FEATURES OF INTEL CORE i7 PROCESSORS

P.Sangeetha[1], Mrs. M. Mythili[2]
[1]M.phil Full Time Research Scholar Department of Computer Science
[2]Assistant Professor Department of Computer Science & Applications
Vivekanandha College of Arts and Science for Women (Autonomous), Namakkal, Tamilnadu, India
Psangeetha33@gmail.com[1],mythili28@gmail.com[2]

Abstract---Intel's Core i7 processors are based on the Penryn manufacturing process the company introduced last year, but otherwise there are few similarities with the Core 2 Duo, Core 2 Quad, and Core 2 Extreme lines. A Core i7 processor fit in familiar LGA775 motherboard chip sockets the Intel norm for years now. Core i7 processors employ a new technology the Intel Quick Path Interconnect (QPI), for increased bandwidth and reduced latency. Hyper-Threading has also been reintroduced the line, so each core process two threads simultaneously making eight-core processing a reality. And in case that not enough multiprocessing for the technology can support as eight physical cores meaning that 16-core processing. The road to the Core i7 actually started with the demise of Intel's Netburst architecture. Intel's old strategy for producing microprocessors was to simply increase the core clock speeds, instruction sets and cache sizes a few ticks every year. Every time this happened the power draw and heat levels would increase as well, until eventually Intel hit a brick wall with the Pentium 4. They are 64 bit processors in computer architecture, 64-bit integers, memory addresses or other data units are those that are at most 64 bits wide. Also 64-bit CPU and ALU architectures are those that are based on registers, address buses or data buses of that size. The need for core i7 processors requires a comparison with their immediate predecessors. The comparison can be summarized as follows. The Core i7 is a completely new architecture which is much faster and more efficient than the Core 2 Duo. Currently only the Core i7 920, 945 and 965 XE versions are available. Of that the Core i7 920 is available at just offers better performance than almost all Core 2 Duo processors.

Keywords---Intel core i7, Penryn manufacturing, Motherboard chip, Quick Path Interconnect(QPI), Hyper-Threading, Intel's Netburst architecture, ALU architecture, Core 2 Due .

1. INTRODUCTION

The Intel Penryn microarchitecture, which included the Core 2 family of processors, was the first mainstream Intel microarchitecture based on the 45nm fabrication process. This allowed Intel to create higher-performance processors that consumed similar or less power than previous-generation processors. The Intel Nehalem micro architecture that encompasses the Core i7 class of processors uses a 45nm fabrication process for different processors in the Core i7 family. Besides using the power consumption benefits of 45nm, Intel made some dramatic changes in the Nehalem microarchitecture to offer new features and capabilities in the Core i7 family of processors. This white paper explores the details on some key features and their impact on test, measurement, and control applications.

Intel core i3, i5, and i7 naming scheme for their CPUs for quite a while now, but what these labels mean tends to slowly change over time as new features are introduced or older ones get replaced. On top of this, the naming scheme between desktop and mobile CPUs is often different as well. In this article, we will go over what differentiates i3, i5, and i7 processors for both mobile and desktop Haswell CPUs. The biggest thing you need to know in regards to the i3, i5 and i7 naming scheme is that it is primarily a way for Intel to separate their CPUs into three performance tiers:

a. *Intel Core i7*: High-end
b. *Intel Core i5*: Mainstream
c. *Intel Core i3*: Entry-level

There are a few differences in features (notably Hyperthreading, cache size and number of cores), but as we will show later in this article there is actually very little that differentiates an i5 CPU from an i7 CPU. The biggest thing that this naming scheme gives you is a starting place when choosing a CPU. If you use your computer for basic tasks like surfing the web, then an i3 CPU is likely a great choice. If you use your computer for a variety of tasks that require a bit more power (including gaming), than an i5 CPU might be a better choice. If you run multiple applications that require a lot of CPU power, then an i7 CPU is probably right for you.

Figure1: The Intel Core i7 920 processor

2. FEATURES OF INTEL COURE i7 PROCESSORS

A. New Platform Architecture

An Intel microarchitecture for a single processor system included three discrete components a CPU, a Graphics and Memory Controller Hub (GMCH), also known as the north bridge and an I/O Controller Hub (ICH), also known as the south bridge. The GMCH and ICH combined are referred to the chipset. The older Penryn architecture, the front-side bus (FSB) was the interface for exchanging data between the CPU and the north bridge. If the CPU had to read or write data into system memory or over the PCI Express bus, then the data to traverse over the external FSB.

