Receiver Compliance Testing

How to Achieve Industry Interoperability

May ’05 Presentation to Ethernet over Backplane working group

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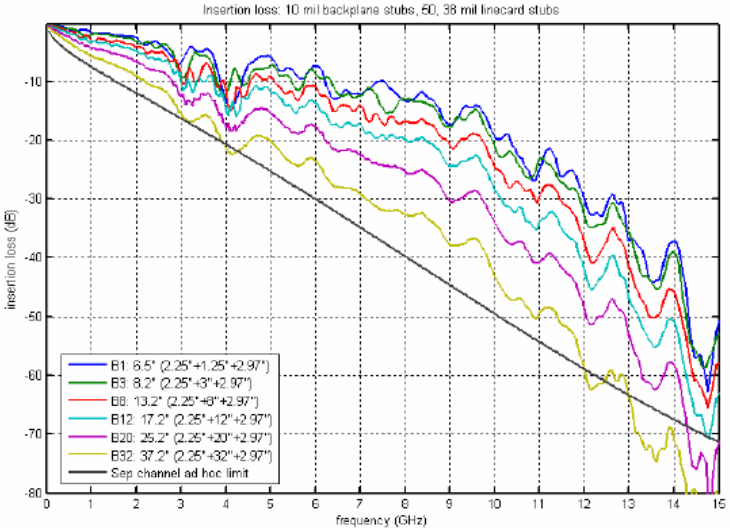
Industry Interoperability

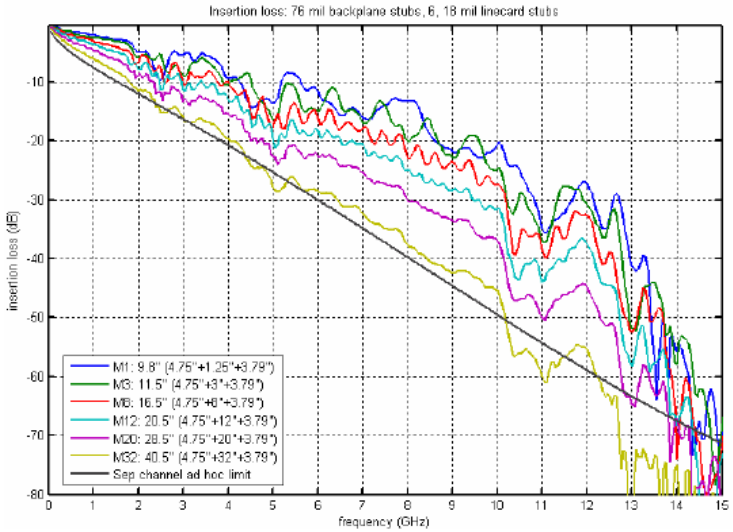
- **Interoperability: The Primary Objective of all Standards Efforts**
  - How are we in 802.3ap going to address this?
- **Transmitter Compliance:**
  - Transmitter definition in the works:
    - Electrical specs, jitter specs, FFE configuration, Filter templates, etc.
  - How to test for compliance?
    - May need some definition of test patterns and procedures, but this is relatively straight forward BAU and I expect we all see a basic path to get there!
- **Receiver Compliance:**
  - A receiver shall operate with BER of better than E-12 when receiving a compliant transmit signal through a compliant backplane channel.
    - Sounds great…….but…….
    - What does that mean????
  - How to test for compliance and provide confidence in industry interoperability?
    - Subject of this presentation

