Multiprocessing

Module 3

Self study material

Operating systems 2020

1DT003, 1DT044 and 1DT096

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Multiprocessing (1)

Multiprocessing is the use of more than one CPU in a computer system.

- ★ The CPU is the arithmetic and logic engine that **executes user applications**.
- ★ With multiple CPUs, **more than one** set of **program** instructions can be **executed at the same time**.
- ★ All of the CPUs have the same user-mode instruction set.
- ★ A running job can be rescheduled from one CPU to another.

Source: https://en.wikipedia.org/wiki/Multiprocessing 2016-02-04

https://en.wikipedia.org/wiki/Asymmetric_multiprocessing 2016-02-04

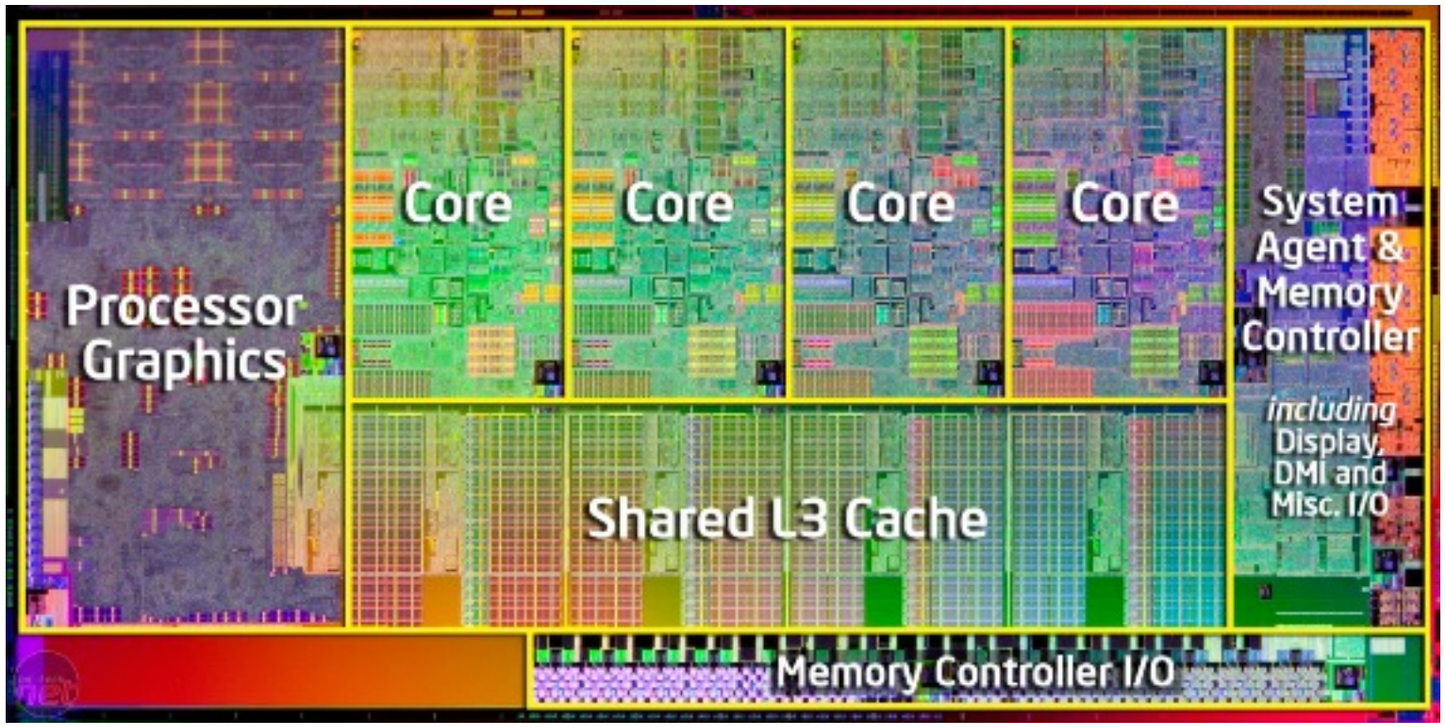
Multiprocessing (2)

The definition of multiprocessing can vary with context, mostly as a function of how CPUs are defined.

