



# Updated 802.3cb Backplane Channel Analysis and PHY proposals

---

Peter Wu, Jin Zhang, Marvell Semiconductor

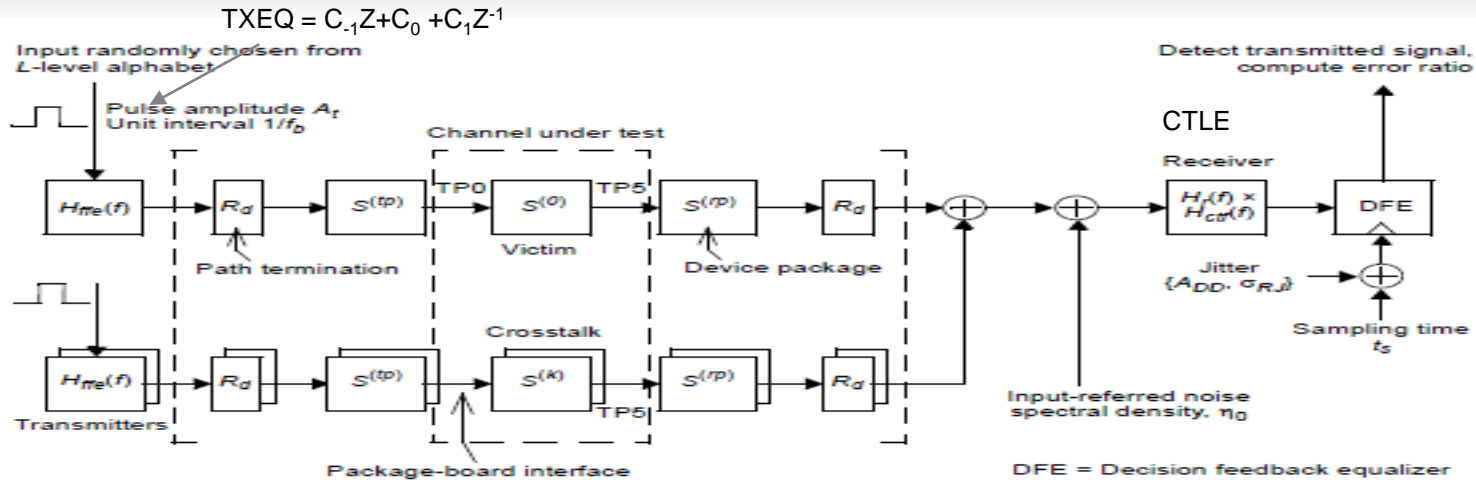
## Supporters

- ▶ Anthony Calbone, Seagate Technology
- ▶ Richard Mellitz , Intel

## Outline

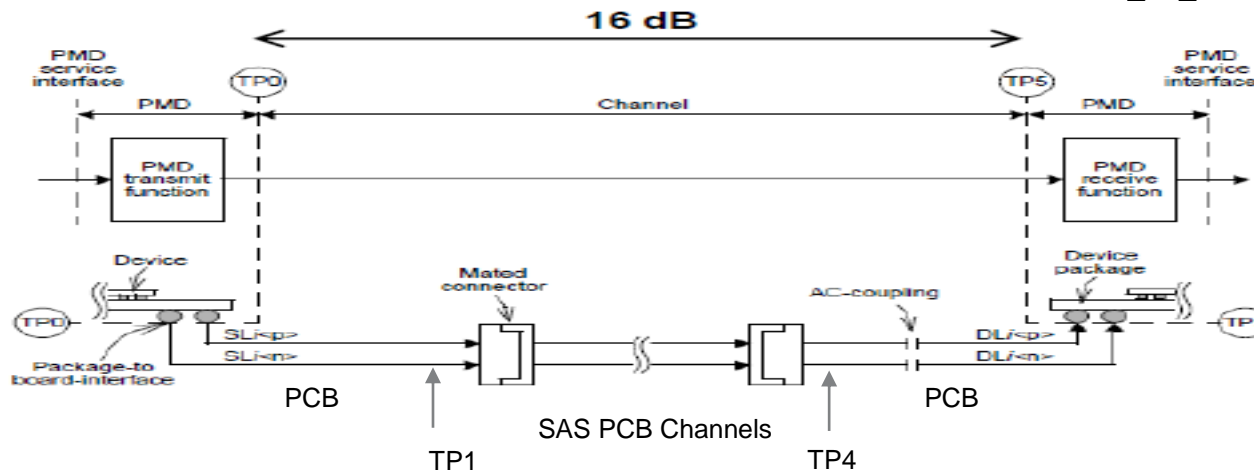
- COM model parameters descriptions-with updated configurations
  - How did we unitize COM
- Updated Channel Analysis of 56 SAS backplane channels with COM model – 5GBASE-R
  - Initial results - wu\_CU4HDDSG\_01\_1115.pdf
  - Updated package models
  - PCB Loss consideration
- PHY Proposals

