Reducing Desktop PC Power Consumption
Idle and Sleep modes

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Introduction

- 70% of people surveyed* leave one or more of their work PC's on when not using them
- 50% leave their home computer on when not interacting with it
- Top reasons for leaving a PC on when not in use (same for work and home):
  1. Don't want to wait for it to boot up.
  2. No reason to turn it off
  3. Applications that need to run
- Most common reasons for turning PC off when it is not in use:
  - Conserve power
  - Security
- Rapid-Resume "Sleep" modes can address all these except for applications
  - Wake On LAN capability can address many application needs, but has adoption issues.
- To address reason 3 and conserve power a lower-power "Idle" mode could be used

*2002 web survey. n=~1000

Possible Power Savings for Home Desktop PCs

- Studies suggest home desktop PCs are “on” an average 50 hours per week
  - But only in actual use 10 hrs/week
  - Leaving 40 hours of unused ‘on’ time
- Example: Sleep mode could save consumers ~$15 and ~200 kWh per year per PC (2004):
  - Sample Dell Dimension 4600 in sleep mode used 8w vs. 120w in normal on use
    - Peak Usage (Media Center TV time-shifting) = ~200w
    - Desktop/Web surfing/e-Mail = ~120w
    - S3 Sleep mode = ~8w
  - Power Cost
    - 200 kWh * $0.06 (Austin Energy 2004 rates) = $15/year
- Reduced-power Idle mode potential savings yet to be determined
  - Idle will use more power than sleep mode.
  - Few effective desktop PC idle implementations today
  - No standard definition or test methodology

Power consumption is an issue across industry

- Apple Mac G5, 1.6GHz OSX 10.4*
  - Desktop ~100W
  - Serene Screen Aquarium Screensaver ~ 140W
  - Highest measured ~ 165W

- Dell Dimension 4600, 3.0 GHz P4, Microsoft Media Center*
  - Desktop ~100 – 115W
  - Serene Screen Aquarium Screensaver ~ 140W
  - Highest measured ~ 190W

* This data obtained with low-cost clamp-on ammeter.
Actual values vary based on measurement equipment

Desktop Sleep Mode Impacts

- ACPI specification including sleep modes released in 1996
- In 1999, sleep modes were tried on desktops
  - Enabling S3 sleep mode led Dell customer call rate into millions of dollars/year
    - Customers upset with lost data and locked up machines
    - Sleep mode quickly disabled by default across industry
- By 2005, Sleep modes are slowly becoming mainstream on desktops
  - Dell Optiplex corporate desktop systems now default to enabling S3 sleep
  - Dimension consumer desktop sleep-enabled rate increasing
  - Customer calls and satisfaction issues with sleep still happen, but at much lower rate
  - Bad memories from early sleep implementations still persist. Common recommendation from online experts is to disable power management
  - Sleep is still unreliable– easy for software to block unintentionally, Wake On LAN works now, but still not widely used.
- Key lesson for other power-conserving modes: If they are not robust, well-designed and well-tested from the outset, adoption will be very slow.

What next?

- Continue encouraging use of sleep modes and driving industry suppliers to actively support sleep modes
  - Sleep mode with offers best opportunity for highest level of power conservation
  - Future operating systems, software and hardware can improve reliability and user accessibility of sleep mode
  - Wake-on-LAN adoption should be encouraged to permit more systems to use sleep modes
- If sleep mode still is not used, lesser power savings may be available with an ‘active-idle’ mode for desktops
  - Will need new operating systems, application software, drivers and devices

Home PC Trends – “Digital Home”

- Increasing broadband network adoption
  - 55% of US internet users in Jan 2005 used broadband
- Increasing home network installs, almost entirely wireless networks
- Home desktop PCs transitioning to media servers
  - Content acquisition & conversion
    - TV personal video recording
    - Internet Download
    - P2P applications
  - Low-cost player appliances emerging
    - Most are 802.11-based with little UI
    - Periodically ping servers for presence and content updates
    - Some standards-based, some not
- Home WoL adoption very low
  - Future technologies promise “home WoL”, but response must be close to instant and 100% reliably for adoption.
  - Wireless and security add a new set of issues
- Little to no consumer demand for Energy Star today
  - Ideal would be ‘automatic, non-intrusive and free”

Idle mode

What is “idle”?

For discussion, split ‘idle’ into two parts, “long-term” and “short-term”.

- “Short-term idle”
  - User is not actively doing anything this second
    - Ex: reading document, momentary distraction, pause between keystrokes, etc
    - Lots of these events, but difficult to save much power
    - User may still be looking at screen, applications still actively running, expects instant activity and response
- “Long-term idle”
  - User has not done anything for several minutes
    - Meeting, lunch, break, gone home, watching TV, etc
    - Not actively interacting with PC
    - User does not shut off or sleep system
  - Much more opportunity to conserve power
    - Screen can blank, unused devices can be sleeping or throttled back
  - But, more and more software runs while the user isn’t there
    - Virus & spyware scanning, IT management, File Indexing, TV recording, Media serving, auto-updates, License renewals, screensavers, etc

Examples

Long-term idle examples:

- User goes home from work at the end of the day, leaving their desk PC running. The system is idle until later that night when the corporate IT department updates the system software and scans for viruses, after which the system returns to idle.
- At home, user turns on home PC to read personal e-mail and Instant Messages. When the user steps away from their PC, the system is idle. Instant Messages and E-mails are received and immediately available when the user returns. Later at night the system will be idle until the operating system indexes the users documents and scans the system for spyware.
- Key difference between long-term idle and sleep mode is system processing and activity continues in idle. Sleep modes will conserve more power than idle.

