Multi-Gig Automotive EEE Proposal

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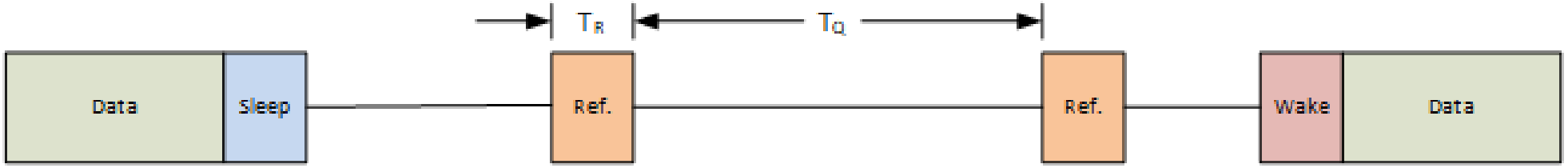
Past 802.3ch EEE proposals as of the September, 2018 Interim

- Souvignier proposed to extend 1000BASE-T1 EEE to Multi-Gig Automotive EEE in souvignier_3ch_01a_0718.pdf
  - Quiet-Refresh (QR) cycle was TBD
  - Wake is scheduled and in-band but not detailed
  - OAM passed during Refresh
- Benyamin and Langner submitted a EEE proposal, benyamin_3ch_01_0918.pdf, at the September, 2018 Interim meeting
  - Specified the QR cycles
  - Wake uses the traditional 802.3az (10G EEE) Alert
  - Pass OAM data during Refresh
- We detail our EEE proposal in this presentation



