Auto-Negotiation Baseline Proposal

IEEE 802.3bp – Plenary – November 2014

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Agenda

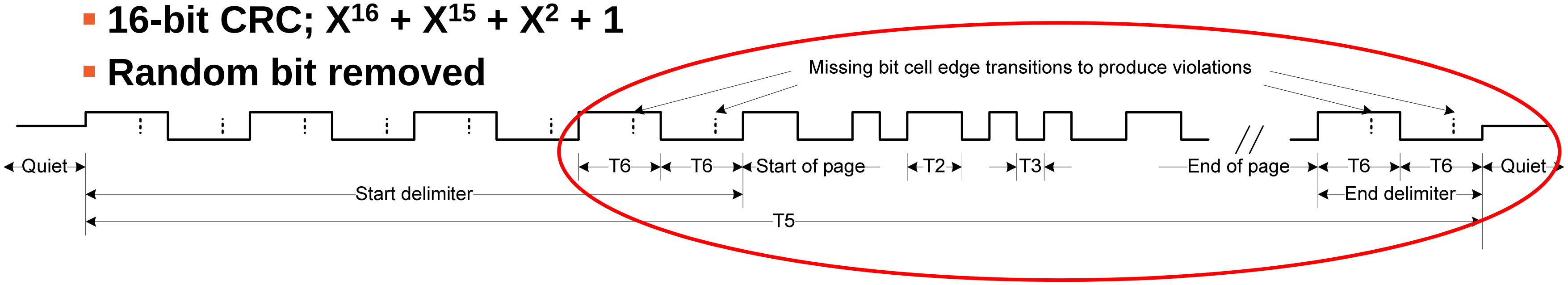
- General points of agreement
- Updates
- Open issues
- Baseline Proposal
- Performance simulation results
- Next steps

What occurred thus far

- March 2014 - Details of single pair auto-negotiations presented
  - Lo_3bp_03_0314.pdf
  - Lo_3bp_04_0314.pdf
- May 2014 – Improvements on above
  - Thaler_01_0514.pdf
- May 2014 – Added auto-negotiation to 1000BASE-T1 objectives
  - Lo_Thaler_Tazebay_01_0514.pdf
- June 2014 – Offline discussions
- July 2014 – Additional work - state machines presented
  - Lo_3bp_02a_0714.pdf
- September 2014 – Additional work - DME performance
  - McClellan_Lo_3bp_01_0914.pdf

Agreed items in June discussions

- Use Clause 73 as starting point – ok
  - Lo_3bp_04_0314.pdf
- Half duplex concept for auto-negotiations - ok
- Circled portion of page below agree upon
  - 64-bit page
  - 48-bit data
  - 16-bit CRC; $X^{16} + X^{15} + X^2 + 1$
  - Random bit removed



Agreed items in June discussions

- Starting polarity will be randomized instead of using random bit
- Base period T3 will be 8ns if 750MHz baud rate selected
- Delimiter T6 will be 3 T3 periods instead of 4 T3 periods
- Single CRC match instead of 3 matching pages
  - ability_match and acknowledge_match redefined

Agreed items in June discussions

- **Most bits of base DME page defined**
  - D[4:0] = S[4:0] = 00001 – IEEE 802.3
  - D[9:5] = E[4:0] = Echoed Nonce
  - D[13] – RF
  - D[14] – Ack
  - D[15] – Next page
  - D[20:16] = T[4:0] = Transmitted Nonce
  - D[47:21] = TBD – Ability fields
  - D[63:48] = CRC16
- **Receive state machine can be optimized not to waste first received page**
- **Silence limits of +/- 50mV**

July update

- Complete half duplex autoneg state machines
  - Transmit – see correction on next slide
  - Receive
  - Half Duplex
  - Arbitration

