

Computer Power Management: It's Time to Wake Up

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ABSTRACT

Computer power management (CPM) can save up to \$45/PC annually by activating existing Windows settings that place the computer (hard drive, CPU, etc.) into a low-power sleep mode. Overall, CPM could save the United States over 26 billion kWh annually in energy. Although technically more challenging than activating similar settings on a computer monitor, CPM has become more and more commonly implemented at organizations. This paper presents the potential savings through CPM activation, the barriers to CPM activation, the various technical solutions available to activate and manage CPM activation, and steps the energy-efficiency community can take to promote CPM.

Introduction

For the past 5 years, the United States Environmental Protection Agency (EPA) has promoted the use of monitor power management (MPM), which places computer monitors into low-power sleep modes, at large organizations through the ENERGY STAR Million Monitor Drive (MMD) campaign. EPA has recruited some of the most prominent companies in the U.S. into the campaign, including General Electric, Nike, the Ford Motor Company, Wal-Mart, Cisco Systems, and Intel. A complete list of participating companies is available at www.energystar.gov/powermanagement. National Public Radio covered GE's involvement in the program in June 2004.¹ By the end of 2005, close to 10 million monitors were addressed through the MMD campaign.

Due in part to the efforts of EPA and to improvements in computer technology, MPM has become much more common in businesses, where enablement rates are reported to be 72 percent (Lawrence Berkeley National Labs, 2004). Corporate IT departments have recognized MPM's stability, ease of company-wide activation, and end-user acceptance. More often than not, corporate IT departments have set MPM to be activated by default on their corporate template image so all their computers have MPM activated.

There is also an enormous potential for savings by similarly increasing the activation rate of CPM (also known as the S3 sleep state, system standby; and the S4 sleep state, hibernate).² Only 6 percent of computers in commercial settings have CPM activated (Lawrence Berkeley National Labs, 2004). This paper quantifies the enormous potential savings of CPM (up to \$45/PC annually), reviews the perceived and real barriers to CPM implementation, discusses and

¹ To hear the story, please go to <http://www.npr.org/templates/story/story.php?storyId=1960428>

² System standby (S3) saves information to RAM and draws about 2 watts of power and wakes up quickly in 5-10 seconds. However, you lose information in the event of a power loss. Hibernate (S4) saves the same amount of energy as system standby but wakes up slower (20+ seconds). Hibernate saves work to the hard drive and information is not lost in the event of a power loss. Shutdown (S5 sleep state) is reached when you manually shut off your computer.

provides examples of implementation solutions, and discusses steps that the energy-efficiency community can take to promote CPM.

What Are The Potential Savings With CPM?

The potential energy savings from activating CPM have been steadily increasing during the past few years due to two trends in the IT industry:

- **Computers are left on continuously.** Due to perceived security risks, many businesses leave their computers on 24 hours a day so network administrators can quickly send out software updates and security patches. At least half, and probably more, of the PCs used by businesses are left on continuously. A new Pentium 4 computer left on can use 600 kWh of electricity or more per year, most of it wasted. For computers left on continuously, CPM can save 80 percent of the energy used.³ Recent estimates indicate that only 36% of desktops are turned off at night (Lawrence Berkeley National Labs, 2004).
- **New computers use much more energy than even recent models.** New computers use twice the energy of old ones due to faster processors and video cards. For example, a PC from 3 years ago used 35 watts, compared to 70 watts today.⁴ In sleep mode, these computers use only 2 watts. Figure 1, on the next page, shows power draws of a Pentium 4 computer as it enters sleep mode and wakes back up.

