

# Discussion 18

# IO & Virtual Memory

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# Short intro to OS

- One of the first things that runs when your computer starts
- Loads, runs and manages programs
- Services: File System, Network stack, printer, etc.
- Finds and controls all the devices in the machine in a general way.

# Short intro to OS

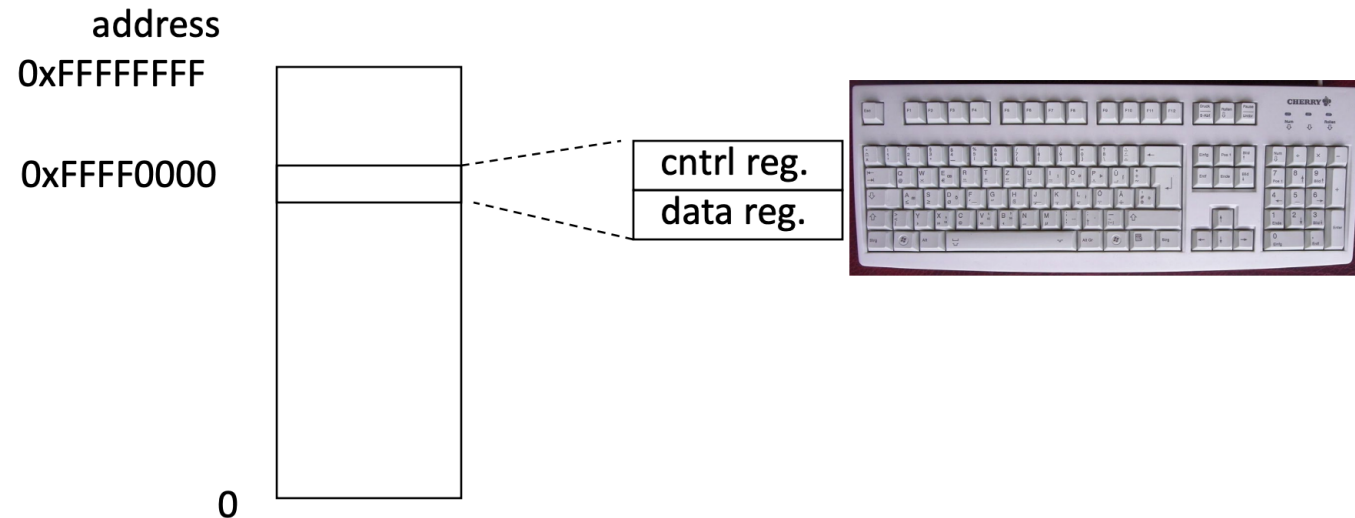
- Provide interaction with the outside world (Interact with devices)
- Provide isolation between running programs (processes)
  - Virtual Memory
  - Difference between Threads & Processes

# IO – Program interact with outside world

- What must the processor do for I/O?
  - Input: reads a sequence of bytes
  - Output: writes a sequence of bytes
- Interface options
  - Some processors have special input/output instructions
  - Memory Mapped Input/Output (used by RISC-V)

