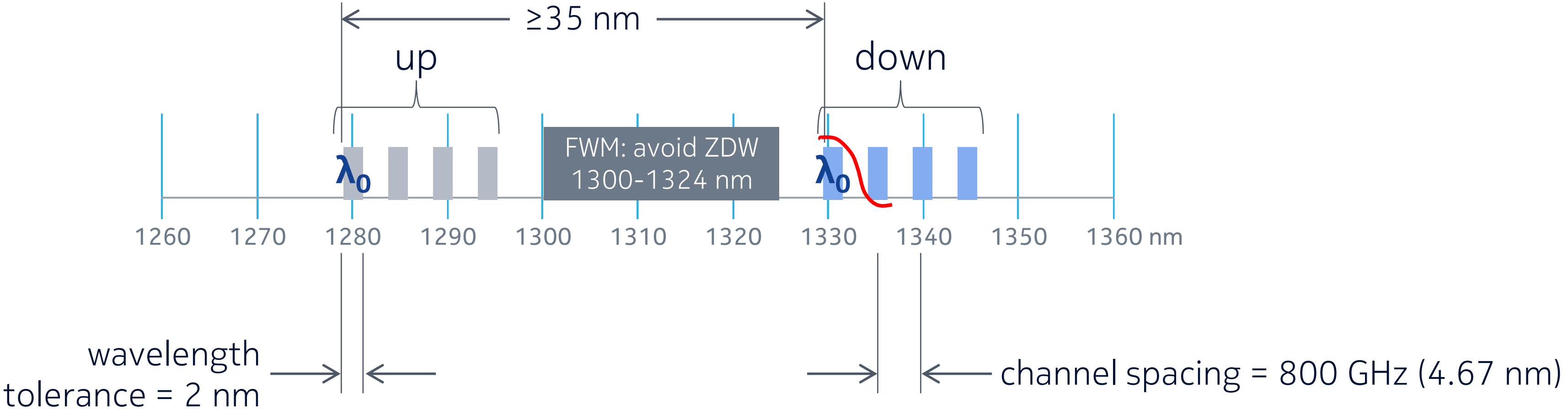
Avoiding the FWM impairment if all wavelengths are in the O-band

- The simplest design rule to avoid FWM: avoid the zero dispersion wavelength window, 1300-1324 nm.
- One wavelength can be in 1300-1324 nm, but only if it is guaranteed that the fiber ZDW is not in the center of two wavelengths (i.e. use wider/unequal spacing).
- References:
  - johnson_3ca_1_0716
  - van_veen_3ca_1_0716

- Note: satisfying these constraints may make it more difficult for the important DML option for the 25G OLT, since 1310 nm is out of scope.
- DML dispersion penalty (20 km):
  - liu_3ca_3_0516: 2 dB @1320 nm
  - tanaka_3ca_1_0516: 1.5 dB @1330 nm
  - houtsma_3ca_1_0716: 1.65 @1330 nm (1.15 dB for 10 km)

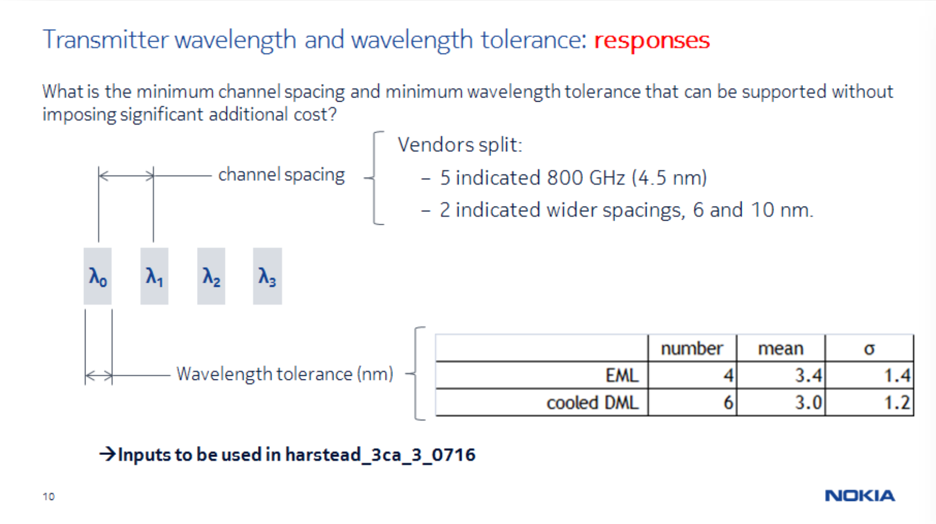
Option 1: 1+3 based on 100G Ethernet 800 GHz CS



