10GBase-T EEE Specifications

Refresh, Quiet

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Supporters

- Gavin Parnaby (Solarflare)
- George Zimmerman (Solarflare)
- Dimitry Taich (Teranetics)
- Michael Grimwood (Broadcom)

References

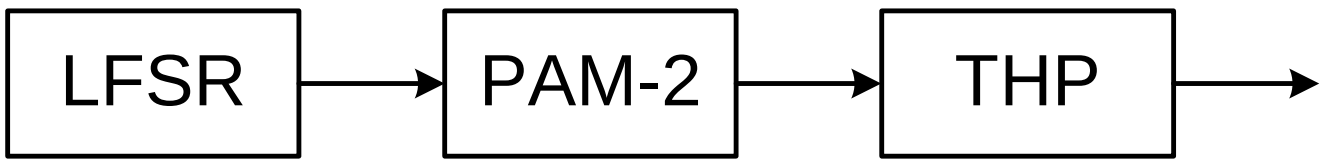
- Some of the ideas presented in this proposal are based on a number of previous presentations including:
  - zimmerman_02_0308.pdf
  - taich_02_0508.pdf

Definition, Usage and Desirable Features

- Refresh: is used to update receiver parameters
  - Timing information
  - Filter coefficients
- Quiet: allows PHY to shut down major blocks for power saving
- Define the new signals in the existing framework of 10GBase-T to avoid:
  - new signal specification
  - new test definition
- Refresh signal specifications should allow:
  - simple coefficient update for filters
  - simple timing recovery

Transmitter Specifications: Signal Path

- Training path: LFSR + PAM2 + THP
- Training LFSR, free running, non-stop
- THP coefficients same as in normal mode
- Transmit power (PBO) and PSD (both magnitude and phase responses) identical to normal mode



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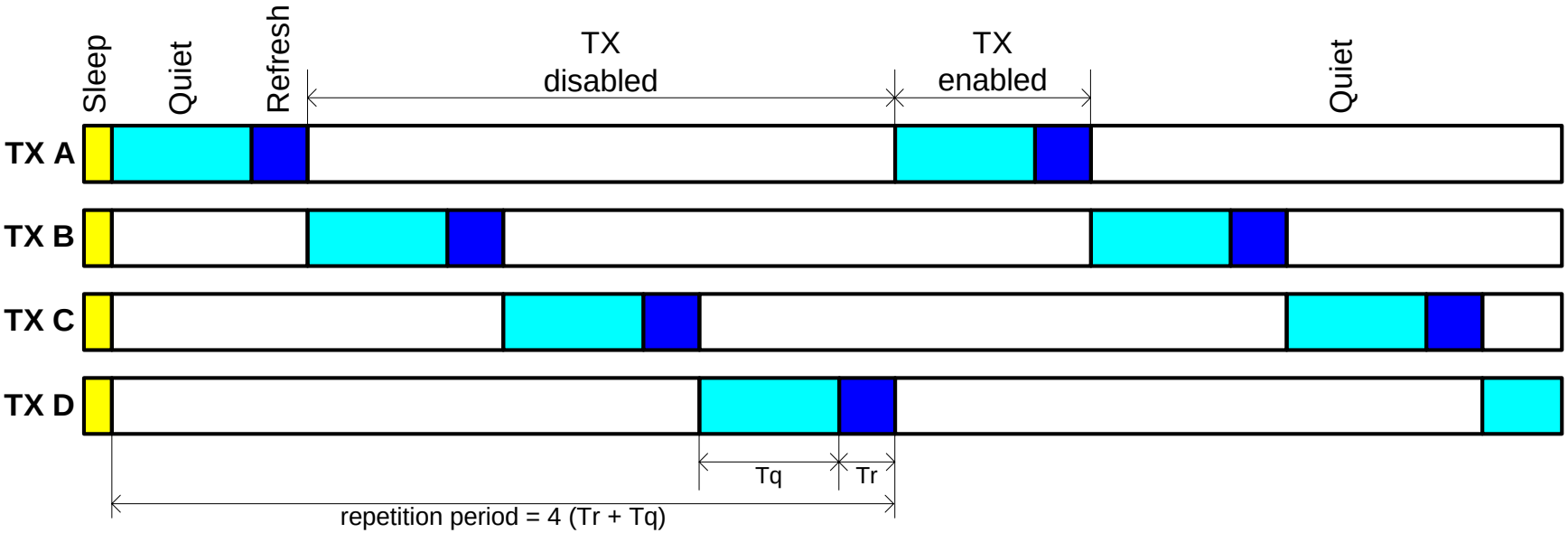
Transmit Specifications: Staggered Signaling



- Time unit: T = 1 LDPC frame = 256 PAM2 symbols = 320 ns
- Refresh duration: Tr = M*T
- Quiet duration: Tq = N*T

