Hyper-threaded and Dual-Core CPU Technology
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Hyper-threaded and Dual-Core CPU Technology

Abstract

Processor (or CPU) manufacturers, such as Intel and AMD, face an ever-increasing demand for processing power. CPU over clocking, the traditional method of increasing CPU performance, has reached its technological limits. Over clocking has two primary undesirable side effects – more heat, and the generation of more electronic noise within the CPU. The heat can cause a server to fail, and the electronic noise can cause corruption within the data stream.

Processors do not execute processes, they execute threads. One process can launch many threads. The operating system is responsible for allocating resources, like CPU and RAM, to those threads. One can conclude that the more CPUs you have, the more threads can be handled at once, hence the advent of hyper-threading single processors and dual-core processors. However, this technology is only an advantage if applications are designed to work in such an environment. Single threaded applications will run on these newer processors just as if they were running on a single processor. This whitepaper discusses both hyper-threading and dual-core technologies, as well as information on how to detect whether or not a machine has such processors installed.

Hyper-threaded CPUs

Hyper-threading, or Hyper-Threaded Technology (HTT), is actually Intel’s trademark for their multi-threading technology, but has become a common name for all processors of this type. It is essentially a cut down version of dual core (discussed later). Execution units on a hyper-threaded CPU share certain elements, such as cache and
pipelines. The operating system sees a single hyper-threaded processor as two separate logical CPUs. Threads can be scheduled to execute on any of these logical processors. The main strength of hyper-threading is that it allows for flexible scheduling of all available execution slots, which increases efficiency by keeping the execution core as busy as possible. All that is required to take advantage of this technology is symmetric multiprocessing (SMP) support in the operating system. However, since hyper-threaded possessors still share the same cache, it is possible for applications performance to actually degrade if both threads are contending for the CPU cache at the same time. Figure 1-1 shows a graphical display of the thread and pipeline relationship in a hyper-threaded CPU:

Figure 1-1

**Single Hyper-threaded CPU**

**CPU – 1:**

Process Flow

Thread 1  ================ >
Thread 2  ================ >
--------------------------

Pipeline

The future of hyper-threading is somewhat uncertain, especially on server class machines, where dual core technology is rapidly gaining in popularity.
Dual-Core CPUs

Differing from hyper-threading, dual-core processors have two completely independent processing cores contained within the same die/socket. It is a CPU that contains two complete execution cores in one physical processor. A dual-core CPU will execute threads faster than a hyper-threaded CPU. In addition, dual-core CPUs can be hyper-threaded for even greater potential performance. In order to keep heat under control, dual core CPUs usually have much lower clock speeds. These slower clock speeds makes it essential for new applications to be programmed in such a manner to take advantage of the multiple thread paths, meaning SMP support. If an application is not SMP aware, then it is simply running on one, slower, processor just like in the past. In addition, operating systems that support what is known as thread-level parallelism (TLP) benefit from dual-core technology even if the applications installed are not programmed to take advantage of the dual cores. However, users running non-SMP aware applications may still benefit from dual-core technology. For example, the operating system would route processing threads from one application through one core, and the threads of another application through the second core. Even though dual-core processors technology has separated many of the processing components, they still share some common key elements, such as memory controller and bus. Dual-processors do not share any of these items, and are therefore faster than a single-core processor. In addition, a dual-core processor will be faster than a single-core processor, but not twice as fast, which is what one might think.

Figure 1-2 shows a graphical display of the thread and pipeline relationship in a dual-core CPU:
Licensing Implications

Common licensing practice is to charge on a per-CPU basis. This was straightforward when only single-core CPUs were involved. Now the question is – charge per physical CPU, or charge per CPU core? Currently, Microsoft, Intel, and AMD are of the opinion that license fees should apply to physical CPU. However, this issue is still unresolved, and it seems that the trend may be towards manufacturers charging per CPU die, or chip.
Identifying and Monitoring Hyper-threaded and Dual-Core CPUs

It is not possible to effectively detect whether or not processors are hyper-threaded or dual-core from within an operating system. An external tool is required to perform this task. Intel has an extremely effective tool for this purpose. It can be downloaded from their website either as a completely pre-packaged executable, or a text file of sample code can be downloaded and customized. This is an extremely handy tool and can be found at:


An example of the pre-packaged executables output is shown below in Figure 1-3:

Figure 1-3
Monitoring hyper-threaded CPUs within Windows operating systems can be accomplished via PerfMon.exe. As previously mentioned, the OS recognizes a single hyper-threaded CPU as two logical processors. Therefore the Processor performance counters will show two CPU instances, as shown in Figure 1-4:

![Add Counters](image)

This screenshot was taken from a two-CPU machine with hyper-threading support enabled. The operating system, and therefore Perfmon.exe, recognize four processors – 0 through 3. Dual-core CPUs, unless hyper-threaded, will appear as a single processor instance within PerfMon.exe.
Summary

New CPU technologies, such as hyper-threading and dual-core, are becoming much more common as processor manufacturers try to keep pace with the demands for more processing power. This whitepaper discussed both hyper-threading and dual-core processors, including the basic differences between the two technologies. In addition, information on how to effectively identify what type of processor is installed in a machine or server was also provided. We hope you find this information helpful.

Additional Reading

http://msdn.microsoft.com/msdnmag/issues/05/06/HyperThreading/default.aspx
http://msdn.microsoft.com/msdnmag/issues/06/09/CLRIinsideOut/
http://www.ddj.com/dept/debug/184417069