Updates on Baseline Proposal for 800G-FR4 Objective

Guangcan Mi, Yu Tian, Ruoxu Wang
Huawei Technologies Co. Ltd

HUAWEI

Supporter

Introduction

- In November 2022, we proposed a set of power budget and baseline specifications for 200G/lane optical PMDs below 2km in mi_3df_01a_2211 . Since then
  - > Demonstration on 200G/lane PAM4 transmission reported in OFC and journals
  - > Basic structure of FEC chosen, with details left open for discussion . Motion 5 of March Plenary in 2023
  - > Bypass of some of the FEC features under discussion → bigger impact on the PSM objectives brown_3dj_optx_01b_230413
  - > Influence of AUI BER rate to optical PMD BER threshold was discussed he_3dj_optx_01a_230413
  - > Need of a stronger Reference receiver discussed rodes_3dj_optx_01_230413 and mi_3dj_optx_01_230427

- This contribution updates the power budget and baseline proposal for 800G-FR4 optical PMD.

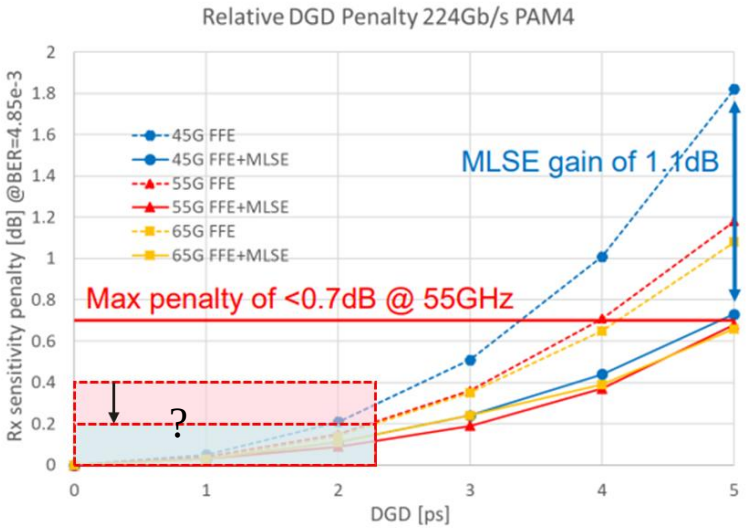
Considerations on DGD penalty

The DGD_max is calculated based on $DGD\_max = PMD\_max * sqrt(Lkm) * S$

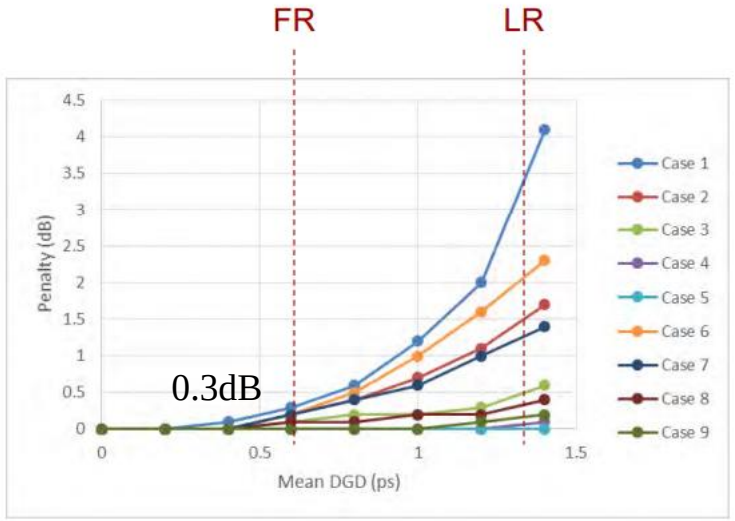
	PMD_Q	PMD_max	S	L(km)	DGD_max (ps)
100GBASE-FR 400GBASE-FR4	0.2	0.43	3.75	2	2.3
800G-DR4	0.2	0.45	3.75	0.5	1.14
800G-DR4-2 800G FR4	0.2	0.43	3.75	2	2.28→ 2.3ps

