Multi- Core Processor : Overview and Challenges

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ABSTRACT : Multi-Core processor represents an evolution changes in converting computing as well setting the new trend for high performance computing(HPC). The move towards chip-level multi processing architecture with a large number of cores continue to offer dramatically increased performance and power characteristics .Nonetheless , this moves also presents significant challenges wand discuss the advantage sad disadvantages. This paper describe how far the industry has progressed and evaluate some of the challenges we are facing with the multi- core processors.

KEYWORD:- *Multi-core processor, Core, Homogenous,Heterogenous;*

1. Multi -Core Processor

Multi-core is usually the term used to describe two or more CPUs working together on the single chips .It refers to an architecture in which a single physical processor incorporate the core logic of more than one processor. A single integrated circuit is used to package or hold these processors. Also called multi-core technology , it is a type of architecture where a single physical processor contains the core logic of two or more processor. These processor are packaged in Single Integrated Circuit(IC).These single integrated circuits are known as a **die**. Multi core architecture places multiple processor cores and bundles them as a single physical processor. The objective is to create a system that can complete more tasks at the time, thereby gaining better overall system performance.

Multi-Core can also refer to multiple dies packaged together . Multi- core enables the system to perform more task with a greater overall system performance.This technology is most commonly used in multi-core processor,where two or more processor chips or core run concurrently as a single system. Multi-core based processors are used in mobile devices ,desktops, workstations and servers.

Multi-core capability provides two or more complete sets of execution resources to increase compute throughput.Multi-core platforms provide the next generation of performance, cost-efficiency and business value.

2. Architecture

Multi-core architecture entails silicon design engineers placing two or more execution core, or computational engines, within a single processor package. This multi- core processor plugs directly into a single processor socket, but the operating system perceives each of its execution core as a discrete logic processor with all the associated execution resources.

Generally, architecture of multi-core classified as:-

• Homogenous :- use one core design repeated.

- Heterogeneous:- use a mixture of different cores ,each optimized for different roles.
  Multi core chips do more work per clock cycle , are able to run at a lower frequency and may enhances user experience in several ways such as improving performance of computer and bandwidth intensive activities.The architecture of a multicore processor enables communication between all available cores to ensure that the processing tasks are divided and assigned accurately. At the time of task completion, the processed data from each core is delivered back to the motherboard by means of a single shared gateway. This technique significantly enhances performance compared to a single-core processor of similar speed.

3. What Is Core?

A core is usually the basic computation unit of the CPU that handles the mathematical and logical operations. In **Laymens Ternas,** we can say core takes high level machine instructions and the decodes them into physical circuit operations and collection of such "cores" with supporting hardware makes a CPU.

Now we distinguish between cores, processors and nodes.

Cores = central processing units, including the logic needed to execute the instruction set, registers & local cache.

Processors = one or more cores on a single chip,in a single socket, including shared cache and network and memory access connections.

Node = a board with one or more processors and local memory, network attached.

4. Difference Between Single Core And Multi Core Processor.

Single Core Processor	Multi Core Processor
Processor use one core to process operation.	Processor use more then two cores to process different operations.
A single core slow then dual and multicore.	Multicore system is faster than single core processor.
Use less power.	Use less power then single core processor.
Less heat generated.	More heat generated.
Good battery life.	Lower battery life.
Example:-Pentium 4670.	Example:-Intel Core i5-2400.
Single Core Processor has 78GHz operating frequency.	4GHz operating frequency.
Chip package data rate is 78Gb/s	4Gb/s.
Bandwidth is 125GByte/s.	1TeraByte/s.
Total number of pins on chip is 3840.	9000(estimates).

5.Technical Factors of Multicore Processor.

Since computer manufacture have implemented Symmetric Multiprocessing(SMP) deigns using discrete CPUs, the issues regarding implementing multi core processor architecture and supporting it with software are

- Using a proven processing core design without architectural changes reduces design risk significantly.
- Motivation for multi-core processors comes from its performance gains in processor. This is due to 3 factors

  # THE MEMORY WALL:- the increasing gap between processor and memory speeds. This pushes the catch size .

  # **THE ILP WALL** :- The increasing difficulty of finding enough parallelism in a single instruction stream to keep a high performance.

