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Subject: المعالج والحاسبة الدقيقة

المحاضرة 4

Relationship Between Registers and Memory

: اعداد

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Difference Between Registers and Memory

The significant difference between registers and memory lies in the way the two store the data and instructions for CPU utilization. In simplest terms, a register stores the instructions which the CPU currently processes. While memory stores the data and instructions that the processor while operation may require.

The instructions/programs held on a temporary basis by the register and memory are used by the processor to perform program execution efficiently.

Before dealing with the detailed description of the difference between register and memory have a brief idea about –

What is CPU?

CPU, the abbreviation used for central processing unit generally termed as the processor is a unit through which the computer interacts with the various applications and installed programs within the system. In order to execute this the processor requires data and instructions, which are accessed through register and memory.

The register is a unit present within the CPU that stores all those operands and instructions which the CPU requires for ongoing process in execution.



However, memory resides out of the CPU architecture but is also used for the purpose of storing instructions that the register will need at the time of functioning.

Content: Registers vs Memory

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Comparison chart

Basis for Comparison	Register	Memory
Basic	A unit to store data and instructions that are currently in execution by the CPU.	A unit to store the data and instructions accessed by the CPU for various program executions.
Exist	Within the CPU	Outside the CPU
Storage size measured in	Bits	Kilobytes, Gigabytes, etc.
Data fetching speed	More	Comparatively less
Storage capacity	Small	Comparatively large
Controllability	Exist	Do not exist
Accessibility by CPU	Direct	Via register.
Examples	Program Counter, instruction register,	Primary memory or RAM.



address register, data
register, accumulator,
etc.

Definition of Registers

A register is one of the key elements present within the CPU that is used for the purpose of storing operands, instructions/programs relative to the current use of the processor. Within the processor, some of the registers are at the address side while some are present at the data side. By the use of internal buses, the various registers form connections with each other.

Registers are formed by a combination of various D-type latches where all of them share a common clock input and this combination offers temporary storage space within the CPU itself.

Some of the registers are discussed below:

- **PC:** Program Counter used to store the address of the upcoming instruction in the queue which is to be fetched from memory.
- **IR:** Instruction register stores the recently fetched instruction.
- **MDR:** Memory Data register is used to store the data which is read out or written into the addressed location in the main memory.
- **AC:** Accumulator is a register that stores the results of various arithmetic and logic instructions.
- **MAR:** Memory Address Register stores that address of main memory from where the data is required to be fetched.
- **General Purpose Registers:** These hold the temporary data relative to current execution.
- **Condition Code Register:** It has various flags that show the status information of the program execution.



Definition of Memory

The memory sometimes called primary memory comprises random-access memory and is used to store data and programs and is of volatile nature. This acts as the main memory of the system and is not present within the CPU rather exists on the motherboard but forms a connection with the CPU using buses.

As this memory offers random accessing ability thus stores valuable data and a set of instructions that the CPU can access. Basically, whenever the microprocessor needs to carry out a task, the necessary information is retrieved from the main memory by the processor. The operating speed of the computer relies very much on the amount of RAM it has.

When a system has less main memory then additional memory resources are used by incorporating hard drives. However, this leads to the slowing down of the overall system performance.

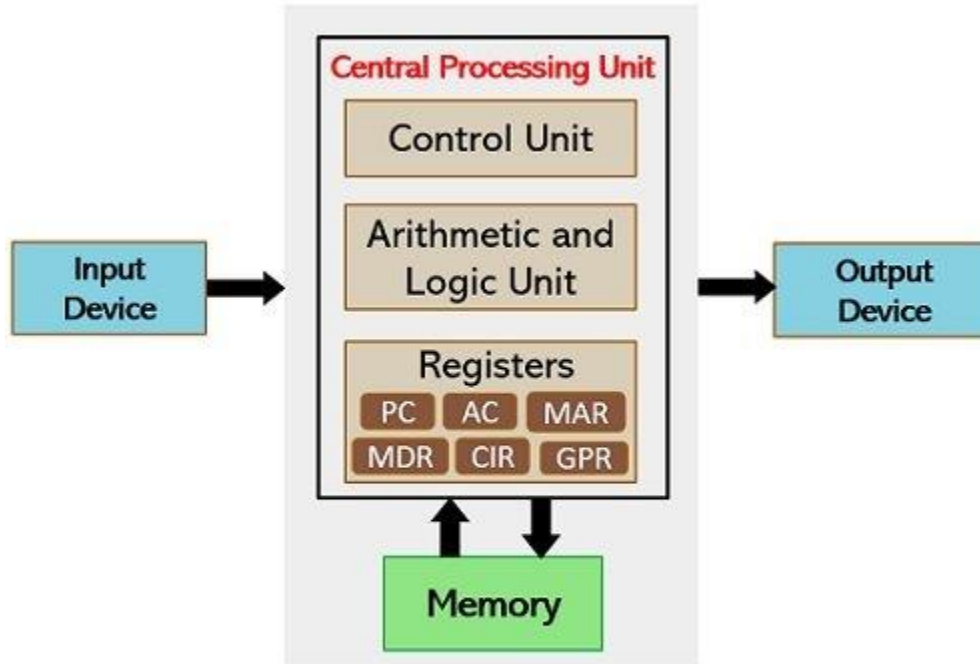


Key Differences Between Registers and Memory

1. Both register and memory are used for storing data and instructions however, the key factor of differentiation between the two is that register offers faster content accessibility in comparison to memory. Due to this reason, in a single clock cycle the processor executes multiple instructions within the register which is not possible with memory.
2. The storage size offered by registers is generally 32 to 64 bits comparatively smaller than that of memory which offers sizes ranging between Kilobytes to Terabytes.
3. Registers reside within the CPU whereas memory exists outside the CPU thus, operands and instructions get fastly retrieved from registers than memory.
4. The central processing unit directly accesses the register during program execution whereas the memory is accessed by the processor with the use of register.
5. Registers offer the user's controllability over its content whereas the data and instructions in memory are of uncontrollable nature.
6. The various examples of registers are accumulator, program counter, stack pointer, instruction register, etc. While random access memory, known as the primary memory is the main memory that we have dealt here.

How a registers and memory combinedly operate?

Computer architecture is not as much complex as we think. The figure below represents a simple architectural representation of a computer system comprising of CPU and main memory.



Computer System Architecture

Register within the CPU is used with the aim to quickly retrieve the data for the current execution purpose of the CPU. The RAM also stores data and instructions and its data can be accessed comparatively faster than hard drives. But for efficient processing CPU holds memory locations within it which are termed as a register that retrieves those data and instructions from RAM which the CPU may require for further execution.

Basically, a CPU works in three cycles:



1. Fetch
2. Decode
3. Execute

At the beginning of program execution, initially, the instruction is required to be **fetch**ed from the main memory into the register. Here program counter is used to holds the address of the main memory locations from where the next instruction is to be fetched. Once the instruction is fetched it is stored in the instruction register and the opcode is **dec**oded by the control unit.

The control unit after decoding **exec**utes the decoded instruction and the output is stored in the memory via register.

Conclusion

The above discussion concludes that registers and memory are different in the sense of their storage capacity, their ability to provide data along with their presence in the system architecture. These criteria generate the difference in the way the two operate.