CS 4410
Operating Systems

Memory Management

Summer 2016

Cornell University

Today

- Overview of memory
- The role of operating systems in memory management.

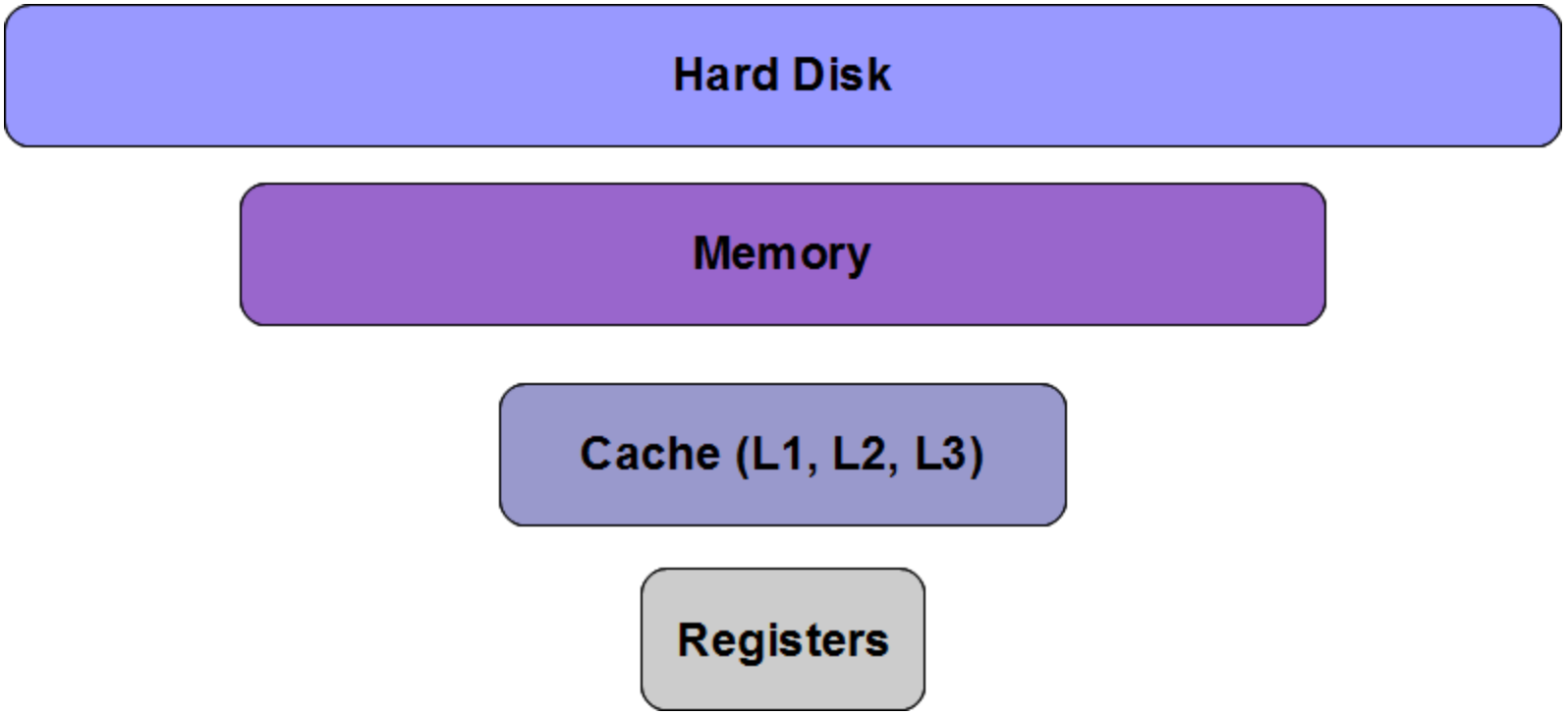
Program → Process

For a program to become process, and be executed on CPU, it should first be loaded from the hard disk into memory.

Execution cycle of an instruction

- CPU fetches the next instruction from **memory**.
- Operants of the instruction are loaded from **memory** and stored into registers.
- Store the output of the instruction into a register.
- Copy the result into **memory**.

Storage Hierarchy



Memory

- A large array of words.
- Word = 4 or 8 bytes.
- One address for every word.
- Content:
  - Instructions
  - Data

Memory Management

- The operating system dictates how the memory is shared among processes.
- Basic concerns:
  - Allocation
  - Protection
  - Relocation

Allocation strategy

- Should processes have contiguous space of physical addresses in memory?
- Is memory partitioned into fixed- or variable-sized segments?
  - If variable-sized segments, which allocation algorithm is used?
    - First fit: allocate first hole that is big enough.
    - Best fit: allocate the smallest hole that is big enough.
    - Worst fit: allocate the largest hole.

Fragmentation

- External fragmentation
  - First-fit, Best fit
  - There is enough total memory space to satisfy a request but the available spaces are small and not contiguous.
- Internal fragmentation
  - Break the physical memory into fixed-sized blocks and allocate memory in units based on block size.
  - The allocated memory is slightly larger than the requested memory.

