Super-PON PMD Refinements

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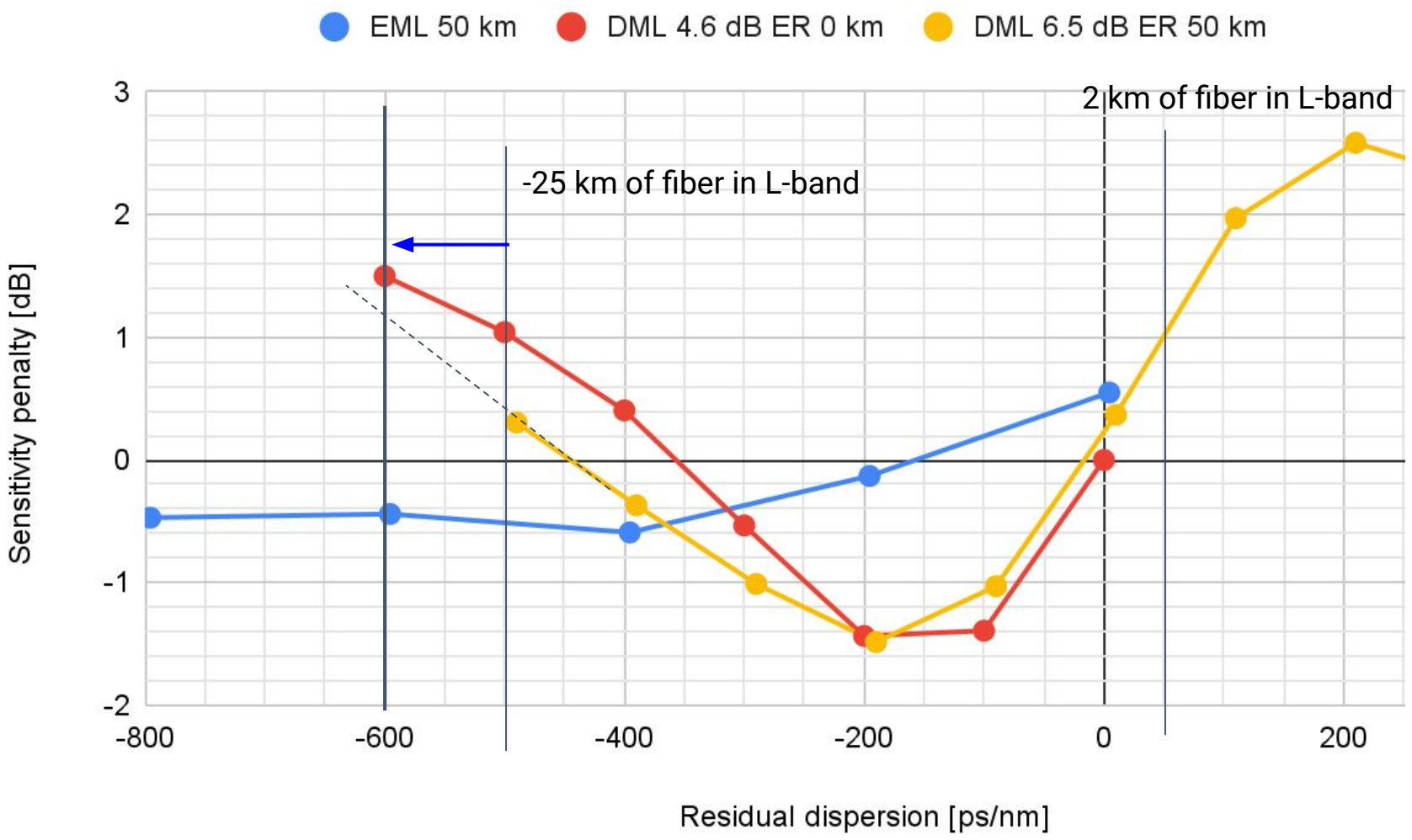
Google Fiber

Last meeting

- Suggested operation between -500 ps/nm to 0 ps/nm residual dispersion for ONTs
- This amounts to 25 km assuming a CD value of 20 ps/nm/km
- For two DCMs, this is not enough range
  - No margin for fiber variation
  - Cannot define an overlapping link length
- We need to expand the window slightly to allow for more flexible link design

From last meeting



- Ignore 4.6 dB ER DML line to expand range
- DML at 6.5 dB ER allows for operation down to -600 ps/nm
- Can adjust the laser to be more negatively chirped for better residual dispersion performance
- 650 ps/nm is 32.5 km