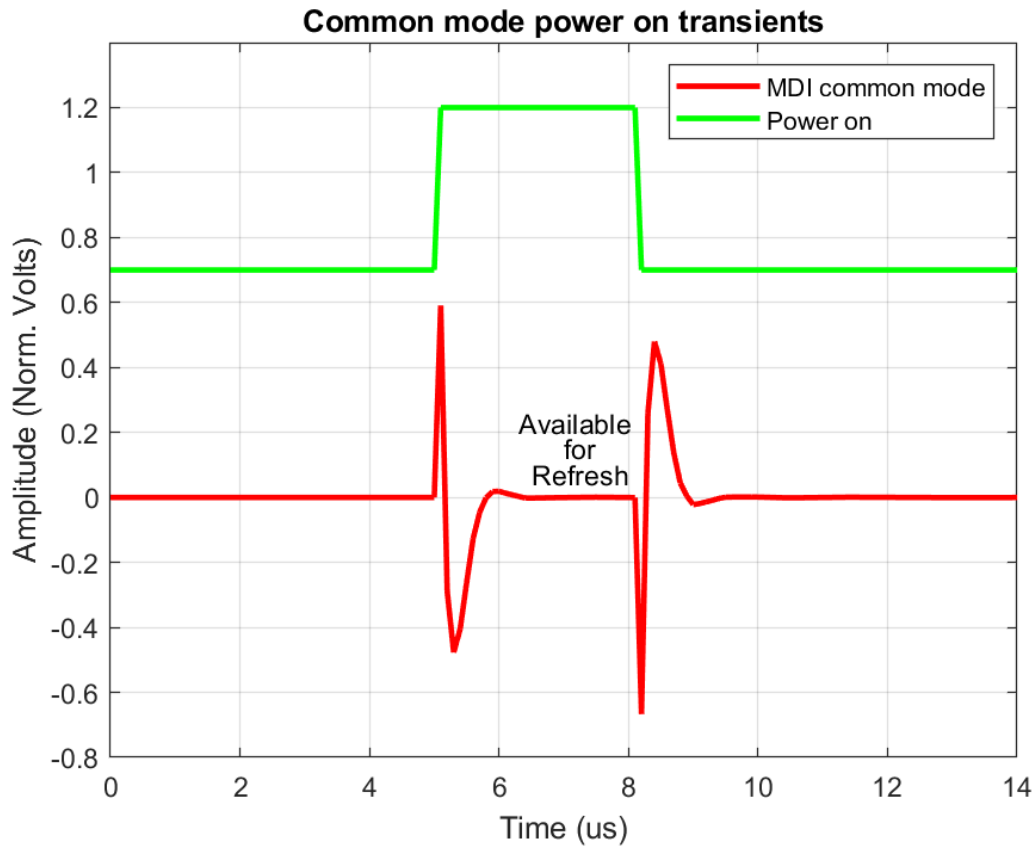
Quiet/Refresh considerations

- What drives the Quiet (T_Q) and Refresh (T_R) lengths?
- T_Q should long enough to realize power savings
  - Need time before and after Refresh to gracefully change power states
- T_Q should be short enough such that clock drift doesn't affect data detection
  - Frequency offset < 50 ppm
  - Frequency drift < 0.1 ppm/sec
    - Phase error due to drift increases proportionally with FS but inversely proportional with T_Q^2.
  - Although 802.3az (10G EEE) survived with T_Q = 40.96 us the T_Q for 802.3ch (Multi-Gig Automotive) should be smaller
- T_R should long enough to:
  - Keep the decimation, $T_R/(T_R + T_Q)$, reasonable ~ 5%
  - Be an increase over 802.3az and 802.3bp (1000BASE-T1)
  - Fit the "down and back" echo into a Refresh. Easily done for 15 m cables.

Power on transients

- Voltage regulators and decoupling circuits deal with changing current demands
- Change in power state + reactive components = non-zero response

- MDI will see power on transients
- Although transients are common mode,
  - Finite common mode to differential conversion
  - Another noise source
  - Impacts asymmetrical LPI
  - Want response to die down before sending Refresh
- Need to reduce this noise source's rate of occurrence
  - Make T_q as long as possible



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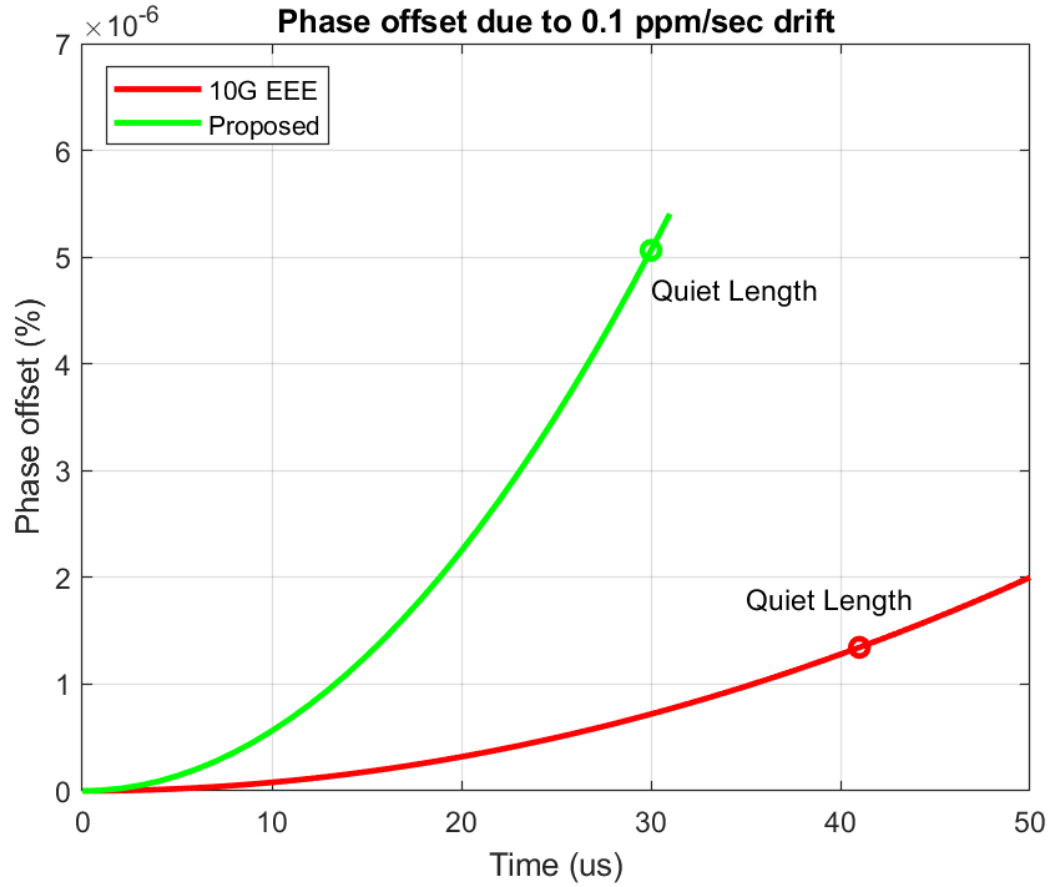
Phase error due to frequency drift

