

Presentation to IEEE P802.3ap Backplane Ethernet Task Force March 2005 Working Session

Title: NRZ/DFE Simulation Results over Ad-hoc Channels

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Date: March 11, 2005

Abstract: This contribution provides simulation results of performance analysis across the set of test channels proposed for use by the signaling ad-hoc. Simulations are performed using a full function simulator which constructs a complete end to end transceiver-package-channel-package-transceiver model.

Outline



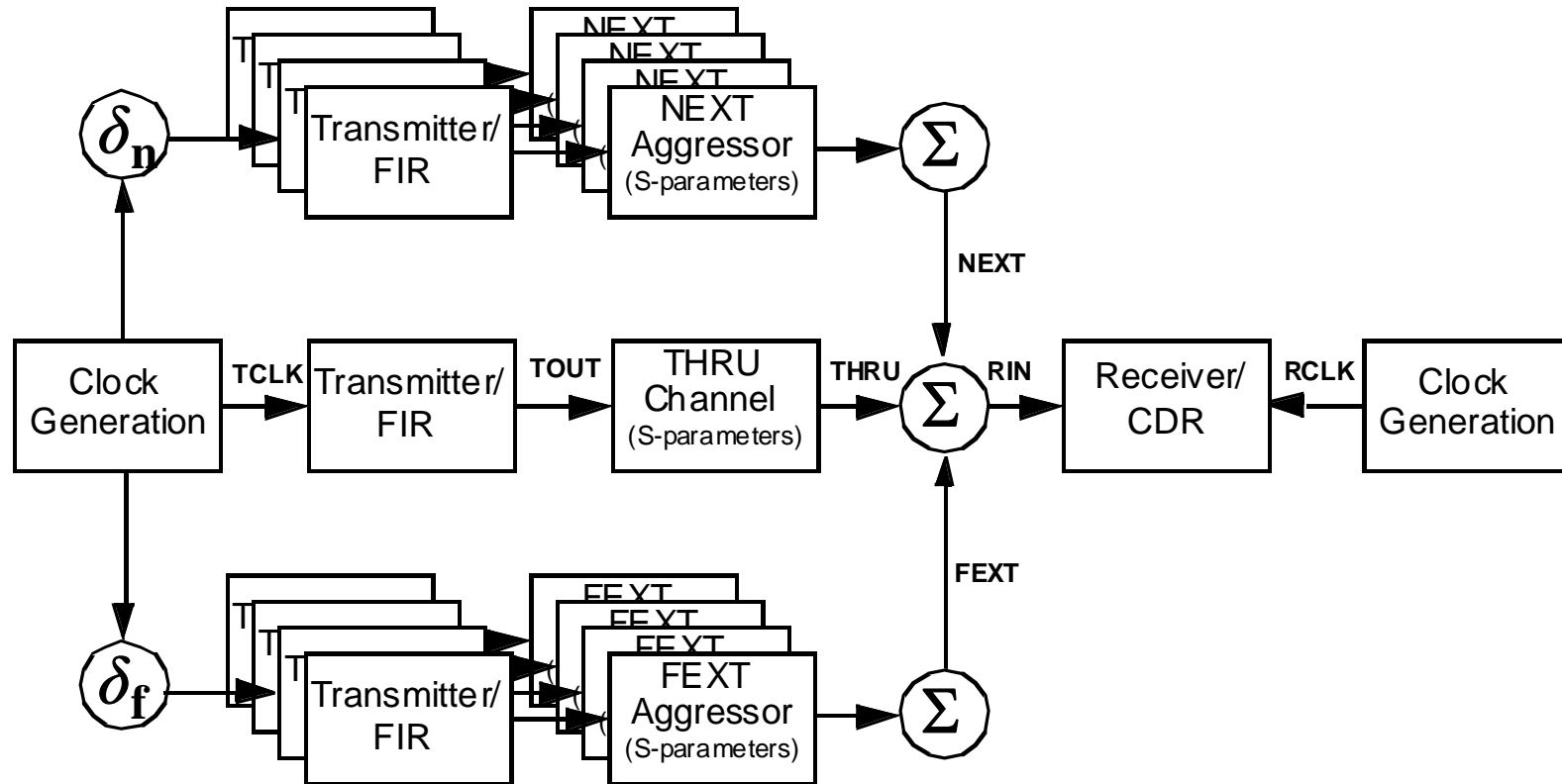
Configuration for signaling ad-hoc simulation model

