Further on the COM Analysis for 200G/L AUI C2M – TP1a Simulation

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Outline

- Background and Introduction
- TP1a Simulation for 200G/L C2M
- Summary

Introduction

- **This presentation is the update to lit_3dj_01a_230116 and lit_3dj_02a_230116 with**
  - **TP1a simulation**
  - **Address different technical considerations, especially**
    - AUI BER under different FEC architecture
    - Test methodology with/without link training
- **The intention of this presentation is NOT to**
  - **Address any specific FEC architecture**
  - **Propose any specific compliance methodology**

COM Simulation Setting

- COM 4.0 used, COM spreadsheet in appendix
- 112 test channels, details in appendix
- Reference COM parameters

Exploratory of 802.3dj Medium Loss C2M

Exploratory of 802.3dj High Loss C2M

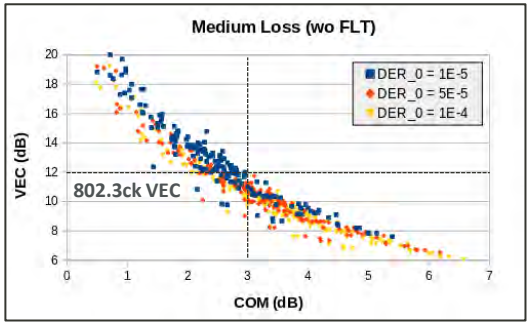
Parameter	802.3ck C2M	802.3ck CR	802.3ck KR	802.3ck C2M-like	802.3ck C2M-like + FLT	802.3ck CR-like
DER_0	1E-5	1E-4	1E-4	1E-5/5E-5/1E-4	1E-5/5E-5/1E-4	1E-5/5E-5/1E-4
SNR_TX	32.5	32.5	33	32.5	32.5	33
R_LM	0.95	0.95	0.95	0.95	0.95	0.95
TxFIR Length	4 (2 pre)	5 (3 pre)	5 (3 pre)	5 (3 pre)	5 (3 pre)	6 (4 pre)
eta_0	4.10E-08	9E-09	8.2E-09	2.05E-08	2.05E-08	4.1E-09
N_b	4	12	12	8	8	24
N_bg	0	3	3	0	3	6
N_bf	-	3	3	3	3	3
N_f	-	40	40	80	80	80

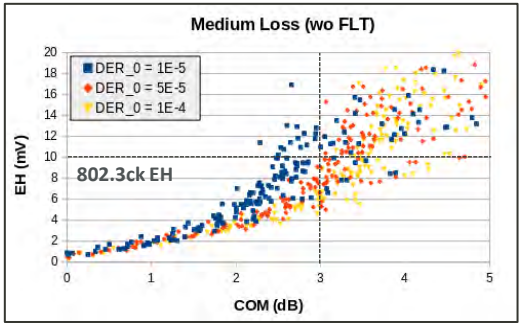
- COM vs TP1a simulation
  - Assumption of optimal TxEQ
    → Result in an optimistic estimate of VEC/EH

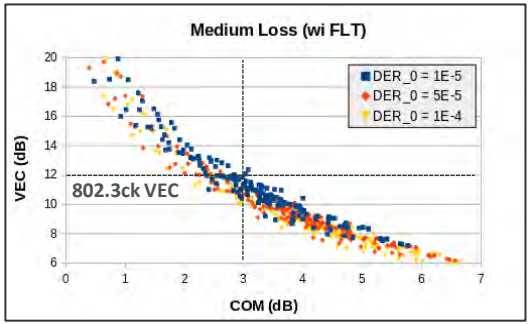
	COM Simulation	TP1a Simulation
z_p (TX)	[15 30 45; 1 1 1; 1 1 1; 0.5 0.5 0.5]	[15 30 45; 1 1 1; 1 1 1; 0.5 0.5 0.5]
z_p (NEXT)	[8 8 8; 0 0 0; 0 0 0; 0 0 0]	[0 0 0; 0 0 0; 0 0 0; 0 0 0]
z_p (FEXT)	[15 30 45; 1 1 1; 1 1 1; 0.5 0.5 0.5]	[15 30 45; 1 1 1; 1 1 1; 0.5 0.5 0.5]
z_p (RX)	[8 8 8; 0 0 0; 0 0 0; 0 0 0]	[0 0 0; 0 0 0; 0 0 0; 0 0 0]
C_p	[0.5e-4 0.5e-4]	[0.5e-4 0]
PMD_type	C2C	C2M
T_O	-	50
samples_for_C2M	-	100