The new Nehalem microarchitecture Intel moved the memory controller and PCI Express controller from the north bridge to the CPU die, reducing the number of external data bus that the data to traverse. These changes help increase data-throughput and reduce the latency for memory and PCI Express data transactions. These improvements make the Core i7 family of processors ideal for test and measurement applications such as high-speed design validation and high-speed data record and playback.

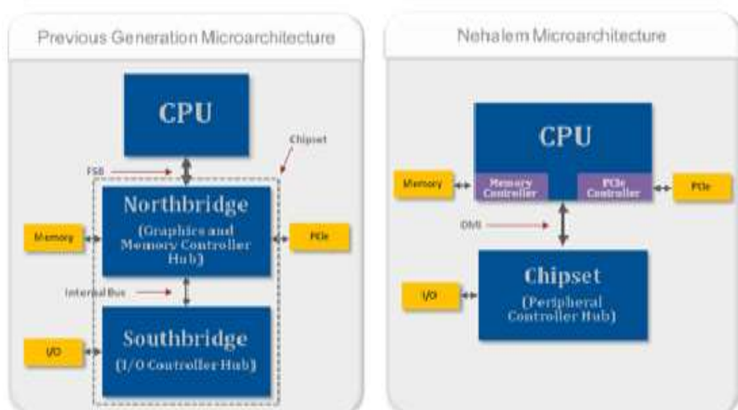

Figure1: The higher-level architectural differences between the previous generation and the new Nehalem microarchitecture for Single-processor systems.

B. Higher-Performance Multiprocessor Systems with QPI

Not only was the memory controller moved to the CPU for Nehalem processors, Intel also introduced a distributed shared memory architecture using Intel Quick Path Interconnect (QPI). QPI is the new point-to-point interconnects for connecting a CPU to either a chipset or another CPU. It provides up to 25.6 GB/s of total bidirectional data throughput per link. Intel's decision to move the memory controller in the CPU and introduce the new QPI data bus an impact for single-processor systems. However, this impact is much more significant for multiprocessor systems.

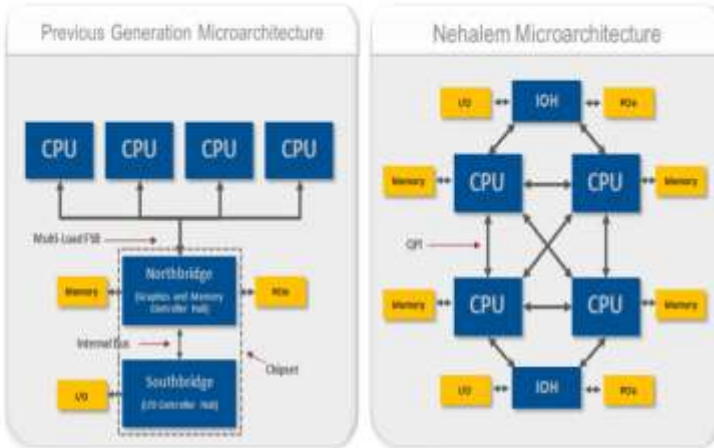

Figure2: The higher-level architectural differences between the previous generation and the new Nehalem microarchitecture for multiprocessor systems.

The Nehalem microarchitecture integrated the memory controller on the same die as the Core i7 processor and introduced the high-speed QPI data bus. In a Nehalem-based multiprocessor system each CPU has access to local memory but they also can access memory that is local to other CPUs via QPI transactions. For example, one Core i7 processor can access the memory region local to another processor through QPI either with one direct hop or through multiple hops. With these new features, the Core i7 processors lend themselves well to the creation of higher-performance processing systems. For maximum performance gains in a multiprocessor system, application software should be multithreaded and aware of this new architecture. Also, execution threads should explicitly attempt to allocate memory for their operation within the memory space local to the CPU on which they are executing. By combining a multiprocessor computer with PXI-MXI-Express to a PXI system, processor intensive applications can take advantage of the multiple CPUs. Examples of these types of applications range from design simulation to hardware-in-the-loop (HIL).

C. CPU Performance Boost via Intel Turbo Boost Technology

About five years ago, Intel and AMD introduced multicore CPUs. Since then a lot of applications and development environments have been upgraded to take advantage of multiple processing elements in a system. However, because the software investment required re-architecting applications, there are still a significant number of applications that are single threaded. Before the multicore CPUs, these applications saw performance gains by executing on new CPUs that simply offered higher clock frequencies. With multicore CPUs, this trend was broken as newer CPUs offered more discrete processing cores rather than higher clock frequencies.

