Update on 1000BASE-T1 EEE:
LPI-FEC Interaction

Kanata, ON, Canada

September 8, 2014

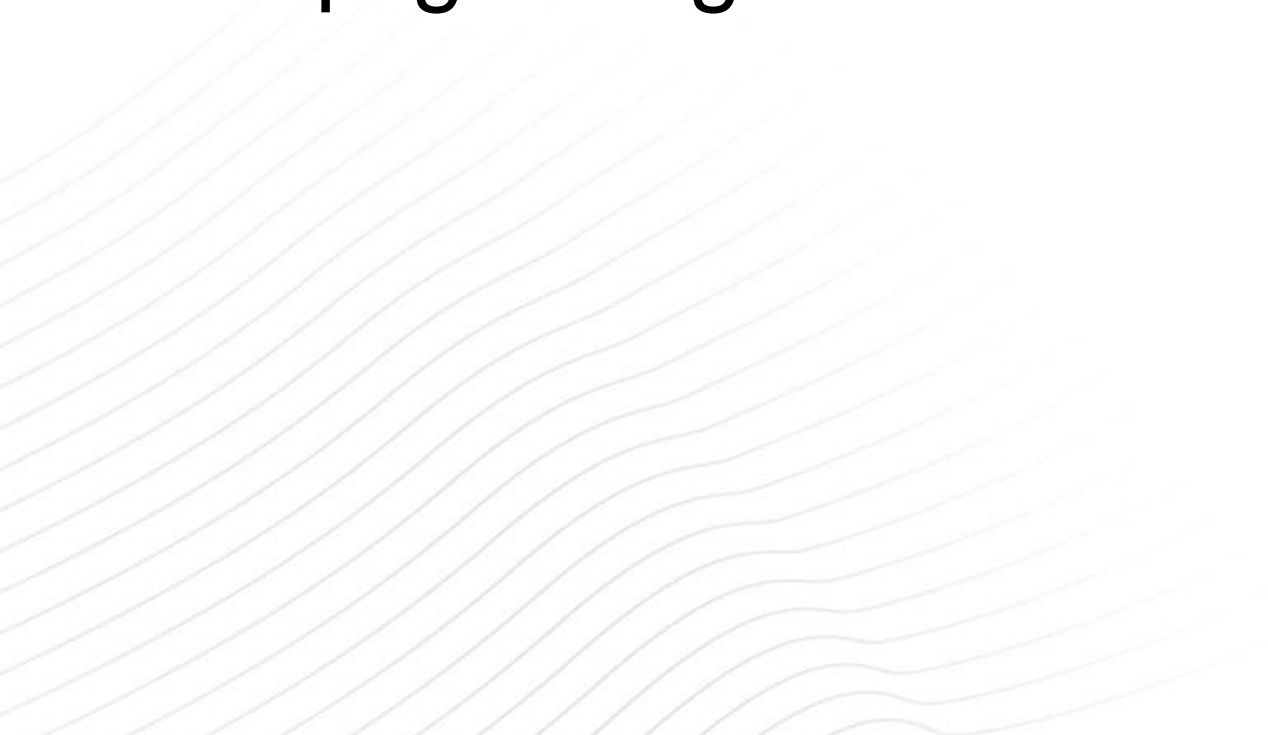## Jim Graba

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Overview

- LPI Refresh

- Synchronize LPI with FEC Frames

- Exiting LPI

- LPI Exit Latency

- LPI Parameter Choices

- Conclusions

LPI Refresh

- 10G EEE
  - LPI Refresh is composed of THP encoded PAM2 => Refresh signal power = Data signal power
  - PAM2 generated by 33 bit training scrambler
  - Able to use known data in the Refresh

- 1000BASE-T1 Refreshes should be composed of PAM3 instead of PAM2
  - Keeps data and Refresh and signal power equal
  - Resynchronization at LPI exit is easier
  - Can still use known data in the Refresh

- Use the data transmit channel for LPI mode
  - Keep the RS cadence constant regardless of enter/exit LPI times
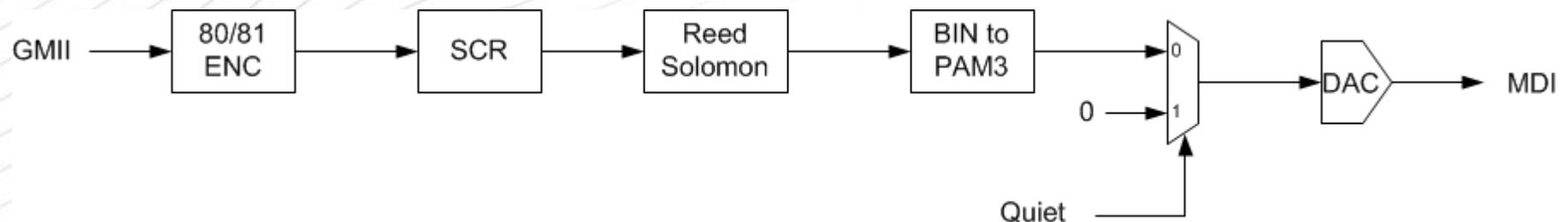
Refresh Composition