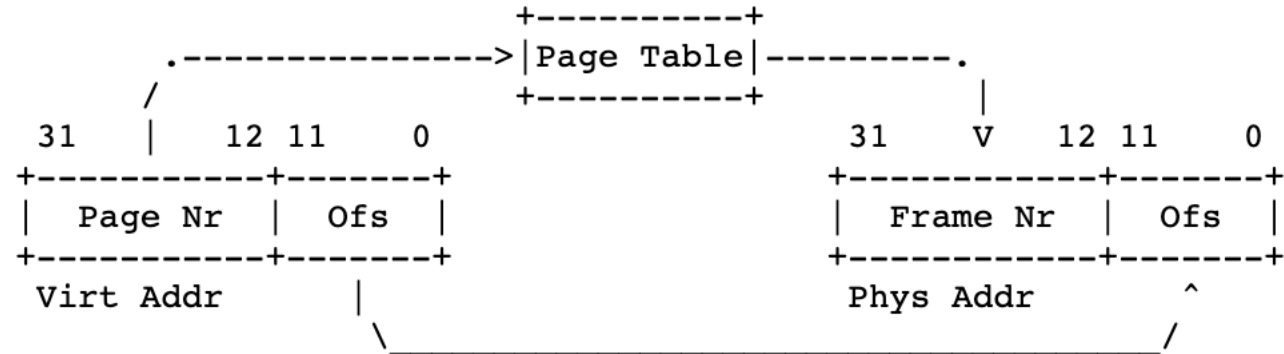
# Memory mapped IO

- Certain addresses are not regular memory
- Instead, they correspond to registers in I/O devices
  - Control Register, says if it's OK to read/write (I/O ready)
  - Data Register, contains data



# Virtual Memory - Pages

- A *page*, sometimes called a *virtual page*, is a continuous region of virtual memory 4,096 bytes (the *page size*) in length.
- A *frame*, sometimes called a *physical frame* or a *page frame*, is a continuous region of physical memory.

