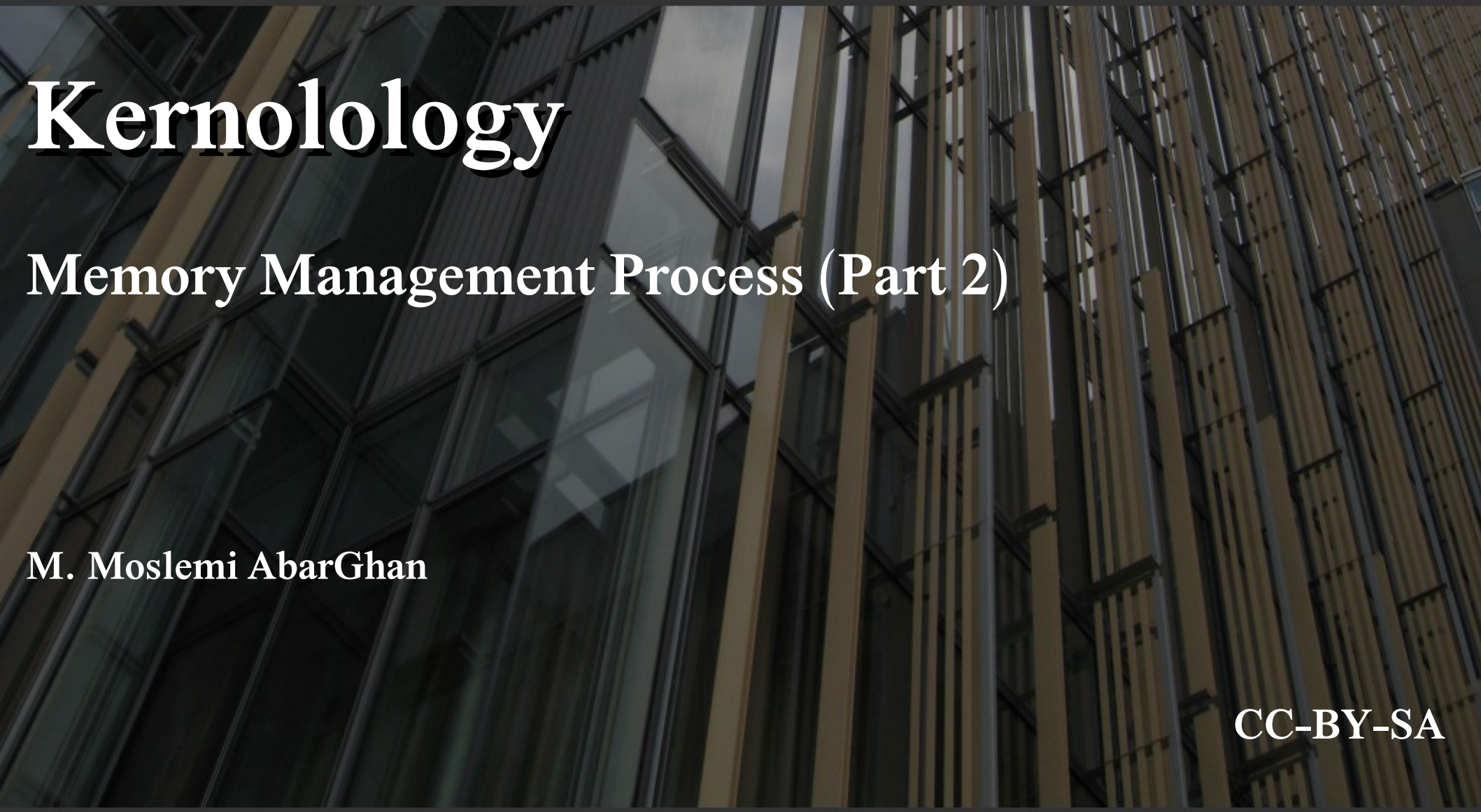


Kernolology

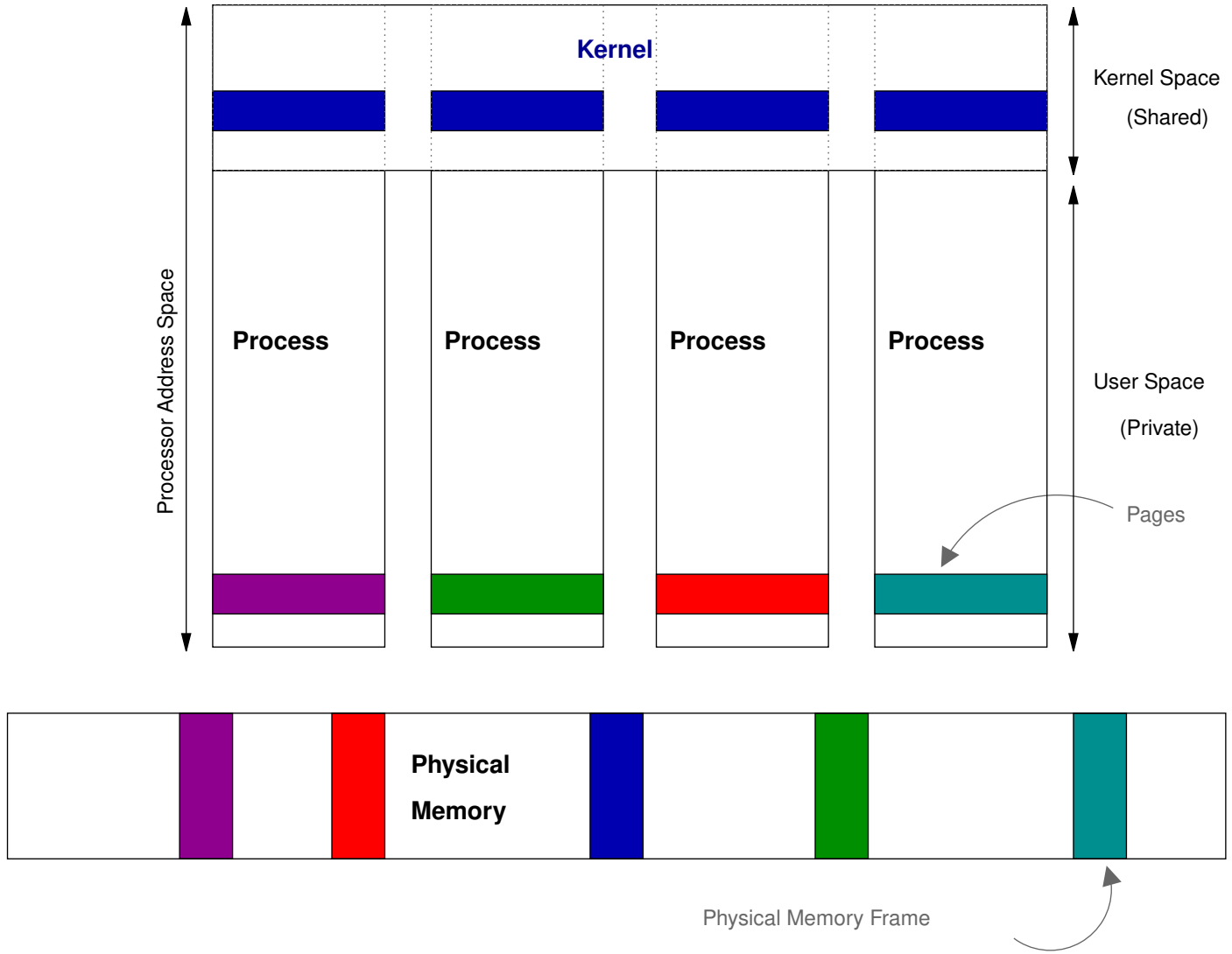
Memory Management Process (Part 2)

M. Moslemi AbarGhan

Memory Paging

Concept: What is the Memory Paging?

Memory Paging is a Fundamental concept in the Linux **Kernel's Memory Management System**. It involves dividing the Virtual and Physical memory into **Fixed-size Blocks** called **Pages** and **Frames**, respectively. Paging enables efficient and flexible use of memory, providing the basis for many **Advanced Memory Management Features**, such as **Virtual Memory**, **Memory Protection**, and **Efficient Swapping**.


Kernel
Kernel Space
(Shared)
Process
Process
Process
Process
Processor Address Space
User Space
(Private)
Pages
Physical
Memory
Physical Memory Frame

