Auto-Negotiation Update

IEEE 802.3bp – Interim Meeting - September 2014

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Agenda

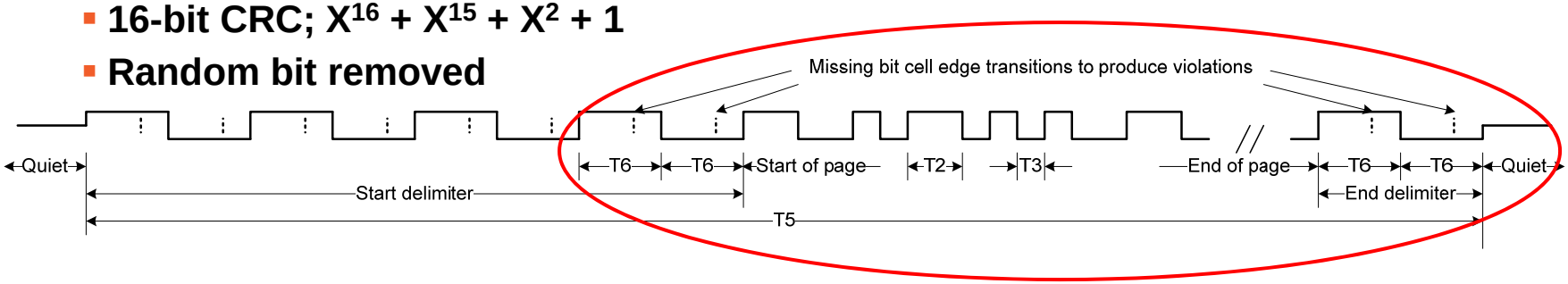
- General points of agreement
- Tentative items
- Performance simulation results
- Open items
- Next steps

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

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

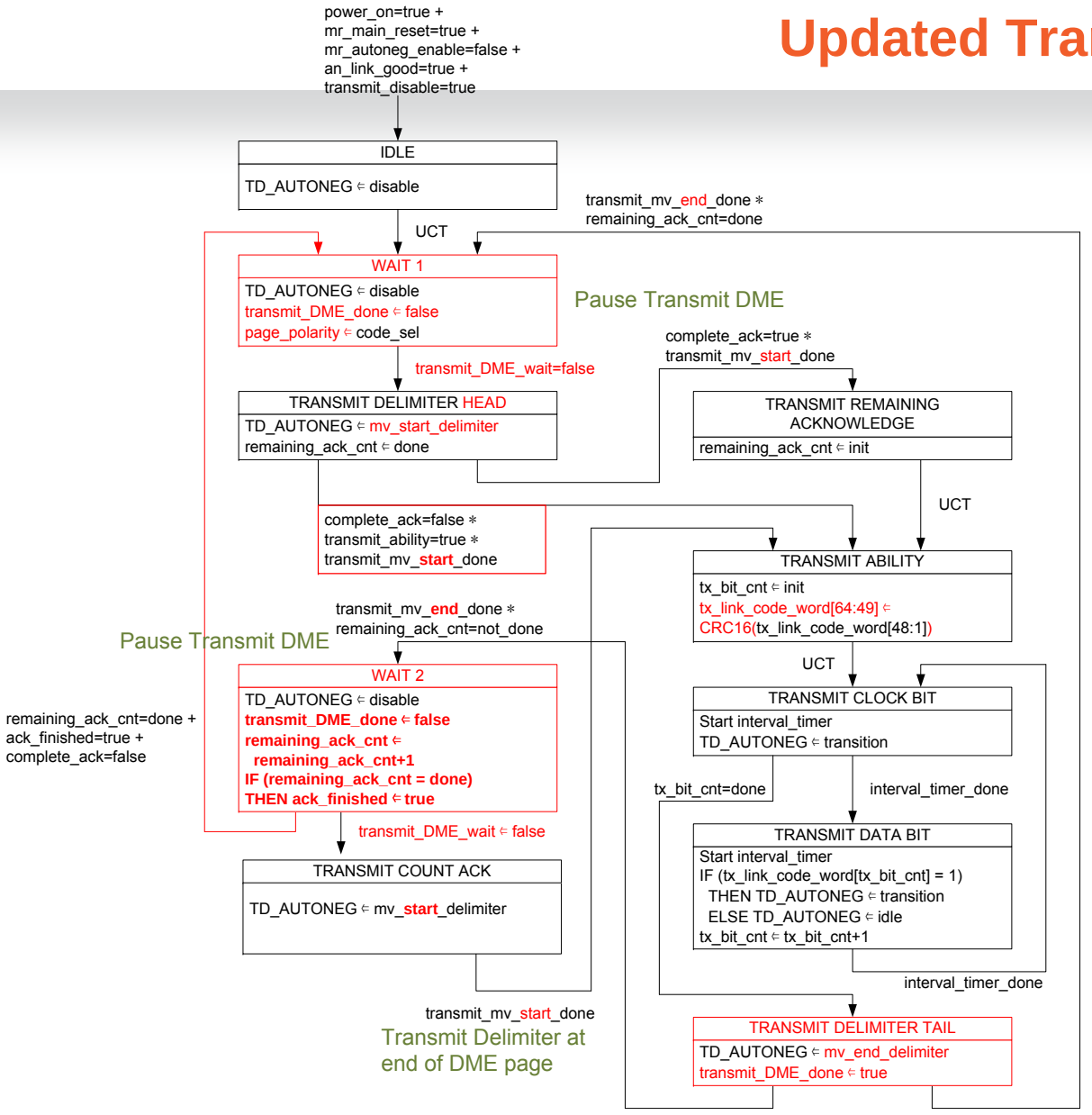
- **Most bits of base DME page defined**
  - D[4:0] = S[4:0] = 00001 – IEEE 802.3
  - D[9:5] = E[4:0] = Echoed Nonce
  - D[13] – RF
  - D[14] – Ack
  - D[15] – Next page
  - D[20:16] = T[4:0] = Transmitted Nonce
  - D[47:21] = TBD – Ability fields
  - D[63:48] = CRC16
- **Receive state machine can be 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**