- The parity bits in the RS(450, 405) are 1/10 the length of the code word
  - Let the partial frames = 1/10 of the code word length => PF = 10

- Now the Refreshes can be aligned to the RS frame such that each Refresh can contain data and parity bits
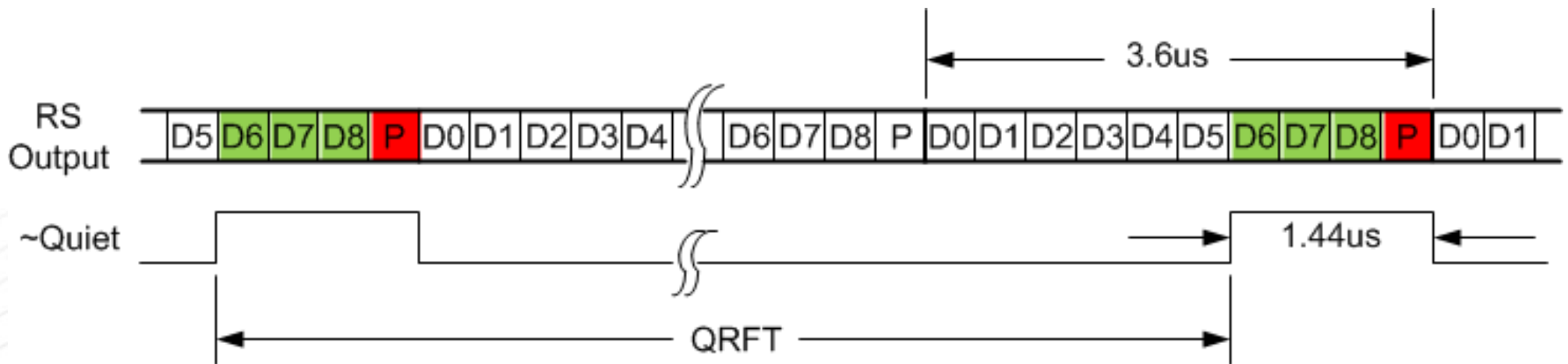
  - RS frames and LPI state machine must be synchronized at link up.
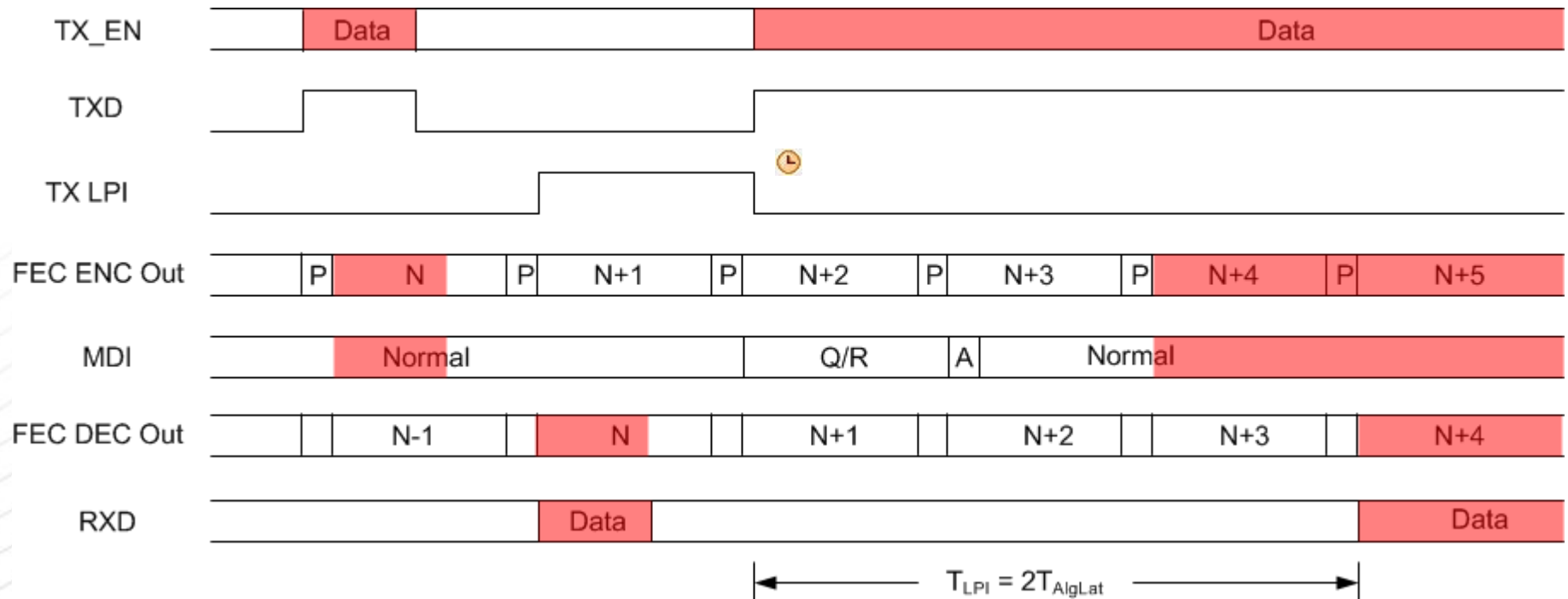
Exiting LPI Mode

