Approach For Supporting Legacy Channels Per IEEE 802.3bj Objective

Jitendra Mohan, Texas Instruments

Pravin Patel, IBM

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Agenda

- **Approach to enable NRZ over legacy channels**
  - **Per *Mohan_0917_v2, Chicago meeting***
- **Example legacy channel**
- **Simulation Results**
- **Summary**

Supporters

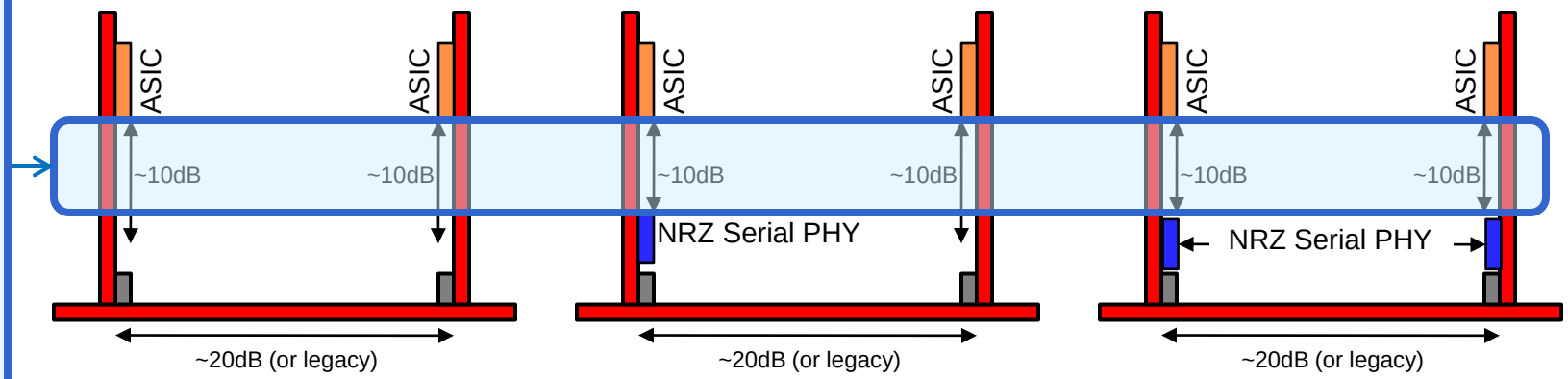
- **Tom Palkert, Xilinx**
- **Myles Kimmitt, Emulex**
- **Peerouz Amleshi, Molex**
- **Mark Bugg, Molex**
- **Iain Robertson, TI**
- **Karl Muth, TI**

Long reach proposal

Mohan_0911_v2.pdf, Sep 2011 IEEE meeting, Chicago

- **Break the longest links into two or three segments**
  - **Consider the following example for a 40dB loss channel that may prove difficult for NRZ**
  - **End to end loss: 40dB**
  - **Two segments: 30dB and 10dB**
  - **Three segments: 10dB, 20dB and 10dB → theoretically >>40dB!**

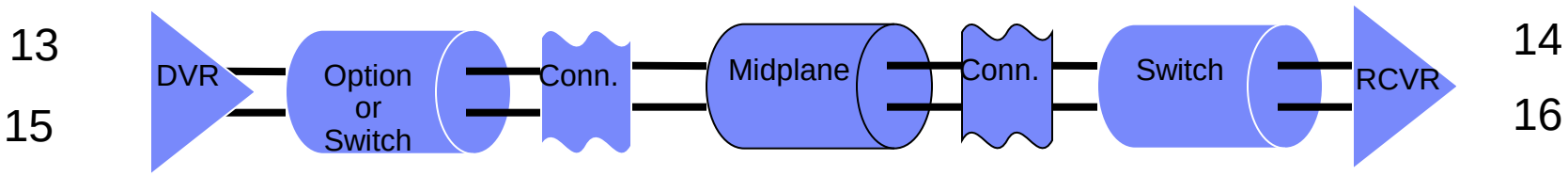
Similar to CEI-VSR host channel



- **Benefits**
  - **Extend the reach of NRZ beyond 40dB**
  - **Retain the benefits of NRZ – backward compatibility, forward integration etc.**
  - **No $$ penalty for majority of 25G links that are much better than KR**

Simulated Channel Construction

Contribution: Pravin Patel, IBM



	Option/Switch	Backplane	Switch
Length	3”	20” – 24”	3”
Board Thickness (mils)	96	220	120
Trace Widths (mils)	7.5mil	7.5mil	7.5mil
# of Layers	12	26	14