Concept: Key Concepts of Memory Paging

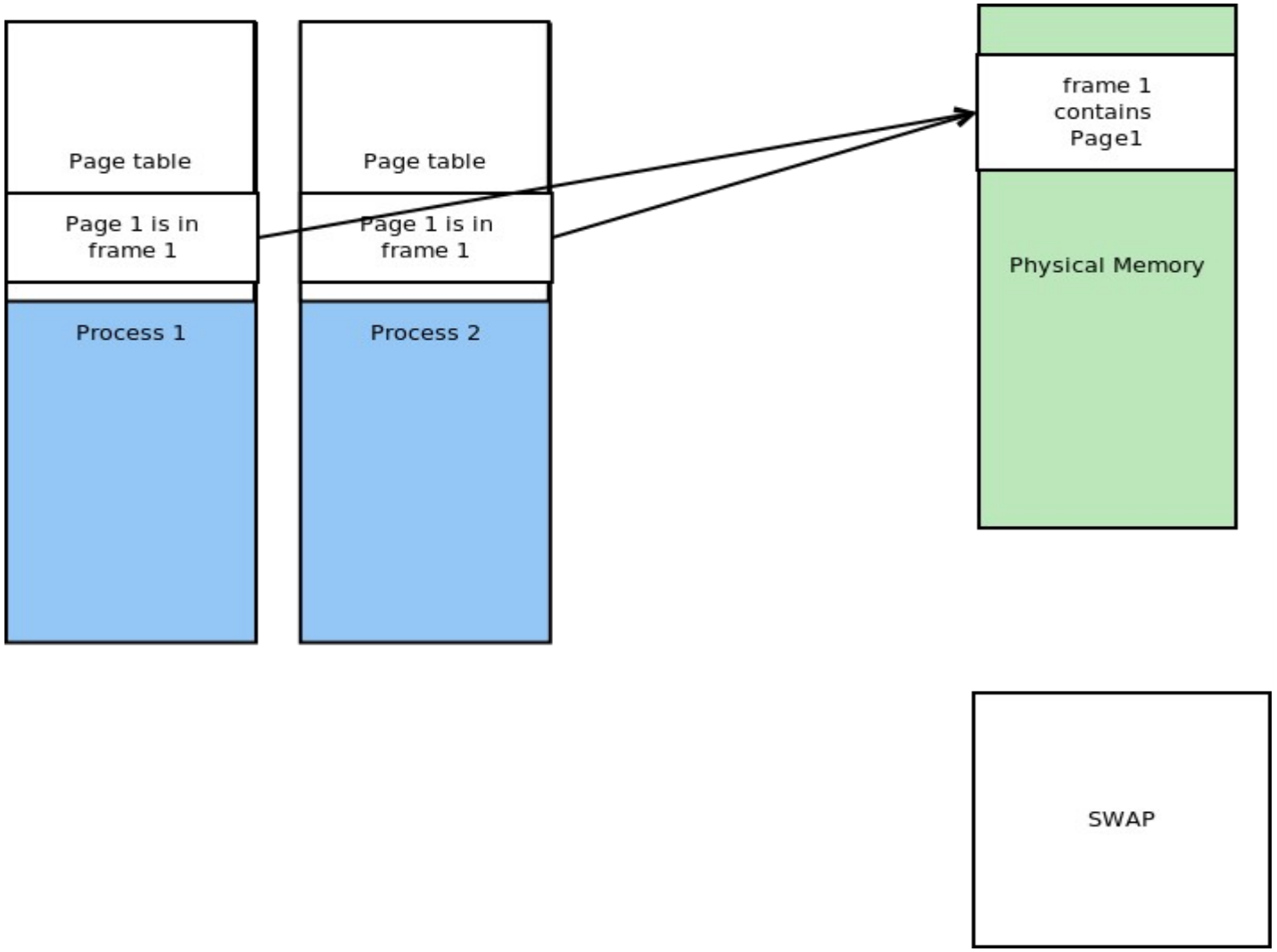
- Pages and Page Frames:

1) Virtual Pages: The basic units of virtual memory, typically 4 KB in size, though larger sizes like 2 MB (huge pages) and 1 GB (gigantic pages) can also be used.