Configuration to explore primary impairments in channels

Simulation results

Summary

High Level Simulation Structure:



Simulation setup for ad-hoc model

Simulation model summary

▪ Configuration	NRZ FFE3/DFE5
▪ Launch amplitude set to minimum	800 mVpp
▪ Transmitter DJ set to maximum	0.15 UIpp
▪ Transmitter RJ set to maximum	0.0107 UIrms (0.15UIpp @ 10^{-12} BER)
▪ Tx/Rx termination set to nominal (ideal)	5050/5050 ohms
▪ Receiver DJ	0.10 UIpp
▪ Receiver RJ set to maximum	0.0107 UIrms (0.15UIpp @ 10^{-12} BER)
▪ DCD	0.03 UI
▪ Data rate	10.3 Gbps
▪ Receiver offset	0 ppm
▪ Data pattern	PRBS15
▪ Random noise	1.46mV rms
▪ AC coupling:	not included (DC coupled)
▪ Package	Spec_RL_cap_like
▪ Simulation time	1M bits

Results provided for 3 different BERs

- ▶ E-12, E-15, E-17 (simulator defaults, not re-written to provide E-18)
- ▶ Results are actual margins
 - Simulations include all Xtalk channels, PNA effects, full CDR algorithm, minimum latch overdrive, etc.

Simulation Runs

Primary results provided based on signaling ad-hoc setup

- ▶ As defined on previous page
- ▶ Summary provided for Goergen, Tyco, Molex, and Peters channels @ BER of E-12
 - Complete results provided in spreadsheet

Additional runs to examine effects of key impairments on Tyco, Molex, & Peters channels

- ▶ Ad-hoc setup excluding NEXT channels
- ▶ Ad-hoc setup excluding FEXT channels
- ▶ Ad-hoc setup excluding all Xtlk channels (NEXT and FEXT)
- ▶ Ad-hoc setup excluding Xtlk and DCD (PNA effects)

Additional configuration to further explore Peters channels

- ▶ FFE4/DFE10 configuration
- ▶ NOTE: This is not proposed or recommended as an implementation approach
 - Significant area/power penalty imposed on higher quality channels

Results for Goergen Channels



timing margin (ps _{p-p} @ BER 10 ⁻¹²)	Ch #1	Ch #2	Ch #3	Ch #4	Ch #5	Ch #6	Ch #7
Signal ad-hoc setup	10.3	15.3	21.5	12.7	2.3	16.1	16.7

voltage margin (mV _{p-p diff} @ BER 10 ⁻¹²)	Ch #1	Ch #2	Ch #3	Ch #4	Ch #5	Ch #6	Ch #7
Signal ad-hoc setup	35	49	69	40	2	52	61

Results for Tyco Channels



timing margin (ps _{p-p} @ BER 10 ⁻¹²)	Case1	Case2	Case3	Case4	Case5	Case6	Case7
Signal ad-hoc setup	15.1	14	9.4	21.1	21.7	4.1	16.3
no NEXT	19.2	17.4	12.2	24.3	26.7	10.4	20.3
no FEXT	19.6	17.5	9.5	23.3	31.4	8.9	16.2
no Xtlk	23.5	22.7	12.8	28	28.7	13.1	12
no Xtlk or DCD	29.2	25.9	22	30.2	24.8	17.2	21.4

voltage margin (mV _{p-p diff} @ BER 10 ⁻¹²)	Case1	Case2	Case3	Case4	Case5	Case6	Case7
Signal ad-hoc setup	38	43	20	59	64	12	53
no NEXT	62	53	28	81	88	37	62
no FEXT	57	50	22	70	108	26	47
no Xtlk	72	66	30	88	112	45	43
no Xtlk or DCD	92	81	53	100	96	58	71

Results for Molex Channels



	Inbound				Outbound			
timing margin (ps _{p-p} @ BER 10 ⁻¹²)	j2k2	j3k3	j4k4	j5k5	j2k2	j3k3	j4k4	j5k5
Signal ad-hoc setup	3.6	E-11	E-07	7.0	13.9	4.6	8.2	15.8
no NEXT	7.5	6.7	E-10	9.7	16.4	11.6	15.7	18.1
no FEXT	12.3	20.8	18.1	22	27.2	23.9	23	26.3
no Xtlk	13.6	18.6	12.4	24.7	25.7	23.9	24.7	29.8
no Xtlk or DCD	19.3	21.6	15.4	24.7	25	27.8	27.8	26.8

