Ethernet Technology Summit

Tutorial T2B
Ethernet: An Energy-Efficient Technology

Michael J. Bennett

Lawrence Berkeley National Laboratory

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Agenda

- Introduction
  - Mike Bennett, Sr. Network Engineer, LBNL
- Public Policy and Networks
  - Bruce Nordman, Researcher, LBNL
- Ethernet Networking Moves to Greener Pastures
  - Jason Rock, Product Marketing Manager, Vitesse Semiconductor

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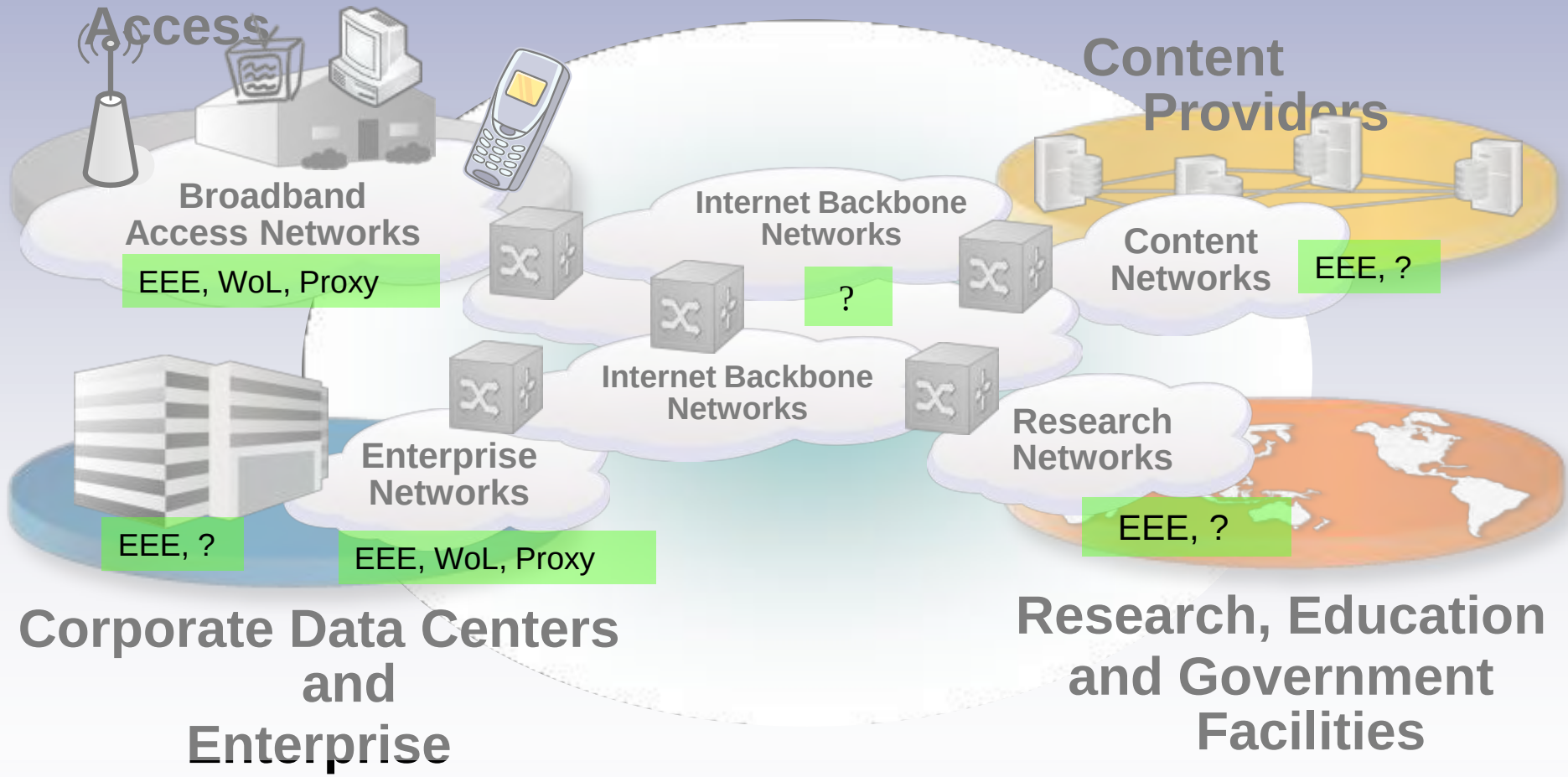
- 10GBASE-T, The Data Center, and Efficiency
  - George Zimmerman, CTO and Founder, SolarFlare Communications
- Remote Wakeup with Network Proxying
  - Rob Hays, Strategic Planning Director, Intel
- 10GBASE-T and Wake-On-LAN
  - Bill Woodruff, VP New Initiatives and Standards, Aquantia

Energy Efficiency in The Ethernet Ecosystem



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What is Energy Efficient Ethernet?

