Asymmetrical Data Transmission

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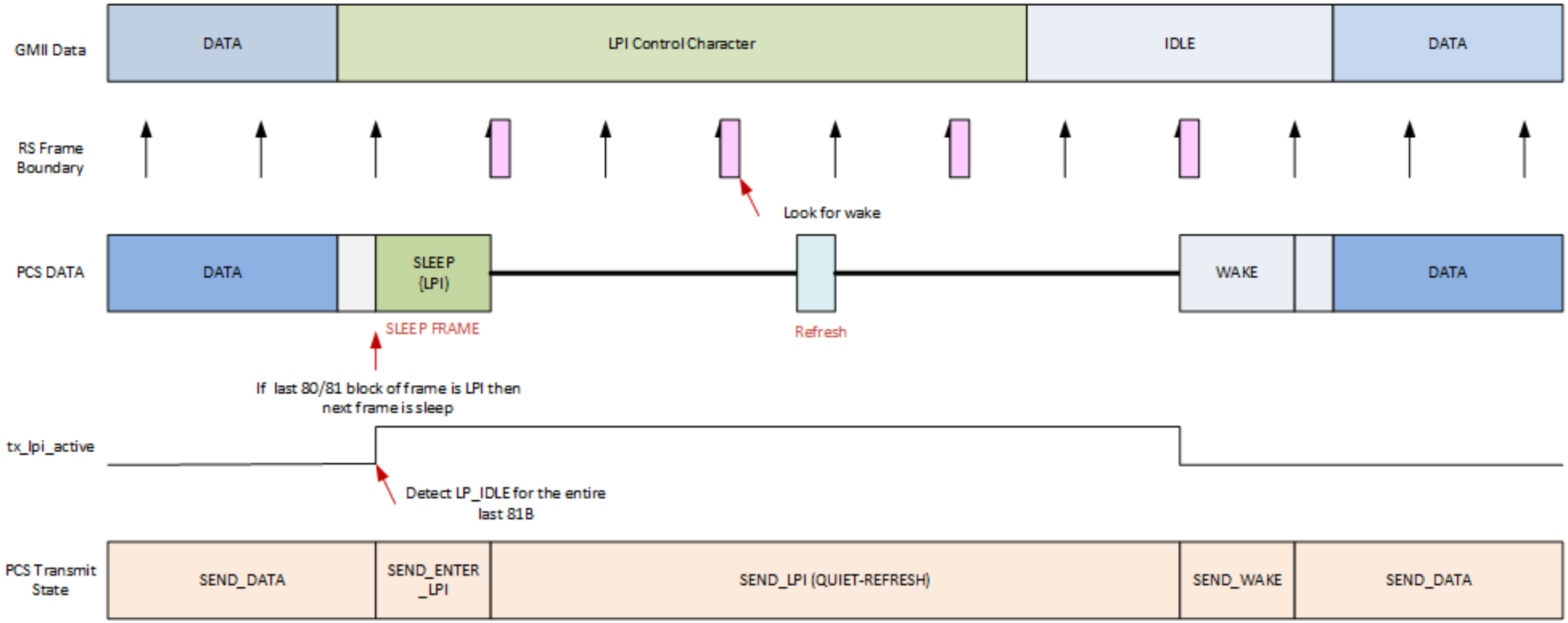
Presentation outline

- Section I:
  - 1000BASE-T1 EEE Overview
  - Proposal to extend 1000BASE-T1 EEE to Multi-Gig Automotive EEE

- Section II:
  - Introducing asymmetrical data transmission mode without EEE
  - Proposal to add optional asymmetrical mode to Multi-Gig Automotive PHY