	Inbound				Outbound			
voltage margin (mV _{p-p, diff} @ BER 10 ⁻¹²)	j2k2	j3k3	j4k4	j5k5	j2k2	j3k3	j4k4	j5k5
Signal ad-hoc setup	11	0	0	18	38	8	27	40
no NEXT	21	17	0	30	49	27	33	36
no FEXT	39	53	51	68	74	67	69	69
no Xtlk	46	59	39	74	82	74	80	82
no Xtlk or DCD	65	73	54	85	91	95	91	90

Results for Peters Channels



	Bottom			Middle		Top		
timing margin (ps _{p-p} @ BER 10 ⁻¹²)	b1	b12	b20	m1	m20	t1	t12	t20
Signal ad-hoc setup	9.3	5.8	0.9	7.3	0.2	E-05	E-05	E-04
no NEXT	15.3	12.6	16.5	8.5	21.4	E-05	E-09	0.1
no FEXT	14.9	12	2.3	9.1	10.9	E-05	E-05	E-04
no Xtlk	16	20.9	15.8	11.6	20.8	E-07	E-08	3.2
no Xtlk or DCD	20.7	15.9	22.4	8.2	20.5	E-06	E-09	5.6

	Bottom			Middle		Top		
voltage margin (mV _{p-p_diff} @ BER 10 ⁻¹²)	b1	b12	b20	m1	m20	t1	t12	t20
Signal ad-hoc setup	30	18	2	21	2	0	0	0
no NEXT	53	39	46	29	46	0	0	2
no FEXT	42	41	7	38	28	0	0	0
no Xtlk	62	69	55	42	51	0	0	10
no Xtlk or DCD	74	54	68	27	74	0	0	17

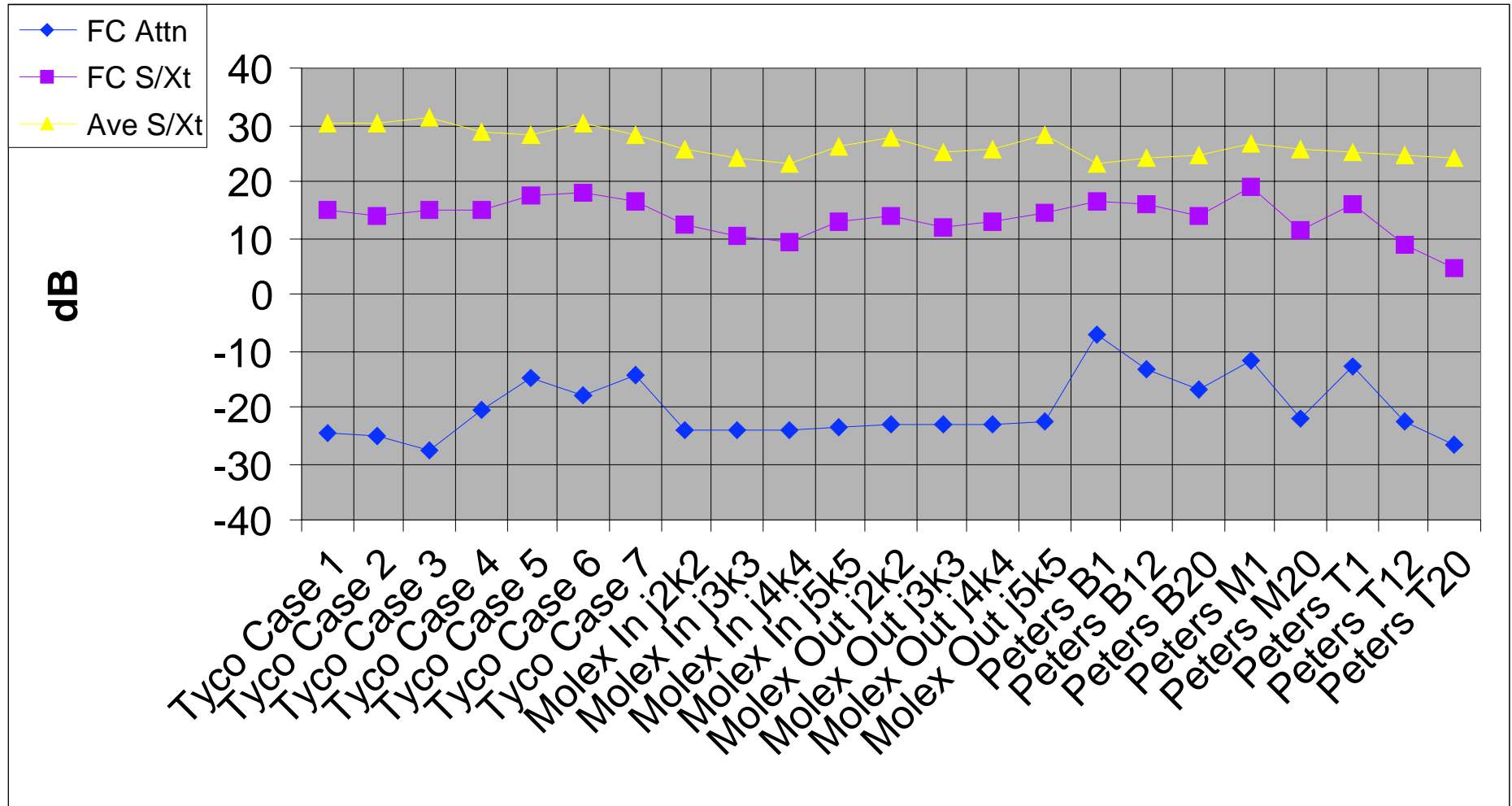
Results for Peters Channels - FFE4/DFE10