- In our 2022 November contribution, we suggested 0.4dB allocation for DGD penalty
- There is potential to save some from this allocation
  - If Stronger Rx equalization be used/adopted
  - Progress on 200G/lane Tx with 55GHz+ BW performance, e.g. OFC2023 M2D.3, ECOC2022 Th1E.4.
- Relies on more experimental Data or simulation based on actual device performances

Previous analysis regarding DGD penalty in 802.3df/dj



kuschnerov_3df_01b_221012



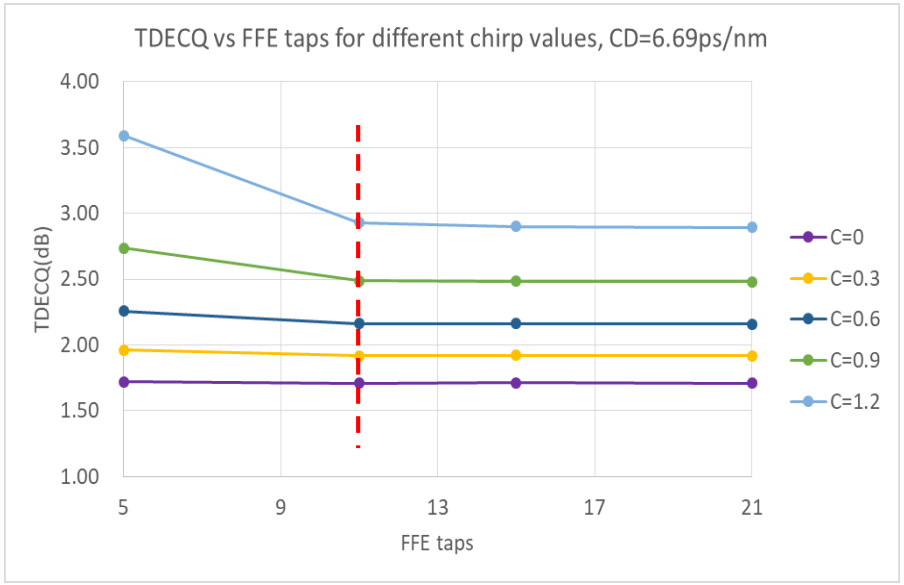
zhang_3df_01b_2207

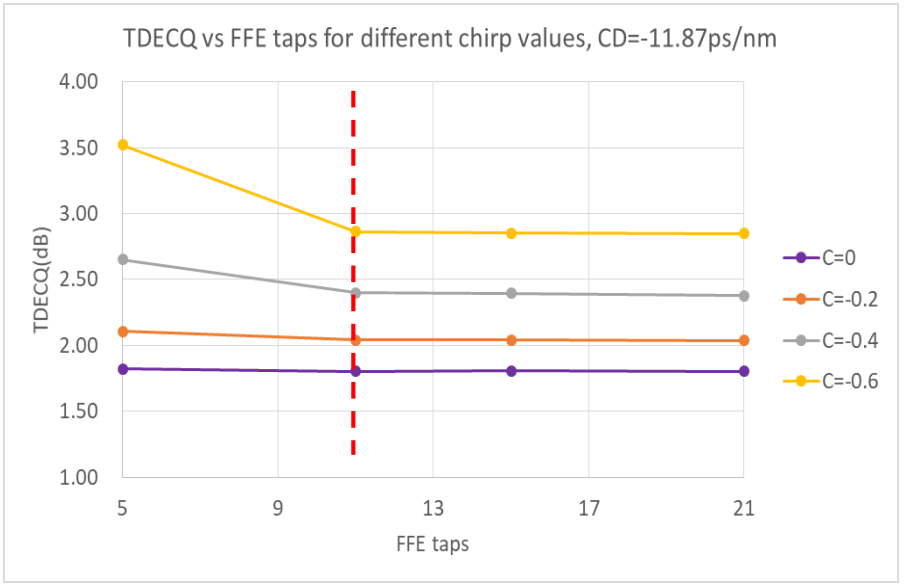
HUAWEI

Reference Receiver and TDECQ

As discussed in Mi_3dj_01_230427, the need of a stronger reference receiver was discussed

- x taps of FFE + advanced algorithm was suggested
- In this proposal Reference receiver left to be TBD
- Taking 11-tap FFE as a reference point to bound the TDECQ value from our simulation result.
- TDECQ_max set to 3.4dB