All Printed Circuit Boards:

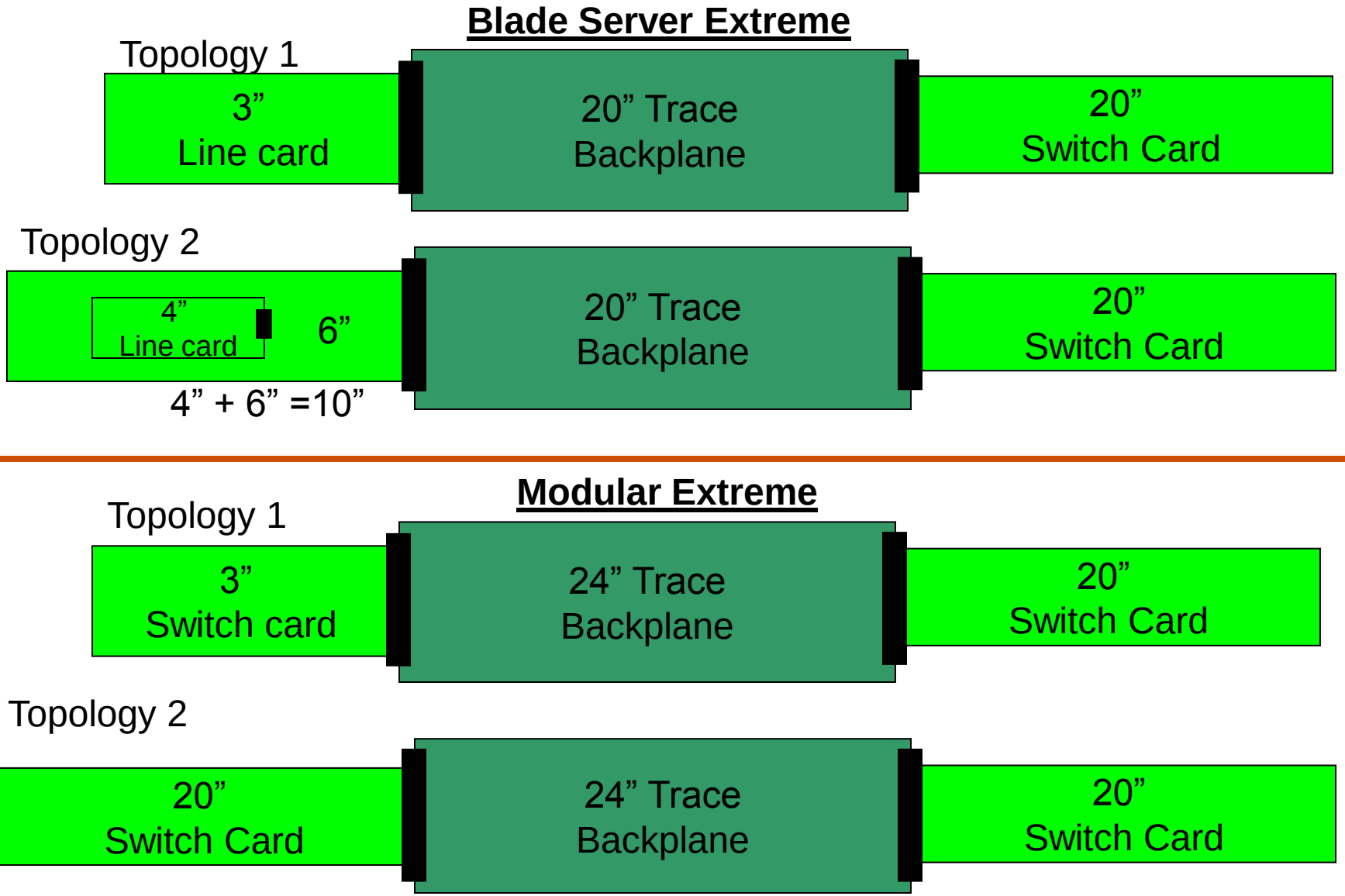
- Signal Layer: 1/2 oz copper
- Stripline: Yes
- Material: 802.3ap Improved FR4
- Df: 3.6@ 1Ghz
- Df: 0.0092 @ 1Ghz
- Via stub: ~ 15mil
- Differential Impedance: 100 Ohm
- Connector: Impact Plus