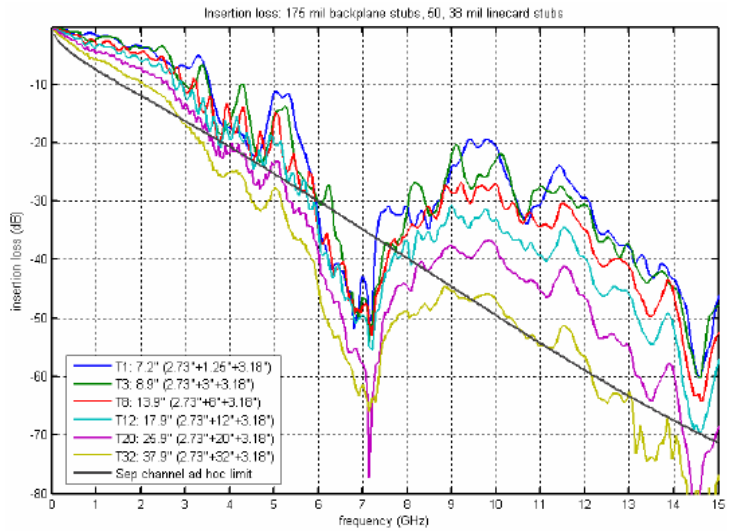
What's Needed to Test Receiver Compliance?

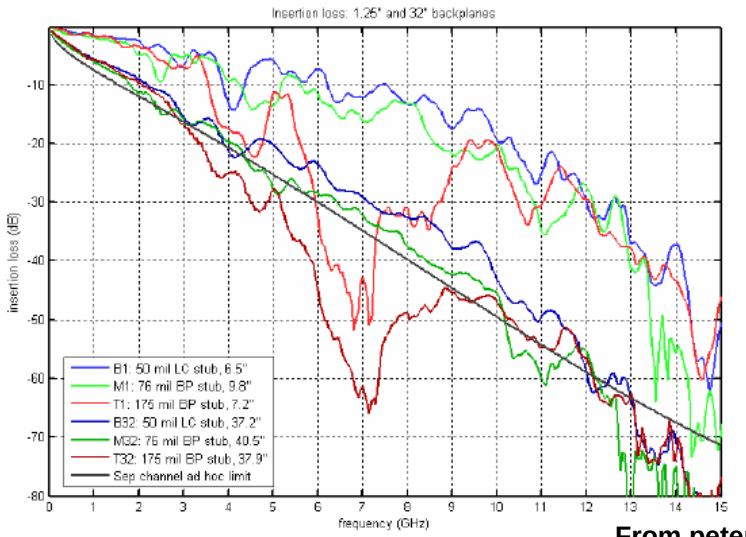
- **Given the primary compliance directive:**
  - A receiver shall operate with BER of better than E-12 when receiving a compliant transmit signal through a compliant backplane channel.
- **Two key items are needed for receiver testing**
  - A compliant transmitter or a piece of test equipment to emulate a compliant transmitter
  - A compliant channel
- **Let's start with the compliant channel**
  - Will the standard define the channel that vendor's must test with?
    - Note that this is the first step to defining a receiver compliance point
  - Will the standard leave it up to each individual vendor to select a test channel?
    - Let's first consider the implications of this….

Which Channel(s) Should be Tested?





