NGBASE-T Requirements

Learning from 10GBASE-T

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10GBase-T : Historical Review

- 10Gbase-T was standardized in 2006 (802.3an)
- Three generations of technology 130nm/90nm,65nm and 40nm, moving into 28nm
- Power was ~10-12W nominal in 130nm/90nm
- 2.5w ~ 4W nominal reported from PHY vendors at 40nm for CAT6A 100meter reach
- Single port -> Dual/Quad Port Chip
- LPI/EEE mode added later(802.3az)
  - Achieves additional power reduction when there is no traffic
  - Will achieve better power savings over time as the design evolves

Misconceptions regarding 10GBASE-T power

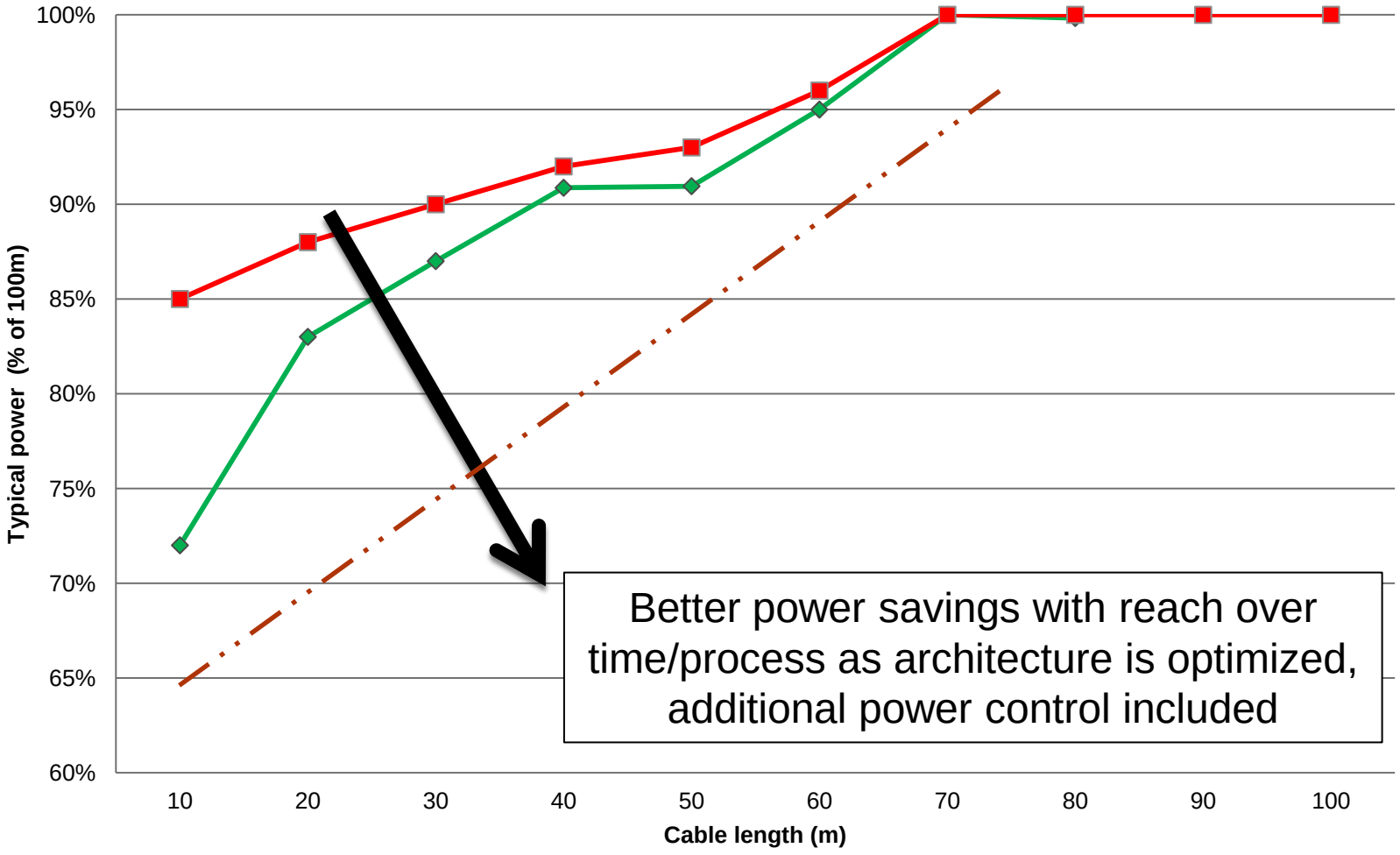
- **Misconception #1: 10GBaseT PHYs operate at full power regardless of the channel conditions**
  - PHYs monitor cable length, channel conditions, SNR
  - The receiver is dynamically optimized to use less power
  - Vendors already offer shorter reach modes with reduced max power
    - Remember: power is not specified in IEEE
- **Misconception #2: AFE power does not scale with process or link length**
  - New architectures/algorithms improve AFE performance..
  - ..and allow reduced power with shorter links
  - From 130nm-> 40nm, power reduced by 3-4x
  - Further reductions are expected for 28nm, 20nm
  - Increasing use of DSP to correct analog imperfections, reduce overall PHY power, and improve scaling with reach
  - Transmit PBO allows transmit power saving at reduced link length

