Energy Efficient Digital Networks

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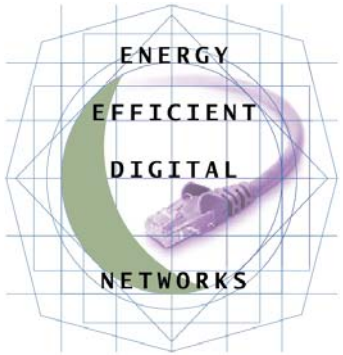
Overview

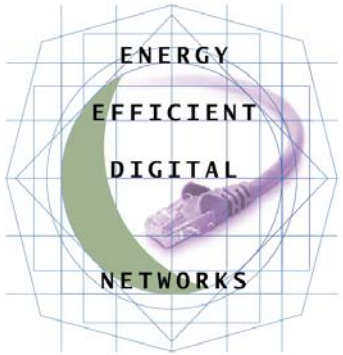
- Background on Electronics and Digital Networks
- LBNL Project: "Energy Efficient Digital Networks
- Future Directions



Electronics and Networks

- **Electronics <u>are</u> an end-use of electricity**
  - **–*"Devices whose primary function is Information (obtain, store, manage, present)"***
  - **–Includes both Information Technology (IT) and Consumer Electronics (CE)**

- **Electronics consumption in U.S. today**
  - **–At least 250 TWh/year <u>and rising</u>**
    - **About 7% of all U.S. electricity consumption**
  - **–Much of this digitally networked already**



Our Future?

Media room in high-end home

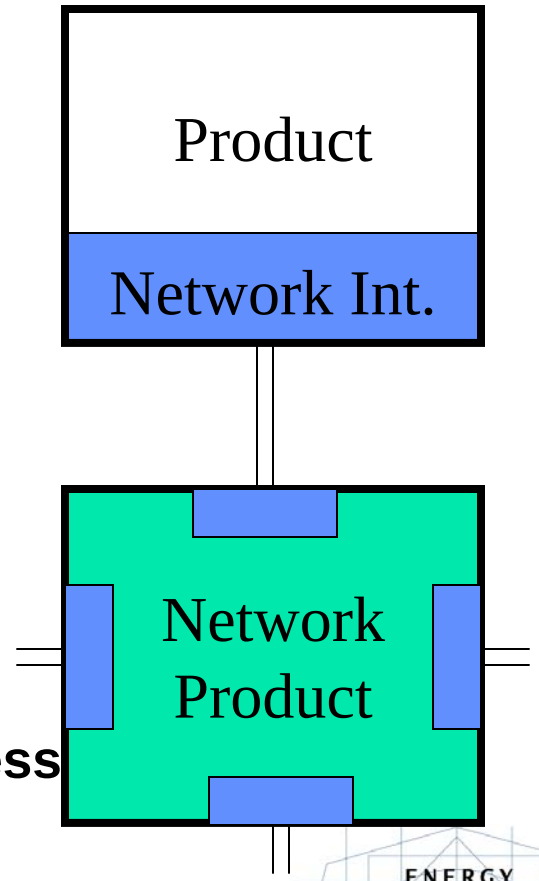
Electronics are Different

- Service provided is information, not “physical”
- Energy cost usually small fraction of purchase price
- Service-provider selection of products
  - Set-top boxes, Broadband modems, Mobile phones
- Key role of Power Supplies / DC Power
- Number of discrete devices per home
- Rate of Change: Technology, Models, Product Types, …
- Digital Network Connections
- Capability and power consumption can change with software / updates
- Key role of industry/technology standards
- Energy consumption often usage dominated
  - Easy for device activity to deliver no useful service
  - Configuration can be critical
  - User Interface important