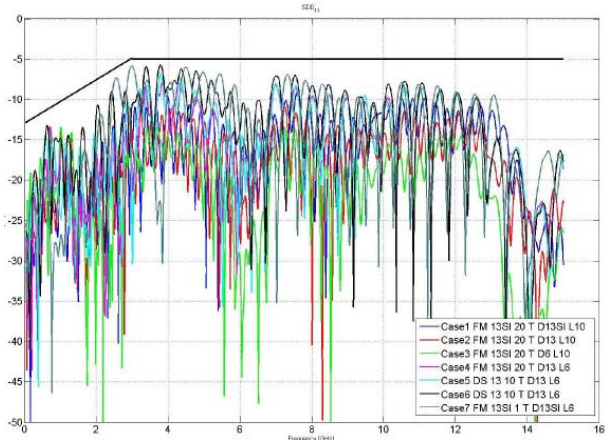


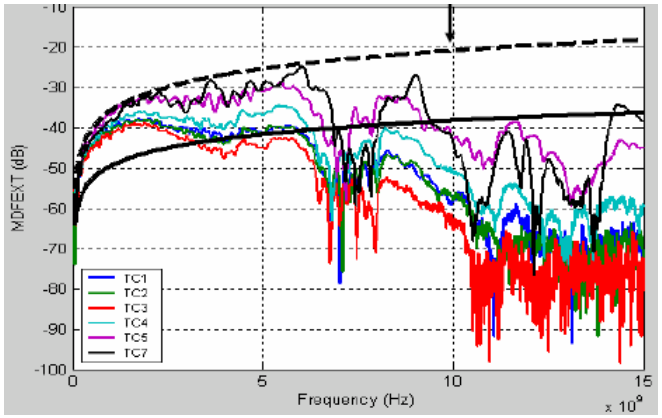


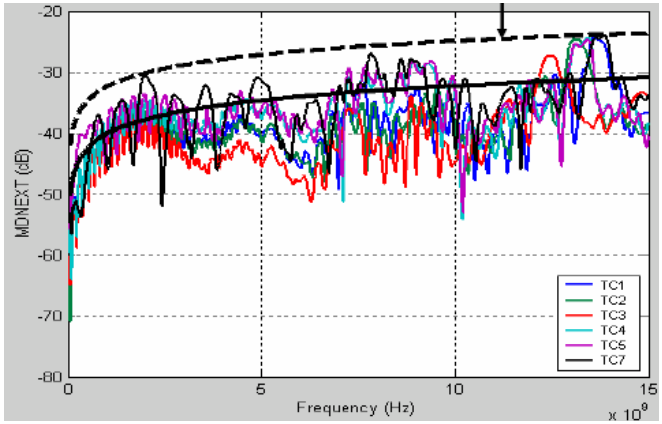
From peters_01_0904

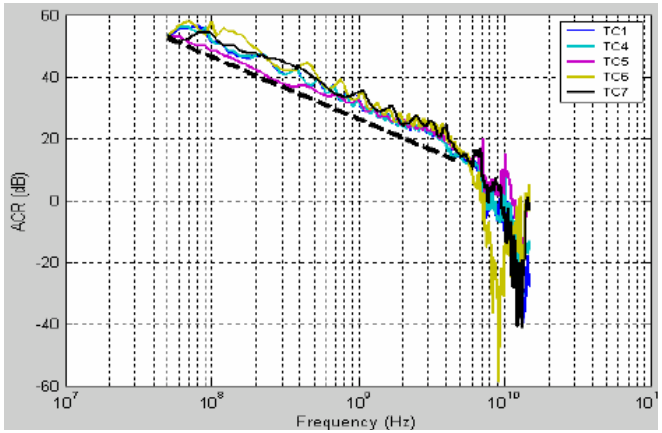
Which Channel(s) Should be Tested?

- **Assume for the moment a worst case SDD21 or set of SDD21's has been selected**
  - Still need to consider Return Loss, NEXT, FEXT, ACR, Group Delay…









From:

dambrosia_02_0904

dambrosia_03_0904

Which Channels Should be Tested?

- **How does one build a worst case card?**
  - Trying to build a test card which drives all parameters to their worst case, without going over to any significant extent, is extremely difficult in itself
  - Even when done, worst casing all individual parameters is not necessarily a worst case system
    - e.g. Worst case attenuation will limit reflection impact of worst case return loss
    - Similar situation with crosstalk
    - How to select where crosstalk enters the channel?
      - Channel split between backplane and line card?
- **Who builds these cards?**
  - Each individual vendor selects their own worst case definition and builds their own worst case cards?
- **What motivates a serdes vendor to diligently select and build a set of test cards with a comprehensive array of absolute worst case parameters?**
  - Not to suggest any vendor would be underhanded and purposely cut corners to claim compliance
  - However, there won't be any significant level of confidence that testing across vendors will be comparable to any reasonable extent

What is a Compliant Transmitter?

