Making
Power Management (PM) Successful

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June 20, 2005

Overview

- Background
- Usage Environments
- Problems / Solutions
  - "Network Problem" & Solutions
- Conclusions

"Enabling" defined broadly — includes PM enabled but not functioning

Assumptions

- Present enabling rates are low
- Increasing enabling rates will help industry, consumers, and ENERGY STAR
- Enabling will be even more important in future as
  - More types of devices have multiple power modes
  - More types of devices get network connections
  - Difference between On and Sleep power remains large
  - On-times increase
- Disabling caused by diverse problems and has diverse solutions

What We Know

Enabling Rates

– Commercial: **6%**   [LBNL, 2003]

– Residential: ongoing TIAX study

<div align="right">=> Enabling Rates Low</div>

On-times

– Commercial: **2/3** of PCs On continuously

– Residential: 10% 24/7 ; and 10% >40 hours/week
  (combined ~3/4 of on-time) [RECS, 2001]

Since 2001, average on-time up significantly and rising

=> Comm. already high; Resid. catching up

What We Know, cont.

Networks

- Commercial: Most PCs networked, but environments vary
- Residential
  - Most home PCs in multiple-PC homes (2001)
  - Networks from
    - multiple PCs
    - notebooks/wireless
    - single PC with broadband connection
    - PC to non-PC networked products

=> Networked PCs the rule

Power Levels

- Sleep levels << Idle levels

=> Large potential savings

Usage Environments: Degree of "Networking"*

	Commercial	**Residential**
"None"	Centrally Controlled	Dial-up or no Internet
Limited	One or two NW applications	One or two NW applications
High	Complete flexibility	Complete flexibility

*Networking = TCP connections persistent or from outside

Problems
(Obstacles, Challenges, …)

- Stigma: Past experience or rumor
- Tools: Lack of native tools for central enabling
- Legacy PCs, Applications, OS, Peripherals & Drivers
- Network Availability: IT Staff & General
- Confusing User Interfaces
- Disabled on Acquisition (IT Staff, purchase, friend)
- "Temporary" Disabling
- OS Upgrade
- Persistent Applications ("screensavers", PVR, digital picture frames, etc.)
- ……

Topics in brown covered earlier

3.8 Potential Barriers To Power Management

Even though a computer or monitor may have power management features, power management may not always operate effectively. There are many reasons why power management can be defeated in systems that have the feature.

Networks

Computer networks pose special challenges for power management. ....

Upgrades

Power management capabilities may change when PCs are upgraded …

Software Interactions

Some application software can interfere with power management, …

Section 4.4 provides a troubleshooting guide for dealing with these and other problems.

Solutions

- PR/Education re: that PM can work well
- PR/Education re: persistent applications
- Tools for central enabling
- Replace legacy applications, drivers & hardware
- Use Wake On LAN (WOL); scheduled activity/wakeup
- Better / consistent user interfaces (IEEE 1621)
- Central information resource for PM enabling
- Fix Network Problem
- "Aware" Sleep

Topics in brown covered earlier

Network Problem

PCs lose *general* network connectivity in sleep
- Failed discovery
- Failed connection initiation
- Lost TCP connections
- Routine network activity (e.g. DHCP)

- Applies to many but not all usage environments
- Critical for resource sharing including remote desktop, file sharing, resource discovery
- Critical for communications applications (IM, VOIP, etc.)

- WOL: Wake On LAN — Wake on MAC address **(too little or not at all)**
- DPF: Directed Packet Filtering — Wake on various packet types **(too little, too much, or both)**

- Proxy: Entity that maintains network presence for sleeping PC and wakes as needed
  - External: UPnP — Universal Plug and Play
  - Internal: SmartNIC — Smart Network Interface Controller
- "Aware" Sleep — Processor/OS/Memory stay on

$\Rightarrow$ **Only proxy or aware sleep can provide general network connectivity**
$\Rightarrow$ **Once exists, should be inexpensive**

Proxy Solution

1. PC awake; becomes idle
2. PC transfers network presence to proxy on going to sleep
3. Proxy responds to routine network traffic for sleeping PC
4. Proxy wakes up PC as needed.
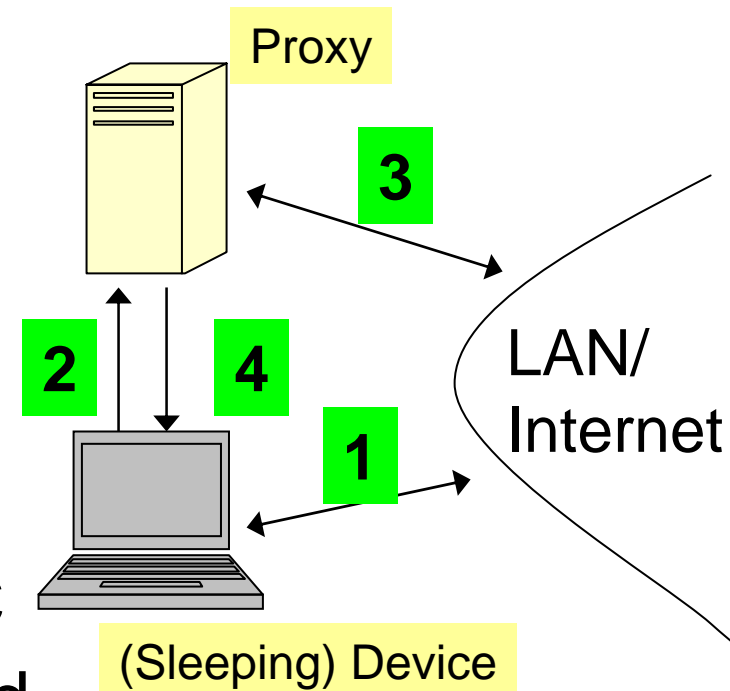
Proxy can be *internal* (NIC) or *external* (in other PC, network switch/router, dedicated device, ….)

Proxy

3

2   **4**

1

LAN/ Internet

(Sleeping) Device

Criteria for a Sleep-friendly PC

- Require no changes to existing protocols, and minimal changes to applications
- No change in user experience
- Maintain network presence (DHCP, ARP, etc.) with little or no wakeup of PC
- Generate routine packets as needed
- Reliably and robustly wake up PC when needed
- Not wake up PC when not needed
- Provide for exposing power state to network

Conclusions

- Power management can be successful and should be a priority

- Barriers and solutions are diverse

- Details need to be hashed out by smaller group

- Way forward includes spec. requirements, industry initiatives, and public sector efforts (including EPA)

*Do we have an **En**abling Problem or a **Dis**abling Problem?*