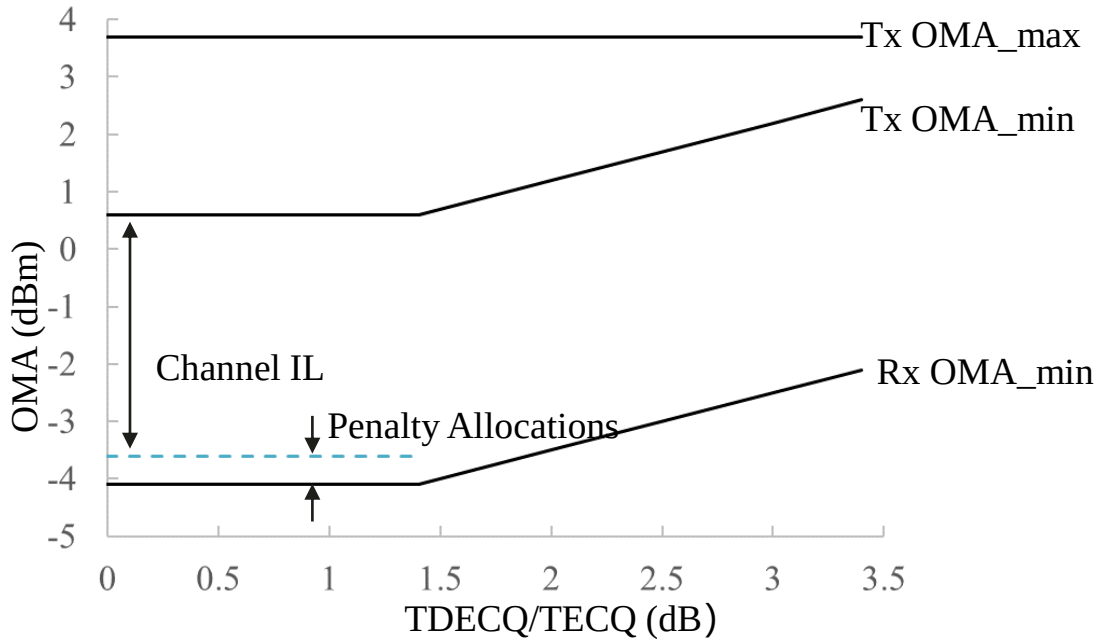
- Relatively ideal case, not considering impact of temperature, BW deterioration, jitter and etc.

HUAWEI

Updated power budget of the optical link

	800G-FR4
power budget	7.9
channel IL	4
maxim discrete reflectance	-35
allocation for penalties	0.7
maxim positive dispersion	6.6
min negative dispersion	-11.7
DGD_max	2.28
optical return loss(min)	25
TDECQ_max	3.4 ~~3.7~~

MPI Penalty	0.3
DGD Penalty	0.4



HUAWEI

Updated Transmitter and Receiver Baseline

		800G-FR4	
Description		Value	Unit
Signaling Rate, each lane(range)		113.4375 ±50ppm	GBd
Modulation Format		PAM4	-
Lane Wavelength(Range)		1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Average Launch Power, each lane(max)		4.9	dBm
Average Launch Power, each lane(m,in)		-2.4	dBm
Transmitter OMA_outer max		3.7	dB
Transmitter $OMA_{outer\ min}$	TDECQ<1.4dB	0.6	dBm
	1.4dB≤TDECQ≤3.4dB	-0.8+TDECQ	dBm
TDECQ(max)		3.4	dB
TECQ		Same as TDECQ	dB
|TDECQ-TECQ|		TBD	dB
Average launch power of OFF transmitter, each lane(max)		-16	dBm
Extionction Ratio (min)		3.5	dB
Transmitter Transition time		8	Ps
over/under-shoot(max)		TBD	%
RIN_xOMA^a		-139	dB/Hz
Optical Return loss tolerance(max)		17.1	dB
Transmitter reflectance(max)		-26	dB

