Dual-Core Processors on Dell-Supported Operating Systems

With the advent of Intel’s dual-core processors, in addition to existing Hyper-Threading capability, there is confusion regarding the number of processors that software reports. In particular, the confusion lies around the number of processors expected to be displayed by Dell BIOS, as well as the number of processors that will be licensed and utilized by the various operating systems. This whitepaper explains how Dell BIOS and Dell-supported operating systems will report dual-core processors.

Processor Terminology

Socket: a physical package containing a processor with one or more cores.
Core: an individual processor within a socket. The new Intel processors can contain two cores per socket.
Hyper-Threading Module: an individual software thread that simulates a unique processor for the task scheduler. The new Intel processors allow two threads per core.

Dell BIOS Enumeration

Dell BIOS enumerates cores and threads in such a way as to help ensure the most efficient use of resources, in case not all of the available logical processors can be utilized. Since cores give better performance than Hyper-Thread modules, cores are enumerated first. Thus, for a four socket system, Hyper-Thread modules would be enumerated in the following order:

Socket1, Core1, HT Module 1
Socket2, Core1, HT Module 1
Socket3, Core1, HT Module 1
Socket4, Core1, HT Module 1
Socket1, Core2, HT Module 1
Socket2, Core2, HT Module 1
Socket3, Core2, HT Module 1
Socket4, Core2, HT Module 1
Socket1, Core1, HT Module 2
Socket2, Core1, HT Module 2
Socket3, Core1, HT Module 2
Socket4, Core1, HT Module 2
Socket1, Core2, HT Module 2
Socket2, Core2, HT Module 2
Socket3, Core2, HT Module 2
Socket4, Core2, HT Module 2

Windows Operating Systems

Windows 2000 Server and its variants are not aware of multiple cores or Hyper-Threading. Therefore, each Hyper-Threaded module and each core within a socket appear as a separate physical processor to Windows 2000.

Windows 2000 Server only supports up to four processors. On a system with a single socket containing a dual-core processor with Hyper-Threading enabled in BIOS, all four Hyper-Thread modules will appear and be made available to the task scheduler. Windows displays processor information in System Information, which can be viewed by running msinfo32.exe from a command prompt.

In this example, Windows 2000 Server utilizes the following processors in the order listed below:
Socket 1, Core 1, HT Module 1;
Socket 1, Core 2, HT Module 1;
Socket 1, Core 1, HT Module 2;
Socket 1, Core 2, HT Module 2;

Conversely, if two sockets are populated, Windows 2000 Server will only utilize the first four modules that the BIOS enumerates. In this example the modules utilized will be:

Socket 1, Core 1;
Socket 2, Core 1;
Socket 1, Core 2;
Socket 2, Core 2;

In a similar manner, if four sockets are populated only the first core in each socket will be utilized.

On the other hand, Windows 2000 Advanced Server will utilize the first 8 processors that are enumerated.

Windows Server 2003, however, is much more intelligent with regard to processor instances. From a licensing standpoint, Windows Server 2003 only counts sockets. Therefore, for Windows Server 2003 Web Edition, which allows a maximum of 2 sockets, 8 Hyper-Thread modules will be displayed in System Information and utilized by the scheduler. These Hyper-Thread modules are as follow:

Socket 1, Core 1, HT Module 1;
Socket 2, Core 1, HT Module 1
Socket 1, Core 2, HT Module 1;
Socket 2, Core 2, HT Module 1;
Socket 1, Core 1, HT Module 2;
Socket 2, Core 1, HT Module 2;
Socket 1, Core 2, HT Module 2;
Socket 2, Core 2, HT Module 2;

If more sockets are installed in a Web server system, Windows will still utilize only the first 2 sockets it encounters.

Microsoft Windows Small Business Server 2003 also has a two-processor limit. If SBS 2003 is installed on a system with dual-core and Hyper-Threading processors, a warning message appears indicating that more than two processors are in use. However, after the install completes, the utilization will be identical to Web server, allowing full performance on a dual-socket system.


Thus on a four-socket PowerEdge 6800 running either Standard or Enterprise Edition, System Information will display 16 processors, and each will be assigned tasks by the scheduler.

