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An Overview of Multi Core Processors

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Abstract: A multi-core processor is a component which computes with two or more cores, which are the independent processing unitsand read and execute programming instructions. Addition of parallelism, Concurrency, Synchronization, Hyperthreading have enormously increased processing power of computer system. [1,2] This paper gives briefing upon evolution of multi-core processors and its performance over single core processors.

Keywords:- *Microprocessor, Core, Processors, multithreading technologies, High performance computing(HPC).*

I. INTRODUCTION

For surviving in today's competition market, several industries started to focus on manufacturing faster and smarter chips. The inclination of increasing a processor's speed, to get a boost in performance is a way of the past. For increasing the speed, several techniques were used, clocking the chip at higher frequency is one of them.

This is why parallel processing techniques are used which include data and instruction level parallelism. This technique was very beneficial as compared to previous one. Afterwards, Multi core processor came into consideration as a new technique. As the number of cores increased, the performance started to increase as well. It also uses the concept of parallel processing and also provides several facilities. So, this is the most popular processor which is still in use.

II. SINGLE CORE PROCESSORS

A single core processor consists of an integrated chip with one Control Processing Unit (CPU). Microprocessors have been single core since their commencement in the late 20th century. After the completion of thisperiod, chips with multiple (more than two) CPUs developed. A processor or microprocessor is a small chip that resides in computer and other electronic devices. It is considered as the intellect of a computer. Its elementary job is to get the input and deliver the suitable output. Although, this may appear to be a simple task, modern processors can handle trillions of calculations per second.

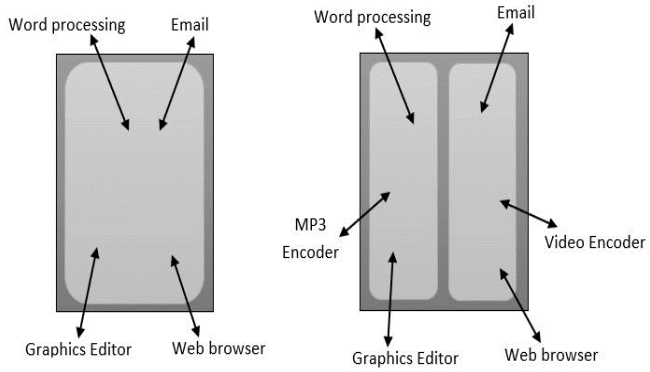

Fig 1:- Single Core Processor

III. MULTI CORE PROCESSORS

"A Multi-core processor is typically a single processor which contains several cores on a integrated chip".[3]

A multicore processor is a processor which contains numerous chips embedded in a single processor. The main source of its popularity isits very high performance. It is because of having the parallel processing technique which was absent in single core processor. The input to a core of CPU is just the ordinary CPU instructions like add, sub, mul, div and mov. There are CPUs of different core levels – two cores, four cores, six cores, eight cores, ten cores and more.

There are two types of multi-core processors. They are Homogenous multi-core processors and Heterogeneous multicore processors.

The processors in which all the cores manufactured with identical core are called Homogeneous multi-core processors. The processors that use different features are called Heterogeneous multi-core processors.

Embedded systems, data, web server or web commerce, signal processing, CAD/CAM, image processing, networking and graphics are among the most important applications of multicore processors.

Multiple cores which are present on processor combine themselves to give a great performance but it doesn't mean that each core has a same performance. They can be same or may not be same. But overall, they maintain their performance and give better results. It can be judged by executing the programs on a single core & multicore processor. Single core processors

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running multiple programs would assign time slice to work on one program and then assign different time slices for the remaining programs. There are several benefits using the multicore. If execute the program on single processor then it will be done by time slicing of each process and if any one of them has consumed more time then rest will also be processed late but due to having a concept of parallel processing technique in multi core if one is late then also all other tasks will not be as shown in figure 2.