# Utilization of COM model 93A – Analysis SAS PCB Channels

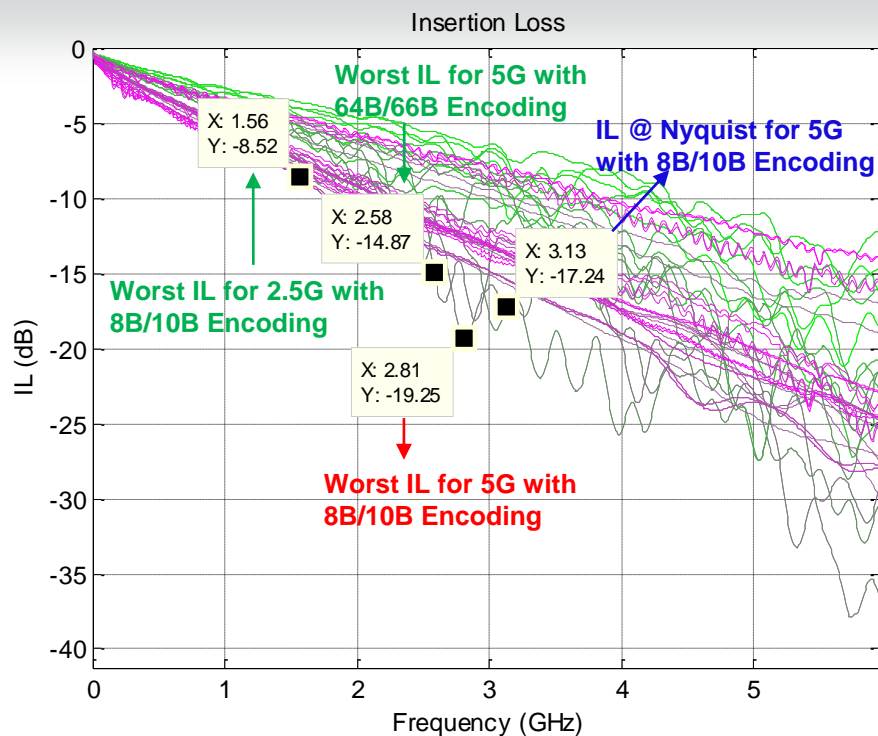


802.3bj

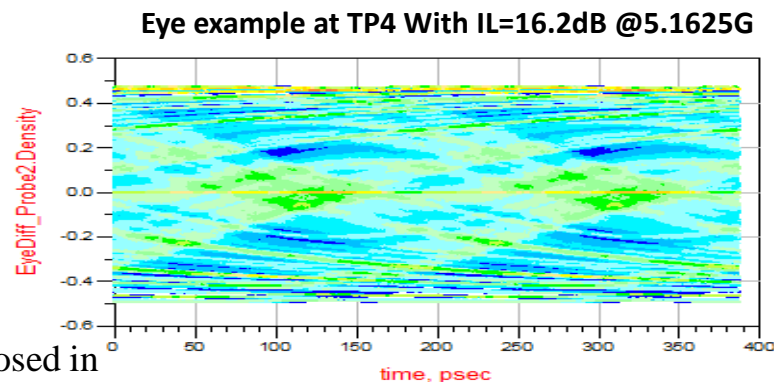
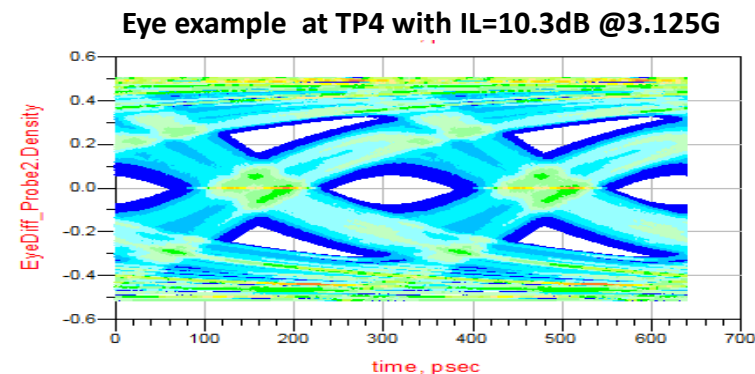
calbone\_cb\_PMD\_Update\_2-25-2016.pdf