To provide a performance boost for lightly threaded applications and to also optimize the processor power consumption, Intel introduced a new feature called Intel Turbo Boost. Intel Turbo Boost is an innovative feature that automatically allows active processor cores to run faster than the base operating frequency when certain conditions are met. Intel Turbo Boost is activated when the OS requests the highest processor performance state. Turbo Boost is Intel's terminology for overclocking CPUs, allowing them to run faster than their base clock speed. Both Core i7 and i5 processors support Turbo Boost.

The maximum frequency of the specific processing core on the Core i7 processor is dependent on the number of active cores and the amount of time the processor spends in the Turbo Boost state depends on the workload and operating environment. The processing cores in the quad-core Core i7 processor change to offer the best performance for a specific workload type. In an idle state, all four cores operate at their base clock frequency. If the application creates only two execution threads, then two idle cores are put in a low-power state and their power is diverted to the two active cores to allow them to run at an even higher clock frequency. Similar behavior would apply in the case where the applications generate only a single execution thread.

D. Improved Cache Latency with Smart L3 Cache

Cache is a block of high-speed memory for temporary data storage located on the same silicon die as the CPU. If a single processing core, in a multicore CPU, requires specific data while executing an instruction set, it first searches for the data in its local caches (L1 and L2). If the data is not available, also known as a cache-miss, it then accesses the larger L3 cache. Exclusive L3 cache, if that attempt is unsuccessful, then the core performs cache snooping searches the local caches of other cores – to check whether they have data that it needs. Attempt also results in a cache-miss it then accesses the slower system RAM for that information. The latency of reading and writing from the cache is much lower than that from the system RAM, therefore a smarter and larger cache greatly helps in improving processor performance.

The Core i7 family of processors features an inclusive shared L3 cache that can be up to 12 MB in size. Figure 4 shows the different types of caches and their layout for the Core i7-820QM quad-core processor used in the NI PXIe-8133 embedded controller. The NI PXIe-8133 embedded controller features four cores, where each core has 32 kilobytes for instructions and 32 kilobytes for data of L1 cache, 256 kilobytes per core of L2 cache, along with 8 megabytes of shared L3 cache. The L3 cache is shared across all cores and its inclusive nature helps increase performance and reduces latency by reducing cache snooping traffic to the processor cores. An inclusive shared L3 cache guarantees that if there is a cache-miss, then the data is outside the processor and not available in the local caches of other cores, which eliminates unnecessary cache snooping. The L3 is designed to use the inclusive nature to minimize snoop traffic between processor cores. The latency of L3 access may vary as a function of the frequency ratio between the processor and the uncore sub-system.

This feature provides improvement for the overall performance of the processor and is beneficial for a variety of applications including test, measurement and control. Each physical processor may contain several processor cores and a shared collection of subsystems that are referred to as "uncore". Specifically in Intel Core i7 processor the uncore provides a unified third-level cache shared by all cores in the physical processor, Intel Quick Path Interconnect links and associated logic.

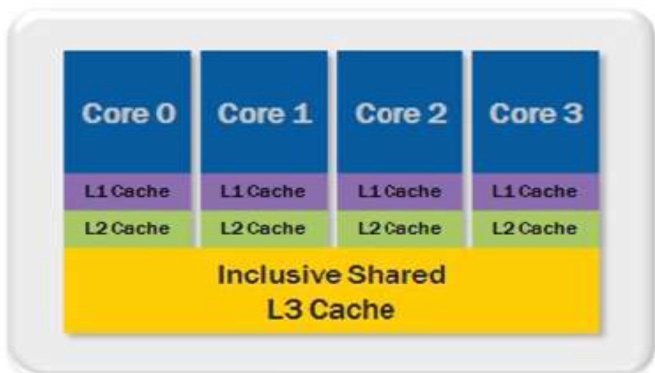

Figure 3: The Core i7 processor offers better cache latency for increased performance

E. Optimized Multithreaded Performance through Hyper-Threading

Intel introduced Hyper-Threading Technology on its processors in 2002. Hyper-threading exposes a single physical processing core as two logical cores to allow them to share resources between execution threads and therefore increase the system efficiency (see Figure 5). Because of the lack of OSs that could clearly differentiate between logical and physical processing cores, Intel removed this feature when it introduced multicore CPUs. With the release of OSs such as Windows Vista and Windows 7, which are fully aware of the differences between logical and physical core, Intel brought back the hyper-threading feature in the Core i7 family of processors.

