Working Parallel With Hyper Threading

Abstract

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*In today's competitive world, to achieve maximum performance in shorter duration is the need in every field. Same is the situation in the field of processing of hardware and software of computer systems. At a given time, more than one activity must be carried out, that is where a need of Parallel Processing creeps in. To achieve maximum performance, nearly 100 % CPU utilization must be done. To facilitate the need of Parallel activities,**Hyper-threading**. Technology is used the processors. It is used to improve parallelization of computations of microprocessors.. Hyper-threading works by duplicating certain sections of the processor. It works on the fact of logical processors, allowing operating system to appear as two "processors", to schedule two threads simultaneously, thus increasing speed of computing. This technology is transparent to operating systems and programs. All that is required to take advantage of hyper-threading is symmetric multiprocessing(SMP) support.Execution units on a hyper-threaded CPU share certain elements, such as cache and pipelines. Hyper-threading is effective as it allows for flexible scheduling of all execution slots, so that core is busy as possible.*

1. Introduction to Parallel Computing:

To carry out lot of calculations simultaneously , a computation method used is **Parallel computing** ,operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently . There are several different forms of parallel computing: bit-level, instruction level, data, and task parallelism. Ideally, parallel processing makes a program run faster .One way to achieve Parallelism in Computing is Hyper Threading.

2. Hyper Threading: At a given point of time, a general processor handles one instruction from one program , the processor divides its resources in an efficient manner between various programs and the user is in an illusion that the system is running more than one program in a specified time. But in reality, CPU transits back and forth between programs. A **Thread** is each instruction which is sent to the processor.

Hyper-threading (officially **Hyper-Threading Technology**, and abbreviated **HT Technology**, **HTT** or **HT**) is Intel's term for its simultaneous multithreading implementation in their Atom, Core i3, Core i5, Core i7, Itanium, Pentium 4 and Xeon CPUs. Hyper-Threading Technology focuses on simultaneous Multi-Threading. **A single physical processor appears like two logical processors with duplicated architecture state.** It i*s b*ased on the **Simultaneous Multi-Threading** (SMT) method. This Technology allows programs to run multiple threads in parallel on one processor.

The Pentium 4 3.06 GHz processor is the first Intel desktop processor that can process two independent threads at the same time. This allows two threads from

applications(single/two)to execute in parallel, increasing processor utilization .Hyper-Threading Technology-capable processors offer significant performance improvements for multi-threaded and multi-tasking workloads without sacrificing compatibility with existing software or single-threaded performance. Remarkably, Hyper-Threading Technology implements these improvements at a very low cost in power and processor die size. With a SMT (Simultaneous Multi-Thread) enabled OS like Win2000/XP, Linux, etc. the operation system will identify the P4 3.06 GHz CPU as two logical processors that share the single physical CPU's resources. A physical processor can be thought of as the chip itself, whereas a logical processor is what the computer sees - with Hyper-Threading enabled the computer can have one physical processor installed in the motherboard, but the computer will see two logical processors, and treat the system as if there were actually two processors.
The following figure shows the working of Processor without HT technology:

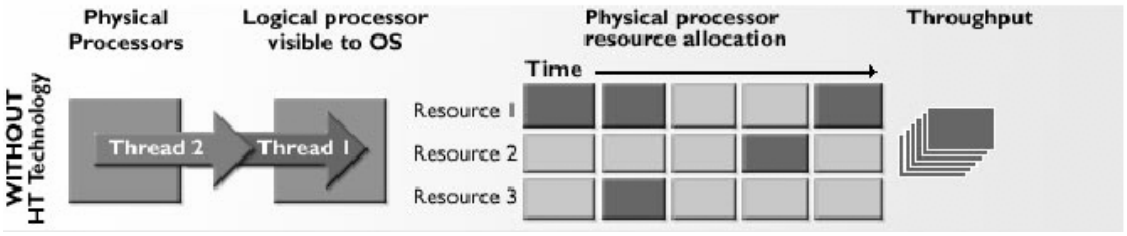

fig.1

Fig. 1 shows the working of a Processor without Hyper threading Technology. It can be clearly seen that there is one physical Processor and OS views only one Processor , Thread 1 is followed by Thread 2, resources utilization is by Thread1 and Throughput is achieved for Thread1 and then will be followed by Thread2, this making execution speed slower.
The following figure shows the working of Processor with HT technology:

fig.2

Fig. 1 shows the working of a Processor with Hyper threading Technology. It can be clearly seen that there is one physical Processor and OS views two Processors (that is logical implication by OS and Software) , two Threads :Thread 1 and Thread2. Both Threads are executed simultaneously by two logical Processors at the same time. Resources are used by both Threads thus making efficient se by sharing, replicating The available resources and therefore throughput is more at a given instant of time as

compared to Fig. 1 because of two threads. Single physical processor's resources are shared by two logical processors, each of them has architectural registers. HT Technology capable processor looks like two processors to software, including operating system and application code. Thus enabling software to have privileges of thread level parallelism. Various Resources are replicated between logical processors like Control registers, general purpose registers , Instruction pointers, Register renaming tables, Debug registers and Machine state registers. By replication there is improvement in Branch Prediction ,simltaneous track exection is carried out, storage of reslts is undertaken. Some Resources are partitioned like Re-order Buffers,Load/Store Buffers.
It allows operations from one logical processor to bypass operations of the other logical processor that may have stalled.To improve the dynamic utilization of the resources Trace Caches, Level Caches,Exection nits are shared. The operating system also plays an important role in HT Technology. The OS assigns operations to the independent logical processors, if OS understands that one of the logical CPU's is to remain idle, the OS will issue a HALT command to the free logical processor thus devoting all of the other system resources to the working logical processor. Execution trace cache access is arbitrated by the two logical processors every clock. If a cache line is fetched for one logical processor in one clock cycle, the next clock cycle a line would be fetched for the other logical processor provided that both logical processors are requesting access to the trace cache. If one logical processor is stalled or is unable to use the execution trace cache, the other logical processor can use the full bandwidth of the trace cache.Ths achieving **Front End Pipelining.** The Execution Core is powerful**.** The core can dispatch up to six µops per cycle, provided the µops are ready to execute. Once the µops are placed in the queues waiting for execution, there is no distinction between instructions from the two logical processors. After execution, instructions are placed in the re-order buffer. The re-order buffer decouples the execution stage from the retirement stage. The re-order buffer is partitioned such that each uses half the entries. The retirement logic tracks when instructions from the two logical processors are ready to be retired. It retires the instruction in program order for each logical processor by alternating between the two logical processors. If one logical processor is not ready to retire any instructions, then all retirement bandwidth is dedicated to the other logical processor.

3. Conclusion: Hyper Threading has the potential to significantly boost system performance under certain circumstances. Some programs will notice a performance boost, and in some cases, other programs will see a performance hit with HT enabled. As more and more software is written specifically for Hyper Threading, the performance differences will grow larger. Thus, by using Hyper Threading Technology Performance can be increased by viewing logically two processors and sharing and replicating resources. Thus achieving parallelism in computations.

4. References:

1. www.intel.com
2. www.overclock.net/intel-cpus/75216-dual-core-vs-ht.html

3. www.techterms.com/definition/hyperthreading