# Channel Analysis of Insertion loss ( TP1 -> TP4)



| Scheme        | 2.5G<br>8B/10B | 5G<br>64B/66B | 5G<br>8B/10B |
|---------------|----------------|---------------|--------------|
| Worst IL (dB) | 8.52           | 14.87         | 19.25        |



- Reference to 2.5GBASE-KX and 5GBase-KR IL loss budget proposed in calbone\_cb\_PMD\_Update\_2-25-2016.pdf

## COM – Channel Operating Margin ( Annex 93A) – Simulation Configurations

- 2.5G-BASE-X – 8B/10B
  - Baud rate: 3.125G.
  - CTLE
  - TX EQ: No
  - DFE: No
- 5G BASE-R –64B/66B
  - Baud rate: 5.15625G
  - CTLE
  - With/Without: TX EQ of 3-Tap FIR
  - DFE: 6-Tap or No DFE

## TX Pre-emphasis as Parameters

- ▶ Optimal 3-Tap TX pre-emphasis (search)

|       |                |
|-------|----------------|
| c(0)  | 0.62           |
| c(-1) | [-0.18:0.02:0] |
| c(1)  | [-0.38:0.02:0] |

- ▶ 2dB TX pre-emphasis

|       |           |
|-------|-----------|
| c(0)  | 0.8972    |
| c(-1) | [-0.1028] |
| c(1)  | [0]       |

- ▶ No TX pre-emphasis

# COM model parameters -5GBASE-R example

Table 93A-1 parameters

| Parameter           | Setting         | Units   | Information         |
|---------------------|-----------------|---------|---------------------|
| f_b                 | 5.15625         | GBd     |                     |
| f_min               | 0.05            | GHz     |                     |
| Delta_f             | 0.01            | GHz     |                     |
| C_d                 | [0.9e-3 0.9e-3] | nF      | [TX RX]             |
| z_p select          | [2]             |         | [test cases to run] |
| z_p (TX)            | [12 42.3]       | mm      | [test cases]        |
| z_p (NEXT)          | [12 12]         | mm      | [test cases]        |
| z_p (FEXT)          | [12 42.3]       | mm      | [test cases]        |
| z_p (RX)            | [12 42.3]       | mm      | [test cases]        |
| C_p                 | [2e-4 2e-4]     | nF      | [TX RX]             |
| R_0                 | 50              | Ohm     |                     |
| R_d                 | [55 55]         | Ohm     | [TX RX]             |
| f_r                 | 0.75            | *fb     |                     |
| c(0)                | 0.62            |         | min                 |
| c(-1)               | [-0.18:0.02:0]  |         | [min:step:max]      |
| c(1)                | [-0.38:0.02:0]  |         | [min:step:max]      |
| g_DC                | [-12:1:0]       | dB      | [min:step:max]      |
| f_z                 | 1.2890625       | GHz     |                     |
| f_p1                | 1.2890625       | GHz     |                     |
| f_p2                | 5.15625         | GHz     |                     |
| A_v                 | 0.4             | V       |                     |
| A_fe                | 0.4             | V       |                     |
| A_ne                | 0.6             | V       |                     |
| L                   | 2               |         |                     |
| M                   | 32              |         |                     |
| N_b                 | 6               | UI      |                     |
| b_max(1)            | 0.35            |         |                     |
| b_max(2..N_b)       | 0.35            |         |                     |
| sigma_RJ            | 0.01            | UI      |                     |
| A_DD                | 0.06            | UI      |                     |
| eta_0               | 5.20E-08        | V^2/GHz |                     |
| SNR_TX              | 30              | dB      |                     |
| R_LM                | 1               |         |                     |
| DER_0               | 1.00E-12        |         |                     |
| Operational control |                 |         |                     |
| COM Pass threshold  | 3               | dB      |                     |
| Include PCB         | 0               | logical |                     |