- ★ Multiple cores on one die
- ★ Multiple dies in one package
- ★ Multiple packages in one system unit

Multicore

A multi-core processor is a single computing component with two or more independent actual processing units (aka cores), which are the units that read and execute program instructions.



A quad core processor with a single GPU and a single shared L3 cache.

Source: https://en.wikipedia.org/wiki/Multi-core_processor 2016-02-04

Processing unit (core)

A processing unit (aka core) read and execute program instructions.

- ★ The processing unit (core) carries out the instructions of a computer program by performing the basic arithmetic, logical, control and input/output (I/O) operations specified by the instructions in the program.

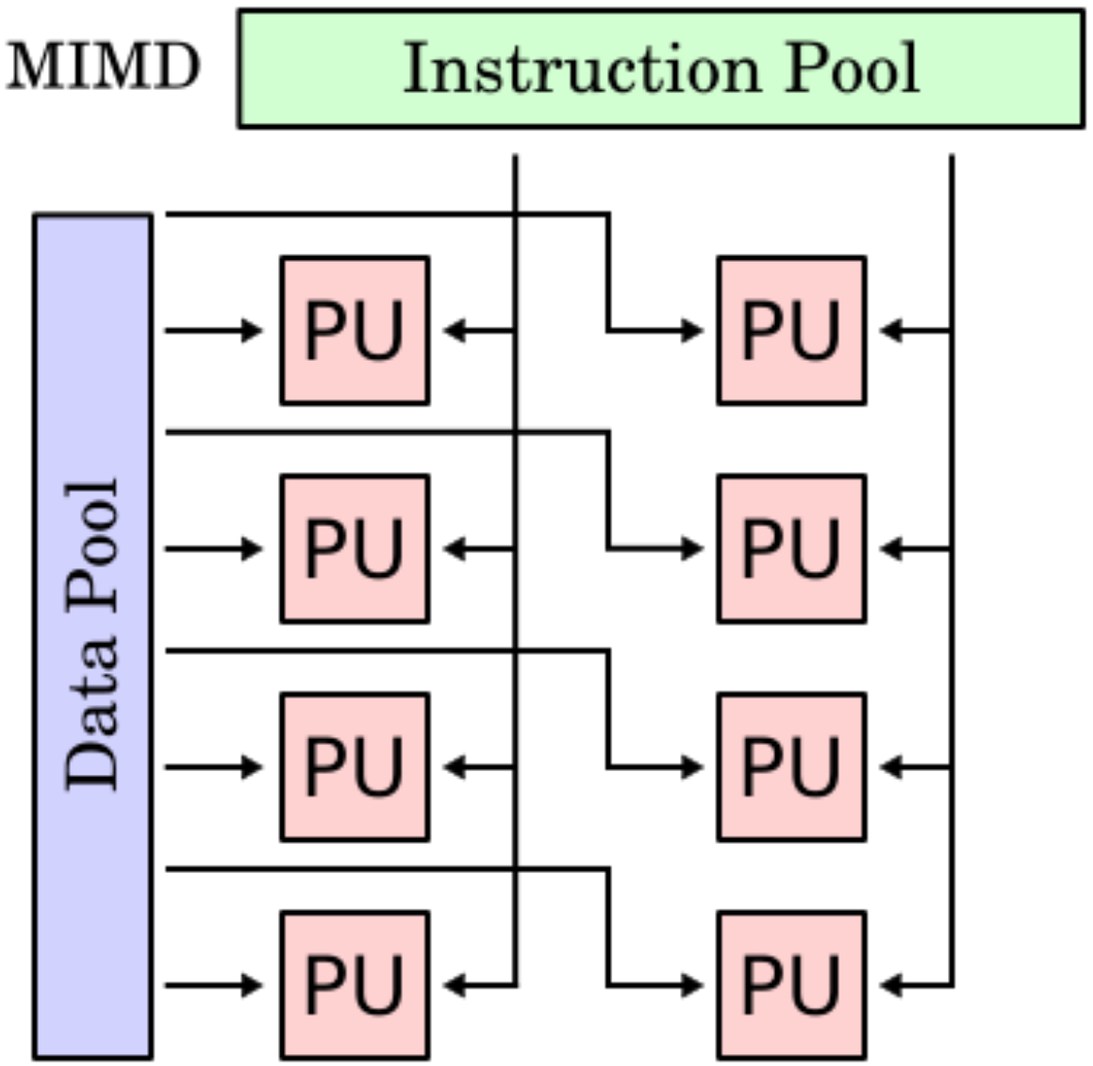
- ★ Traditionally, the term CPU refers to a processor, more specifically to its processing unit and control unit (CU), distinguishing these core elements of a computer from external components such as main memory and I/O circuitry.

