

Computer System

Virtual Memory-Recap

06-01-2024

Agenda

- **Virtual Memory**
- **Key Concepts**
- **How Virtual Memory Works**
- **Benefits of Virtual Memory**
- **Page Replacement Algorithms**
- **Allocation Strategies**
- **Challenges and Considerations**
- **Conclusion**

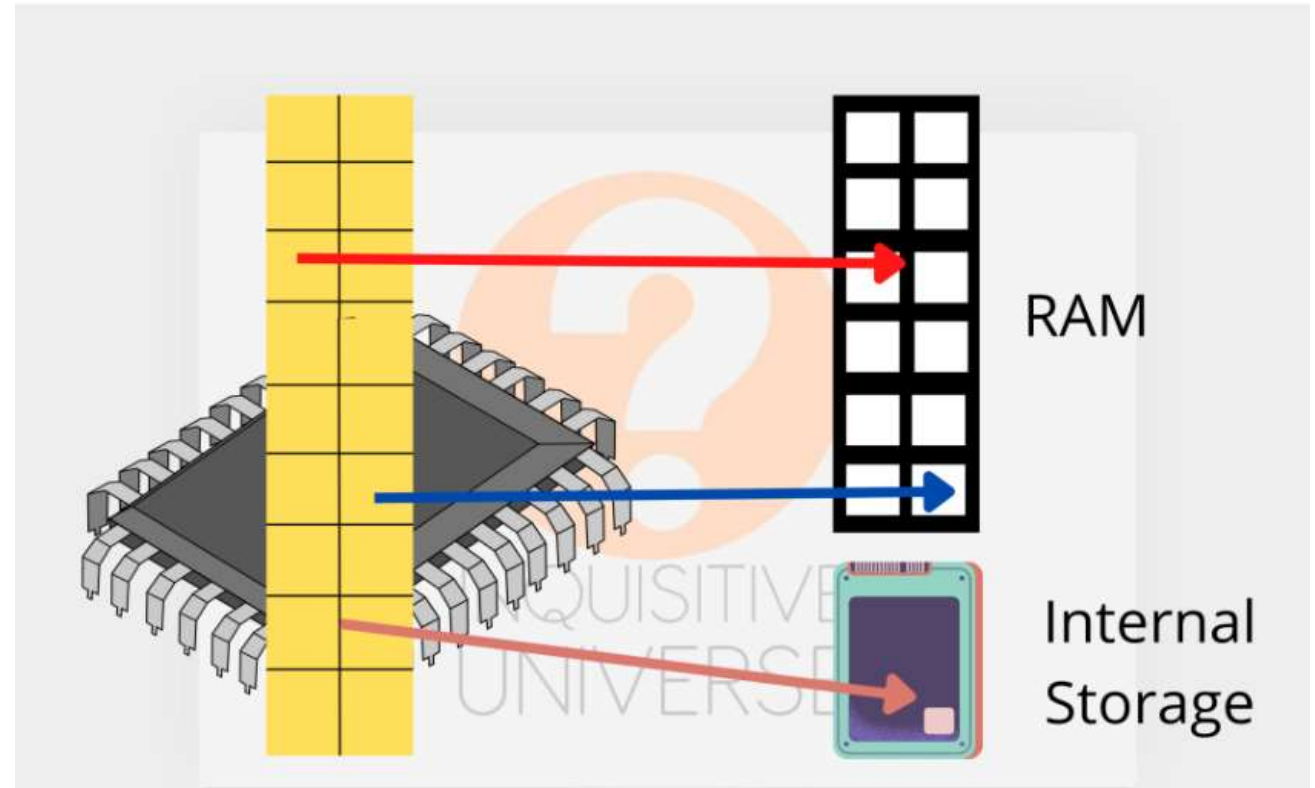
Virtual Memory

- **Definition**

Memory management technique that creates an "idealized abstraction of the storage resources" available on a machine, allowing programs to perceive a large, contiguous memory space regardless of the underlying physical memory.