However, optical vendor input indicates potential cost impacts

Cost view on channel spacing and wavelength tolerance

From harstead_3ca_1_0716:



Transmitter wavelength and wavelength tolerance: responses

What is the minimum channel spacing and minimum wavelength tolerance that can be supported without imposing significant additional cost?

channel spacing

Vendors split:

- 5 indicated 800 GHz (4.5 nm)
- 2 indicated wider spacings, 6 and 10 nm.

λ_0 λ_1 λ_2 λ_3

Wavelength tolerance (nm)

	number	mean	σ
EML	4	3.4	1.4
cooled DML	6	3.0	1.2

→Inputs to be used in harstead_3ca_3_0716

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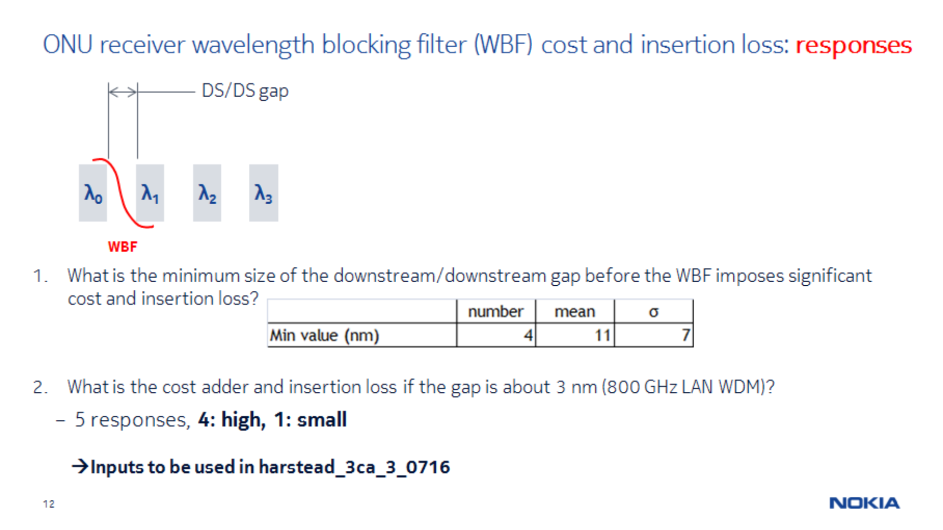

ONU receiver wavelength blocking filter (WBF) cost and insertion loss: responses

1. What is the minimum size of the downstream/downstream gap before the WBF imposes significant cost and insertion loss?

	number	mean	σ
Min value (nm)	4	11	7

2. What is the cost adder and insertion loss if the gap is about 3 nm (800 GHz LAN WDM)?
   - 5 responses, **4: high, 1: small**

