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Performance Analysis and Parallelism of Multi-Core Processors

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Abstract: **-- After many years of single core processor's dominance in the computing industry, multi-core central processing units (CPUs) have gained popularity due to their high performance. The critical levels of CPU performance include the different levels of parallelism, architectures, and it is therefore, critical to analyze the multi-core designs to ensure that the performance is in line with the expected specifications. This research paper is a detailed overview of the multi-core processors, parallelism and the performance measurement of the CPUs with more than one core.**

I. INTRODUCTION

Performance Analysis and Parallelism of Multi-Core Processors Analyzing the behavior and architecture of multi-core processors is critical in understanding their performance. The single-core CPU have a single core in its processor. As the pioneer CPU in the computing industry, the use of a single core CPU is on the decline due to the development of more advanced CPU processors (Chhibber & Garg, 2014). As compared to the latest CPU chips, single-core chips use less energy and produces less heat. Despite these advantages, the hardware runs slow and often freezes when the user opens many programs simultaneously. To address these shortcomings, Multi-Core Processors were developed and computer making companies are now using these powerful core processors to address the increasing demand for more powerful computers. Multi-Core Processors allows more than one core to run at slower speeds and lower temperatures (Chhibber & Garg, 2014). As opposed to the single core processors, the new chips supports multiple execution pipelines with each having the resources required to run without interfering with the resources needed by the other software threads (Mohanty, Turuk, & Sahoo, 2012). More of these, they can execute multiple instructions, process multiple data and share the same memory. Each multi-core design contains more than one processor packaged as one, with the aim of enabling the system to run more tasks simultaneously to achieve higher system performance.

The different types of multi-core processors are the Dual Core CPU and Quad-Core CPU. The dual-core CPU has double execution cores within a single circuit, whereby the two cores work as a single unit, but each has its own controller and cache to increase the processing speed (Chhibber & Garg, 2014). They perform tasks faster at reduced costs, but also waste a lot of power and requires the software to be customized for a dual-core CPU, which increases the costs of software installation. On the other hand, The Quad-Core CPU has 4 processors and there are more variations depending on the manufacturer. For instance, some chips may shared caches, and it is also possible to have homogeneous or heterogeneous multi-core systems (Mohanty, Turuk, & Sahoo, 2012). The Quad-Core CPU supports multitasking, runs intensive applications, there is minimal heat and power usage and these computers can be used for long term. Regardless of these strengths, The Quad-Core CPU lowers battery life, requires customized software, and it is incompatible with some hardware.

TYPES

There are different technologies used to execute multiple programs. Every program has an execution thread (Venu, 2012). The development of operating systems has led to multi-tasking where one program could be put to a halt while another one is running and a quick swap of these programs gives an appearance of running many programs simultaneously (Chhibber & Garg, 2014). Over the years, the processor design has been developed to support more instructions in parallel, also known as Hyper-Threading (HT). Furthermore, programs with multiple threads could improve their performance by 30% (Ogundairo & Omosehinmi, 2015). The high-performance speed achieved by multi-processors leads to a high power consumption.

Furthermore, since the multi-core CPUs uses parallelism to improve performance, it is paramount to understand parallelism while analyzing the performance. The instruction-level parallelism (ILP) involves executing the different programs together, and this could improve the

performance based on the instruction mix selected (Chhibber & Garg, 2014). The common types of ILPs used in the modern computers are the out-of-order execution, address speculation and prediction among others. Thread-level parallelism (TLP) executes the individual task threads fed to the CPU together while Data-Level Parallelism involves sharing the data through memory coherence, thus improving the performance by reducing the loading time and access memory (Park, Wang, Jayasinghe, & Kanemasa, 2013). The popularity of computers and the increased demand for high performing computers have driven the need for performance analysis.

There are different methods of evaluating the multi-core CPU performance. The first step is formulating the evaluation technique through measurement, simulation, and analytical modeling. The choice depends on different factors, and more than one technique should be used to measure the final performance (Roy, Xu, & Chowdhury, 2008). Performance metrics are the measurement units of CPU activity, and the choice depends on the services provided by the system in question. Some of the common metrics include Higher is Better (such as throughput), Lower is Better (such as the execution time) and Nominal is Best (such as power usage) (Gummadi & Shanmugasundaram, 2011). These metrics are founded on the criteria of time, rates, and the available resources.

In addition, there are different factors which affect the system performance, which also largely depends on the projected performance of the CPU to give the expected outcomes. These are the memory architecture used, memory speed, scalability which is dependent on the rate at which workload increases, I/O bandwidth, the interaction between cores in multi-core CPU's, the nature of the operating systems, CPU clock speed, type of CPUs and Cache coherence (Pa, 2016). These are just but some of the factors, which determines the performance of the multi-core CPUs.

II. CONCLUSION

In conclusion, modern computer performance has improved a lot. The increased demand for faster and power efficient multi-core processors have spurred innovation in this field of technology. To enhance the measurement of system performance, there is the need to evaluate the system based on the expected outcomes.

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