Low Power Data

Hossein Sedarat

March 2019

ETHERNOVIA

Interest in Low Power Data Mode

From 802.3ch meeting on 1/19:

- Straw Poll #5: Should the Task Force investigate asymmetric framework with the goal of having the feature scoped out in March:

  Yes: 20

  No: 6

- Straw Poll #6: If the asymmetric framework added x months to the P802.3ch timeline would you support it?

  x = 9: 2

  x = 3: 15

  x = 6: 7

=> A lot of interest as long as the spec comes together quickly

ETHERNOVIA

Prior Contributions

- Current active discussion on PCS:
  - http://www.ieee802.org/3/ch/public/jan19/Lo_3ch_01_0119.pdf
  - http://www.ieee802.org/3/ch/public/nov18/souvignier_3ch_02_1118.pdf

- Some ideas on PMA:
  - http://www.ieee802.org/3/ch/public/adhoc/Lo_3ch_01_adhoc_0219.pdf
  - http://www.ieee802.org/3/ch/public/jul18/souvignier_3ch_01a_0718.pdf

Outline

To propose a PMA frame-work for low data-rate mode

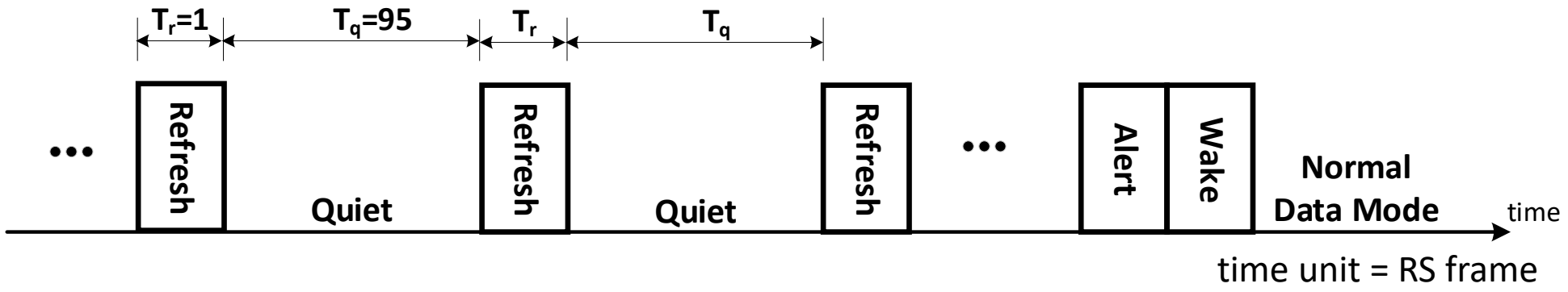
1. That can coexists with nominal rate on opposite direction
2. That consumes low power
3. For a quick consensus, reuses as much as what is already debated and defined in the current draft
    - Modulation
    - Baud-rate, bandwidth and PSD
    - Precoding
    - Bit-mapping
    - FEC: Reed-Solomon code
    - Frame structure
    - Timing recovery

EEE for Low Power Data Mode

- EEE frame-work is well-suited low-power data mode:
  - Asymmetric operation
  - A low-power mode
  - Signaling is already debated and is almost finalized
  - Bonus: seamless transition between normal data mode and low-power mode

