Mitigating Interaction Problems of Impedance Matching between Channel and Rx (#r02-10/14/55)

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Supporters

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Overview

- Interaction Problems of Z Matching between Channel and Rx
  - Difficult to test Channel in the worst case for <u>unknown</u> Rx impedance
  - Difficult to test Rx in the worst case for <u>unknown</u> Channel impedance
    - Impedance matching significantly affects the performance (e.g. COM value)
    - Impedance variation is inevitable in actual manufacturing
  - These problems have been discussed in P802.3cd since last November

- Two Proposals to Mitigate these Problems (need both)
  - Use nominal values for COM impedance parameters (i.e. Rd and Zc)
    - Tighten Channel Variation
  - Specify return loss (RL) of test channel for Rx Interference Tolerance Test
    - Tighten Rx Variation
    - Ensure some margin for interoperability

- This presentation is a summary of three presentations in Ad Hoc
  - hidaka_061417_3cd_01_adhoc.pdf : nominal values for COM Z parameters
  - hidaka_061417_3cd_02_adhoc-v2.pdf, hidaka_070517_3cd_01_adhoc.pdf : RL of test channel for Rx ITT

Nominal Values for COM Z Parameters (Rd, Zc)

- Regardless of whether interoperability margin is enough or not, there are problems to use high Rd and low Zc
  - Problems to use high Rd and low Zc
    - It is not the worst case at all
    - It is biased positive (favoring) to some channels, negative (penalizing) to some channels, and neither positive nor negative to many channels
      - It increases variation of channel characteristics, degrading margin for interoperability
    - It gives misleading impression and illusion of max impedance tolerance
  - Advantages to use nominal Rd and nominal Zc
    - It is not biased to any channels
      - It reduces variation of channel characteristics, improving margin for interoperability
    - It gives a warning that max impedance tolerance is not specified
- COM value will be slightly adjusted so that change of Rd and Zc generally will not affect pass/fail status of existing channels

Tightening Variation by Nominal Reference

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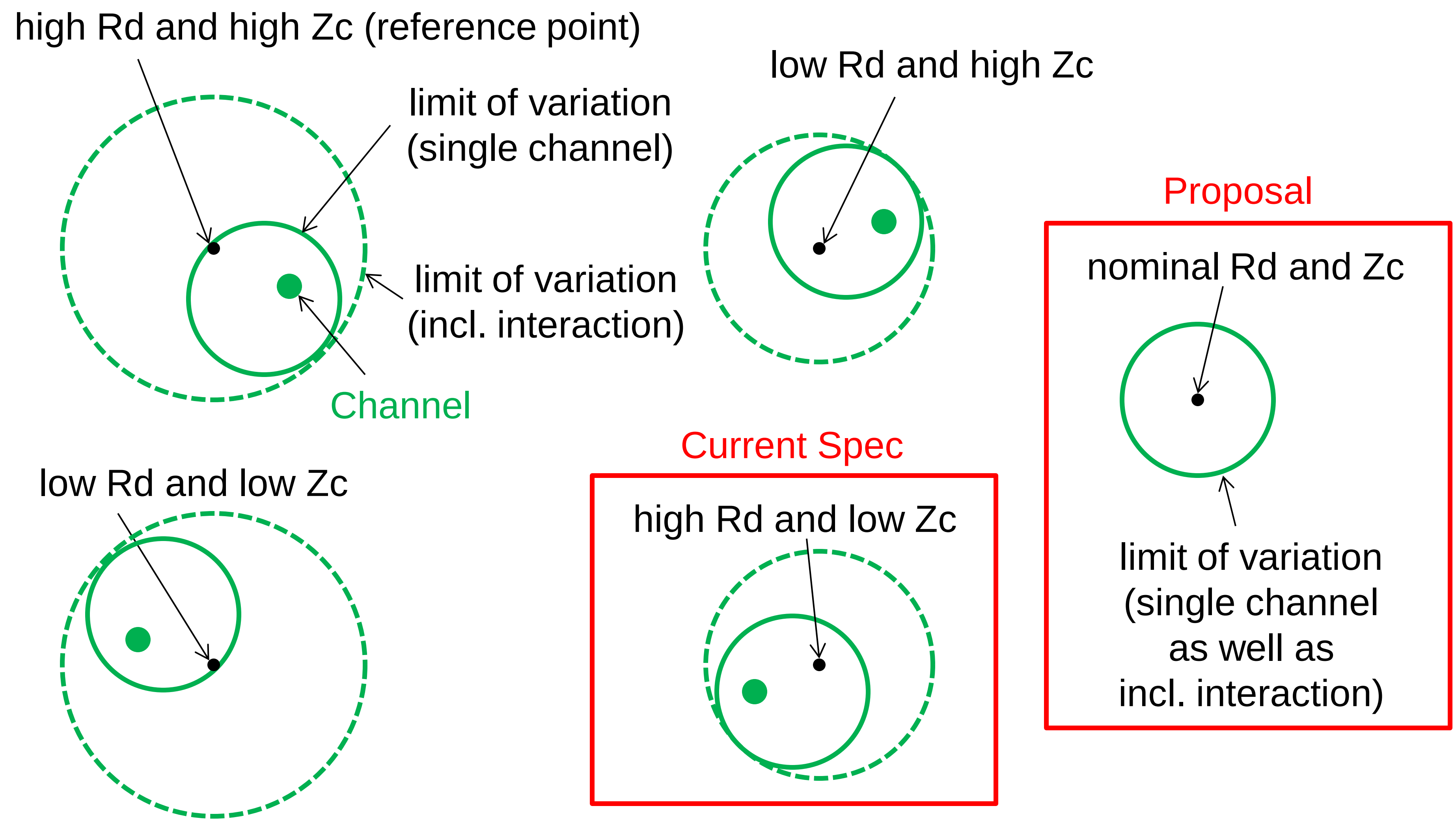
Hyper Space of Channel Characteristics



