Reach and Energy Efficiency in NG-BASE-T

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Energy Efficiency in NG-BASE-T

- Efficiency can be measured with the TEER
  - Telecommunications Energy Efficiency Ratio*

$$TEER = \frac{L_{max}}{a * P_{\mathrm{idle}} + \mathrm{b} * P_{\mathrm{u}} + \mathrm{c} * P_{100}}$$

  - Takes into account power consumption dependency on traffic load
- Efficiency can be increased by
  - Reducing consumption when the link is idle (P_{idle}, P_u)
  - Reducing consumption when the link is active (P_u, P_{100})

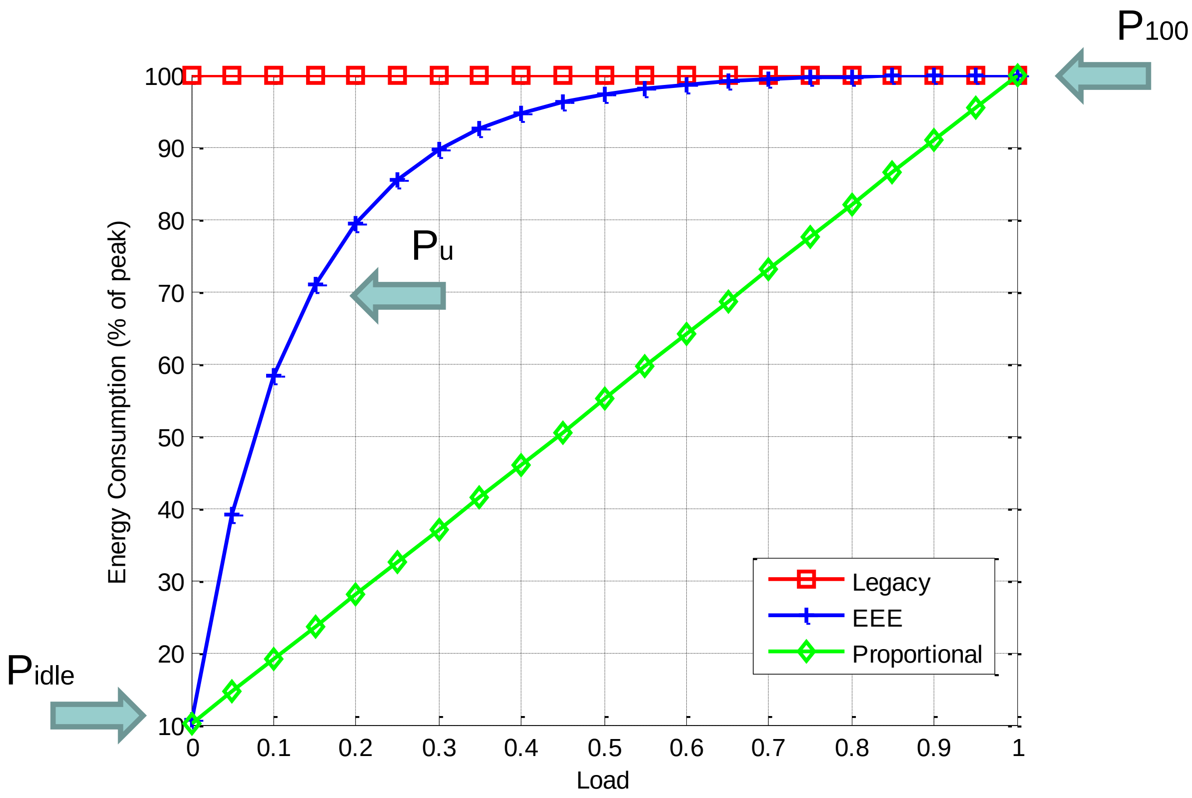
*Alliance for Telecommunications Industry Solutions (ATIS) – 2009 Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products.

Energy Efficiency in NG-BASE-T

- Existing approach (LPI/Energy Efficient Ethernet)
  - Focuses on reducing energy consumption during idle periods
  - The reduction during idle periods can be very large (>90%)
  - Works well at very low loads (end user)
  - Mode transition overhead reduces savings at medium loads
  - Further savings possible with coalescing (but impacting delay)

Energy Efficient Ethernet (EEE)

- 10GBASE-T



* P. Reviriego, J.A. Hernández, D. Larrabeiti, J.A. Maestro, "Performance Evaluation of Energy Efficient Ethernet", IEEE Communications Letters, Vol. 13, No 9, September 2009, pp. 697-699.