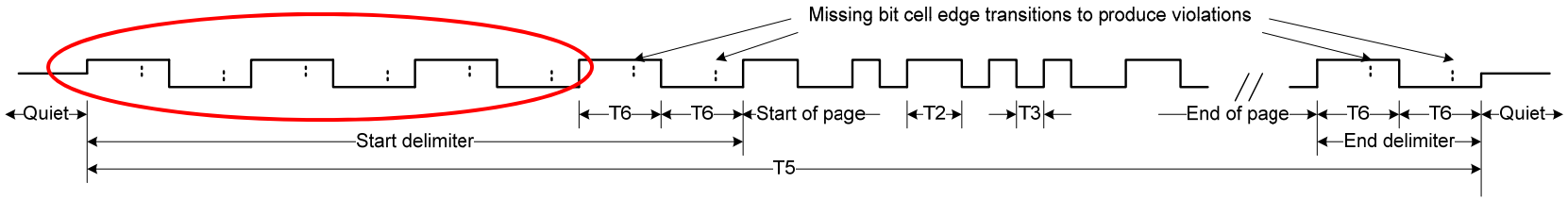
Updated Transmit State Machine



- **Differentiate start and end delimiters**
- **Incorporate CRC16**
- **Randomize starting polarity**
- **Changes from July in bold**

Tentative items

- What pattern to use in circled portion below



- remaining_ack_cnt – tentatively set to 3
- Number of page(s) transmitted per turn – tentative 1, more needed?
- DME Page bits
  - D[11:10] – Do we keep or eliminate pause bits
  - D[12] – Force Master/Slave – do we support force mode
  - Proposed 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

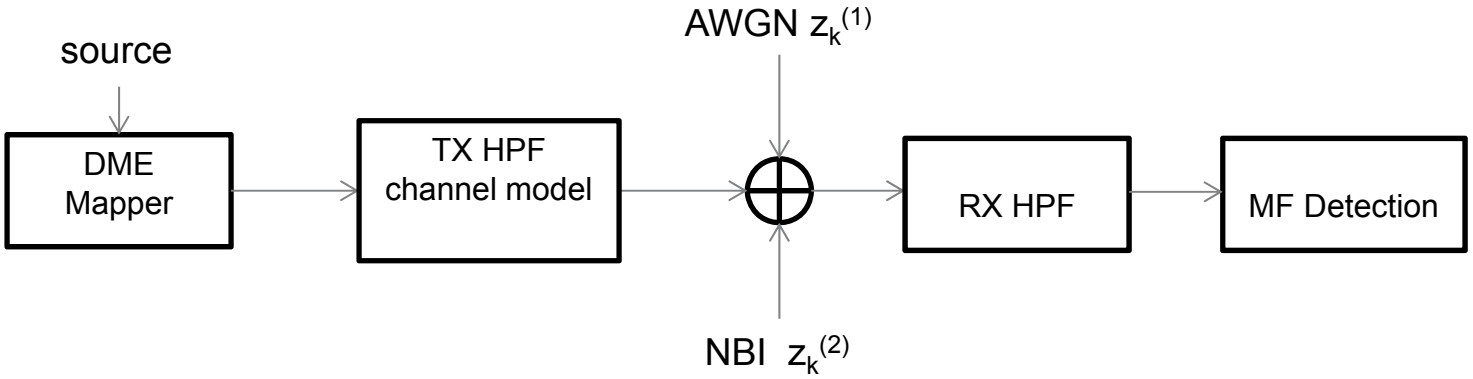
Link Code Words Per Page

- 1 vs 3 duplicate 64-bit LCW per page– first order analysis
- Typical exchange – 1 base page, 4 base pages with ACK
  - 1 LCW – 6.8us per page, 34us for complete exchange
  - 3 LCW – 10.9us per page, 54.5us for complete exchange
- In case of bit error in LCW
  - 1 LCW – requires 1 additional page exchange: 40.8us
    - 2 additional pages: 47.6us
  - 3 LCW – no additional page exchange: 54.5us
    - Under what bit error rate conditions will 3 LCW be more efficient than 1 LCW?