Hyper-Threading Technology benefits from larger caches and increased memory bandwidth of the Core i7 processors, delivering greater throughput and responsiveness for multithreaded applications. Intel Hyper-Threading increases CPU performance for multi-threaded tasks and is helpful for multitasking when several applications are running simultaneously.

As discussed above, all Core i7 processors and mobile i5 processors support hyper-threading.

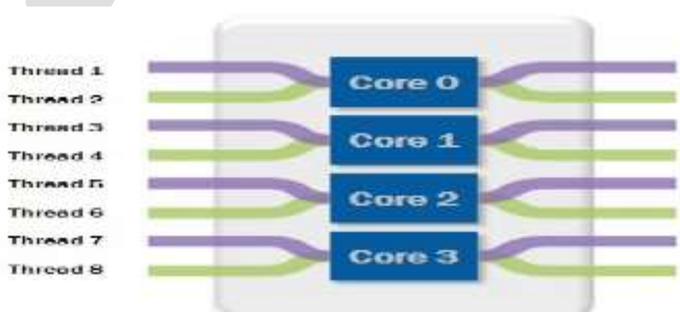

Figure 5: Hyper-threading allows simultaneous execution of two execution threads on the same physical CPU core.

F. Higher Data-Throughput via PCI Express 2.0 and DDR3 Memory Interface

To support the need of modern applications to move data at a faster rate, the Core i7 processors offer increased throughput for the external databus and its memory channels. The new processors feature the PCI Express 2.0 databus, which doubles the data throughput from PCI Express 1.0 while maintaining full hardware and software compatibility with PCI Express 1.0. A x16 PCI Express 2.0 link has a maximum throughput of 8 GB/s/direction. To allow data from the PCI Express 2.0 databus to be stored in system RAM, the Core i7 processors feature multiple DDR3 1333 MHz memory channels. A system with two channels of DDR3 4/4 www.ni.com to allow data from the PCI Express 2.0 databus to be stored in system RAM, the Core i7 processors feature multiple DDR3 1333 MHz memory channels. A system with two channels of DDR3 1333 MHz RAM had a theoretical memory bandwidth of 21.3 GB/s.

This throughput matches well with the theoretical maximum throughput of an x16 PCI Express 2.0 link. The NI PXIe-8133 embedded controller uses both of these features to allow users to theoretical stream data at 8 GB/s in a PXI Express system. Certain test and measurement applications – such as high-speed design validation and RF record and playback – that require continuous acquisition or generation of data at extremely high rates benefit greatly from these improvements.

G. Improved Virtualization Performance

Virtualization is a technology that enables running multiple OSs side-by-side on the same processing hardware. In the test, measurement, and control space, engineers and scientists have used this technology to consolidate discrete computing nodes into a single system. With the Nehalem mircoarchitecture, Intel has added new features such as hardware-assisted page-table management and directed I/O in the Core i7 processors and its chipsets that allow software to further improve their performance in virtualized environments. These improvements coupled with increases in memory bandwidth and processing performance allow engineers and scientists to build more capable and complex virtualized systems for test, measurement and control. Intel core i5 and i7 specifications are in two ways:

a) Specifications for Desktop i5 and i7 CPUs All Core i5 and Core i7 Ivy Bridge processors for desktop have 4 cores and a Direct Media Interface with Integrated GPU.

b) Specifications for Mobile i5 and i7 Processors For the mobile versions of Ivy Bridge i5 and i7 processors (used in laptops and notebooks), things are a little different. Core i5 mobile processors are dual-core and so are some i7 processors, while other i7 CPUs are quad-core. All Core i5 and i7 mobile processors support hyper-threading. So there is a smaller performance gap between i5 and dual-core i7 mobile processors. Quad-core i7 mobile processors do deliver increased performance but may sacrifice some battery life to do so.

H. Remote Management of Networked Systems with Intel Active Management Technology (AMT)

AMT provides system administrators the ability to remotely monitor, maintain, and update systems. Intel AMT is part of the Intel Management Engine, which is built into the chipset of a Nehalem-based system. This feature allows administrators to boot systems from a remote media, track hardware and software assets, and perform remote troubleshooting and recovery. Engineers can use this feature for managing deployed automated test or control systems that need high uptime. Test, measurement, and control applications are able to use AMT to perform remote data collection and monitor application status. When an application or system failure occurs, AMT enables the user to remotely diagnose the problem and access debug screens. This allows for the problem to be resolved sooner and no longer requires interaction with the actual system. When software updates are required, AMT allows for these to be done remotely, ensuring that the system is updated as quickly as possible since downtime can be very costly. AMT is able to provide many remote management benefits for PXI systems. For customers using the NI PXIe-8133, National Instruments offers a NI Labs download that enables AMT capabilities on this embedded controller.

