25Gb/s Technical Feasibility Results

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Introduction

- On June 22 Ethernet Alliance hosted a 25Gb/s Technical Feasibility Event @ UNH-IOL
- Participation by Amphenol Corporation; Arista Networks, Inc.; Cisco Systems, Inc.; Dell, Inc.; FCI; Hitachi, Ltd.; Intel Corporation; Ixia; Luxshare-ICT; Marvell Technology Group Ltd.; Mellanox Technologies Ltd.; Molex Incorporated; QLogic Corporation; Spirent Communications Plc.; TE Connectivity Ltd.; and Xilinx, Inc.

Foreword

- The devices and channels used during this testing were not necessarily designed to meet any specific 25Gb/s standard, and should be considered “as-is.”
- Interoperability results are from “system” level interoperability – Fault is not assigned to any single device or channel in the system
- Some testing was “experimental” and the data may contain results with non-optimal settings

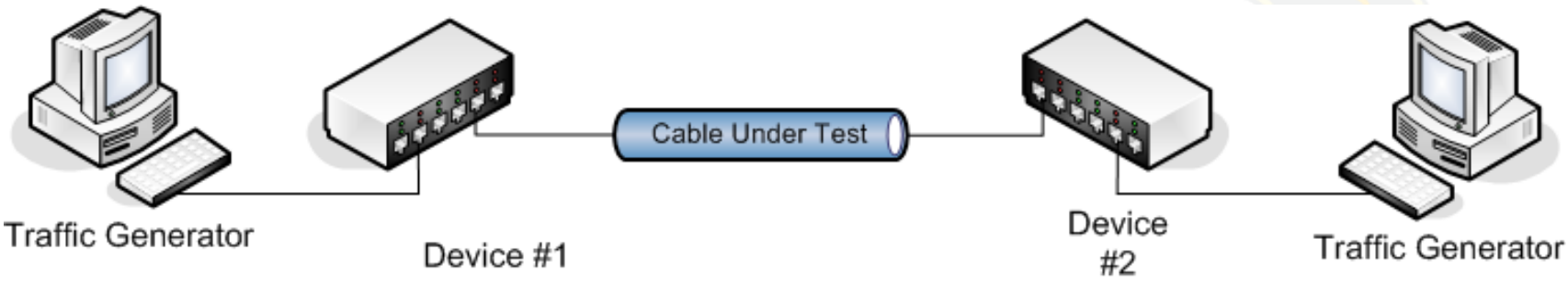
Executive Summary

- Overall success (establishing Link and meeting target BER) was 86.4%. FEC off for 99% of test cases
- There were successful test results of >=3m with no FEC.
- Cables with COM values >2 dB exhibited a 91% or greater pass rate.
- The level of maturity of the technology observed considered high given the early stage of the standardization process.
- Industry needs to address: implementation of auto-negotiation, memory mapping, compliance to transmitter output waveform

Overview of Tests

- Test #1 - Link configuration involved establishing link and hot-plugging both ends of the interconnecting channel.
- Test #2 (“BER Confidence Test”) – involved sending traffic for ~2-5 minutes. Traffic varied from packets to PRBS patterns. Any error was counted as a “fail.” Establishes a minimum confidence interval level of 95% for BER 1E^-12.
- Test #3 – Transmitter output waveform – electrical evaluation
- Test #4 – Channel characterization – Electrical evaluation

General Test Setup



Transmitter Output Waveform Summary

Test Name	Device A	Device B	Device C	Device D	Device E	Lower Limit*	Upper Limit*
DC Amplitude (V*f*)	0.44751	0.533631326	0.415675	0.277187	0.533133	0.34	0.6
Peak p(k)	0.233111	0.368567632	0.232602	0.169287	0.327673	-	-
Minimum pk allowed (V*f*) x 0.45	0.201379	0.240134097	0.187054	0.124734	0.23991	-	-
RMS error – e(k)	0.05836	0.065727642	0.047724	0.050281	0.057006	-	
C(0)	0.998983	0.999647388	0.999911	0.99908	0.999835	-	-
C(-1)	0.003719	0.001745956	0.000897	0.002849	0.001222	-	-
C(+1)	0.000329	0.000566087	-0.00017	0.000906	-0.00017	-	-
C(0) Increment	0.008051	0.000187361	0.013403	0.03556	0.015721	0.0083	0.05
C(0) Decrement	0.008678	6.73549E-05	0.013465	0.035627	0.026897	0.0083	0.05
C(-1) Increment	0.004962	0.011488424	0.006525	0.006581	0.000112	0.0083	0.05
C(-1) Decrement	0.004813	0.011526296	0.007011	0.006981	0.010659	0.0083	0.05
C(+1) Increment	0.005209	0.000331949	0.011177	0.009276	0.005016	0.0083	0.05
C(+1) Decrement	0.004048	5.03547E-05	0.01031	0.008751	0.012469	0.0083	0.05
C(-1) Equalizer Coefficient Initialization	1.070769	1.371046609	1.374049	1.203023	1.018193	1.161	1.419
C(+1) Equalizer Coefficient Initialization	2.051107	2.463755484	2.531321	2.432014	1.015482	2.313	2.827
C(+1) Coefficient Full-scale Ratio	1.954251	5.726292815	1.327338	1.116824	3.073825	4	-
C(-1) Coefficient Full-scale Ratio	0.995777	0.998221324	1.03315	1.018216	2.236523	1.54	-