Operating power vs. reach:

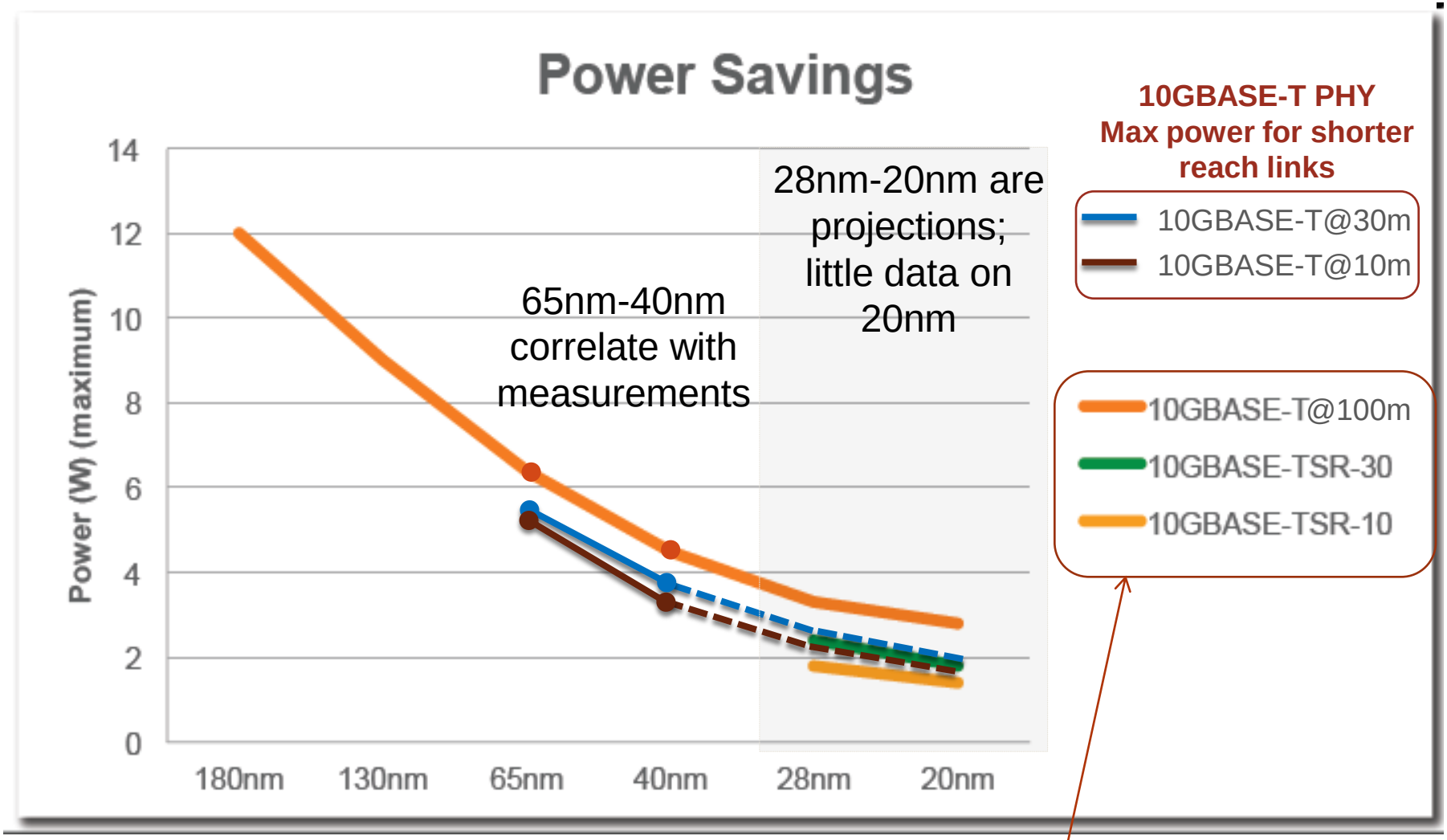
PHY vendors have used many techniques to lower the power for links with reduced reach

- Transmit power back off (PBO) [part of 802.3an]
  - Reduces TX power
    - Reduces alien crosstalk
    - Typically turns off some TXDAC currents to save power
- FEXT canceller power down, tap shutdown
- FFE and Echo/NEXT canceller partial taps shutdown/power off
- Dynamic length and resolution control on digital filters
- Power islands, power gating, clock gating
- ADC and other receiver circuits work in low power mode with reduced requirements for linearity and noise
  - At 30 meter and lower, ENOB requirement can be reduced by ~1-2 bits, receiver AFE works with much lower power
  - Increasing use of digital processing for converters
- Dynamic LDPC power control
  - Smooth reduction in power consumption at shorter length as SNR increases and fewer LDPC iterations are used

