

# Virtual Memory

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# What is Virtual Memory?

- Virtual memory is a memory management technique that provides an “illusion” of a large main memory.
- It allows execution of processes that may not be completely in main memory.
- Provides abstraction between logical (virtual) and physical addresses.

## Key Idea

Separation of user logical memory from physical memory.

# Logical and Physical Address

## Logical Address (Virtual Address)

- Generated by the CPU during program execution.
- Refers to a location in the **virtual address space**.
- Each process has its own separate logical address space.

## Physical Address

- The actual location in the main memory (RAM).
- Corresponds to the hardware memory unit.
- Generated by the **Memory Management Unit (MMU)** after address translation.

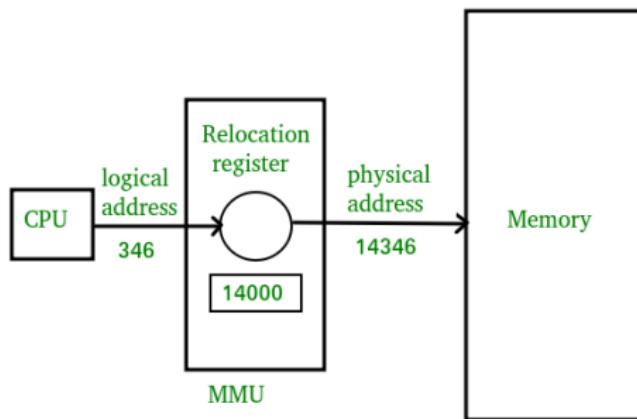
## Key Point

- Users work with logical addresses, while hardware deals with physical addresses.
- The MMU maps logical addresses to physical addresses dynamically.

# Address Translation

## Concept

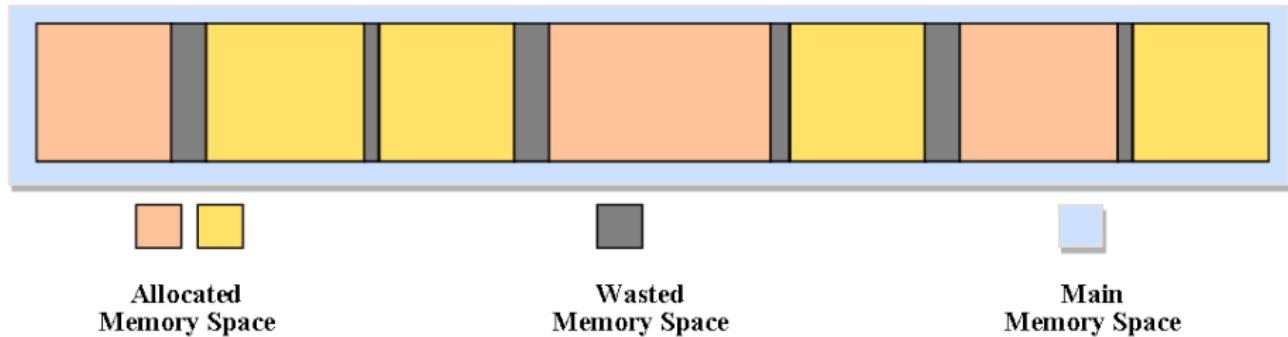
- Address translation is the process of converting a **logical (virtual) address** into a **physical address**.



# Need for Paging

## Problem with Contiguous Allocation

- In contiguous memory allocation, each process must occupy a single continuous block in physical memory.
- Leads to **external fragmentation**.
- Difficult to allocate memory when free space is scattered.

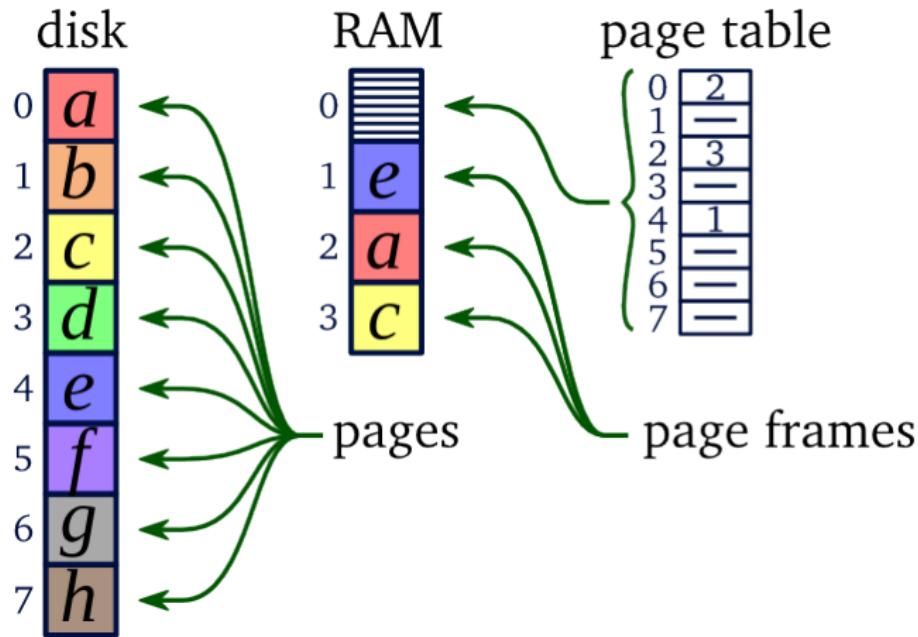


## Solution

- **Paging** allows non-contiguous allocation of physical memory.
- Divides both logical and physical memory into fixed-size blocks.

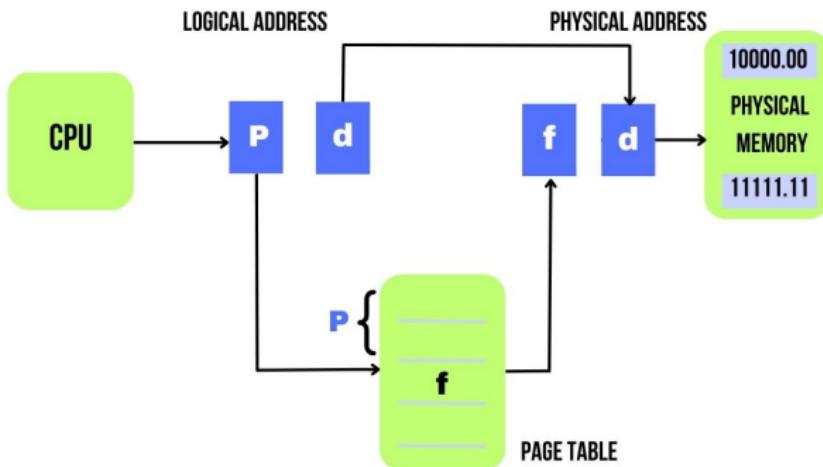
# Paging

- Divides physical memory into fixed-size blocks called **frames**.
- Divides logical memory into blocks of same size called **pages**.
- Page table maintains mapping between pages and frames.



# Steps in Address Translation

- ① CPU generates a logical address.
- ② The MMU divides it into:
  - **Page Number (p)** – used as an index into the page table.
  - **Page Offset (d)** – combined with frame number to form physical address.
- ③ The page table provides the corresponding **frame number**.
- ④ The frame number and offset are concatenated to form the physical address.



# Conclusion

- Virtual memory bridges the gap between limited physical memory and large program demands.
- It provides abstraction, flexibility, and security at a manageable performance cost.

**Thank You!**