BER objective for nAUI I/F

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Mark Gustlin – Cisco
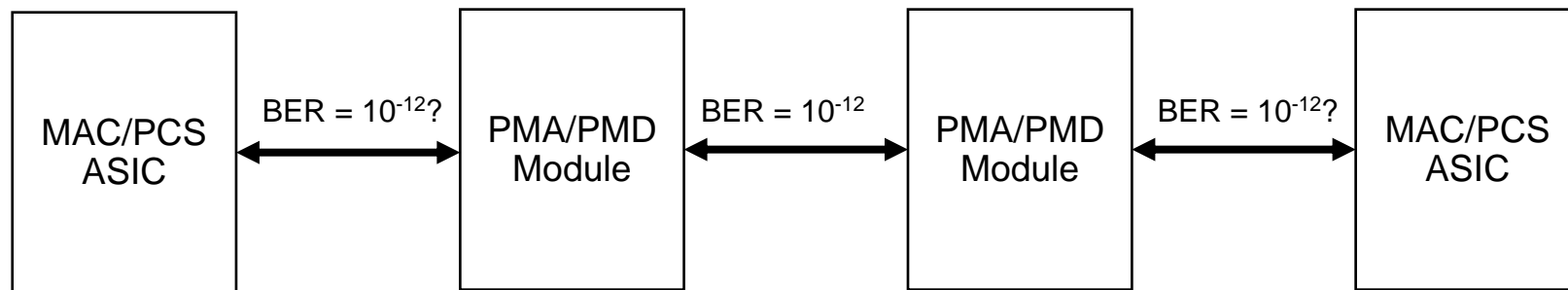**Mike Li –Altera**

Supporters

- Ali Ghiasi – Broadcom

- Ryan Latchman - Gennum

Background

Our Project BER objective is:

- Support a BER better than or equal to 10^{-12} at the MAC/PLS service interface

- But the Optional nAUI is just one link in the chain of interfaces, should its BER be 10^{-12} or something better?

Background

MAC/PCS ASIC — BER = 10^{-12}? — PMA/PMD Module — BER = 10^{-12} — PMA/PMD Module — BER = 10^{-12}? — MAC/PCS ASIC

- If we have three segments, each with a BER of 10^{-12}, then the overall BER objective of 10^{-12} is not met (instead we get 3×10^{-12})

- If we leave the PMD to PMD link at 10^{-12} then the nAUI I/F should be at least a couple of orders of magnitude better to not significantly impact the overall BER of the system

Why we need a better BER for nAUI

- If nAUI is anything like XAUI, it will gain widespread industry acceptance for many applications

- A chip-to-chip BER of 10^{-12} is **_not_** sufficient for many applications (too many drops, see table below for 100GbE)

- But it takes a long time to test to 10^{-15}? Not necessary:

  - Design for 10^{-15}

  - Test and extrapolate to 10^{-15} (for PMA, BER at 10^{-9} or smaller is largely affected by small probability random jitter (RJ) that is well-modeled by Gaussian, enabling accurate extrapolation)

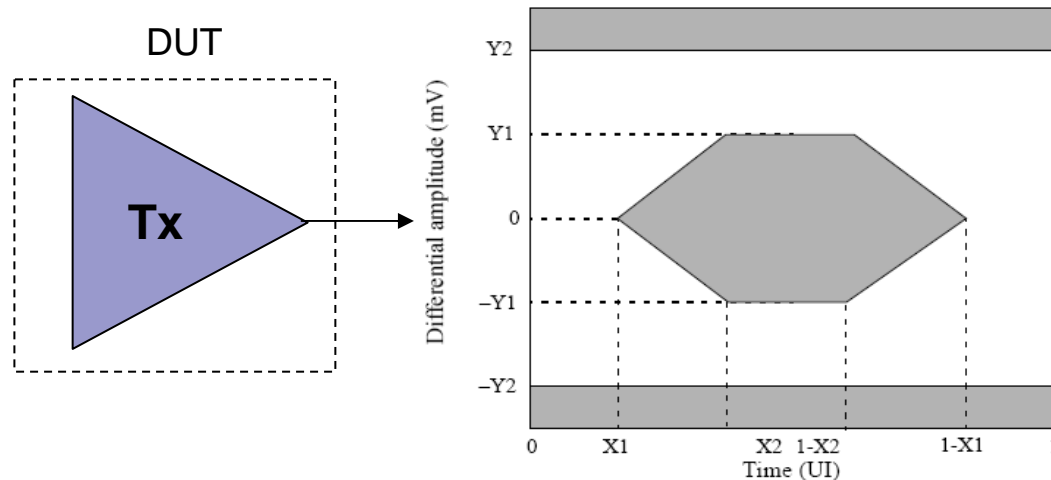| BER	Packet drops per Minute	Packet drops per hour
10^{-12}	6	371
10^{-13}	.6	37
10^{-14}	.06	3.7
10^{-15}	.006	.37