- Upper / Lower limits are based on Clause 92.8.3.5, no limits yet defined for 802.3by Draft 1.1
- May not represent optimized values, due to time available for Tx setup

COM Observations

- Many of the cables brought to the event weren't designed for this specific standard and may have been designed for alternative “25Gb/s or greater” technologies.
- The worst case cables available were chosen to push the limit and stress the robustness of the technology.
- Despite very few COM passes of CA-N cables, interoperability still occurred at reasonably high rate.

COM Summary

Cable	Connector	Length	CA-N COM Test 1	CA-N COM Test 2	CA-S COM Test 1	CA-S COM Test 2	CA-L COM Test 1	CA-L COM Test 2
A	SFP	1m	3.992	3.5785	5.6539	5.2522	7.7251	7.3273
B	SFP	1m	3.9108	3.3037	5.5625	4.9897	7.5511	7.1366
C	SFP	1m	3.8388	3.178	5.498	4.8616	7.5189	6.971
D	QSFP	1m	3.4091	2.6159	5.0618	4.3058	7.1528	6.4388
E	SFP	2m	3.1084	2.3452	4.7919	4.0787	6.8926	6.22
F	QSFP	3m	3.0246	1.9837	4.7037	3.6965	6.8323	5.9072
G	SFP	3m	2.9757	2.141	4.6638	3.8534	6.8149	5.9886
H	SFP	3m	2.8011	1.8912	4.5007	3.6283	6.5855	5.8233
I	QSFP	3m	2.6544	1.81	4.3643	3.5748	6.6033	5.697
J	QSFP	3m	2.6038	1.7768	4.2993	3.5073	6.5316	5.848
K	SFP	2m	2.3387	1.5288	4.0844	3.2994	6.3095	5.4956
L	QSFP	3m	2.2693	1.4569	3.9489	3.1728	6.2241	5.4551
M	QSFP	2m	2.1982	1.2001	3.8988	2.9572	6.1031	5.1455
N	QSFP	3m	2.1556	1.3199	3.887	3.0788	6.1659	5.3776
O	SFP	4m	1.7917	0.6397	3.5408	2.4181	5.7189	4.7464
P	SFP	3m	1.3401	0.0785	3.0768	1.8518	5.2452	4.1242
Q	SFP	5m	0.3455	-1.0693	2.1137	0.6678	4.3219	3.1353
R	SFP	5m	0.2735	-1.386	2.0255	0.3005	4.3649	3.0239
S	QSFP	3m	0.026097	-1.386	1.7662	0.30945	4.1662	2.8413
T	QSFP	6m	-0.00868	-1.4963	1.7768	0.25562	4.0685	2.7217
U	QSFP	2m	-0.18902	-1.467	1.5559	0.26457	3.7417	2.6507
V	SFP	3m	-0.3989	-1.9034	1.3607	-0.1975	3.715	2.3952
W	SFP	5m	-0.9065	-2.5161	0.8479	-0.82	3.2735	1.8625
P/F			6 / 23	3 / 23	16 / 23	13 / 23	23 / 23	18 / 23