Return Loss (RL) of Test Channel for Rx ITT

- In Clause 93, RL of test channel for Rx ITT was specified to meet EQ (93-2)
  - EQ (93-2) is RL of test fixture, that is rather good
  - With good RL of test channel, broadband noise (BBN) is always injected
  - *Overstress* of BBN may be one reason of ample interoperability margin of existing 25G NRZ SerDes
    - BBN (a.k.a. Gaussian noise) has *infinite* range of noise-amplitude distribution
    - Reflection and crosstalk have *limited* range of noise-amplitude distribution
- Lack of RL spec of test channel for Rx ITT may seriously degrade interoperability margin of 50G PAM4 SerDes
- Since we defined RL of test channel as test-fixture grade for Clause 93, we should do the same in Annex 120D, Clause 137, and Clause 136
  - It is also feasible, because we just re-use the same RL mask

Conclusion

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- Proposal 1 : Use nominal Rd and Zc values
  - Adjust Ave, Afe, Ane not to change vf value at TP0a
  - Adjust Channel COM generally not to affect pass/fail of existing channels

	Annex 120D	Clause 137	Clause 136
Rd	50 Ω	50 Ω	50 Ω
PKG Zc	95 Ω	95 Ω	95 Ω
PCB Zc	N/A	N/A	100 Ω
Av	0.418 V	0.415 V	0.415 V
Afe	0.418 V	0.415 V	0.415 V
Ane	0.604 V	0.604 V	0.604 V
Channel COM	3.1dB	3.0dB	3.3dB

- Proposal 2 : Specify return loss of test channel for Rx ITT by
  - EQ (93-2) (RL of test fixture) for Annex 120D and Clause 137
  - EQ (92-38) (RL of mated test fixture) for Clause 136

Back up Slides

- Effects of nominal Rd and Zc values on COM values
  - Simulation results not to affect pass/fail of existing channels
  - Reported in hidaka_061417_3cd_01_adhoc.pdf

COM Parameters for Annex 120D (Common)

