

Re-evaluation of DER_MLSE in COM

COM Commit Request Numbers 4p7_6

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Introduction

- Recently, a method for adding an additional noise to the reference receiver was adopted ([healey_3dj_01_2409.pdf](#)) and added to the draft standard (D1.3: 178A.1.11.1)
- The target for this additional noise was to de-rate the extra COM margin (ΔCOM) that an MLSE-based receiver offers over a DFE-based receiver
- While this ΔCOM de-rating achieves its own specific purpose, it breaks the fundamental relationship between error ratio and signal and noise:

$$DER = 1 - CDF^{-1} \left(A_s \times 10^{\frac{\Delta\text{COM}}{20}} \right)$$

where ΔCOM (in [dB] and > 0) is the extra SNR achieved by the MLSE-based receiver over the DFE-based receiver

- As a result, after ΔCOM de-rating, DER_{MLSE} needs to be re-evaluated with the de-rated ΔCOM
- Currently, the reported DER_{MLSE} is wrong and users may have noticed that $DER_{\text{MLSE}} > DER_{\text{DFE}}$ (!!!), which is obviously wrong for a positive ΔCOM

Change

- Re-evaluate DER_MLSE_trunc and DER_MLSE using the equation from the previous slide
 - ❖ add 4 lines, including comments

```
2230 %% shakiba_3dj_01_2407
2231 % delta_com=20*log10(1/A_s *-CDF_inv_ev ( DER_MLSE ,p_an,P_an ) )- param.Q ;% shakiba_3dj_01_2405
2232 - delta_com=20*log10(1/A_s *-CDF_inv_ev ( DER_MLSE_trunc,p_an,P_an ) )- Q_budget_adj ;% shakiba_3dj_01_2405
```

Insert here

```
%% shakiba_3dj_01_2407
% delta_com=20*log10(1/A_s *-CDF_inv_ev ( DER_MLSE ,p_an,P_an ) )- param.Q ;% shakiba_3dj_01_2405
delta_com=20*log10(1/A_s *-CDF_inv_ev ( DER_MLSE_trunc,p_an,P_an ) )- Q_budget_adj ;% shakiba_3dj_01_2405
% Following three lines recalculate DER_MLSE_trunc and DER_MLSE after additional receiver noise derates delta_com
DER_MLSE_trunc = CDF_ev(A_s*10^(delta_com/20),PDF, CDF); % Re-evaluates DER with truncation (delta_com includes truncation)
delta_com_notrunc=20*log10(1/A_s *-CDF_inv_ev ( DER_MLSE,p_an,P_an ) )- Q_budget_adj ; % Calculates delta COM without truncation
DER_MLSE = CDF_ev(A_s*10^(delta_com_notrunc/20),PDF, CDF); % Re-evaluates DER without truncation
```

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- Few notes (for more interested people):
 - ❖ Note that “MLSE_results” field reports DER for both with truncation (“MLSE_DER_trunc”) and without truncation (MLSE_DER)
 - ❖ “delta_com” in the code assumes truncation
 - ❖ “delta_com_notrunc” calculation is needed for DER_MLSE (without truncation) re-evaluation
 - ❖ When truncation is turned off (standard and default COM parameter), delta_com = delta_com_notrunc and DER_MLSE_trunc = DER_MLSE

Example Outputs

- For one example channel:

Before Change	After Change	After Change + Change 4p7_5
<pre>CDF: [1x8573 double] PDF: [1x1 struct] DER_MLSE_trunc: 0.0072 Q_budget_adj: 0 COM_from_matlab: -0.7485 DER_MLSE: 0.0072 DER_DFE: 8.8608e-04 COM: -0.1852 delta_com: 0.5633 g_an: 0.6510</pre>	<pre>CDF: [1x8573 double] PDF: [1x1 struct] DER_MLSE_trunc: 2.6802e-04 Q_budget_adj: 0 COM_from_matlab: -0.7485 DER_MLSE: 2.6802e-04 DER_DFE: 8.8608e-04 COM: -0.1852 delta_com: 0.5633 g_an: 0.6510</pre>	<pre>CDF: [1x8573 double] PDF: [1x1 struct] DER_MLSE_trunc: 2.6802e-04 Q_budget_adj: 0 COM_from_matlab: -0.7485 DER_MLSE: 2.6802e-04 DER_DFE: 5.9072e-04 COM: -0.1852 delta_com: 0.5633 g_an: 0.6510</pre>

- Before change, despite delta_com being positive, DER_MLSE > DER_DFE, which is obviously wrong

Thank You 😊

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