
High Performance Computing

Lecture 13

Matthew Jacob

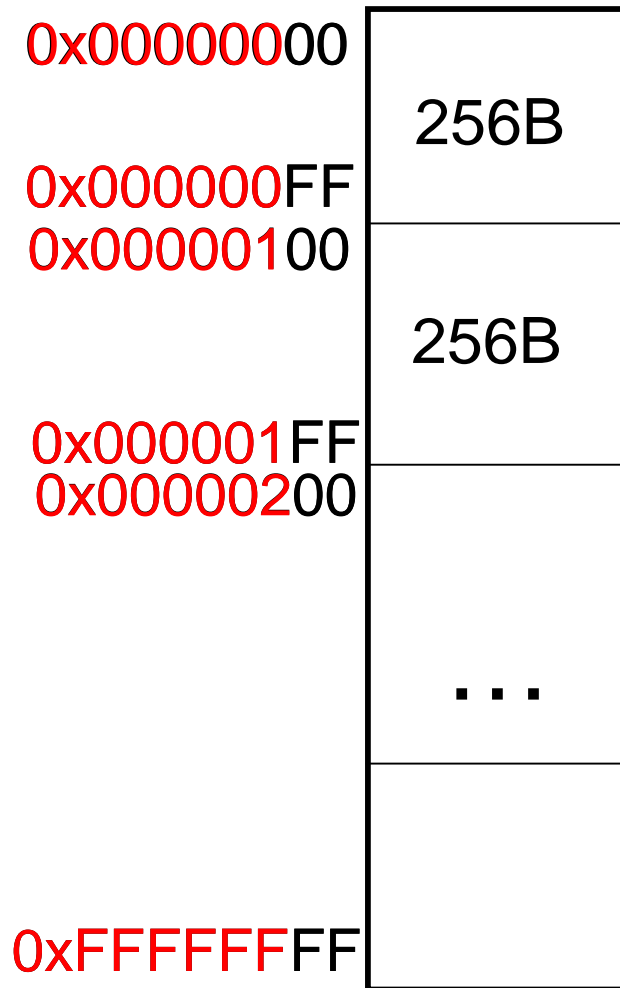
Indian Institute of Science

Main Memory Management

- Example: Paged Virtual Memory
- Recall: Need for Address Translation
- To translate a virtual address to the corresponding physical address, a table of translation information is needed
- The size of the address translation table ..
 - ... can be reduced by not managing translations on byte basis but at some larger granularity
- **Page**: fixed size unit of memory (contiguous memory locations) for which a single piece of translation information is maintained