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)**

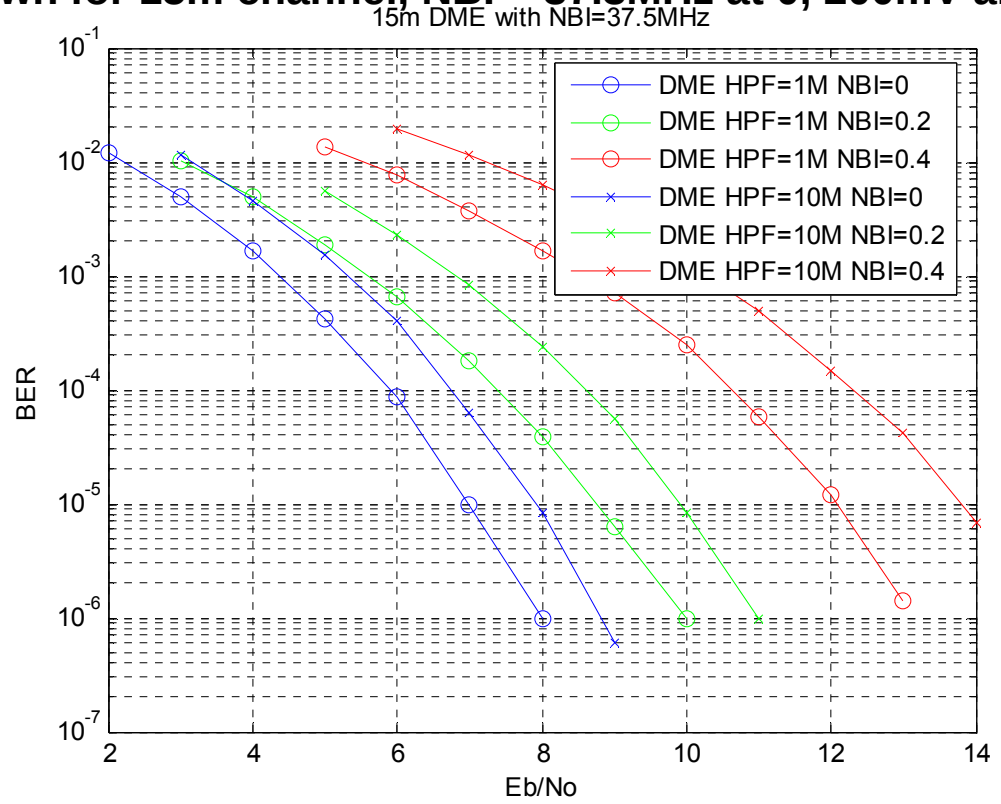
Simulation Model



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

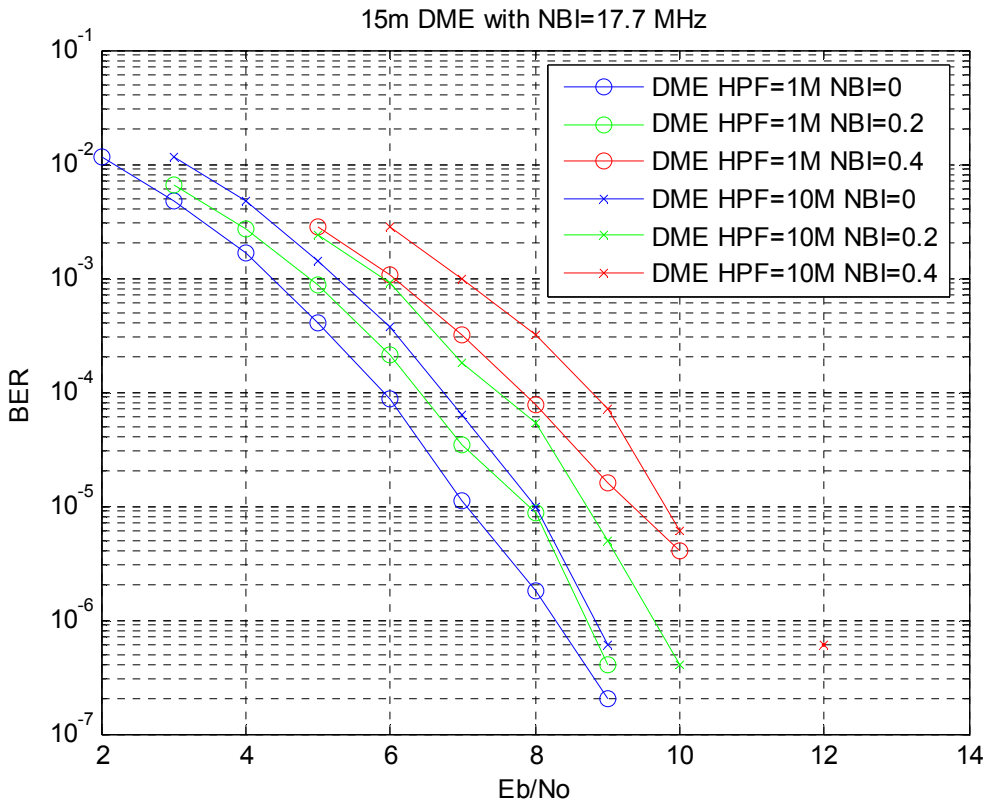
DME BER vs. impairments 15m NBI = 37.3MHz