Feasibility: Today's Transceiver Can Support BER = 10^{-15}

Experimental Results From A 40 nm FPGA (Altera) SERDES Test Chip Transmitter

- **Test Pattern**

    PRBS 2^{31}-1

- **Vod**

    600 mV

- **DJ (δ-δ)**

    5.08 ps, 0.0524 UI

    Exceeds D1.0 XLAUI/CAUI requirement (0.17 UI)

- **RJ (rms)**

    1.46 ps, 0.0151 UI

- **TJ (@ BER = 10^{-12}, measured)**

    25.6 ps, 0.264 UI

    Exceeds D1.0 XLAUI/CAUI requirement (0.32 UI)

- **TJ (@ BER = 10^{-15}, extrapolated)**

    28.26 ps, 0.291 UI

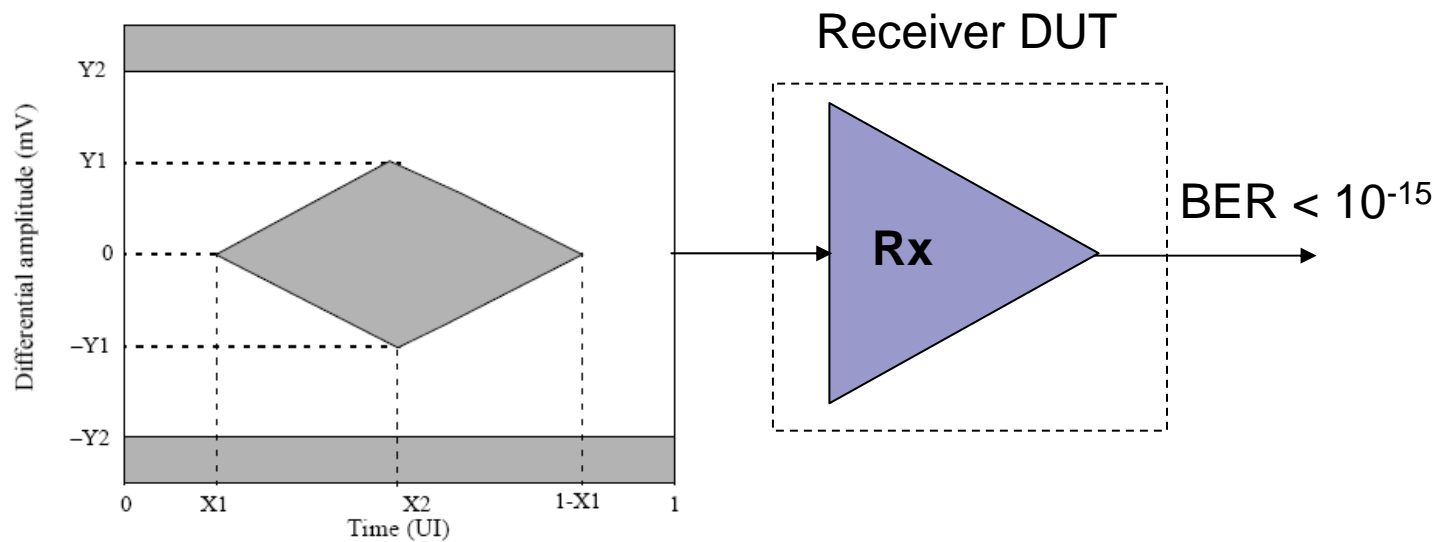   Still exceeds D1.0 XLAUI/CAUI requirement (0.32 UI)