→Inputs to be used in harstead_3ca_3_0716

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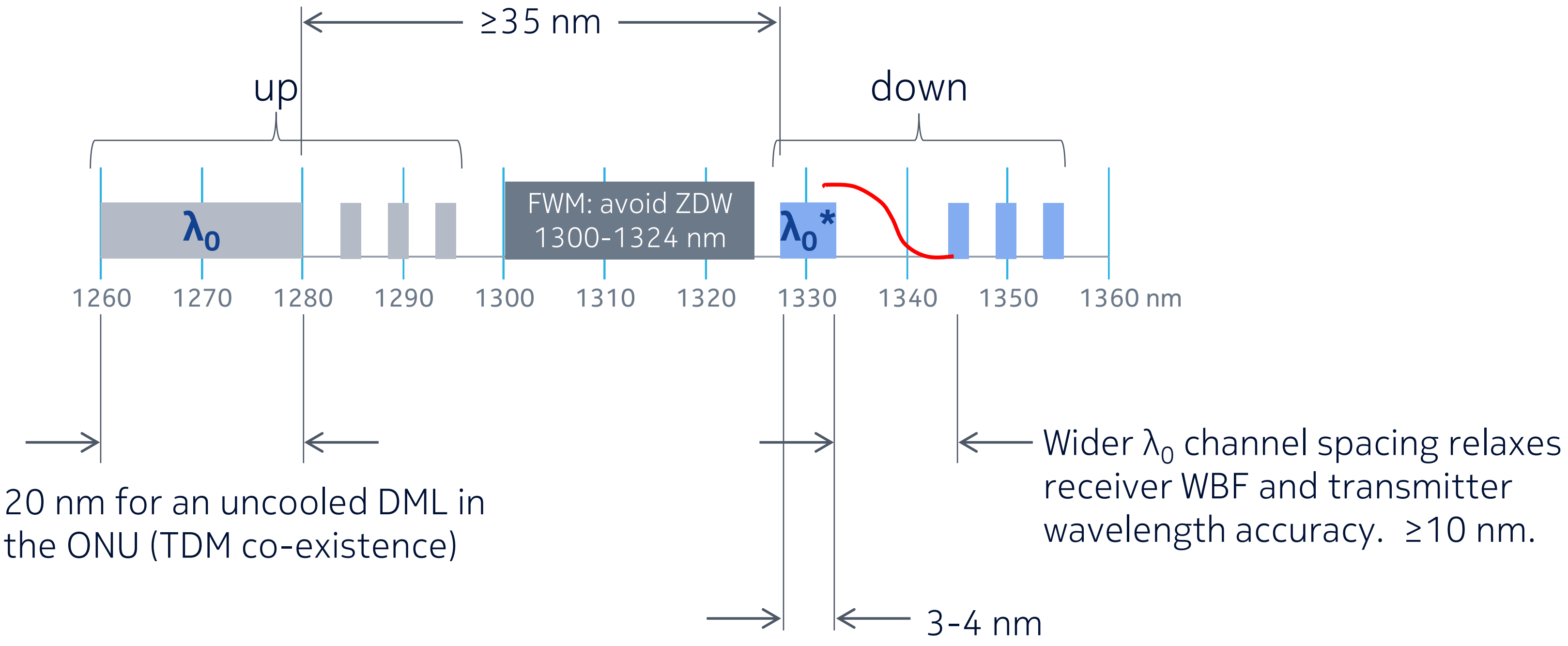
Option 2: 1+3 based on 100G Ethernet 800 GHz CS, but accommodating low cost 25G EPON



*downstream λ_0 (only) might be OK in upper end of ZDW zone, with this unequal/wider spacing.

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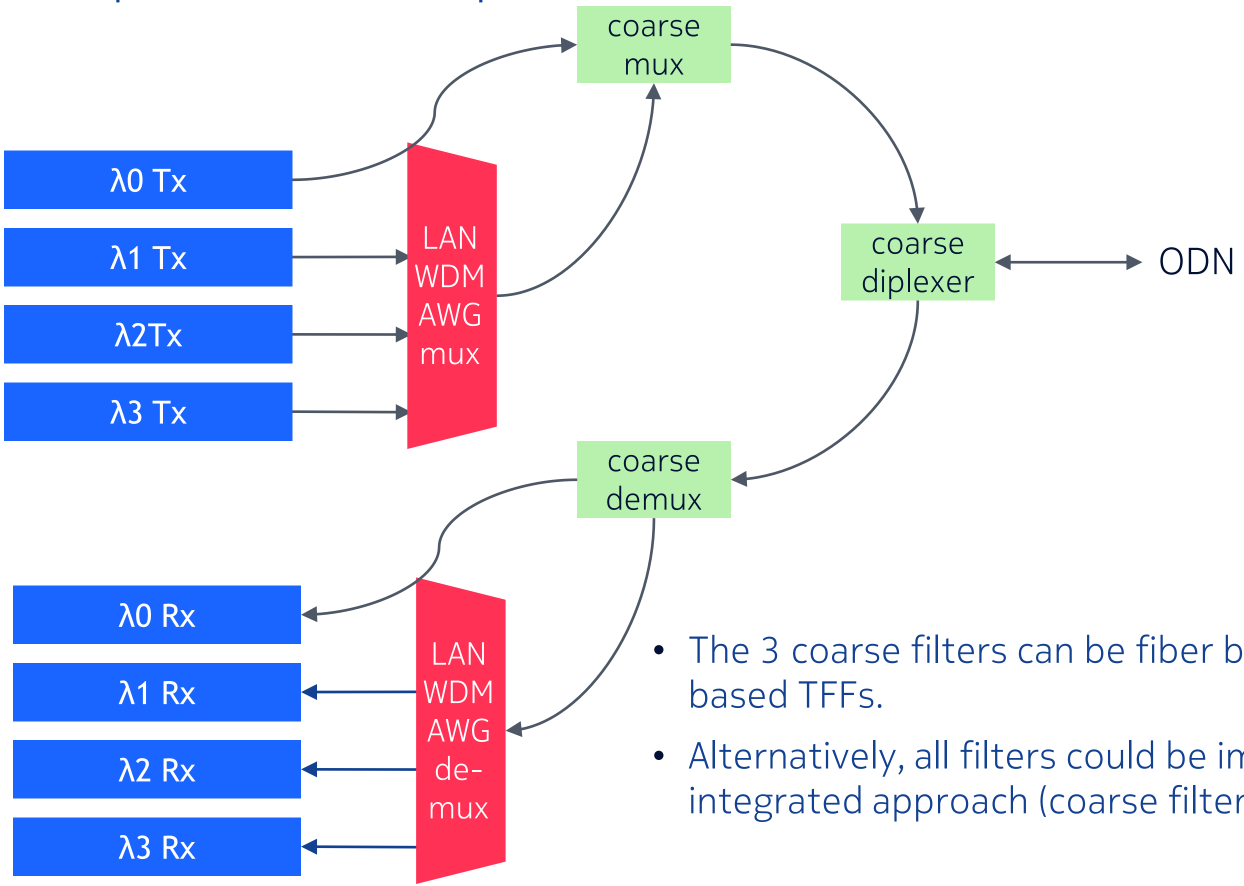
Option 2: possible filter implementation