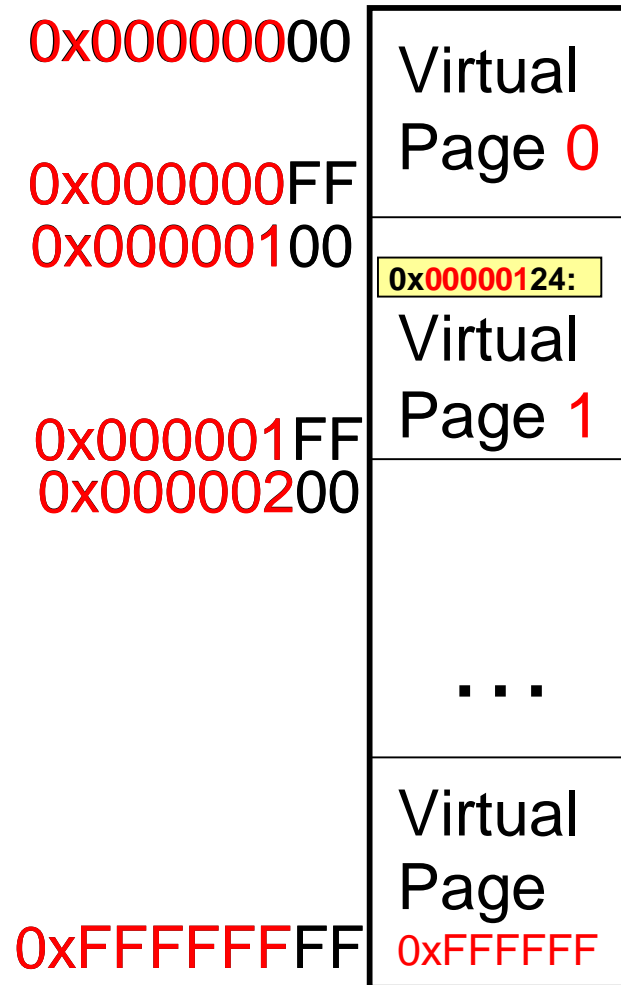
Paged Virtual Memory

PROGRAM/PROCESS
Virtual Address Space

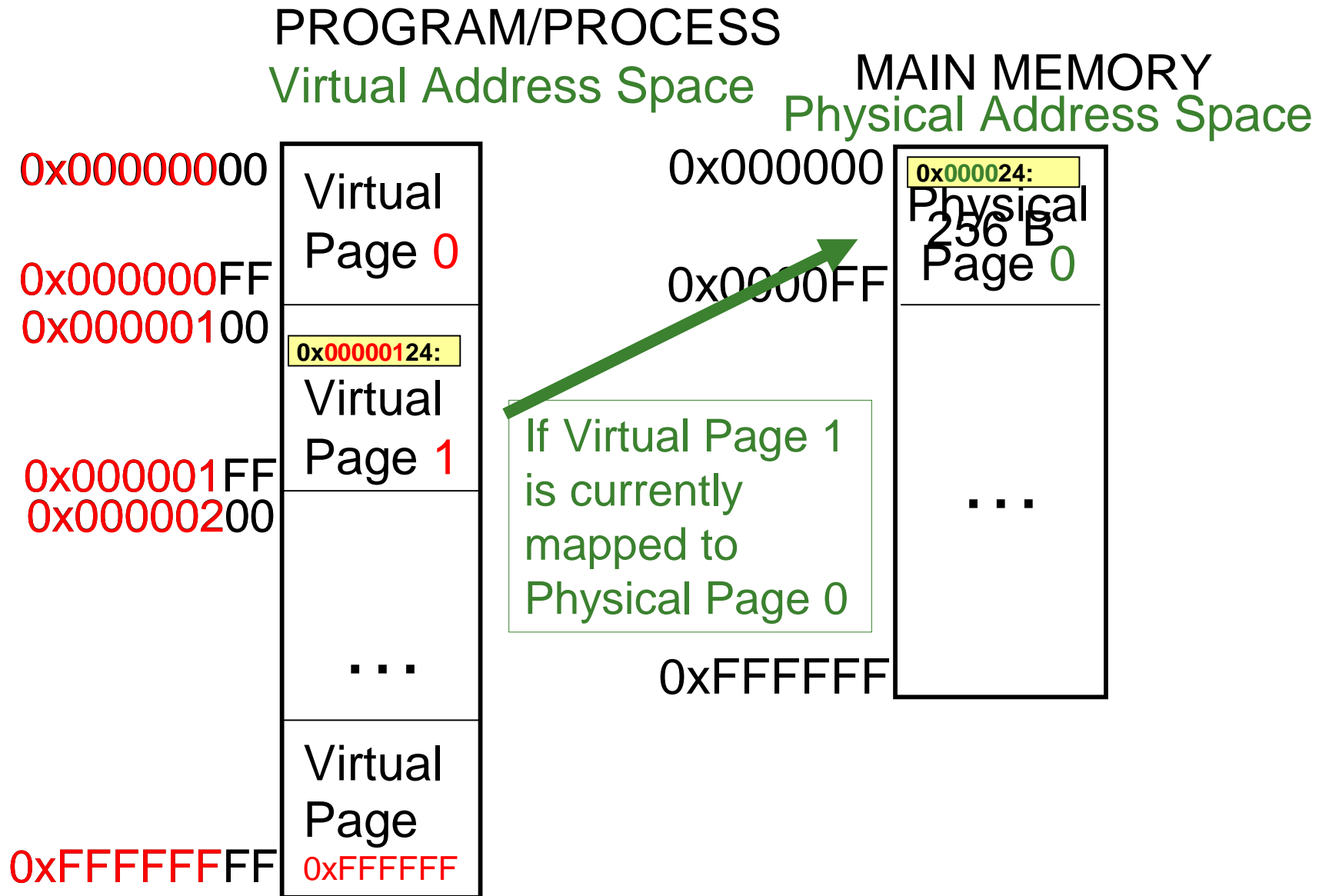


