10GBASE-T EEE Proposal
xLPI

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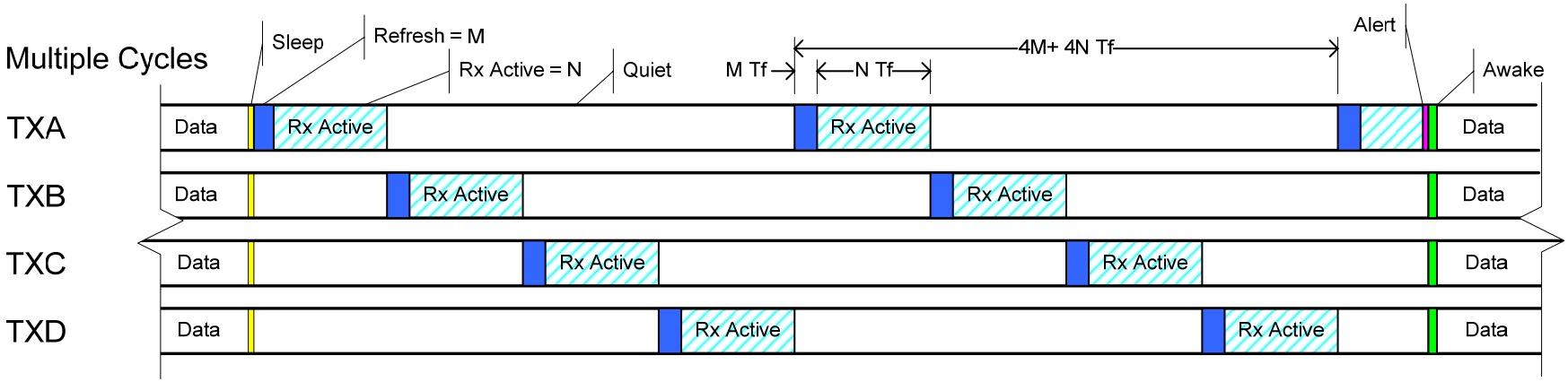
Supporters

Highlights

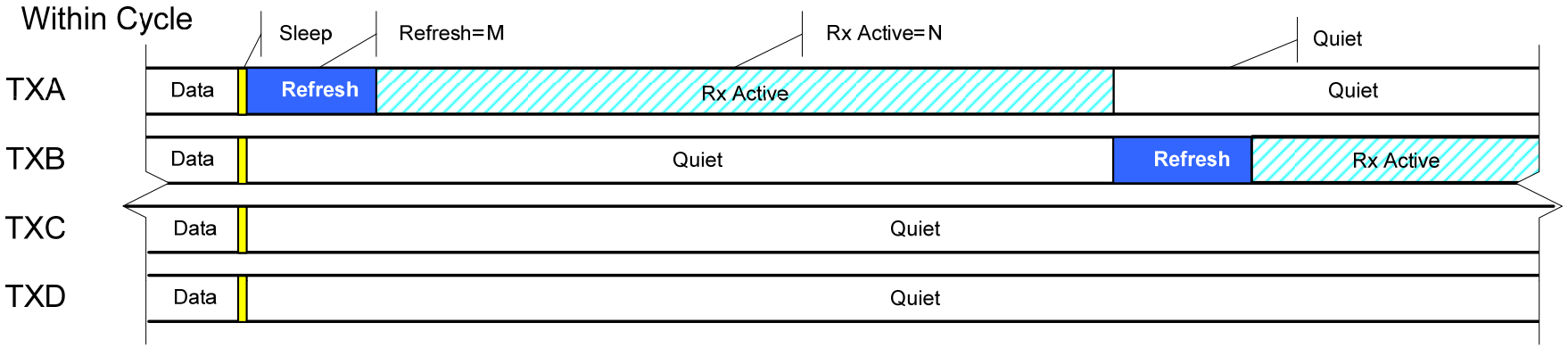
- Common Elements with LPI
  - Refresh / quiet concept
  - Structure of Sleep and Alert/Awake commands
- Enhancements offered with xLPI
  - Staggering refresh over the 4 channels
    - Reduces power and implementation complexity
  - Leverage PAM2 for refresh functionality
    - Increases noise margin, reduces Rx power
  - Expand when Alert signal can be sent; Define Alert

New Proposal - xLPI



- Assume N=100 for baseline
  - M is vendor dependant, M & N set in Autonegotiation
- Staggered timing spreads refresh over 4 channels, reducing power
- Alert is a Tf frame, and can occur anytime

