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25G/50G/100G EPON wavelength plan comparisons

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Straw Poll # 1

The 802.3ca standard shall specify wavelengths for 25G, 50G, and 100G systems in O-Band.

Yes:	15
No:	0
Not enough information:	9

Those voting "Not enough information" in Straw Poll #1 suggested the following information is needed to make a decision.

1) Exact (detailed) wavelength plan including support for coexistence (TDM or WDM).
2) Full cost comparison between all O-Band and other solutions.
3) More consensuses in presentations.
4) Dispersion compensation analysis of all solutions.
5) Full power budget for full 100G system (including mux losses) and what is needed to close the gap.

Wavelength Plan Inventory as of 7/27/16

	A	B	C	D	E	F	G
ds0	O	O	O	S/C/L	O	O	
ds1	O	O	S/C/L	S/C/L	S/C/L	L	
ds2	O	O	S/C/L	S/C/L	S/C/L	L	
ds3	O	O	S/C/L	S/C/L	S/C/L	L	
ds4	none	O or none	S/C/L or none	none	none	L	
us0	O	O	O	O	O	O	
us1	O	O	S/C/L	O	O	C	
us2	O	O	S/C/L	O	O	C	
us3	O	O	S/C/L	O	O	C	
us4	none	O or none	S/C/L or none	none	none	C	
author	JJ+FE+YG #1	EH #1	EH#2	JJ	DL	ED	

kramer_3ca_5_0716.pdf

Note: of the 6 plan options in contribution liu_3ca_1_0916.pdf ,only plans recommended in its Summary slide are considered

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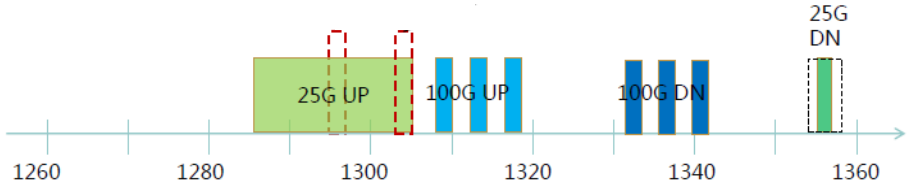
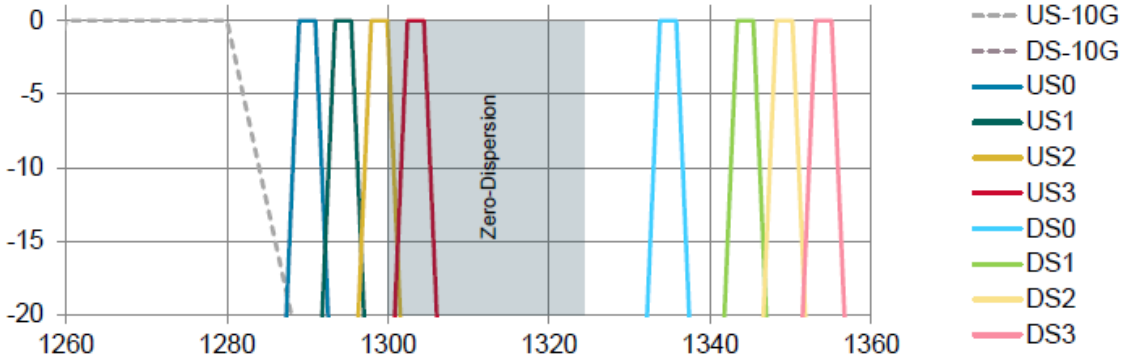
Plans A/B: All O-band