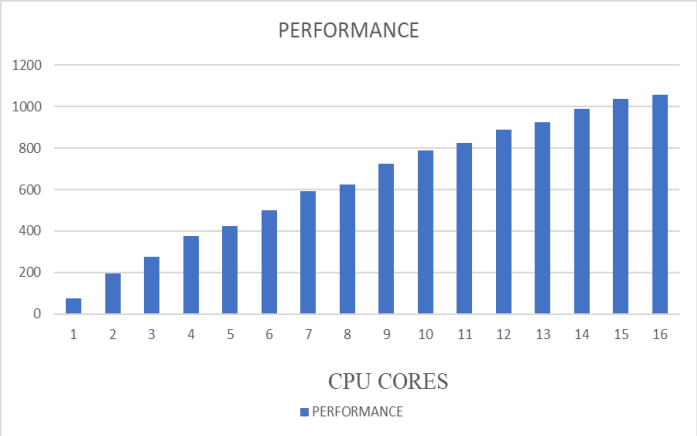

Fig 2:- Performance of increasing no. of cores

2 key factors determining the power of processor:

- Number of cores.
- Frequency.

A processor is able to execute multiple tasks simultaneously. For example, music can be listened while surfing the web on your computer. Multi core

processor has its own execution time for each process or task in milliseconds. It is so fast that it cannot be recognized while the execution. It looks like all the tasks are performed at the same time singly. Number of cores is an important key factor for their performance. This performance is totally dependent upon the capability of cores to execute the programs which makes it more energy efficient and low power consuming cores as shown in the figure 3.

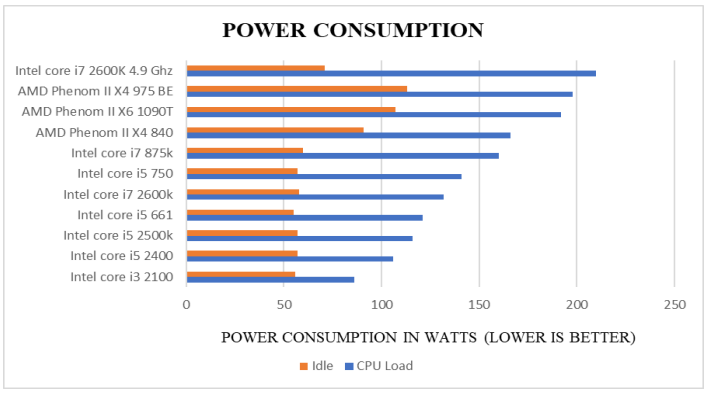

Fig 3:- Power Consumption

Multicore processor has been designed in pattern of separation so that unused cores can be powered on or off according to the need so as to govern power dissipation. These can use homogenous or heterogeneous core according to the necessity of the application. In the case of homogenous microprocessor, every core present in the CPU is identical in nature. This type of processor uses partitioning and applying different methodology so that massive applications can be managed as smallapplications which can be further executed using parallel processing technique. It includes the features like cache, message passing system, threading, share memory and resources, reduces design complexity, reusability, reduces verification effort and it makes easier to fulfill the requirement of the market. In the case of heterogeneous cores, it consists of focused applications specific processor cores which would perform the aimed task so that issue of different variety of applications running on the computer can be easily executed. In case of sequential programming, multi core processor is notvery beneficial because theircompilers are developed to use parallel processing so that multiple tasks can be performed on different cores.

IV. COMPARISON BETWEEN SINGLE CORE AND MULTI CORE PROCESSORS

A. *Processor Tasks Analysis*

In today's computing world modern operating systems such as Windows XX, Linux or Mac OS X comprise of many processes taking place at the same time. For example, one process manages memory resources, another sends documents to a printer for printing, and the third checks for interrupt which thorough different attached input and output devices. In addition to operating system tasks, the processor also runs Web browser, video player, real time clock and other application programs.

B. *Memory Bandwidth Utilization*

Even though a multi-core processor has numerous CPUs, they share other components, such as RAM (Random Access Memory). Memory bandwidth is the rate at which the processor chip accesses data in RAM.There may occur a blockage when all the processors need to read the information and store the results simultaneously.