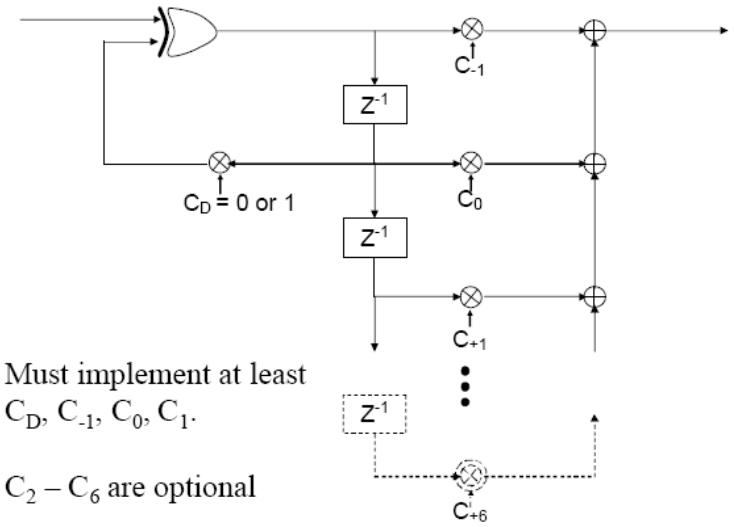
- **We have basic electrical specs – this is certainly a start!**
  - A comprehensive test procedure would need to worst case these
  - However, worst case is different for through vs. xtalk channels
    - Min launch voltage, wc jitter, slow tr/tf, etc for through channel
    - Max launch voltage, fast tr/tf for cross talk channels

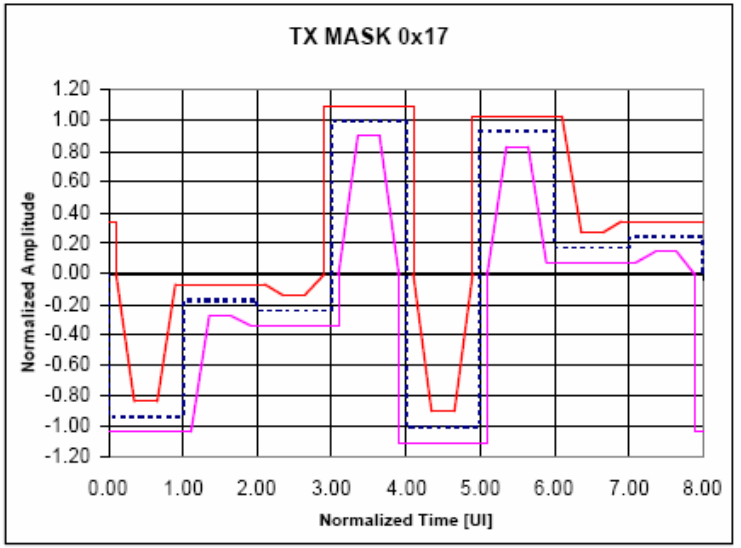
Parameter	Value	units
Baud rate tolerance	10.3125GBd +/- 100ppm	GBd
Diff. Amplitude (1) maximum minimum	1200 800	mVp-p mVp-p
Common-Mode Voltage	TBD	V
Diff. Output Return Loss minimum	Figure	dB
Output Template	Figure	V
Transition Time min Measured between 20% and 80%	24	ps
Output Jitter (2) Random Deterministic Total	 .15 0.15 0.3	 UIp-p UIp-p UIp-p

From gaither_01_0105

What is a Compliant Transmitter?

- **More specifically, how is it configured for receiver testing?**
  - We have a minimum defined equalizer architecture
  - We have transmit masks being defined
    - These are sample masks for Tx characterization of a few settings
  - We have an adaptive equalization protocol being defined
    - But convergence algorithms will be vendor unique





From gaither_01_0105

What is a Compliant Transmitter?