Idle Issues

- Scheduled and unattended tasks are becoming more prevalent
  - Some use a large part of system resources. Some can be slowed down effectively, some cannot.
  - Users want these (mostly).
  - Examples:
    - TV PVR recordings
    - Virus & spyware Scanning
    - Instant messaging
    - Active screensavers
    - Automatic software updates
    - File indexing
    - Media serving to network devices
    - Trickle download of large files
    - System management
    - Peer-to-peer file sharing
    - Remote Desktop / Remote media access
    - Virus / spyware infections

Implementing Idle Mode

- Detecting idle can be difficult
  - Media PCs often have little user interaction for long periods of time.
  - Software can generate events that reset idle timers
    - Heavy CPU usage
    - Polling hardware such as disks and sound cards
- Idle feature will need to be designed into new operating systems, new software, new drivers and new hardware to work right
  - Likely not feasible to retrofit older systems
  - Adoption based on system refresh cycles
    - Example: Windows 2000 support officially EOL from Microsoft, yet many thousands of systems and institutions still use it
  - OS and hardware developers just beginning to look at idle for non-portable systems
- Portable PCs can provide some of the answers, but not all

Idle issues

Which system is idle?

Measuring Idle .. Issues

- % CPU is not an effective measure
  - CPU speeds can dynamically change
  - Most are software estimations
    - Windows Performance Monitor is known to be inaccurate
- Software is effectively unique on every system
  - Constant updates, configuration changes, driver spins, disk layout, etc
    - Even same version numbers vary
  - Very difficult to specify and reproduce exact setup without fixed images
    - Fixed images quickly become stale and unrepresentative

Idle Mode Testing

Test Design Goal:

- Simulate the power consumption of an operating PC system during periods of low demand, such as after a user steps away from a running PC system, expecting programs to continue to run during their absence.

Test requirements (priority order)

1. Test must be repeatable and deterministic
2. Test must be relatively easy to setup and perform
3. Test should resemble user reality

Tradeoffs for requirement 3:

- Network connections cause great difficulties meeting requirement #1. Many user systems are networked, which causes end-user experience to vary.
- Scheduled tasks and background processing such as file-indexing, TV-recording and virus scanning will increase power consumption during potential idle periods
- No user input or output during test. Screen and video can be blanked – This allows the monitor to enter a power saving state, as well as graphics hardware. Lesser amounts of power savings are available if the user chooses to leave video and display on.

Idle Test Method Proposal

Proposed test method (adapted from Noah Horowitz' NRDC document):

- Residential & Commercial Definition of Idle Mode:
  - Computer is operating (CPU not in a sleep mode*) with all internal hardware and monitor connected; operating system fully loaded; no hard drive or optical drive activity occurring; no ethernet, modem, or wireless network connection established; no keyboard or mouse activity; no additional USB, Fireware, or other peripheral devices (ex: printers, scanners, modems, etc) connected. Audio off. Scheduled software tasks such as virus scanning, defragmenting, indexing and graphic screensavers are not active.
  - * "not in a sleep mode" means the operating system software is running and the system could accept input from keyboard, mouse or network. The CPU and other devices may be operating in reduced-power modes, as long as I/O and processing requirements are met. Rotating media (ex; hard-disk drives and CD/DVD drives) may be spun down. CD and other removable media drives may have media removed. Removable batteries are not installed

Proposed test procedure:

- Start up a computer not connected to the Internet, network, or any peripherals other than the standard keyboard, monitor and mouse
- Bring up operating system 'desktop' screen, wait 20 minutes and then record the average AC current draw of the system unit over a 10 minute time interval
- Monitor is asleep and video is blanked. Monitor power consumption is not measured.

Idle test proposal open issues

- What software should be used?
  - Static image? Dynamic?
- How to address and test unique (build-to-order) systems?
- What measurement tools should be used?
- Other test conditions (environment, etc)

Summary

- Sleep modes conserve more power than idle modes
  - Continue encouraging use of sleep modes and driving industry suppliers to actively support sleep modes
  - Sleep mode with offers best opportunity for highest level of power conservation
  - Wake-on-LAN adoption should be encouraged to permit more corporate systems to use sleep modes
- Idle mode could provide some help to systems not using Sleep
  - Significant challenges to implementing and testing
  - Successful adoption of a full Idle mode will take time
    - Requires cooperation from hardware, drivers, application software and operating-system providers.
      - Lining all these up successfully will not be rapid
    - Longer product lifecycles will slow broad adoption