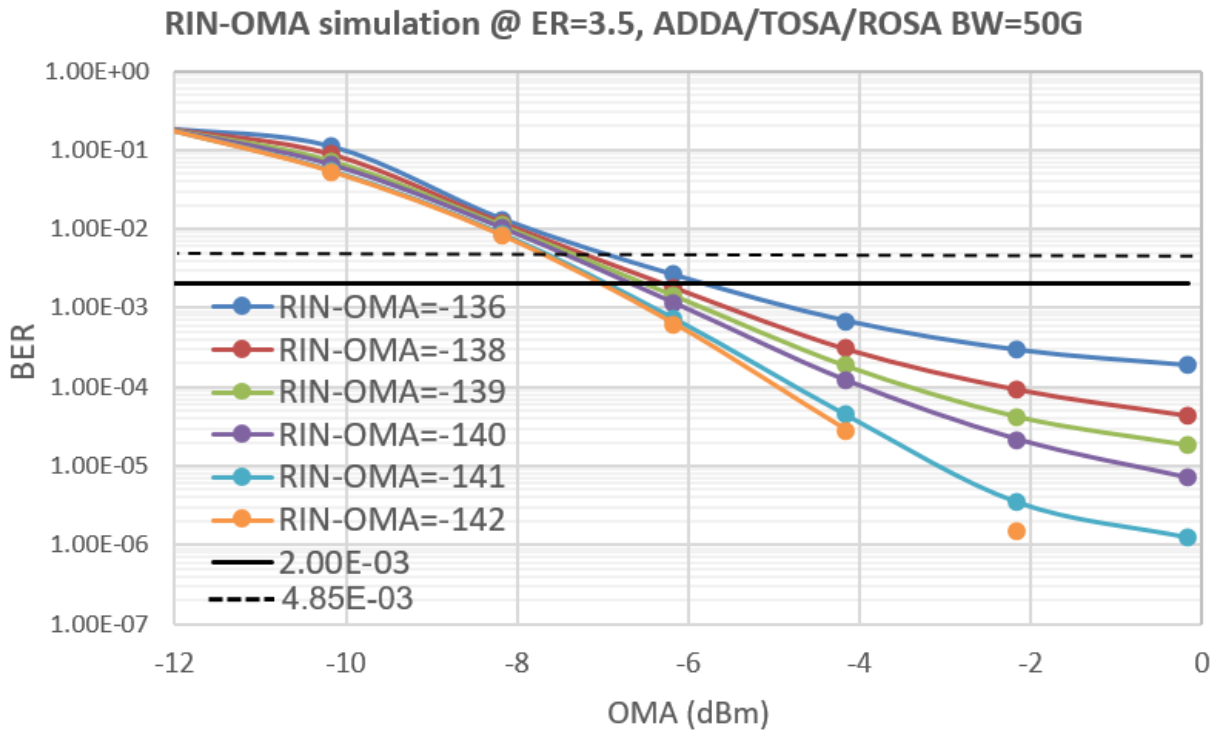
		800G-FR4	
Description		Value	Unit
Signaling Rate, each lane(range)		113.4375 ±50ppm	GBd
Modulation Format		PAM4	-
Lane Wavelength(Range)		1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Damage threshold, each lane		5.4	dB
Average receive Power, each lane(max)		4.9	dBm
Average receive Power, each lane(min)		-7.1	dBm
Receiver OMA_outer max		3.7	dB
Difference in receive power between any two lanes (OMAouter) (max)		TBD	dB
Receiver reflectance(max)		-26	dB
Reciever Sensitivity OMA_{outer}, each lane(max)	TECQ<1.4dB	-4.1	dBm
	1.4dB≤TECQ≤3.4dB	-5.5+TECQ	dBm
Stressed receiver sensitivity (OMA_{outer}), each lane(max)		TBD	dBm
Conditions of stressed receiver sensitivity(SECQ)		3.4	dB

[a]: x refers to the value of Optical return loss tolerance(max) of each column.
KP4 + Hamming(128,120) was assumed ; Reference receiver TBD

HUAWEI

Considerations on RIN_OMA

Preliminary simulation assumed
- Component BW of 50GHz
- BER limit 2e-3
- FFE equalizer



RIN_OMA has impact on both Receiver Sensitivity and the error floor.
We suggest to use -139dB/Hz RIN_OMA, considering
- It allows for two orders of magnitude protection of BER error floor from the BER limit
- It is achievable
  - Recent demonstrations on EML shown better performance than -139dB/Hz RIN_OMA
  - For laser + MZ modulator architecture, low RIN noise is achievable with high power DFB lasers.