Energy Efficiency in NG-BASE-T

- An example for 10GBASE-T
  - Assume P_{100} is 4 Watts
  - At 10% load power consumption is approx 60% (P_u = 2.4 Watts)
  - P_{idle} can be 0.4 Watts or less
- For an end user we can have a= 0.99, b= 0.009 and c = 0.0001 leading to

$$TEER = 10/(0.99*0.4+ 0.009*2.4+0.0001*4) \cong 24$$

Which is dominated by P_{idle} and much better than 2.5 without EEE

Energy Efficiency in NG-BASE-T

- Limitations of LPI scheme (like in EEE) for NG-BASE-T
  - Traffic load will be significant
  - Higher speeds will mean significant mode transition overhead
  - Low latency requirements will restrict the use of coalescing
- This means that power consumption in active mode has to be optimized to achieve good energy efficiency

Energy Efficiency in NG-BASE-T

- An example for 10GBASE-T
  - Assume P_{100} is 4 Watts
  - At 10% load power consumption is approx 60% (P_u = 2.4 Watts)
  - P_{idle} can be 0.4 Watts or less
- For a data center server we can have a= 0.1, b= 0.8 and c = 0.1 (in line with*) leading to

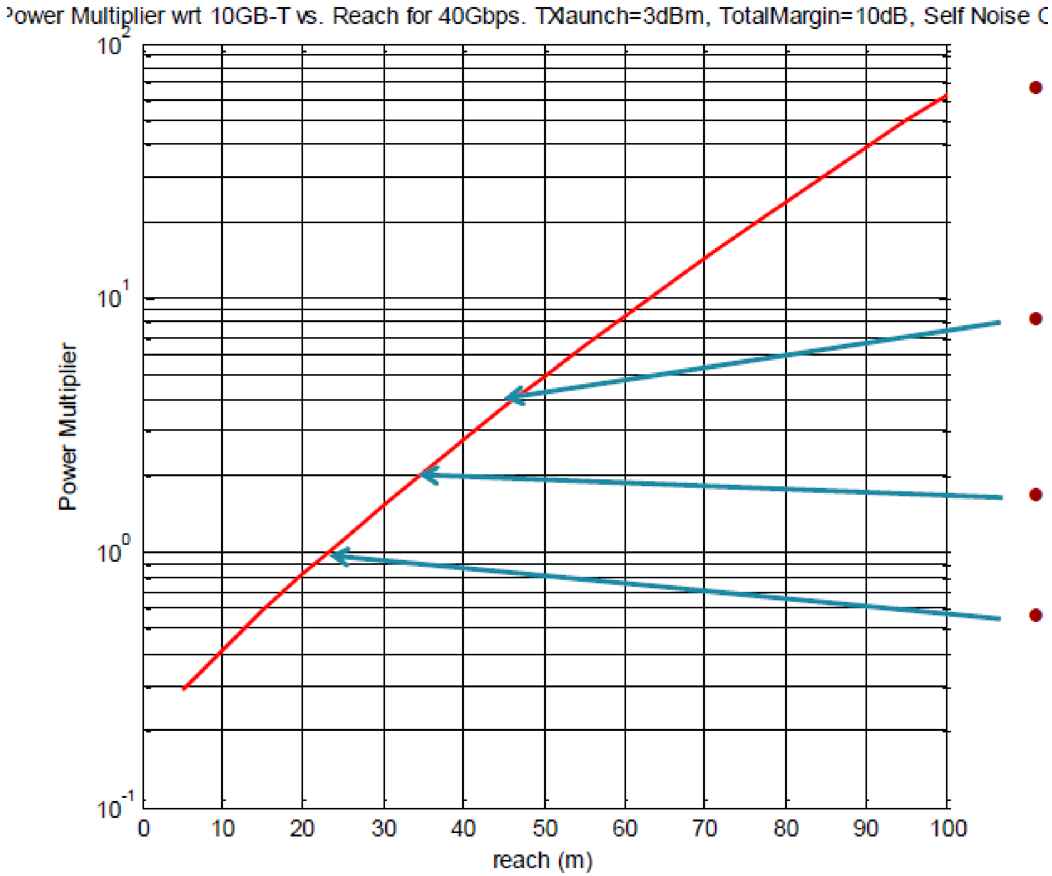
$$TEER = 10/(0.1*0.4+ 0.8*2.4+0.1*4) \cong 4.2$$

Which is dominated by P_u and close to the value of 2.5 without EEE

* ENERGY STAR® Program Requirements Product Specification for Large Network Equipment Preliminary Approach For Determining Energy Efficiency Rev. Oct-2012

Energy Efficiency in NG-BASE-T

- Power consumption versus Reach



- Every ~12m increase in reach approximately doubles power
- About 4x Power/port @ 46m (same pJ/bit as 10GBASE-T)
- About 2x Power/port @ 34m
- About 1x Power/port @ 22m

*Will Bliss A Simple Model of Relative Power vs. Reach, Sept. 17, 2012 for IEEE 802.3 Next Generation BASE-T study group

Energy Efficiency in NG-BASE-T

- Power consumption versus Reach
  - Most links are short, specially in data centers
  - Potential for large energy savings if designs are optimized or adapt to reach
  - Savings complement those of LPI
- In the previous example if power for a 10m link can be reduced to 2 Watts then

  TEER = 10/(0.1*0.2+ 0.8*1.2+0.1*2) ≅ 8.5

Much better than with LPI only

Energy Efficiency in NG-BASE-T

- Conclusions
  - Optimizing consumption during idle periods provides only limited savings
  - Reducing consumption when active is possible by optimizing the PHY for short channel lengths
  - Options to optimize/adapt PHYs for different reach should be considered