Tools:

- Ansoft Q3D for Tline models
- Ansoft HFSS for Via model
- Ansoft Designer to combine models
- Djordjevic-Sarkar Model for Frequency dependent loss

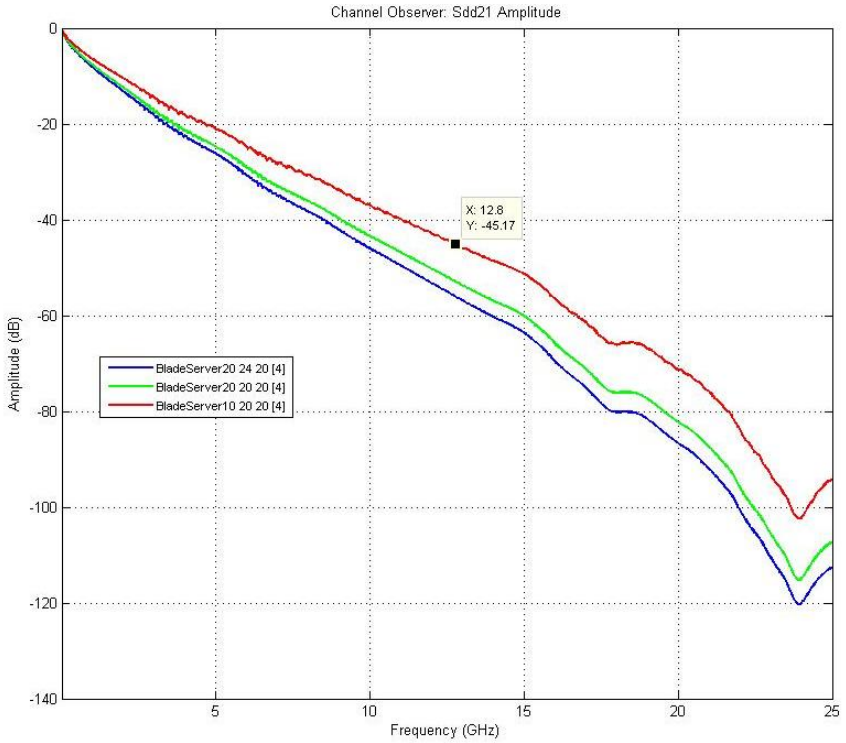
Legacy Channels

Contribution: Pravin Patel, IBM



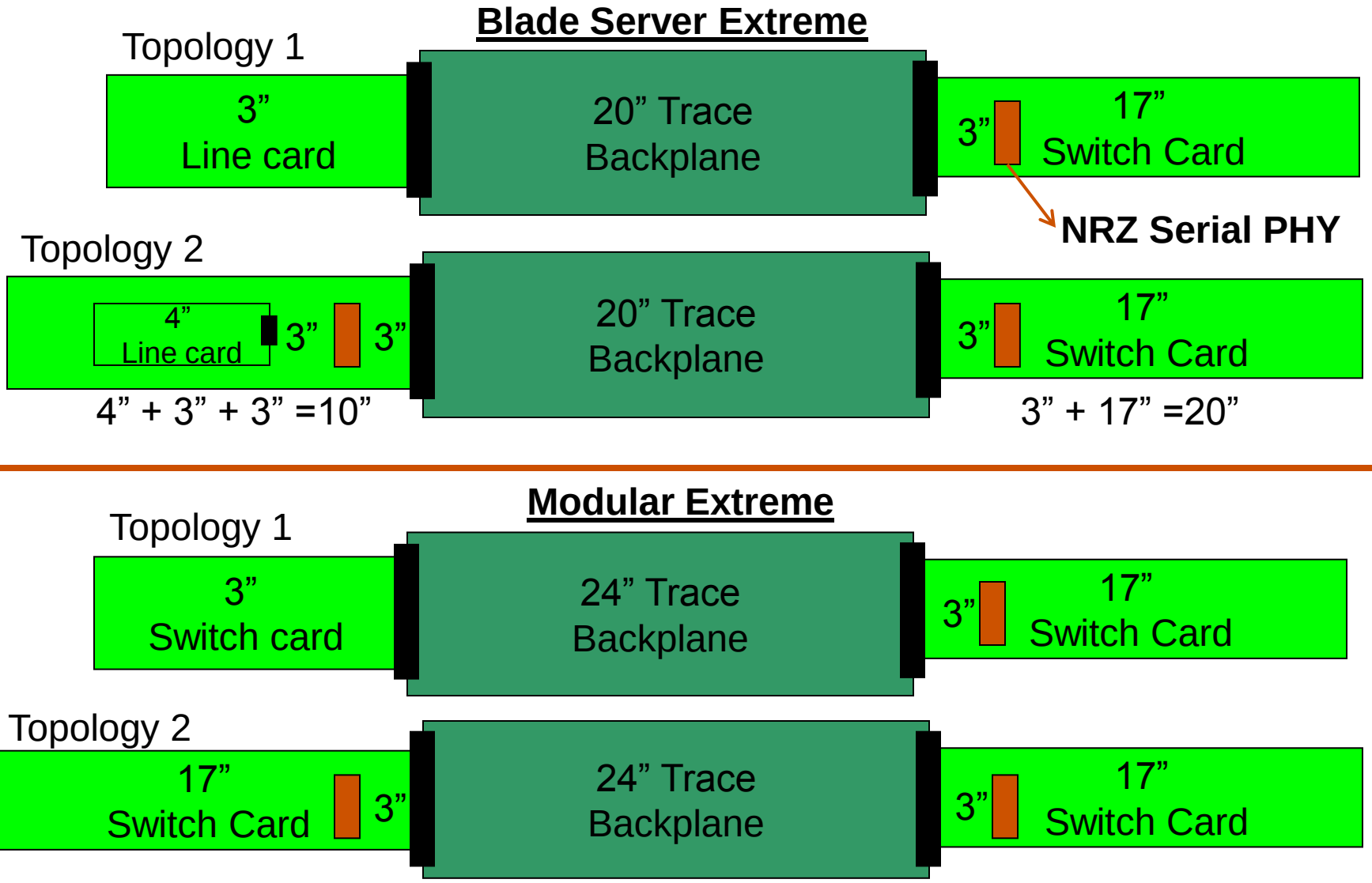
Legacy Channels

- **Too much loss at Nyquist**
  - **43” to 64”, 2 connectors**
  - **Loss: -45dB to -55dB**
- **Six aggressors**