Energy Efficient Ethernet

- EEE is a method to facilitate transition to and from lower power consumption in response to changes in network demand
  - In the process of being specified for:
    - » 100BASE-TX (Full Duplex)
    - » 1000BASE-T (Full Duplex)
    - » 10GBASE-T
    - » 10GBASE-KR
    - » 10GBASE-KX4
    - » 1000BASE-KX
  - Uses Low Power Idle (LPI) to save energy

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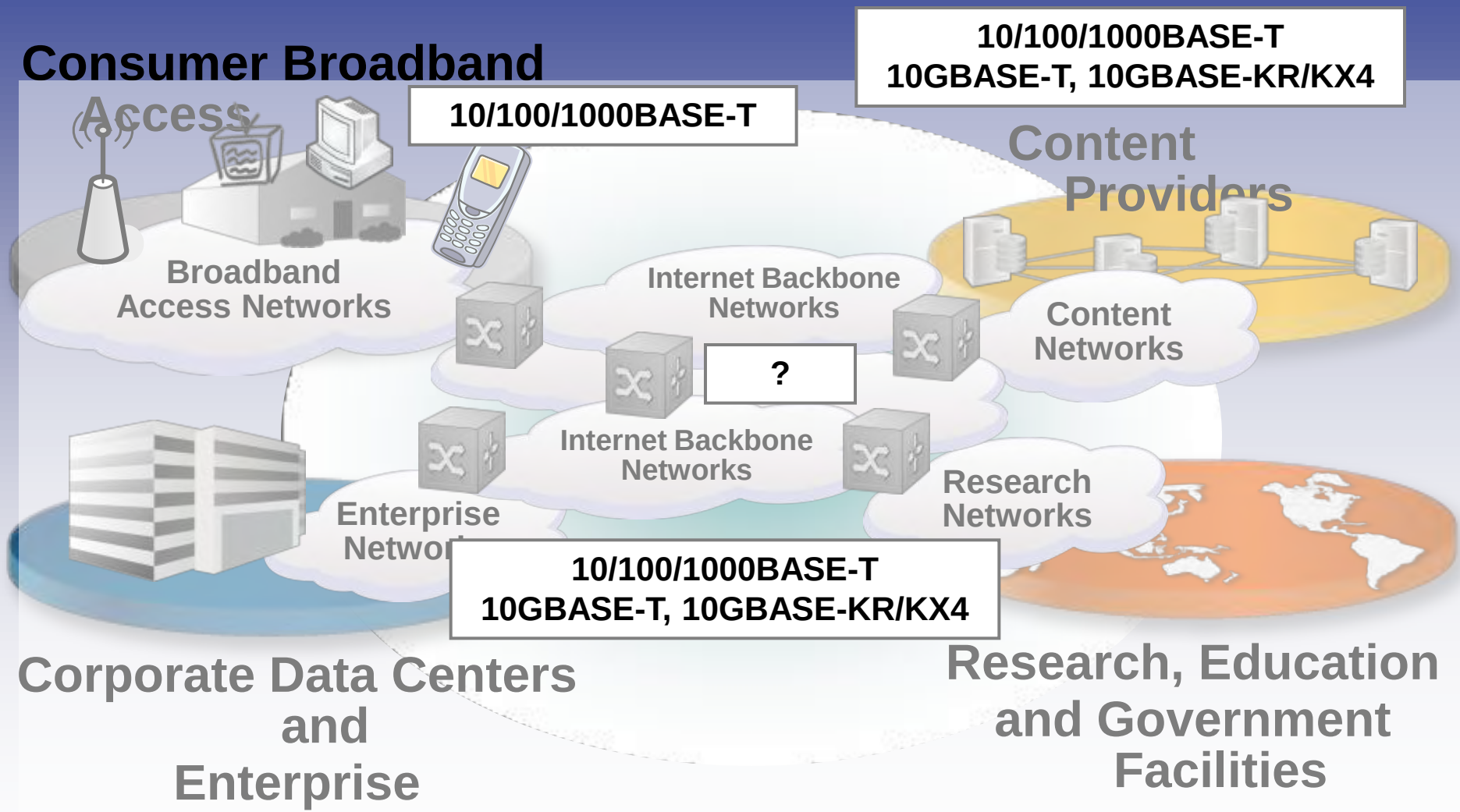
Where EEE Fits in The Ecosystem