- The 3 coarse filters can be fiber based or free-space-based TFFs.
- Alternatively, all filters could be implemented in a fully integrated approach (coarse filters as MZIs.)

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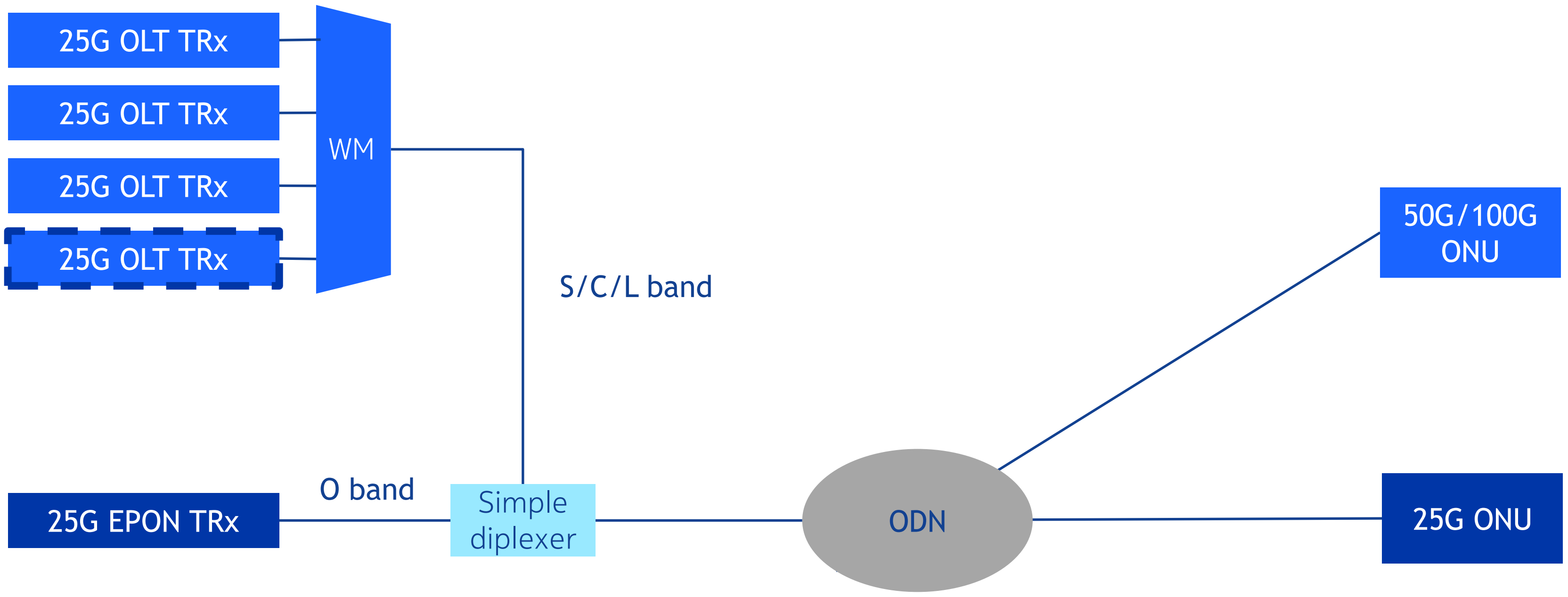
Now consider Option “0”: 50G/100G wavelengths in S/C/L band (1+3 or 1+4)