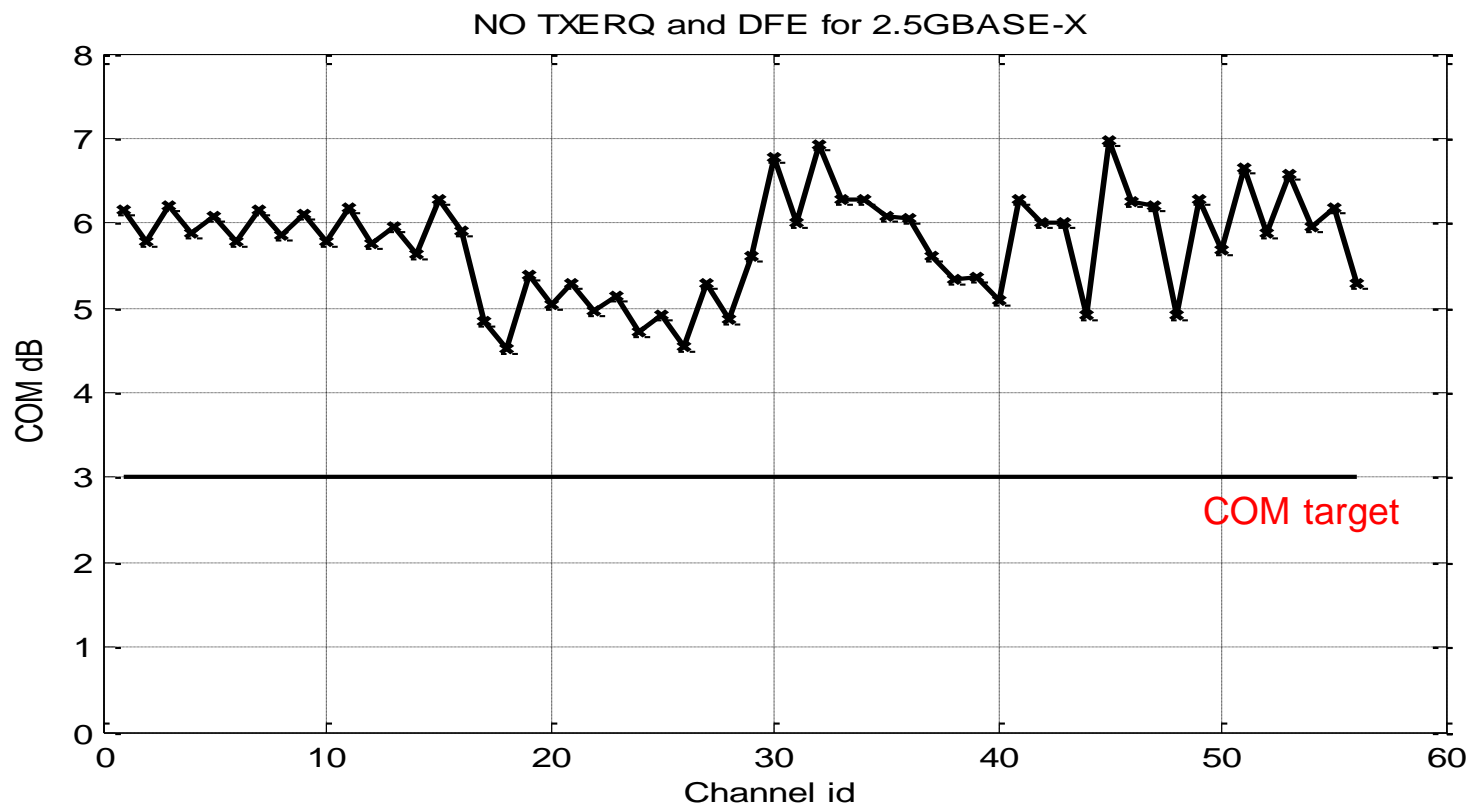
- 3.125 for 2.5GBASE-KX case
- The package model includes PCB channel effect about 1.8dB at 3.15GHz
- Total Tp0 – Tp5
- C(0) set to 1 c(-1) and c(1) set as 0 if NO TXEQ
- N\_b set to 0 if No DFE used