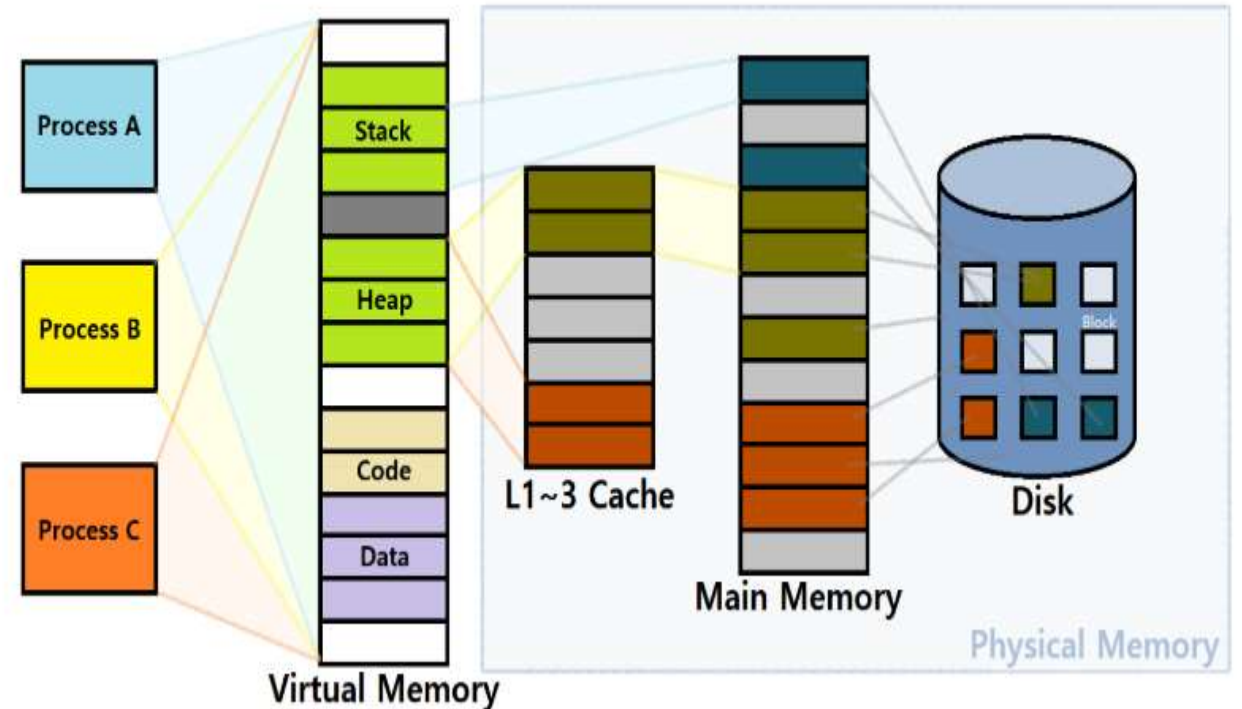
- **Purpose:**

It enables systems to run larger applications or multiple programs simultaneously by utilizing both physical memory (RAM) and secondary storage (disk).