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Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	26.5625	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.8e-4 1.8e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[30]	mm	[test cases]
z_p (NEXT)	[12]	mm	[test cases]
z_p (FEXT)	[30]	mm	[test cases]
z_p (RX)	[30]	mm	[test cases]
C_p	[1.1e-4 1.1e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[55 55]	Ohm	[TX RX]
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.15:0.05:0]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-15:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	53.125	GHz	
A_v	0.44	V	
A_fe	0.44	V	
A_ne	0.63	V	
L	4		
M	32		
N_b	10	UI	
b_max(1)	0.5		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	2.60E-08	V^2/GHz	
SNR_TX	31	dB	
R_LM	0.95		
DER_0	1.00E-05		
Operational control			
COM Pass threshold	3	dB	
Include PCB	0	Value	0, 1, 2
g_DC_HP	[-4:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\V165_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	V164	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	1.30E-02	ns
T_r_meas_point	0	logical
T_r_filter_type	1	logical

Non standard control options		
INC_PACKAGE	1	logical
IDEAL_RX_TERM	0	logical
INCLUDE_CTLE	1	logical
INCLUDE_TX_RX_FILTER	1	logical
COM_CONTRIBUTION	0	logical

Table 93A–3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 1.734e-3 1.455e-4]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	90	Ohm

Table 92–12 parameters		
Parameter	Setting	
board_tl_gamma0_a1_a2	[0 4.114e-4 2.547e-4]	
board_tl_tau	6.191E-03	ns/mm
board_Z_c	110	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	72	mm
z_bp (FEXT)	72	mm
z_bp (RX)	151	mm

- Yellow cells were changed as the following slide

COM Parameters for Annex 120D (Difference)

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- Based on slide 9 of hidaka_060717_3cd_adhoc-v2.pdf
  - Tx Amplitude for Zc90/93/95/100 were calibrated at TP0a

Label	D3.0	D3.1	D3.2	Zc90	Zc93	Zc95	Zc100
R_d	55	55	55	50	50	50	50
Z_c	85	90	90	90	93	95	100
A_v	0.45	0.45	0.44	0.419	0.418	0.418	0.417
A_fe	0.45	0.45	0.44	0.419	0.418	0.418	0.417
A_ne	0.63	0.63	0.63	0.604	0.604	0.604	0.604
C_d	2.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4	1.8E-4
f_p2	1E+99	2*f_b	2*f_b	2*f_b	2*f_b	2*f_b	2*f_b
z_p	30	30	30	30	30	30	30

18 Channels for Simulation for Annex 120D

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Category	CH #	IL 13.28G	Description	Channel Data Source
A	4	20.9dB	Cisco Backplane	P802.3cd 50/100/200GbE TF (Cisco_Backplane_channel_data.zip)
B	17,18,19	~20dB	Intel 100Ω Backplane	50G/NGOATH Study Group (mellitz_01_021716_20dB_6_channels.zip)
C	32,33,34	~20dB	Intel 85Ω Backplane	
D	42	21.8dB	TE Backplane	P802.3cd 50/100/200GbE TF (TEC_STRADAWhisper27in_Meg6_*.zip)
E	44, 45	~19dB	Cavium Backplane	P802.3cd 50/100/200GbE TF (Cavium_20dB_H*.zip)
F	48	19.6dB	Intel Mezzanine Channel	P802.3bs 200/400GbE TF (mellitz_3bs_*_0714.zip)
	49	14.7dB		
	50	6.9dB		
	51	19.5dB		
	52	17.4dB		
	53	11.0dB		
	54	9.2dB		
G	55	18.6dB	TEC ARMOR Mezzanine	P802.3bs 200/400GbE TF (TEC/shanbhag_01_0914.zip)