3. THE ADVANTAGES OF INTEL i7 PROCESSORS

The Core i7 is Intel's current most powerful processor, most have clock speeds or GHz just below the absolute best Core 2 Duo processor or higher than the Core 2 Duo and unlike the best Core 2 Duo processors have larger cache (the larger the cache, the faster the processor can work), 4 physical processing cores instead of 2 and with hyper-threading 4 cores plus 4 virtual cores so almost like having 8 cores in one computer. Obviously the major difference is the amount of processing cores, the more cores your computer, the more things you can do at once on your computer but overall the i7 kills the Core 2 Duo in terms of performance. Now that does come at a price, i7 processors require DDR3 RAM which is more expensive than the DDR 2 you can get away with Core 2 Duo's, it requires more expensive motherboards and if you're buying an i7 to really take advantage of it expensive graphics cards and large power supplies are necessary as well. Bottom line, because the i7 at least matches the Core 2 Duo in most models on GHz clock speed, has 2 more physical processing cores, 4 more virtual ones (the Core 2 Duo has none) and a larger cache it is definitely a better processor all around.

4. DISADVANTAGES OF INTEL i7 PROCESSORS

Talking about the two laptop makers above, I don't see that very good Integrated Graphics is going along with the Core i7. Just something in an Nvidia GeForce 9800GT mobile GPU (Graphics Processing Unit) . But that's purely a disadvantage of the laptop makers, and not a disadvantage of the Intel Core i7. As for 'talking' about the Intel Core i7 as a whole and its new technology, it depends on what you wish to do with a computer. The Intel Core i7 is a quad core processor. Intel also brought back HT, Hyperthreading Technology. In the old Pentium 4 processors that had HT, the Operating System, (WinXP is an example of an O/S. Not trying to insult your intelligence), saw the Pentium 4 as having TWO processor cores. One was a physical, real, processor core. The other was a virtual core. If two threads are being used by EACH core of an Intel Core i7, the O/S 'sees' it as having EIGHT processor cores.

5. CONCLUSION

The Core i7 family of processors based on the Intel Nehalem microarchitecture offers many new and improved features that benefit a wide variety of applications including test, measurement and control. Engineers and scientists can expect to see processing performance gains as well as increases in memory and data throughput when comparing this microarchitecture to previous microarchitectures. Intel Core i7 processor is Intel's first CPU designed based on **Nehalem micro architecture**. This processor is ideal for computer 3D games, multitasking and multi-threading applications. The main thing to remember is that i7 CPUs are at the high end of the product line, i5 CPUs are in the middle, and i3 CPUs are entry level. The Intel Ark is one way to, and it allows you to select multiple CPUs to compare side by side. Additionally, if you are in the market for a new computer based on these CPUs, our sales staff is always happy to answer questions at sales@pugetsystems.com. This gives you a decent starting place to look for a CPU based on what you will be using your computer for, but you will likely need to look at the individual specs for multiple CPUs to determine which is actually the right fit for you. While there are a few things that the i3/i5/i7 naming scheme tells you, it is really no substitution for actually looking at the specifications of individual CPUs.

REFERENCES:

[1] Series Datasheet, "Intel® Core™ i7-900 Desktop Processor Extreme Edition Series and Intel® Core™ i7-900 Desktop Processor", Volume 2
[2] http://ark.intel.com/
[3] http://ark.intel.com/products/family/79318/Intel-High-End-Desktop-Processors#@Desktop
[4] http://ark.intel.com/products/family/65504/3rd-Generation-Intel-Core-i5-rocessors#@Desktop
[5] http://www.intel.in/content/dam/doc/product-brief/performance-core-i7-processor-brief.pdf
[6] http://www.intel.in/content/dam/doc/product-brief/core-i7-ee-brief.pdf
[7] http://download.intel.com/pressroom/kits/corei7/pdf/Core%20i7%20Product%20Brief.pdf
[8] http://ark.intel.com/products/family/75023/4th-Generation-Intel-Core-i7-Processors#@All
[9] http://www.intel.com/products/processor/core2duo /index.htm?iid