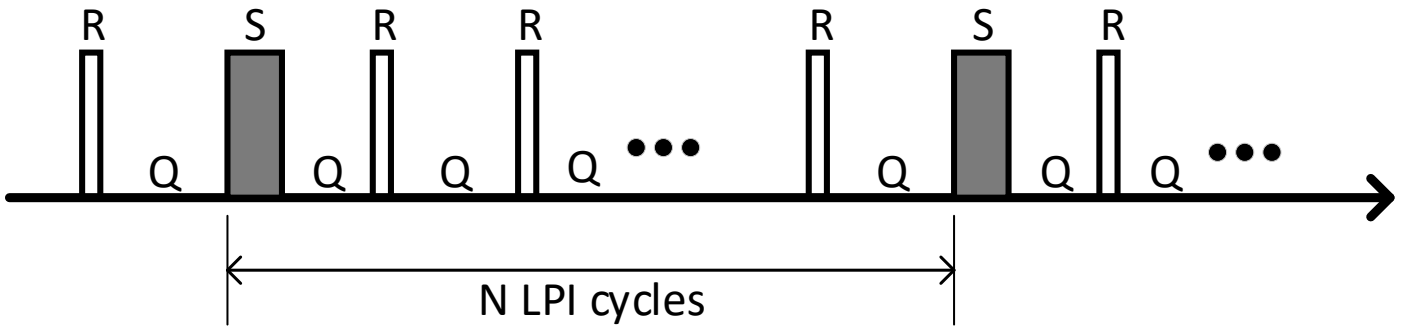
Low-Power Idle (LPI)

- During LPI, the transmitter is mostly quiet but periodically sends a short *Refresh* training signal so that the link-partners remain synchronized and are able to track variations in channel and noise
- LPI is terminated and normal data mode starts with *Alert* followed by *Wake* frames



Low-Power Data (LPD)

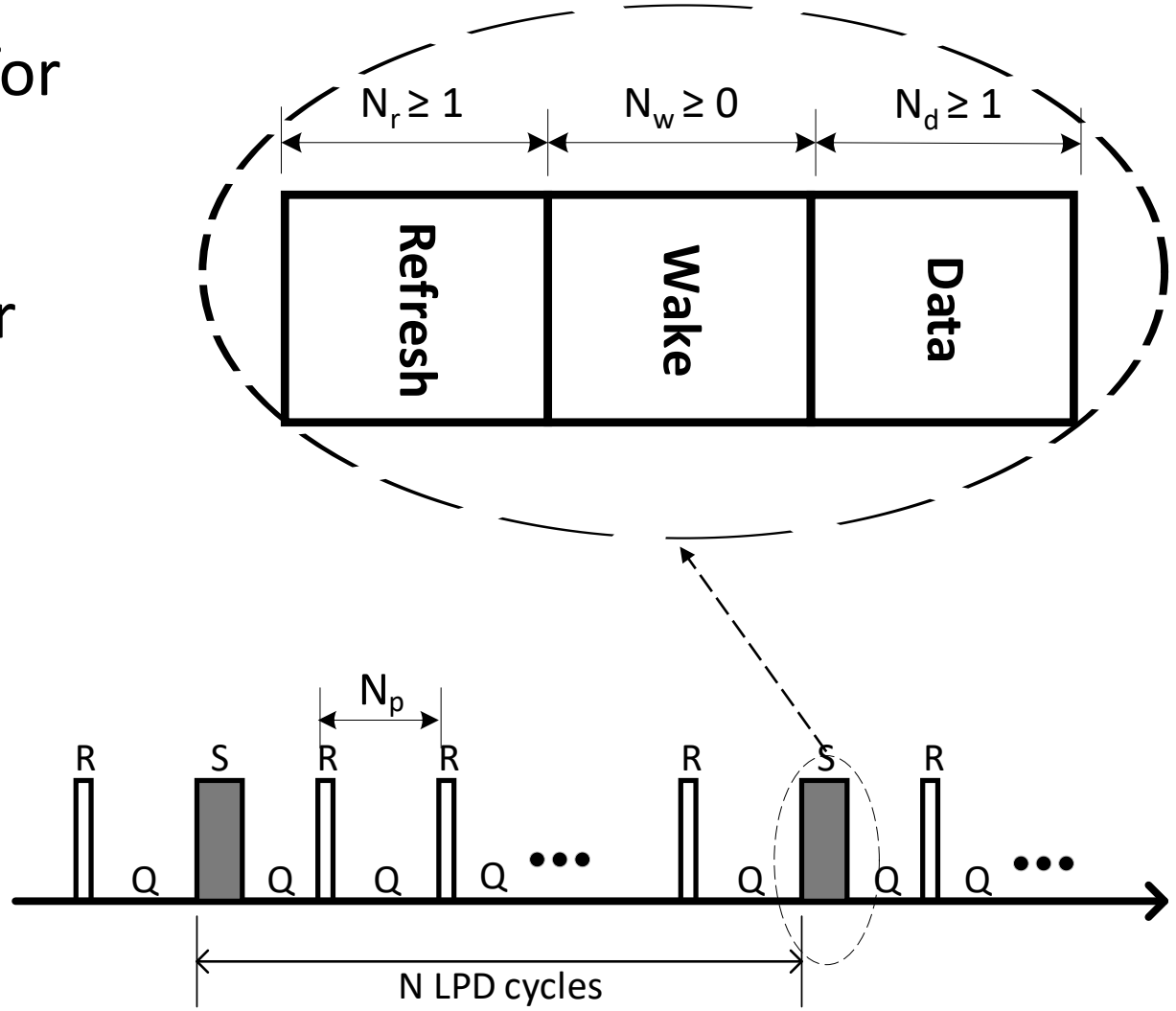
- A new ordered set or control character at XGMII interface signals the transition to Low-Power Data (LPD) mode
- LPD is similar to LPI, except every N cycles of Q-R, a new Special signal replaces Refresh
  - The Quiet time that follows the special signal is shortened to preserve the Q-R period
- Alert detection may not be needed