EPA estimates that the nationwide savings available if all office desktops had power management activated is 26 billion kWh annually⁵, equivalent to:

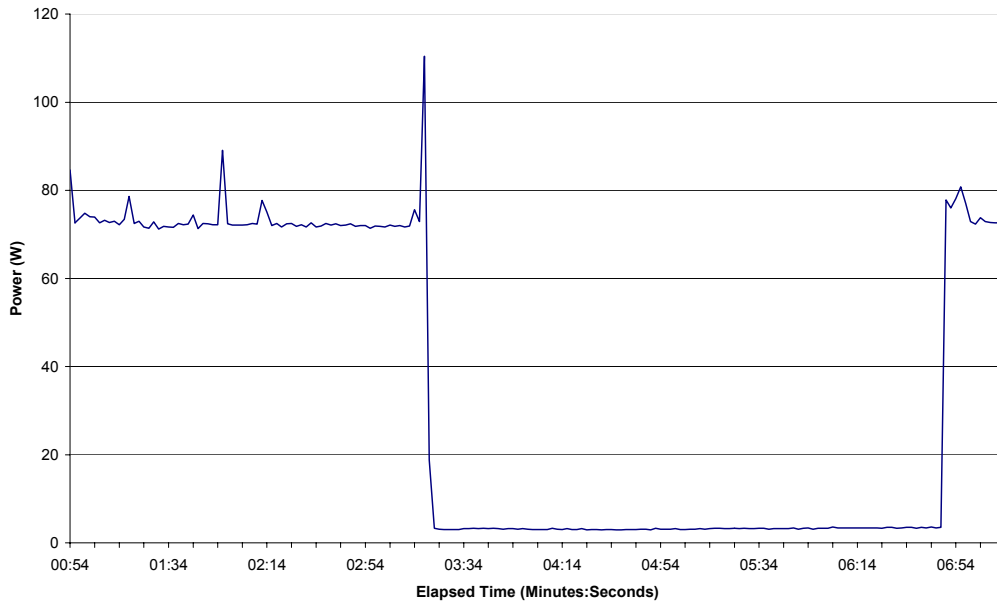
- \$2.4 billion in energy bills
- Enough electricity to light all the homes in California and New York
- 19 million tons of carbon dioxide gas emissions

³ Data from the development of the ENERGY STAR computer spec (to be finalized in 2007) indicate that the average Pentium IV computer uses around 68.7 watts when active. If on 24/7 or 8760 hours a year, the computer will use around 600 kWh per year. If a computer is set to sleep aggressively and assume the computer is only on 6 hours a day over 5 days a week or 1560 hours, or 17% of the energy.

⁴ Lab testing, The Cadmus Group, 2005.

⁵ Assumed: 911,160,000 office computers based on EPA 2005 Climate Change Action Plan; 68.7 watts active and 2 watts in sleep based ENERGY STAR data; 64% were left on at night and 6% already power managed (Lawrence Berkeley National Labs, 2004); Set to go to sleep after 30 minutes of inactivity; National average commercial rate of electricity of 8.97 cents per kWh. (DOE Energy Information Administration, 2005). Used savings calculator at www.energystar.gov/powermanagement

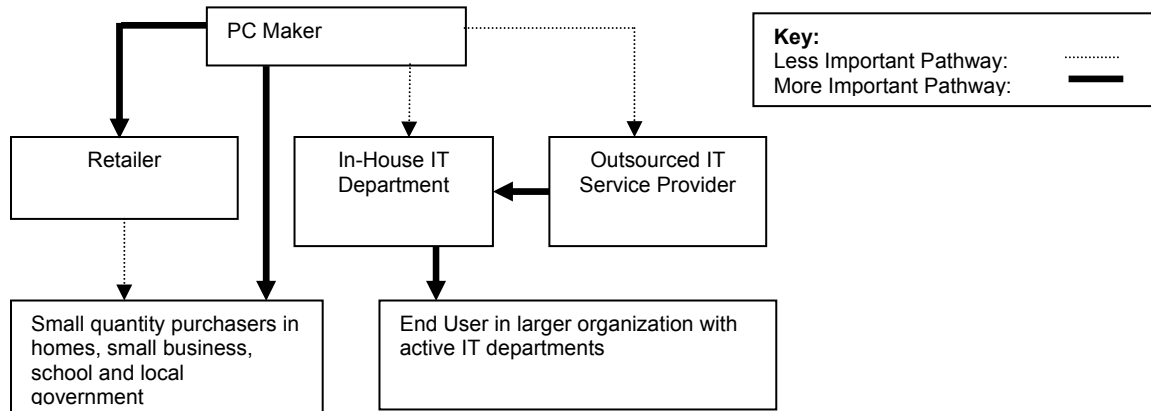
Figure 1. Power Usage vs. Time for Computer Entering Sleep Mode and Waking Up



Who Is Responsible For CPM Activation?