Definition of Refresh

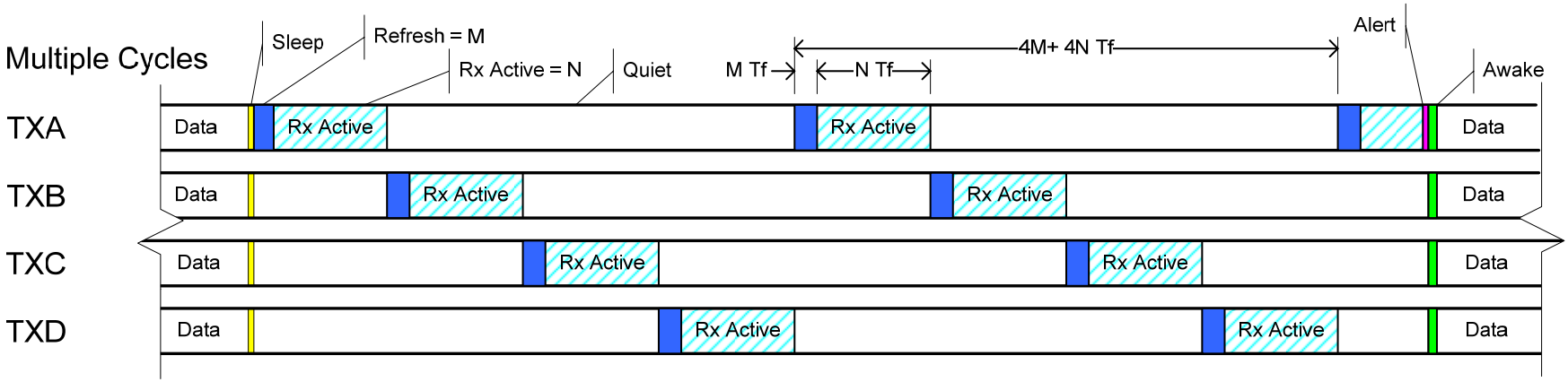


- Refresh need only occur on one lane at a time
- Refresh is M frames in length, M is vendor dependant
- Alert can occur within, and truncate, a Refresh period

Master	A	B	C	D	A	B	C	D	…
Slave	C	D	A	B	C	D	A	B	…

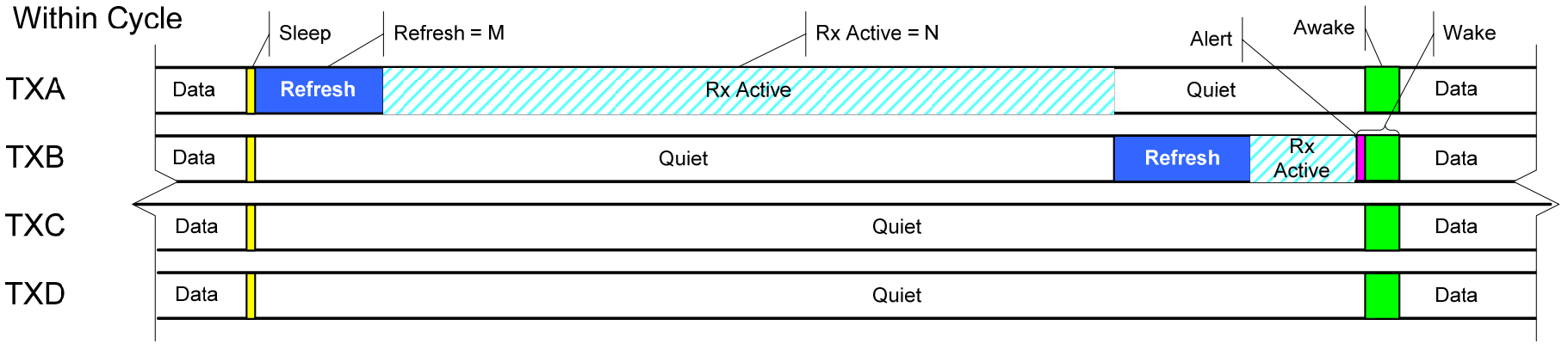
Lane assignments if Master and Slave both enter LPI