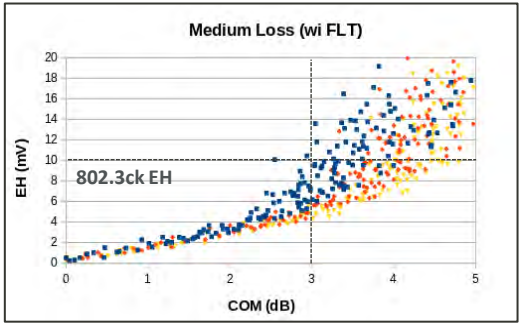
Correlation between COM and VEC/EH: Medium Loss

- **Ballpark figure of VEC and EH for 200G/L medium loss C2M is similar to that of 802.3ck C2M**







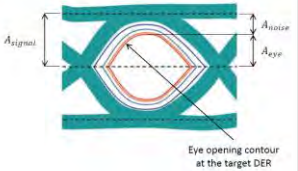


Recap VEC and COM from shakiba_3dj_01_230116

Feasibility of measurement window in calculating VEC?

SNR, COM, and VEC

$$COM = 20\log_{10}\left(\frac{A_{signal}}{A_{noise}}\right)$$
$$VEC = 20\log_{10}\left(\frac{A_{signal}}{A_{eye}}\right)$$
$$\rightarrow \quad COM = -20\log_{10}\left(1 - 10^{-VEC/20}\right)$$



- COM and VEC are related to SNR

$$SNR[dB] = 10\log_{10}\left(\frac{1}{3}\frac{L+1}{L-1}\frac{A_{peak}^2}{\sigma_{noise}^2}\right)$$ (Appendix A)

$$A_{peak} = (L-1)A_{signal}$$
$$A_{noise} = k_{DER}\sigma_{noise} \quad \leftarrow$$

k_{DER} is a multiplier factor that determines how many σ's away from mean achieves target DER (a.k.a. Q factor for Gaussian noise)

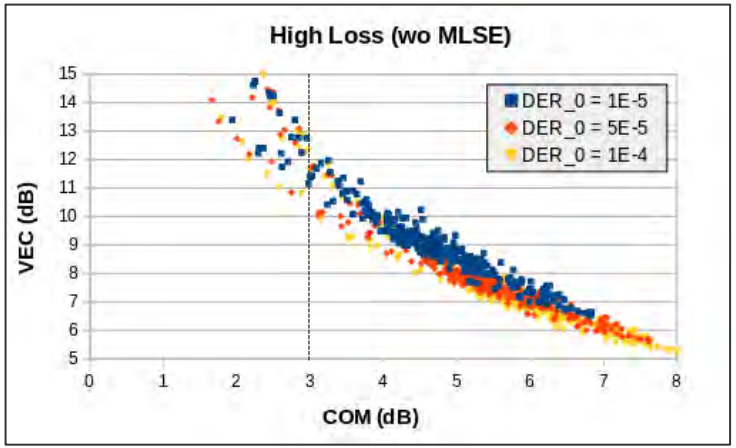
- As a result COM can be expressed as

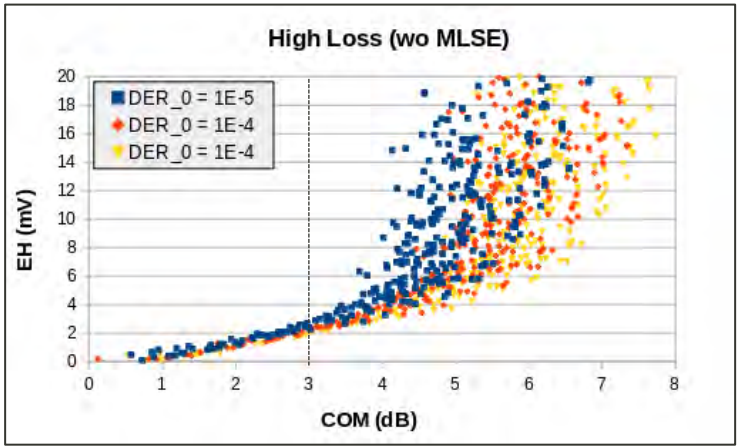
$$COM = SNR[dB] - 10\log_{10}\left(\frac{L^2-1}{3}k_{DER}^2\right)$$