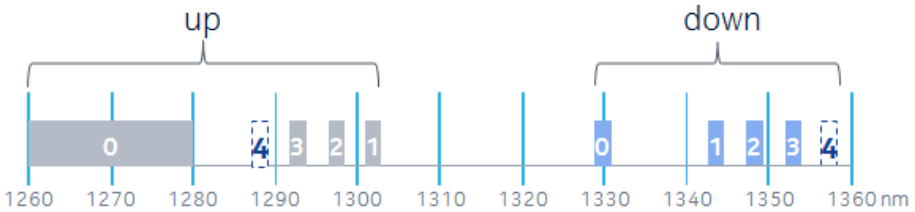
Plan A, Option 1
liu_3ca_1_0916.pdf

Plan A
johnson_3ca_1_0916.pdf

Plan B
harstead_3ca_2_0916.pdf







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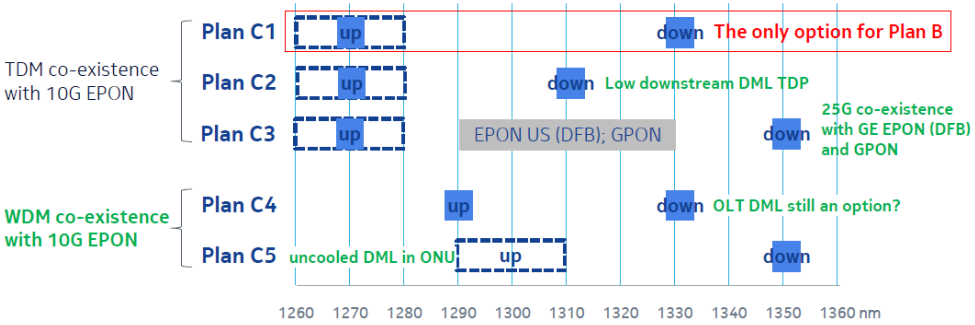
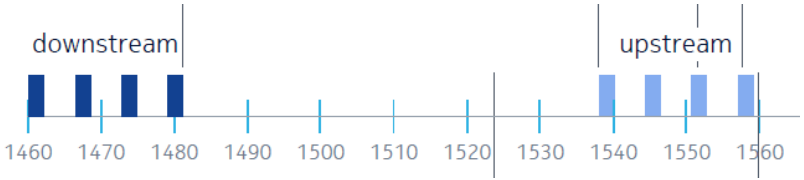
Plan C: 25G in O-band, 100G in S/C-band

Plan B
harstead_3ca_3_0916.pdf





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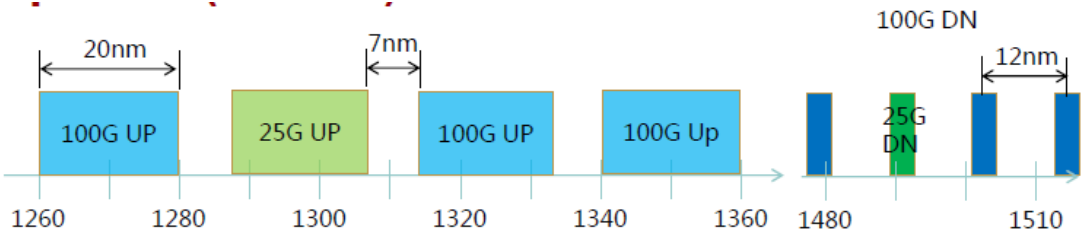
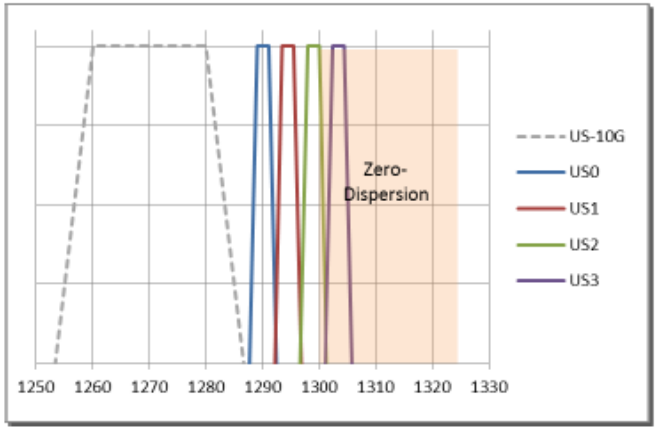
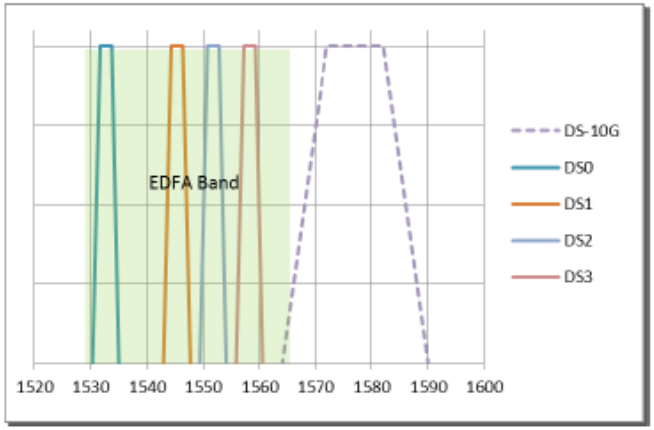
Plan D: US in O-band, DS in S/C-band