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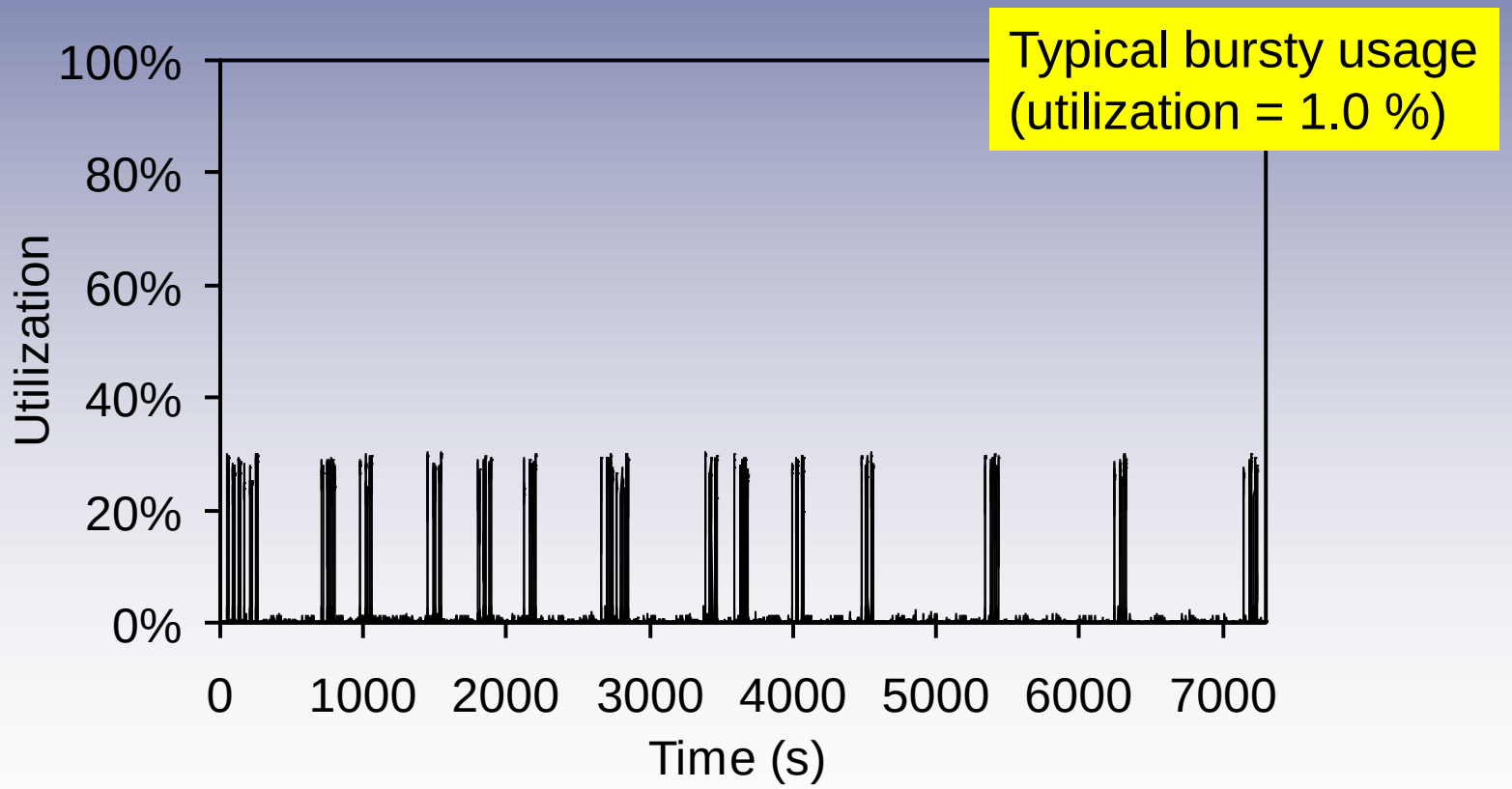