Networks

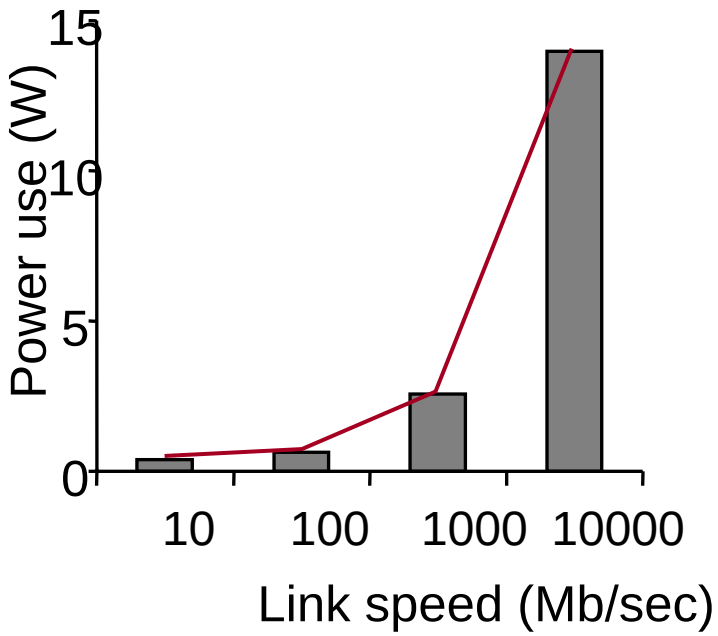
How networks drive energy use

- **Direct**
  - **Network interfaces (NICs)**
  - **Network products**
- **Induced in Networked products**
  - **Increased power levels**
  - **Increased time in higher power modes**
- **Network equipment ….**
  - **Modems, routers, switches, wireless access points, …**
- **… vs networked equipment**
  - **PCs, printers, set-top boxes, …**



Why do networks matter?

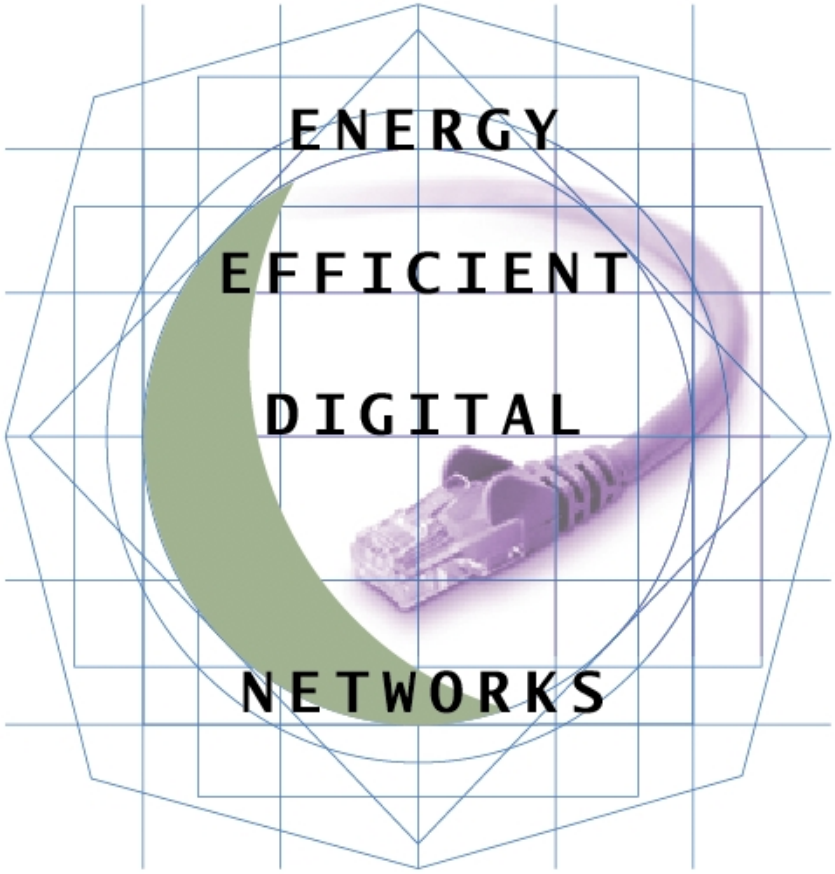
- Network equipment and interfaces use an increasing amount of energy
- Network standards constrain product design and energy standards
  - Can prevent savings
  - Can enforce savings
- Standards development is slow and complex
- Most network standards are global so savings global