Section I: Multi-Gig Automotive EEE

1000BASE-T1 EEE Overview – pt 1/2



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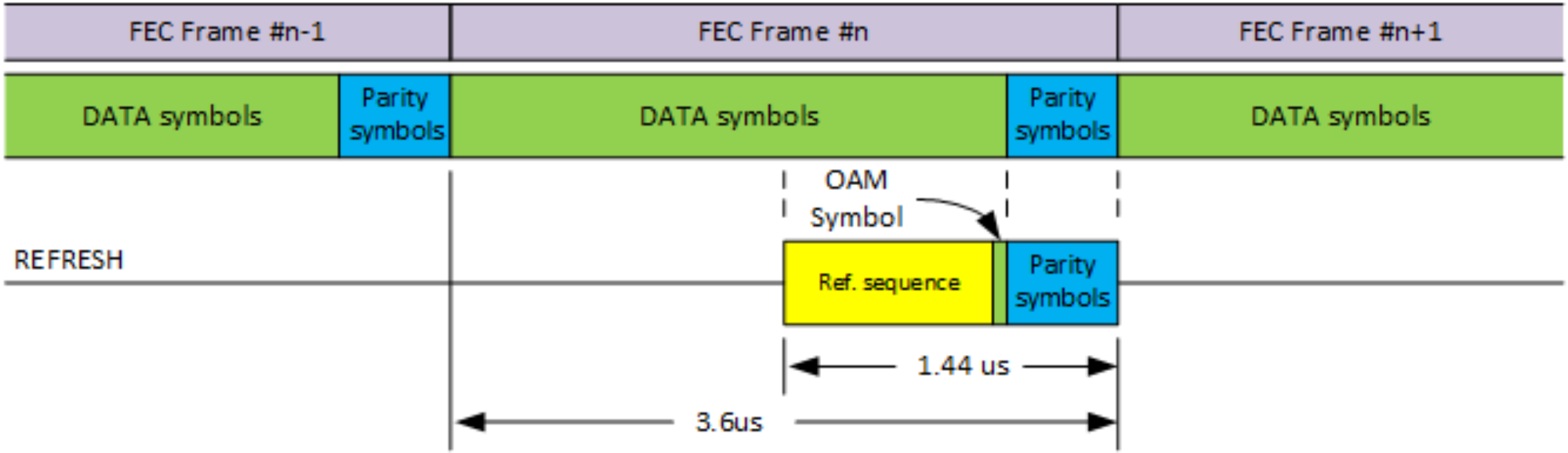
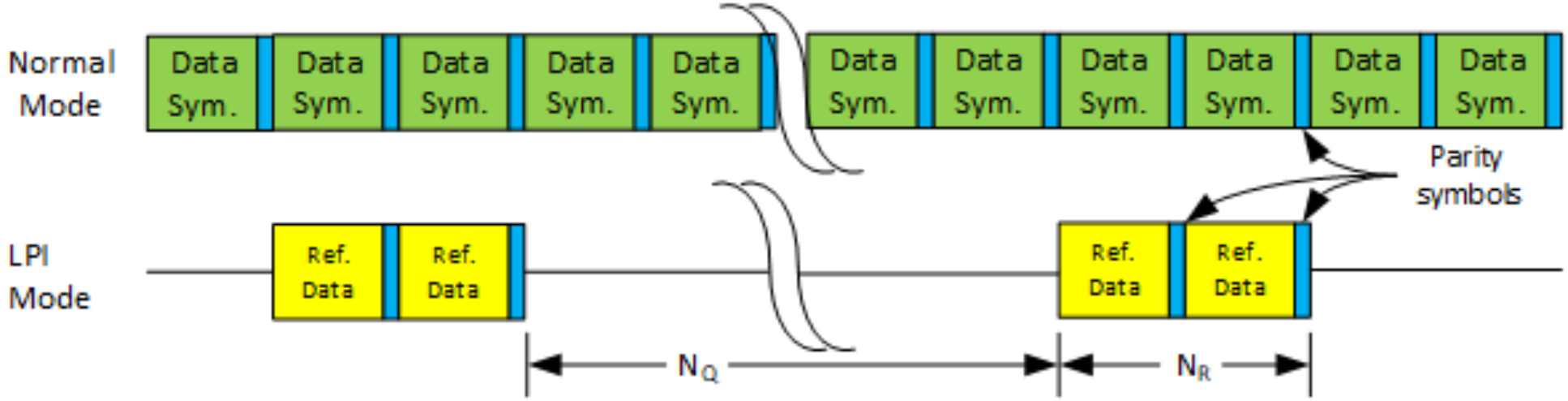
1000BASE-T1 EEE Overview – pt 2/2

- 1000BASE-T1 EEE vs 10GBASE-T EEE
  - Wake is scheduled and in-band
  - Pass OAM data during the Refresh
  - Refresh is fraction (40%) of a FEC frame