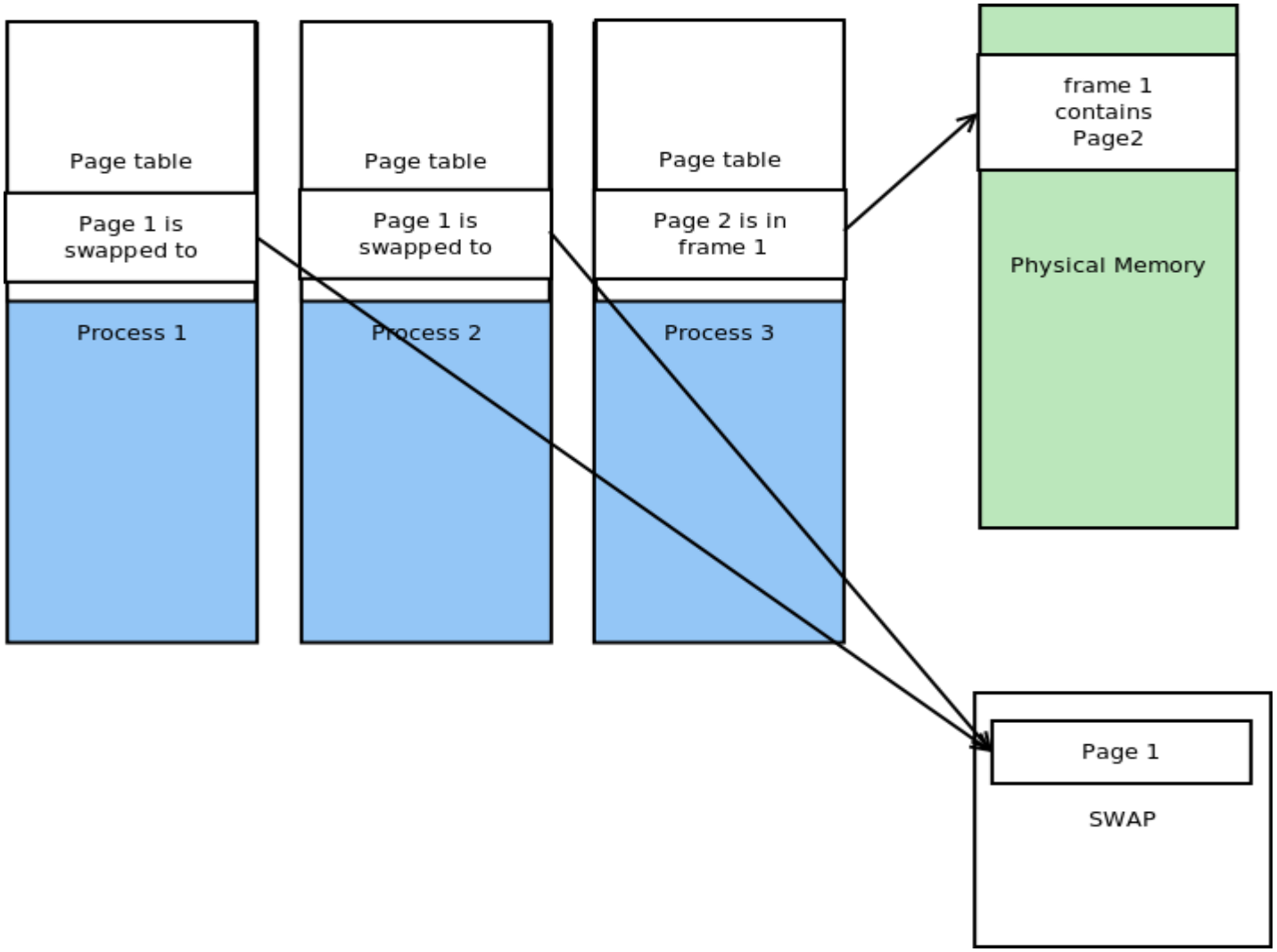
2) Physical Frames: (Page Frames) The corresponding units in physical memory (RAM) where the pages are mapped.

- Page Tables: A data structure used by the kernel to keep track of the mapping between virtual pages and physical page frames.