- Which suggests that COM is in fact a kind of SNR with a notion of DER directly built in it

Correlation between COM and VEC/EH: High Loss

- **Ballpark figure of VEC for 200G/L medium loss C2M is similar to that of 802.3ck C2M**
- **>= 2 mV of EH can pass 3 dB COM → Sensitive to measurement noise**
  - **Note: VEC/EH/COM shown in this presentation is calculated based on the optimal TxEQ, practical implementation can be worse even with the support of link training**





Summary

- Ballpark figure of VEC for both medium and high loss C2M will be similar to that of 802.3ck C2M
  - 802.3ck C2M: VEC (max) at TP1a = 12 dB
- A wide range of EH, distributed between 2 to 12 mV, can meet 3 dB COM
  - Tolerance of measurement noise for high loss application?
  - Feasibility of eye-opening reference parameters?
  - Feasibility of VEC & EH specifications for 802.3dj C2M?
- If without link training, how Module compliance works under Host with wide range losses?
  - Call to action: Module-to-Host channel contributions needed
- Methodology of incorporating MLSE effect into VEC/EH required

Appendix

COM Spreadsheet for TP1a Test: Medium Loss C2M

Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	106.25	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[0.4e-4 0.9e-4 1.1e-4 ; 0 0 0]	nF	[TX RX]
L_s	[0.13 0.15 0.14; 0 0 0]	nH	[TX RX]
C_b	[0.3e-4 0]	nF	[TX RX]
z_p select	[1 2 3]		[test cases to run]
z_p (TX)	[15 30 45; 1 1 1; 1 1 1; 0.5 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[0 0 0; 0 0 0; 0 0 0; 0 0 0]	mm	[test cases]
z_p (FEXT)	[15 30 45; 1 1 1; 1 1 1; 0.5 0.5 0.5]	mm	[test cases]
z_p (RX)	[0 0 0; 0 0 0; 0 0 0; 0 0 0]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.5e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.413	V	vp/vf=
A_fe	0.413	V	vp/vf=
A_ne	0.45	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.1]		[min:step:max]
c(-3)	[-0.06:.02:0]		[min:step:max]
c(1)	[-0.1:0.02:0.1]		[min:step:max]
N_b	8	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	[0.3 0.3 0.2*ones(1,5)]		As/dfe2..N_b
b_min(1)	0.3		As/dffe1
b_min(2..N_b)	[0.05 0.05 -0.05*ones(1,5)]		As/dfe2..N_b
g_DC	[-13:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-3:0.5:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	
Butterworth	1	logical	include in fr
Raised_Cosine	0	logical	include in fr
RC_Start	6.70E+10	Hz	start freq for RCos
RC_end	7.97E+10	Hz	end freq for RCos

I/O control		
DIAGNOSTICS	0	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\c2m_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M_eval	
COM_CONTRIBUTION	0	logical
Operational		
ERL Pass threshold	7.3	dB
COM Pass threshold	3	db
VEC Pass threshold	12	db
EH_min	10	Value
DER_0	1.00E-05	
T_r	3.75E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	0	mV
PMD_type	C2M	
T_O	50	mUI
samples_for_C2M	100	samples/UI
EW	1	
TDR and ERL options		logical
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.01	
N	800	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	UI
N_bx	8	
fixture delay time	[0 0]	
Tukey Window	1	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	2.05E-08	dB
SNR_TX	32.5	
R_LM	0.95	
Enforce Causality	1	
S-parameter magnitude extra	trend_to_DC	

Table 93A-3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0008455 0.000340225]	
package_tl_tau	0.00644805	ns/mm
package_Z_c	92 92 92; 70 70 70; 80 80 80; 100 100 100	Ohm
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 6.44084e-4 3.6036e-05]	1.5 db/in @ 56G
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	125	mm
z_bp (NEXT)	0	mm
z_bp (FEXT)	125	mm
z_bp (RX)	0	mm
C_0	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	**0**	**logical**
Selections (rectangle, gaussian,dual_rayleigh,triangle		
Histogram_Window_Weight	gaussian	selection
Qr	0.02	UI
ICN parameters		
f_v	0.594	Fb
f_f	0.594	Fb
f_n	0.594	Fb
f_2	79.688	GHz
A_ft	0.450	V
A_nt	0.450	V
Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	80	UI span for floating tap
bmaxg	0.2	max DFE value for floa
Receiver testing		
RX_CALIBRATION	0	logical
Sigma_BBN step	5.00E-03	V