System Interoperability Results

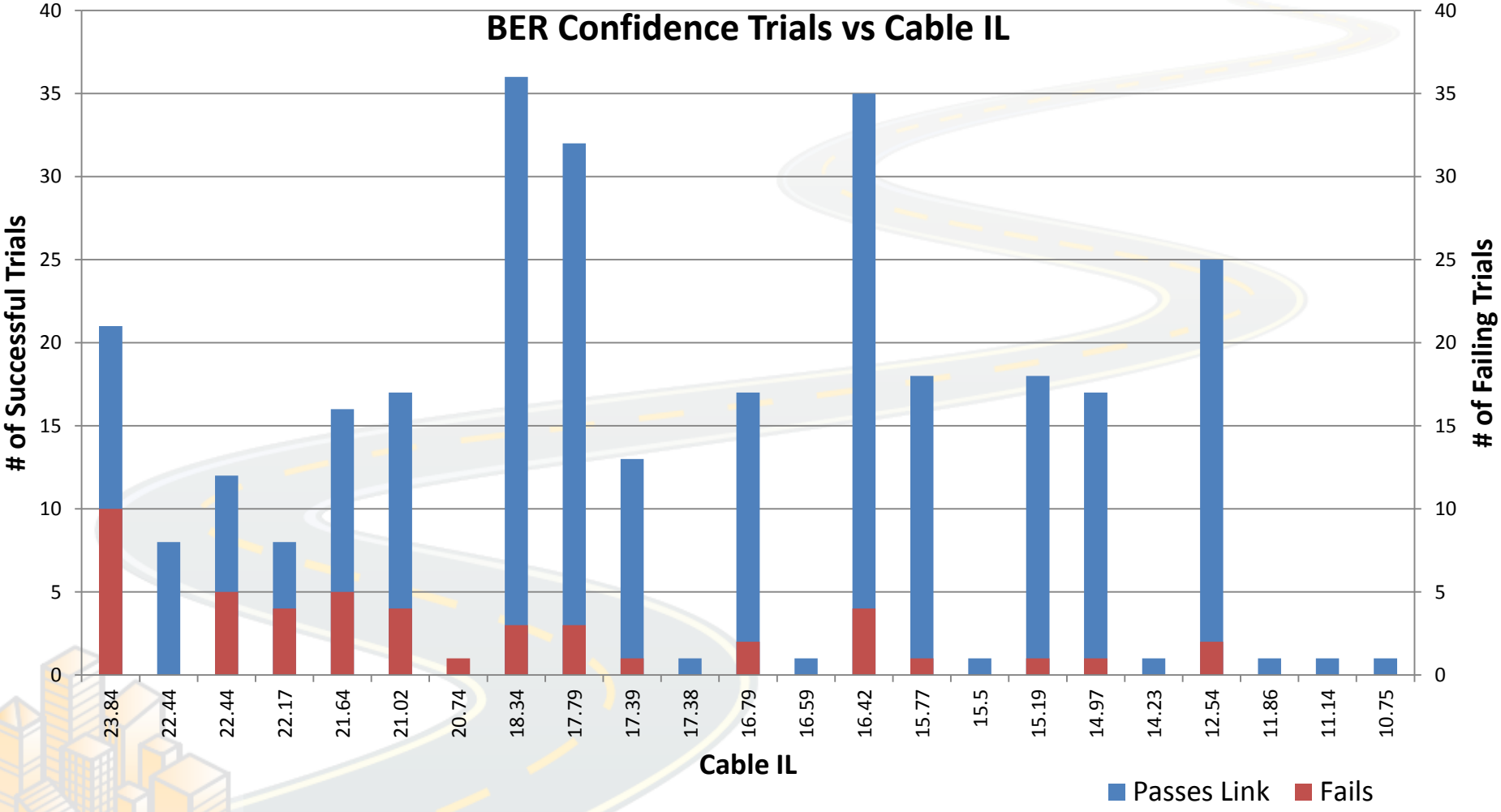
349 Link Configuration attempts recorded
331 “BER Confidence Test” attempts
Cable IL varied from 10.75 to 23.84 dB
FEC Status – Off for 99% of test cases

Key Interoperability Pass/Fail Ratios	
Pass ratio for Link Configuration (All devices)	94.8%
Pass ratio for BER Confidence Test on established links	91.1%
Overall Success ratio	86.4%
Pass ratio for Link Configuration (Without Self testing)	93.8%
Overall Success ratio (Without self testing)	84.2%
Percentage of links established via Auto-Negotiation	4.5%

Cable IL effects on Interoperability

Link Configuration	BER Confidence Test	Insertion Loss of Cable (Host Loss not included, see section 6)	# of trials Link Config	# of trials BER
80.65%	67.74%	23.84	31	31
100.00%	100.00%	22.44	8	8
94.12%	70.59%	22.44	17	17
100.00%	66.67%	22.17	13	12
95.24%	76.19%	21.64	21	21
85.71%	80.95%	21.02	21	21
0.00%	0.00%	20.74	1	1
97.44%	92.31%	18.34	39	39
100.00%	91.43%	17.79	36	35
92.86%	92.86%	17.39	14	14
100.00%	100.00%	17.38	1	1
94.74%	89.47%	16.79	19	19
100.00%	100.00%	16.59	1	1
97.44%	89.74%	16.42	39	39
100.00%	94.74%	15.77	19	19
100.00%	100.00%	15.5	1	1
100.00%	94.74%	15.19	19	19
94.44%	94.44%	14.97	18	18
100.00%	100.00%	14.23	1	1
96.30%	92.59%	12.54	27	27
100.00%	100.00%	11.86	1	1
100.00%	100.00%	11.14	1	1
100.00%	100.00%	10.75	1	1