Concept: Key Concepts of Memory Paging: Page Tables



Concept: Key Concepts of Memory Paging: Page Tables

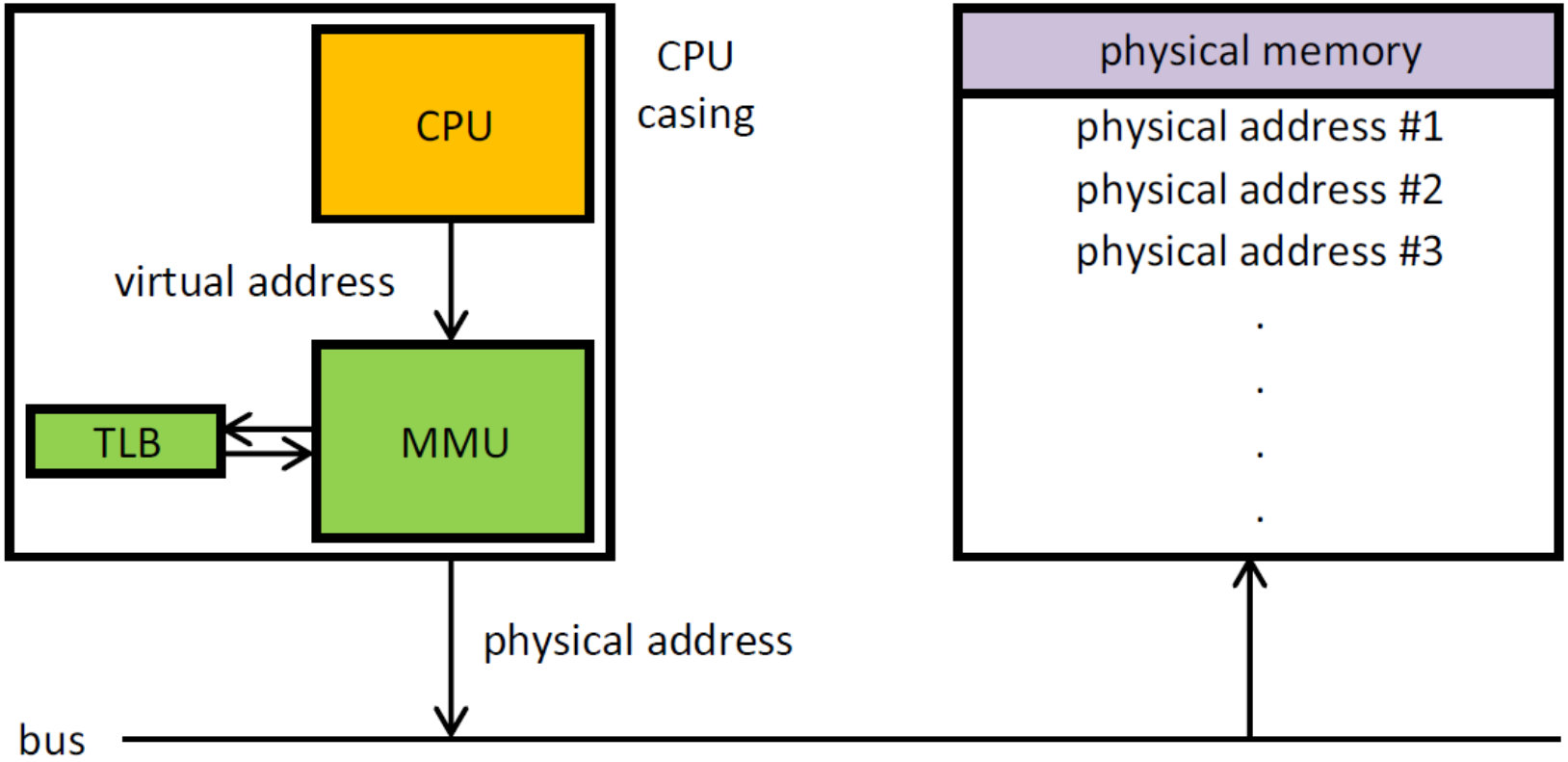


Concept: Key Concepts of Memory Paging

- **Translation Lookaside Buffer (TLB):** A small, fast cache used by the CPU to store recent translations of virtual to physical addresses. The TLB speeds up memory access by reducing the need to repeatedly traverse page tables.