Paged Virtual Memory

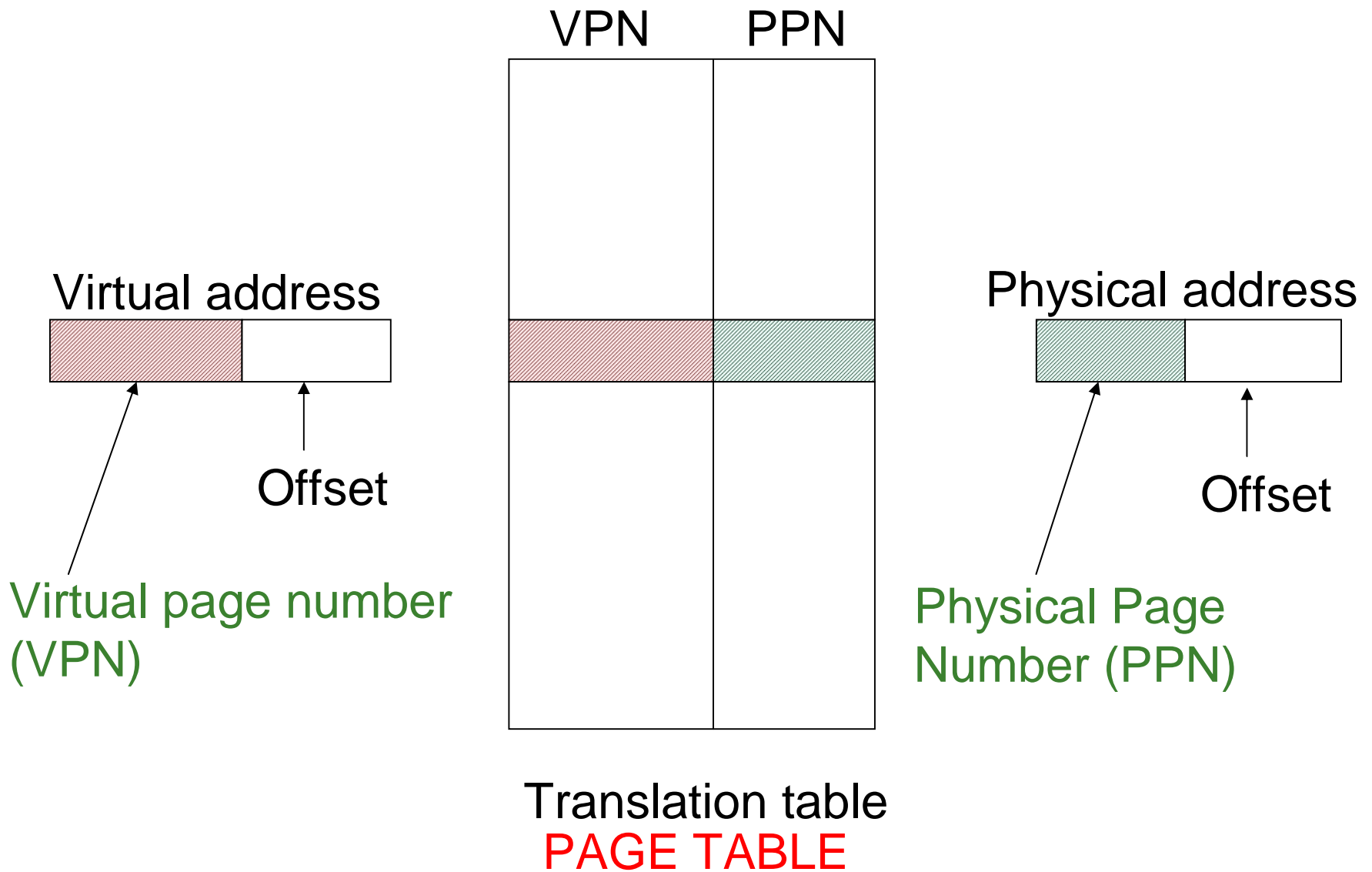
PROGRAM/PROCESS
Virtual Address Space



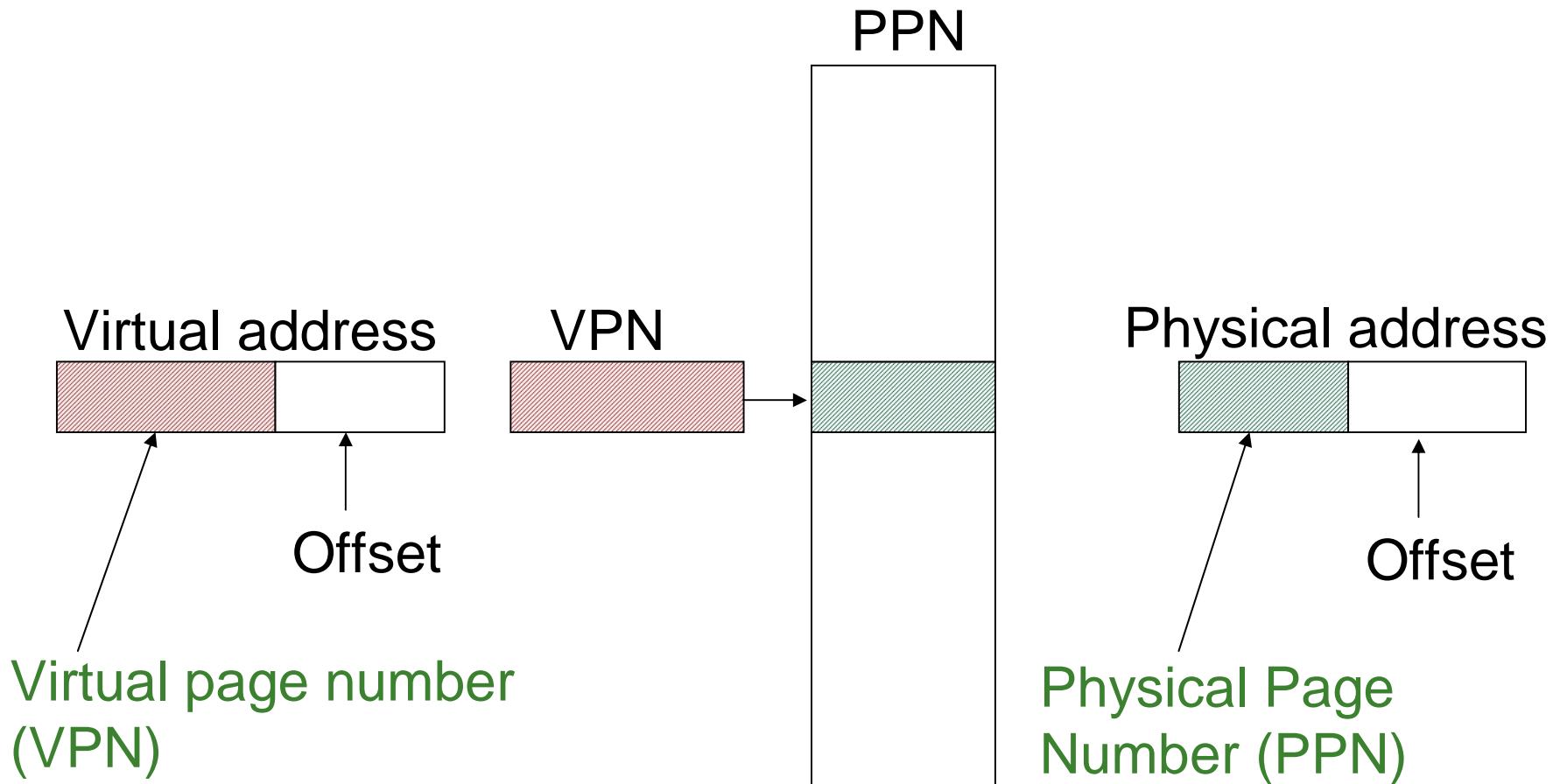