- With digital networks, behavior of one device on network can affect energy use of connected devices
- People as element of network — User Interfaces

"Energy Efficient Digital Networks"

- A set of energy efficiency research projects all with theme of digital networks
- Proposed in 2005 — funded in 2007 by California Energy Commission Public Interest Energy Research (PIER) Program
- Covers both IT and CE products
  - Working with
    - Academia
    - Individual companies
    - Industry standards organizations
    - ENERGY STAR



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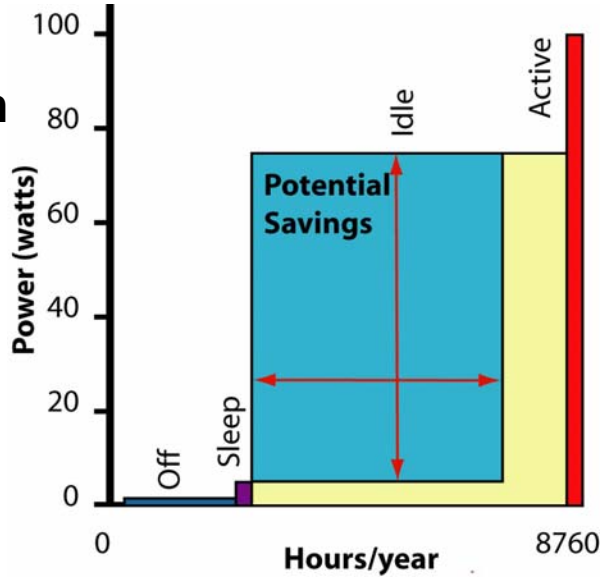
Adaptive Link Rate — Energy Efficient Ethernet

- Concept
  - Add power management to Ethernet
- Method
  - Reduce link rate at times of low traffic levels
    - Traffic levels are low most time on most links
  - Quick transitions and seamless operation essential
- Energy Savings
  - In network interface hardware and rest of system
  - In homes, commercial buildings, and data centers
  - U.S. direct savings — $ several hundred million/year
- Status
  - In midst of IEEE 802.3 (Ethernet) standards process
  - Hardware should be available in 2-3 years
- LBNL role
  - Initiate project, chair committee, link to energy efficiency community

Proxying

- Concept
  - Sleeping PCs to remain fully network connected
- Method
  - Define standard for how network interface can maintain "full network presence"
- Energy Savings
  - Avoids > 50 W for PC being on
  - Likely < 1 W extra for proxy hardware
  - U.S. direct savings — Easily > $1 billion/year



- Status
  - Working with industry to draft content of proxying standard
- LBNL role
  - Initiate project, coordinate with academia, industry, standards organizations, energy community

Other LBNL Network Project Components

- **Network product efficiency specs**
  - ***ENERGY STAR network switches? wireless access points?***
  - **– Choose best candidate product types**
  - **– Collect data to help develop initial draft specification**

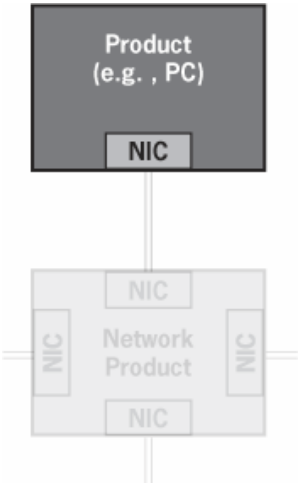
- **Consumer Electronics Inter-Device Power Control**
  - **– Avoid wasted energy use in evolving ecosystem of diverse CE devices (audio and video)**
  - **– Determine best ways for people to control CE power states, for devices to control themselves**
  - **– Work to put these methods into industry standards**

- **Set-top Boxes**
  - **– Explore technology and policy alternatives for greatest savings**

