IEEE B802.3ap - Crosstalk Penalty Analysis
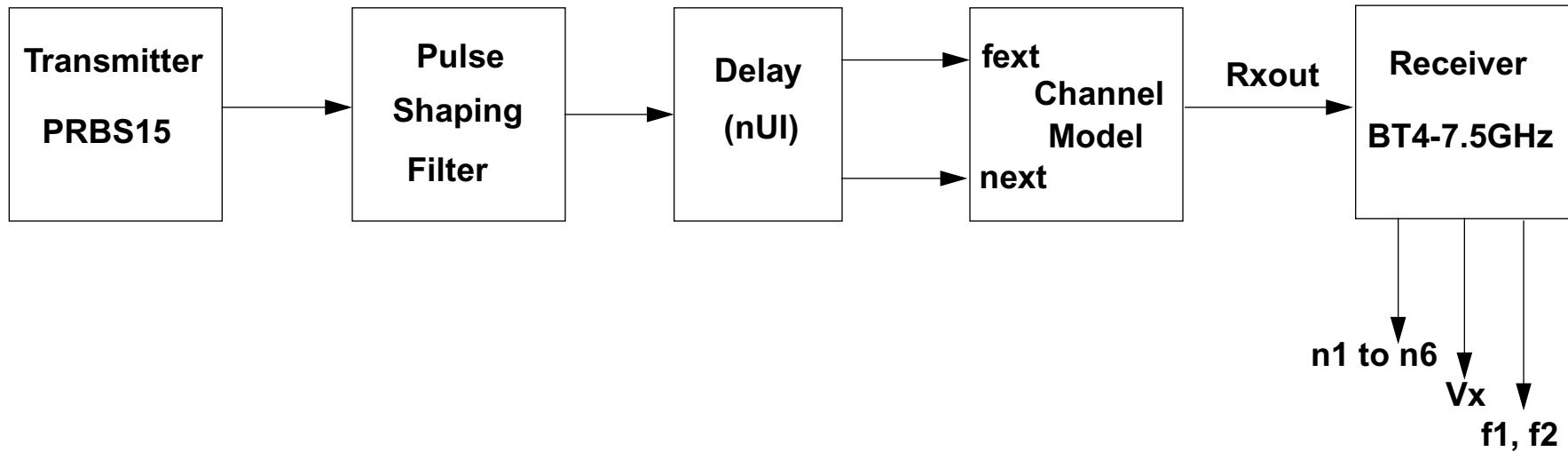
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1. Crosstalk penalty investigation

Simulation environment

| Transmitter PRBS15 | → | Pulse Shaping Filter | → | Delay (nUI) | → | fext / next Channel Model | → Rxout → | Receiver BT4-7.5GHz |

n1 to n6   Vx   f1, f2

- **- Transmitter output level 600 mVpp (differential), PRBS15.**

- **- No transmitter equalization, pulse shaping filter fourth order BT 9GHz, rise and fall times set to 30 ps.**

- **- NEXT and FEXT input signal delayed individually by 0, 1, and 2 UI.**

- **- Receiver bandwidth 7.5 GHz (fourth order BT filter).**

- **- Simulations run with Intel 8 channels and Tyco 7 channels.**

- **- Results recorded for individual contributions (peak value n1 to n6, f1, and f2) and peak receiver cross-talk voltage Vx.**

2. Crosstalk penalty (1)

Table 1: Crosstalk peak voltage (mV$_{peak}$) values for 0 UI, all channels

Channel	$V_{x,peak}$	$V_{n1,peak}$	$V_{n2,peak}$	$V_{n3,peak}$	$V_{n4,peak}$	$V_{n5,peak}$	$V_{n6,peak}$	$V_{f1,peak}$	$V_{f2,peak}$
t1	44.59	7.36	17.0	6.92	7.58	10.99	12.37	20.32	20.88
t12	41.06	7.18	16.57	7.48	7.28	12.16	10.54	10.67	9.86
t20	36	7.16	16.58	6.23	5.83	12.24	8.46	8.15	8.65
m1	46.68	7.87	21.61	6.8	7.16	9.84	9.7	13.72	13.55
m20	58.45	7.9	23.4	7.3	6.35	11.35	10.07	6.74	5.82
b1	60.02	8.05	23.24	9.25	8.63	9.7	7.38	37.8	31.91
b12	51.77	7.07	26.45	6.06	4.51	8.7	6.32	17.7	18.07
b20	54.95	6.22	22.27	4.26	5.94	9.86	6.4	17.63	13.4
tc1	19.5	10.5	3.39	-	-	-	-	6.21	6.2
tc2	19.11	9.76	3.39	-	-	-	-	5.94	5.94
tc3	17.81	7.71	2.73	-	-	-	-	5.04	5.04
tc4	28.32	12.26	4.38	-	-	-	-	8.2	8.2
tc5	36.7	13.9	8	-	-	-	-	13.65	13.65
tc6	32.97	13.93	13.93	-	-	-	-	9.52	9.52
tc7	44.12	16.18	5.49	-	-	-	-	16.78	16.78

IEEE P802.3ap - Ethernet Backplane

3. Crosstalk penalty (2)

Table 2: Crosstalk peak voltage (mV_{peak}) values for 0,1, and 2 UI, channel m20

Delay	$V_{x,peak}$	$V_{n1,peak}$	$V_{n2,peak}$	$V_{n3,peak}$	$V_{n4,peak}$	$V_{n5,peak}$	$V_{n6,peak}$	$V_{f1,peak}$	$V_{f2,peak}$
0	58.45	7.9	23.4	7.3	6.35	11.35	10.07	6.74	5.82
1 UI (next)	42.14	13.94	27.11	7.55	7.97	12.28	8.96	6.78	6.46
2 UI (next)	38.58	10.7	31.18	7.55	10.24	12.77	7.1	6.78	6.46
1 UI (fext)	54.13	7.9	23.4	7.3	6.35	11.35	10.07	6.78	6.46
2 UI (fext)	54.86	7.9	23.4	7.3	6.35	11.35	10.07	6.78	6.47

- The contributions from FEXT do not change significantly with added delay.