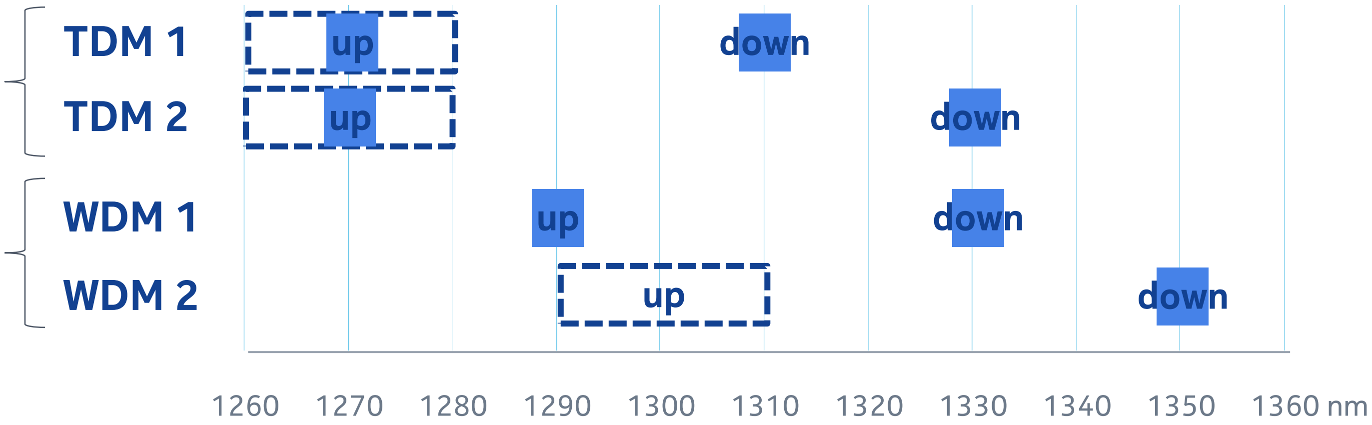


Option "0" allows for the most flexibility to optimize 25G EPON

Cost optimized 25G EPON wavelength plans: (from harstead_3ca_2a_0516, updated)

TDM co-existence with 10G EPON

WDM co-existence with 10G EPON



- 1+3 option 1 allows none of these
- 1+3 option 2 only allows option TDM 2

Comparing the options

Option	Impacts on 25G EPON			Impacts on 50/100G EPON	
	Filter and transmitter costs	Allows for uncooled DML in ONU.	Avoids FWM. Can use +/- 1310 nm (1).	Simple filters	dispersion compensation required
1+3 option1	high	no	no	yes	no
1+3 option2	medium	yes (TDM co-existence only)	no	no	no
option 0	none	yes	yes	yes	**maybe(2)**

Notes:
1. Makes DML option more viable
2. For 10 km, S/C wavelengths would not require dispersion compensation.

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Conclusion

- Putting all wavelengths in the O-band will introduce complexity and inevitably push some costs onto the 1st gen 25G EPON.
- Option “0”, putting the 2nd , 3rd, 4th (and 5th) wavelengths in the S/C/L band, allows for decoupling and cost optimizing both 25G EPON and 50/100G EPON

backup

Why the S/C/L bands make sense for 50G/100G EPON

- Keeping 50G/100G EPON λs out of the O-band will allow for cost optimization of 25G EPON
- Avoid FWM impairments
- Lower fiber loss
- 50G/100G EPON will need optical amplifiers. The C/L band allows for the EDFA option.
- More dispersion, but dispersion compensation will probably be affordable. And maybe not required if only 10 km must be supported (if in S/C bands).
- Re-use of NG-PON2 wavelengths might be considered
- There is more room for additional channels, if desired.
- For operators who care, there will be an option for coexistence with GPON and GEPON
- The 50G/100G EPON time-to-market requirement will be later. There will be industry activity in the C-band for 25 Gbaud lasers by the time 50/100G is required (e.g. inter-datacenter Inphi DWDM already today)