Asymmetrical Use Case

Is There a Need for a PHY Operating High Speed In One Direction and Constant Low Speed In the Other?

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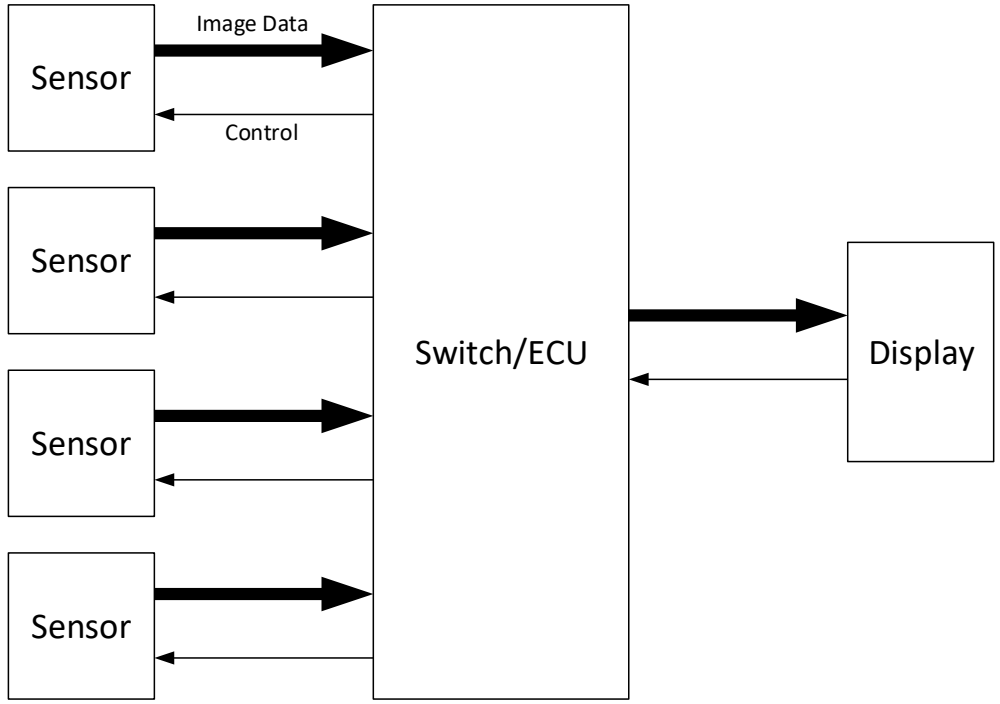
Asymmetrical Use Case

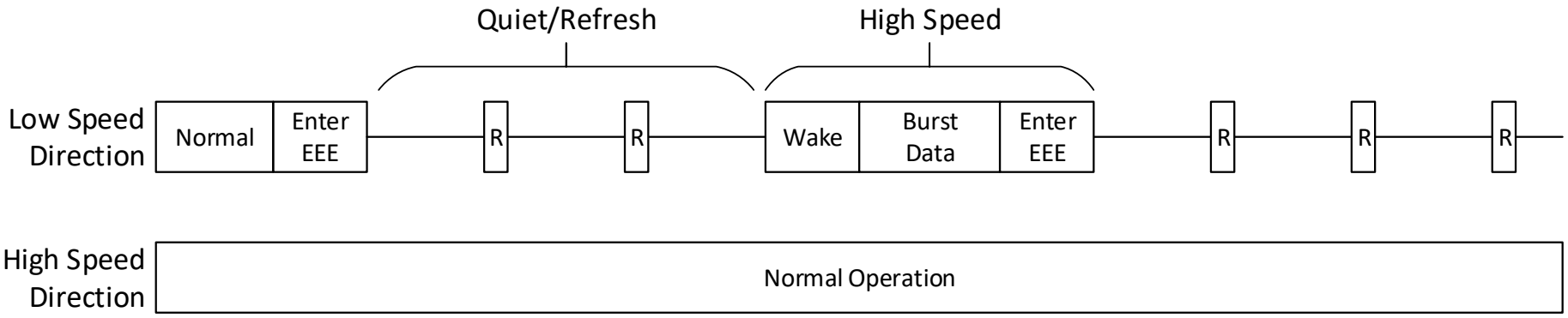
- Sensors and Displays
- High Bandwidth Image Data
- Low Bandwidth Control Signals

- Symmetrical Link Operation
  - Burns additional power
  - Increases complexity



How Asymmetry Is Handled Today

- Use Energy Efficient Ethernet
- Lowers average power and data rate with on/off duty cycling
- Periodic refresh to keep PHYs PLL and DSP locked and trained
- Wakes up only when needed
- Burst data is identical to normal operation