- See Grimwood and Powell's March, 2008 presentation.

$$\varphi_d(t) = F_S * r_d * t^2$$

- Proposed TQ shows a small phase drift ~ 5.1e-6%



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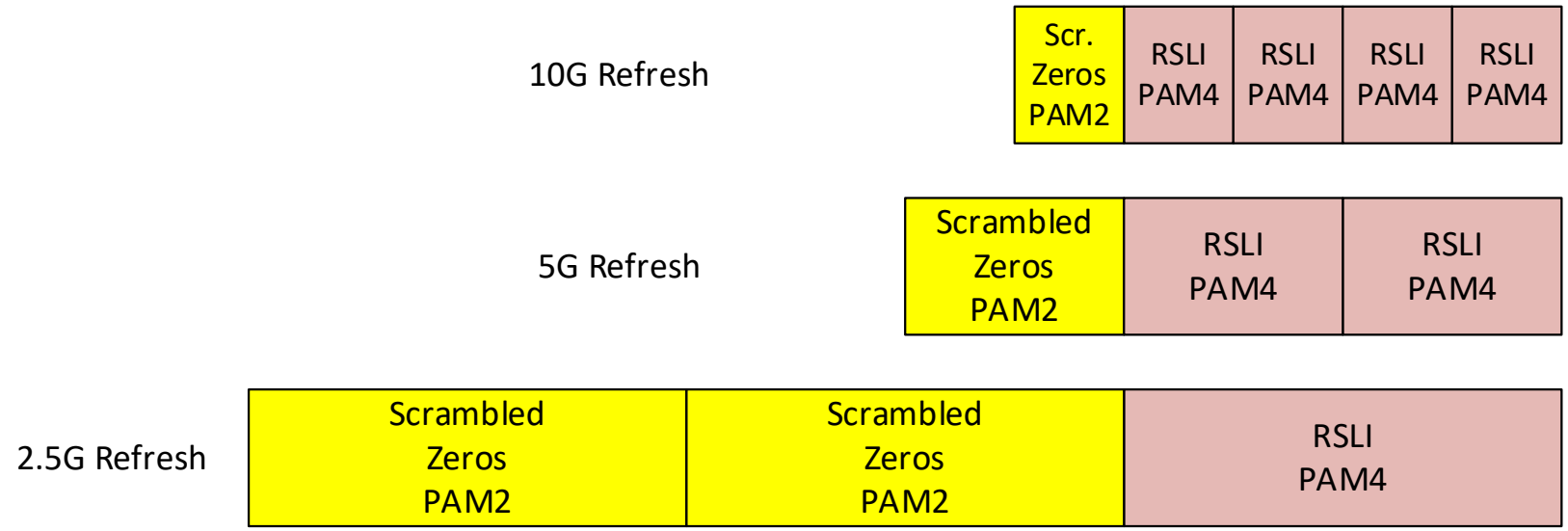
QR proposal

- Keep the Refresh length greater than the length of the 802.3az (10GASE-T EEE) Refresh
  - More immunity to burst noise
- Duty cycle is larger than 802.3az and similar to 802.3bz (5/2.5GBASE-T)
  - Margin to deal with the more difficult automotive environment

	10G RS	10G (us)	5G RS	5G (us)	2.5G RS	2.5G (us)
QR period	100	32	50	32	50	64
Ref. length	5	1.6	3	1.92	3	3.84
Duty cycle	5%	-	6%	-	6%	-

