ALBUKHARY INTERNATIONAL UNIVERSITY
SCHOOL OF COMPUTING AND INFORMATICS

CCC1133
COMPUTER ORGANIZATION AND ARCHITECTURE

GROUP ASSIGNMENT (20%)

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PART A	MARKS		PART B	MARKS
50 MARKS			50 MARKS	
TOTAL (100)				

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Introduction

The processor or Central Processing Unit (CPU) is the heart of any computer system. The CPU's primary function is to execute instructions provided by the operating system and software applications. The CPU plays a crucial role in the overall performance of a computer system. This is why CPU technology continues to advance. Therefore, the CPU is considered one of the most important components in a computer system, and its performance can have a significant impact on the overall performance of the computer. In summary, it is important to learn about the history, evolutions, architecture and designs to truly understand the role of CPU in the modern times.

History and Evolution of Processor

A. History of Processor

The history of processors is a mere extension of the early history of computing hardware. The history of processors shows the way they evolved in terms of form, design, implementation, and functions as follows.

The Intel 4004 is the first commercial microprocessor that was released in 1971. It was designed by Ted Hoff and Federico Faggin of Intel and Masatoshi Shima of Busicom. Intel 8008 was developed by Victor Poor and Harry Pyle of CTC, and Ted Hoff, Faggin, Stanley Mazor, and Hal Feeney from Intel. It is also known as MCS-8 and was launched in April 1972. The Intel 8080 was launched in April 1974, Intel 8086 was developed in 1978 and the development team for architecture consisted of Stephen P. Morse and Bruce Ravenel. The clock speed was 10 MHz.

Intel 8088 was launched on 1 July 1979 and based on the new HMOS technology. The frequency was designed with 10 MHz. In 1987, Sun Microsystems developed SPARC. The designed clock speed was 40 MHz. It consists of 1.8 million transistors with 256 I/O pins. Am386 was built in 1991. It had a clock speed of 40 MHz and was a competitor to Intel. The excellent performance of AMD made it the second-best choice after Intel for many manufacturers.

In 1993 the Pentium family started with the launch of the P5 processor. It was released on March 22. In 1995, Pentium Pro was the first processor of the Pentium II series. It came with a clock speed of 200 MHz.This processor was built with approximately 5.5 million transistors.Pentium II released on 7 May 1997, This processor comes with a slot or socket module. This made it simple for users to use computers in limited space. Pentium III successor was launched on 26 February 1999. It was launched in Celeron (Low-end version) and Xeon (High-end version).

Athlon is under AMD and it was released on 23 June 1999. The first processor reached the speed of 1 GHz and the competitor of Intel Pentium III because it was faster. Pentium IV processor was Intel's new single-core processor family issued in 2000, with clock speeds from 1.3 GHz to 3.08 GHz. In 2003, Pentium M was released and was a mobile single-core processor from Intel. It achieved a clock speed of 2.26 GHz. Intel Core 2 was also known as E6320 and it was released on July 27, 2006. Since 2011, the processor has been removed from the price list.

B. Evolution of Processor

As we trace the history of the microprocessor, we look at its evolution and the forces that pushed it forward. Microprocessors can be classified into five generations that have their characteristics.

1. **First Generation Microprocessor (1971-1973)**

   The size of microprocessors is 4-bit. These microprocessors processed instructions serially, fetching the instruction, decoding it, and then executing it.

2. **Second Generation Microprocessor (1974)**

   The second generation shows the beginning of very efficient 8-bit microprocessors. This technology, instructions, speed, execution, and chip density have increased fivefold from the first generation.

3. **Third Generation (1979)**

   This microprocessor generation differed from previous generations in that all major workstation manufacturers began developing their own RISC-based microprocessor architectures. Microprocessors with 16 bits progressed in this era.

4. **Fourth Generation (1981)**

   This era shows the beginning of 32-bit microprocessors. Microprocessors can issue and retire more than one instruction per clock cycle.