  #THE POWER WALL:- The trend of consuming exponentially increasing power with each factorial increase of operating frequency.

Multi-core architectures are being developed but so are the alternatives.The basic development process and some tips on how to decide on a multicore programming model based on the type of programing require for some given application space.

6.Advantages Of Multicore Processor.

- **Multicore integrates all the CPUs on a single chip.So the communication between different CPUs generally reduced .Multicore provides many advantages few of them are discuss below.**
- **Multi-core processor will work faster for certain programs,since it use one single chip to contain all CPUs.**
- **Multi-core may not get as hot when it is turned on.**
- **It needs less power because it can turn off some sections if they aren´t needed.**
- **The multiple CPU cores on the same die allows the cache coherency circuitry to operate at much higher clock rate.**
- **The signals between different CPUs travel shorter distances, therefore they degrade less.**
- **Combining equivalent CPUs on a single die significantly improves the performance of cache snoop operations.**
- **Signals between different CPUs travel shorter distance and therefore those signals degrade less.**
- **Multi core make use of proven CPU core library design and produce a product with lower risk design error .**
- **They drive multithreading and parallelism at a higher level and provide it to mainstream computing .**

- **Multi-core processors can execute completely separate threads of code, a number of different usage models are possible.Two applications can execute simultaneously.**
- **Concurrent workloads can be virtualized or a fault isolation and failover implementation can be employed. Additional threads can be utilized for background applications such as virus protection, security, compression, encryption and synchronization.**
- **Multi-core processors can be used to facilitate even more effective server consolidation.**

7. Disadvantages Of Multi-Core Processor.

- Multi-Core processor have only 60-80% more speed then normal processor.
- Multi -core processor are costly than single core processors.
- They are more difficult to manage thermally than lower-density single-core processors.
- This feature is not supported by all operating systems .
- Operating systems compiled for a multi-core processor will run slightly slower on a single-core processor.
- The number of the transistors implemented in a dual CPU is doubled Vs a single core processor, but even with this transistors count, the new designs enables the processor to operate within the same or even a reduced power envelop.
- Many applications will experience significant negative multi-core processor performance impacts unless optimized to account for them.
- Where run times are the critical constraint and processor utilization is less critical, running singlecore density can help performance. The scheduler can support single-core runs.

8. Multi-Core Challenges.

Multi -Core on a single chip give rise to many challenges .

POWER AND TEMPERATURE

If two cores were placed on a single chip, consume twice as much power and generate a large amount heat. To account multi-cores runs at a lower frequency to reduce power consumption. Many design also incorporate a power control unit that shut down unused cores or limit the amount of power.

To account for heat generated by multiple cores on a single chip, the chip is architecture so that the number of hot spots dose not grow too large and heat is spread out across the chip.

CACHE COHERENCE

Cache coherence is a concern in a multi- core environment because of distributed cache. Since each core has its own cache, the copy of data in that cache may not always be most up to date version. One core writes value to specific location;when the second core attempts to read that value from its cache it will not have the updated copy unless its cache entry is invalidated and

a cache miss occurs. If this coherence policy was not in place garbage data would be read and invalid results would be produced.

- **MULTITHREADING**

Rebuilding applications to be multithreaded means a complete rework by programmers. Programmers have to write applications with subroutines able to be run in different cores meaning that data dependies will have to be resolved . Applications should be balanced.

9.Conclusions

Multicore processors are being accepted in all segments of the industry for more performance and general-purpose programmability . The implementations of multicore processors are numerous and diverse. Designs range from conventional multiprocessor machines to designs that consist of a "sea" of programmable arithmetic logic units (ALUs). In this article, we cover some of the attributes common to all multicore processor implementations and illustrate their advantages and disadvantages.Multi- core processors become the standard for delivering greater performance, improved performance per watt, and new capabilities across desktops, mobile and server platforms.

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