A LEVEL
COMPUTER SCIENCE

Lesson Element

Structure and function of the processor

Clock speed

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Clock Speed' activity which supports OCR A Level Computer Science.

The Activity:

The purpose of this activity is to demonstrate the effect of changing the clock speed of a computer system. To complete this, learners should know the function of a CPU in a computer system and know something about the fetch-execute cycle.

This activity offers an opportunity for English skills development.

Associated materials:

'Clock Speed' Lesson Element learner activity sheet.

Introduction

Before starting, it would be useful to recap speeds in bits per minute (bpm) as you will inevitably talk about processor speeds in gigahertz, megahertz and possibly even kilohertz.

You will be demonstrating underclocking and overclocking a system by means of getting your learners to clap in time with you.

Task 1

Tell the learners that they have to clap in time with you and keep to your pace. To start off with assume a slow clap. Learners will take a few seconds to match your speed.

1. Slow (clap then count to 3 seconds in your head)
2. Medium (clap then count 1 second)
3. Fast (clap every 0.5 seconds)
4. Superfast (clap as fast as you can)

After completing each of the different speeds, ask the learners how easy it was for them keep in time with you.

Discuss what would have happened over time if you have continued clapping at the faster pace. Do computers have those kinds of limitations?

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Questions learners may ask:

Learners may ask you if the computer will explode if you overclock it too much. To answer this, you could show learners a video demonstrating the negative effect of overclocking on a computer:

https://www.youtube.com/watch?v=6122t8xU6KU

https://www.youtube.com/watch?v=DzTNlI9te1w

There are many more examples on YouTube of overclocking gone wrong.

This activity is a good lead in to the fetch-execute cycle as you can go on to cover what happens during each clock cycle. The learner sheet is to be completed afterwards to expand learners' knowledge of the CPU cycle.

What is a clock speed?

A clock speed is the speed of a computer processor. It is measured in cycles per second. The CPU requires a fixed number of clock cycles, to execute each instruction; the faster the clock speed, the faster the CPU can execute instructions. It can be possible to increase the speed of a processor by increasing the number of cores it has, whilst still keeping the same clock speed. For example, a dual core 2.6 GHz processor would be capable of running faster than a single core 2.6 GHz processor.

What happens within a CPU cycle?

Inside a computer the CPU is repeatedly reading, or fetching, an instruction from memory and then executing that instruction. Some instructions on a CPU take multiple cycles to execute. Within a CPU cycle the processor is fetching, decoding or executing instructions.

If my CPU processes data at 1,800,000,000 clock cycles per second, is that fast?

As clock speed is measured in GHz, this clock speed is 1.8 GHz. Some Intel processors can get up to around 4.0 GHz and the same goes for AMD processors. How effective a CPU processes data is not just related to the CPU speed. Technology such as hyper-threading and multi-core processors can play a part in increasing the CPU speed.

'Fewer clock cycles with more work are better than more clock cycles with less work.' What advantages are there of setting your clock speed to be slower (underclocking it)?

Underclocking is a technique that produces a reduction in power consumption, heat output and noise. It is used to extend the life of some mobile phones, laptops and other mobile devices.

Some CPUs have inbuilt power-saving options which undervolt the processor as a default option. Undervolting is a system where you lower the CPU's voltage but do not change the clock speed; if you can undervolt without underclocking, you will save on energy **and** power, but not affect the performance of the computer.

What advantages are there of setting your clock speed to be faster (overclocking it)?

Overclocking increases the performance of the CPU. A CPU with a clock rate above the manufacturer's specified rate performs more cycles per second. The additional clock cycles allow data to be processed faster.

What are the dangers of overclocking a system?

An overclocked component operates outside of the manufacturer's recommended operating conditions, so overclocking can create unpredictable errors which may lead to system instability and data loss. Overclocking a CPU can void the CPU's warranty as well as take years off of the life of the CPU. One of the more obvious issues with overclocking a CPU is that it increases the CPU's power consumption and causes it to generate more heat. In turn the CPU will need better cooling, which consumes additional electricity.

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