- Improved collision resolution time

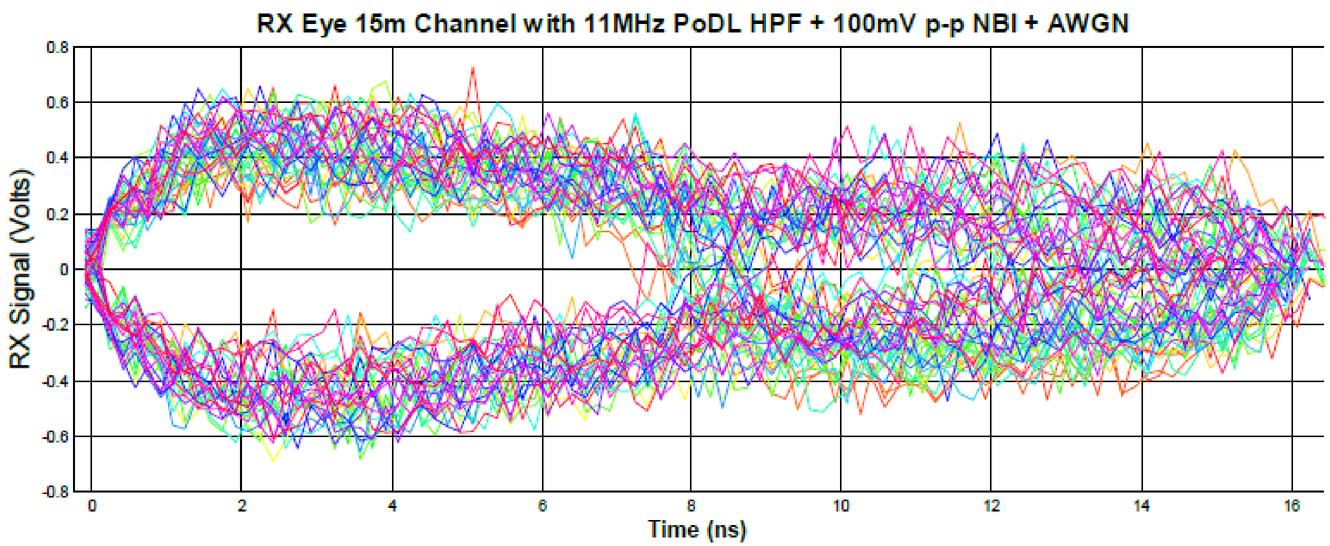
September update

- Updated Transmit state machine
  - Differentiated start and end delimiters
  - Incorporated CRC16
  - Randomized starting polarity
- D[24:21] Ability Field
  - D[21] – reserve for 1TCPE
  - D[22] – reserve for 1TCPE EEE
  - D[23] – 1000BASE-T1
  - D[24] – 1000BASE-T1 EEE
- DME performance simulations

Open Issues in September

tu_3bp_01a_0914

- T3 selection
  - T3 = 8ns is not suitable for 100BASE-T1 AFE.
  - 100BASE-T1 PHY requires T3 >= 15 ns due to AFE baud rate = 66.6MHz.
- PoDL HPF introduces droop into the DME response
  - Closes the eye of the data transition period (half symbol)



Why Differential Manchester Encoding?

- Manchester is a DC free code
  - Ideal for high pass / band pass channels
  - 2 fundamental frequencies: F and F/2
- Auto channel is a band pass channel
  - PoDL high pass at 1MHz to 10Mhz
  - 100BASE-T1 receiver low pass around 33MHz
- Differential Manchester
  - Polarity insensitive
  - Simple and robust decoding

Differential Manchester Decoding

- Level detection at the data half period
  - Compare to clock half period: change -> bit = 1
  - Suffers heavily due to droop from 10MHz HPF
  - Data eye closes due to droop
- Level detection at the clock half period
  - Compare to previous clock half period: change -> bit = 0
  - Suffers little due to droop from 10MHz HPF
  - Clock period eye stays open
- Edge Detection
  - Subtract the data amplitude from the clock amplitude – analog or digital
  - Improves immunity to noise
- Matched filter
  - Oversampled detection
  - Improves immunity to noise and NBI

