Task 3a:

Define the following: Task, Pipelining, Shared Memory, Communications, Synchronization. (in your own words)

Task – a set of instructions for the processor to execute

Pipelining – a type of parallel computing where a task is broken up for different processors to execute

Shared memory – computer architecture where processors have direct access to physical memory (hardware POV); parallel tasks can have direct address and same logical memory (programming POV)

Communications – data exchange

Synchronization – coordination of parallel tasks where, most of the times, one task needs to reach the same logical point

Classify parallel computers based on Flynn's taxonomy. Briefly describe every one of them.

Flynn's taxonomy helps distinguish multi-processor computer architecture through instruction stream and data stream. Instruction and data stream can be separated through single or multiple state. There are four possible classifications: SISD (single instruction, single data), SIMD (single instruction, multiple data), MISD (multiple instruction, single data), MIMD (multiple instruction, multiple instruction). SISD works with the oldest type of computers where one instruction is processed by the CPU in one clock cycle with only one data input. SIMD computers process one instruction through multiple processing units and work best for graphics and image processing. There are two types of SIMD: processor arrays and vector pipelining. MISD has each processing unit process data independently through separate instruction streams with singular data as input. Not many MISD computers exist. MIMD computers have multiple instructions being processed through multiple processing units. Most modern day computers fall into this category such as supercomputers, gaming computers, multicore PC's.

What are the Parallel Programming Models?

Parallel Programming models are abstractions above hardware and memory architectures. The models include shared memory (without threads), threads, distributed memory/message passing, data parallel, hybrid, SPMD (single program multiple data), and MPMD (multiple program multiple data).

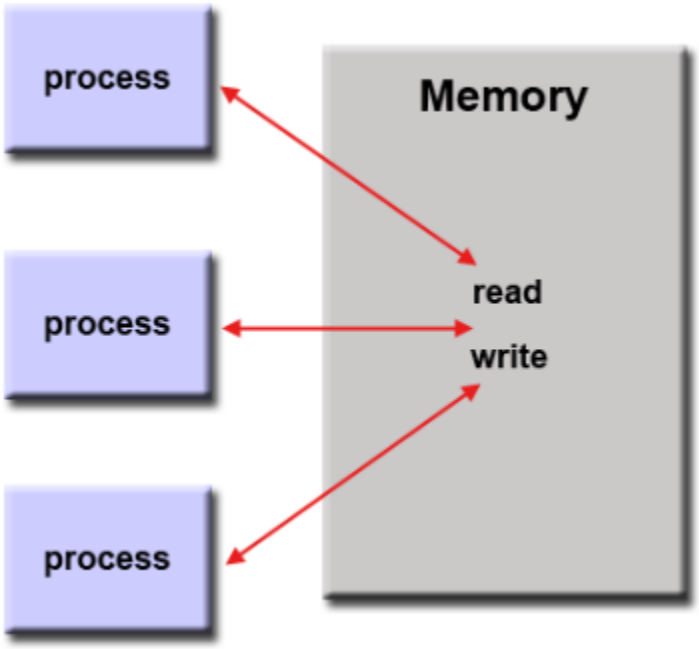
List and briefly describe the types of Parallel Computer Memory Architectures. What type is used by OpenMP and why?

There two common types of shared memory parallel computer memory architectures: UMA (uniform memory access) and NUMA (non-uniform memory access). UMA uses identical processors and has similar access and access times to memory. UMA is also commonly called Cache Coherent UMA, which means that if one processor updates a location in shared memory,

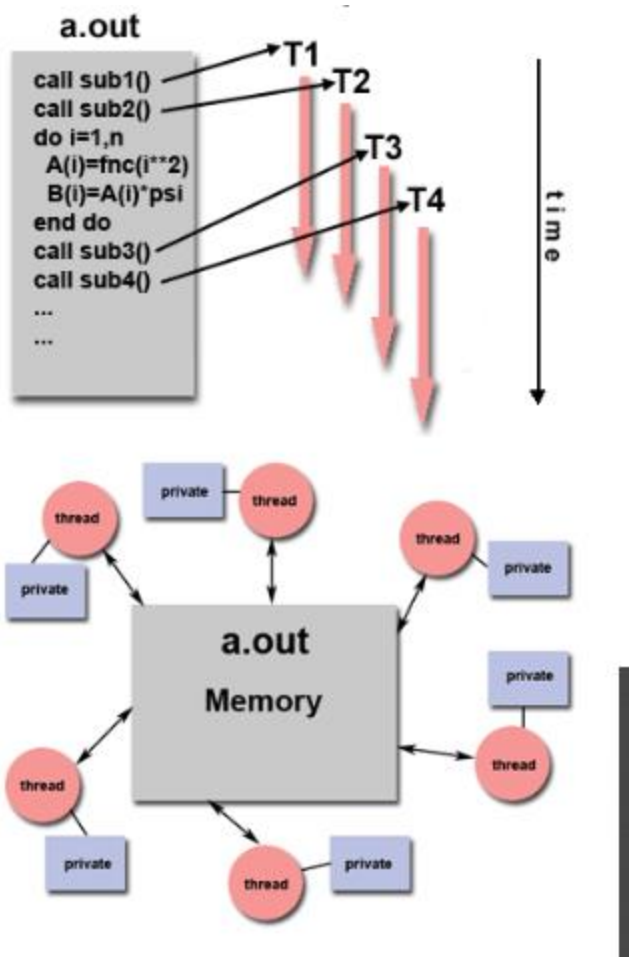
all the other processors are also aware of the update. All of this is executed at the hardware level. NUMA works by mostly physically linking two or more SMP's (symmetric multiprocessor). One SMP can directly access memory to another SMP, BUT not all processors have the same access time to the rest of the memories and the link time is slower. OpenMP uses UMA because each processor can have a private cache memory.

Compare Shared Memory Model with Threads Model? (in your own words and show pictures)

With shared memory, tasks share the same address and is the simplest parallel programming model. An advantage a programmer has with this model is that there is no need to explicitly communicate data between the tasks since they have shared memory. However, it becomes increasingly difficult to manage and understand local data.



The threads model uses a single "heavy weight" process that can have multiple "light weight" execution paths. Threads usually require synchronization and communication through global memory. a.out is an example of using threads to execute a program by communicating through global memory. Each thread contains local data, but then shares all contents and memory space of a.out. Some operating system such as Unix/Linux use threads like POSIX threads. POSIX threads are C language only and require close attention to detail. OpenMP is an example of portable threads and is available only multiple platforms and available in C, C++, and Fortran languages.



What is Parallel Programming? (in your own words)

Parallel programming is using multiple processors to execute a single or set of instructions. It ensures quicker execution time and is useful for executing complex programs. However, a slight disadvantage to parallel programming is that if the programmer wants to tweak the code, they would have to target different points of the code to improve it. It is not as straightforward as serial programming.

What is system of chip (SoC)? Does Raspberry PI used system on SoC?

A SoC contains all the computer components into a single silicon chip. It usually contains a CPU, GPU, memory, USB controller, power management circuits, and wireless radios. A system that uses SoC is Raspberry PI.

Explain what the advantages are of having a System on a Chip rather than separate CPU, GPU and RAM components.

Significant advantages of having a System on a Chip rather than a separate CPU, GPU, and RAM components are its size vs. functionality and requires less power. The SoC is only slightly bigger than a CPU, but it has a lot more functionality that just a separate CPU. Because of small

size and high functionality, you can use SoC's to build smartphones and tablets. Also due to high integration and shorter wiring, the SoC requires less power. This is most convenient for mobile computing. Furthermore, the SoC uses less number of chips, so it is also cost effective.