Efficient Power Management

on Dell PowerEdge Servers with AMD Opteron Processors

Efficient power management enables enterprises to help reduce overall IT costs by avoiding unnecessary energy use. This article describes how to enable and validate AMD PowerNow!™ power management technology on Dell™ PowerEdge™ servers with AMD™ Opteron™ processors.

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Efficient power management in enterprise data centers has become increasingly critical to help control costs. Dell PowerEdge servers with AMD Opteron processors enable enterprises to take advantage of AMD PowerNow! technology to provide this management in their data centers. AMD PowerNow! technology allows operating systems to dynamically adjust processor power states, voltage, and clocking frequencies depending on workload, which helps reduce total power consumption and related IT costs while providing enhanced performance/watt capabilities and performance on demand; for example, the processor can run at a low power state when the system is idle, avoiding unnecessary power use and reducing cooling requirements. AMD tests have shown that enabling AMD PowerNow! technology allows for power savings of up to 65 percent at 60 percent processor utilization and up to 75 percent during processor idle when compared to power consumption with this technology disabled.¹

This article provides step-by-step guidance to help administrators enable AMD PowerNow! technology on Dell PowerEdge servers with AMD Opteron processors, including details on additional software and driver components required to use AMD PowerNow! technology as well as basic ways of validating its functionality to help ensure effective power management. The instructions in this article apply to PowerEdge 6950 and PowerEdge SC1435 servers (see the “Power-friendly Dell PowerEdge servers with AMD processors” sidebar in this article) with AMD Opteron processors running the Microsoft® Windows Server® 2003 OS with Service Pack 1 (SP1), Microsoft Windows Server 2003 x64 Editions, the Red Hat® Enterprise Linux® OS, or the Novell® SUSE® Linux Enterprise Server OS.

¹ These average results are based on a four-socket internal AMD test platform with four AMD Opteron 8220 SE processors; four 1 GB, 667 MHz double data rate 2 (DDR2) dual in-line memory modules (DIMMs) per socket (for a total of 16 GB of memory); and a 250 GB Serial ATA (SATA) hard drive. For more information about AMD PowerNow! technology and processor utilization, see “Managing Data Center Power and Cooling with AMD Opteron Processors and AMD PowerNow! Technology,” by Brent Kerby, in Dell Power Solutions, February 2007, www.dell.com/ downloads/global/power/ps1p07-20070204-AMD.pdf.
When implementing a power management system, enterprises should always consider the trade-off between power efficiency and performance, particularly the impact that power management can have on the performance of critical applications.

**Updating the BIOS to enable power management**

The first step in using AMD PowerNow! technology on Dell servers is to update the BIOS token to enable power management. Administrators can do this by changing the Demand-based Power Management BIOS token from “Disabled” to “Enabled.”

In addition to this manual option, administrators can use the Dell OpenManage™ Deployment Toolkit (DTK), Dell OpenManage Server Administrator (OMSA), or the BIOS setup utility to update the token. These tools can play a key role when carrying out one-to-one (local or remote) or one-to-many BIOS token updates. For all of these methods, a system reboot is required to make the token update effective.

**Dell OpenManage Deployment Toolkit.** Administrators can use the following command in the DTK to update the Demand-based Power Management BIOS token:

```
syscfg --dbpm=enable
```

This command can be replicated for one-to-many environments or scripted.

**Dell OpenManage Server Administrator.** Administrators can use the OMSA command-line interface (CLI) or graphical user interface (GUI) to carry out one-to-one system monitoring and configuration. To update the Demand-based Power Management BIOS token through the CLI, administrators can use the following command:

```
omconfig chassis biossetup
attribute=dbpm setting=enable
```

To update the token through the GUI, administrators can select the appropriate server, go to System > Main System Chassis > BIOS, select the Setup tab, then select “Enable” (see Figure 1).

**BIOS setup utility.** Administrators can update the Demand-based Power Management BIOS token with the BIOS setup utility by performing the following steps:

1. Power the system on.
2. Press F2 during the system power-on self-test to enter the BIOS setup utility.
3. Press the right-arrow key to reach the Advanced screen.
4. Press the down-arrow key to highlight “Power Management” and press Enter.
5. Press the right-arrow key to change the mode to “Enable.”
6. Exit the utility and allow the system to continue booting.

**Enabling AMD PowerNow! technology in Microsoft Windows Server 2003**

After updating the BIOS, administrators must perform three key steps to enable AMD PowerNow! technology on servers running Windows Server 2003 with SP1 or Windows Server 2003 x64 Editions: installing the AMD PowerNow! driver, installing the appropriate OS hot fix, and selecting the appropriate power scheme.

**Installing the AMD PowerNow! driver**

Using AMD PowerNow! technology with Windows Server 2003 requires version 1.3.2 or later of the amdk8.sys driver. Administrators can download the latest version of this driver from www.amd.com.