Source: https://en.wikipedia.org/wiki/Multi-core_processor 2016-02-04

https://en.wikipedia.org/wiki/Central_processing_unit 2016-02-04

Multiprocessing (3)

In Flynn's taxonomy, multiprocessors are **M**ultiple **I**nstruction, **M**ultiple **D**ata (**MIMD**) machines.



As they are normally construed to be tightly coupled (share memory), multiprocessors are not the entire class of MIMD machines, which also contains message passing multicomputer systems.

PU = Processing Unit (of a uni-core or multi-core CPU)

Asymmetric multiprocessing (AMP)

In an asymmetric multiprocessing system, not all CPUs are treated equally.

For example, a system might only allow one CPU to:

- ★ execute operating system code and accesses the operating system data structures, alleviating the need for data sharing
- ★ perform I/O operations.

Other AMP systems:

- ★ could allow any CPU to execute operating system code and perform I/O operations, so that they were symmetric with regard to processor roles
- ★ but attached some or all peripherals to particular CPUs, so that they were asymmetric with regard to peripheral attachment.

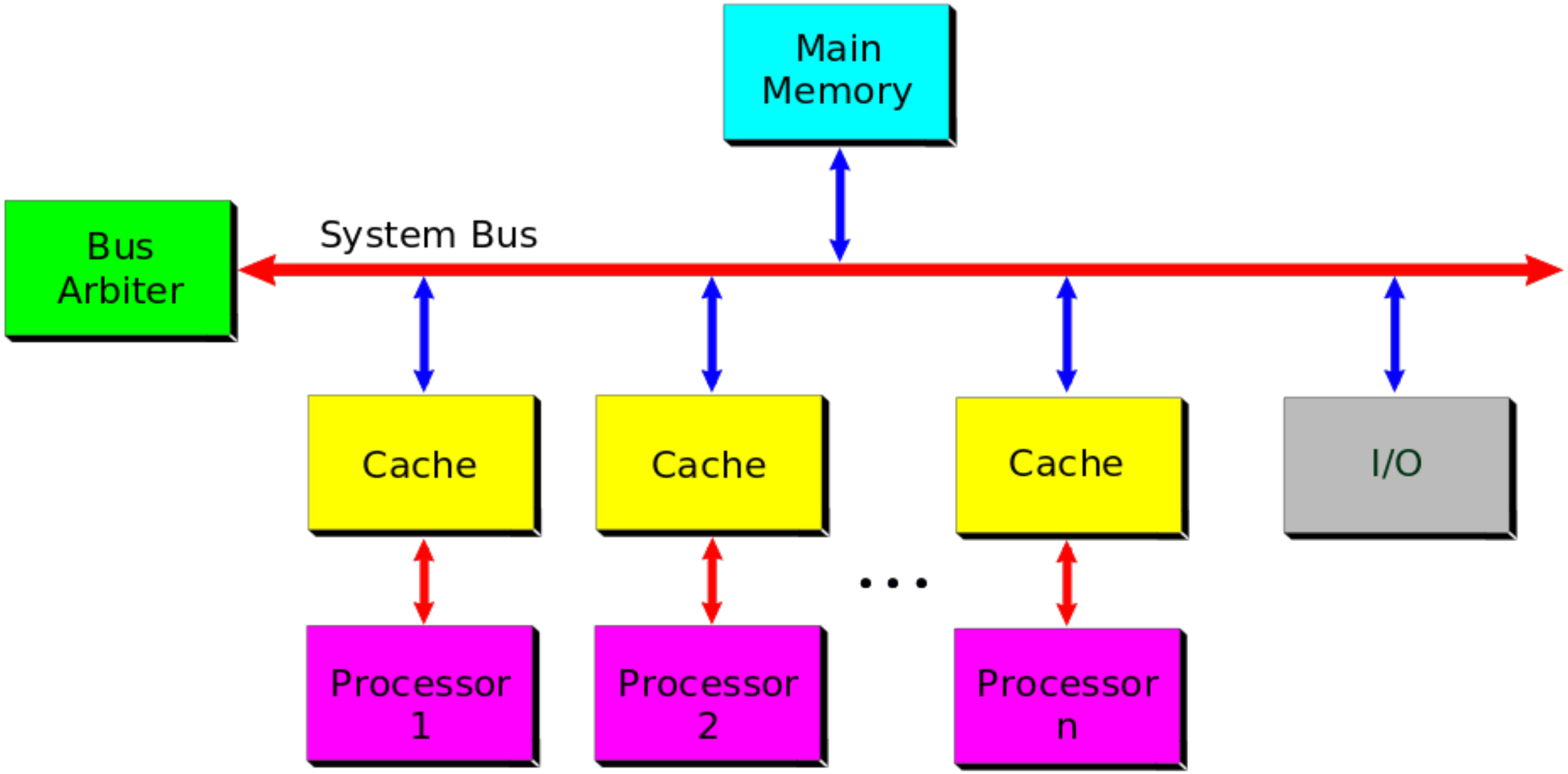
Source: https://en.wikipedia.org/wiki/Asymmetric_multiprocessing 2016-02-04

Symmetric multiprocessing (SMP)

A symmetric multiprocessor system (SMP) is a multiprocessor system with centralized shared memory called main memory (MM) operating under a single operating system with two or more homogeneous processors.

Each processor is self-scheduling, all processes in common ready queue, or each has its own private queue of ready processes.

Symmetric multiprocessing (SMP)



Each processor is self-scheduling, all processes in common ready queue, or each has its own private queue of ready processes.

Processor affinity (1)

The binding and unbinding of a process or a thread to a central processing unit (CPU) or a range of CPUs.

Processor affinity is used so that the process or thread will execute only on the designated CPU or CPUs rather than any CPU.

- ★ Each item in the ready queue has a tag indicating its kin processor.
- ★ At the time of resource allocation, each task is allocated to its kin processor in preference to others.

Processor affinity takes advantage of the fact that some remnants of a process that was run on a given processor may remain in that processor's memory state (for example, data in the CPU cache) after another process is run on that CPU.

- ★ Scheduling that process to execute on the same processor could result in an efficient use of process by reducing performance-degrading situations such as cache misses.

Processor affinity (2)

The binding and unbinding of a process or a thread to a central processing unit (CPU) or a range of CPUs.