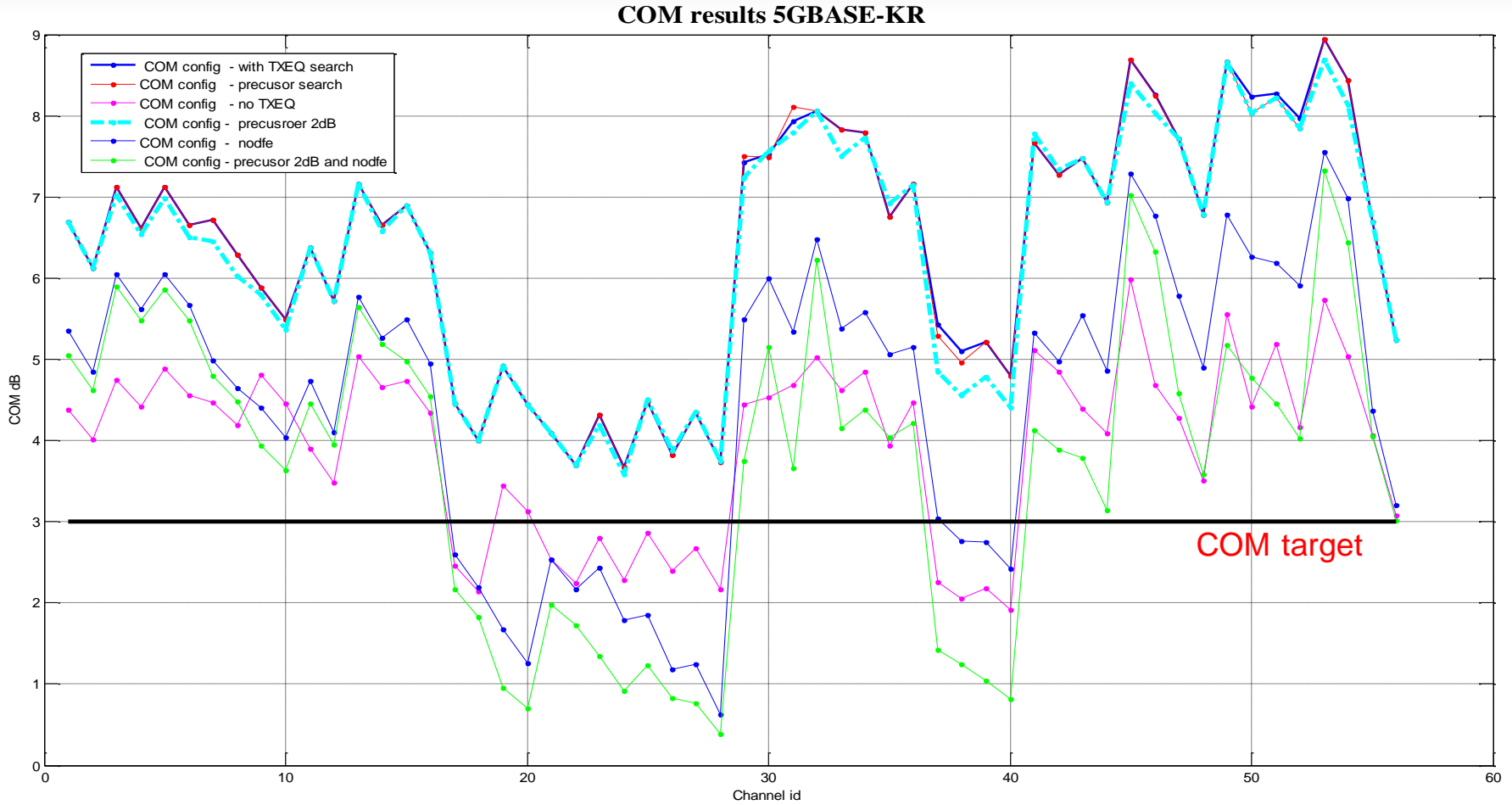
# SAS channel and Results – 5GBASE-R

| Config number | Channel                      | Xtalk                               | COM(TXEQ/DFE) (dB) | COM(TXEQ [-0.1 0.9] (dB) | COM ( NO DFE) | COM ( no TXEQ) (dB) |
|---------------|------------------------------|-------------------------------------|--------------------|--------------------------|---------------|---------------------|
| 1             | 'HP01'                       | 'HP19'                              | 6.69               | 6.69                     | 5.35          | 4.38                |
| 2             | 'HP01'                       | 'HP15+HP16+2HP17+2HP18'             | 6.12               | 6.12                     | 4.85          | 4.02                |
| 3             | 'HP02'                       | 'HP19'                              | 7.12               | 7.02                     | 6.05          | 4.75                |
| 4             | 'HP02'                       | 'HP15+HP16+2HP17+2HP18'             | 6.62               | 6.54                     | 5.62          | 4.41                |
| 5             | 'HP03'                       | 'HP19'                              | 7.13               | 6.98                     | 6.05          | 4.88                |
| 6             | 'HP03'                       | 'HP15+HP16+2HP17+2HP18'             | 6.65               | 6.51                     | 5.67          | 4.56                |
| 7             | 'HP04'                       | 'HP19'                              | 6.72               | 6.45                     | 4.99          | 4.47                |
| 8             | 'HP04'                       | 'HP15+HP16+2HP17+2HP18'             | 6.29               | 6.03                     | 4.64          | 4.19                |
| 9             | 'HP05'                       | 'HP19'                              | 5.88               | 5.80                     | 4.40          | 4.81                |
| 10            | 'HP05'                       | 'HP15+HP16+2HP17+2HP18'             | 5.49               | 5.36                     | 4.04          | 4.46                |
| 11            | 'HP06'                       | 'HP19'                              | 6.38               | 6.38                     | 4.73          | 3.90                |
| 12            | 'HP06'                       | 'HP15+HP16+2HP17+2HP18'             | 5.72               | 5.72                     | 4.10          | 3.49                |
| 13            | 'HP07'                       | 'HP19'                              | 7.16               | 7.16                     | 5.78          | 5.04                |
| 14            | 'HP07'                       | 'HP15+HP16+2HP17+2HP18'             | 6.66               | 6.58                     | 5.27          | 4.65                |
| 15            | 'HP08'                       | 'HP19'                              | 6.89               | 6.89                     | 5.49          | 4.73                |
| 16            | 'HP08'                       | 'HP15+HP16+2HP17+2HP18'             | 6.31               | 6.31                     | 4.95          | 4.34                |
| 17            | 'HP09'                       | 'HP19'                              | 4.46               | 4.46                     | 2.59          | 2.45                |
| 18            | 'HP09'                       | 'HP15+HP16+2HP17+2HP18'             | 4.00               | 4.00                     | 2.19          | 2.14                |