Paged Virtual Memory



Address Translation

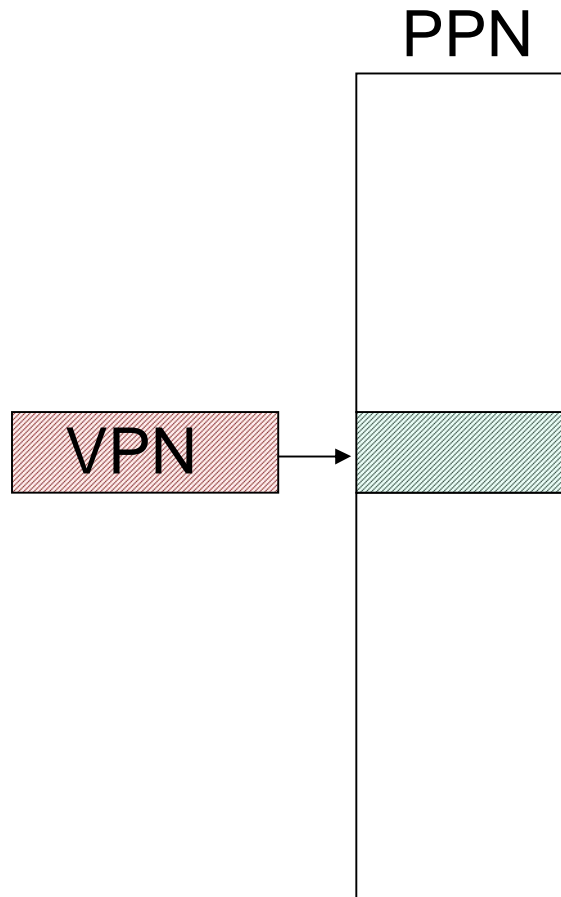


Address Translation