Plan D, option 3
liu_3ca_1_0916.pdf



Plan D
johnson_3ca_2_0916.pdf





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Comparison: all proposed plans

Simple scoring: ✓= 1; ✗= -1

Option	Bands	Co-existence with 10G EPON	Impacts on 25G EPON				Impacts on 100G EPON				
			Leverages DC O-band laser tech.	Low cost ONU laser	WBF (DS0/DS1 gap)	Dispersion compensation?	Leverages DC O-band laser tech	Filters: uniform CS and width	SOA: narrow passband, spectrum	EDFA option	Dispersion compensation ?
Plan A, option 1	All O-band	WDM	✓yes	✓yes, uncooled DML	✓≥10 nm	✓no	✓✓DS&US	no	no	no	✓no
Plan A	All O-band	WDM	✓yes	no, cooled , 2 nm width	8 nm (can increase?)	✓no	✓✓DS&US	✓yes	✓yes	no	✓no
Plan B	All O-band	TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	✓✓DS&US	1+3: no ✓1+4: yes	1+3: no ✓1+4: yes	no	✓no
Plan C	25G in O, 100G in S/C	WDM or TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	no	✓yes	✓yes	✓US	for >10 km
Plan D, option 3	US in O, DS in S	start WDM, then TDM	no	✓yes , uncooled DML	✓≥10 nm	for >13 km	✓US	✓yes	no	no	for >10 km ✗? duplex TRx
Plan D	US in O, DS in C	WDM	no	no, cooled , 2 nm width	8 nm (can increase?)	for >10 km	✓US	✓yes	✓yes	✓DS	for >10 km ✗? duplex TRx
Plan F	25G in O, 100G in S/L	?	✓yes	?	?	✓no	no	✓yes	✓yes	✓✓US and DS	✗? for >8 km

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Comparison: View if conservative on FWM

Simple scoring: ✓= 1; ✗= -1

Option	Bands	Co-existence with 10G EPON	Impacts on 25G EPON				Impacts on 100G EPON				
			Leverages DC O-band laser tech.	Low cost ONU laser	WBF (DS0/DS1 gap)	Dispersion compensation?	Leverages DC O-band laser tech	Filters: uniform CS and width	SOA: narrow passband, spectrum	EDFA option	Dispersion compensation ?
Plan A	All O-band	WDM	✓yes	no, cooled , 2 nm width	8 nm (can increase?)	✓no	✓✓DS&US	✓yes	✓yes	no	✓no
Plan B	All O-band	TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	✓✓DS&US	1+3: no ✓1+4: yes	1+3: no ✓1+4: yes	no	✓no
Plan C	25G in O, 100G in S/C	WDM or TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	no	✓yes	✓yes	✓US	for >10 km
Plan D	US in O, DS in C	WDM	no	no, cooled , 2 nm width	8 nm (can increase?)	for >10 km	✓US	✓yes	✓yes	✓DS	for >10 km ✗? duplex TRx
Plan F	25G in O, 100G in S/L	?	✓yes	?	?	✓no	no	✓yes	✓yes	✓✓US and DS	✗? for >8 km