HUAWEI

Summary

- The power budget and baseline proposal for 800G-FR4 was updated
  - > Reconsidering DGD Penalty
  - > Update reference receiver consideration and TDECQ_max
  - > Tx and Rx specification were shown based on CWDM wavelength plan
- PSM objectives (800G-DR4 and 800G-DR4-2) were not discussed in this contribution
  - > Its major application in DC requires low latency
  - > Details of FEC has note worthy impact on latency
  - > Very low dispersion could potentially loosen the requirement on Rx equalization
  - > Final decision on FEC and reference receiver will largely change the specification of these objectives
- Measurements on true devices are needed to build the specs!
  - > CWDM was proposed to be the objective, but achievability with sufficiently low penalty will require reconfirmation by testing
  - > Possibility of saving some power budget out of allocated penalties
  - > TBDs in the Tx and Rx spec table

Thank you.

把数字世界带入每个人、每个家庭、
每个组织，构建万物互联的智能世界。

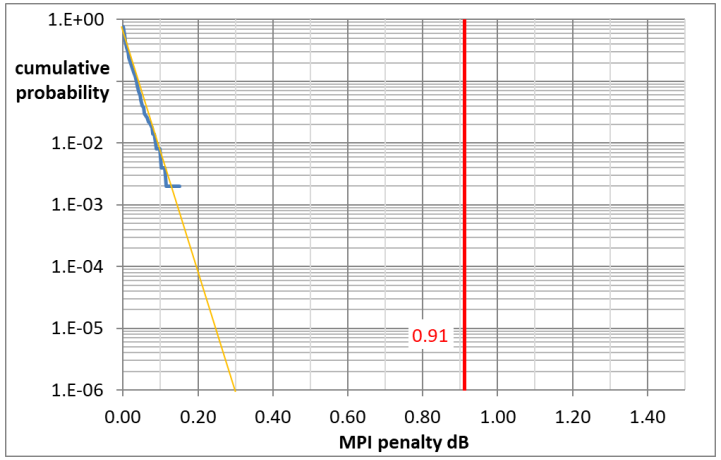
Bring digital to every person, home and organization for a fully connected, intelligent world.

Backup Slides

MPI penalty – 2km application

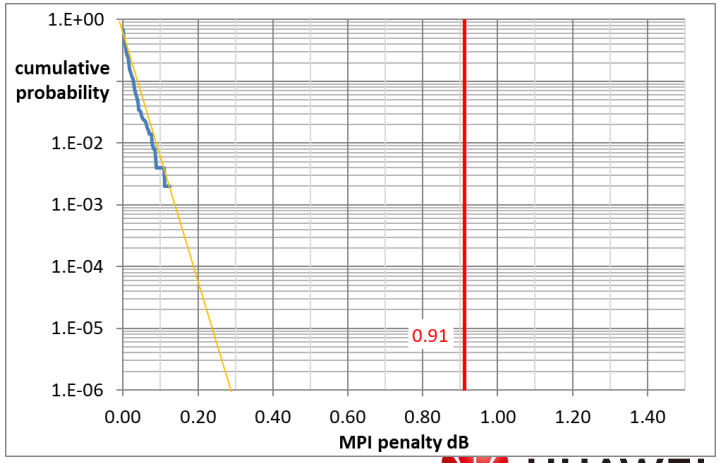
Random phase between reflectors, random selection of modulation levels
Polarization assumed aligned

					PAM-N N=										ER	dER	1/1-dER	inner/outer OMA	1
Baseline BER 2.0E-03	average phase= 3.106680048				4										3.5	0.447	1.8073	0.33	1
	PMD													PMD					
	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12							
	Rpmd	RconF	RconG	RconG	RconH	RconK	RconK	RconH	RconG	RconG	RconF	Rpmd		N value used to					
Reflection level inputs->	-26	-35	-55	-55	-55	-55	-35	-35	-55	-55	-35	-26		4					
	phase between int1-int2	phase between int2-int3	phase b int3-int4	phase b int4-int5	phase b int5-int6	phase betwe int6-int7	phase bet int7-int8	phase be int8-int9	phase between int9-int1	int10-in	int11-int12								



Random phase between reflectors, random selection of modulation levels
Polarization assumed aligned