| 19            | 'HP10'                       | 'HP19'                              | 4.92               | 4.92                     | 1.68          | 3.45                |
| 20            | 'HP10'                       | 'HP15+HP16+2HP17+2HP18'             | 4.45               | 4.45                     | 1.26          | 3.12                |
| 21            | 'HP11'                       | 'HP19'                              | 4.09               | 4.09                     | 2.53          | 2.53                |
| 22            | 'HP11'                       | 'HP15+HP16+2HP17+2HP18'             | 3.70               | 3.70                     | 2.17          | 2.24                |
| 23            | 'HP24'                       | 'HP19'                              | 4.31               | 4.20                     | 2.43          | 2.79                |
| 24            | 'HP24'                       | 'HP15+HP16+2HP17+2HP18'             | 3.67               | 3.59                     | 1.79          | 2.28                |
| 25            | 'HP25'                       | 'HP19'                              | 4.48               | 4.50                     | 1.86          | 2.86                |
| 26            | 'HP25'                       | 'HP15+HP16+2HP17+2HP18'             | 3.83               | 3.88                     | 1.18          | 2.40                |
| 27            | 'HP26'                       | 'HP19'                              | 4.34               | 4.35                     | 1.24          | 2.67                |
| 28            | 'HP26'                       | 'HP15+HP16+2HP17+2HP18'             | 3.73               | 3.75                     | 0.63          | 2.17                |
| 29            | 'long_board_to_drive_oldconn | 'long_board_to_drive_oldconn_next'  | 7.43               | 7.24                     | 5.49          | 4.44                |
| 30            | 'short_board_to_drive_oldcon | 'short_board_to_drive_oldconn_next' | 7.53               | 7.56                     | 5.99          | 4.53                |
| 31            | 'long_board_to_board'        | 'long_board_to_board_FEXT'          | 7.93               | 7.79                     | 5.34          | 4.68                |
| 32            | 'short_board_to_board'       | 'short_board_to_board_FEXT'         | 8.05               | 8.05                     | 6.47          | 5.02                |
| 33            | 'b1_thu'                     | 'b1_next'                           | 7.83               | 7.50                     | 5.38          | 4.61                |
| 34            | 'b2_thu'                     | 'b2_next'                           | 7.79               | 7.73                     | 5.59          | 4.85                |
| 35            | 'c1_thu'                     | 'c1_next'                           | 6.76               | 6.93                     | 5.06          | 3.94                |
| 36            | 'c2_thu'                     | 'c2_next'                           | 7.16               | 7.15                     | 5.15          | 4.46                |
| 37            | 'd1_thu'                     | 'd1_next'                           | 5.43               | 4.85                     | 3.04          | 2.26                |
| 38            | 'd1_thu'                     | 'd1_lcc'                            | 5.10               | 4.55                     | 2.77          | 2.06                |