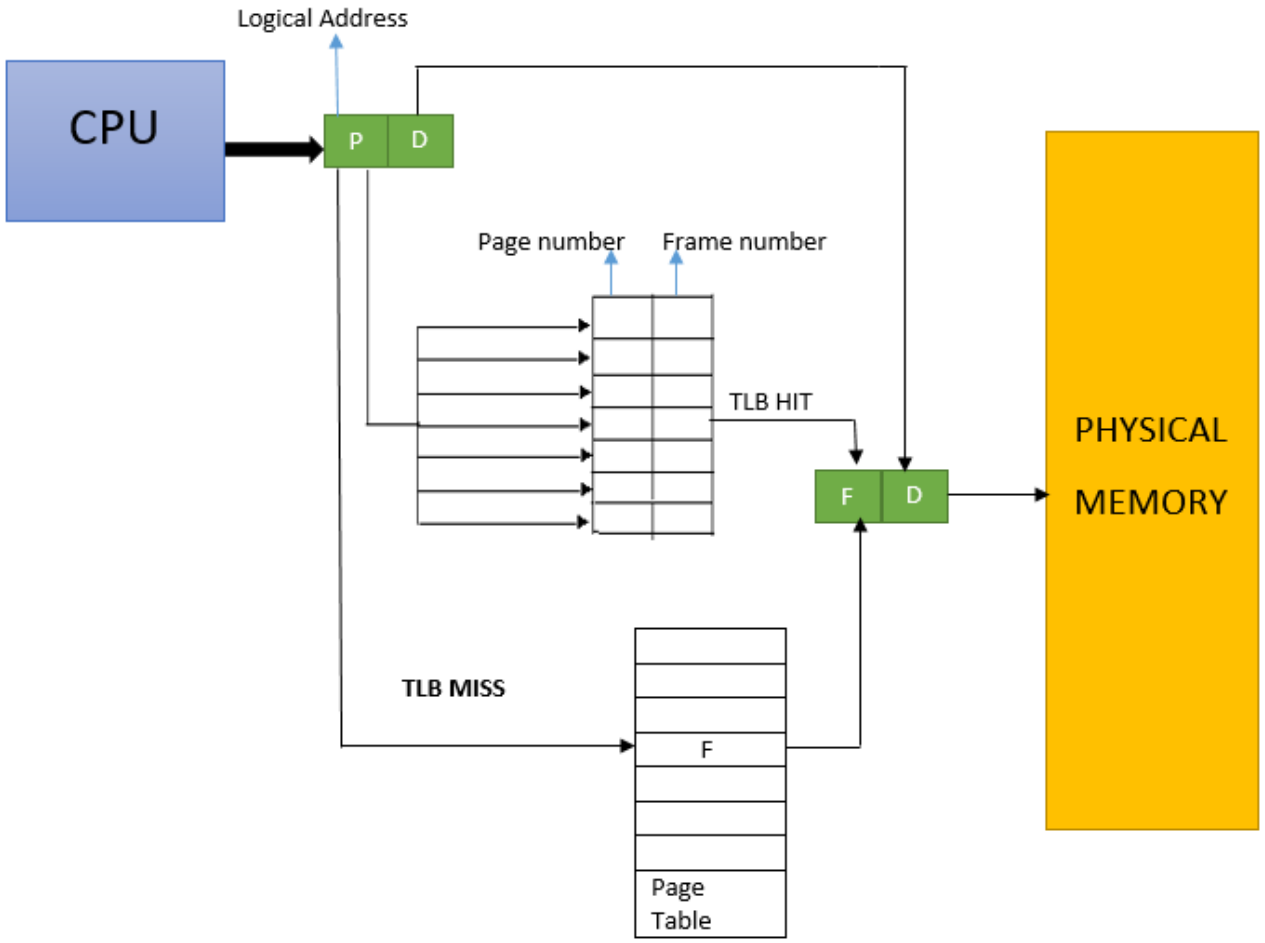
- **Page Faults:** A page fault occurs when a process tries to access a page that is not currently in physical memory (either it's not loaded yet or it has been swapped out). The kernel handles page faults by locating the needed data (from disk, swap space, or other sources), loading it into a free page frame, and updating the page table.