Table 1 shows the available processors and processor mapping for all versions of Windows Server 2003 and Windows 2000 Server.
<table>
<thead>
<tr>
<th>Operating System</th>
<th>Maximum Number of Processors</th>
<th>Number of Processors Windows Reports with Hyper-Threading Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1P (1 Socket)</td>
</tr>
<tr>
<td>Windows 2000 Sever</td>
<td>4 (logical or physical)</td>
<td>2 cores each with 2 Logical processors are recognized - 4 licensed processors</td>
</tr>
<tr>
<td>Windows 2000 Advanced Sever</td>
<td>8 (logical or physical)</td>
<td>2 cores each with 2 Logical processors are recognized - 4 licensed processors</td>
</tr>
<tr>
<td>Windows Server 2003 Web Edition</td>
<td>2 sockets</td>
<td>1 socket = 1 licensed processor; 2 cores; 4 HT threads</td>
</tr>
<tr>
<td>Windows Server 2003 Standard Edition</td>
<td>4 sockets</td>
<td>1 socket = 1 licensed processor; 2 cores; 4 HT threads</td>
</tr>
<tr>
<td>Windows Server 2003 Enterprise Edition</td>
<td>8 sockets</td>
<td>1 socket = 1 licensed processor; 2 cores; 4 HT threads</td>
</tr>
</tbody>
</table>

**OpenManage**

Dell's systems management software, OpenManage™ Server Administrator (OMSA), also reports processor information. Unlike Windows operating systems, OMSA only reports sockets. OpenManage uses SMBIOS to gather processor information, and thus its reports are very similar to what the BIOS displays during POST. OMSA will display the number of processors, the speed of each processor, and the number of cores in each processor. Figure 1 shows an example of an OMSA report of processor information on a PowerEdge Server.
Multi-Processor Support on NetWare

Including systems with multi-core and/or Hyper-Threading processors, NetWare® supports up to 32 processors on the Intel x86 architecture. For example, on a NetWare system with two dual-core processors with Hyper-Threading, the processors will be displayed with CPUCHECK as listed below:

**Processor 0, Speed 2793 Mhz, CPUID: GenuineIntel**
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEFBF0FF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 0

**Processor 1, Speed 2793 Mhz, CPUID: GenuineIntel**
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEFBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 6

**Processor 2, Speed 2793 Mhz, CPUID: GenuineIntel**
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEFBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 2
Processor 3, Speed 2793 Mhz, CPUID: GenuineIntel
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 4

Processor 4, Speed 2793 Mhz, CPUID: GenuineIntel
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 1

Processor 5, Speed 2793 Mhz, CPUID: GenuineIntel
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 7

Processor 6, Speed 2793 Mhz, CPUID: GenuineIntel
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 3

Processor 7, Speed 2793 Mhz, CPUID: GenuineIntel
Genuine Intel® CPU 2.80GHz
Family 15, Model 4, Stepping 8
Feature flags 0000649D:BFEBFBFF
L1 cache: 28K Bytes, L2 cache: 2048K Bytes
Processor Initial APIC ID: 5

Keep in mind that each core or Hyper-Thread is counted as a processor in NetWare, so an eight-socket system with dual-cores and Hyper-Threading would max out the 32-processor limit (8X2X2=32).

Licensing on NetWare is based on the number of users rather than the number of processors. Therefore, licensing is not relevant in the discussion of number of processors, as long as the NetWare system has 32 or fewer processors.

Linux-based Operating Systems

In general, the Linux kernel can support up to 32 processors on the Intel x86 architecture, and is aware of multiple cores and Hyper-Threading. For example, with a Linux kernel running on a system with two dual-core processors, each with Hyper-Threading, the processors will be presented as follows in /proc/cpuinfo:

CPU ID 0: Socket 1, Core 1, HT Module 1;
CPU ID 1: Socket 1, Core 1, HT Module 2;
CPU ID 2: Socket 1, Core 2, HT Module 1;
CPU ID 3: Socket 1, Core 2, HT Module 2;
CPU ID 4: Socket 2, Core 1, HT Module 1;
CPU ID 5: Socket 2, Core 1, HT Module 2;
CPU ID 6: Socket 2, Core 2, HT Module 1;
CPU ID 7: Socket 2, Core 2, HT Module 2;
This behavior, however, varies across Linux distributions depending upon the support provided in the kernel by the vendor.

**Novell/SUSE Linux**

SUSE Linux Enterprise Server 9 is based on the 2.6.5 kernel, but will support up to 32 processors for both the x86 and x86_64 architectures with Service Pack 2 and above. Licenses are provided per CPU socket.

**Red Hat**

Red Hat® Enterprise Linux 3 x86 provides support for up to 16 processors, and Red Hat Enterprise Linux 4 x86 provides support for up to 32 processors; however, both Red Hat Enterprise Linux 3 and 4 x86_64 only provide support for up to 8 processors. Licensing is provided per CPU socket.

**Intel Dual-Core Processors Support on PowerEdge Servers**

<table>
<thead>
<tr>
<th></th>
<th>SC430</th>
<th>PE830</th>
<th>PE850</th>
<th>PE1800</th>
<th>PE1850</th>
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<th>PE2800</th>
<th>PE2850</th>
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<tbody>
<tr>
<td>Intel® Pentium® D</td>
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<td>Intel® Celeron® D</td>
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<tr>
<td>64-Bit Intel® Xeon™ 7020 Processor</td>
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