An interesting fact regarding CPM is that many business line PCs have been set with CPM activated since 2004/2005. This fact begs the question: *Why are CPM activation rates so low if some manufacturers ship their PCs with CPM activated?* Figure 2 shows the market actors who determine whether a PC arrives on a user’s desk with CPM activated. For purposes of examining power management, there are two classes of PC consumers: (1) small-quantity purchasers who do not use an IT department to set up their machines; and (2) users who receive their machines from an IT department.

Figure 2. Market Actors Who Activate CPM



Individual users do not commonly activate CPM, and retailers do not normally change the CPM defaults set by PC makers.⁶ Therefore, activation of CPM by PC makers is crucial for PCs sold to small-quantity purchasers and retailers. However, in most large organizations, in-house IT departments or contracted service providers establish desktop settings of PCs. For example, General Electric purchases PCs, removes settings provided by the PC maker, and re-images the PC with a GE custom software configuration.⁷ We estimate that roughly 7 out of 10 commercial PCs shipped to businesses are re-imaged after they leave the PC manufacturer or are shipped from the OEM with a custom image ordered by the customer.⁸ Therefore, shipment of PCs with CPM enabled does not necessarily result in large corporations saving energy through CPM. In fact, organizations of all sizes often rely on IT service providers called, “system integrators,” to purchase, configure, and install PCs. System integrators frequently “image” new PCs for their customers, which means they load all required software, including the operating system (which controls CPM), on the PCs.

In summary, while PC manufacturers and retailers are the major determiners of whether PCs purchased by small-quantity purchasers are power managed, it is in-house IT departments and IT service providers who determine the rate of adoption of CPM in corporate environments.

What Is Keeping Network Administrators from Activating CPM?

With corporate CPM activation dependant on in-house IT departments and IT service providers, EPA explored why IT professionals are hesitant to activate CPM. These barriers, both real and perceived, keep the rate of CPM activation rates very low. In talking with hundreds of IT managers responsible for millions of computers over the past 4 years, EPA identified four major CPM barriers.

- **IT managers had poor prior experience with CPM in the past.** Early versions of CPM had compatibility issues between hardware and software, leading to reliability problems. Early failed attempts at CPM led to a bias against CPM that still lingers, even though CPM reliability has greatly improved.
- **IT managers have hardware/software conflicts with CPM.** CPM is not 100-percent compatible with all hardware, network, and software configurations. For instance, Novell networks and some anti-virus software have had difficulty accommodating CPM. Most conflicts are software based and lead to “soft failures,” meaning the computers will not enter sleep mode. Less frequent are failures that cause loss of data or PC lockups.
- **IT managers could not centrally manage CPM.** Until the past few years, there were few tools available to activate CPM quickly and easily. In addition, CPM settings are user-based, not machine-based. Therefore, even with CPM activated, a computer in the logged off state does not go to sleep because a user is not logged on.
- **IT managers want computers available 24/7.** Some IT administrators need on-demand 24/7 access to their computers due to security concerns. This issue is the primary

⁶ Based on conversations with the staff of office equipment and home electronics retailers. Members of the staff of a retail office supplies chain, who are responsible for purchasing PCs, said they do not adjust the desktop settings established by the PC maker.

⁷ Based on conversations with GE IT Program Manager.

⁸ Based on conversation with representative of a large manufacturer, 10/20/03.

hindrance to CPM implementation in large organizations. Sleeping computers are difficult to wake up for software updates and security patches. In addition, many companies ask end-users to leave their computers on 24/7 to allow remote access to their machines.

What Solutions Can Address These CPM Barriers?