Power Scaling of 10GBASE-T with reach



10GBASE-T power over reach vs. process technology

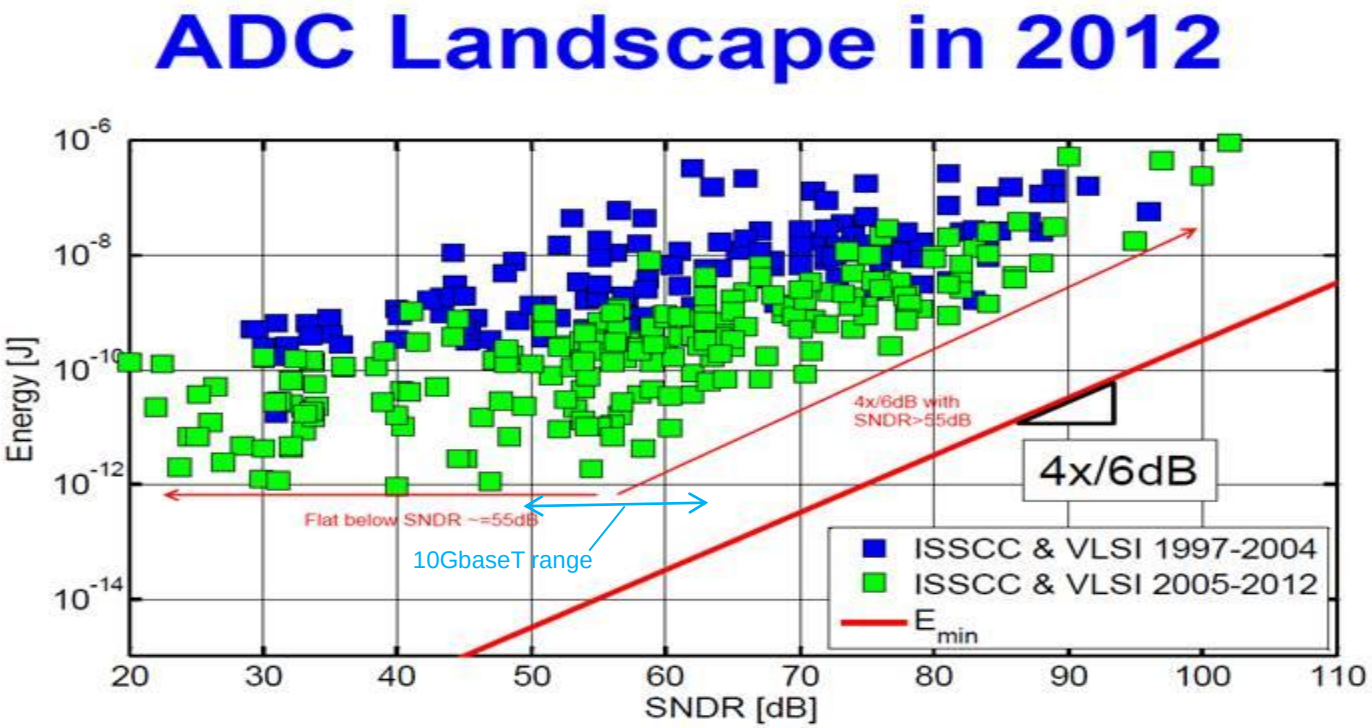


Based on http://www.ieee802.org/3/NGBASET/public/sep12/dove_01b_0912.pdf slide 5

Recommendations: NGBASE-T PHY at 40G

- Define **one PHY** to cover links up to TBD max reach
  - Vendors will define architectures to allow power optimization for shorter reaches
  - Avoid defining multiple PHYs for different reach targets to prevent splitting the market, end-user confusion, and maintain distinct identity
  - Pick the max reach based on ADC power sweet spot (See next slide)
- NGBASE-T should support TX power control negotiation to enable transmit power saving with shorter links
  - as demonstrated with 10GBASE-T
- With shorter links receiver will perform power scaling automatically in AFE and DSP/Digital, depending on channel quality and SNR margin
  - ADC can operate at lower ENOB with reduced power consumption
  - Reduction in Echo/NEXT/FEXT canceller length/resolution, exploit sparsity

ADC power for 40G



- Select a maximum length that can be covered with ADC <9 bit ENOB
  - Avoid the region with dramatically increasing power beyond ~55dB SNDR
  - For shorter reach, ADC can be configured digitally to reduce ENOB/power

Source: Slide 15 at B. Murmann's paper:
http://ewh.ieee.org/r5/central_texas/cas_ssc/meetings/2012/083012/20120830austin.pdf

Thank You !

Questions?