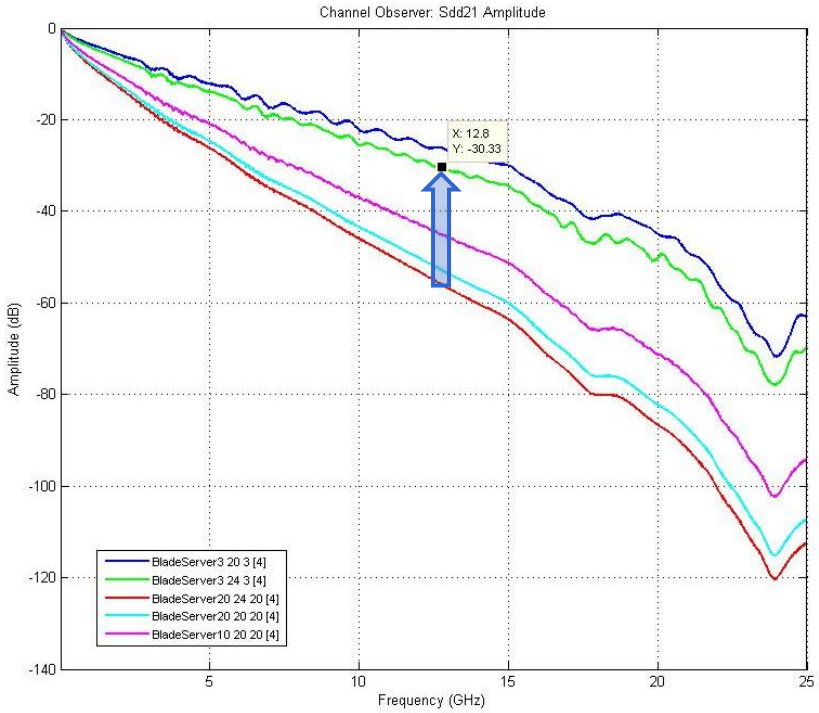
Legacy Channels with NRZ Serial PHY

Contribution: Pravin Patel, IBM



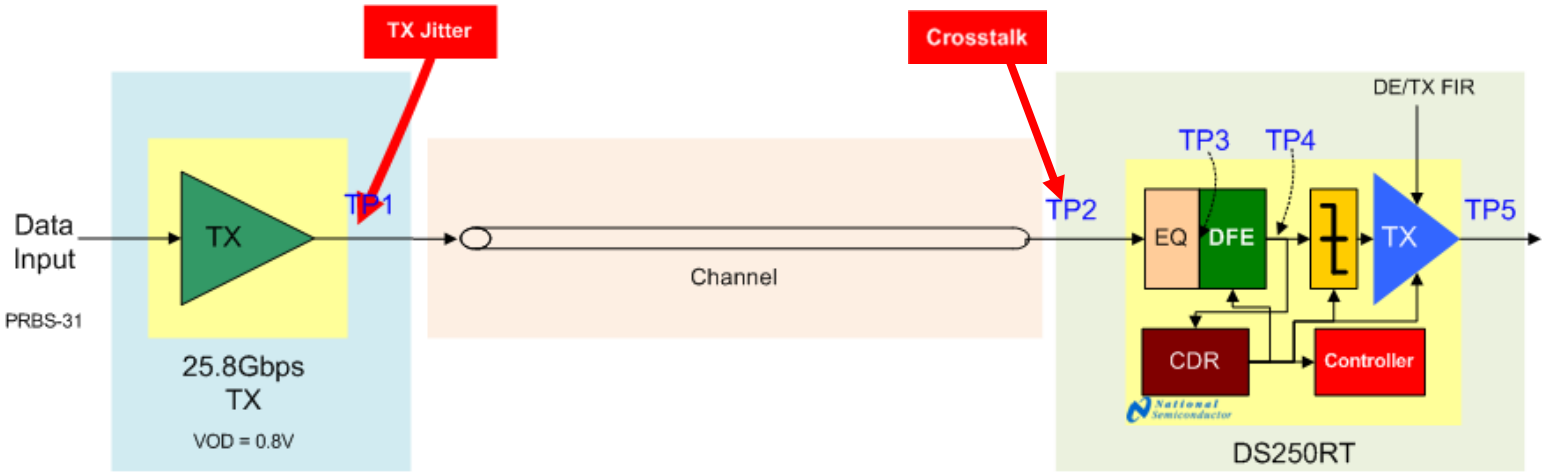
Legacy Channels with NRZ Serial PHY