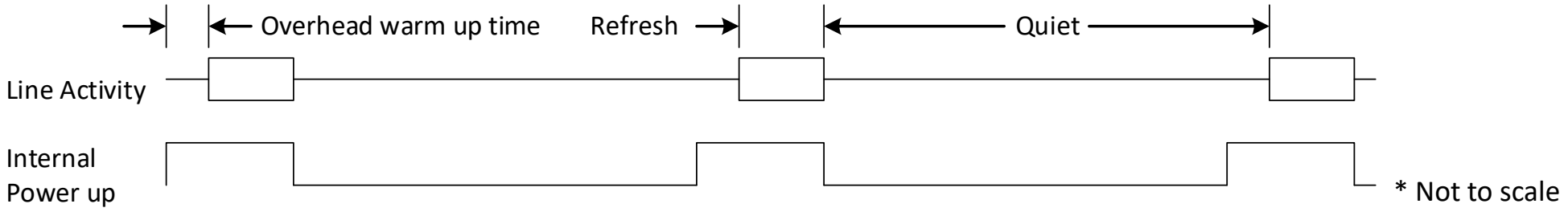


Energy Efficient Ethernet

- Burst on/off – Power savings during quiet period
- Theoretical power consumption is

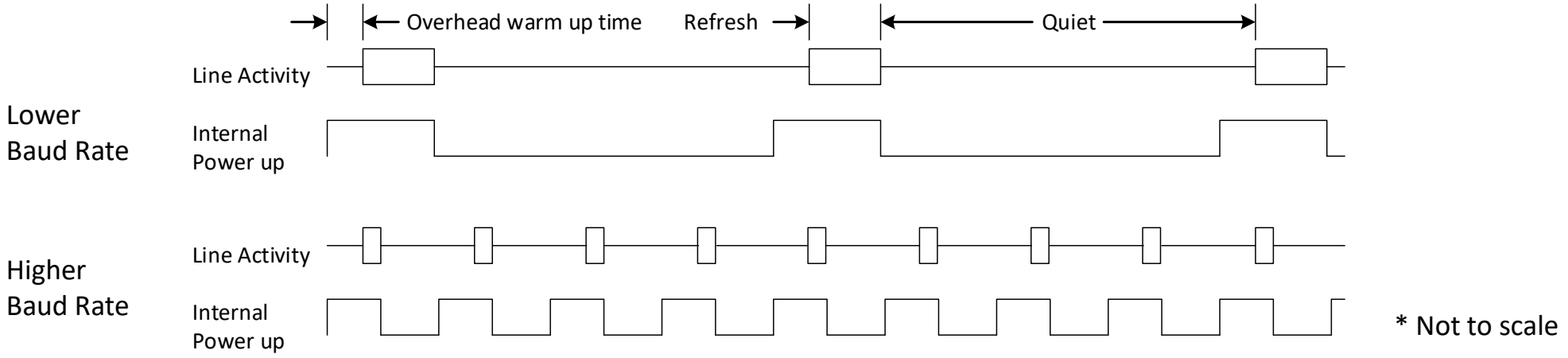
  Trefresh / (Tquiet + Trefresh) x Normal power + power to detect wake

  Trefresh / (Tquiet + Trefresh) about 1:100
- Actual power savings less due to ramp up and other overhead



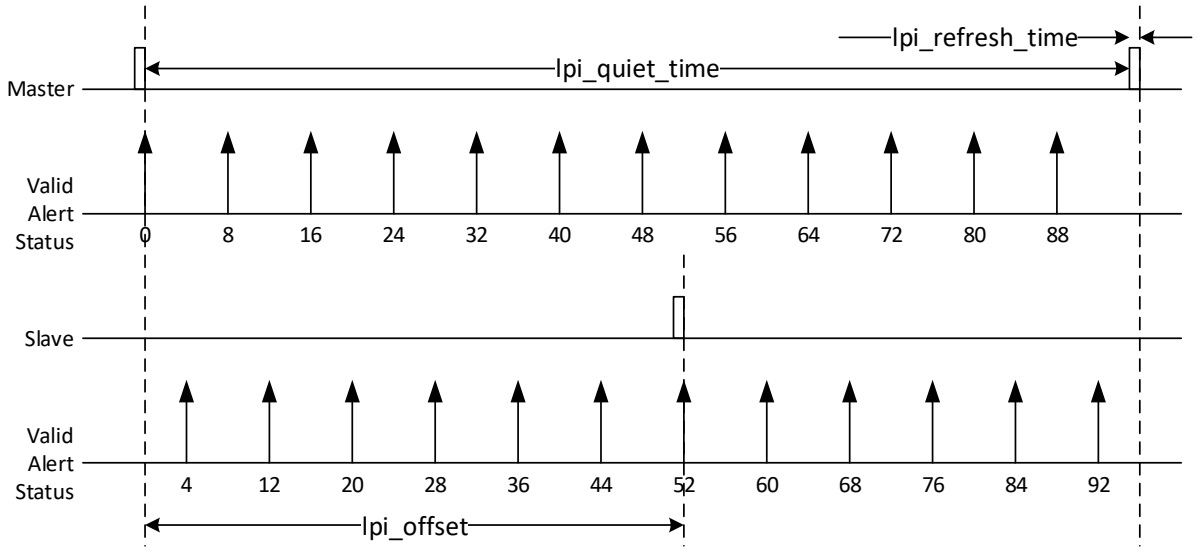
Higher baud rate lowers EEE power efficiency