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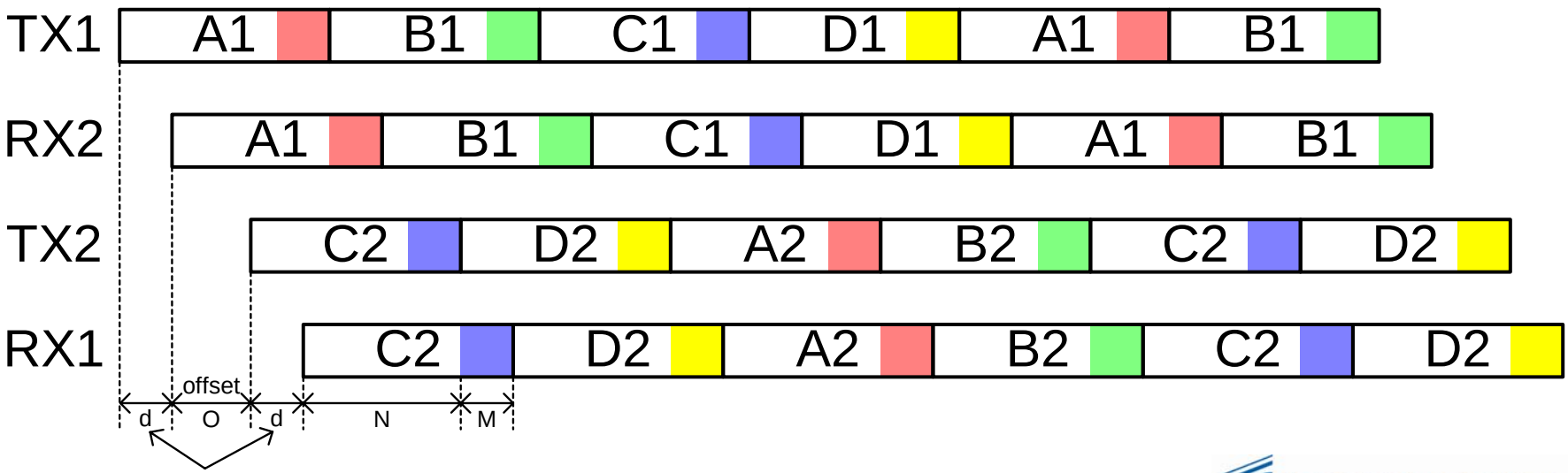
Transmit Specifications: Staggered Signaling

- Only one transmitter channel is enabled at a time
  - Transmitter channels alternate in a round-robin fashion
  - Roughly 75% power saving when both link-partners in LPI
  - At most one NEXT and no FEXT canceller needed
  - Allows simplex operation, no need for echo canceller (proper coordination with link partner needed)
- Enabled transmitter starts with N Quiet frames
- The last M frames of an Enabled period shall be Refresh frames
- A disabled transmitter shall be quiet

Link-Partner Coordination

- Simplified receiver when both link-partners are in LPI
- Goal 1: simplex operation - no need for echo canceller
  - Prevent transmitter and receiver of the same channel to get enabled at the same time
- Goal 2: no near-end crosstalk during refresh
  - Allow transmitters to send refresh only during inactive receive time



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Link-Partner Coordination

- Each link-partner can enter LPI mode independently
- As first link-partner to LPI, Master always start transmission on channel A and Slave on channel C
- Second link-partner to LPI starts transmission on a channel staggered by 2 with respect to its receiving channel
- Enabled duration to be identical on both link-partners
- Second link-partner going to LPI should synchronize the start of the transmit-enabled period with an offset with respect to the start of the receive-enabled period

Parameter Constraints

- Constraint to satisfy goal 1: $0 \le O < \left(M + N - 2d\right)$
- Constraints to satisfy goal 2: $M < O < \left(N - 2d\right)$
- Possible choice for offset: $O = \frac{M + N}{2} - d$
- Constraint on (N+M): $\left(M + N\right) > 2d$

Parameter Constraints

- (M+N) > TBD to ensure simplex operation with longest round-trip delay
- (M+N) < TBD to provide frequent update opportunity for timing recovery and FIRs
  - track low frequency phase jitter and frequency offset
  - track channel variations due to thermal and mechanical effects
- Enabled duration (M+N) to be identical on both sides

- The values of M, N and O are not specified in this proposal and they are subject to further studies
- A study of race condition is warranted

Summary

- LFSR + PAM2 + THP
  - No new signal specification (and test definition) needed
  - Minimal additional signal processing blocks in the transmit path
  - Simple FIR/timing update
- Channel staggering
  - One channel active at a time for power saving
- Link-partner coordination (symmetric mode)
  - Simplex operation, no echo canceller
  - At most one NEXT canceller and no FEXT canceller

Appendix: Parameter Constraints

- Refer to figure in slide 8:

- To ensure simplex operation for PHY2:
  - O+M+N+Te < 2(M+N), where Te is echo response time
  - Simplifies to: O<M+N-Te
- To ensure simplex operation for PHY1:
  - 2d+O+M+N < 2(M+N)
  - Simplifies to: O<M+N-2d

- Te and 2d are roughly equal; the overall constraint is:
  - O<M+N-2d

Appendix: Parameter Constraints

- Refer to figure in slide 8:

- To prevent NEXT on PHY2:
  - N+M<N+O and 2N+M>N+M+O+Tn, where Tn is NEXT response time
  - Simplifies to: M<O<N-Tn
- To prevent NEXT on PHY1:
  - 2N+M>2d+O+N+M and N+M+Tn<2d+O+N
  - Simplifies to: M+Tn-2d<O<N-2d
- Assuming 2d>Tn, the overall constraint is:
  - M<O<N-2d