Proposal 1 – Extend 1000BASE-T1 EEE to Multi-Gig Automotive EEE

- Refresh length integer number of Reed-Solomon FEC frames
- Refresh length needs to be from 1.28 us to 1.5 us
- N_Q & N_R are TBD



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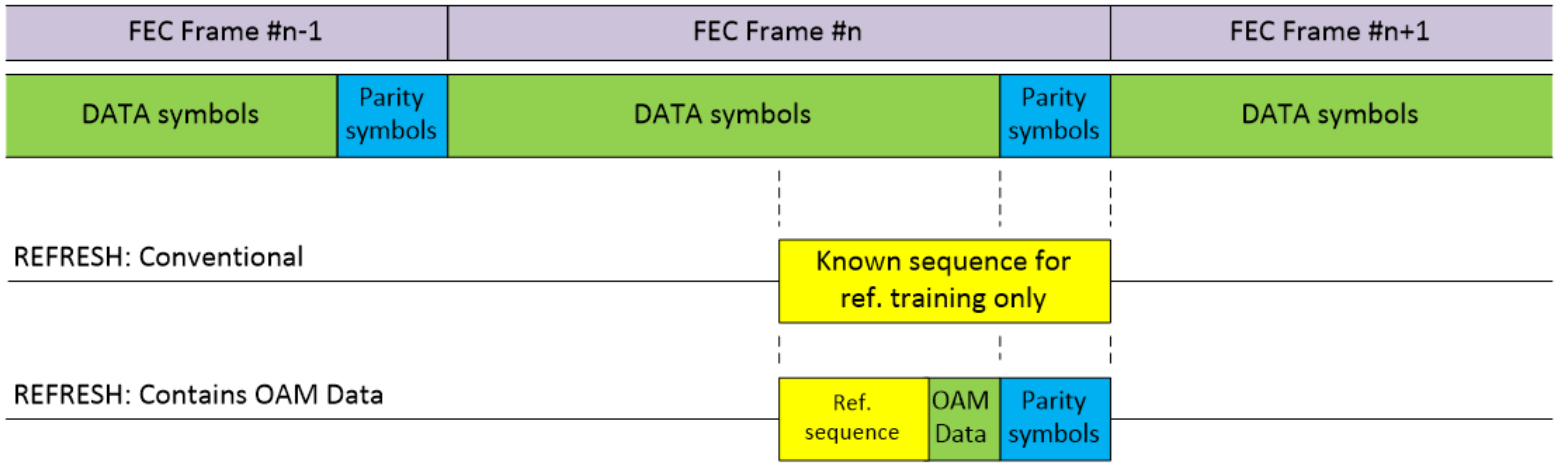
Section II: Asymmetrical Data Transmission

Motivation for Asymmetrical Data Transmission

- Some automotive links need asymmetrical data rates
  - Camera to switch (high) vs switch to camera (low)
  - Switch to display (high) vs display to switch (low)
- Need flexibility in anticipation of different end units & data rates
  - Data rates may be preconfigured and exchanged during training
  - Data rates may be configured on-the-fly via OAM or other protocol in data mode
- PHY configurable for symmetrical or asymmetrical data rates

Prior Concept Based on LPI Refresh (Jan. 2015) – pt 1/2

- Optional employment of the existing systematic block forward error correcting code (FEC).
- Align the LPI REFRESH signal with the FEC frame so that it consists of 3 sections:
  - Known reference sequence
  - Part of the FEC systematic symbols
  - The entire FEC parity symbols
- Apply punctured FEC encoding and decoding on the OAM data symbols and the parity symbols.