Depending on network management protocols, homogeneity of PCs and an organization's commitment to energy efficiency, CPM activation can be the simple application of a network tool. However, at its most complicated, CPM can require an IT manager to consider some innovative solutions. With major improvements in CPM reliability and manageability, however, EPA is beginning to see a trend towards more companies activating CPM. In fact, although we still believe that activation of CPM is low, we see ample evidence that CPM is becoming more commonplace. In fact, we have now activated CPM on computers at over 40 organizations across the country. Below we detail how the CPM barriers described in the previous section have been addressed through technological improvements and network software tool solutions and offer examples of successful CPM implementation.

CPM Works Best on New Computers

CPM on the latest computers (Pentium 4 at least) running the latest operating systems (such as Windows 2000 and XP) has evolved into a reliable means of saving energy due to IT industry power management standardization efforts. Evidence of the stability of CPM is that PC makers have shipped computers with CPM activated for a number of years. In addition, Apple computers have come out of the box with CPM set. Operating systems are also improving the CPM experience. CPM has been improved by Apple's new operating system, OS X Tiger, and will also be enhanced for PC users by the next Microsoft operating system, Vista. Microsoft's efforts to improve the power management experience for end-users and network administrators include:

- Making system standby, not shutdown, will be the default off state. With this innovation, CPM will become commonplace in office settings. IT administrators and end users will become familiar with its dependability and convenience.
- Making central management of sleep setting available through standard Microsoft network management tools.
- Improving the reliability of sleep by preventing programs and drivers from blocking sleep.
- Improving wake-up times from sleep to less than 2 seconds.
- Ensuring the CPM works when the user is logged off the machine.

IT Managers Should Perform Pilot Tests on CPM

Given the possibility of hardware/software conflicts with CPM, IT managers are encouraged to run simple pilot tests before activating CPM network wide. A few years ago, GE conducted rigorous CPM pilot tests on its core software load before rolling out CPM across 75,000 computers. The pilot tests revealed no conflicts with CPM and the rollout across various

business units did not lead to additional Help Desk calls. GE indicated that the key to the successful corporate-wide implementation was the company's consistent IT infrastructure. CPM is now part of the core image used at all GE business units. GE saves \$2.5 million annually through CPM and MPM activation.⁹

Tools Make CPM Centrally Manageable.

A number of network tools are available to allow IT administrators to quickly and easily activate CPM across an entire organization. These tools include:¹⁰

- **1E's NightWatchman**, which allows IT administrators to shutdown their PCs (enter the S5 sleep state). Vision Service Plan used 1E products to save \$145,000 per year.
- **Apple's OS X Tiger Server and Remote Desktop 2**, both of which allow CPM to be centrally controlled for Macs.
- **Desktop Standard's Policy Maker** group policy tool¹¹, which, along with providing hundreds of other capabilities, activates CPM. Bemis Company, Inc., the largest flexible packaging company in the United States, used Policy Maker to activate CPM on 5,000 PCs.
- **Verdiem's Surveyor**, a comprehensive power management tool, allows the activation of CPM and measures and demonstrates the cost savings. Verdiem has had significant success with school districts, government agencies, and colleges and universities. For example, the 21,000-student Edmonds School District, Washington State's eighth-largest district, used Surveyor to save 181 kWh/PC annually.
- **EZ GPO**, a simple tool developed by EPA, uses group policy to change CPM settings. In addition, EZ GPO allows CPM to work in the logged off state. The free software tool has been downloaded over 20,000 times since June 2003. A variety of organizations have used it to activate CPM:
 - The University of Wisconsin-Oshkosh activated CPM on 500 computers in a lab
 - Contra Costa County, California activated CPM on 1,400 machines
 - North Thurston Public Schools in Washington State activated CPM on 4,000 computers
 - The US Army activated CPM on 5,000 laptops in Iraq.

IT Managers Can Keep Their Computers on 24/7 and Use CPM

EPA has identified a number of solutions for organizations that want to keep their computers on 24/7 for on-demand patching and updating. Although these solutions may lead to hesitation from some risk-adverse IT managers, a number of institutions are adopting them.