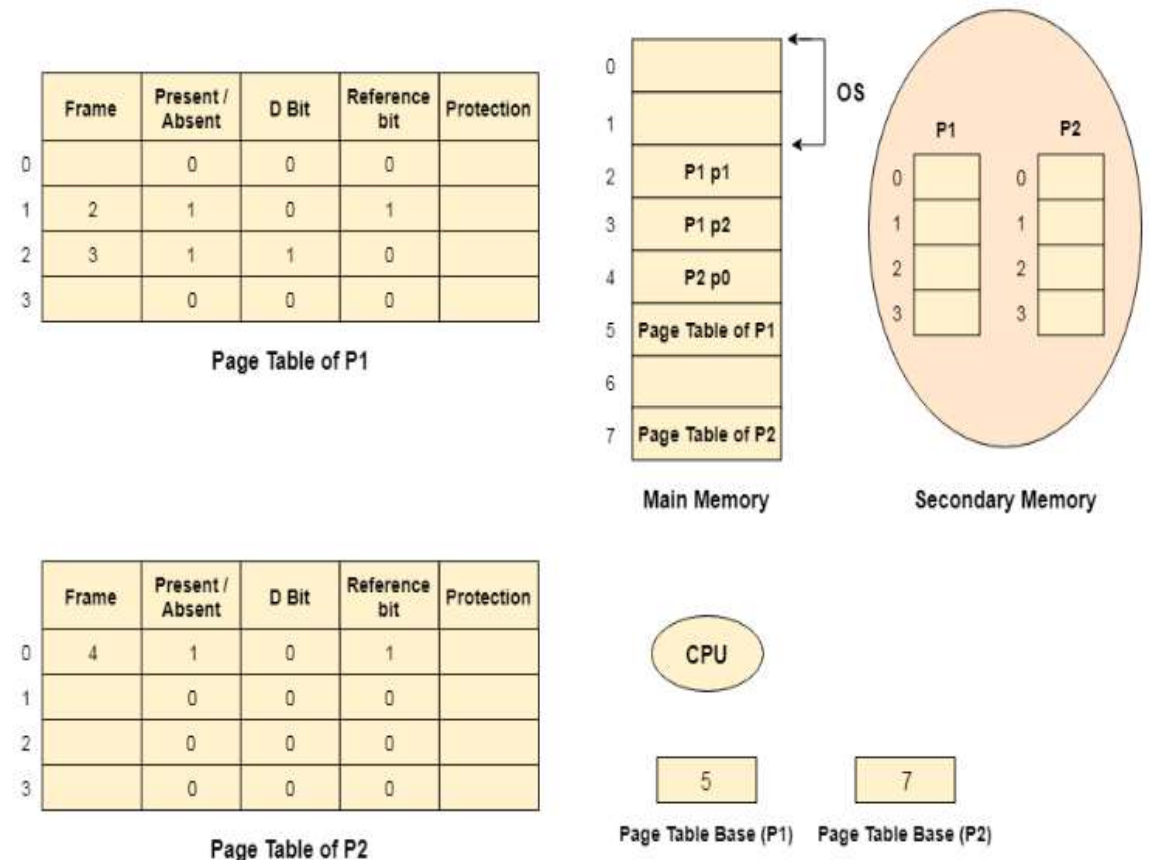
Key Concepts

- **Virtual Address Space:** The range of addresses that an application can use, which the operating system maps to physical
- **Paging:** Divides virtual memory into fixed-size blocks called pages, which correspond to blocks in physical memory known as frames.
- **Segmentation:** Divides virtual memory into variable-sized segments based on logical divisions within a program, such as functions or data structures.



How Virtual Memory Works

- **Address Translation:** The Memory Management Unit (MMU) translates virtual addresses to physical addresses.
- **Page Tables:** Data structures that store the mapping between virtual pages and physical frames.
- **Demand Paging:** Pages are loaded into physical memory only when they are needed, reducing the initial load time and memory usage.



Benefits of Virtual Memory

- **Isolation:** Each process operates in its own virtual address space, enhancing security and stability.
- **Efficient Memory Use:** Allows for more processes to run concurrently by utilizing disk space to extend RAM.
- **Simplified Programming:** Programmers can write code without worrying about the physical memory limitations or allocation.

Page Replacement Algorithms

- **FIFO (First-In-First-Out):** Replaces the oldest page in memory.
- **LRU (Least Recently Used):** Replaces the page that hasn't been used for the longest period.
- **Optimal:** Replaces the page that will not be used for the longest time in the future (theoretical).

Allocation Strategies

- **Equal Allocation:** Each process receives an equal share of the available frames.
- **Proportional Allocation:** Frames are allocated based on the size or priority of each process.
- **Global vs. Local Allocation:** Determines whether page replacement can occur across all processes (global) or is restricted to the process that caused the page fault (local).

Challenges and Considerations

- **Thrashing:** Occurs when excessive paging operations reduce overall system performance.
- **Overhead:** Maintaining page tables and performing address translations can introduce computational overhead.
- **Security:** Ensuring that processes cannot access each other's memory spaces without permission.

Conclusion

- Virtual memory allocation is a fundamental aspect of modern operating systems, providing flexibility, security, and efficient use of resources.
- Understanding its mechanisms and strategies is crucial for system optimization and effective application development.