ONU transmit

Current parameters (current draft)	New parameters (proposal)	Current values (in draft)		
Parameter	**Parameter**	**10GBASE-SP1-Ux**	**10/2.5GBASE-SP1-Ux**	**Unit**
Signaling speed (range)	Signaling speed (range)	10.3125 ± 100 ppm	2.578125 ± 100 ppm	GBd
Channel center frequencies	Channel center frequencies	L-band 1 (upstream)		THz
Maximum spectral excursion (after turn-on time)	Maximum spectral excursion (after turn-on time)	± 15		GHz
Maximum mean channel output power	Maximum mean channel output power	8	4.5	dBm
Minimum mean channel output power	Minimum mean channel output power	see equation xx	-0.5	dBm
Minimum side-mode suppression ratio (SMSR)	Minimum side-mode suppression ratio (SMSR)	38		dBm
Minimum channel extinction ratio	Minimum channel extinction ratio	see equation xx	6	dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}		UI
Maximum transmitter (residual) dispersion OSNR penalty -400 to +200 ps/nm residual CD -400 to +1000 ps/nm residual CD	Maximum transmitter (residual) dispersion OSNR penalty -600 to +50 ps/nm residual CD -600 to +1000 ps/nm residual CD	2.0	1.0	dB
Average launch power of OFF transmitter (max)	Average launch power of OFF transmitter (max)	-45		dBm
$RIN_{15}OMA$ (max)	$RIN_{15}OMA$ (max)	-128		dB/Hz
Turn-on time (max)	Turn-on time (max)	512		ns
Turn-off time (max)	Turn-off time (max)	512		ns

Correction on previously presented OSNR calc

- **Previous** US OSNR calculation
  - OSNR = 58 + P(fiber input) - NF - L(span) - log(#spans)
    OSNR = 58 + 4 - 6 - 41 - log(1)
    OSNR = 15 dB
- **Corrected** US OSNR calculation
  - OSNR = 58 + P(fiber input) - NF - L(span) - log(#spans)
    OSNR = 58 + 4 - 6 - 41 -1 -log(1)
    OSNR = 14 dB

Loss of the band-mux. This is not part of the link budget calculation but is between the ONU and the EDFA

OLT receive

	Current draft values		Updated values for next draft		
Parameter	**10GBASE-SP1-Dx**	**10/2.5GBASE-SP1-Dx**	**10GBASE-SP1-Dx**	**10/2.5GBASE-SP1-Dx**	**Unit**
Signaling speed (range)	10.3125 ± 100 ppm	2.578125 ± 100 ppm	10.3125 ± 100 ppm	2.578125 ± 100 ppm	GBd
Channel frequency range	187.600 to 189.092		187.600 to 189.092		THz
Bit error ratio (max)	10^{-2}		10^{-2}		
Maximum mean input power	-6		-6		dBm
Minimum mean input power	-20.6	-25.1	-20.6	-25.1	dBm
Minimum OSNR	15	10.5	14	9.5	dB (0.1 nm)
Receiver OSNR tolerance	12.9	8.4	12.9	8.4	dB (0.1 nm)
Receiver reflectance (max)	-12		-12		dB
Damage Threshold	-5		-5		dBm
Signal detect threshold (min)	-45		-45		dBm
Treceiver_settling (max)	800		800		ns

OLT transmit

Current parameters (current draft)	New parameters (proposal)	Current values (in draft)	
Parameter	**Parameter**	**10GBASE-SP1-Dx 10/2.5GBASE-SP1-Dx**	**Unit**
Signaling speed (range)	Signaling speed (range)	10.3125 ± 100 ppm	GBd
Channel center frequencies	Channel center frequencies	C-band 1 (downstream)	THz
Maximum spectral excursion	Maximum spectral excursion	± 15	GHz
Maximum mean channel output power	Maximum mean channel output power	1.5	dBm
Minimum mean channel output power	Minimum mean channel output power	-2.5	dBm
Minimum side-mode suppression ratio (SMSR)	Minimum side-mode suppression ratio (SMSR)	35	dB
Minimum channel extinction ratio	Minimum channel extinction ratio	8.2	dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}	UI
Transmitter and dispersion penalty (TDP) @ 0 to 1000 ps/nm residual CD	Transmitter and dispersion penalty (TDP) 0 to 900 ps/nm residual CD	1.0	dB
$RIN_{15}OMA$ (max)	$RIN_{15}OMA$ (max)	-120	dB/Hz
Average launch power of OFF transmitter (max)	Average launch power of OFF transmitter (max)	-39	dBm
Optical return loss tolerance (max)	Optical return loss tolerance (max)	15	dB

DS moved to C-band. Lower dispersion.