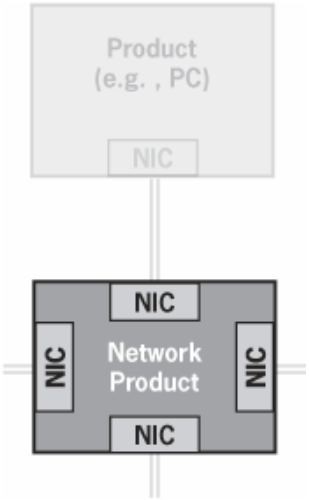
- **Firewire / i.Link / IEEE 1394**
  - **– Identify strategies to improve efficiency**

Efficiency Approaches

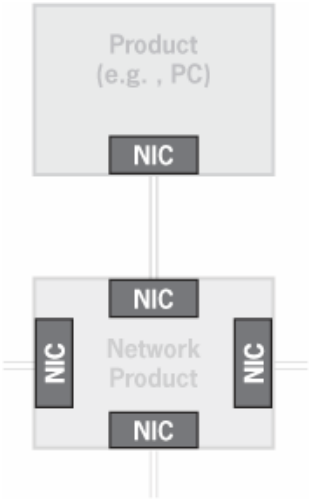
IT/CE Product Focus



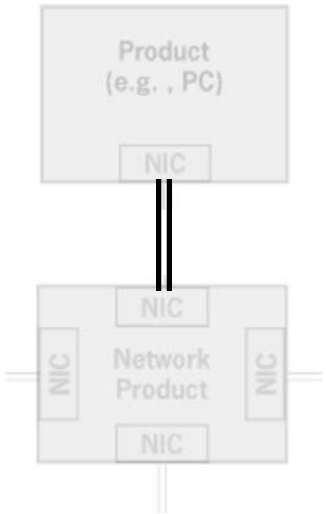
Network Product Focus



Network Interface Focus



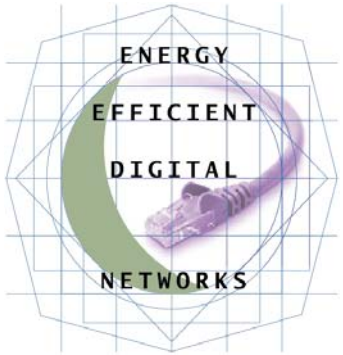
Protocol Focus



Need all approaches

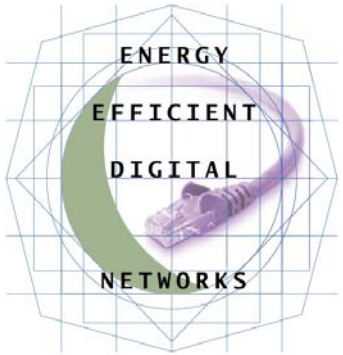
Future Needs

- More comprehensive work on electronics generally
  - e.g., how to move mobile electronics technology into grid-powered products
  - Leverage industry research
- Further exploration of digital network energy issues
  - Special attention to user interfaces
- "Buildings as Networks"
  - Embody energy efficiency "guiding principles" into emerging standards for networking non-electronic building end uses
    - Lighting, HVAC, Appliances, …
    - Thermostats
- Low-voltage DC power distribution within buildings
- Need to establish standards for lighting control user interfaces



State Connections

- Assess energy consumption of electronics in states/regions
- Work with local electronics companies to improve energy efficiency of products
- Ensure electronics owned by state and local governments operated efficiently
- Encourage Federal government to take the lead in addressing electronics energy use
- Where services are regulated at state or local level (e.g., cable, phone) require energy efficient equipment



Summary

Networks and network connectivity increasingly affect electronics energy consumption and potential savings

Many options exist to realize energy savings through digital networks (in electronics and other end uses)

Energy efficiency policy and research need to:

- Acknowledge electronics as an end use
- Increase investment in solutions to electronics and networks energy use
- Anticipate emerging energy problems and opportunities