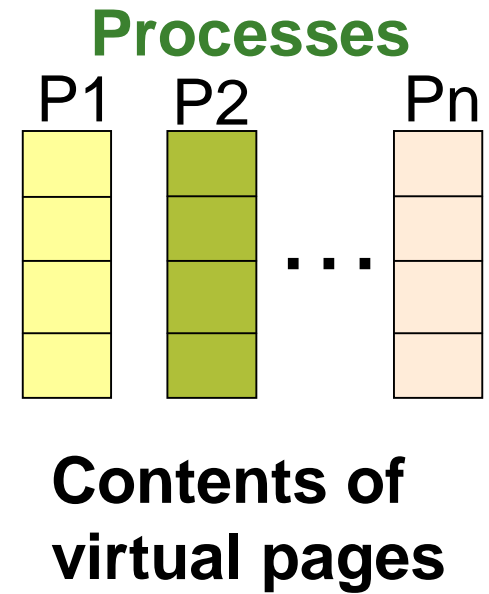
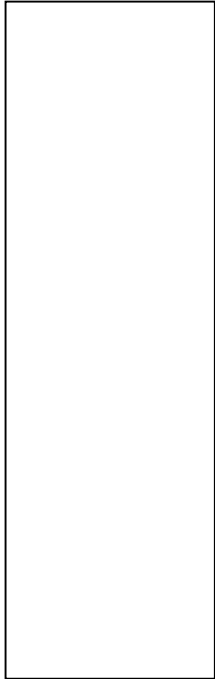
PAGE TABLE

Keeping Track: Page Table Entry



What's happening...