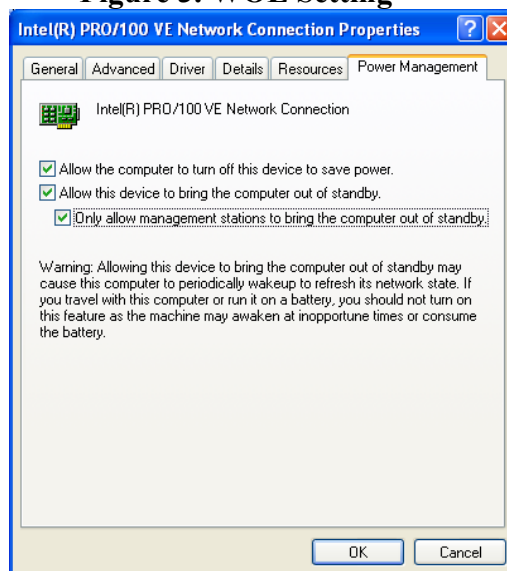
⁹ Read the GE case study at www.energystar.gov/powermanagement

¹⁰ Learn more about these tools at www.energystar.gov/powermanagement.

¹¹ Group Policy is a Microsoft technology that supports one-to-many management of machines and users in an Active Directory environment. By editing Group Policy Objects (GPOs) to contain policy settings and targeting the GPO at the intended machines or users, specific configuration parameters can be centrally managed.

- **1E's NightWatchman and SMSWakeUp.** NightWatchman places computers into shutdown (S5 sleep mode), and SMSWakeup allows IT managers to wake the computers out of shutdown (S5 sleep state) for updates.
- **Verdiem's Surveyor software.** Surveyor not only centrally activates CPM, but also can ensure that every PC is awake and ready for after-hours remote back-ups or software upgrades.
- **Wake on LAN (WOL).** With Wake on LAN (WOL) activated, network administrators can wake up sleeping machines at any time to perform on-demand patches or updates by sending a packet, commonly referred to as a "magic packet." The WOL setting, tied to the network interface card (NIC) driver, is activated by selecting the appropriate options on the network adapter power management properties, located in the device manager. On the power management tab, select "Allow this device to bring the computer out of standby" and "Allow only management workstations." The only problem is that the WOL setting is not typically activated by default on machines. Post deployment activation of WOL is difficult because PCs require different ways of setting WOL in the PC. However, for a homogeneous population of PCs imaged from the same machine, a network administrator should be able to activate WOL by pushing out a registry key or using a third-party tool such as Ghost. This type of homogeneous population allowed the University of Wisconsin-Oshkosh to activate WOL throughout their computer lab.¹² In addition to these solutions, Microsoft is looking to address this issue by asking its partners to activate the WOL setting by default. (See screen shot of WOL setting in Figure 3 below.)

Figure 3. WOL Setting



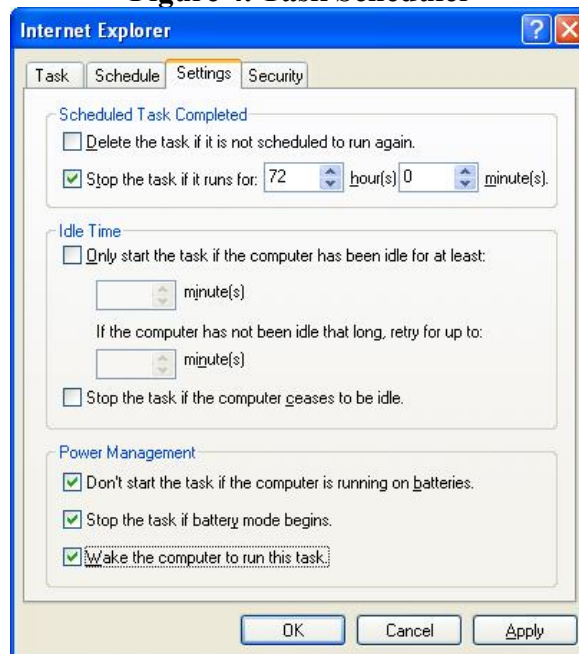
- **Scheduled Tasks.** Windows Task Scheduler (set through the operating system) sets tasks to run at a certain time on a PC. These tasks can be set to run by first awakening the sleeping computers for updates. Although simple to set on an individual PC, distributing these settings across a network requires third-party tools or batch files to

