A LEVEL

Topic Exploration Pack

H446

COMPUTER SCIENCE

Theme: Types of Processor

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OCR
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Contents

This Topic Exploration Pack should accompany the OCR resource 'Types of Processor' learner activities, which you can download from the OCR website.

This activity offers an opportunity for English skills development.

Types of Processor

- The differences between and uses of RISC and CISC processors
- GPUs and their uses including those not related to graphics
- Multicore and parallel systems.

This Topic Exploration Pack focuses on different types of processor and their typical uses. Learners will consider different types of processor structures to provide increased computing power and efficiency. It is valuable to begin by discussing the wide variety of computing devices and specific purposes eg System on Chip (SoC), supercomputers and games consoles.

Learners will compare and contrast RISC (Reduced Instruction Set Computers) and CISC (Complex Instruction Set Computers) as alternative approaches. It would be worth recapping the Fetch Decode Execute cycle to consider how either approach might be advantageous. It is likely that learners will be aware of the increased system demands needed to play games and will doubtless find the development of Graphics Processing Units fascinating. It is worth tracing development from simple arcade systems through to modern day PC graphics cards console systems. They need to appreciate that the GPU has a specialised purpose and that it works in tandem with the CPU to run programs with demanding graphics.

Other types of coprocessor should also be mentioned such as those for performing floating point operations in obsolete PC systems (the so-called FPU), I/O coprocessors in mainframe systems and those managing network operations (dubbed NPUs). However, many of these examples are now obsolete as CPUs have become more sophisticated and their functionality more comprehensive.
The best-known, modern implementation of the coprocessor is the GPU (Graphics Processing Unit). Learners need to understand that a GPU is a parallel processor which is not well-suited to general multitasking duties performed by the CPU.

Instead its speciality is working on large sets of complex data associated with rendering graphics. However, as a parallel processor, a GPU can run programs not associated with graphics that similarly contain large data sets such as simulations, financial computation and processing audio data. The large-volume production and relatively low cost of a GPU, makes it a realistic alternative for programmers coding software for parallel processors.

It is highly likely that learners will use a system which has two, three or four cores. They will appreciate that this enables them to run multiple processes at exactly the same time without the need for time-slicing or similar scheduling algorithm as would be required on a single core CPU. It is also important to discuss the importance of cache memory in improving performance and that cache can be shared between cores or may be dedicated. The cores will be interconnected within the CPU and may allow for a degree of parallelism. Multicore processors also tend to consume less power, support higher clock rates and are more efficient than an equivalent number of single core processors. They are therefore ideal for mobile computing devices.

Parallelism in modern computing is an important concept for learners to grasp. As has been discussed earlier, multicore processors allow for separate processes to be run simultaneously. Graphics Processing Units allow for multiple execution pathways to work together on one specific task so are classified as parallel processors. Supercomputers consist of many processors that collaborate on a task to carry out complex calculations. Cray computers are a well-known brand of supercomputers. Their currently marketed model, XC40, boasts 6144 cores!

If a budget does not run to a commercial supercomputer, a ‘loosely coupled’ cluster of machines that are networked together, can process data collaboratively. The Beowulf cluster uses a number of simple Linux computers that has considerable processing power at an affordable cost.

Processors may also work collaboratively across the internet. Grid computing is also an example of distributed computing.

Learners should also be familiarised with the terms scalar and vector (array) processors. Scalar processors work on a Single Instruction and Single piece of Data (SISD). Vector processors work on a Single Instruction but Multiple Data items (SIMD).

Summary of Suggested Activities

Activity	Learning Objective	Resources Required	Additional Activities and Links
Developing an instruction set	Learners will consider what is an instruction set.	Mini whiteboards or sticky notes	In this activity learners are challenged to think about basic assembly language instructions needed for a generic CPU. They need to consider all mathematical operations. Learners will realise that some operations consist of a sequence of simple steps. They need to make the decision to either combine these into a new instruction or leave them as simple instructions to be completed in sequence.
RISC and CISC debate	Learners will know the differences between and uses of RISC and CISC processors.	Internet connected computers	Learners will be divided into two teams: one CISC and one representing RISC. Each team chooses a speaker to promote their particular architecture. The team collaborate on carrying out research and constructing their argument. After the initial speeches questions may be asked by the "opposition". A chairperson will manage the debate. Resources: http://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/risccisc/
GPU history and development	Learners will know the purpose of GPUs and their uses including those not related to graphics	Internet connected computers	The focus for this activity is the development of Graphics Processing Units from the perspective of games consoles and arcade machines. Learners will produce an interactive presentation or a blog on the topic. Information sources: http://www.techspot.com/article/650-history-of-the-gpu/ http://en.wikipedia.org/wiki/Graphics_processing_unit

Activity	Learning Objective	Resources Required	Additional Activities and Links
Processor type card trumps	Learners will know different types of processor including multicore and parallel systems.	Electronic blank card sets for learners to complete, internet connected computers.	Learners will research different types of processor and approach to computing including: scalar, vector, GPU, multicore and distributed.

Approaches to delivery

This is essentially a theoretical topic but the inclusion of a variety of research-based activities will allow learners to gain a deep understanding of the different approaches to processor development. It is important that they also gain a summary overview of each processor type and its typical uses suitable for examination revision.

Activity 1

Objectives:

- Learners will consider what an instruction set is.

Resources:

- Mini whiteboards or sticky notes.

Main Activity:

In this activity, learners are challenged to think about basic assembly language instructions needed for a generic CPU. They need to consider all mathematical operations. Learners will realise that some operations consist of a sequence of simple steps. They need to make the decision to either combine these into a new instruction or leave them as simple instructions to be completed in sequence.

Learners will work in small groups to produce an instruction set for a fictional CPU. A suitable starter would be to discuss what an instruction set is. They will then work in small groups to define an instruction set for a fictional new CPU. They should begin by thinking about typical mathematical operations. Challenge them to consider how to calculate the average of a group of numbers and whether there should be an instruction called “average” or whether to use add and divide instructions in combination.

Key questions and follow up activities:

- Which approach is most efficient: combining and executing simple instructions in combination or having an instruction set that includes complex instructions?
- Which companies have developed RISC processors?
- What are the potential advantages of the RISC approach?
- What are the typical uses of RISC machines?
- How does CISC compare with RISC?

Raspberry Pi activity:

- Find out about the ARM System On Chip processor used in the Raspberry Pi and its instruction set.

Activity 2

Objectives

- Learners will know the differences between and uses of RISC and CISC processors.

Resources

- Internet connected computers for carrying out research
- http://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/risccisc/

Main Activity

Learners will begin by dividing into two teams: “Team CISC” and “Team RISC”. Each team chooses a speaker to promote their particular architecture. They then will spend approximately 20 minutes preparing their argument about why their approach is the most efficient, carrying out research and constructing their argument. When they have prepared, each team will present their proposal. After the initial speeches questions may be asked by the “opposition”. A chairperson will manage the debate. They should be prepared to answer questions via the chairperson.

Key Questions

- Are there any performance advantages between CISC and RISC processors?

Activity 3

Objectives

Learners will know the features of different types of processor.

Resources

Learners will complete a set of cards including the features of different types of processor. They will then use the cards to play a game of "trumps". This will help to assist in the learners' ability to compare performance based on architecture. Learners will research different types of processor and approach to computing including: scalar, vector, GPU, multicore and distributed.

Key Questions

- Which processors are most suited to executing highly complex calculations?
- Which are best suited to processing large volumes of complex data?
- Which processors are most suitable for mobile computing?

Version 1

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