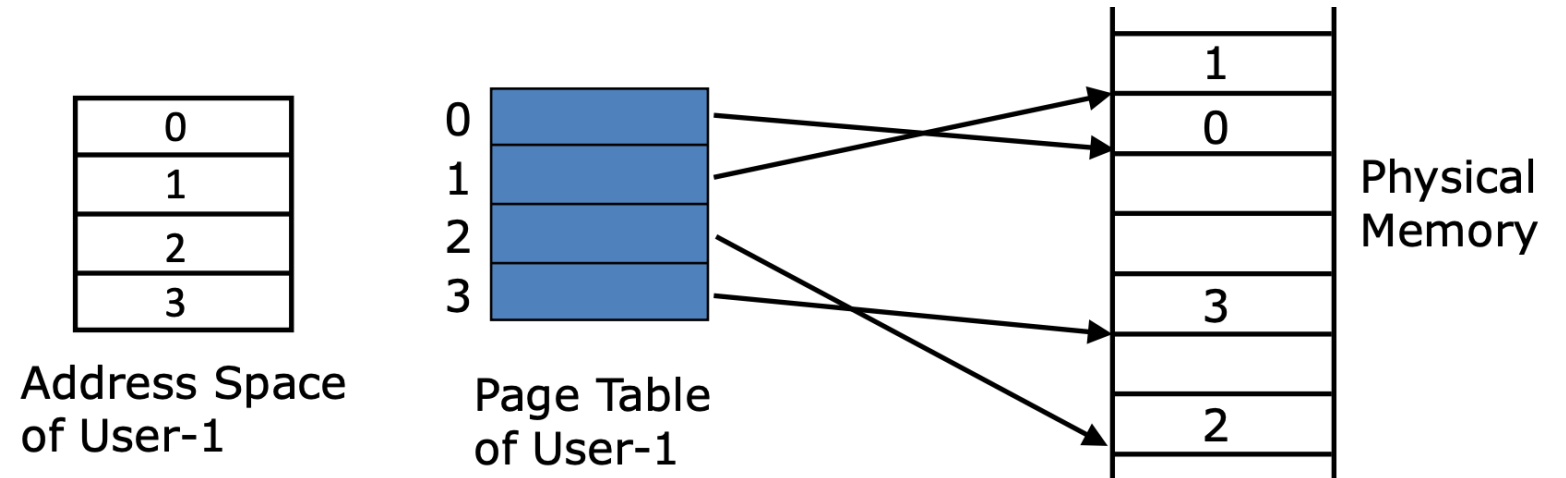


# Virtual Memory – Page Tables

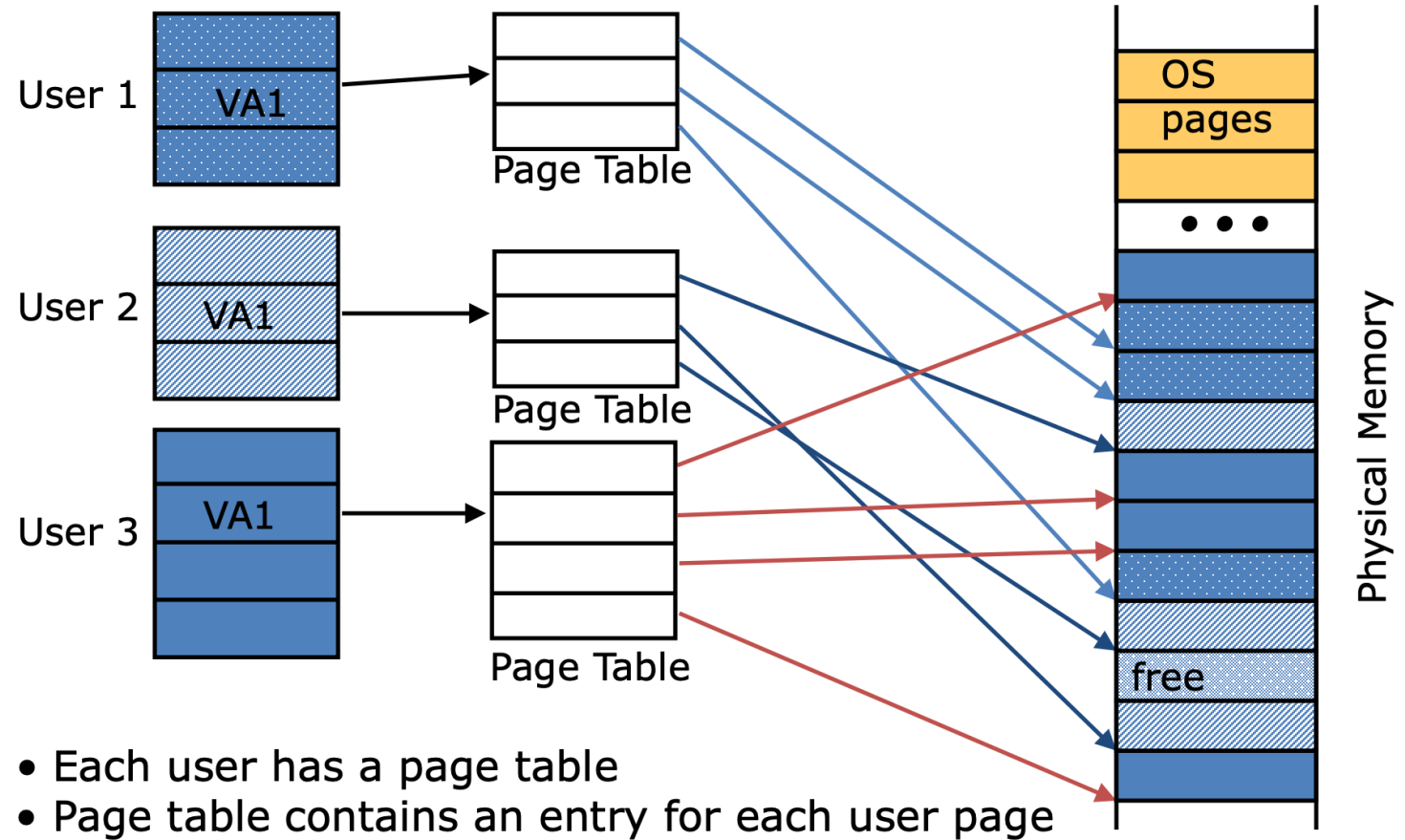
- Processor-generated address can be split into:



- May be not continuous in physical memory, PTs is stored in main memory.