Refresh content

- Refresh composition:
  - First frame (s) are PAM2 zeros scrambled by the training scrambler
  - Subsequent frames are PAM4 RS FEC frames with /LI/s (RSLI)
- RS FEC frame contains OAM data



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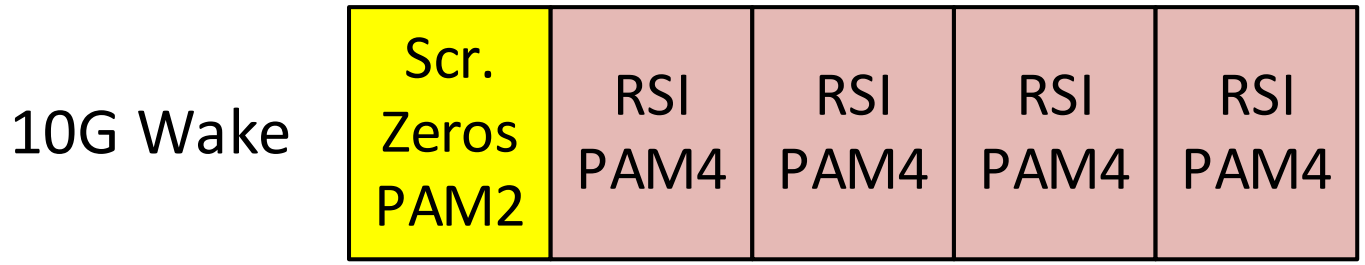
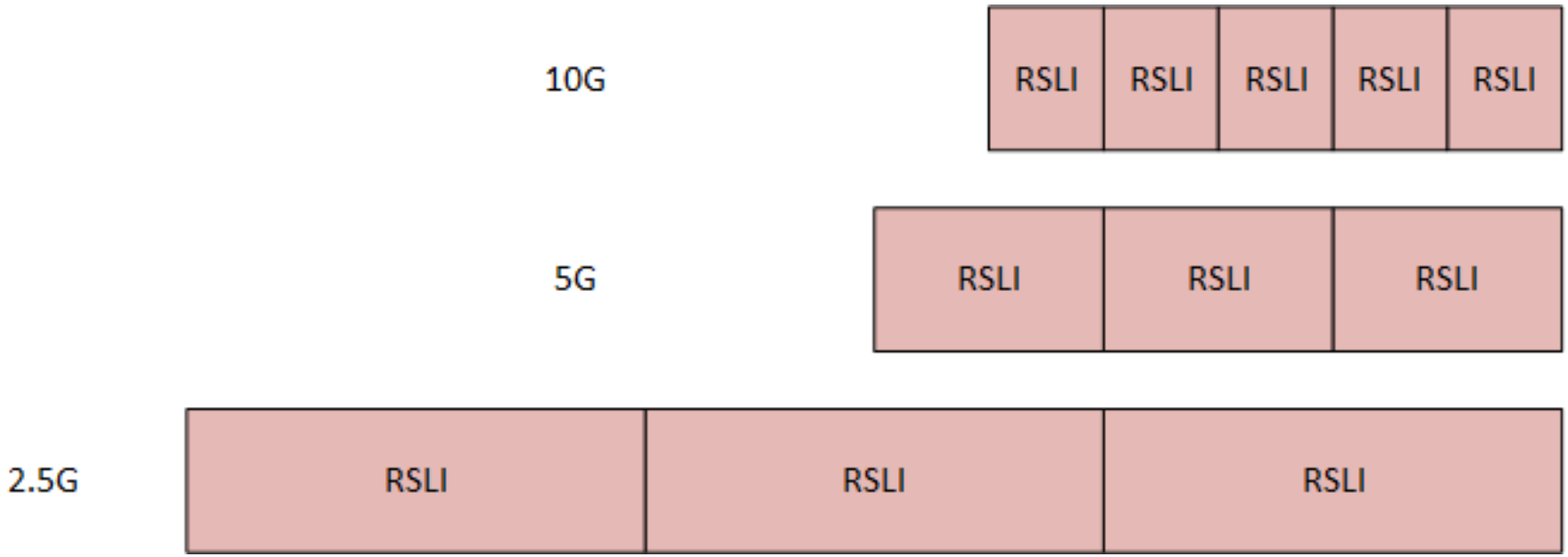
1000BASE-T1 style Wake