- **Manageable loss**
  - **Longest channel: 64” → 30”**
  - **Loss: -55dB → -30dB**



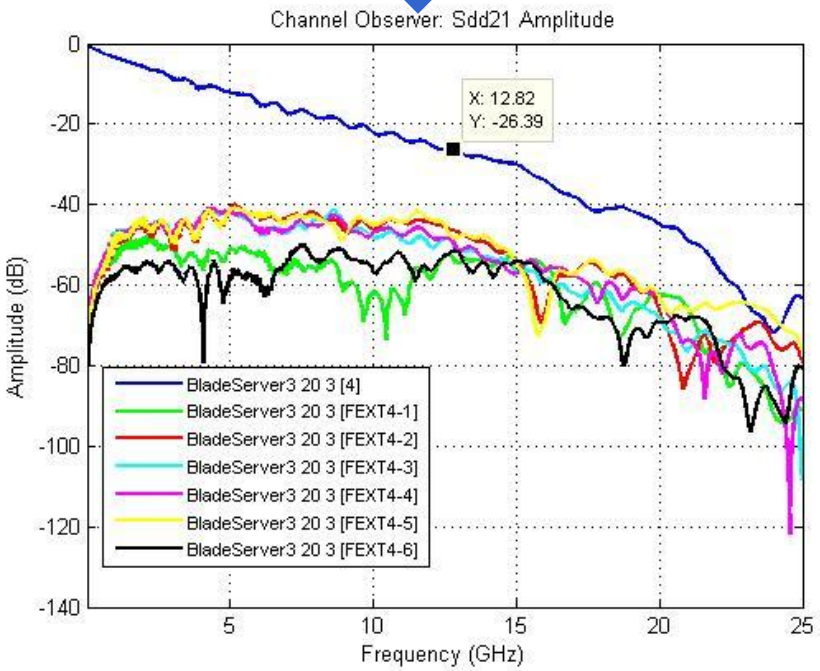
System Simulations
Mohan_0911_v2.pdf, IEEE Chicago meeting