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Comparison: view if 10 km reach

Simple scoring: ✓= 1; ✗= -1

Option	Bands	Co-existence with 10G EPON	Impacts on 25G EPON				Impacts on 100G EPON				
			Leverages DC O-band laser tech.	Low cost ONU laser	WBF (DS0/DS1 gap)	Dispersion compensation?	Leverages DC O-band laser tech	Filters: uniform CS and width	SOA: narrow passband, spectrum	EDFA option	Dispersion compensation ?
Plan A, option 1	All O-band	WDM	✓yes	✓yes, uncooled DML	✓≥10 nm	✓no	✓✓DS&US	no	no	no	✓no
Plan A	All O-band	WDM	✓yes	no, cooled , 2 nm width	8 nm (can increase?)	✓no	✓✓DS&US	✓yes	✓yes	no	✓no
Plan B	All O-band	TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	✓✓DS&US	1+3: no ✓1+4: yes	1+3: no ✓1+4: yes	no	✓no
Plan C	25G in O, 100G in S/C	WDM or TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	no	✓yes	✓yes	✓US	✓no
Plan D, option 3	US in O, DS in S	start WDM, then TDM	no	✓yes , uncooled DML	✓≥10 nm	✓no	✓US	✓yes	no	no	✓no
Plan D	US in O, DS in C	WDM	no	no, cooled , 2 nm width	8 nm (can increase?)	✓no	✓US	✓yes	✓yes	✓DS	✓no
Plan F	25G in O, 100G in S/L	?	✓yes	?	?	✓no	no	✓yes	✓yes	✓✓US and DS	✗? for >8 km

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Comparison: View if conservative on FWM, and 10 km reach

Simple scoring: ✓= 1; ✗= -1

Option	Bands	Co-existence with 10G EPON	Impacts on 25G EPON				Impacts on 100G EPON				
			Leverages DC O-band laser tech.	Low cost ONU laser	WBF (DS0/DS1 gap)	Dispersion compensation?	Leverages DC O-band laser tech	Filters: uniform CS and width	SOA: narrow passband, spectrum	EDFA option	Dispersion compensation ?
Plan A	All O-band	WDM	✓yes	no, cooled , 2 nm width	8 nm (can increase?)	✓no	✓✓DS&US	✓yes	✓yes	no	✓no
Plan B	All O-band	TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	✓✓DS&US	1+3: no ✓1+4: yes	1+3: no ✓1+4: yes	no	✓no
Plan C	25G in O, 100G in S/C	WDM or TDM	✓yes	✓yes , uncooled DML	✓≥10 nm	✓no	no	✓yes	✓yes	✓US	✓no
Plan D	US in O, DS in C	WDM	no	no, cooled , 2 nm width	8 nm (can increase?)	✓no	✓US	✓yes	✓yes	✓DS	✓no
Plan F	25G in O, 100G in S/L	?	✓yes	?	?	✓no	no	✓yes	✓yes	✓✓US and DS	✗? for >8 km

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Conclusions

Plans which optimize costs across 25G and 100G EPON: **simple comparison**

Plan	1+3	1+4
All Plans considered	A-1, A, B	B
Plans conservative on FWM	A, B	B
Plans if 10 km reach	A-1, A, B	B
Plans conservative on FWM and if 10 km reach	A, B	B

Plans A-1, A, and B are “tied” in 1+3. A-1 and B put more emphasis on 25G, while A puts more on 100G.

This is a simple comparison. A more sophisticated and quantitative comparison must be done before making a decision.