¹² See University of Wisconsin at Oshkosh case study at: <http://www.energystar.gov/powermanagement>

distribute scheduled tasks. (See screen shot of Task Scheduler in Figure 4 below. Note how the “Wake the machine to run this task.” option is checked.) These third-party tools include:

- **Desktop Standard’s Policy Maker** uses scheduled tasks to wake up a machine at a predetermined time, force a group policy object that turns off standby or hibernate, conduct automatic updates or patches, and force another group policy object to re-establish standby or hibernate.
- **Dameware Utilities**, which can remotely install and manage scheduled tasks through remote procedure call (RPC) and remote administration of client machines.

Figure 4. Task Scheduler



We have established that long-standing problems with CPM implementation have viable, robust solutions that save energy for almost any organization. Next, we propose means for the energy efficiency community to promote CPM to take the effort to the next level and transform the market.

What Should The Energy-Efficiency Community Do Next?

As the momentum for CPM builds, EPA will continue with it outreach and technical assistance efforts to make CPM more and more commonplace in organizations throughout the U.S. However, there are a number of steps the energy-efficiency community can take to promote CPM. We propose that utilities, energy-efficiency organizations, and even individuals take this message to their stakeholders, customers, and constituents. Below we outline the steps that the energy efficiency community can take to promote CPM.

Become Comfortable with CPM

Before promoting CPM, the energy efficiency community should become comfortable with it and activate CPM internally. EPA can support these efforts by working with IT staff to ensure a smooth activation of CPM. The steps to help organizations become more comfortable with CPM include:

1. **Convincing IT managers that CPM is reliable and easy to use.** EPA can help explain to the IT manager the benefits of running CPM on a small test network. Doing so will demonstrate that CPM works and that older legacy software, which in the past could complicate CPM implementations, is not an issue on new machines.
2. **Deploying the right CPM tools and methods.** For each network environment, EPA can determine the best method or tool available for a company's computing environment. The majority of IT administrators are most comfortable using in-house network procedures and tools. In other cases, IT managers may want to consider EPA's EZ GPO tool, which activates CPM through group policy objects, or any of the other mature, tested software tools that have been used by businesses for a number of years.
3. **Running a tiered activation of CPM.** EPA will recommend to risk-averse IT administrators a cautious and gradual approach to CPM activation across an entire network. Weeklong tests could be conducted on a series of small five-to-six-node networks, each from a different business unit, to gauge CPM activation performance and ease of implementation, end-user reaction, and availability of the sleeping computers. After each small network has completed a successful CPM activation, the overall results should be evaluated and presented to senior IT management for review. Upon a favorable IT review, to start, the least mission-critical business unit should activate CPM on its entire set of computers. From there, other business units can follow with CPM activation.

Promote CPM Activation

Upon gaining confidence in CPM, the energy-efficiency community can promote CPM through a variety of means. Getting the word out through the community is extremely important to CPM promotion. As more and more organizations take advantage of this energy-savings opportunity, momentum will build. For example:

- **State energy offices** could promote CPM to other state offices through an outreach and technical assistance program. These efforts could range from a state-wide declaration to activate CPM on every new machine used by the state to a post-deployment activation of CPM at all state agencies using network tools.
- **Utility and regional energy efficiency programs** could make CPM part of their program plans, offer incentives to commercial customers for CPM activation, or promote CPM to residential customers, perhaps through simple instruction manuals, as an easy means to save energy. A good first step would be to conduct CPM studies on some of the larger, more PC-intensive customers in a territory.

- **Individuals** should demand that their new PCs come with CPM activated. Without customer demand for CPM, PC makers and retailers will not make CPM part of the standard default offerings on all their PCs. The energy-efficiency community should make CPM part of their standard residential energy efficiency tips.

Conclusion

CPM is a viable technical opportunity to save enormous amounts of energy by setting computers to enter a low power sleep mode when inactive. A number of technical solutions to the four common barriers to CPM were detailed. However, despite the resolution of technical issues, the energy-efficiency community needs to embrace CPM as a core offering in their efforts.

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