Concept: Key Concepts of Memory Paging: TLB

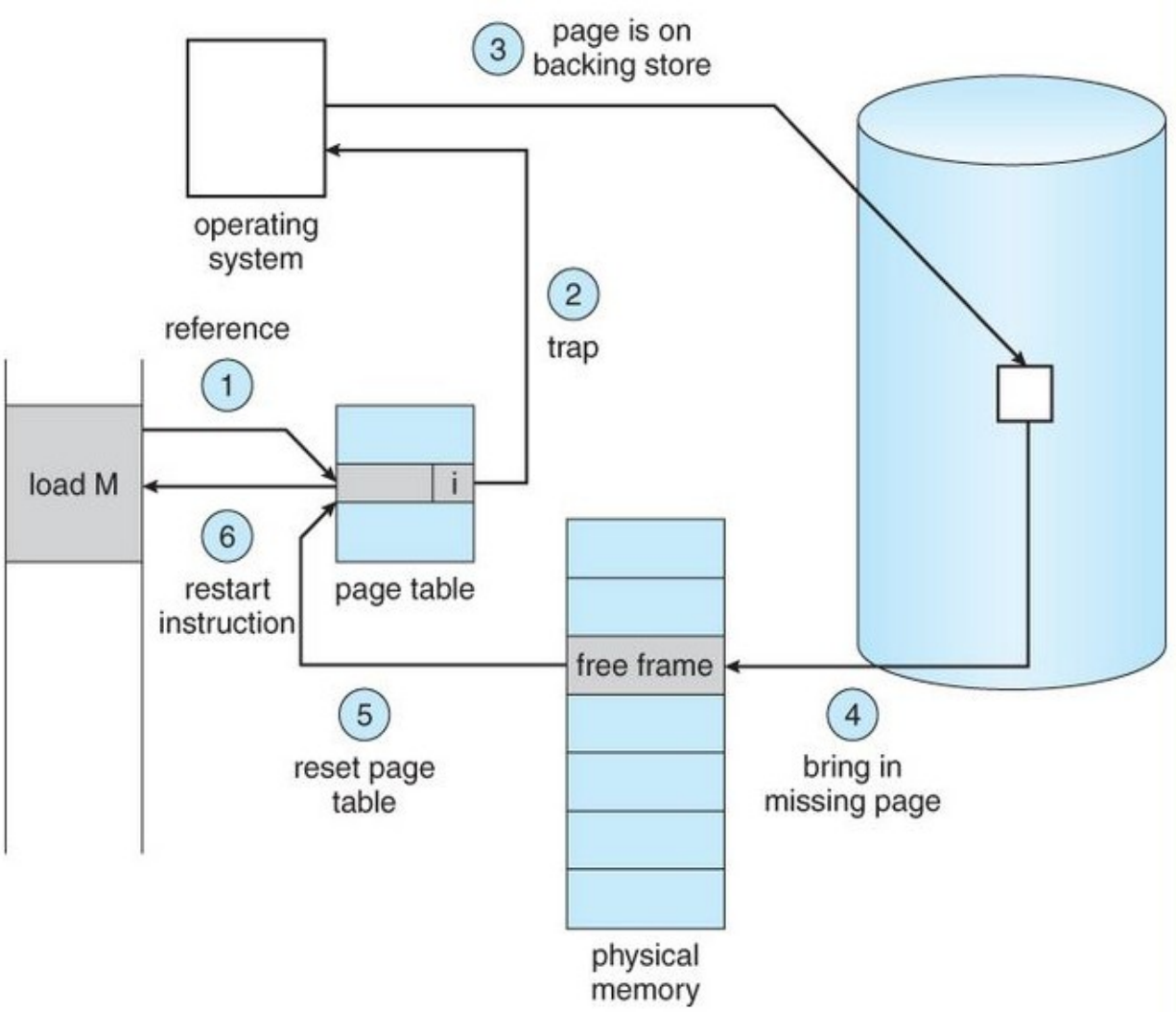


CPU: Central Processing Unit
MMU: Memory Management Unit
TLB: Translation lookaside buffer

