Issues to Consider for Low Frequency Limit

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Preparation for SA ballot – Focus on the Technical

- We need to make sure we are ready to correct or add any significant technical matter on initial SA ballot
- Out-of-Scope comments on D2.1 raised that the low frequency limits for specifications need a look
- This presentation tries to raise some of the issues and considerations to consider, work to be done, and a possible change.

Low frequency Parameters to consider and minimum frequencies

Type	Parameter	Minimum Defined Frequency
Noise	Alien Crosstalk coupling	1 MHz
Noise	Transmit PSD Upper Mask	0 Hz
Received Signal Level	Link Segment Insertion Loss	10 MHz
Received Signal Level	Transmit PSD Lower Mask*	5 MHz
PHY Impairment	Link Segment Return Loss	30 MHz
PHY Impairment	MDI Return Loss	5 MHz

* Frequency content of the Transmit Signal below the minimum frequency of the Transmit PSD Lower Mask is implied by the Transmit Droop Specification, but this does not directly control the received signal level

How These Limits Impact PHY Implementations

- We cannot simply assume these behave as a model, even though they probably do
  - Interoperable, standards-compliant PHYs should work in the worst-case specified, not “assumed”

- Crosstalk Noise received: TX PSD upper mask – Crosstalk Loss
  - Below 1 MHz, Max noise psd jumps to TX PSD upper mask level
    - Crosstalk loss must be assumed 0 below minimum freqeuency
- Received Signal levels: TX PSD lower mask - Link Seg IL
  - Limited by link segment IL
- Baseline wander at the receiver: TX PSD lower mask, TX droop – Link Seg IL
  - Limited to a 10 MHz low frequency cutoff of channel insertion loss combined with TX droop
- Echo level: (function of) TX PSD upper mask, Link Seg RL, MDI RL & Link Seg IL, Residual Echo Metric
  - Far-end MDI echo: TX PSD upper mask – (MDI RL + 2*Link Seg IL)
    - Limited by 10 MHz cutoff of Link Seg IL between 10 MHz & 5 MHz, by 5 MHz cutoff of MDI RL below
    - Jumps to TX PSD upper – MDI RL from 10 MHz to 5 MHz, then to TX PSD upper from DC to 5 MHz
  - Link-segment echo: TX PSD upper mask – Link Seg RL
    - RL could jump from 20 dB to 0 at 30 MHz – Jumps echo PSD to TX PSD upper mask below 30 MHz
  - UNCLEAR whether residual echo metric changes this

Thoughts on limits

- Probably good to keep upper TX PSD specified down to DC
  - Eliminates situations where undefined parameters are paired…
- Link Segment Return Loss of 30 MHz is way out of line
  - Probably should be harmonized with Link Segment IL at 10 MHz
  - Echo below 10 MHz probably not a problem (Relatively low bandwidth keeps power reflected down)
    - 0dB RL gives < 20mVrms echo component in 100 Ohms
  - May want to consider potential time-dispersion properties in simulation
- Many specifications are limited by undefined Link Segment IL below 10 MHz
  - Baseline wander will likely control this - investigated before – probably needs another look
  - Likely the most sensitive consideration - Should confirm with simulation
    - Feyh_3cy_01b_01_11_09_21.pdf suggested definition down to 2 MHz was needed
  - Removed energy is at most -94 dBm/Hz X 10 MHz = -24 dBm -> 20 mVrms (100 Ohm) max. removed low frequency components – is this a problem? (design specific)
- Crosstalk coupling lower frequency can be increased to match Link Segment IL

Easy Simplifications to consider that might help

- Continue practice of defining transmit PSD upper mask to DC
  - Likely ‘met by design’ – hasn’t caused anyone measurement problems so far…
- Define Alien Crosstalk down to 10 MHz – no need to go lower
  - Coupling physics are naturally low at low frequencies
  - Bandwidth ratio (10MHz/7031MHz = 0.14%) derates the low freq noise impact
    - At least -28 dB-Hz in total power and 0.14% minimizes it in DFE contribution
- Consider “flat lining” losses below some frequency, down to frequency determined by baseline wander simulations (likely the most sensitive spec, call this X MHz)
  - Extend Link Segment IL & RL so they can be met by design
  - Link Segment IL – flat lined at loss level of 2 connectors down to X MHz?
    - Should be easy to “meet by design”, need guidance on connector losses
  - Link Segment RL – flat lined at 20 dB down to X MHz
    - Check if there is a frequency where this becomes a problem
  - MDI RL – flat lined at 0 dB to X MHz

THANK YOU