- **Matlab based SI simulation tool**
  - **Correlated with lab measurements**
  - **Time domain analysis for deterministic effects**
  - **Overlay statistical analysis for random effects**
  - **S-parameter channel model including crosstalk**
    - **25% higher aggressor, asynchronous frequency, PRBS-23**
  - **Package model**
  - **Transmit model: 0.8Vpp; 3-tap FIR; 2.8ps DJ, 0.28UI TJ @ 1e-15**



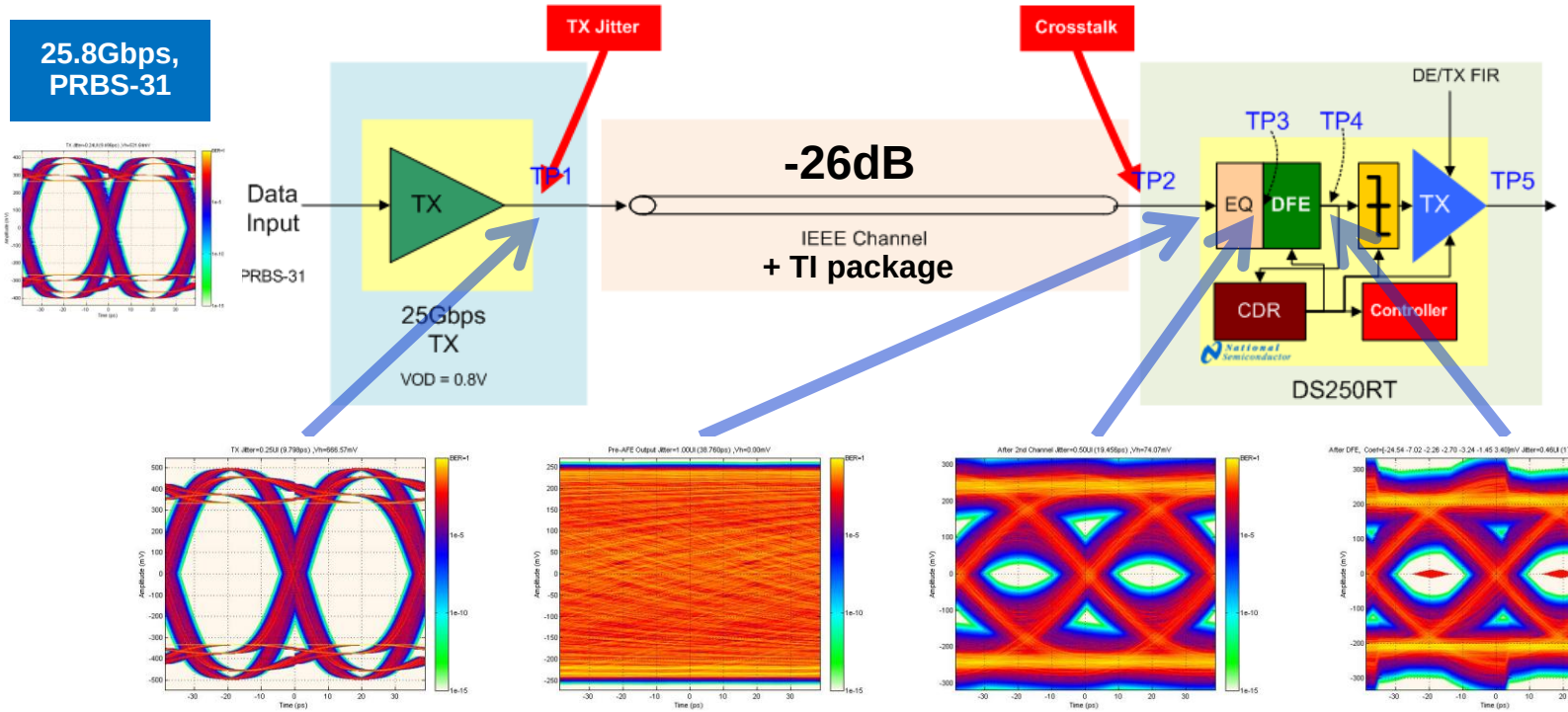
Backplane Segment of Blade Server Channel