After installing the driver, administrators must modify the boot.ini file to include the `/USEPMTIMER` switch for multiprocessor support. This switch forces the system to use the power management timer (PMT) rather than the time stamp counter (TSC). Because of the frequency-variant nature of TSCs, using TSCs instead of PMTs can cause symmetric multiprocessing (SMP) system processors to run at different frequencies.

Administrators can avoid this step by using the AMD setup utility to install the driver; the installer automatically updates the boot.ini file to include the `/USEPMTIMER` switch. They can verify this switch is present by checking the boot.ini file following driver installation.

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![Figure 1. Demand-based Power Management screen in the Dell OpenManage Server Administrator GUI](image-url)
POWER-FRIENDLY DELL POWEREDGE SERVERS WITH AMD PROCESSORS

Dell PowerEdge 6950 and PowerEdge SC1435 servers are designed for efficiency and scalability. Dual-core AMD Opteron processors enable these servers to take advantage of both the efficiency of the AMD Direct Connect Architecture and the power management capabilities of AMD PowerNow! technology, helping reduce overall data center power and cooling costs.

The PowerEdge 6950 server uses dual-core AMD Opteron 8200 series processors. These 64-bit processors help PowerEdge 6950 servers provide high performance while minimizing power consumption. For example, tests performed by Dell engineers in August 2006 showed that the PowerEdge 6950 used up to 20 percent less power than a previous-generation PowerEdge 6850 server configured with dual-core Intel® Xeon® 7100 series processors.*

The PowerEdge SC1435, designed for high-performance computing clusters and distributed Web serving, uses dual-core AMD Opteron 2200 series 64-bit processors that help provide exceptional performance and performance per watt compared with previous-generation PowerEdge SC servers. For example, tests performed by Dell engineers in September 2006 demonstrated that the PowerEdge SC1435 could provide up to 128 percent higher performance and up to 138 percent higher performance per watt than a previous-generation PowerEdge SC1425 server with single-core Intel Xeon processors.**

Dell PowerEdge 6950 servers enable exceptional performance for demanding applications such as database, server consolidation, virtualization, and migration from costly proprietary RISC-based systems.

Because they are based on industry-standard components, Dell PowerEdge servers enable organizations to simplify operations, improve resource utilization, and scale out in cost-effective increments. In addition, the dual-core AMD processor–based servers are designed to provide electrical, thermal, and socket compatibility with upcoming quad-core AMD processors. Once those processors become available, enterprises should be able to seamlessly upgrade dual-core AMD processor–based systems for increased performance.

For more information about Dell systems with AMD processors, visit www.dell.com/amd or www.dell.com/energy.

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* Based on AC power measurements using an Extech 380803 Power Analyzer taken during the peak load of the SPECjbb2005 benchmark test performed by Dell Labs in August 2006 on a PowerEdge 6950 with four dual-core AMD Opteron 8220 SE processors at 2.8 GHz, 32 GB of 667 MHz DDR2 memory, and Microsoft Windows Server 2003 Enterprise x64 Edition with SP1, as compared with a PowerEdge 6850 with four dual-core Intel Xeon 7140 processors at 3.4 GHz, 16 GB of 400 MHz DDR2 memory, and Windows Server 2003 Enterprise x64 Edition with SP1. Actual power consumption will vary based on configuration, usage, and manufacturing variability.

** Based on SPECfp_rate benchmark tests performed by Dell Labs in September 2006. Performance tests used a PowerEdge SC1435 server with two AMD Opteron 2220 SE processors at 2.8 GHz, 8 GB of 667 MHz DDR2 memory, a SATA 80 GB, 7,200 rpm hard drive, and the 64-bit Red Hat Enterprise Linux 4 Update 4 OS. Performance/watt tests used a PowerEdge SC1435 server with two AMD Opteron 2218 processors at 2.6 GHz, 8 GB of 667 MHz DDR2 memory, a SATA 80 GB, 7,200 rpm hard drive, and the 64-bit Red Hat Enterprise Linux 4 Update 4 OS. Both were compared with a PowerEdge SC1425 with two single-core Intel Xeon processors at 3.8 GHz, 8 GB of 400 MHz DDR2 memory, a SATA 80 GB, 7,200 rpm hard drive, and the 64-bit Red Hat Enterprise Linux 4 Update 4 OS. Actual performance and power consumption will vary based on configuration, usage, and manufacturing variability.
Installing the appropriate OS hot fix
To avoid a known deadlock that can occur in the Windows Server 2003 kernel on systems with two or more AMD Opteron processors, administrators should install the hot fix available at support.microsoft.com/kb/924441.

Selecting the appropriate power scheme
Administrators should set the server to use the “Server Balanced Processor Power and Performance” power scheme. They can set this option by selecting Start > Control Panel > Power Options and using the “Power schemes” drop-down menu, as shown in Figure 2.