5. **Fifth Generation (1995)**

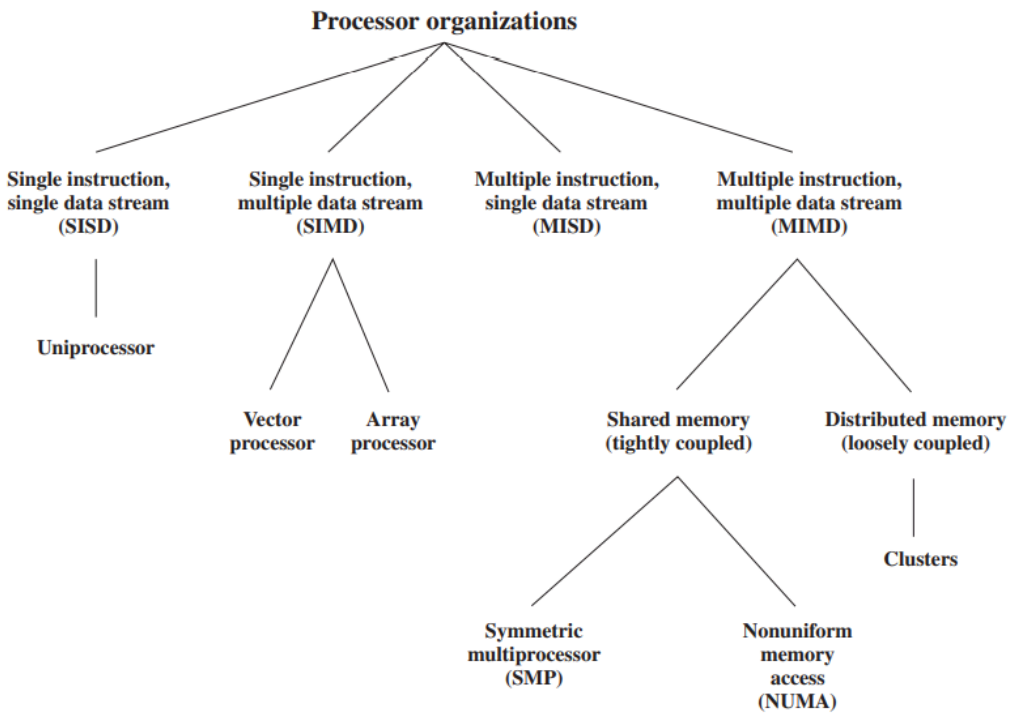
   Fifth-generation microprocessors used decoupled superscalar processing. In this generation, the focus is on introducing chips with on-chip functionalities, in addition to improvements in the speed of memory and I/O devices, as well as the introduction of 64-bit microprocessors.

Architecture and features of multiprocessor and multicore

A. Architecture and features of Multiprocessor

A data processing system with several processors can run many programmes or mathematical operations consecutively. Another name for it is a multiprocessing system. Similar to multiprogramming, which enables the use of several threads for a single task, multiprocessors use more than one processor.

The phrase "multiprocessor" can also refer to multiple independent computers operating in parallel. It's also known as clustering.



Only when two or more components that can execute instructions independently are present in a system can it be referred to as a multiprocessor system. In a multiprocessor system, a distributed strategy is used. In the distributed approach, no work is fully completed by a single processor. Instead, the subtasks are performed by many processors.

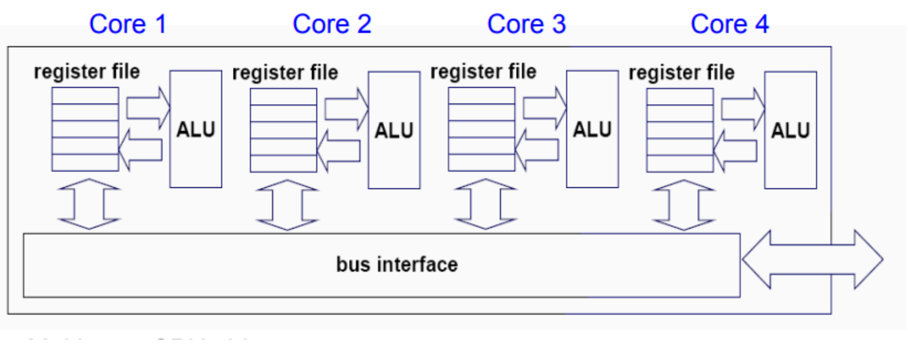
Feature of Multiprocessor

- **Parallel Processing** : This implies the simultaneous usage of numerous processors. These processors have a single architecture and are made to do a specific purpose.
- **Distributed Computing**: An interconnected processor network is necessary for this distributed processing. This network's processors can be viewed as standalone computers with problem-solving capabilities. Each of these distinct processors is often given a different job.
- **Pipelining** : this approach separates a task into a number of smaller tasks that must be finished in a specific order. The functional units support each subtask. All of the serially connected devices operate simultaneously.