Contribution: Pravin Patel, IBM



IBM Blade Server Channel

Backplane Segment of Blade Server Channel



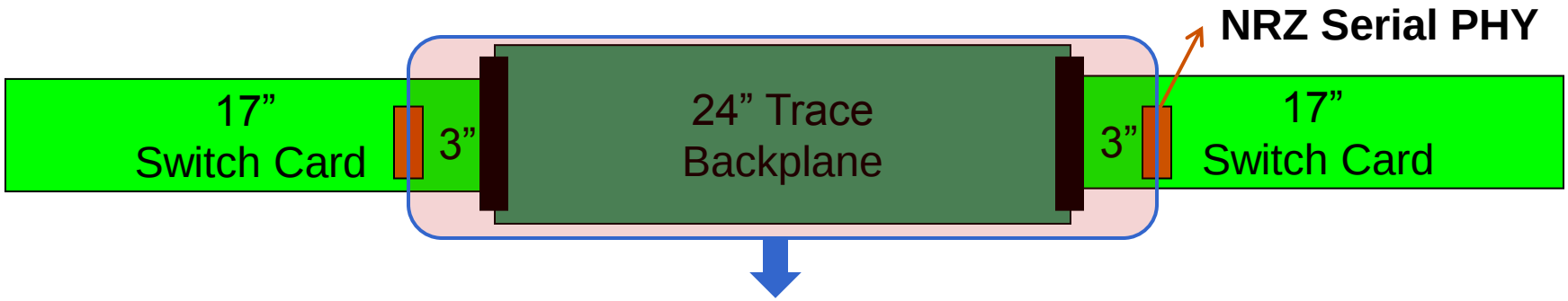
TP1: After package	TP2: After BP Channel	TP3: After CTLE	TP4: After DFE
Jitter = 0.25UI	Jitter = 1UI	Jitter = 0.5UI	Jitter = 0.46UI
$V_{eye\text{-}height}$ = 660mV	$V_{eye\text{-}height}$ = 0V	$V_{eye\text{-}height}$ = 74mV	$V_{eye\text{-}height}$ = 105mV
$V_{peak\text{-}peak} \approx$ 1000mV			
TX FIR = [-1dB,0dB,-3dB]			

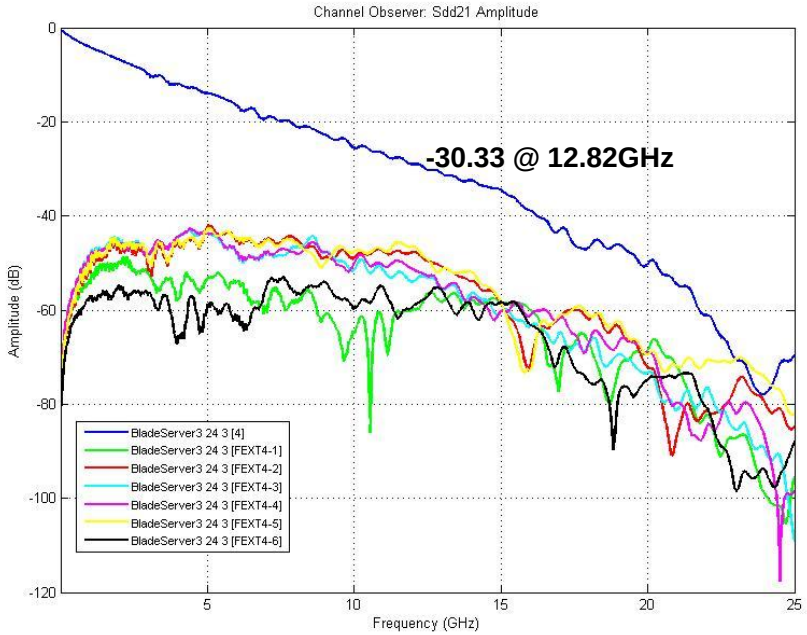
Notes:

- ***IEEE 25Gbps TX Jitter: 2.8s DJ, 0.28UI TJ at BER < 10^{-15}***
- ***TX V_{OD} = 0.8V, Aggressor V_{OD} = 1V***
- ***6 Asynchronous Crosstalk Aggressors***
- ***Simulation BER Setting: 10^{-15}***