Results for Annex 120D

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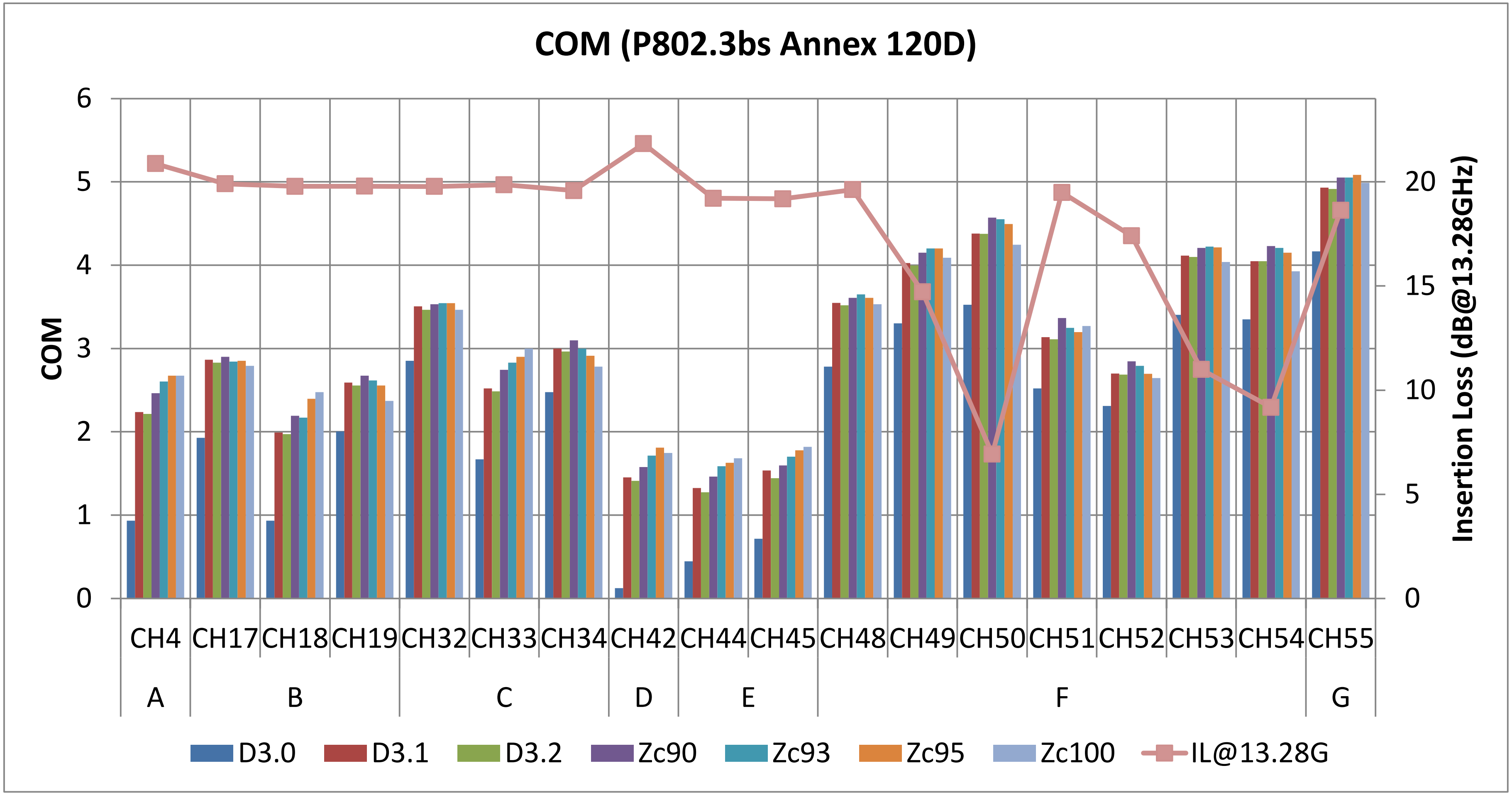

- F and G have one mezzanine connector (relevant for 120D)
- A thru E have two backplane connectors (only for information)

Results for Annex 120D (ΔCOM from D3.0)