	Bottom			Middle		Top		
timing margin (ps _{p-p} @ BER 10 ⁻¹²)	b1	b12	b20	m1	m20	t1	t12	t20
ffe4/dfe10 ad-hoc setup	14.3	8.7	6.8	10	10.7	E-08	E-06	E-05
no NEXT	11.1	19	16.3	9.5	18.9	E-11	0.7	0
no FEXT	17	15.4	5.9	10.1	12.3	E-07	E-05	E-05
no Xtlk	20.7	21.7	17.2	14	24.1	E-011	0.1	5.7
no Xtlk or DCD	21.5	27	21.9	17	23.7	4.7	0.1	11.3

	Bottom			Middle		Top		
voltage margin (mV _{p-p_diff} @ BER 10 ⁻¹²)	b1	b12	b20	m1	m20	t1	t12	t20
ffe4/dfe10 ad-hoc setup	70	24	24	40	32	0	0	0
no NEXT	57	77	70	48	67	0	4	1
no FEXT	86	68	20	57	42	0	0	0
no Xtlk	106	98	84	69	78	0	1	13
no Xtlk or DCD	101	107	80	81	95	13	2	34

Channel Characteristics



Channel Solution Set



Summary:

- ▶ Tyco channels: moderate to severe attenuation, moderate crosstalk, low to severe stub effects
 - Marginal channels are primarily limited by stub effects
- ▶ Molex channels: severe attenuation, high to severe crosstalk, low stub effects
 - Channels are primarily limited by crosstalk
- ▶ Peters channels: low to severe attenuation, severe crosstalk, moderate to severe stub effects
 - Channels are limited by combination of stub effects and crosstalk

Minimum horizontal eye margin	Goergen	Tyco	Molex	Peters
10% margin at E-12	channel #1 channel #2 channel #3 channel #4 channel #6 channel #7	case 1 case 2 case 4 case 5 case 7	outbound j2k2 outbound j5k5	none
10% margin at E-15	channel #2 channel #3 channel #6 channel #7	case 4 case 5 case 7	outbound j5k5	none
10% margin at E-17	channel #3 channel #6 channel #7	case 4 case 5 case 7	none	none

Conclusion

NRZ/DFE signaling can meet the needs of 10Gbps Ethernet over backplane

- ▶ Already defined for 11Gbps OIF CEI Long Reach
- ▶ Prime candidate for 8.5Gbps FCS

The channel set before the working group is overly aggressive

- ▶ Significant subset is beyond the capabilities of reasonable serdes implementations
- ▶ This is true relative to all signaling proposals before the group

To get back on track the group needs to:

- ▶ Formalize a signaling selection
- ▶ Scale back on the channel set
- ▶ Roll up our sleeves and define a specification the industry can have confidence in