- http://www.ieee802.org/3/bp/public/jan15/graba_3bp_01_0115.pdf

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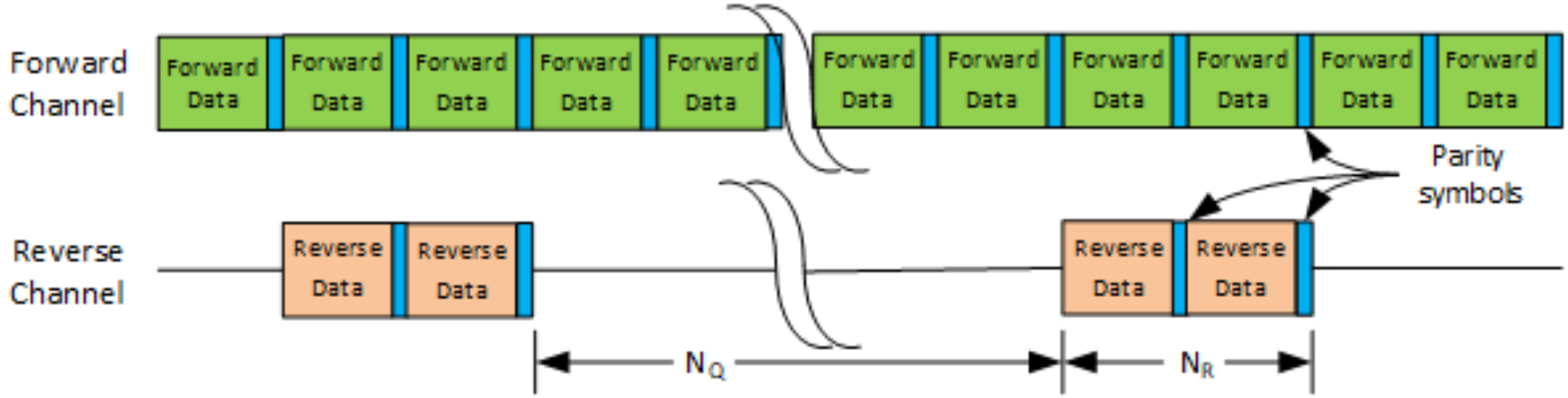
Prior Concept Based on LPI Refresh (Jan. 2015) – pt 2/2

- Enable robust OAM channel during LPI mode
  - REFRESH signals always starts with known reference sequence for maintaining link integrity
  - Rest of REFRESH signal aligned to FEC data and parity symbols, which enabled FEC error protection
- Reduced latency and power consumption when transferring OAM data ➔ no need to exit LPI mode
- Mechanism for passing user data at a reduced rate while in LPI mode
  - For example: 45 (OAM + Parity) + 90 (User data) + 45 (Reference data) = 10 80B/81B blocks per REFRESH => 9.259 Mbps
  - Future proofing for highly asymmetrical data transfer requirements

- http://www.ieee802.org/3/bp/public/jan15/graba_3bp_01_0115.pdf

Proposal 2 – Add asymmetrical data mode

- Concept discussed in 802.3bp January 2015:
  - http://www.ieee802.org/3/bp/public/jan15/graba_3bp_01_0115.pdf
- Also discussed in 802.3ch September 2017:
  - http://www.ieee802.org/3/ch/public/sep17/dalmia_3ch_01_0917.pdf
- Operates as an optional mode, independent of EEE
- Low data rate = full data rate * N_R / (N_R + N_Q)
- Support low data rates from 100 Mb/s to 1 Gb/s