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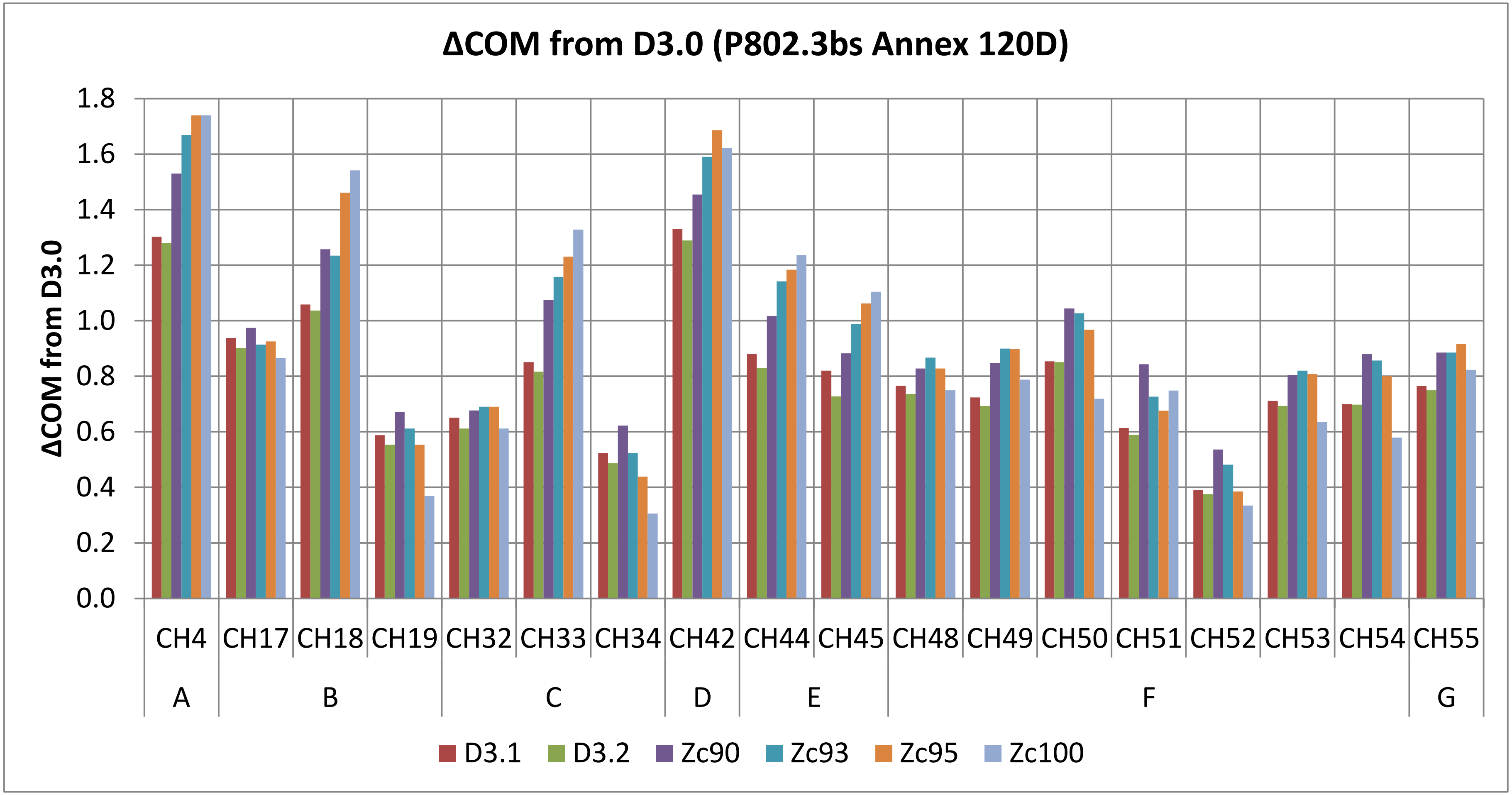

- Large improvement (~0.8dB) mainly due to Cd (280fF→180fF)
  - Since COM was not changed, it was budget transfer from Rx to channel
- This is only for information, and not used for my proposal

Results for Annex 120D (ΔCOM from D3.2)