- Refresh with non-interleaved RS FEC frames composed of /I/s (RSI)
- Possible start every other Refresh start
  - Predictable timing for power on circuitry => RX power savings possible
  - Wake is a Refresh with /I/s
- Can adapt echo filter on this in-band signal
  - 10G style Alert isn't spectrally rich and can cause poor echo filter adaptation
  - Scrambled Wake data indistinguishable from non-EEE customer data
- Clock information is available during Wake
- First frame is composed of PAM2 scrambled zeros



Sleep

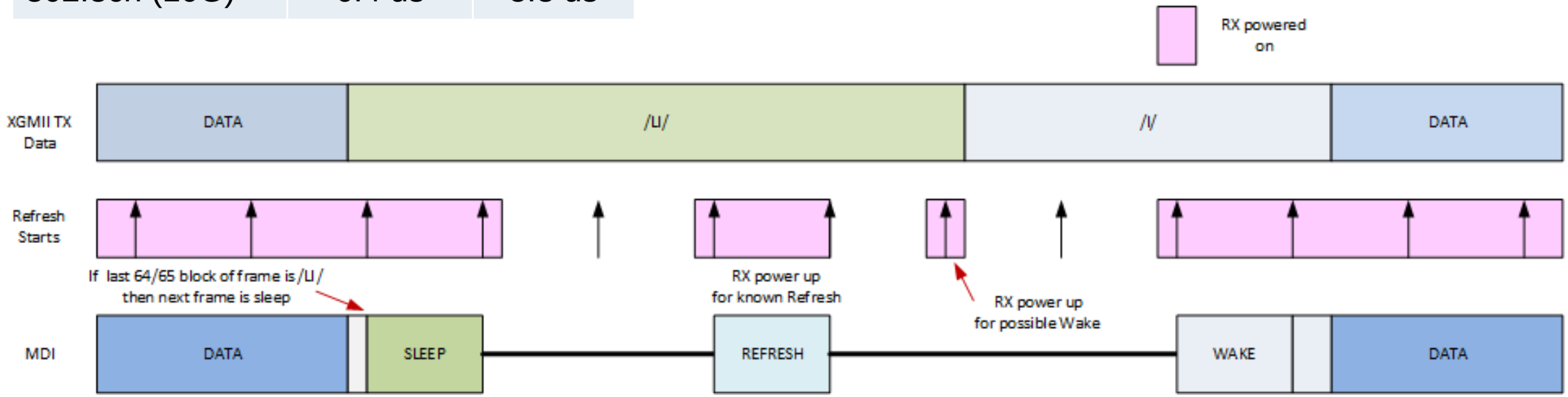
- One Refresh length
- Non-interleaved RS FEC frames filled with /LI/s
- Enough redundancy for RX detection



LPI mode life cycle

- Shows Wake possibilities
- Predictability aids RX power savings
- Latency: only Case 1 is important
- Proposed Case 1 is faster than 802.3az (10G EEE)