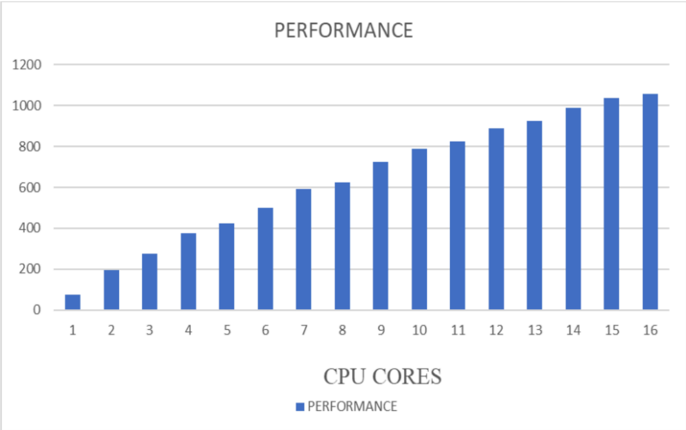
B. Architecture and features of Multicore

Multicore architecture is a general purpose processor that contains multiple cores on the same die and can execute programs simultaneously. A multicore is a single computing component with two or more independent actual processing units called “core” which are units that read and execute program instructions.

The instructions are ordinary CPU instructions (such as add, move data, and branch), but the multiple cores can run multiple instructions at the same time, increasing overall speed for programs amenable to parallel computing. Manufacturers typically integrate the cores onto a single integrated circuit die or onto multiple dies in a single chip package.



There are several benefits using 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 this figure



A processor is able to execute multiple tasks simultaneously. For example, music can be listened to while surfing the web on your computer. Multicore processor has its own execution time for each process or task in milliseconds. It is so fast that it cannot be recognized during the execution. It looks like all the tasks are performed at the same time singly. Multicore are widely used across many application domains, including general-purpose, embedded, network, digital signal processing (DSP), and graphics (GPU).

Comparison of multiprocessors on the market

A. Past

Multiprocessing was the development of what are now known as numerous computer systems. That machine's D-825 operating system was one of the earliest general support operating systems. The origins of today's multiprocessor computing may be discovered in early studies on what were then dubbed multiprocessor computers.

B. Current

Auerbach identified 45 out of the 158 models included in a recent international study of the architectural features of medium and large scale systems as having the hardware ability to create a multiprocessor. It is crucial to note that not all of the systems included in the Auerbach research or the author's own table of the characteristics of contemporary systems have had the availability of a multiprocessor operating system confirmed.

Comparison of multicore on the market

Today, multicore architectures are an inflection point in mainstream software development. Intel and AMD, the top industry rivals, have already introduced dual-core and quad-core chips for desktop PCs. And that's just the start of a trend that could bring an important change to PCs: multicore processing. Intel currently uses Core Duo (based on Pentium M), Core 2 Duo and Xeon (based on Core) microprocessors with dual-core technology for low-end computers. Besides increased processor speed, one of the primary differences between the Intel's Core Duo and the Core 2 Duo is an increase in the amount of the shared Level 2 cache.

The Core 2 Duo has doubled the amount of on-board cache to 4 MiB. Both chips have 65 nm process technology architecture and support a 667-1066 MHz front-side-bus (FSB). The AMD's first desktop-based dual core processor family the Athlon 64 X2 can be distinguished from Intel's early dual-core design, as the X2 mated two cores into a single chip, rather than two chips on a single package. Intel's method with the Pentium D may have had theoretical yield advantages, but it gave up some performance advantage since interprocessor communication still happened over external pins, rather than internally. The X2 improved upon the performance of the original Athlon 64, especially for multi-threaded software applications (Laurianne, 2005)

Future trends and design issues of multiprocessor and multicore

A. Issues in multiprocessor scheduling

There is a task force in parallel programming made up of many tasks. Performance is boosted during scheduling because the processor is given the ready task. A shared variable or message passing is used to communicate between processes, which may be one programme or several. It can be challenging to schedule a processor in a multiprocessor system. Therefore, the three challenges in multiprocessor scheduling are as follows.

1. **Cache Corruption**

   Initially, there was a very high miss ratio when the processor was switching to another task; this issue is known as cache corruption. If multiple tasks are successfully running on different applications processors, that means for every task switch, data needed by the previous task must be flushed or purged from cache and new data should be brought into cache for new tasks.