# Virtual Memory

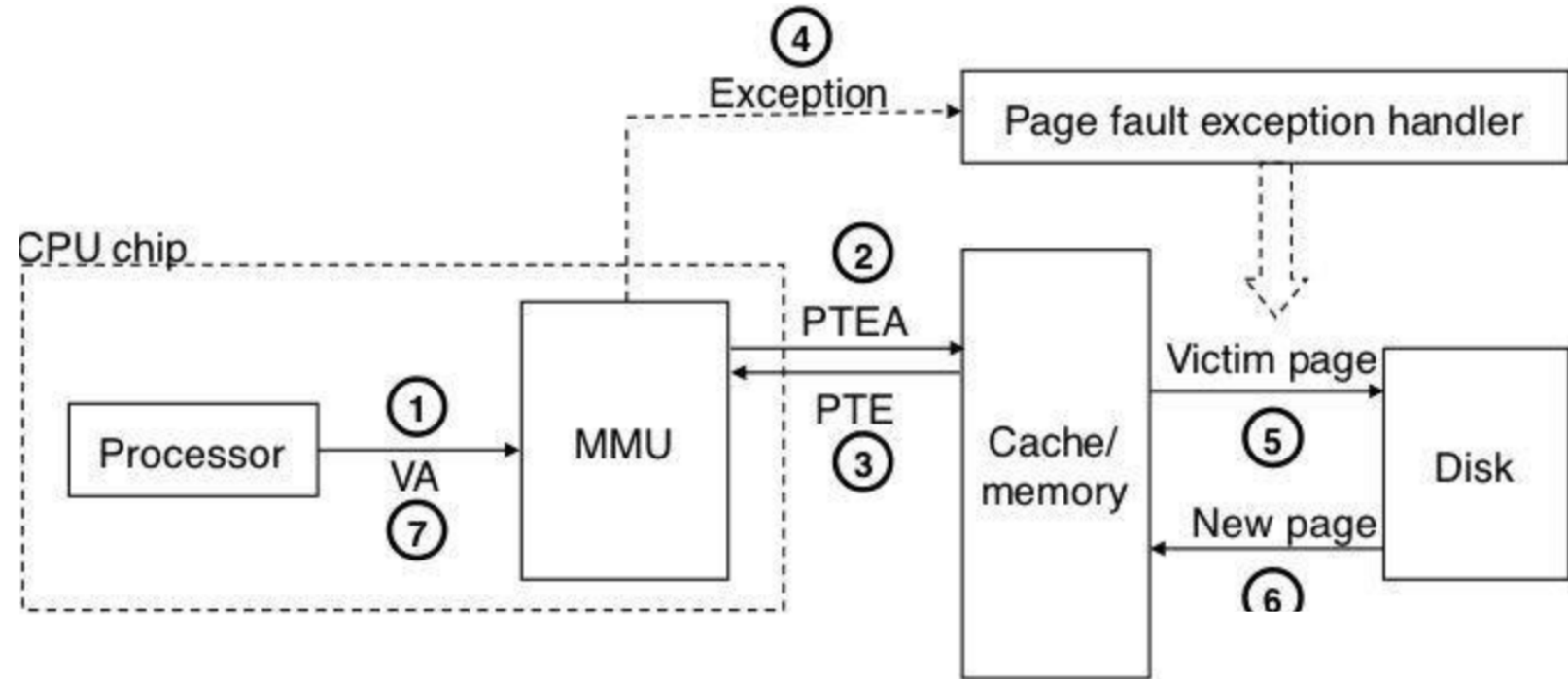




# Virtual Memory - Swapping

- Basic idea: Use part of disk as memory
  - When physical memory is used up, “evict” a page from physical memory to disk (swap out).
  - When programs need this evicted page, a “page fault” will be generated, and OS will swap it into memory (may cause the eviction of another page).
  - How to decide which page to evict?
    - FIFO
    - Clock algorithm
    - Second chance algorithm
    - ...

# Virtual Memory – Page fault & Swapping



# What's more ...

- Will be covered in OS course (next semester).

## 4. Project 3: Virtual Memory

By now you should have some familiarity with the inner workings of Pintos. Your OS can properly handle multiple threads of execution with proper synchronization, and can load multiple user programs at once. However, the number and size of programs that can run is limited by the machine's main memory size. In this assignment, you will remove that limitation.

You will build this assignment on top of the last one. Test programs from project 2 should also work with project 3. You should take care to fix any bugs in your project 2 submission before you start work on project 3, because those bugs will most likely cause the same problems in project 3.

You will continue to handle Pintos disks and file systems the same way you did in the previous assignment (see section [3.1.2 Using the File System](#)).



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Thanks!