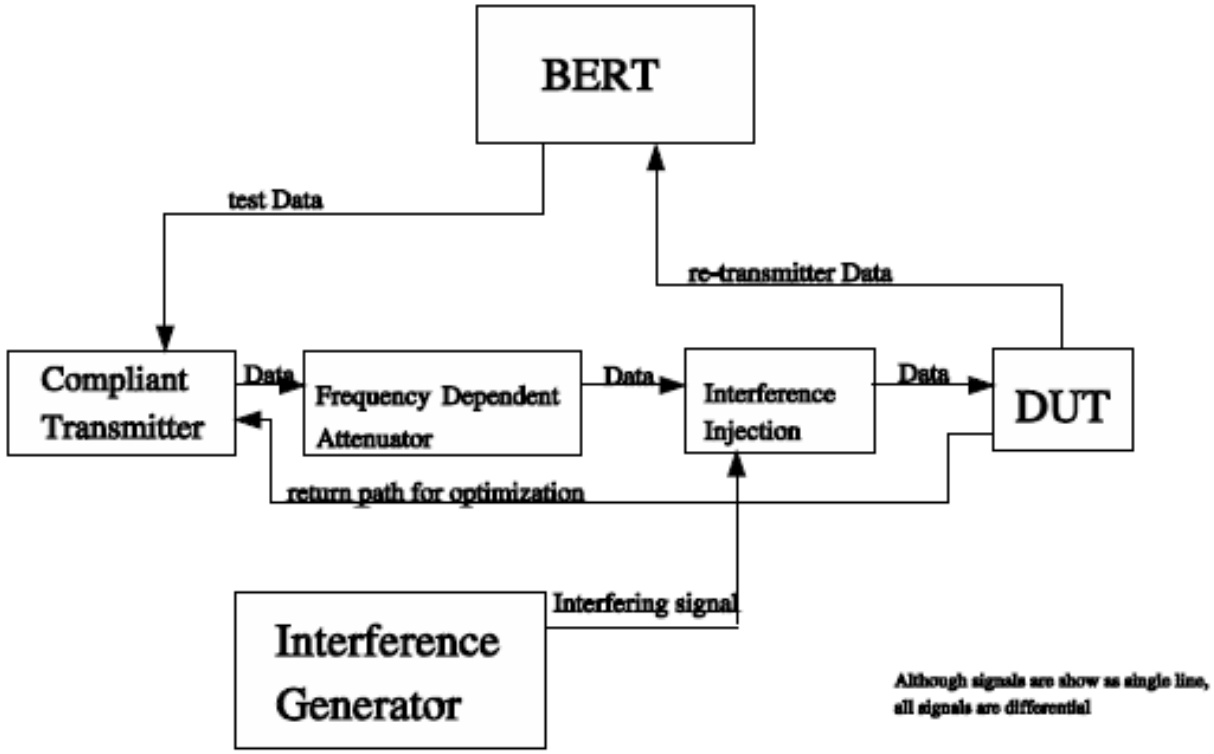
- **To build a comprehensive test, one must:**
  - Configure a transmitter or piece of test equipment for wc electrical specs relative to through channel
  - Configure equalizer settings for the worst case expected deviation an adaptive algorithm may settle on
    - This is currently undefined, and left open to vendor interpretation
  - Configure a transmitter(s) or piece(s) of test equipment for wc electrical specs relative to cross talk channel(s)
- **Where does one get this test apparatus?**
  - Test equipment with this configurability is not generally available
  - Vendor transmitter hardware will not likely be at the extreme worst case

Let's Revisit the Compliance Directive:

- ***A receiver shall operate with BER of better than E-12 when receiving a compliant transmit signal through a compliant backplane channel.***
- **Three fundamental problems exist:**
  - We don't have a compliant channel, we have an array of them
    - Considerably more complex than wireline standard definitions
  - We don't have a compliant transmit signal, we have an array of them
  - We don't have equipment or hardware to setup these tests, even if we knew how to define them
- **How can we get confidence on interoperability and evaluation across vendors?**
  - Vendor A can use a minimalist definition and claim compliance with a very sub-par receiver
  - Vendor B can use an extreme definition that doesn't allow the best performing receiver to pass compliance testing
  - And of course everything in-between

How to Address these Fundamental Issues?