ETHERNOVIA

Special LPD Signal

- Begins with 1 or more Refresh for quick training
- Followed by 0 or more Wake for graceful transition to data
- Ends with 1 or more RS data frames (using normal transmit functions: RS code, scrambler, precoding, PAM4, etc.)



Resisting Noncritical Innovations!

- It is possible to send data with PAM2 modulation
  - 👍It may shorten the training time (Refresh)
  - 👎It doubles the data transmission time
  - 👎Have to spend time to figure out how to do data over PAM2
  - ⇨ Use PAM4 modulation for data
- It is possible to design a new RS code for a shorter data frame
  - 👍It may help with latency
  - 👎Overhead of turning on/off data-path may have negative power impact
  - 👎Have to spend time to figure out how to construct shorter code and frame
  - ⇨ Use integer multiples of RS data frame

Data Rate and Power

- The data rate in fast (R_h) and slow (R_l) directions are related as

$$R_l = \frac{N_d}{N_p \times N} R_h$$

- The power in slow mode (P_l) may be roughly expressed in terms of the corresponding power in fast (P_h) and EEE (P_e) and Alert Detection (P_a) modes as

$$P_l \approx \left(1 + \frac{N_w + N_r - 1}{N_d}\right) \frac{R_l}{R_h} P_h + \frac{96}{N_p} (P_e - P_a)$$

LPI period

Overhead due to Wake and longer Refresh

ETHERNOVIA

Example

Choose $N_r = 1$, $N_w = 0$,

resulting in

$$P_l = \frac{R_l}{R_h} P_h + \frac{96}{N_p} (P_e - P_a)$$

R_h	R_l	N_p	N	N_d
10 G	100 M	100	1	1
5 G	100 M	100	1	2
2.5 G	100 M	100	1	4
10 G	100 M	80	5	4
5 G	100 M	80	5	8
2.5 G	100 M	80	5	16
10 G	10 M	80	25	2
5 G	10 M	80	25	4
2.5 G	10 M	80	25	8

What about OAM?

- OAM may be loaded on either or all of Refresh, Wake and Data frames

- It is beneficial if Refresh and Wake are skipped so that they remain completely known signal

⇨ Use data frames to carry OAM messages during LPD

LPD Proposal

- LPD is proposed as a simple frame-work, based on EEE, to support low data-rate at low power

- Reuses mostly what is already debated and defined in the spec
  - Least impact on the timeline of the task force

LPD data-rate: $R_l = 100\ Mbps$

$N_p = 80,\ N_r = 1,\ N_w = 0$

R_h	N	N_d	P_l
10 G	5	4	$0.01P_h + 1.2(P_e - P_a)$
5 G	5	8	$0.02P_h + 1.2(P_e - P_a)$
2.5 G	5	16	$0.04P_h + 1.2(P_e - P_a)$

ETHERNOVIA