- Alert
  - Occupy D0-D1
  - 720ns
  - Alert composition TBD

- If sending an Alert then send the rest of the RS frame
  - Enough data to synchronize the scrambler
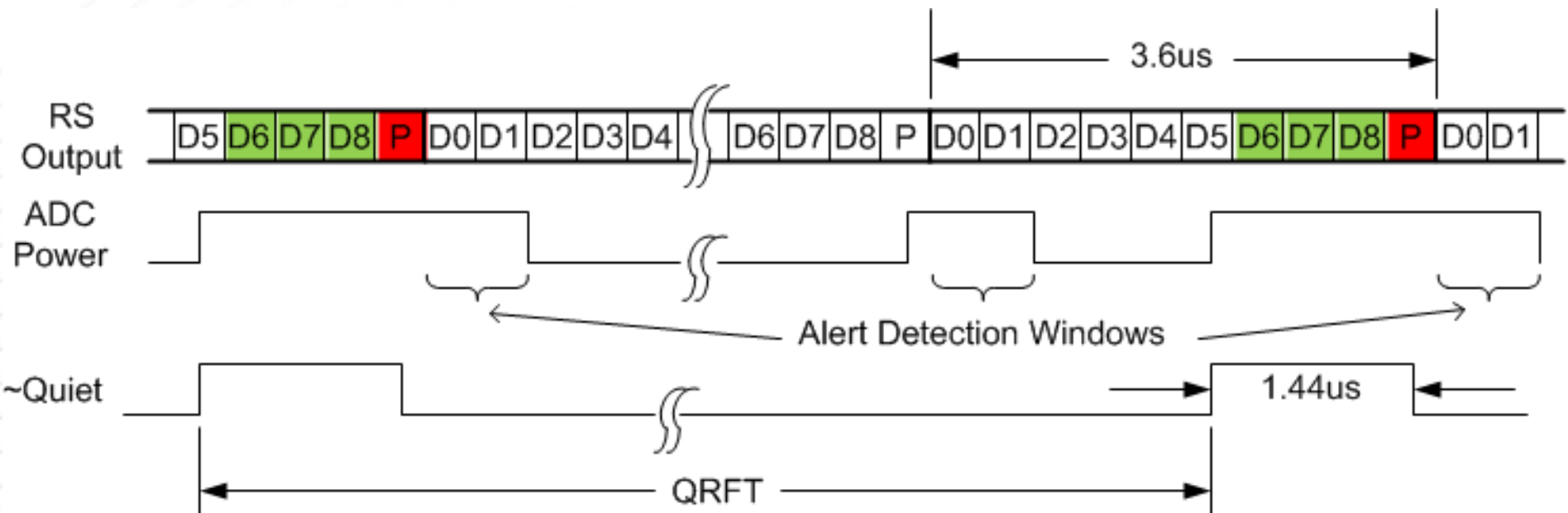
LPI Exit Latency

- $T_{LPI} <= 2*T_{AlgLat} = 10.8us$
  - Increase in latency due to LPI

LPI Parameter Choices

Symbol	Definition	Proposal	Lo: 20140813
RS3	# PAM3 symbols per RS frame	2700	2700
RXT	Duration of RS frame (ns)	3600	3600
PRS3	# PAM3 symbols per partial RS frame	270	180
PRST	Duration of partial RS frame (ns)	360	240
PF	# partial frames per RS frame	10	15
QRF	# RS frame per Quiet Refresh cycle	23	30
QRT	Duration of quiet refresh cycle (ns)	82800	108000
AF	# partial RS frames separating alert	10	17
AlertGran.T	Alert Granularity (ns)	3600	4080
Refresh_LPI	# partial RS frames for refresh	4	6
Refresh_T	Duration for refresh (ns)	1440	1440
QR_Ratio	Quiet/Refresh Ratio	57.5	75
Enter_LPI_RS	# RS frames with all LPI to enter LPI	1	2
Alert_LPI	# alert sequences to exit LPI	2	3
Alert_LPIT	Alert time (ns)	720	720
Exit_LPI_RS	# RS frames with all idles upon exit LPI	1	1
Alert_sym	# symbols in alert sequence	540	540

Conclusions

- **Synchronize Reed Solomon frames to LPI timing**

- **Reduce Quiet/Refresh cycle length**

- **Place Alert at the beginning of the RS frame**