Enabling AMD PowerNow! technology in Linux operating systems
Support for AMD PowerNow! technology in Red Hat Enterprise Linux 4 Update 4 or later and Novell SUSE Linux Enterprise Server 10 is provided by the powernow-k8 driver. Figure 3 summarizes Linux support for AMD PowerNow! technology on PowerEdge servers with AMD Opteron processors. Red Hat Enterprise Linux 4 prior to Update 4 does support dynamic processor-frequency drivers; however, the version of the AMD PowerNow! driver included with the OS does not detect the AMD Opteron processors used in PowerEdge servers, so administrators should disable AMD PowerNow! technology in the BIOS when using Red Hat Enterprise Linux 4 prior to Update 4.

To enable AMD PowerNow! technology on systems running these Linux operating systems, administrators must first check that the system correctly detects the AMD PowerNow! driver, and load it if necessary. In Red Hat Enterprise Linux, they must also carry out some additional configuration steps. Administrators should always check that they are using the latest driver versions, which are available for download from www.amd.com.

Detecting the AMD PowerNow! driver
Administrators can determine whether a Linux-based system is correctly detecting the AMD PowerNow! driver with the following command:

dmesg | grep -i powernow

If this command does not produce any output, they should download the latest version of the powernow-k8 driver from www.amd.com, then load it with the following command:

modprobe powernow-k8

Figure 4 shows the two types of output this command produces depending on whether demand-based power management is enabled in the BIOS. If the command produces output indicating that this option is not enabled, administrators should follow the steps in the “Updating the BIOS to enable power management” section in this article. If AMD PowerNow! technology is enabled in the BIOS, the command loads the driver, then displays the speeds and voltages the processor supports.

Enabling AMD PowerNow! technology in Red Hat Enterprise Linux
To enable AMD PowerNow! technology in Red Hat Enterprise Linux 4, administrators must also perform the following steps:

1. In /etc/cpuspeed.conf, edit or add the DRIVER line to read

   DRIVER="powernow-k8".

2. Enable the cpuspeed daemon with the command

   chkconfig cpuspeed on.

3. Load the powernow-k8 driver with the command

   modprobe powernow-k8.

4. Start the cpuspeed daemon with the command

   /etc/init.d/cpuspeed start.

Using processor frequency tools
Several tools are available in Red Hat Enterprise Linux and SUSE Linux Enterprise Server to adjust processor frequency settings. Red Hat Enterprise Linux primarily uses the cpuspeed daemon, and SUSE Linux Enterprise Server primarily uses the powersave utility.

<table>
<thead>
<tr>
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<th>powernow-k8 driver version</th>
<th>i386 support</th>
<th>x86-64 support</th>
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<tr>
<td>Red Hat Enterprise Linux 4 prior to Update 4</td>
<td>1.00.09b</td>
<td>No (module)</td>
<td>No (built-in)</td>
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<tr>
<td>Red Hat Enterprise Linux 4 Update 4</td>
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<td>Yes (module)</td>
<td>Yes (built-in)*</td>
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<tr>
<td>Novell SUSE Linux Enterprise Server 10</td>
<td>1.60.2</td>
<td>N/A</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* For the x86-64 version of Red Hat Enterprise Linux 4 Update 4, the powernow-k8 driver is included in the kernel and cannot be updated without a kernel recompile.
In Red Hat Enterprise Linux, administrators can use the following commands to set the processor frequency scaling method:

- `killall -SIGUSR1` (processor runs at its fastest speed)
- `killall -SIGUSR2` (processor runs at its slowest speed)
- `killall -SIGHUP` (processor speed is adjusted dynamically)

In SUSE Linux Enterprise Server 10, the powersave utility allows administrators to change several power-related system settings from a single interface. They can use the following commands to set and view the processor frequency scaling method:

- `powersave -f` (processor runs at its fastest speed)
- `powersave -l` (processor runs at its slowest speed)
- `powersave -A` (processor speed is adjusted dynamically)
- `powersave -c` (current setting is displayed)

Administrators can monitor the current processor speed using the command `/proc/cpuinfo`; for examples of the resulting information from this command, see the supplemental online section of this article at www.dell.com/powersolutions.

In the i386 SMP kernel of Red Hat Enterprise Linux 4, the MHz setting reported in `/proc/cpuinfo` does not update when the processor frequency changes, but the bogomips setting does. The MHz setting does update in the x86-64 uniprocessor kernel.

Valuing effective power management

Administrators can validate the effectiveness of AMD PowerNow! technology in a number of ways. For example, they can use AMD tools such as PSTCheck or System Stress Test to verify power state transitions and drops in processor clocking speed. Because other system components besides the processor also consume power, administrators should measure differences in power consumption based on the direct power supplied from the power socket.

Implementing efficient power management

Effective power management can play a key role in managing power use and controlling costs in enterprise data centers. By taking advantage of AMD PowerNow! technology on Dell PowerEdge servers with AMD Opteron processors, enterprises can enhance the efficiency of their power usage and thereby help reduce overall data center costs.

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FOR MORE INFORMATION

Dell and AMD:
www.dell.com/amd

AMD power management: