COMPUTER ARCHITECTURE AND SOFTWARE EXECUTION PROCESS

MEMORY MANAGEMENT

Bachelor in Artificial Intelligence, Data and Management Sciences
CentraleSupelec and ESSEC Business School - 2024/2025

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OUTLINE

Back to the begin - Back to the outline

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MEMORY FOR WHOM AND WHY ?

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- When a machine is started, the **OS** is the **first program** loaded into memory.
- The **OS** needs a **memory space** for :
  - the **code** of its **Core**
  - the **interruptions** table
  - the **processes** table
  - data structures (**PCBs** and others)
  - ...

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For processes (running programs)

- When a process is created, the **OS creates a PCB** and allocates memory for the process.
- For **security** reasons, each **process** must use a separate memory area (**an address space**).
  - which mechanism for **allocating** this space ?
  - how to ensure the **protection** of this area ?
  - how to ensure the **transparency** of this space ?

STORAGE SPACE

Ordered set of **memory words** indexed by their **address** (box number) and containing :

- instructions $\rightarrow$ **PC** register on the processor
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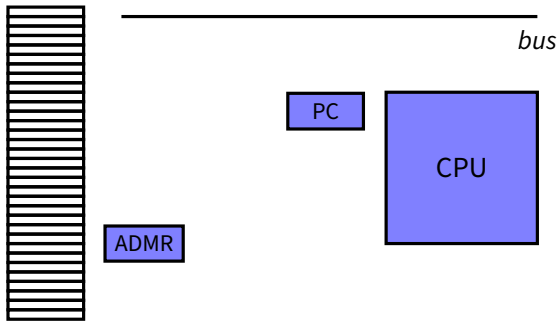

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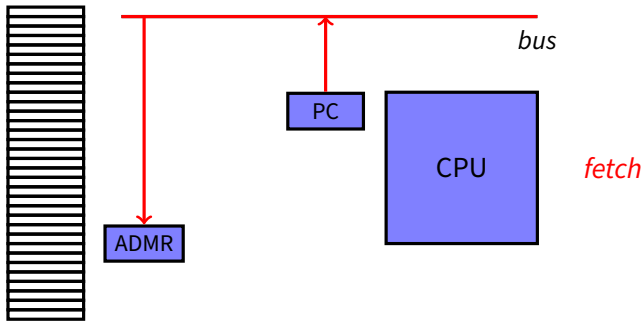

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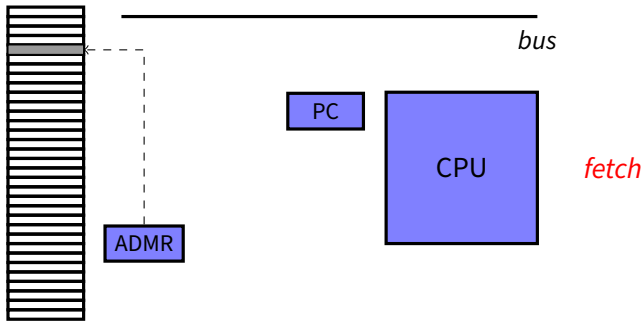

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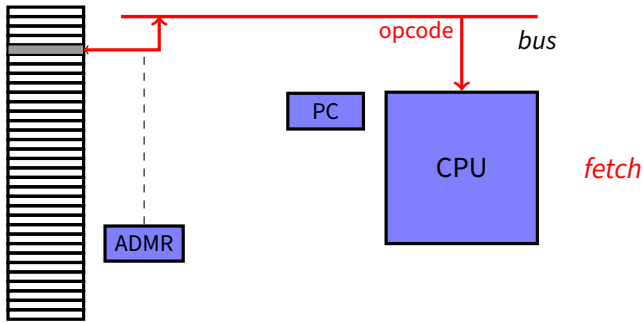

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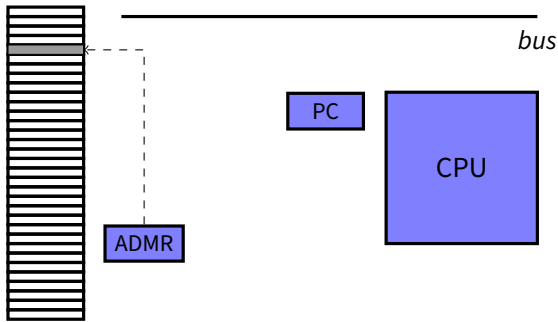

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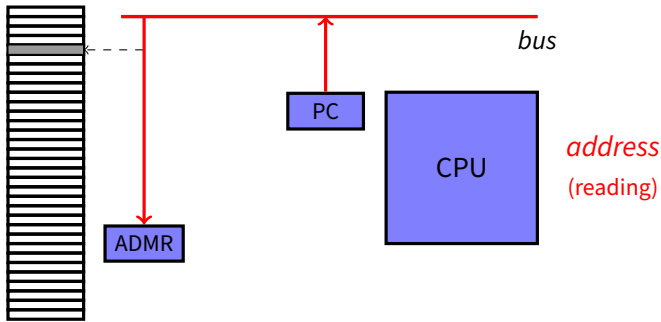

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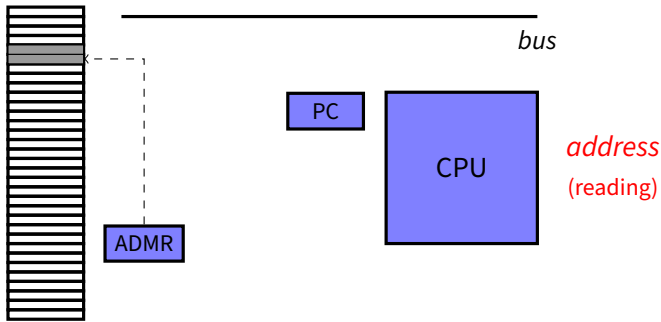

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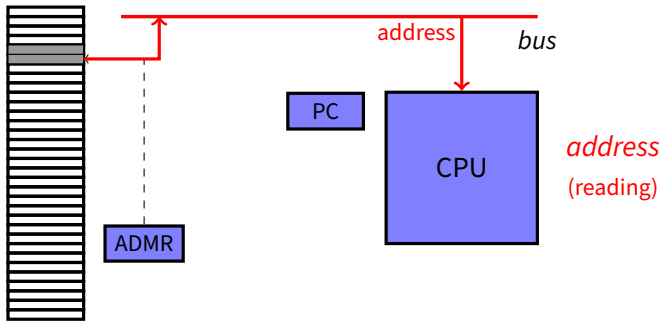

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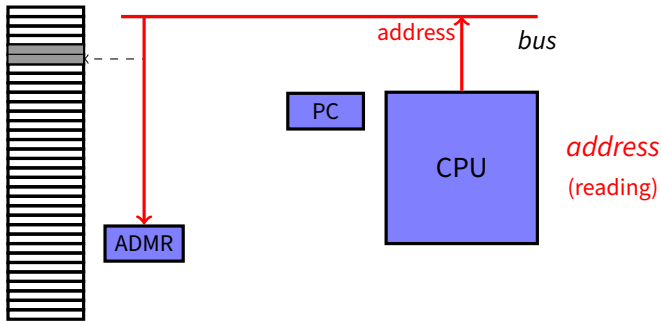

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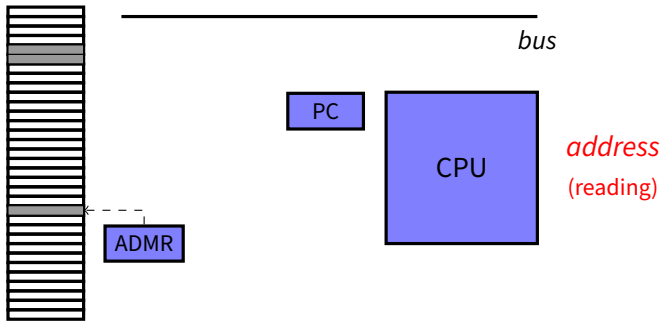

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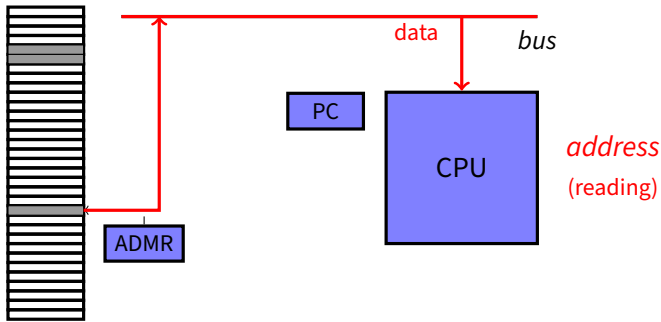

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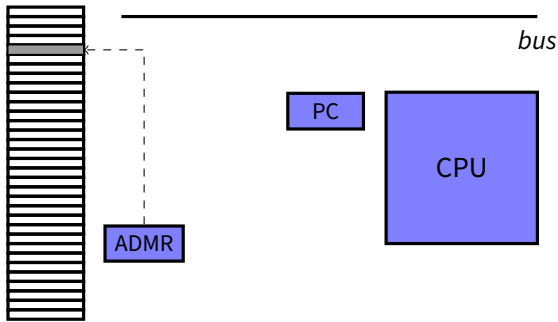

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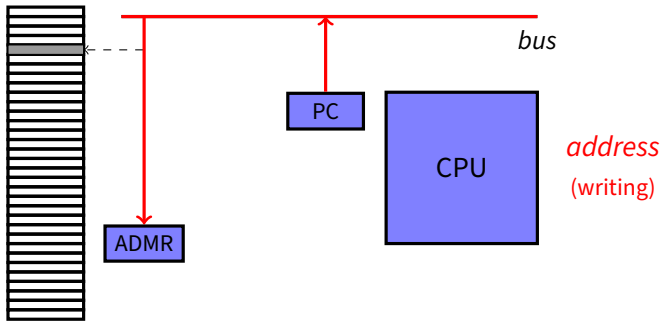

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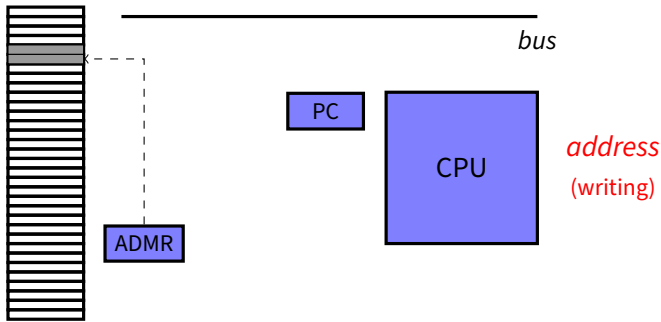

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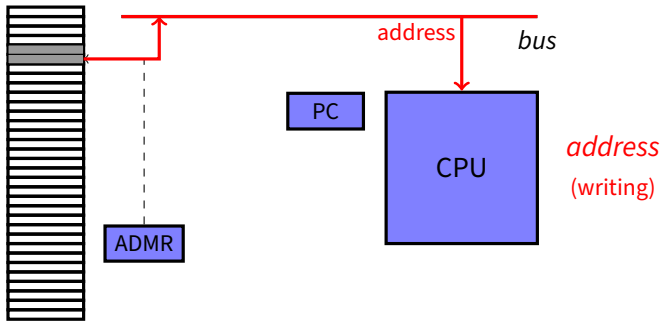

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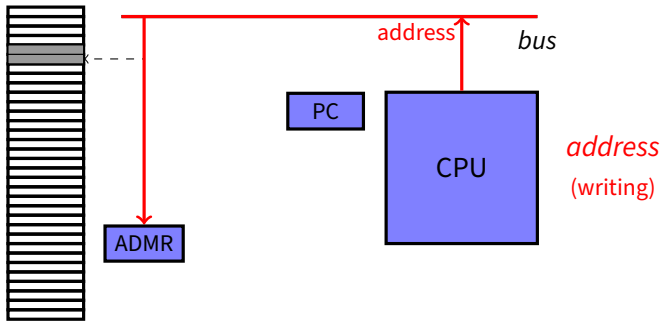

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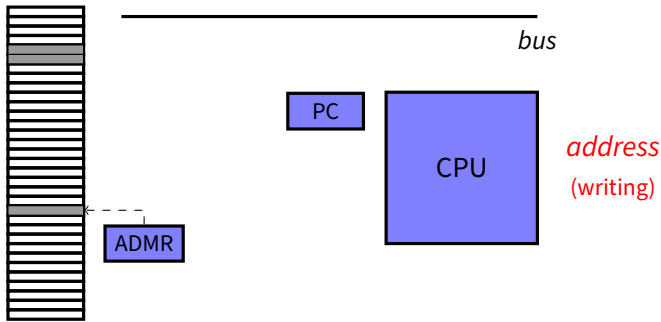

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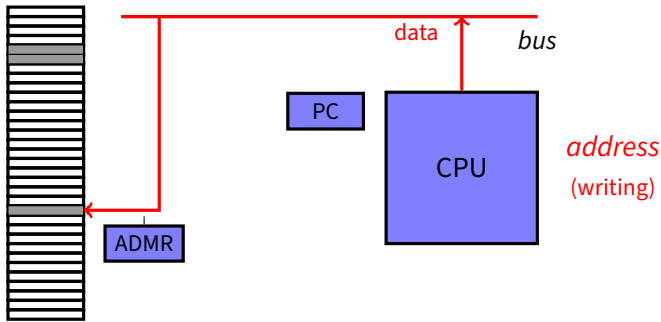

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- **Example** : 32 bits $\rightarrow 2^{32} \approx 4$ GB

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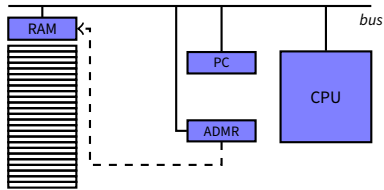
HOW MEMORY WORKS



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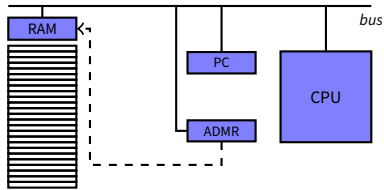

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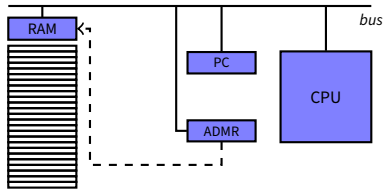

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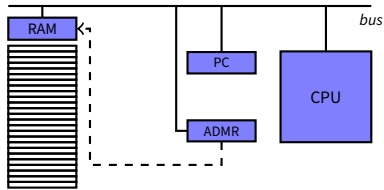
- TThe **CPU** writes on variables **at a given address** in memory.



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ADDRESS SPACE USAGE

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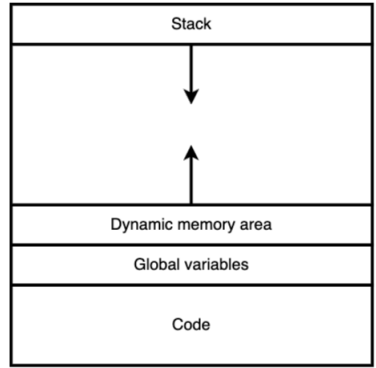
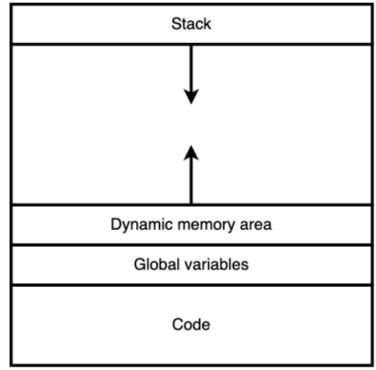


ADDRESS SPACE USAGE

- What does a process's memory space contain ?
  - Code (known size)
  - Global variables (known size)
  - Stack (unknown size)
  - Dynamic memory area (unknown size)
  - ...



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Question
what are the addresses of the variables in memory ?

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symbolic addresses vs **memory** addresses

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Link editing

When creating processes, the **OS** instantiates the program.

- transform **names** of variables into **addresses**.

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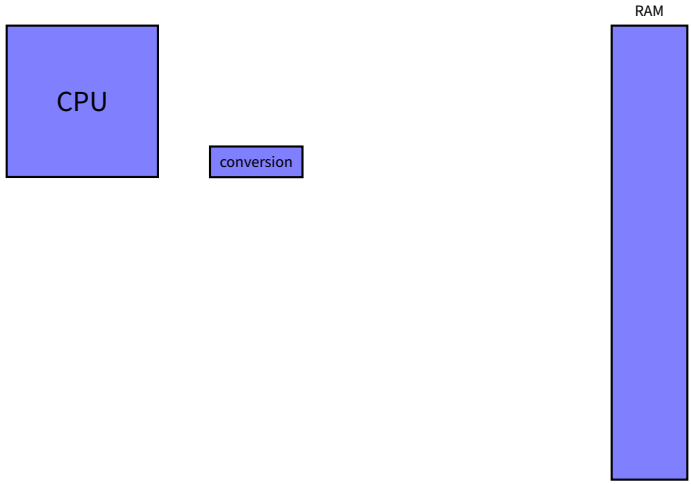
ADDRESS RESOLUTION

MEMORY MANAGEMENT UNIT - MMU



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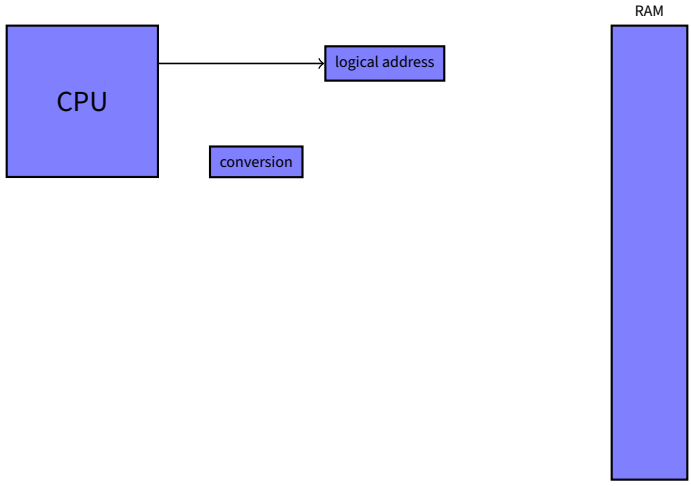

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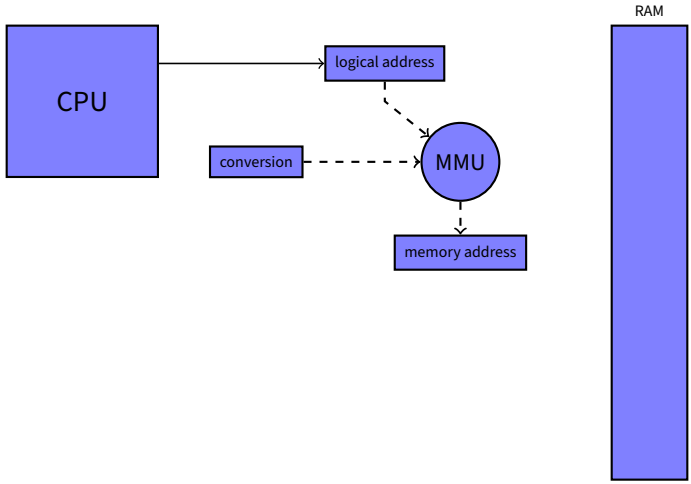

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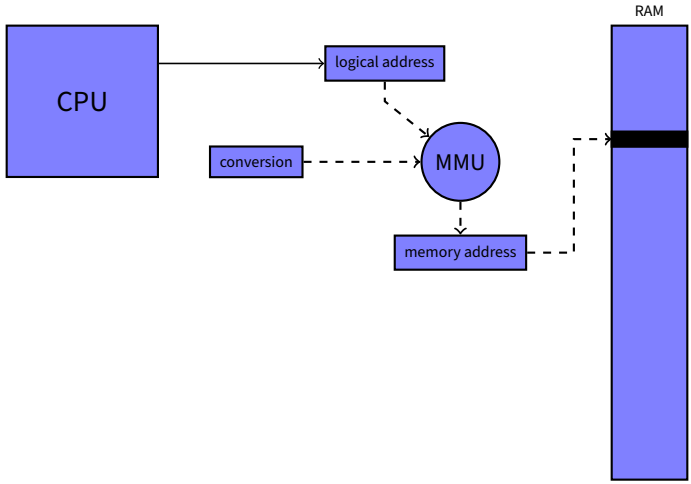

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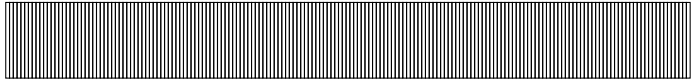
  2. **Non-contiguous allocation** (**by pagination**)

MULTIPROGRAMMING WITH PARTITIONS

Processes constitute **a single, non-decomposable block**.

RAM



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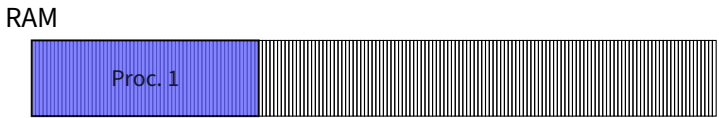

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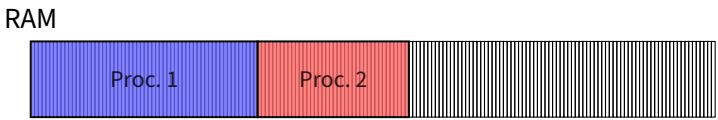

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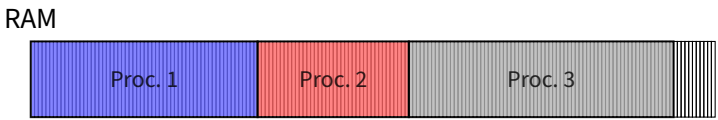

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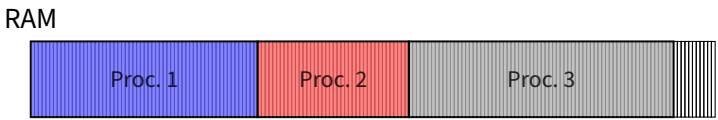

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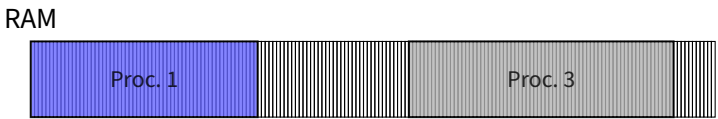

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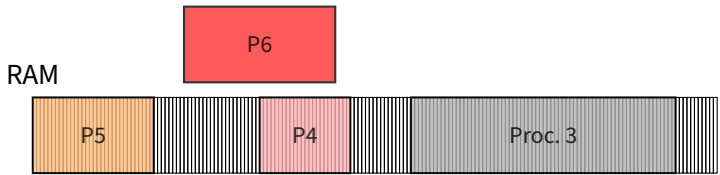

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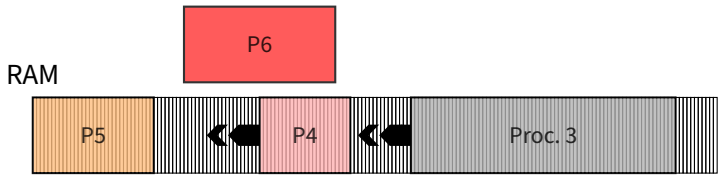

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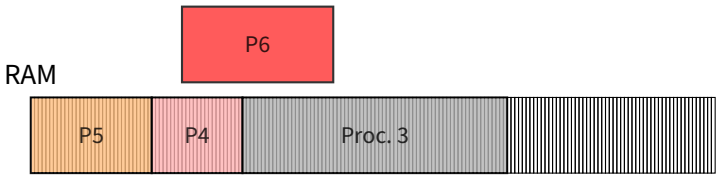

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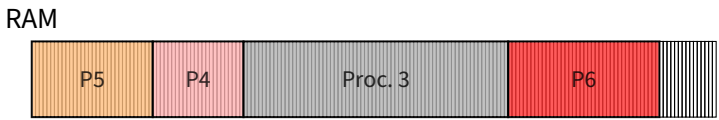

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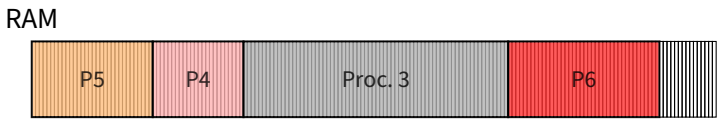

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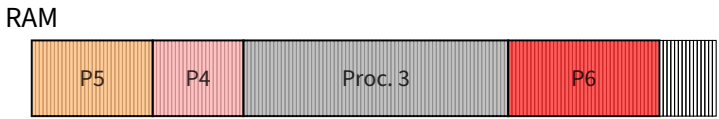

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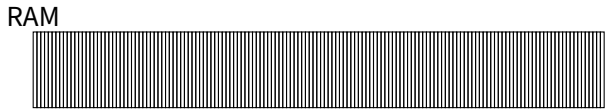

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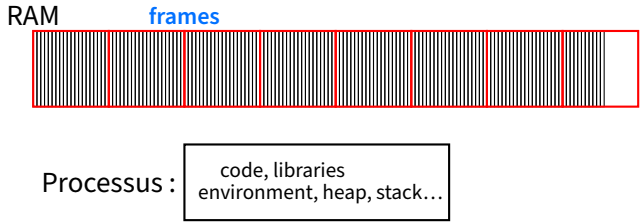

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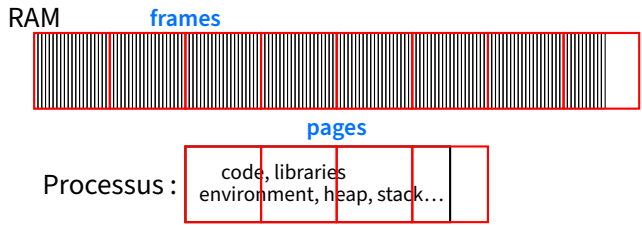

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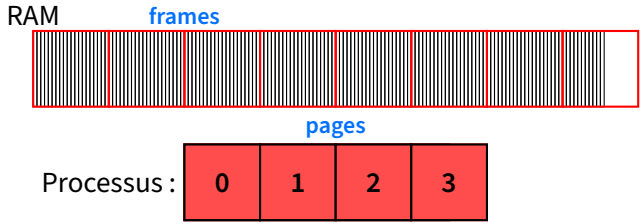

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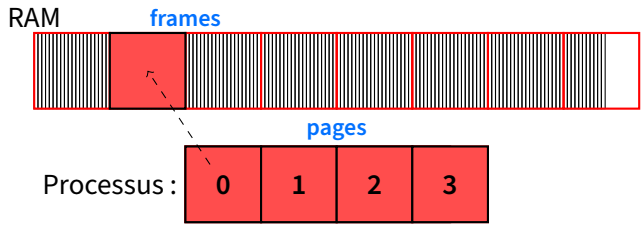

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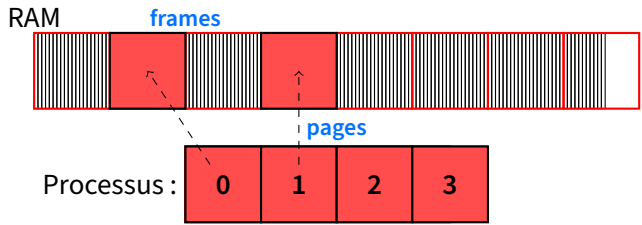

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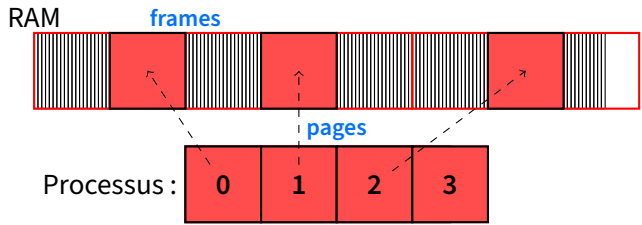

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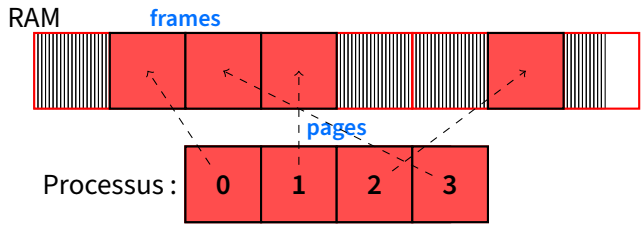

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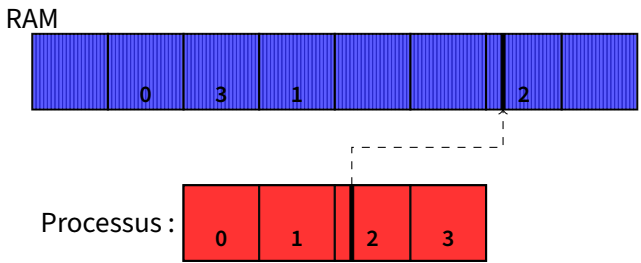

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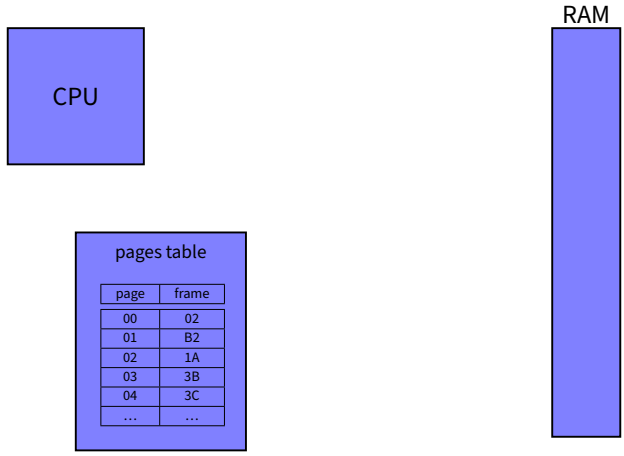

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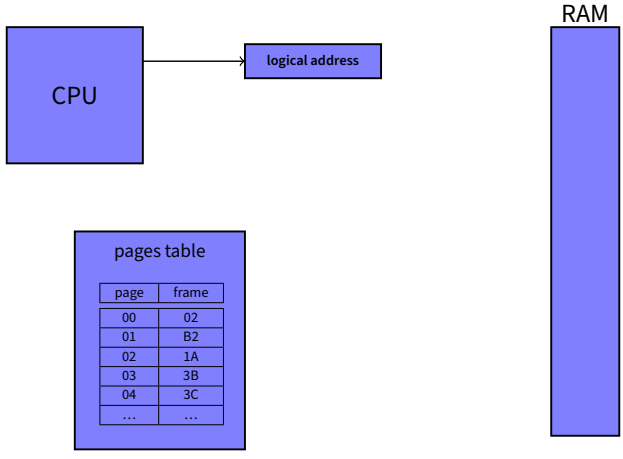

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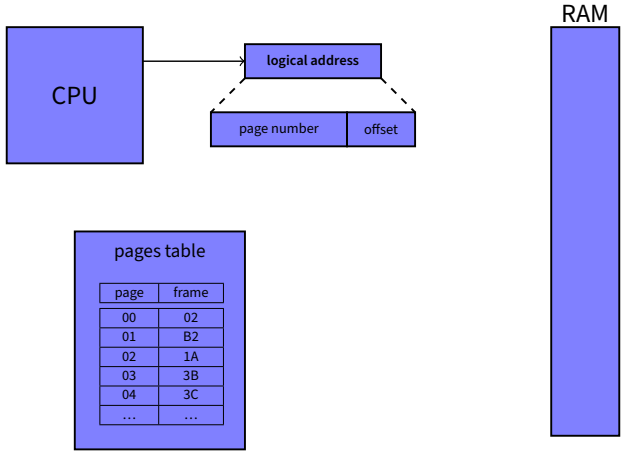

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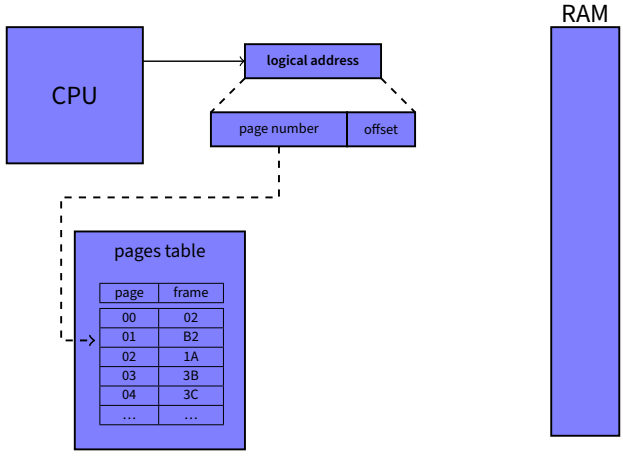

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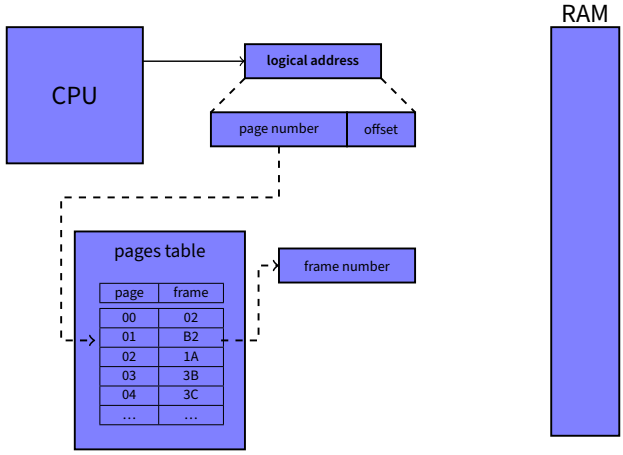

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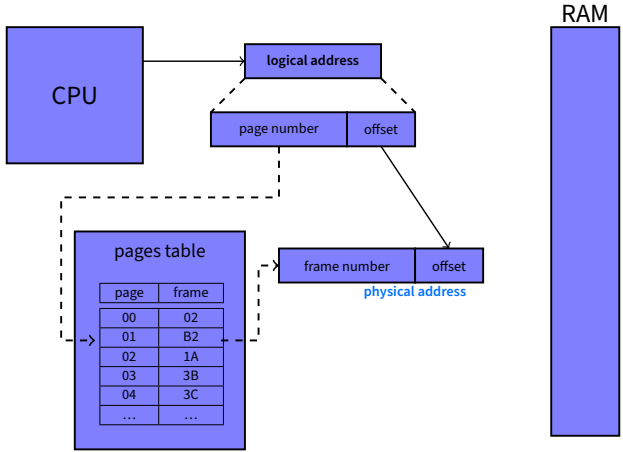

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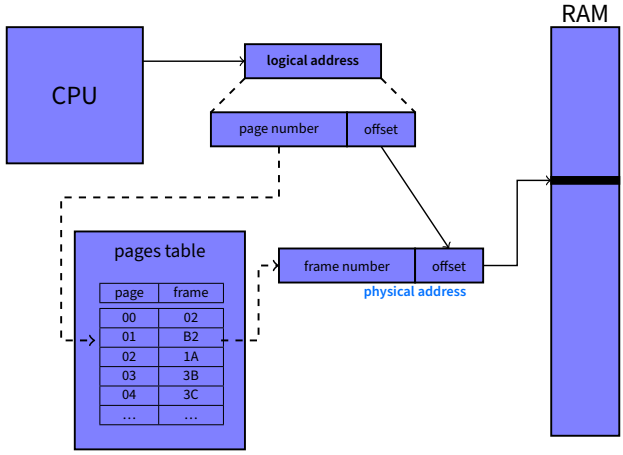

OUTLINE

Back to the begin - Back to the outline

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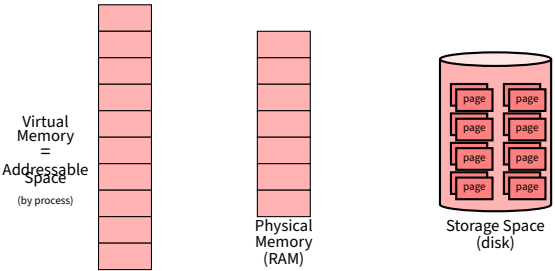

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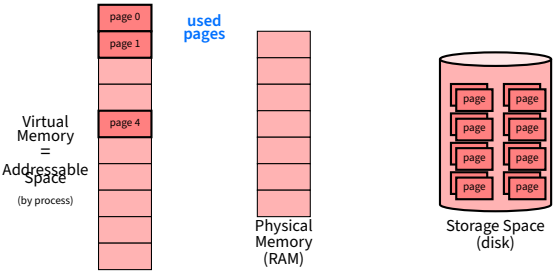

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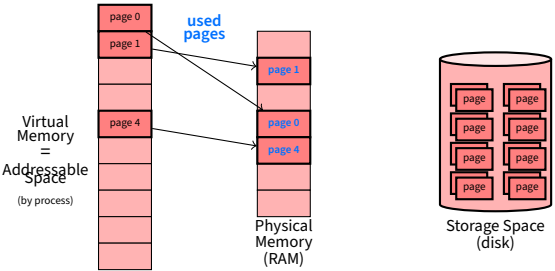

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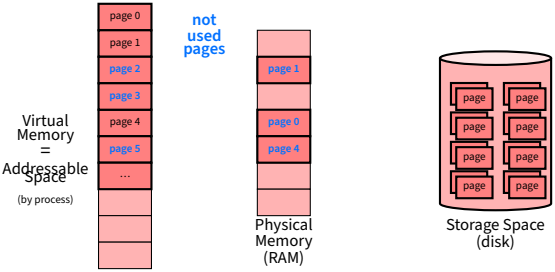

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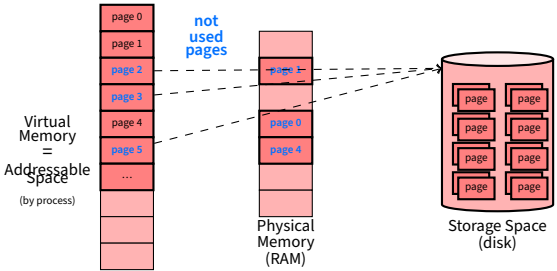

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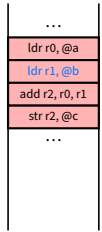
  - ✔ pagination on demand

PAGINATION ON DEMAND



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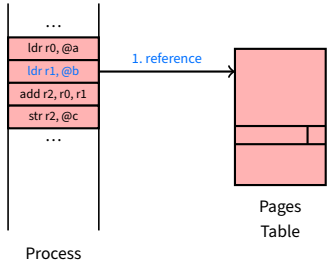

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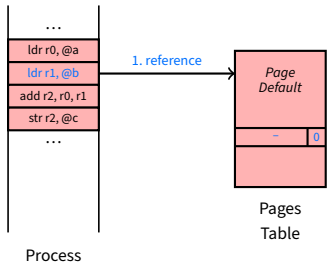

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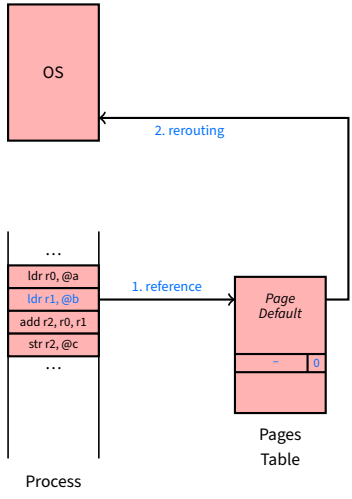

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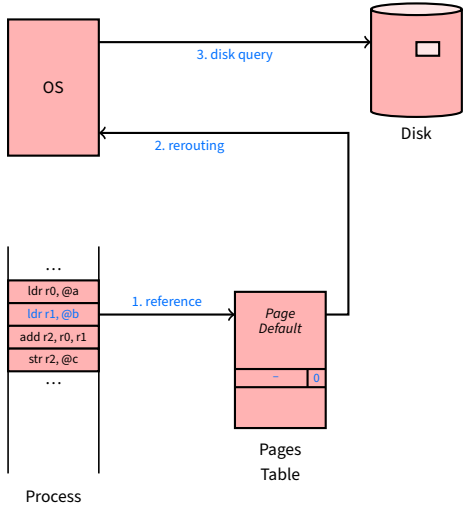