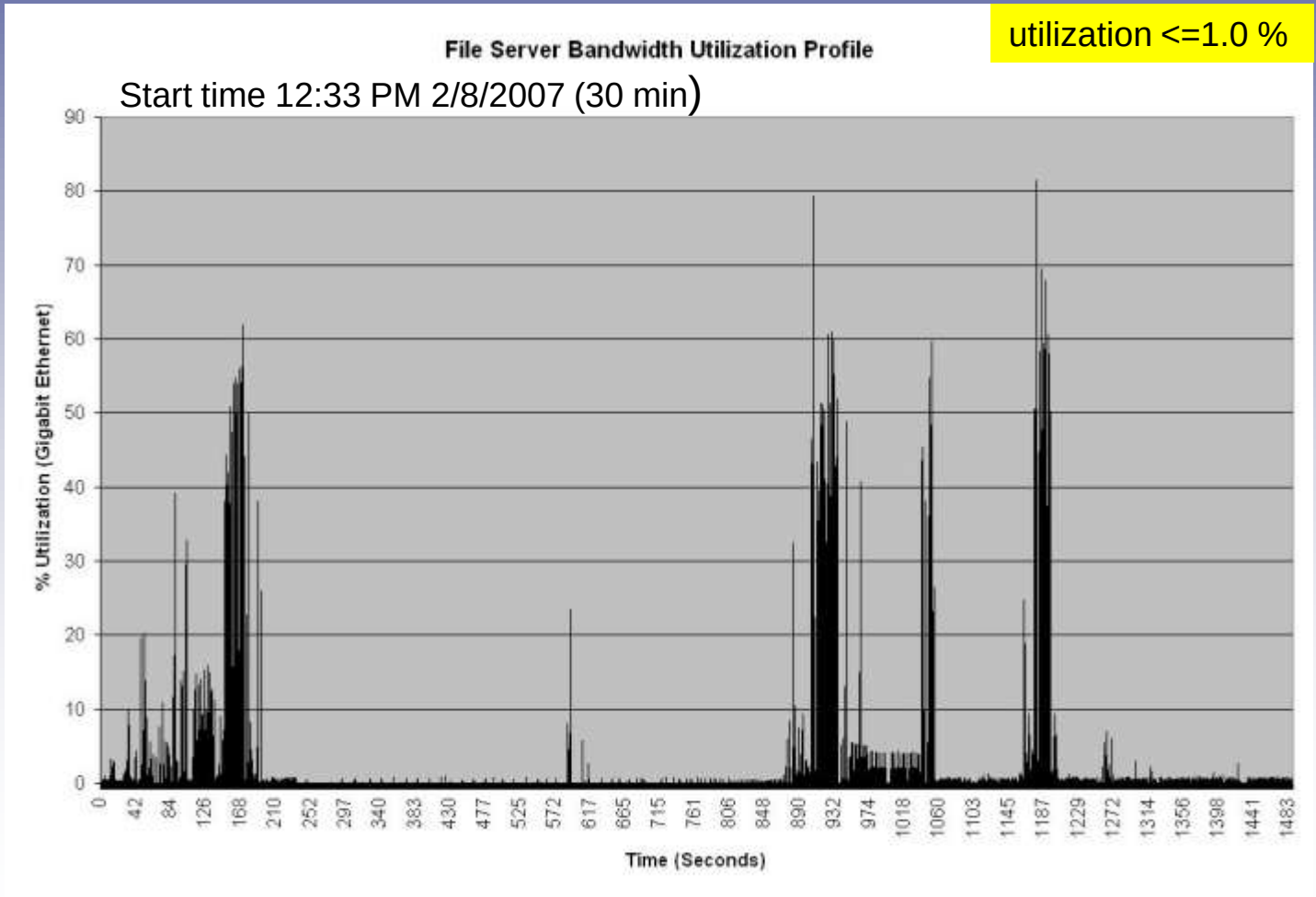
Desktop links have low utilization