Physical VS virtual address

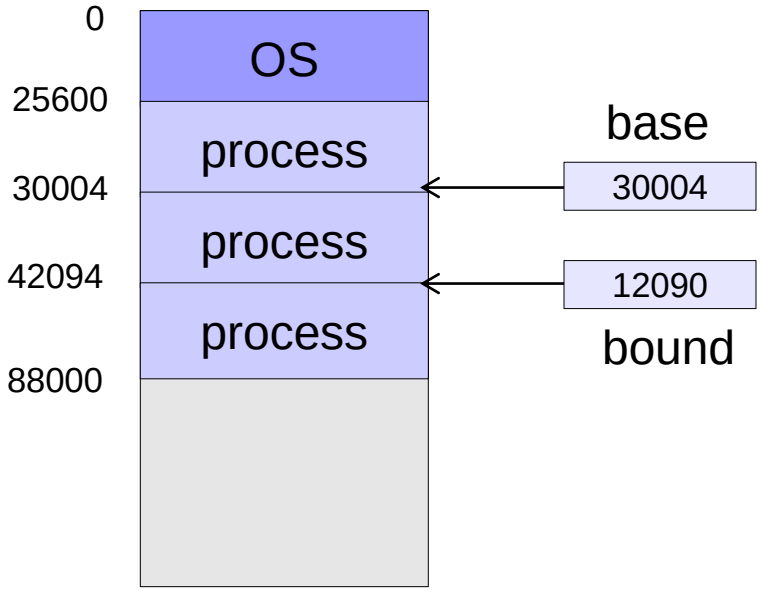
- Each time a process is loaded into memory may occupy different space of physical addresses.
  - It may not be contiguous.
- But the program code uses fixed virtual addresses.
  - Example: JMP 0x56789AB1 (jump to a particular program point)
  - The program is written as if it will run with an infinite contiguous memory space.

Address translation

- The CPU understands virtual addresses.
- The memory unit understands physical addresses.
- The OS and specialized hardware are responsible for translating virtual addressed into physical addresses.
- The translation mechanism gives protection.

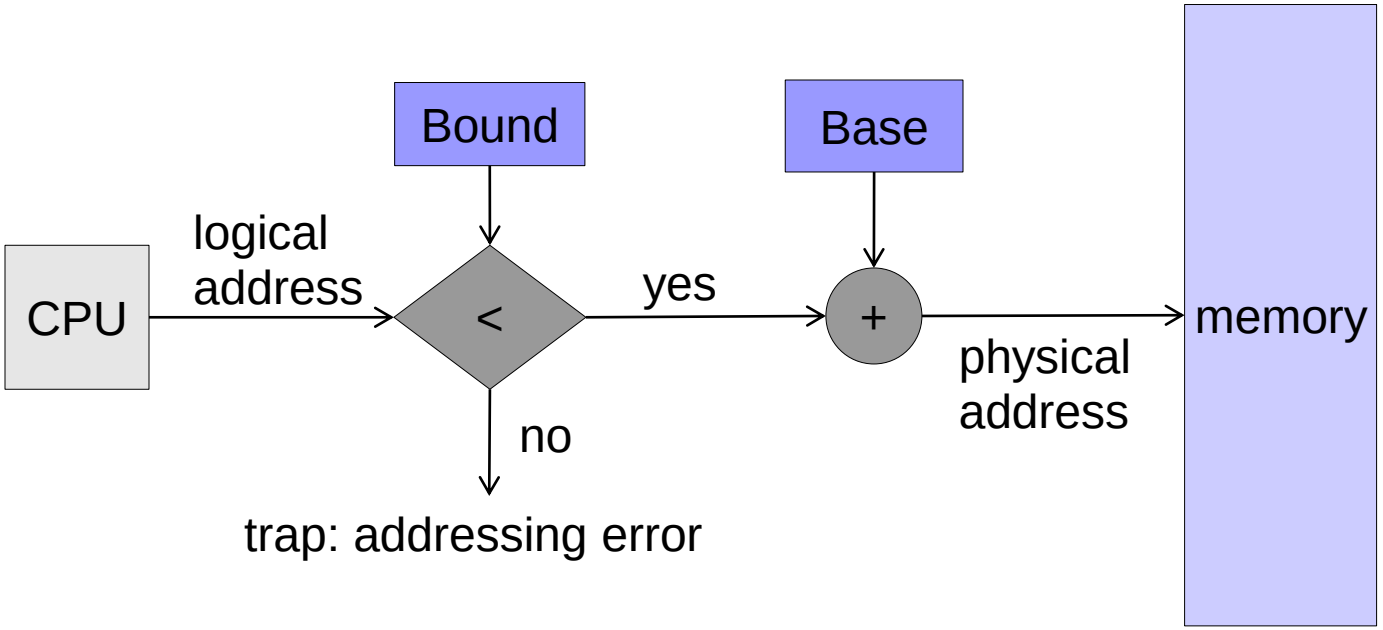
Segmented Memory

- Allocation and protection scheme.
- Each process is contained in a single contiguous section in memory.



Segmented Memory

- The OS is responsible to load the Base and Bound registers.



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Coming up…

- Next lecture: Paging
- HW3 released today
  - Deadlock exercises can be solved
  - Due on Monday.
- Short concise answers!