Wake Latency	Case 1	Case 2
802.3az	7.36 us	4.48 us
802.3ch (10G)	6.4 us	5.8 us



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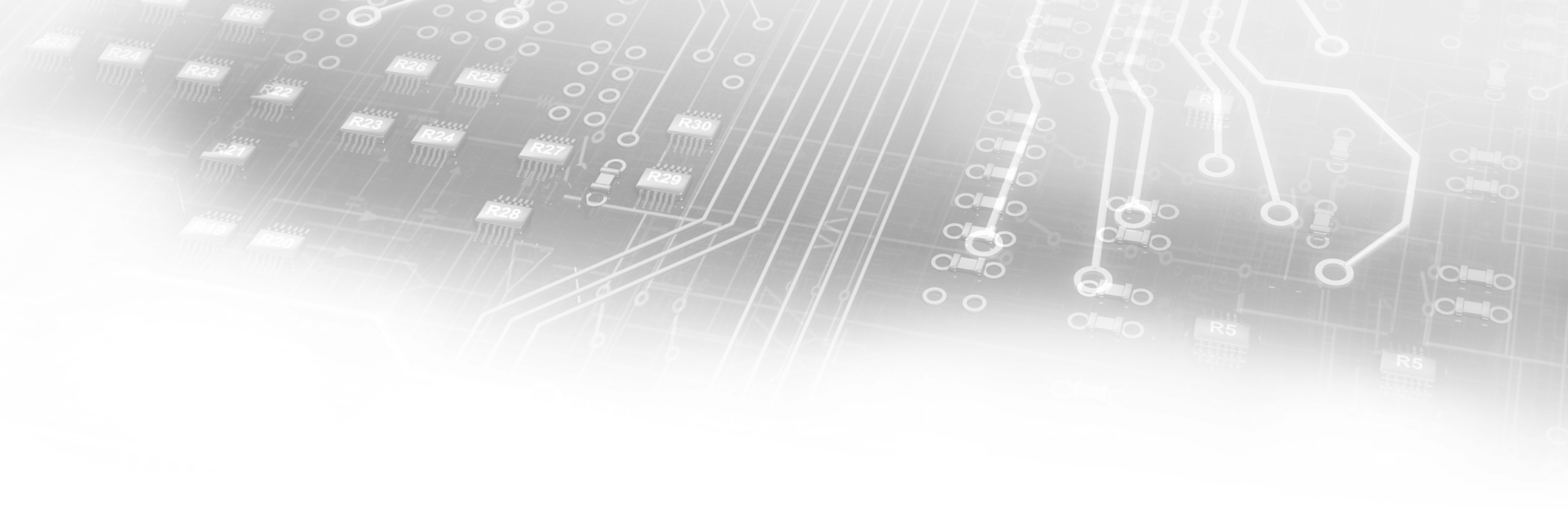

THANK YOU

Backup Slides

QR comparison

- Historical EEE + Proposed

					BR's proposal			AQ's proposal (BR code)*		
	10GBASE-T	802.3bz		1GBASE-T1	10GBASE-T1			10GBASE-T1		
Data Rate (Gb/s)	10	5	2.5	1	10	5	2.5	10	5	2.5
Trans. code rate	0.985	0.985	0.985	0.988	0.985	0.985	0.985	0.985	0.985	0.985
CRC rate	0.997	0.997	0.997	1.000	1	1	1	1	1	1
FEC coding rate	0.909	0.909	0.909	0.900	0.903	0.903	0.903	0.903	0.903	0.903
Modulation gain	3.5	3.5	3.5	1.5	2	2	2	2	2	2
Num TWP	4	4	4	1	1	1	1	1	1	1
Baud rate (MS/s)	800.00	400.00	200.00	750.00	5625.00	2812.50	1406.25	5625.00	2812.50	1406.25
Frame len. (ns)	320.00	320.00	640.00	3600.00	320.00	640.00	1280.00	320.00	640.00	1280.00
Frame len. (symbols)	256	128	128	2700	1800	1800	1800	1800	1800	1800
QR cyc len. (Fr)	128	128	128	24	100	50	50	25	25	25
Ref. len. (Fr)	4	8	8	0.4	5	3	3	0.8	0.8	0.8
QR (us)	40.96	40.96	81.92	86.4	32	32	64	8	16	32
Tq (us)	39.68	38.4	76.8	84.96	30.4	30.08	60.16	7.744	15.488	30.976
Tr (us)	1.28	2.56	5.12	1.44	1.6	1.92	3.84	0.256	0.512	1.024
Tq (symbols)	31744	15360	15360	63720	171000	84600	84600	43560	43560	43560
Tr (symbols)	1024	1024	1024	1080	9000	5400	5400	1440	1440	1440
Ref / QR	3.13%	6.25%	6.25%	1.67%	5.00%	6.00%	6.00%	3.20%	3.20%	3.20%

* Estimate based on interim