	Single Core	Multicore
Power (W)	429.78	107.39
V_{add} (V)	1.0	1.0
I/O Pins	1280	3000
Operating Frequency (Gb/s)	7.8	4
Bandwidth	125 GigaByte/s	1 TeraByte/s
Total no. of pins on chips	3840	9000

Table 1. Single Core VS Multi Core Processor

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V. VERSIONS OF PROCESSORS

- CORE DUO
- CORE SOLO
- CORE 2 SOLO
- CORE 2
- CORE 2 QUAD
- CORE 2 EXTREME
- CORE i3
- CORE i5
- CORE i7

VI. MAJOR PROBLEMS FACED BY MULTI CORE PROCESSORS

The Multicore processor technologies are leading at the present time but it needs some improvement in the programming model so that it can be used in the scientific and engineering application according to their environment in the future. System software for multicore processors should use all the core capabilities and also should deal with non- uniform memory hierarchies in deep. The necessity of changing the platform on which multicore processor is based needs to be raised. Due to increasing number of cores the density of multi core processor is also being increased which increases the need of energyawareness which becomes odd with high performance.

A. Power and Temperature management

If two cores are placed on a single chip without any modification, theoretically, the chip should consume twice as much power and generate a large amount of heat. In order to reduce the power consumption, use the multiple cores at a lower frequency with a number of smaller cores. Each discrete core delivers lower performance than a large complex core instead of integrating multiple complex cores on a die include a power management unit that has the authority to shut down unused cores or limit the amount of power. The chip is manufactured so that the number of hot spots does not grow too large and the heat is spread out across the chip. The processor comprises of a common trend to include temperature monitoring into the system, with its Temperature management unit.

B. Cache coherence

Cache coherence is a feature in a Multicoreenvironment because of the distributed L1 and L2 cache. Since every core has its own cache, the duplicate copy of the data in that cache may not always be the most updated version as per alteration due to several transactions. Garbage data would be read and result in invalid results which can crash the program or the entire computer system if a coherence policy was not in place. Over-all, there are two schemes for the cache coherence, this first one is a snooping protocol and the second, a directory-based protocol. The snooping protocol only works with some bus-based systemoperations. The directory-based protocol can be used on an arbitrary network and is, therefore, scalable. In this scheme a directory is used that holds information about which memory locations are being shared in multiple copies. Snoopy based protocols, have an alternative called directory-based protocols, which achieve low latencies and high bandwidth because of broadcasting and this protocol is executed in current day technologies like in Intel Core2Duo processors.

C. Multithreading

Multithreading or other equivalent processing practices to get the best performance out of the multicore processor is the most important matter. Transformation of applications to be multithreaded means a complete redraft by programmers in most cases to write applications with subroutines able to be run in different cores.

Applications must be stable. All the cores should be used equally used or else the programmer is not taking full advantage of the multicore system.

VII. FUTURE SCOPE

The future of multiprocessor performance is very bright. But optimizations are still needed in order to get most out of the existing advances in technology. In order to maximize the performance, it has been seen that the serial and parallel phase of a software programs must be equal. The future lies in the watchful and intelligent strategy of Heterogeneous Chip Multiprocessors. The advantages of Heterogeneous Chip Multiprocessors clearly outweigh that of Homogeneous Chip Multiprocessors. It will just be a matter of time before the microprocessor architecture moves to a whole new direction in microprocessor design, just like the jump from single core processors to multi core processors.

VIII. CONCLUSION

We lead to a conclusion that multi core processor will be beneficial in the case of big applications which will deal with a huge amount of data &instructions. This processor uses a parallel processing technique which is helpful for increasing the performance during the execution of software program. It made a radical change in the architecture of application programs. According to the application, several multicore processors have been designed. The concept of multithreading has also been introduced for using the same core at the time processing. Power and frequency limitations observed on single core implementations. In spite of various advantages, we have seen the several challenges faced by this microprocessor during the use of multi core processor. And lots of steps were taken for removing the issues but most of them of them still persist till this day.

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