Concept: Key Concepts of Memory Paging: TLB



Concept: Key Concepts of Memory Paging: Page Faults

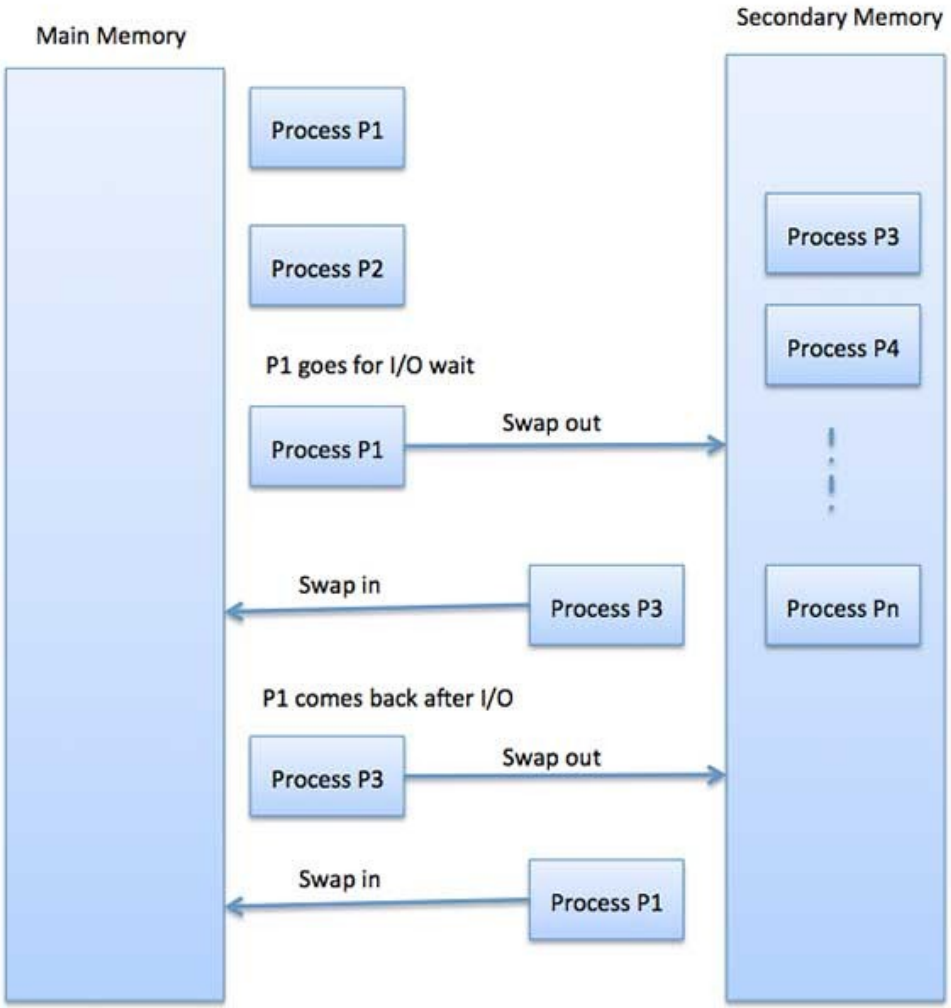


Concept: Key Concepts of Memory Paging

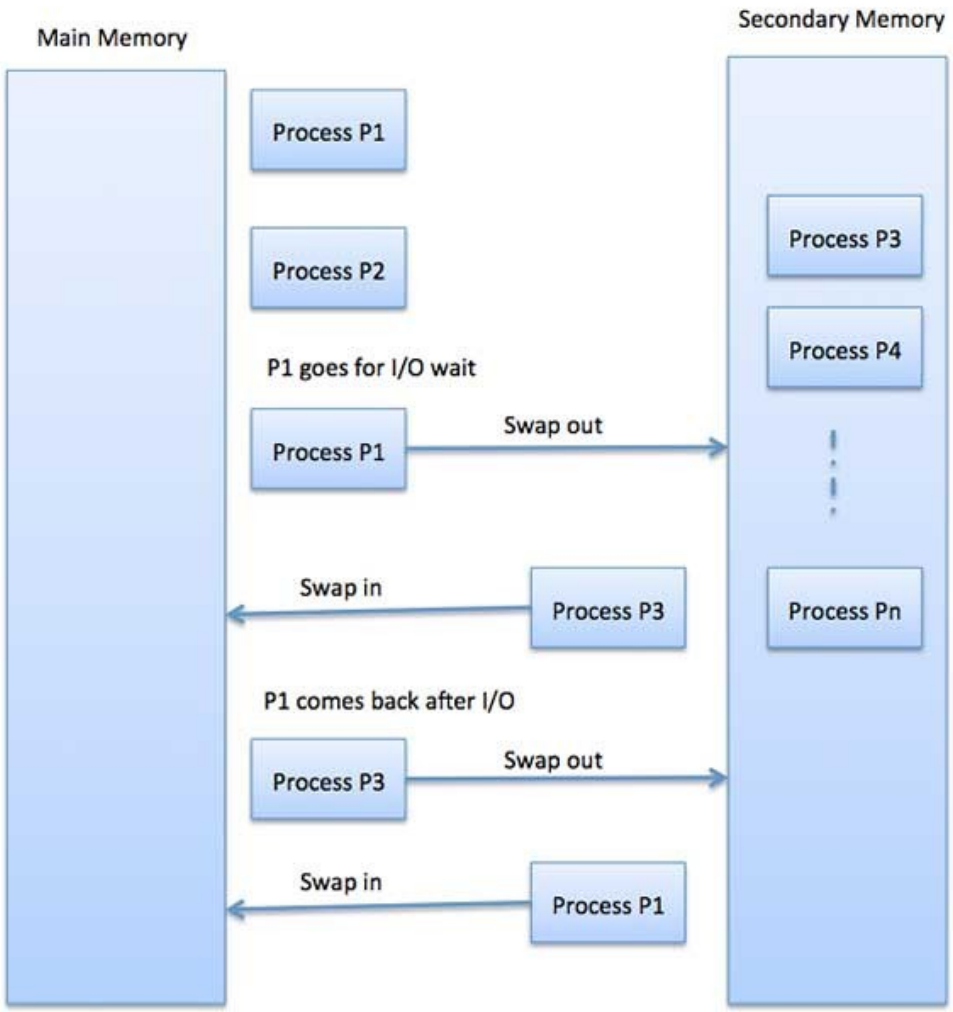
- **Swapping:** When physical memory is full, the kernel can move inactive pages to a swap space on disk. This process, known as swapping, frees up RAM for other active pages. The kernel manages swapping by tracking page usage and selecting less active pages to swap out.

- **Memory Mapping:** The kernel can map files or devices directly into a process's address space. This allows the contents to be accessed as if they were in memory, enabling efficient file and device I/O.

Concept: Key Concepts of Memory Paging: Swapping



Concept: Key Concepts of Memory Paging: Memory Mapping



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