					PAM-N N=										ER	dER	1/1-dER	inner/outer OMA	1
Baseline BER 4.9E-03	average phase= 3.118309958				4										3.5	0.447	1.8073	0.33	1
	PMD													PMD					
	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12							
	Rpmd	RconF	RconG	RconG	RconH	RconK	RconK	RconH	RconG	RconG	RconF	Rpmd		N value used to					
Reflection level inputs->	-26	-35	-55	-55	-55	-55	-35	-35	-55	-55	-35	-26		4					
	phase between int1-int2	phase between int2-int3	phase b int3-int4	phase b int4-int5	phase b int5-int6	phase betwe int6-int7	phase bet int7-int8	phase be int8-int9	phase between int9-int1	int10-in	int11-int12								

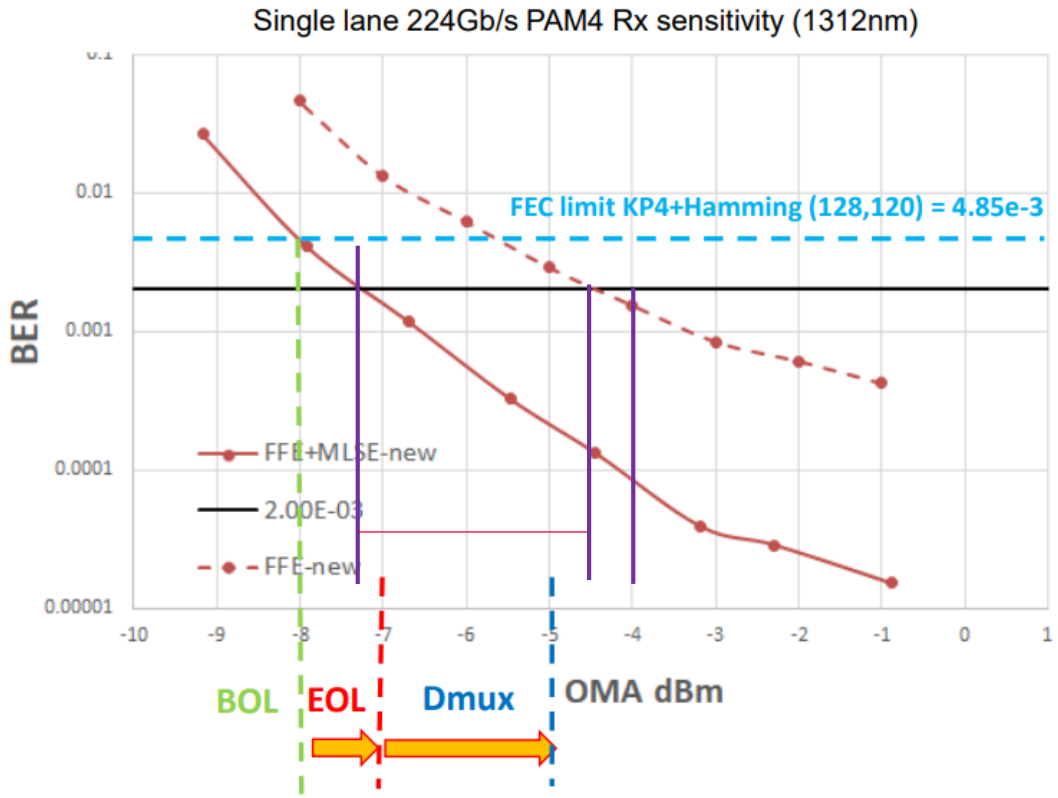


For 2km applications(DR-2 & FR）, MPI penalty 0.3dB

HUAWEI

Revist the experimental result

- As stated in kuschnerov_3df_01b_221012, with FEC limit @4.85e-3, with a strengthened algorithm, FFE+MLSE for the data
  - ~8dBm OMA Rx sensitivity
  - Leaves about ~3dB room for a Rx sensitivity of 5dBm
- Same applies to assuming FEC limit @2e-3, with a strengthened Rx algorithm, FFE+MLSE for the data
  - ~-7.3dBm OMA
  - Leaves about >3dB room for Rx Sensitivity of 4dBm
- The performance can still be improved as the 200G/lane technology evolves
  - Current data areacquired with bandwidth-limited components
  - Room to improve Rx Noise factors



HUAWEI