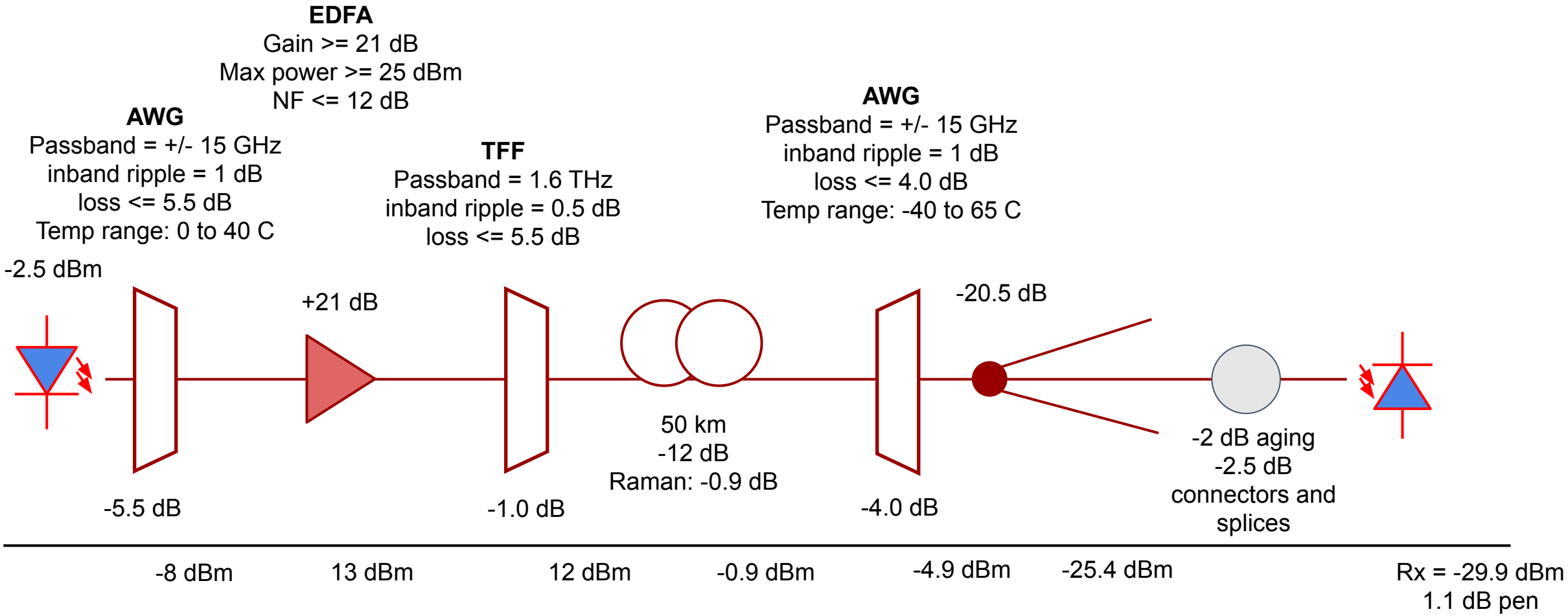
Black link: OLT to ONU

	Current values (in draft)	Proposed values	
Parameter	**10 Gb/s**	**10 Gb/s**	**Unit**
Clear link passband	±15	±15	GHz
Maximum ripple (within the clear link passband)	+2	+2	dB
Maximum (residual) chromatic dispersion	+1000	+900	ps/nm
Minimum (residual) chromatic dispersion	0	0	ps/nm
Minimum optical return loss at transmitter	+20	+20	dB
Maximum discrete reflectance between transmitter and receiver			dB
Maximum differential group delay	+12	+12	ps
Maximum inter-channel crosstalk		0.1	dB
Maximum optical path power penalty	+1	+1	dB
Maximum power excursion			