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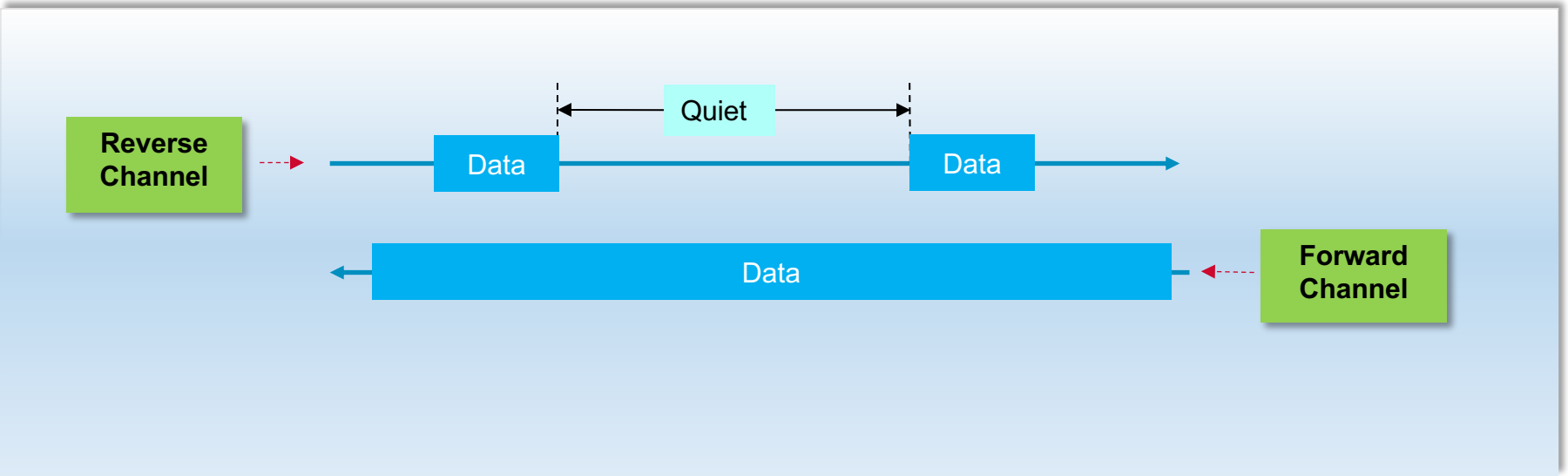
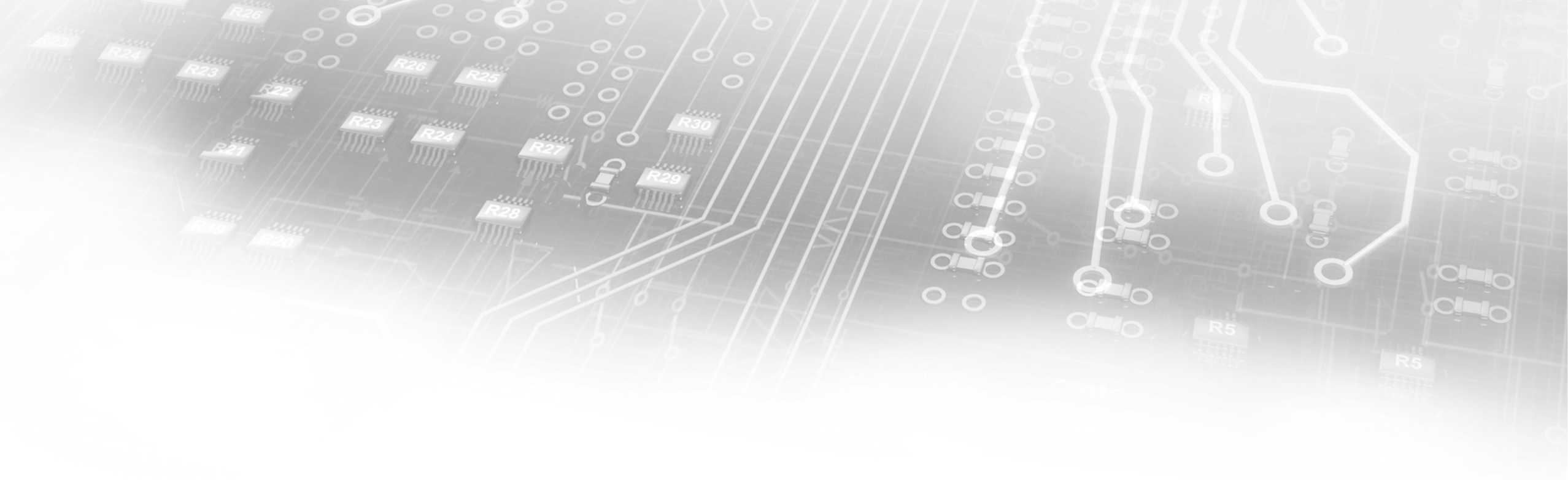
Time-Division Asymmetric Flow



- Forward Channel (full data rate link) not impacted
- Reverse Channel (reduced data rate link) – an example
  - Programmable number of quiet frames per 100 frame window
  - Maximum 98 quiet per 100 frames to ensure link stability
  - Data rate vs power tradeoff

Options for Low Data Rate Path

- Flow Control
  - PHY sends PAUSE frames to control the data rate to be transmitted
- Idle Stuffing
  - Insert enough Idles between packets to achieve the lower data rate
- XGMII repeat
  - Repeat each TX word *N* times
  - $N = \frac{forward\ data\ rate}{reverse\ data\ rate}$



THANK YOU