Main Memory

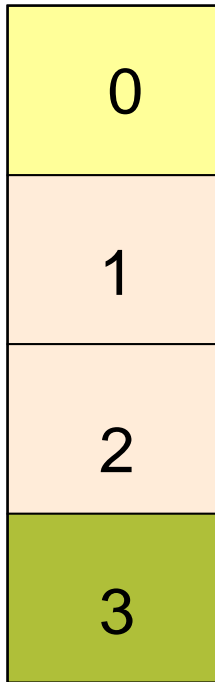


Recall: About Memory

- What is memory?
 - Something that can remember things
- There are different kinds of memory in a computer system
 - Some remember by the state an electrical circuit is in e.g., **SRAM**
 - Others remember by the amount of electrical charge stored in a capacitor e.g., **DRAM** – “Memory”
 - Yet others remember by magnetic or optical properties e.g., Hard disk drive/Mag Tape, VCD/DVD
- They can vary substantially in their speed and capacity

What's happening...

Main Memory



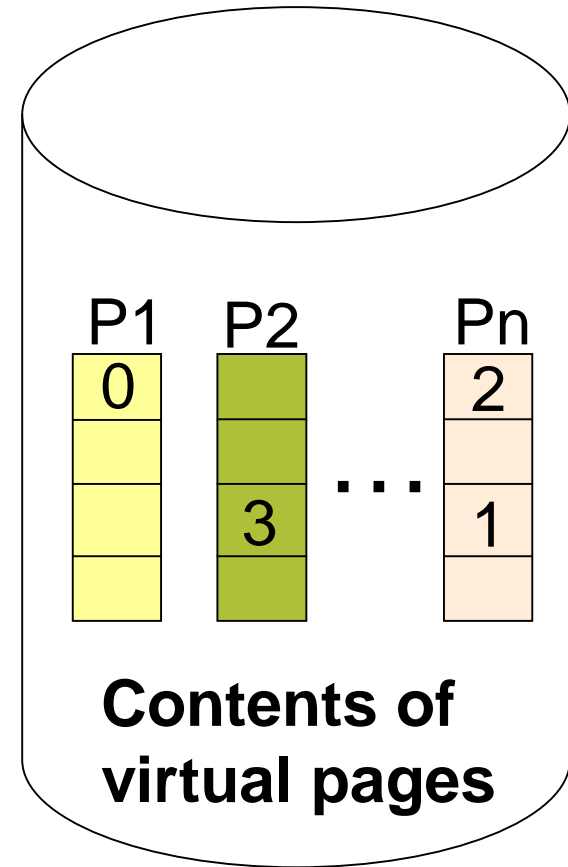
Page Tables

P1	0	0
	1	-
	2	-
	3	-

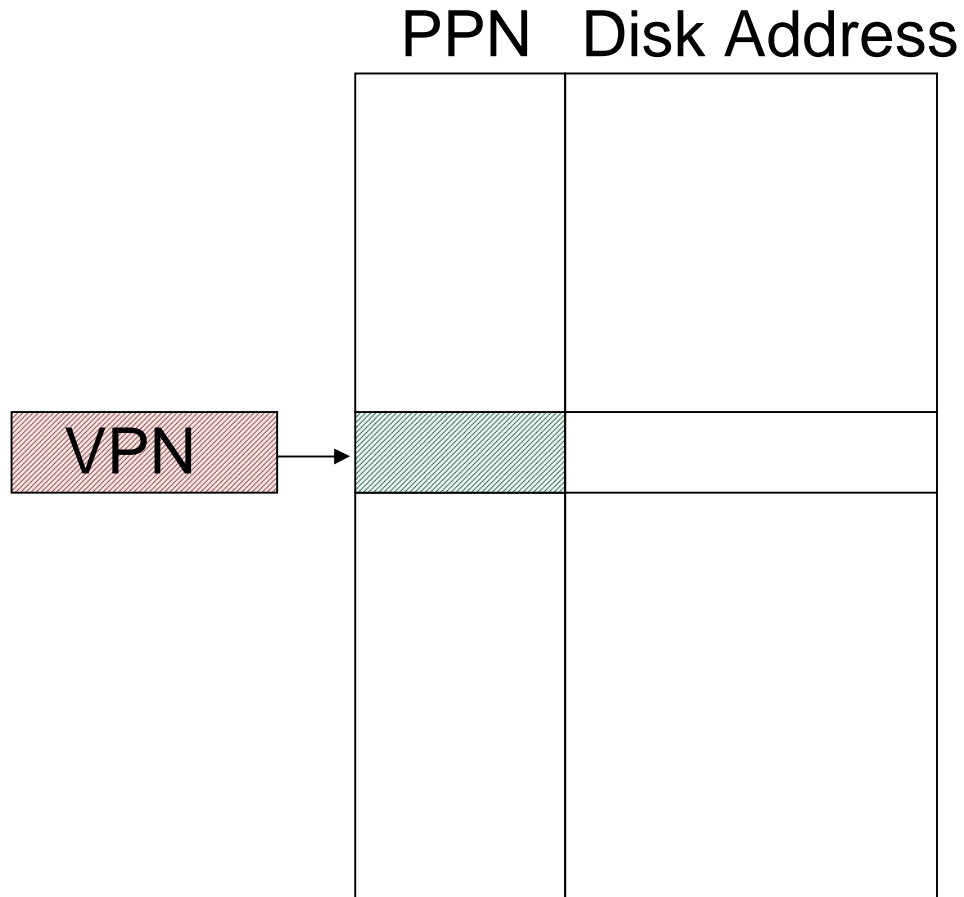
P2	0	-
	1	-
	2	3
	3	-

Pn	0	2
	1	-
	2	1
	3	-

Hard Disk

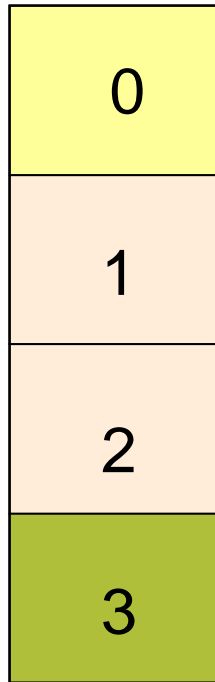


Keeping Track: Page Table Entry



What's happening...