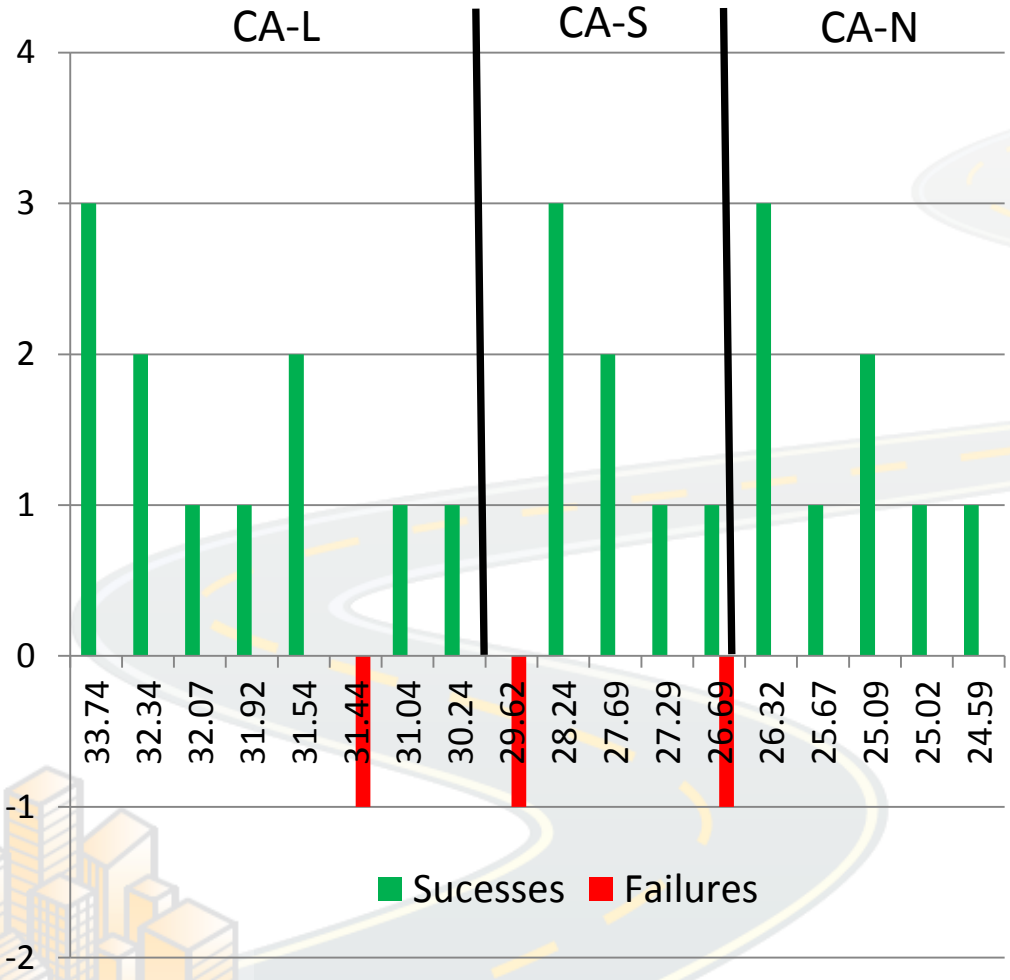
BER Confidence Test Trials vs Cable IL



Interoperability Test Success Rate vs COM

COM Margin (CA-N Test 1)	Link Configuration Success	BER Confidence Test Success
COM > 3db	98%	94%
3 db < COM < 2.5 dB	96%	91%
2.5 db < COM < 2.0 dB	98%	92%
COM < 2.0 db	91%	77%
COM Margin (CA-N Test 2)	**Link Configuration Success**	**BER Confidence Test Success**
COM > 1.2db	97%	92%
COM < 1.2 db	91%	77%

Total IL effects on BER Confidence Test (NO FEC)



- Total IL estimated by adding worst case Tx host IL with worst case Rx host IL with cable IL
- NO FEC
- Observed “failures” noted with different devices and cables

IL	Limit	Total IL
22.48	CA-L	36.1
16.48	CA-S	30.1
12.98	CA-N	26.6