10.3125 Gbps
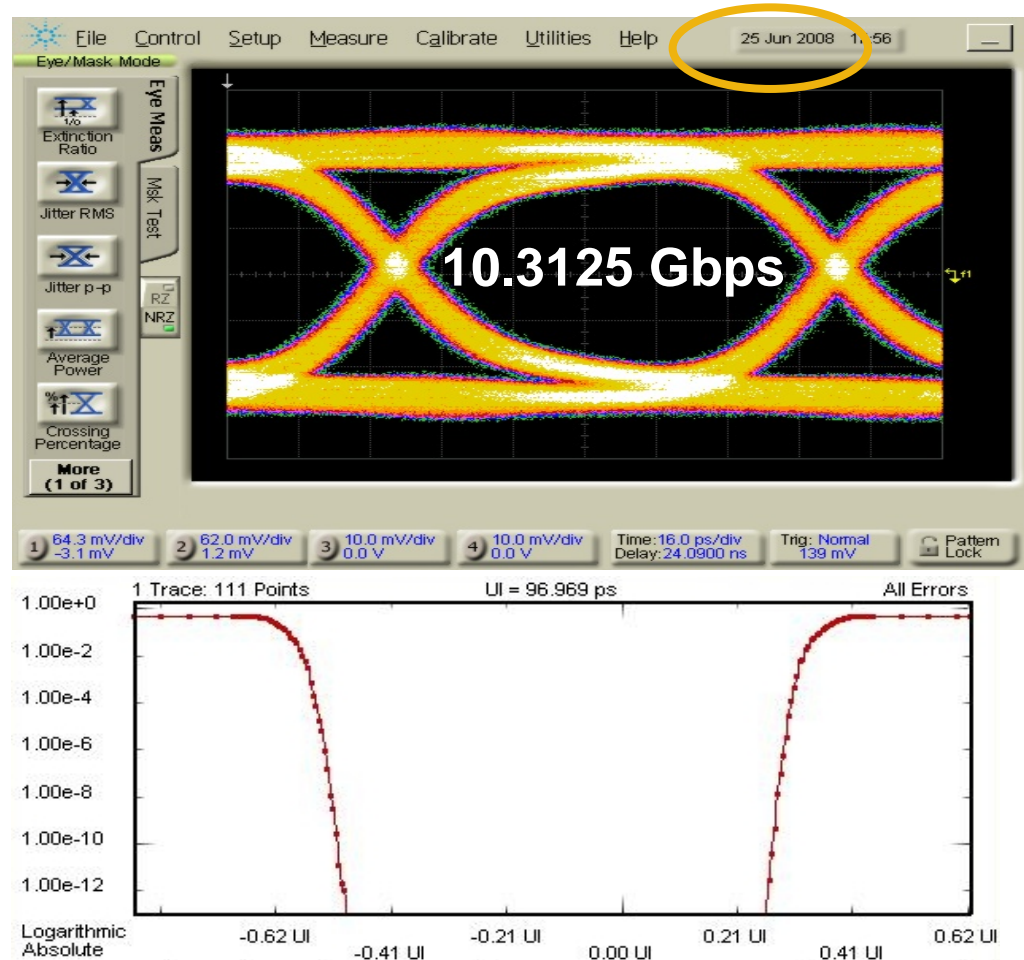
nAUI Transmitter Signaling/Jitter Test

DUT

Maximum Total Jitter	0.32	UI
Maximum Deterministic Jitter	0.17	UI
Transmitter eye mask definition X1	0.16	UI
Transmitter eye mask definition X2	0.38	UI
Transmitter eye mask definition Y1	190	mV
Transmitter eye mask definition Y2	380	mV

- Eye mask will be corresponding to BER=10^{-15} rather than 10^{-12}

- Gaussian for random jitter/noise will be used for extrapolation from BER=10^{-12} to BER=10^{-15}

Receiver DUT

Rx

BER < 10^{-15}

Maximum Total Jitter	0.62	UI
Maximum non-EQ Jitter (TJ - ISI)	0.42	UI
Receiver eye mask definition X1	0.31	UI
Receiver eye mask definition X2	0.5	UI
Receiver eye mask definition Y1	45	mV
Receiver eye mask definition Y2	425	mV

Conclusions

- A BER objective for the nAUI of 10^{-15} is reasonable

  Chip-to-chip interfaces must be have a BER $< 10^{-12}$

  An objective of 10^{-15} is achievable with today's technology

  With a 10^{-15} objective for the nAUI, the PMD interface objective can remain at 10^{-12}