Main Memory



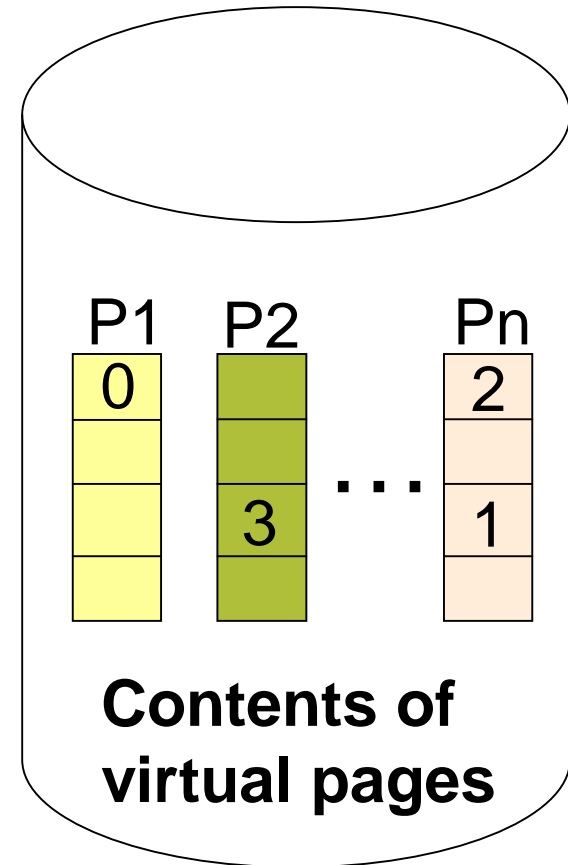
Page Tables

P1	0	0
	1	-
	2	-
	3	-

P2	0	-
	1	-
	2	3
	3	-

Pn	0	2
	1	-
	2	1
	3	-

Hard Disk

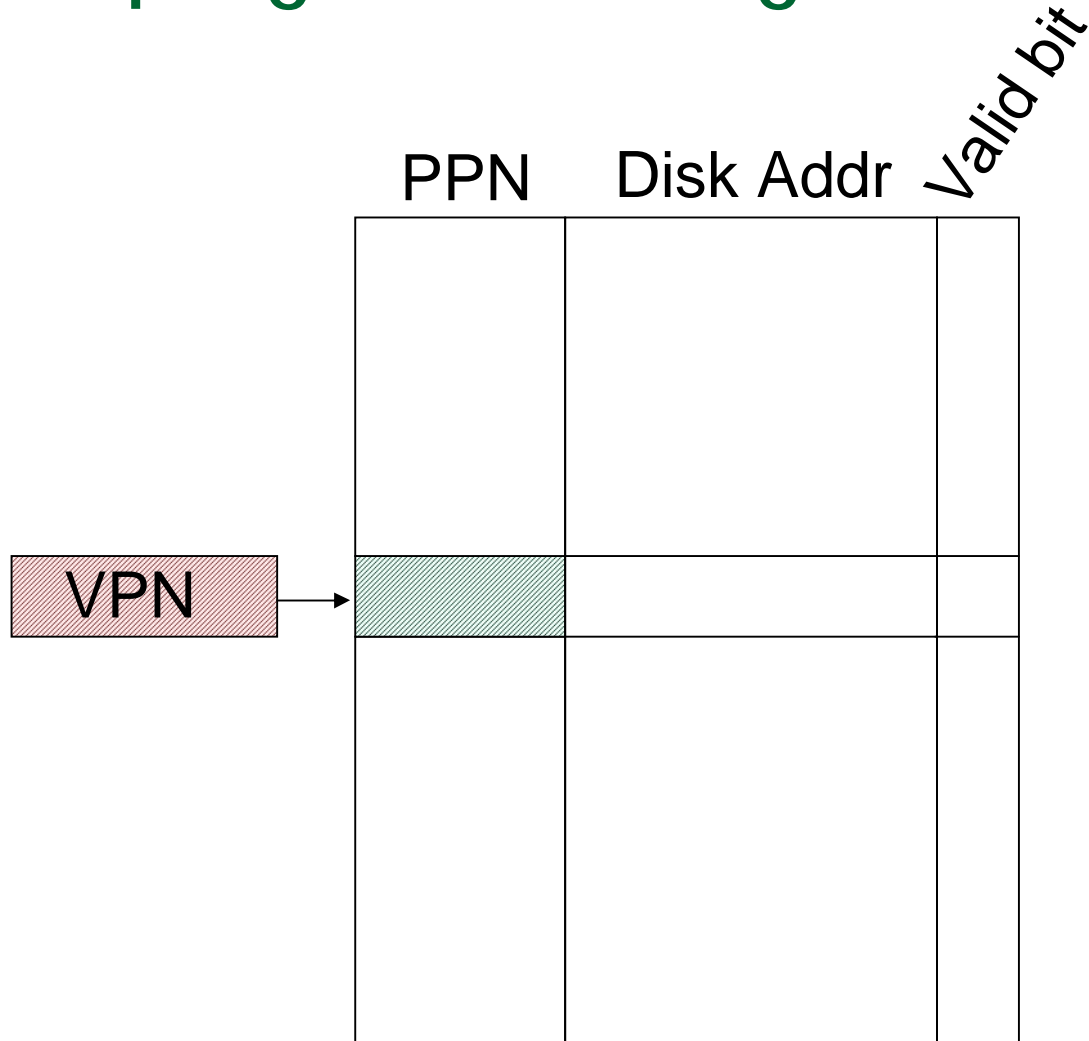


Question: What if Process P1 now accesses a variable that is on its virtual page 3?

Page Fault

- Situation where virtual address generated by processor is not available in main memory
- Detected on attempt to translate address
 - Page Table entry is invalid

Keeping Track: Page Table Entry



Page Fault

- Situation where virtual address generated by processor is not available in main memory
- Detected on attempt to translate address
 - Page Table entry is invalid
- Must be `handled' by operating system
 1. Identify slot in main memory to be used
 2. Get page contents from disk
 3. Update page table entry
- Data can then be provided to the processor