COM Spreadsheet for TP1a Test: High Loss C2M

Table 93A-1 parameters

Parameter	Setting	Units	Information
f_b	106.25	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[0.4e-4 0.9e-4 1.1e-4 ; 0 0 0]	nF	[TX RX]
L_s	[0.13 0.15 0.14; 0 0 0]	nH	[TX RX]
C_b	[0.3e-4 0]	nF	[TX RX]
z_p select	[1 2 3]		[test cases to run]
z_p (TX)	[15 30 45; 1 1 1 ; 1 1 1 ; 0.5 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[0 0 0; 0 0 0 ; 0 0 0 ; 0 0 0]	mm	[test cases]
z_p (FEXT)	[15 30 45; 1 1 1 ; 1 1 1 ; 0.5 0.5 0.5]	mm	[test cases]
z_p (RX)	[0 0 0; 0 0 0 ; 0 0 0 ; 0 0 0]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.5e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.413	V	vp/vf=
A_fe	0.413	V	vp/vf=
A_ne	0.45	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.12]		[min:step:max]
c(-3)	[-0.06:.02;0]		[min:step:max]
c(-4)	[0:.02:0.06]		[min:step:max]
c(1)	[-0.12:0.02:0.1]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	[0.5 0.3 0.3 0.2*ones(1,20)]		As/dfe2..N_b
b_min(1)	0.3		As/dffe1
b_min(2..N_b)	[0.2 0.05 0.05 -0.05*ones(1,20)]		As/dfe2..N_b
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	
Butterworth	1	logical	include in fr
Raised_Cosine	0	logical	include in fr
RC_Start	6.70E+10	Hz	start freq for RCos
RC_end	7.97E+10	Hz	end freq for RCos

I/O control

DIAGNOSTICS	0	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\c2m_[date]\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M_eyal	
COM_CONTRIBUTION	0	logical
Operational		
ERL Pass threshold	7.3	dB
COM Pass threshold	3	db
VEC Pass threshold	12	db
EH_min	10	Value
DER_0	1.00E-04	
T_r	3.75E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	0	mV
PMD_type	C2M	
T_O	50	mUI
samples_for_C2M	100	samples/UI
EW	1	
TDR and ERL options		logical
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.01	
N	800	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	UI
N_bx	8	
fixture delay time	[0 0]	
Tukey_Window	1	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	4.10E-09	dB
SNR_TX	32.5	
R_LM	0.95	
Enforce Causality	1	
S-parameter magnitude extrap	trend_to_DC	

Table 93A-3 parameters

Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 0.0008455 0.000340225]	
package_tl_tau	0.00644805	ns/mm
package_Z_c	[92 92 92; 70 70 70; 80 80 80; 100 100 100]	Ohm
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 6.44084e-4 3.6036e-05]	1.5 db/in @ 56G
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	125	mm
z_bp (NEXT)	0	mm
z_bp (FEXT)	125	mm
z_bp (RX)	0	mm
C_0	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	**0**	**logical**

Selections (rectangle, gaussian,dual_rayleigh,triangle

Histogram_Window_Weight	gaussian	selection
Qr	0.02	UI

ICN parameters

f_v	0.594	Fb
f_f	0.594	Fb
f_n	0.594	Fb
f_2	79.688	GHz
A_ft	0.450	V
A_nt	0.450	V

Floating Tap Control

N_bg	6	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	80	UI span for floating taps
bmaxg	0.2	max DFE value for floati

Receiver testing

RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

Channel List

- **Total of 112 test channels**

CH #	Source	Supporting Presentation
36	OSFP MSA	
21	akinwale_3df_01_2209	akinwale_3df_elec_01_220921
21	akinwale_3df_02_2209	
21	akinwale_3df_03_2209	
3	rabinovich_3df_01_2209	rabinovich_3df_elec_01b_220921
3	rabinovich_3df_02_2209	
5	tracy_3df_02_2211	tracy_3df_02_2211
1	rabinovich_3dj_02_230116	rabinovich_3dj_01_230116
1	rabinovich_3dj_03_230116	

Thank you

Questions and Discussions