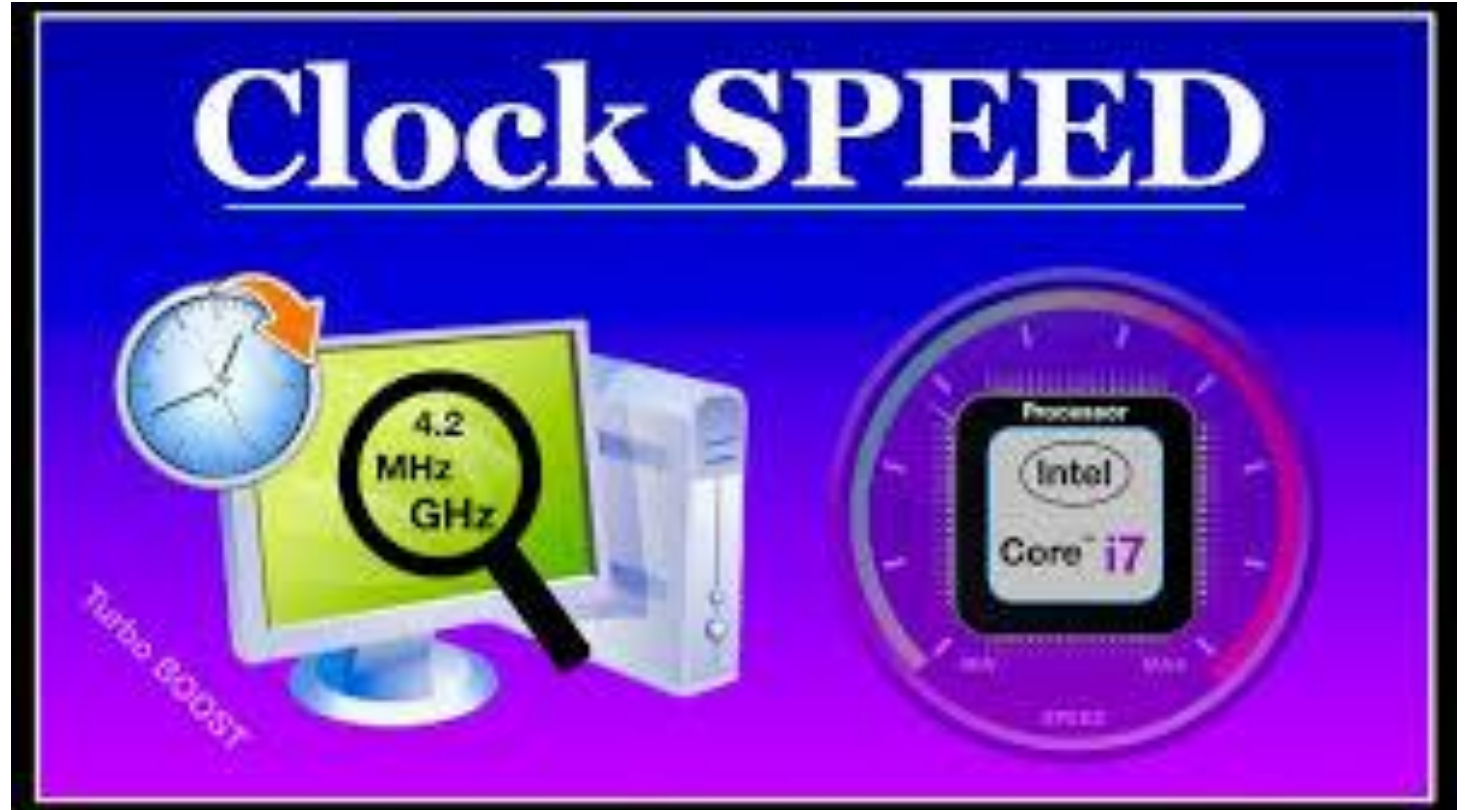# Clock Speed and Instruction per Second

Present by

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Clock Speed and Instruction per Second

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What is Clock Speed?

Definition:

The clock speed of a processor refers to the frequency at which the CPU executes instructions, measured in hertz (Hz).

Typically expressed in gigahertz (GHz), where 1 GHz = 1 billion cycles per second.

How it Works:

Each cycle allows the processor to perform tasks like fetching, decoding, executing, and storing instructions.

Example:

A CPU with a clock speed of 3.5 GHz can perform 3.5 billion cycles per second.

What is Instruction per Second?

Definition:

The number of instructions a CPU can execute in one second.
Measured in terms like MIPS (Millions of Instructions per Second) or FLOPS

Factors Affecting:

CPU architecture
Clock speed
Instruction set efficiency
Number of cores

Relationship Between Clock Speed and Instruction per Second.

Direct Link:

Higher clock speeds typically mean more instructions can be processed per second.

Limitations:

Clock speed isn't the only factor. Instructions per cycle (IPC) and parallel processing capabilities play a huge role.

Illustration:

A CPU running at 3 GHz with 4 instructions per cycle will execute 12 billion instructions per second.

Real-world Example of Clock Speed and Instruction per Second.

CPU A: **3.2 GHz** with **2** instructions per cycle = **6.4 billion** instructions/second.

CPU B: **2.8 GHz** with **4** instructions per cycle = **11.2 billion** instructions/second.

Clock Speed of Core i3:

The Core i3 processors operate at clock speeds ranging from around **2.0 GHz to 4.5 GHz**, depending on the specific model and generation.

This means the processor can complete **2 billion to 4.5 billion cycles per second**.

CPI – Cycles per Instruction

$$CPI = \frac{\text{Total Clock Cycles}}{\text{Total Instructions}}$$

Where:

- **Total Clock Cycles**: The total number of clock cycles used to execute all instructions.

- **Total Instructions**: The total number of instructions executed.

Example of Cycles per Instruction

- A processor executes **1 billion instructions**.

- It takes **3 billion clock cycles** to execute them.

Using the formula:

$$\mathrm{CPI} = \frac{3 \text{ billion}}{1 \text{ billion}} = 3$$

This means the processor requires **3 clock cycles** per instruction on average.

Relationship Between CPI, Clock Speed, and Performance

Execution Time: The time required to execute a program is influenced by CPI:

$$\text{Execution Time} = \frac{\text{Total Clock Cycles}}{\text{Clock Speed}} = \text{CPI} \times \frac{\text{Total Instructions}}{\text{Clock Speed}}$$

Instructions Per Second (IPS): The performance of a processor can also be expressed in terms of IPS:

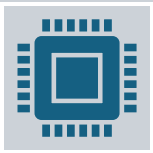$$\text{IPS} = \frac{\text{Clock Speed}}{\text{CPI}}$$

- If clock speed is 3 GHz and CPI is 2:

$$\text{IPS} = \frac{3\,\text{billion cycles/second}}{2\,\text{cycles/instruction}} = 1.5\,\text{billion instructions/second.}$$

Conclusion

Clock speed measures how fast a CPU executes cycles.

Instructions per second provide a clearer picture of real-world CPU capability.

Efficient CPU design balances speed, power, and multitasking.

Thank You!