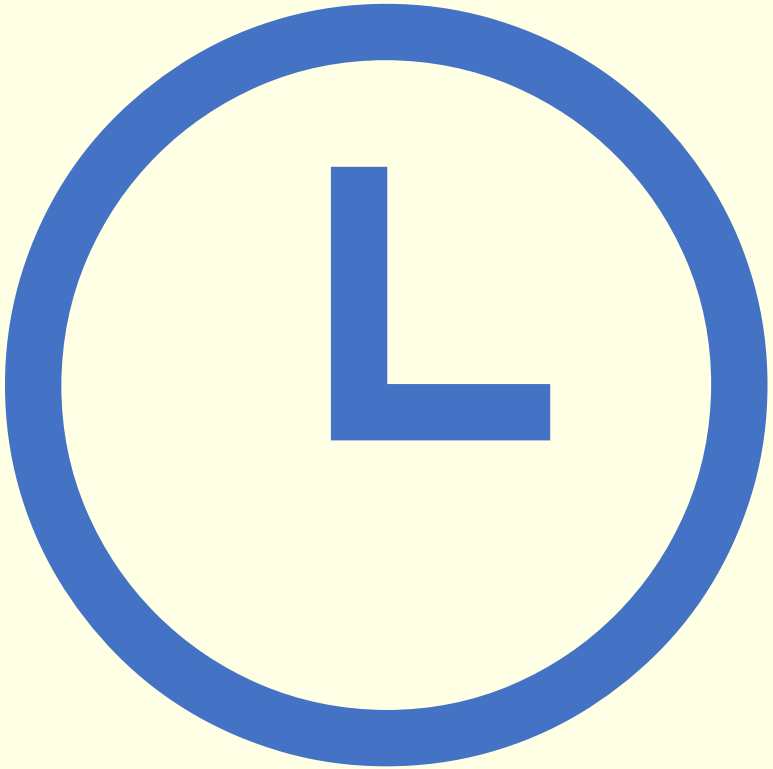
Learning Aims

- Describe the role of the **clock** and explain how the speed of the clock impacts on performance.
- Describe the term **pipelining** and how it relates to CPU performance

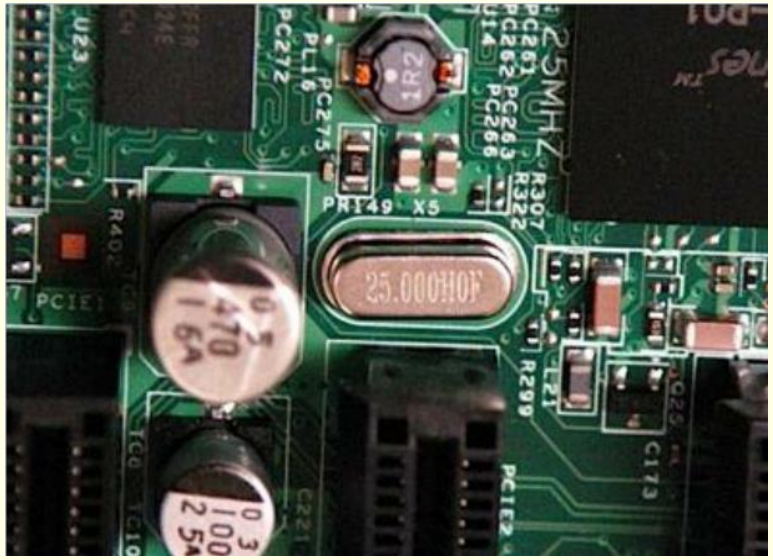


System Clock

- Using a quartz crystal, the clock in a computer breathes life into the microprocessor by feeding it a constant flow of pulses.

- The clock rate of a CPU is normally determined by the frequency of an oscillator crystal.

- In other words, the **frequency of electronic signals per second**



Clock

A clock determines the speed of the CPU.