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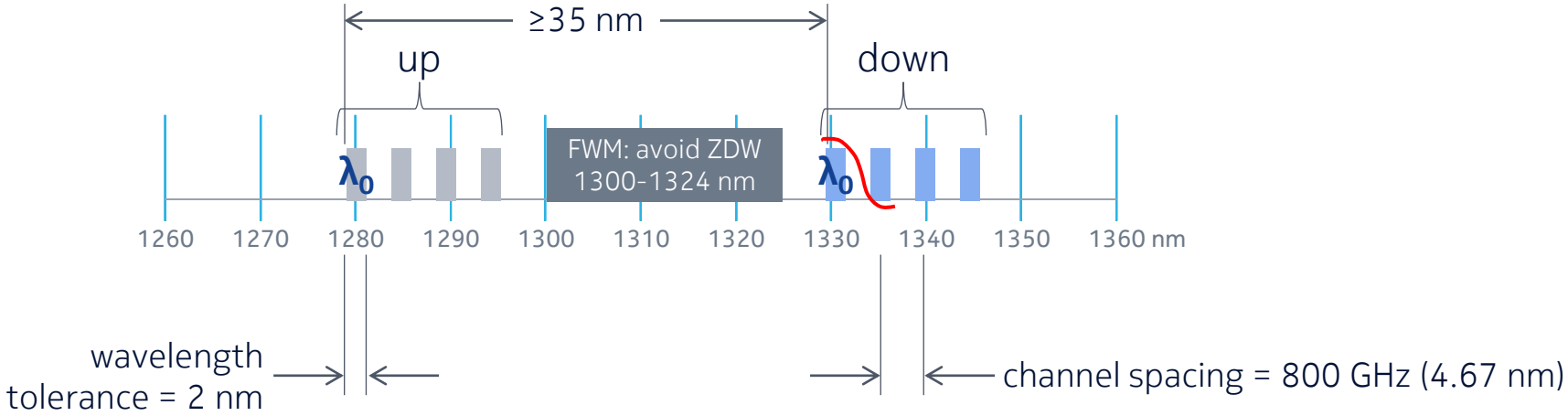
backup

Plan based exclusively on 800 GHz CS



However, optical vendor input indicates potential cost impacts

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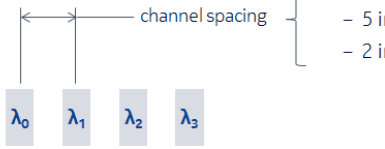
Cost view on channel spacing and wavelength tolerance

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?



Vendors split:
- 5 indicated 800 GHz (4.5 nm)
- 2 indicated wider spacings, 6 and 10 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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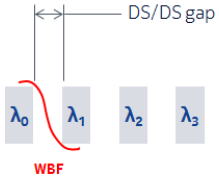
ONU receiver wavelength blocking filter (WBF) cost and insertion loss: responses



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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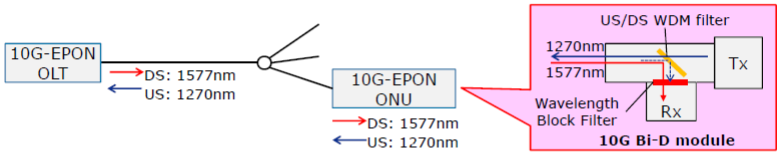
DS/US guard band to avoid collimation cost

funada_3ca_1_0316

Wavelength allocation
-US/DS gap, Rx guard band -

- Existing access network and ONU Bi-D module structure.



- Large part of system cost comes from ONU, keep familiar and economical Bi-D structure for NG-EPON ONU as far as possible.

Light coupling scheme of Bi-D	US/DS Gap	Rx guar band
Non-collimated light	>35nm	>10nm
Collimated light	>20nm	>5nm

This brings us efficient wavelength usage

liu_3ca_2_0516

	DS/US	PD guard band
Focus beam	40nm	10nm
Collimated beam	20nm	5nm

Cost comparison

		Delta Size	Cost
10/10G EPON ONU module (note 1)	Focus beam	-	X
	Collimated beam	Length : ~6mm more Width: ~ 1mm more	1.3X(note 1)

Note: The delta cost (absolute value)of collimated beam structure is roundly same for 10G and 25G (bit rate independent). The cost difference ratio in 25G depends on the cost of 25G optics.