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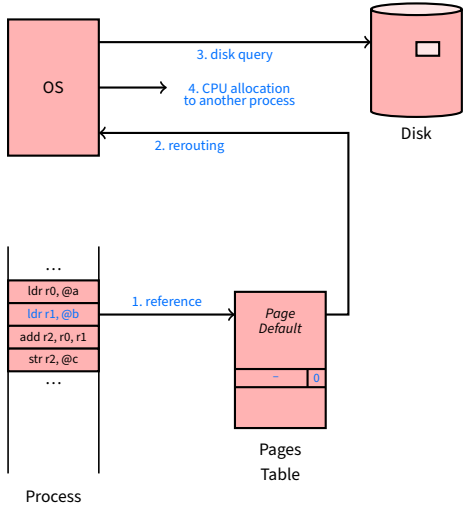

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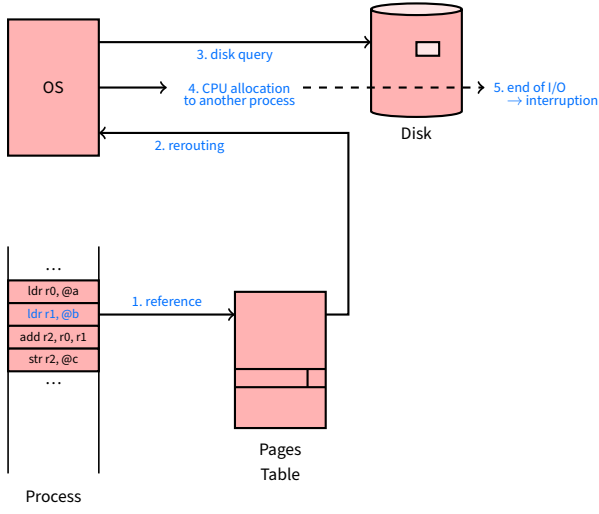

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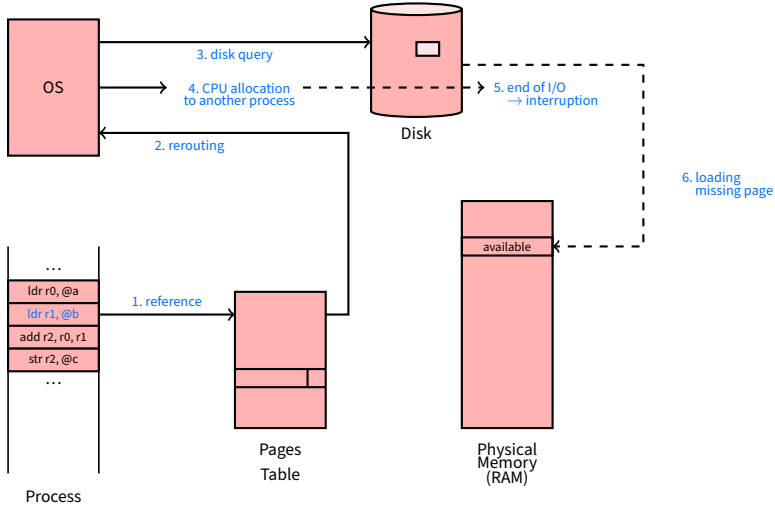

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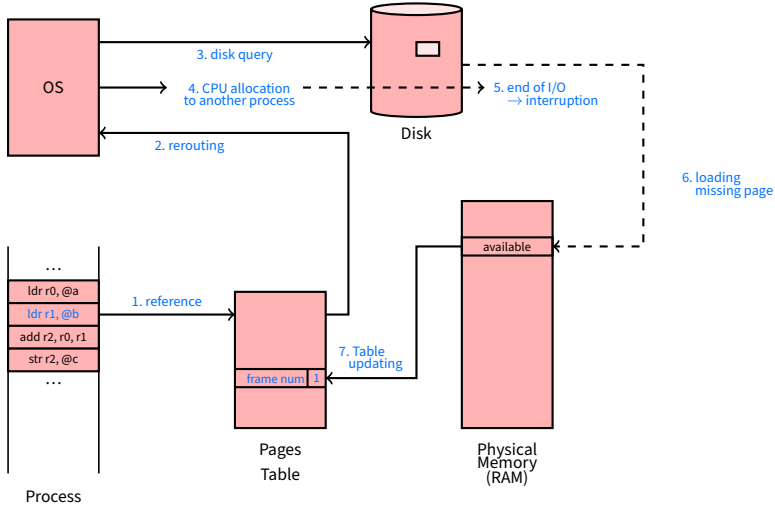

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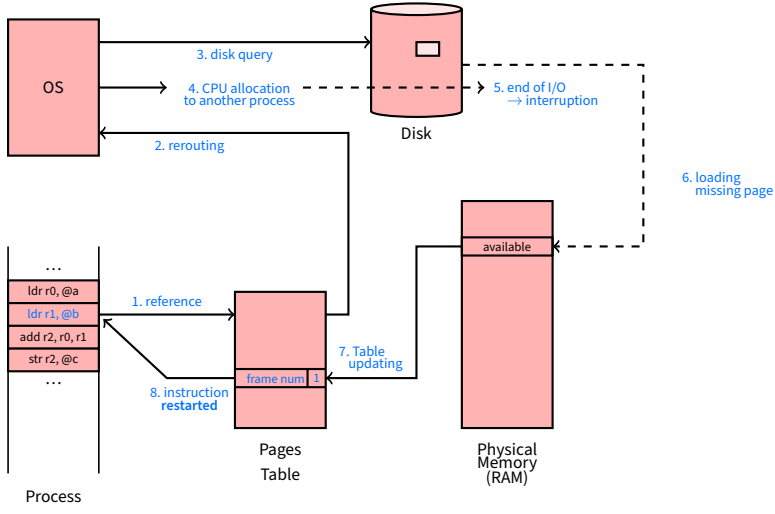

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