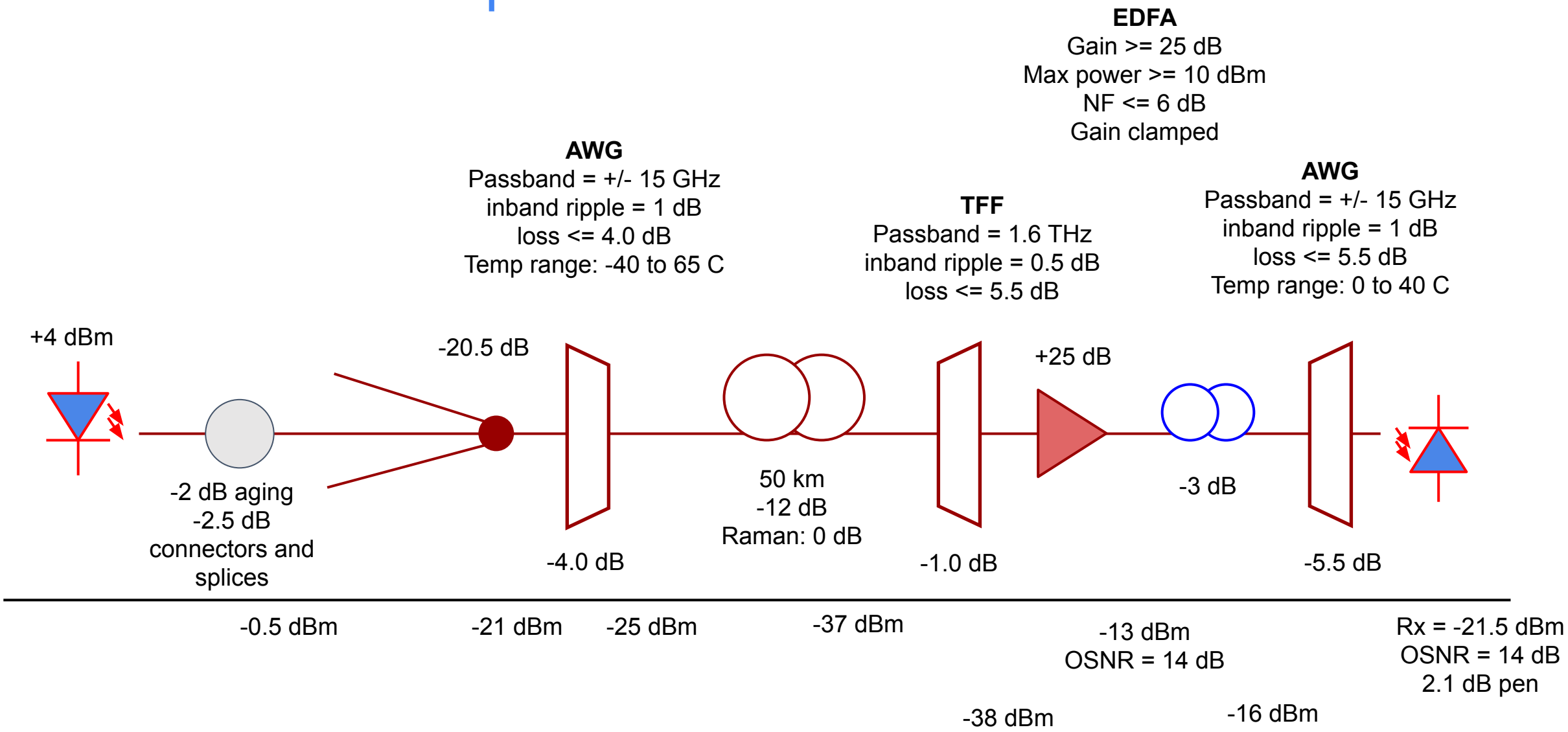
Black link: ONU to OLT

	Current values (in draft)		Proposed values		
Parameter	**10 Gb/s**	**2.5 Gb/s**	**10 Gb/s**	**2.5 Gb/s**	**Unit**
Clear link passband	±15				GHz
Maximum ripple (within the clear link passband)	+2				dB
Maximum (residual) chromatic dispersion	+200	+1000	+50	+1000	ps/nm
Minimum (residual) chromatic dispersion	-400	-400	-600	-600	ps/nm
Minimum optical return loss at transmitter	+20		+20		dB
Maximum discrete reflectance between transmitter and receiver					dB
Maximum differential group delay	+12		+12		ps
Maximum inter-channel crosstalk			0.1		dB
Maximum optical path OSNR penalty	2	1	2	1	dB
Maximum power excursion					dB

Informative - downstream



Informative - upstream



Informative - DCM values

- Assumption: L-band CD is 17 to 20 ps/nm/km
- 25 km to 50 km link
  - min CD = 373; max CD = 1000; difference = 627 ps/nm
  - Recommended DCM value = 970 ps/nm
- 0-30 km link
  - min CD = 0; max CD = 600; difference = 600 ps/nm
  - Recommended DCM value = 575 ps/nm

Summary

- Updated the residual dispersion parameters that transmitters need to be able to tolerate. Updated relevant PMD tables.
- Corrected the US OSNR calculation. Updated the PMD table.
- Updated the Black Link tables with residual dispersion expectations
- High level recommended values for the informative components of a 50 km black link

Thank you