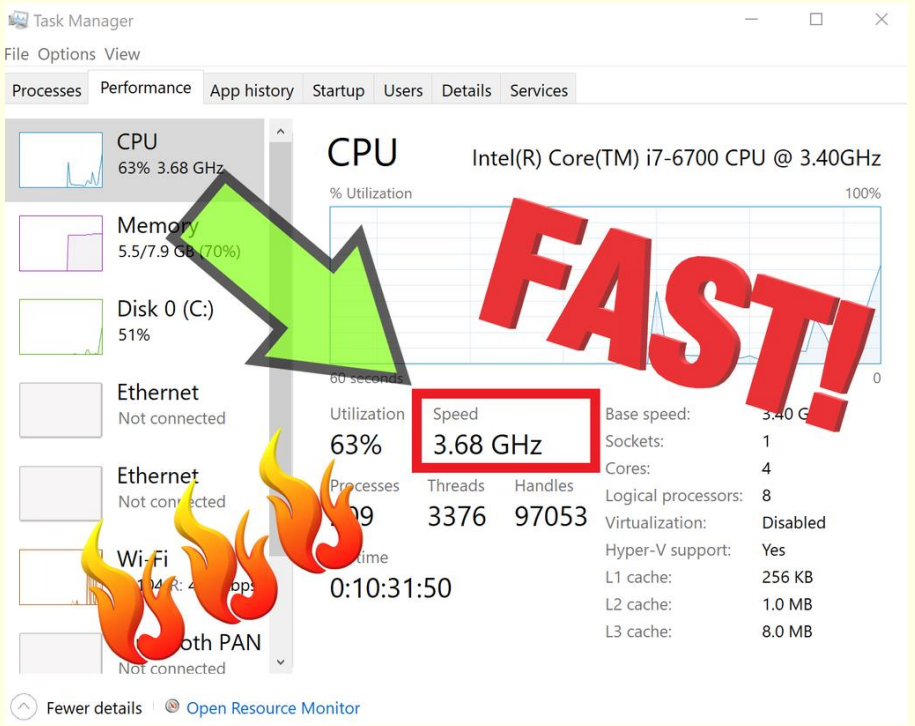
The faster the clock the more instructions can be executed per second

The speed of the clock is measured in **Hertz** (Hz), which is the **amount of cycles per second**.

A clock speed of 500Hz means 500 cycles per second.

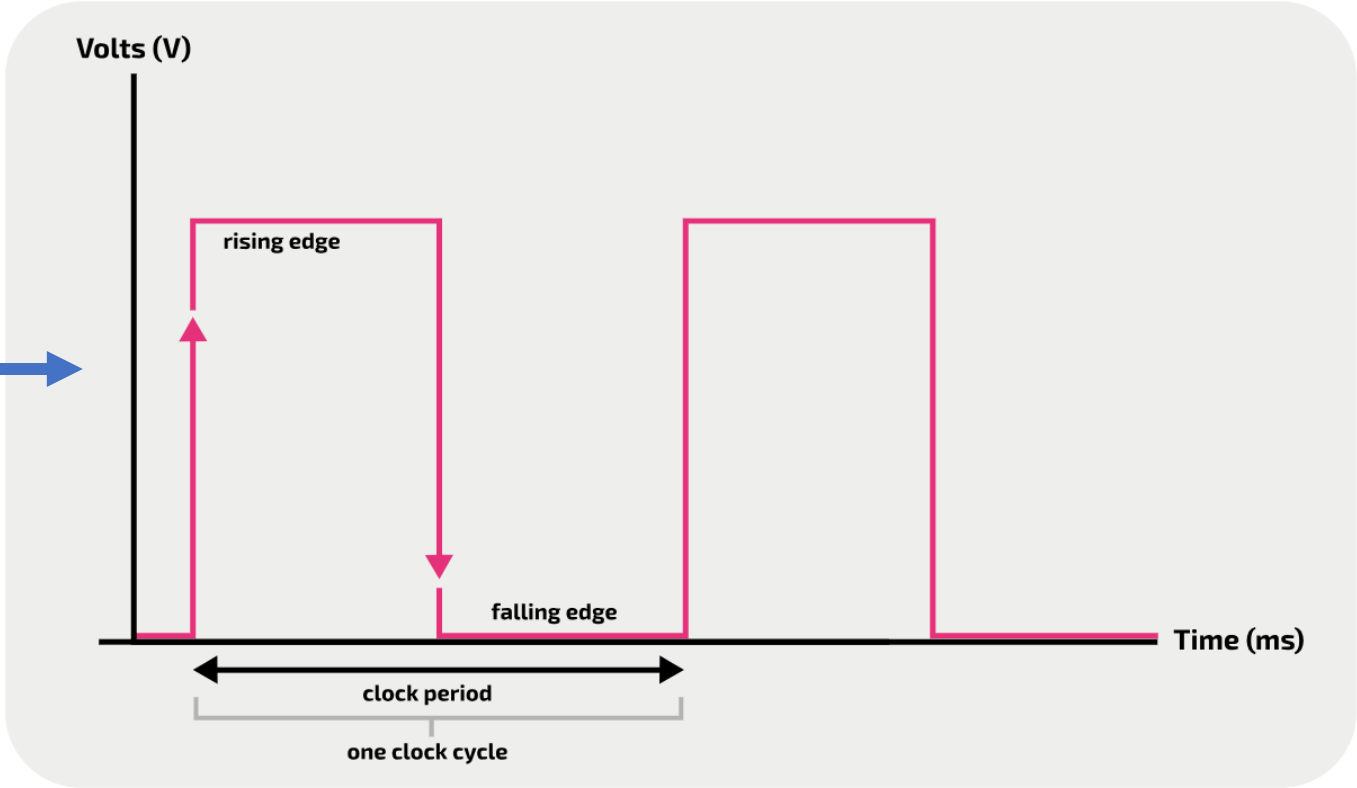
Current computers have clock speeds of **3GHz**, which means **3-billion cycles per second.**