| 39            | 'd2_thu'                     | 'd2_next_hdd'                       | 5.22               | 4.78                     | 2.75          | 2.18                |
| 40            | 'd2_thu'                     | 'd2_next_lcc'                       | 4.80               | 4.40                     | 2.42          | 1.92                |
| 41            | 'a2_thu'                     | 'a2_next'                           | 7.67               | 7.77                     | 5.33          | 5.12                |
| 42            | 'a2_thu'                     | 'a2_lcc'                            | 7.28               | 7.34                     | 4.97          | 4.85                |
| 43            | 'Intel_HDD_BP_C_MB_03_thru'  | 'Intel_HDD_BP_C_MB_03_FEXT'         | 7.47               | 7.47                     | 5.54          | 4.39                |
| 44            | 'Intel_HDD_BP_C_MB_04_thru'  | 'Intel_HDD_BP_C_MB_04_FEXT'         | 6.94               | 6.94                     | 4.86          | 4.09                |
| 45            | 'Intel_HDD_SC_MB_11'         | 'Intel_HDD_SC_MB_11_FEXT'           | 8.69               | 8.40                     | 7.29          | 5.99                |
| 46            | 'Intel_HDD_SC_MB_12'         | 'Intel_HDD_SC_MB_12_FEXT'           | 8.26               | 8.04                     | 6.77          | 4.68                |
| 47            | 'Intel_MB_C_BP_HDD_01_thru'  | 'Intel_MB_C_BP_HDD_01_FEXT'         | 7.72               | 7.72                     | 5.78          | 4.28                |
| 48            | 'Intel_MB_C_BP_HDD_02_thru'  | 'Intel_MB_C_BP_HDD_02_FEXT'         | 6.78               | 6.78                     | 4.90          | 3.51                |
| 49            | 'Intel_MB_LC_HDD_05'         | 'Intel_MB_LC_HDD_05_FEXT'           | 8.66               | 8.66                     | 6.79          | 5.56                |
| 50            | 'Intel_MB_LC_HDD_06'         | 'Intel_MB_LC_HDD_06_FEXT'           | 8.23               | 8.04                     | 6.26          | 4.41                |
| 51            | 'Intel_MB_LC_HDD_07'         | 'Intel_MB_LC_HDD_07_FEXT'           | 8.27               | 8.22                     | 6.18          | 5.18                |
| 52            | 'Intel_MB_LC_HDD_08'         | 'Intel_MB_LC_HDD_08_FEXT'           | 7.97               | 7.85                     | 5.91          | 4.16                |
| 53            | 'Intel_MB_SC_HDD_09'         | 'Intel_MB_SC_HDD_09_FEXT'           | 8.94               | 8.70                     | 7.55          | 5.73                |
| 54            | 'Intel_MB_SC_HDD_10'         | 'Intel_MB_SC_HDD_10_FEXT'           | 8.44               | 8.13                     | 6.98          | 5.03                |
| 55            | 'SAS2_transmittertestload'   | 'HP_19'                             | 6.70               | 6.70                     | 4.37          | 4.06                |
| 56            | 'SAS2_transmittertestload'   | 'HP_15+HP_16+HP_17+HP_18'           | 5.24               | 5.24                     | 3.20          | 3.08                |

# COM results for 2.5GBASE-KX



# COM results for 5GBASE-KR



## Conclusions

- 2.5GBASE-KR
  - All channels pass without TX EQ or DFE.
- 5GBASE-KR
  - All channels pass with one fix setting of Pre-cursor only TXEQ
  - For some channels – DFE is needed

# PHY proposals

## ▶ 2.5GBASE-KX

- At transmitter side, No TXEQ is needed.

## ▶ 5GBASE-KR

- At transmitter side, a fixed level pre-cursor pre-emphasis (2dB) shall be implemented. No TXEQ training is needed.