- **Consider some key aspects of moore_01_0105!**

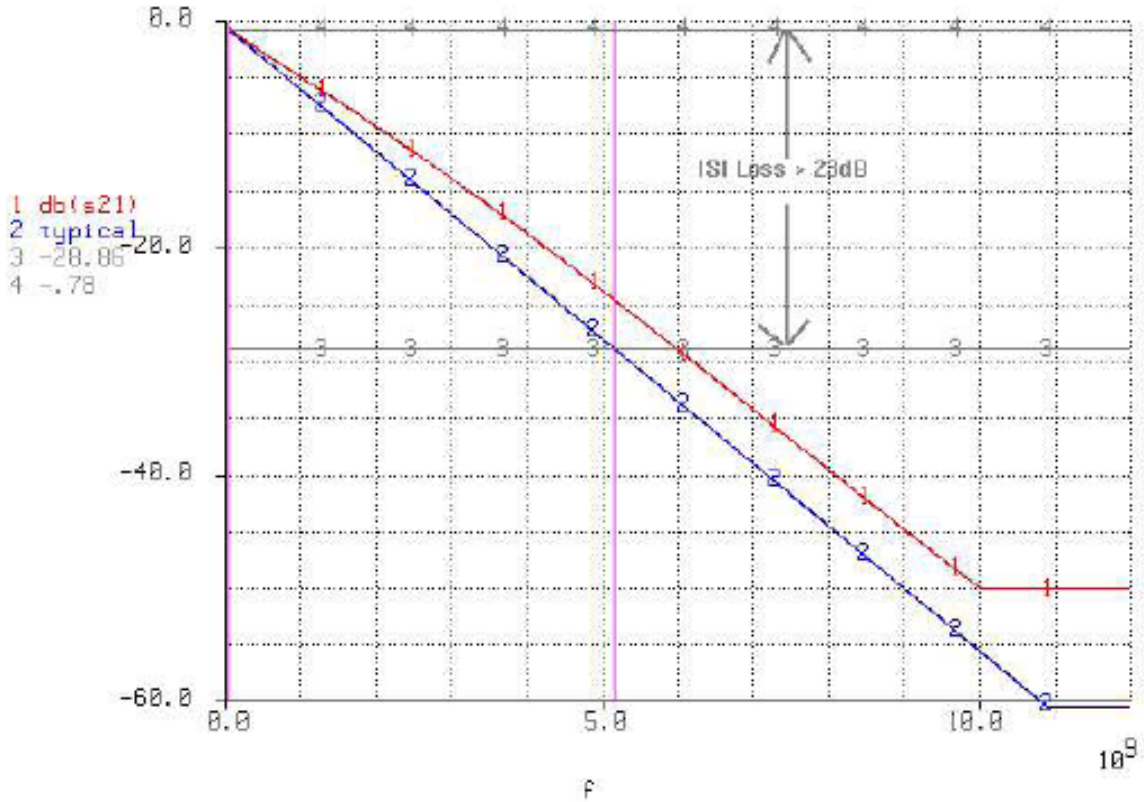


Test setup for Interference Tolerance test

From moore_01_0105

How to Address these Fundamental Issues?

- **The Frequency Dependent Attenuator addresses 2 key aspects:**
  - I know how to build it!
  - I have a high degree of confidence that all vendors will build substantially the same thing!



From moore_01_0105

How to Address these Fundamental Issues?

- **Consider the definition of the transmit test setup:**
  - *The BERT shown in Figure X.1 is optional, if the DUT and the Compliant Transmitter have suitable Built in Self Test (BIST) capability the transmitter can transmit a PRBS pattern and the DUT report Bit Error Rate (BER).*
  - *The Compliant Transmitter can be any transmitter which is fully compliant with 10GBaseKR specifications, except that it shall have no more than 3 equalization taps or the equivalent.*
- **This also address 2 key aspects:**
  - I know how to build it or where to get it!
  - I have a high degree of confidence that testing across vendors will be highly comparable
    - Vendor motivation is to select best performing transmit device
    - The dependency on vendors independently interpreting a wc definition is removed
    - If desired, the variability that does remain could be tightened up by focusing on a defined BERT based test setup

Summary and Recommendation

- **Summary:**
  - The current direction of the 802.3ap standard will not contain a comprehensive receiver specification (whether normative or informative), nor will it contain a normative receiver test methodology.
  - The complexity of the channel space and the transmit configuration space leaves this standard overly exposed to vendor interoperability failures.
- **Recommendation:**
  - Define a normative receiver test methodology to ensure a minimum capability across vendors
    - Use Interference Tolerance Test proposal (moore_01_0105) as a base
    - Consider inclusion of receiver jitter tolerance
    - Call for proposals on other test procedures that may be needed
      - e.g. DCD tolerance