Backplane Segment of Modular Channel

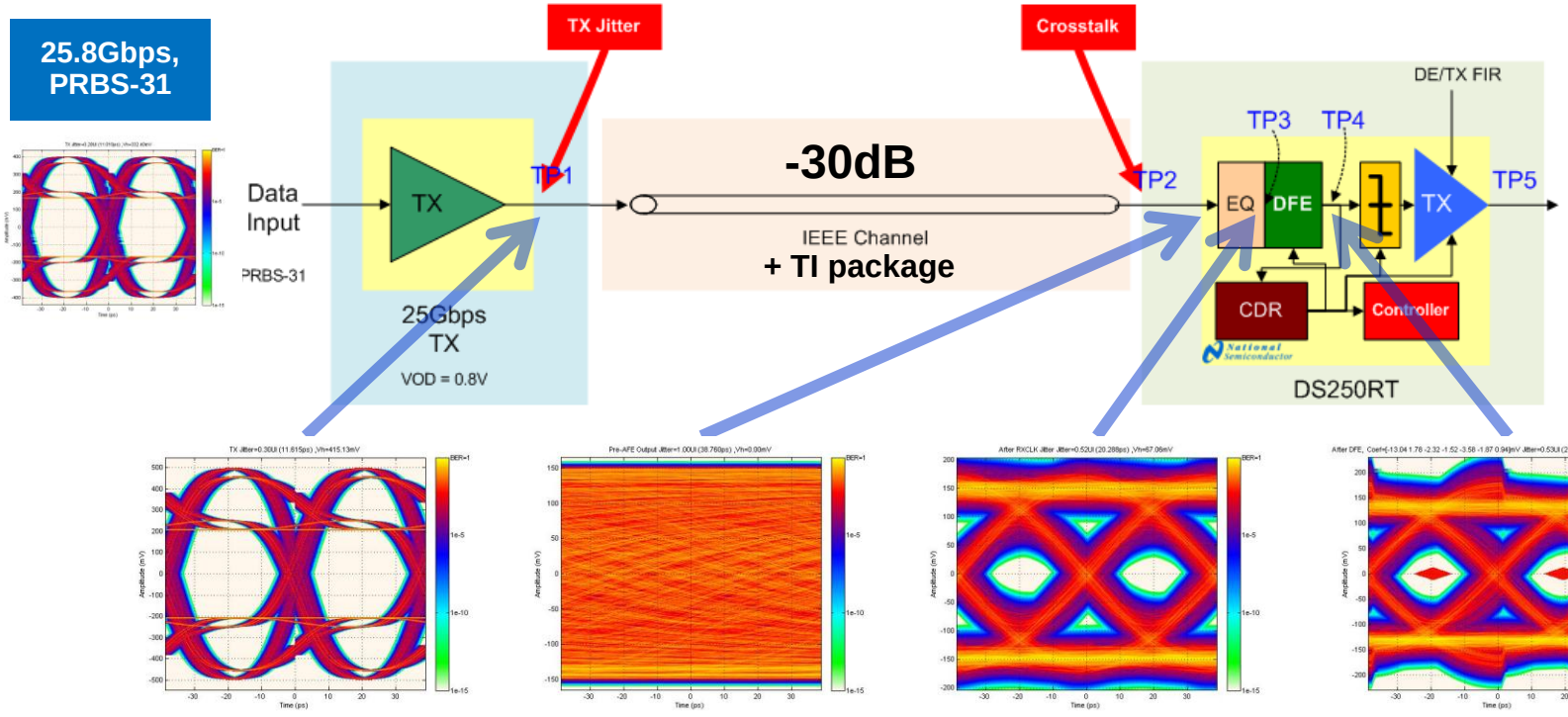
Contribution: Pravin Patel, IBM





IBM Modular Channel

Backplane Segment of Modular Channel



TP1: After package	TP2: After BP Channel	TP3: After CTLE	TP4: After DFE
Jitter = 0.3UI	Jitter = 1UI	Jitter = 0.52UI	Jitter = 0.53UI
$V_{eye\text{-}height}$ = 415mV	$V_{eye\text{-}height}$ = 0V	$V_{eye\text{-}height}$ = 67mV	$V_{eye\text{-}height}$ = 96mV
$V_{peak\text{-}peak} \approx$ 1000mV			
TX FIR = [-1dB,0dB,-6dB]			

Notes:

- ***IEEE 25Gbps TX Jitter: 2.8s DJ, 0.28UI TJ at BER < 10^{-15}***
- ***TX V_{OD} = 0.8V, Aggressor V_{OD} = 1V***
- ***6 Asynchronous Crosstalk Aggressors***
- ***Simulation BER Setting: 10^{-15}***

Summary

- **Use of Serial NRZ PHYs for legacy channels**
- **Simulations over 45-55dB loss legacy channels**
- **Robust operation over example legacy channels**
  - **Using inline retiming**
- **Sufficient margin even without FEC**
  - **Worse connectors**
  - **Higher crosstalk**

Thank You!