- Snapshot of a typical 100 Mb Ethernet link
  - Shows time versus utilization (trace from Portland State Univ.)



Some Server links have low utilization

- Snapshot of a File Server with 1 Gb Ethernet link
  - Shows time versus utilization (trace from LBNL)



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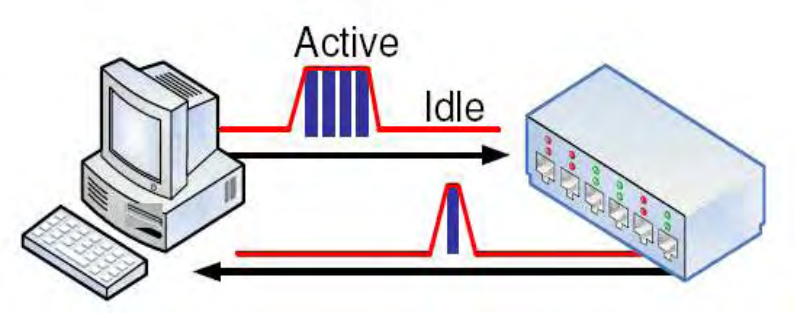
What is Low Power Idle?

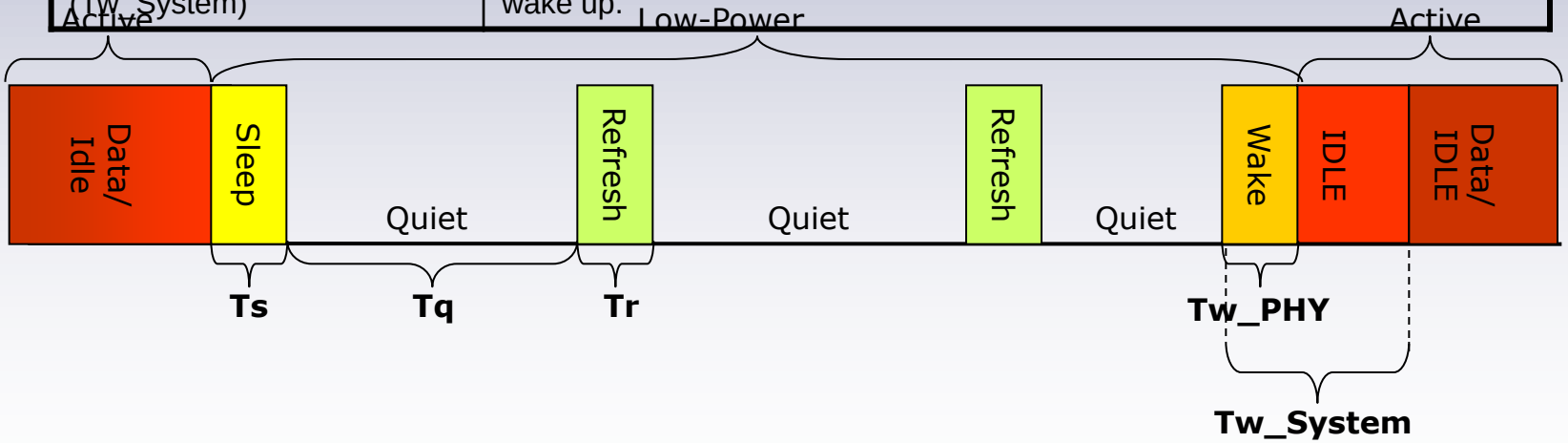
- Concept: Transmit data as fast as possible, return to Low-Power Idle
- Saves energy by cycling between Active and Low Power Idle
  - Power reduced by turning off unused circuits during LPI
  - Energy use scales with bandwidth utilization



What is Low Power Idle?

- A closer look
  - PHY Wake Time values are in the order of 10's of microseconds

Term	Description
Sleep Time (Ts)	Duration PHY sends Sleep symbols before going Quiet.
Quiet Duration (Tq)	Duration PHY remains Quiet before it must wake for Refresh period.
Refresh Duration (Tr)	Duration PHY sends Refresh symbols for timing recovery and coefficient synchronization.
PHY Wake Time (Tw_PHY)	Duration PHY takes to resume to Active state after decision to Wake.
System Wake Time (Tw_System)	Wait period where no data is transmitted to give the receiving system time to wake up.



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Optimizing Energy Efficiency

- Energy Efficiency can be optimized by using link-partner communications after the link is established
  - Use Link Layer Discovery Protocol (LLDP) to change wake times.
  - The longer the wake time, the longer the delay till frames can pass, i.e. latency increases
  - Trade-off between energy savings and latency
- There are system power savings opportunities in addition to PHY power

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Potential Savings from EEE

Assume 100% adoption (U.S. Only)

- Residential
  - PCs, network equipment, other
  - 2 TWh/year
  - $200 million/year
- Commercial (Office)
  - PCs, switches, printers, etc.
  - 1.5 TWh/year
  - $150 million/year
- Data Centers
  - Servers, storage, switches, routers, etc.
  - 0.5 TWh/year
  - $50 million/year

These figures do **not** include savings from cooling/power infrastructure

Total: $400 million/year

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Energy Efficiency and Future Ethernet projects

- Optical Ethernet
  - Optical PHYs were not studied during the study group phase of the EEE. The following need to be studied:
    - Potential for energy savings
    - Whether or not lasers can be turned off (completely) and on
      - If so, is there any negative affect in doing so?
    - Time to transition between states

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Energy Efficiency and Future Ethernet projects

- Considerations for new Ethernet projects
  - Characterize the traffic
    - Defines opportunity to save energy
  - Minimize need to increase buffers/latency
  - Maximize energy savings
  - Remain transparent to upper layers
  - Ability to communicate changes after the link is up
    - LLDP

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