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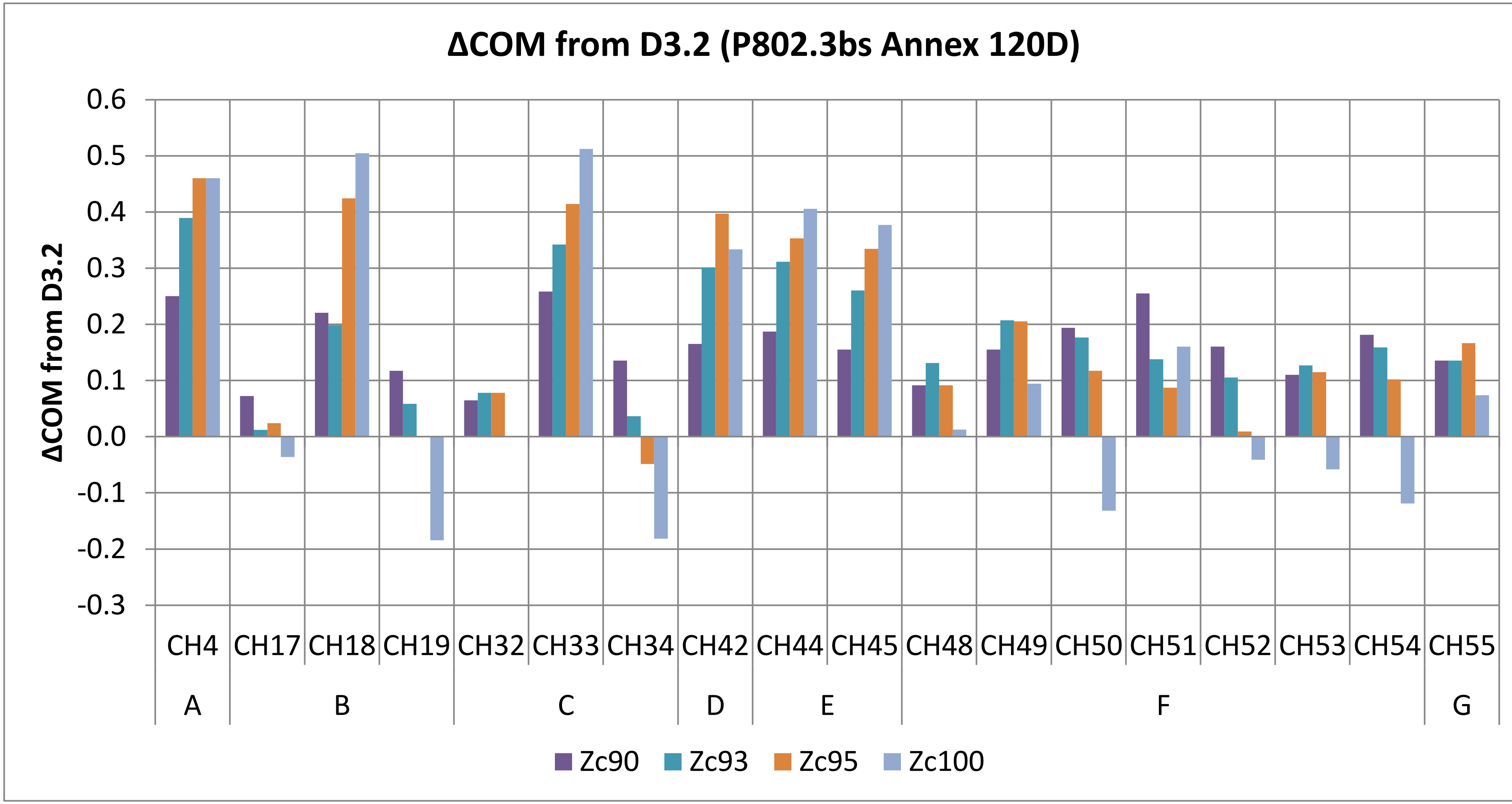

- Zc = 95Ω and COM = 3.1dB seems a reasonable choice
  - Looking at the results of F and G which are relevant for Annex 120D
  - My proposal for Annex 120D is based on this result

Thank you