Each ‘tick’ means that one part of the fetch-decode-execute cycle can be carried out.



- The **system clock** — also simply referred to as the **clock** — generates regular clock pulses by emitting a signal that continuously switches between a low (or '0') and a high (or '1') state.

On the rising edge a FDE task is carried out



The time taken between two sequential rising edges is called a **clock cycle** or a **clock period**. The **clock speed** is measured by the number of clock cycles in one second — 1 clock cycle per second is 1Hz.

Calculating Clock Speed

Herz	Measurement
1 hertz (Hz)	1 clock cycle per second
1 million Hz	megahertz (MHz)
1,000 MHz	gigahertz (GHz)

Some modern-day processors have a clock cycle of over 3GHz! Remember that 1GHz is equal to 1,000,000,000Hz — so 3GHz is 3,000,000,000Hz or 3,000,000,000 clock cycles in one second!

What does Synchronise mean?

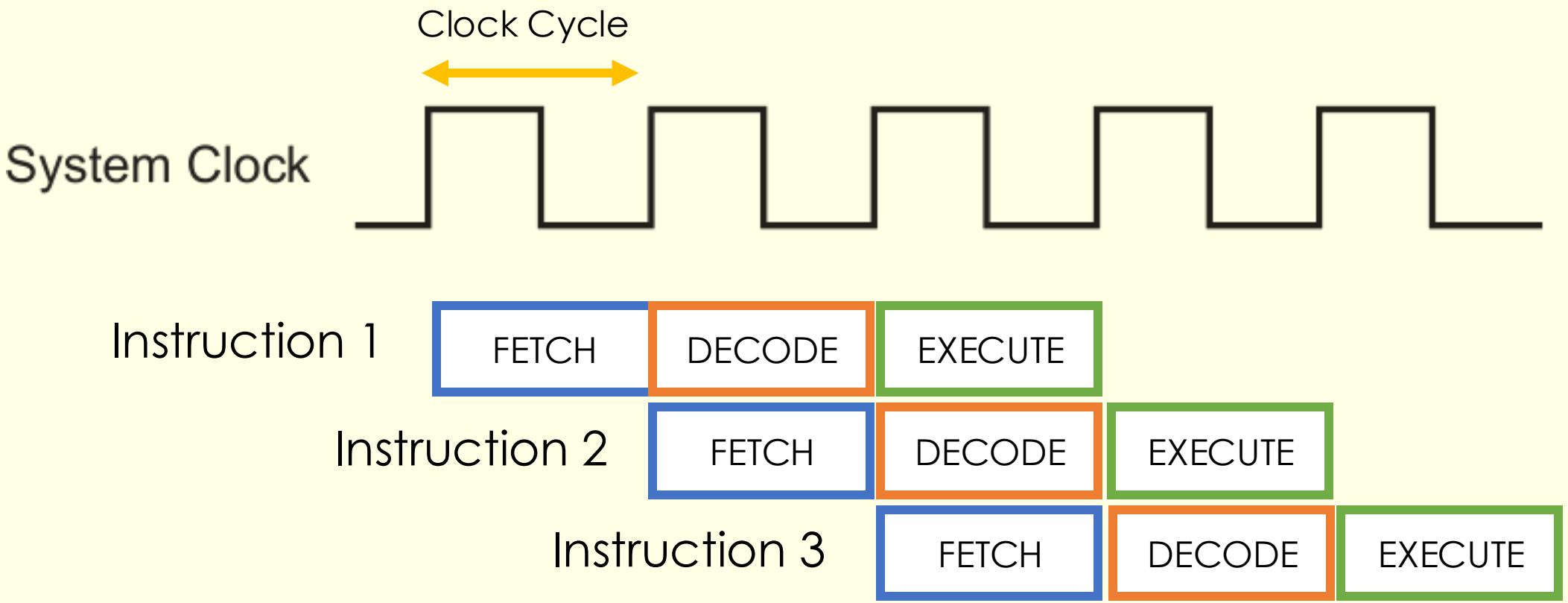
Occur at the same time

The **clock signal** is used to **synchronise** the **operations** of the processor components.