- **Robust BER performance in presence of impairments**
  - **mildly sensitive to the HPF network**
  - **moderately to the NBI resulting**
  - **DME will operate in BER range well below levels that require >1 link code words**
- **BER shown for 15m channel, NBI = 37.3MHz at 0, 200mV and 400mV**



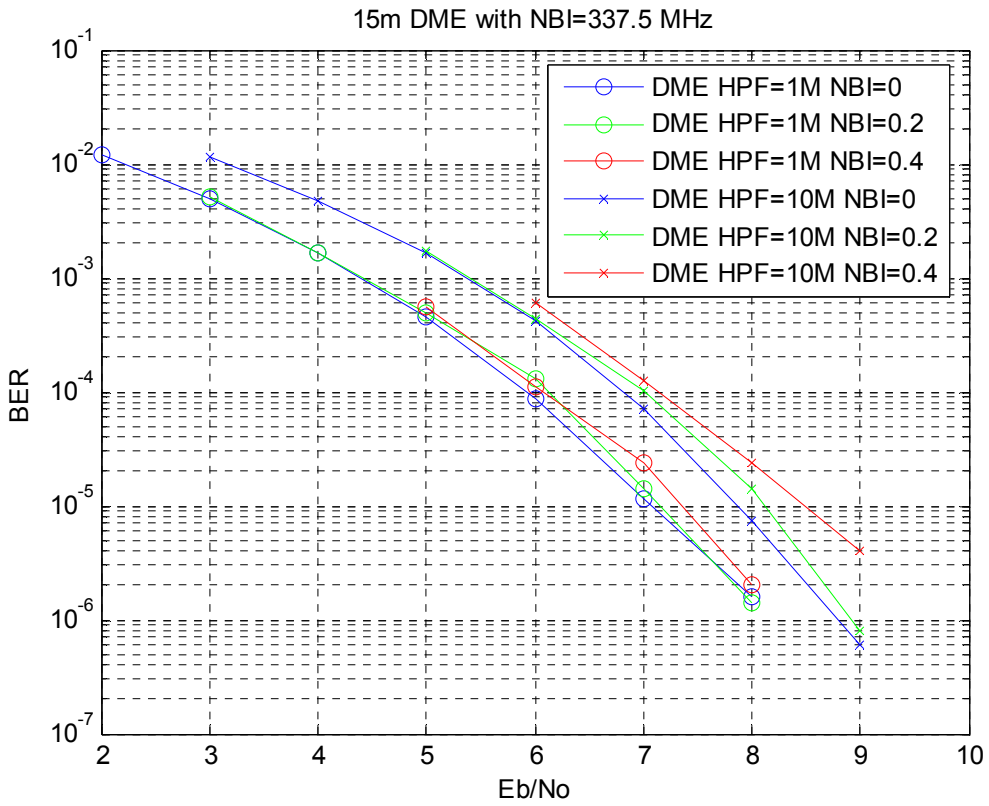
DME BER vs. impairments 15m NBI = 17.7 MHz

- **BER shown for 15m channel, NBI = 17.7 MHz at 0, 200mV and 400mV**



DME BER vs. impairments 15m NBI = 337.5 MHz

- BER shown for 15m channel, NBI = 337.5 MHz at 0, 200mV and 400mV



Open item dependent on other parts of 1000BASE-T1

- **DME transmit electrical levels**
  - **Most likely some threshold easily met by 1000BASE-T PAM3 and 1TPCE PAM3 +1 / -1 levels**

Next Steps

- **Adopt Lo_3bp_04_0314.pdf with changes in Lo_3bp_02a_0714.pdf and this presentation (McClellan_Lo_3bp_01_0914.pdf) 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