- Refresh keeps timing and signal processing parameters from drifting. (% of symbol time)
- Higher baud rate ➔ refresh occurs closer together even though duty cycle remains the same
- Some warm up time does not scale with baud rate. i.e. analog circuits ➔ Less power down time
- In some circuits cannot shut down at all because of fast turn on time required



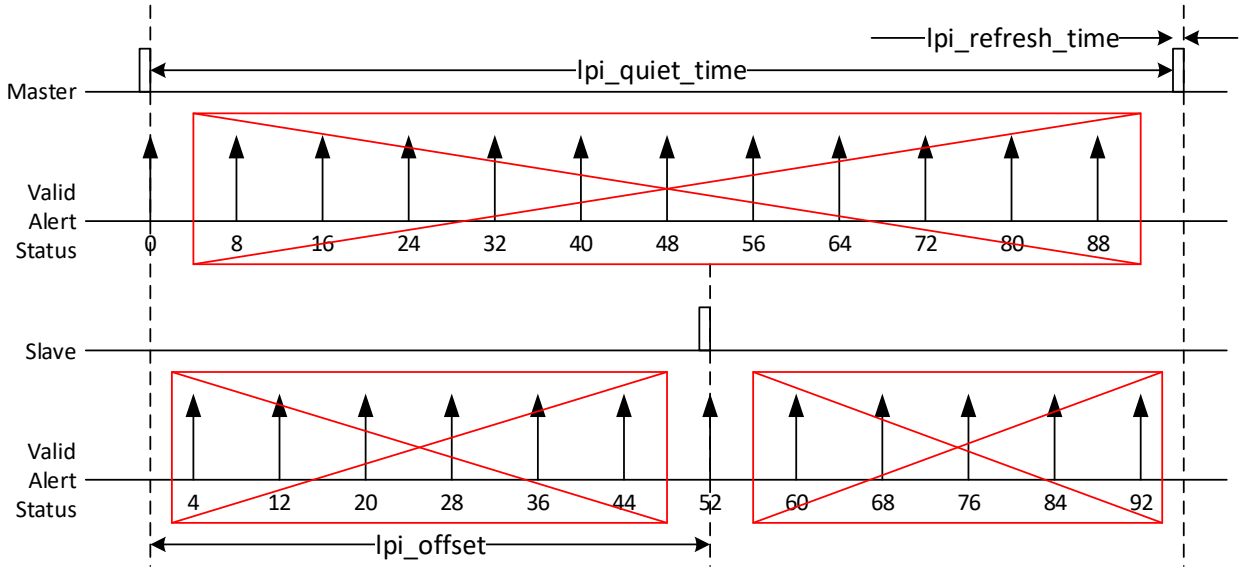
Lower Wake Latency Impacts Power Savings

- PHY has to be primed to wake at set intervals (Valid Alert Status) further reducing power savings
- Shorter intervals ➔ less wake latency ➔ more power consumption



Automotive PHYs Power Saving For Asymmetrical Links

- 100BASE-T1
  - No EEE defined. Must operate in symmetrical mode at all times
- 1000BASE-T1
  - EEE Defined.
- 2.5/5/10GBASE-T1
  - EEE mode 1 – less wake latency (regular)
  - EEE mode 2 – more wake latency



EEE Disadvantages If Link Is Permanently Asymmetric

- Power supply sized for peak power and not for average power
- Cable and connector shielding for EMC/EMI more stringent to handle full duplex during burst
- More complex circuitry required to handle full duplex burst
- If deterministic latency required, have to buffer for worst case wake
- Percent of overhead power increases at higher baud rates

Can We Do Better By Going Slow and Steady?

- EEE on/off duty cycle is only one method to reduce power

- Another way is to keep constant low speed signaling in slow direction
  - Slow down clock frequency
  - Simplify signal processing
  - Reduce transmit amplitude
  - Optimize for constant low speed operation eliminating on/off overhead
  - Others to be explored??
- Average power and peak power similar
- Latency in slow path is fixed
- Possible Cost Reduction – no need for bi-directional operation at high speeds

Questions for 802.1DG

- Is current EEE good enough for automotive use cases?
- Is there a use case where one direction is high speed and the other is constant low speed?
- Is the constant low speed latency an important feature for TSN, or is this a don't care?
- Would PHY power and cost reduction be important enough to run MACs at asymmetric speeds?
- If such an asymmetrical PHY existed how can TSN take advantage of it?

Chicken & Egg

- MACs currently do not operate at asymmetrical speeds so PHYs are not designed for this
- Automotive PHYs currently do not operate at asymmetrical speeds so layer 2 does not consider this in the architecture

- 802.1DG a good place to answer whether a true asymmetrical link segment is beneficial for automotive Ethernet applications

THANK YOU