- The contributions from NEXT will depend on pattern timing, the reflected pulses and the pattern pulse will have different phases, depending on the applied delay.

- Individual next and fext peak values and the cumulative crosstalk peak value may vary in opposite directions.

4. Crosstalk enhancement

- The receive equalizer will amplify the high frequency content of the crosstalk signal, crosstalk enhancement.

- The simulation for Intel channel T1, with the equalizer set for 1E-15 BER, shows a 2 dB increase in the peak crosstalk voltage.
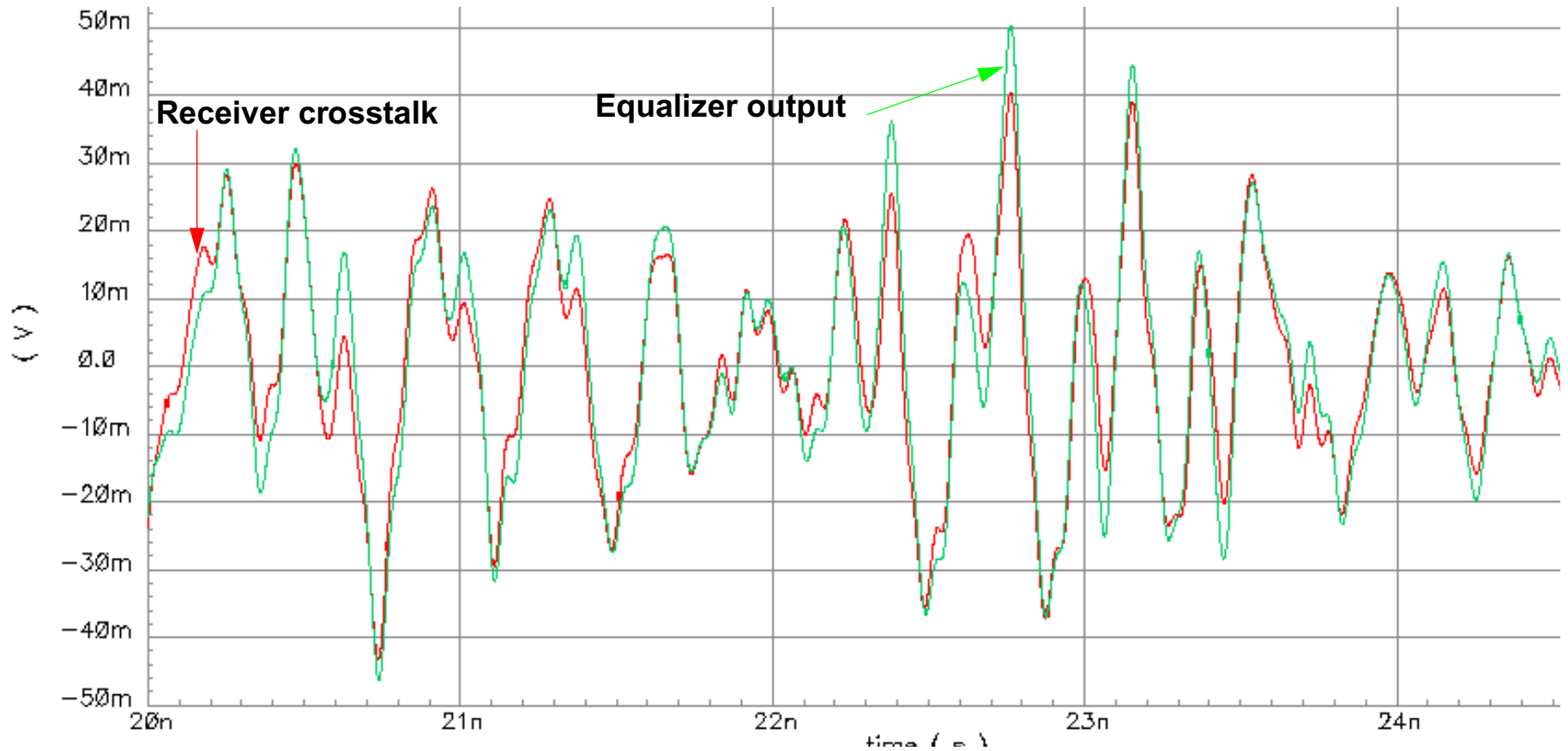
5. Summary

- Crosstalk impact on receiver performance has been reviewed for 8 channels from Intel and 7 channels from Tyco.

- The simulations are based on a PRBS15 NRZ transmitted data. Transmitter signal amplitude is assumed 600 mVpp differential. A pulse shaping filter is used to limit the rise and fall times to 30 ps. Transmitter equalization was not included.

- The receiver is modelled using a fourth order BT LPF (7.5 GHz).

- The maximum peak crosstalk voltage, for a given channel has a variation of +/- 20% depending on the data pattern phase.

- The correlation between crosstalk impulse response and peak voltage crosstalk is very low.

- The receive equalizer will enhance the crosstalk signal (the high frequency part of the spectrum). The additional penalty will depend on the signalling method adopted.