2. **Context Switching Overheads**

   There are numerous instructions that must be executed in order to store and save registers, initialise registers, switch address spaces, etc. during context switching. As a result, programmes' execution progress is automatically slowed down.

3. **Spinlock Inside Preemption (Controlled Critical Section)**

   When additional jobs are spinning the lock to enter the same critical section when a task is already inside one, preemption of that task occurs. Because they keep spinning until the preemption work is rescheduled and the key section execution is finished, these tasks waste CPU cycles.

B. Challenges of multicore systems

Since multicore systems include several processors, it is necessary to keep them all active in order to maximise the usage of the system's many computational cores. For parallel computation to be possible, scheduling techniques must be built to utilise many processing cores. The difficulty lies in adapting multithreaded programmes, both old and new, to benefit from multicore systems.

The difficulty lies in carefully examining the work to identify regions that can be split into distinct, concurrent subtasks that can run concurrently on individual processors to fully utilize multi-core system.

1. **Divided Activities**

   To make full use of multiple computing cores, the challenge is to analyze the problem properly to find areas that can be broken into separate, concurrent subtasks that can be executed parallelly on individual processors.

2. **Balance**

   It is important to establish equality when breaking the task up into smaller assignments so that each one completes roughly the same amount of work.

3. **Data splitting**

   The work must be broken into smaller subtasks, and the data it accesses and manipulates must likewise be split up to operate on various cores so that each subtask can readily access the data.

4. **Data Dependency**

   It's possible that one smaller sub-task depends on the information from another sub-task since separate smaller sub-tasks execute on different cores.

5. **Testing and Debugging**

   Testing and debugging such concurrent activities is more complex than testing and debugging single threaded applications when several smaller sub-tasks are running simultaneously.

Conclusion

In summary, computer organisation and architecture are both important parts of study in computer science as “it is necessary to provide the student with a basic set of concepts about the hardware, the software, and the interface and relationship between them” (New Calazans, 2001). This includes studying components like the processor or known as CPU, which are the main components of a computer. The project has allowed students to study multiple topics about CPU such as history, evolutions and the future trends.Therefore, there is no doubt that the CPU and computers will continue to evolve and remain an important role in the present day and the future.

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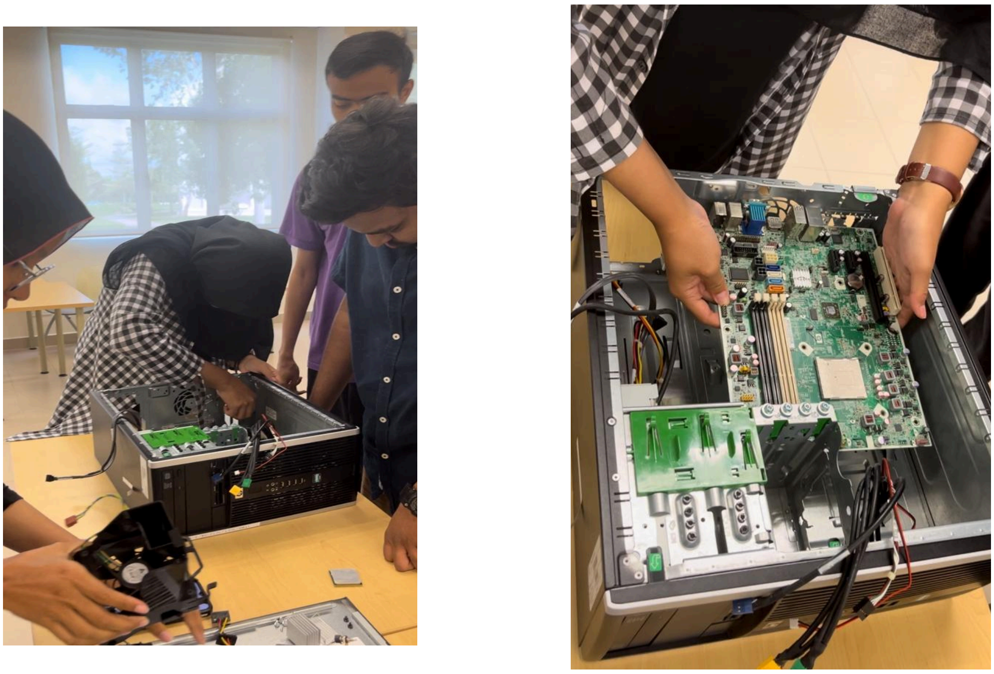
APPENDICES



<Process dismantle of CPU>

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