Definition of Rx Active



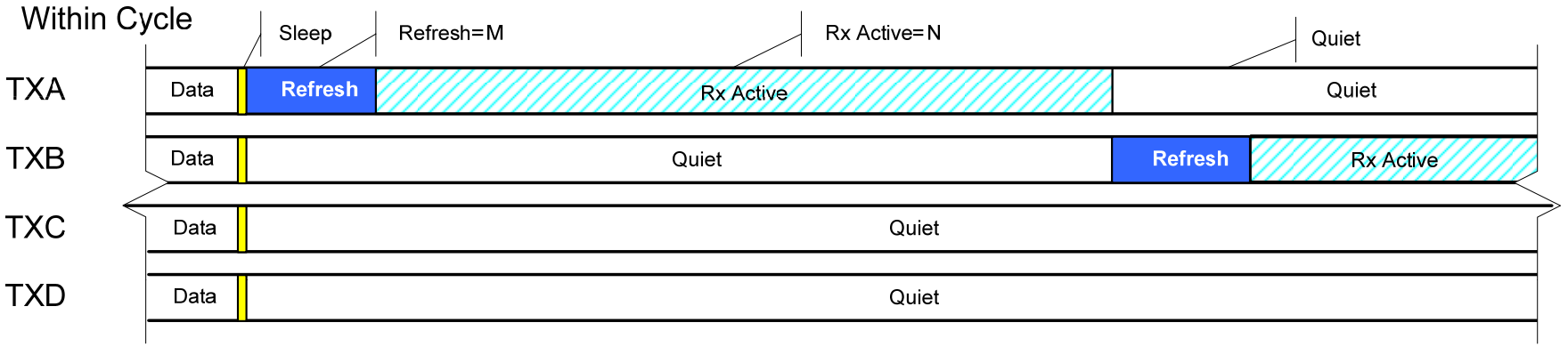
- Transmitter is off during Rx Active (N) unless sending Alert
- Link partner's receiver in Rx Active does not need to be full power, only need to decode Alert signal
- Alert is a simple modification of a single Refresh Tf appearing in the "active" Tx channel
- Awake is as defined in LPI
  - Taw defined in Auto-Neg

Wake-up Time Estimation



- Wake-up time has the following components
  - One Tf for Alert
  - Taw (Awake) for receiver PHY to prepare for receiving data
  - One add'l Tf before Alert based on when command is received
- Tw max =Tf+Tf+Taw(4Tf) = 1.9us
- Tw min = 0+Tf+Taw(4Tf) = 1.6us

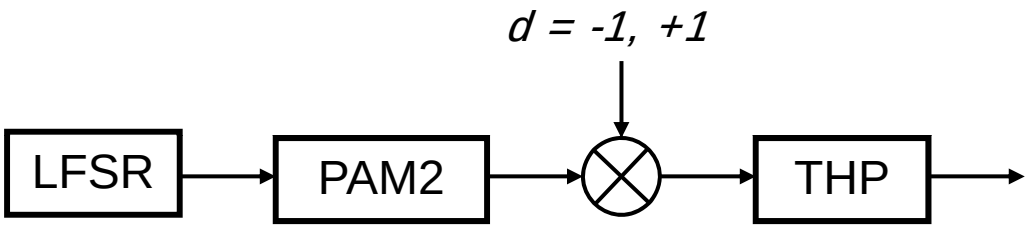
Definition of Quiet



- Transmitter is off during Quiet
- Receiver is off during Quiet

Transmitter Specifications

- Transmit data: LFSR + PAM2 + THP



- Refresh frames: $d = +1$
- Alert frames: $d = -1$

Receiver Complexity

- When in Rx Active
  - No echo canceller, No FEXT canceller, 1 NEXT canceller, 1 FFE
- When in Refresh
  - Implementation dependant, Echo cancellation and other circuits may be active, can reduce power when coefficient calculation is complete
- Extra SNR margin: > 30 dB
  - PAM-2 vs DSQ128: +19 dB
  - 1 bit/frame: +24 dB
  - No LDPC: -9 dB
- Only 1 (simplified) FFE, other filters off
  - Opportunities exist to reduce power in AFE

Power Savings

- Duty Cycle Dependant
  - xLPI (M=20, N=100): 20/(4x20+4x100) = 4.2%
  - LPI (M=4, N=100): 4/(100+4) = 3.8%
  - xLPI (M=4, N=100): 4/(4x4+4x100)= 1%
- Active Power components
  - Simplex: no echo canceller
  - More margin in PAM2-THP: no crosstalk canceller, shorter FFE
  - No LDPC decoder
- Quiescent Power should be the same as for LPI