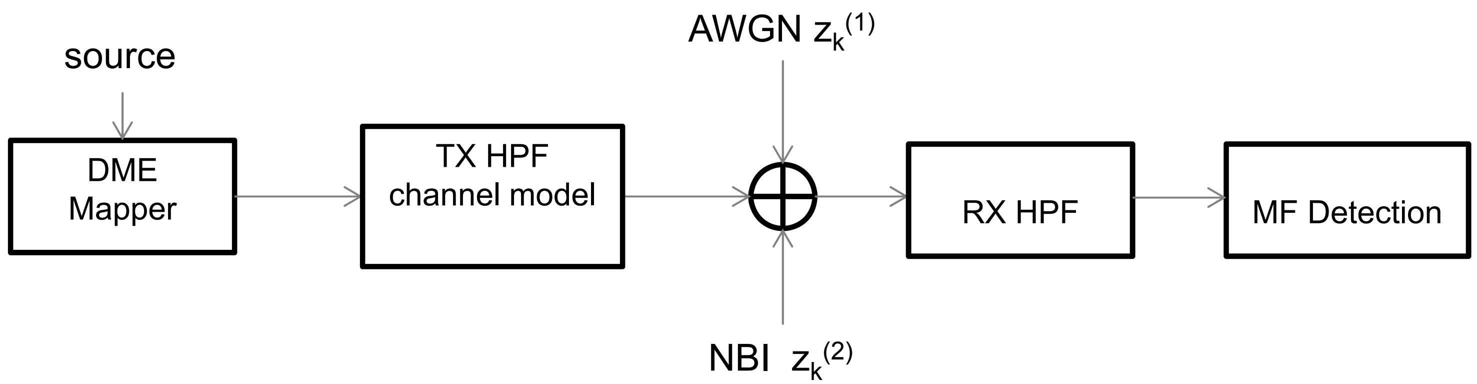
Baseline Proposal

- See submitted draft text
- Set T2 as a common clock to 100M and 1G
  - T3 = 30ns
  - T2 (DME period) = 60ns (**16 2/3 MHz**)
    - 100BASE-T1 clock ÷ 4
    - 1000BASE-T1 clock ÷ 45
- T2 is within the pass band of 100M and 1G
  - 16 2/3 MHz
    - Above the 1MHz and 10MHz HPF for PoDL
    - Below the ~33 MHz bandwidth of 100M
- New start delimiter
  - 32 * T3 PRBS sync pattern includes DME violations
    - High frequency pattern pass through 10MHz HPF for 1G
    - Low frequency DME violation easily detected

DME Performance

- Channel impairments
  - PoDL – DC and low frequency noise, blocked by 10MHz High Pass network
    - HPF filter attenuates low frequency and distorts the pulse response
  - AWGN - multiple broadband noise sources such as thermal noise
  - Inter-symbol interference (ISI) – introduced by the channel, e.g. 15m UTP
  - Narrow Band Interferers (NBI)
    - Worst performance when NBI matches the baud rate

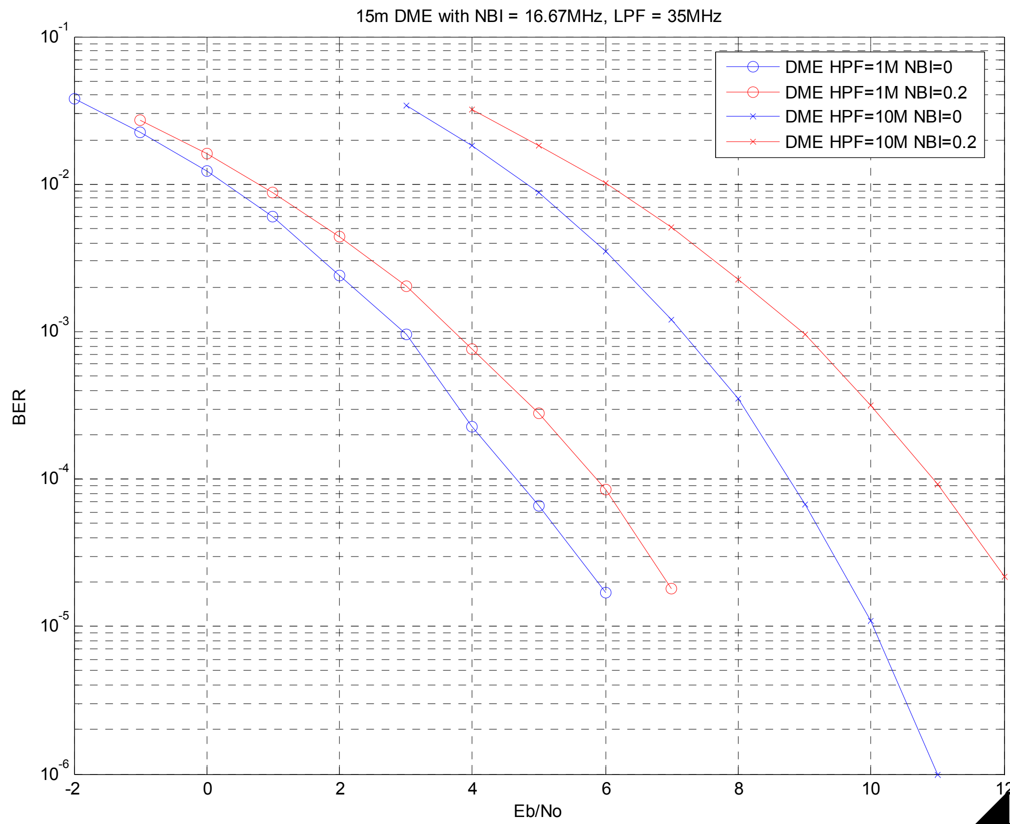
Simulation Model



- No equalizer
- AWGN $z_k^{(1)} \sim N(0, \sigma^2)$
  - $P_{AWGN}=10\log_{10}(\sigma^2/(2/3))$ (dB)
- NBI $z_k^{(2)}=A\cos(2\pi(F_c/F_s)k+p_0)$
  - $P_{NBI} =10\log_{10}(A^2/2)$ (dB)

16 2/3 MHz DME BER vs. impairments, 15m

- Robust BER performance in presence of impairments
  - Acceptable loss due to the HPF network
  - performs well under NBI
- BER shown for 15m channel, NBI = 16 2/3 MHz at 0 & 0.2 Vpk



Next Steps

- Adopt proposed text as auto-negotiation baseline with the understanding that additional changes will be needed once tentative items firm up
- Start work in the ad hoc and build simulations based on adopted baseline to root out hidden issues and refine specification

THANK YOU