What is computer operations?

A given task carried out by the CPU during the Fetch Decode Execute cycle

FDE Clock Cycle



When instructions are processed at the same time is known as pipelining

Pipelining Video

FDE Clock Cycle

What would happen if the clock failed?

- Then the **operations** of the processor components inside the processor would **not** be **synchronised** and it would not be able to process any data.
- The computer would not work.

Pipelining

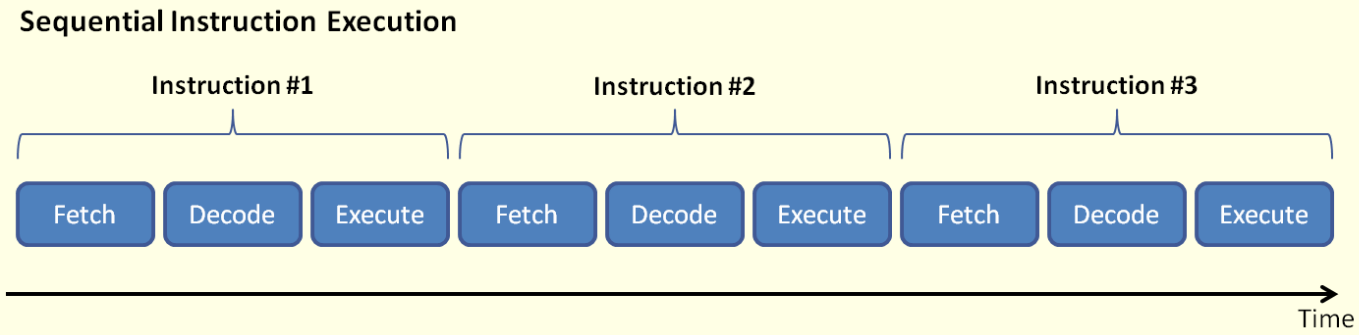
Each instruction that is carried out has several stages (fetch-decode-execute).

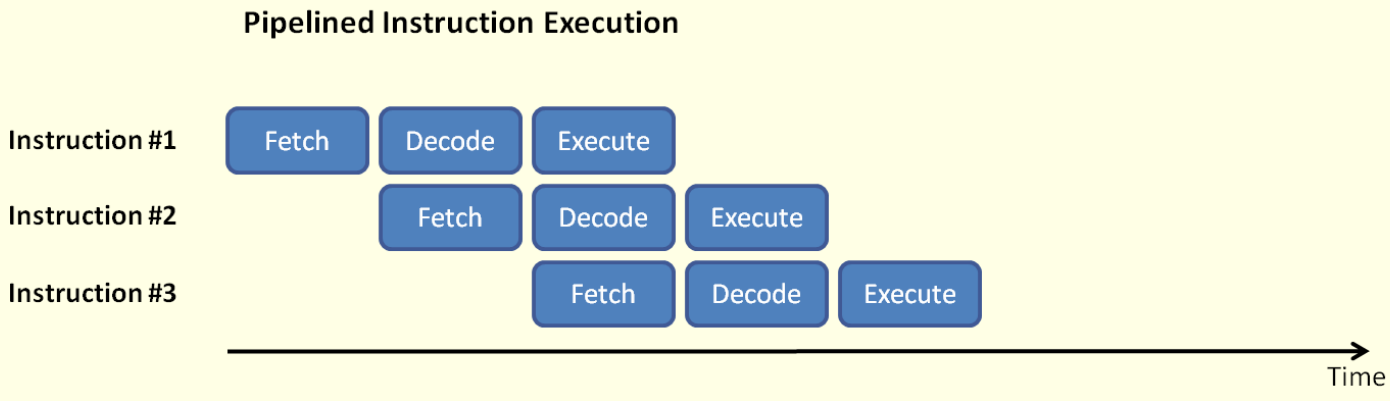
Each component of the CPU has a different job to do in this cycle.

Sometimes, one component has nothing to do whilst it is waiting for the component before it in the sequence to complete its task.

This increases the overall processing time needed.

Pipelining is a method of keeping all the components busy so as to improve overall CPU performance.





Pipelining

Pipelining attempts to keep every component of the CPU busy at all times.

Instructions flow through the CPU in stages.

This means that an instruction can be completed every clock cycle. This increases CPU **throughput** allowing overall performance to be optimised.

A CPU is called 'fully pipelined' if an instruction can be fetched every clock cycle.