Soft affinity

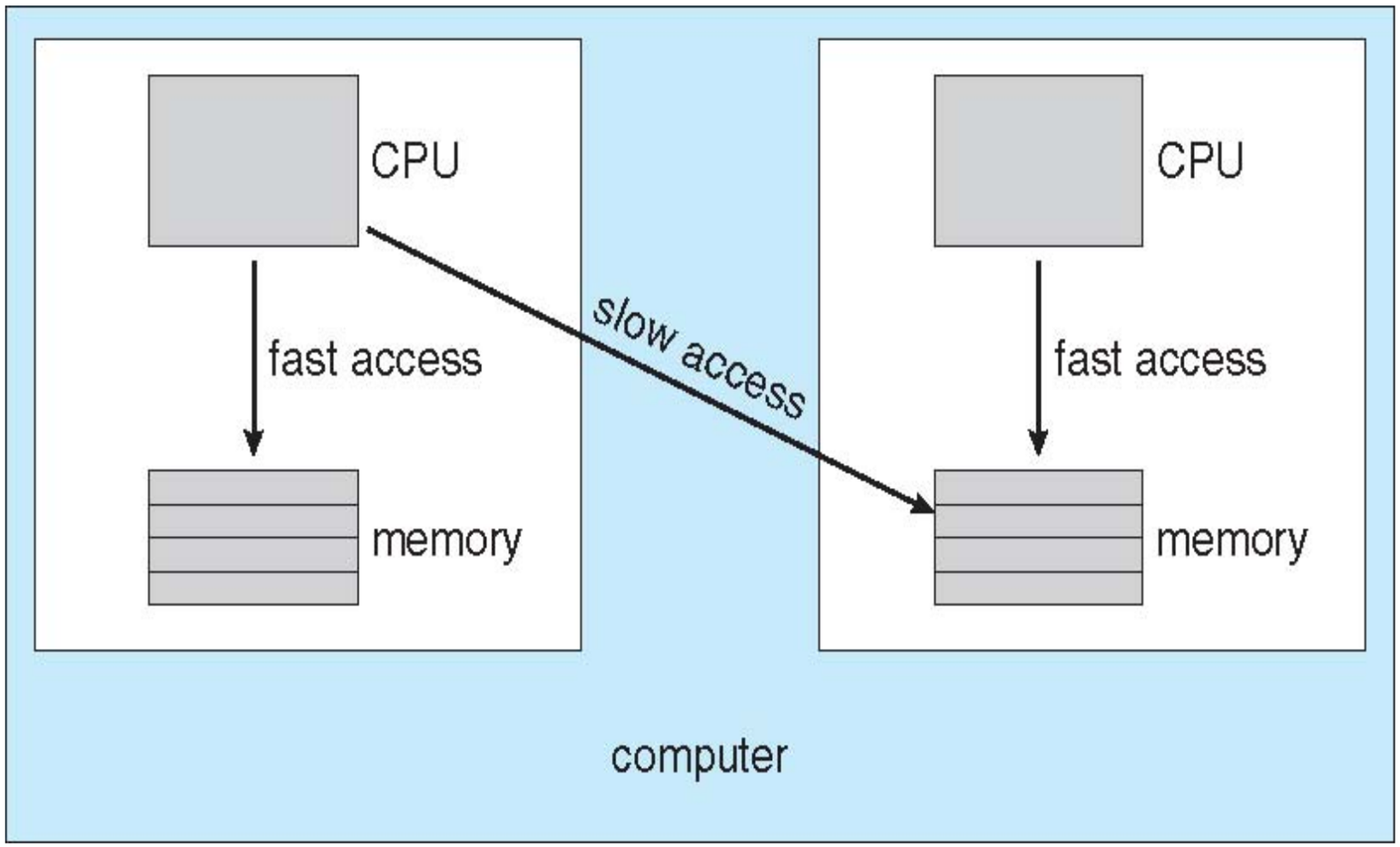
- ★ The tendency of a scheduler to try to keep processes on the same CPU as long as possible. It is merely an attempt; if it is ever infeasible, the processes certainly will migrate to another processor.

Hard affinity

- ★ It is a requirement, and processes must adhere to a specified hard affinity. If a processor is bound to CPU zero, for example, then it can run only on CPU zero. At the time of resource allocation, each task is allocated to its kin processor in preference to others.

Non-Uniform Memory Access (NUMA)

A computer memory design used in multiprocessing, where the memory access time depends on the memory location relative to a processor.



Under NUMA, a processor can access its own local memory faster than non-local memory (memory local to another processor or memory shared between processors).

If the CPU scheduler and the memory-placement algorithms work together, then a process that is assigned affinity to a particular CPU can be allocated memory on the board where the CPU resides.