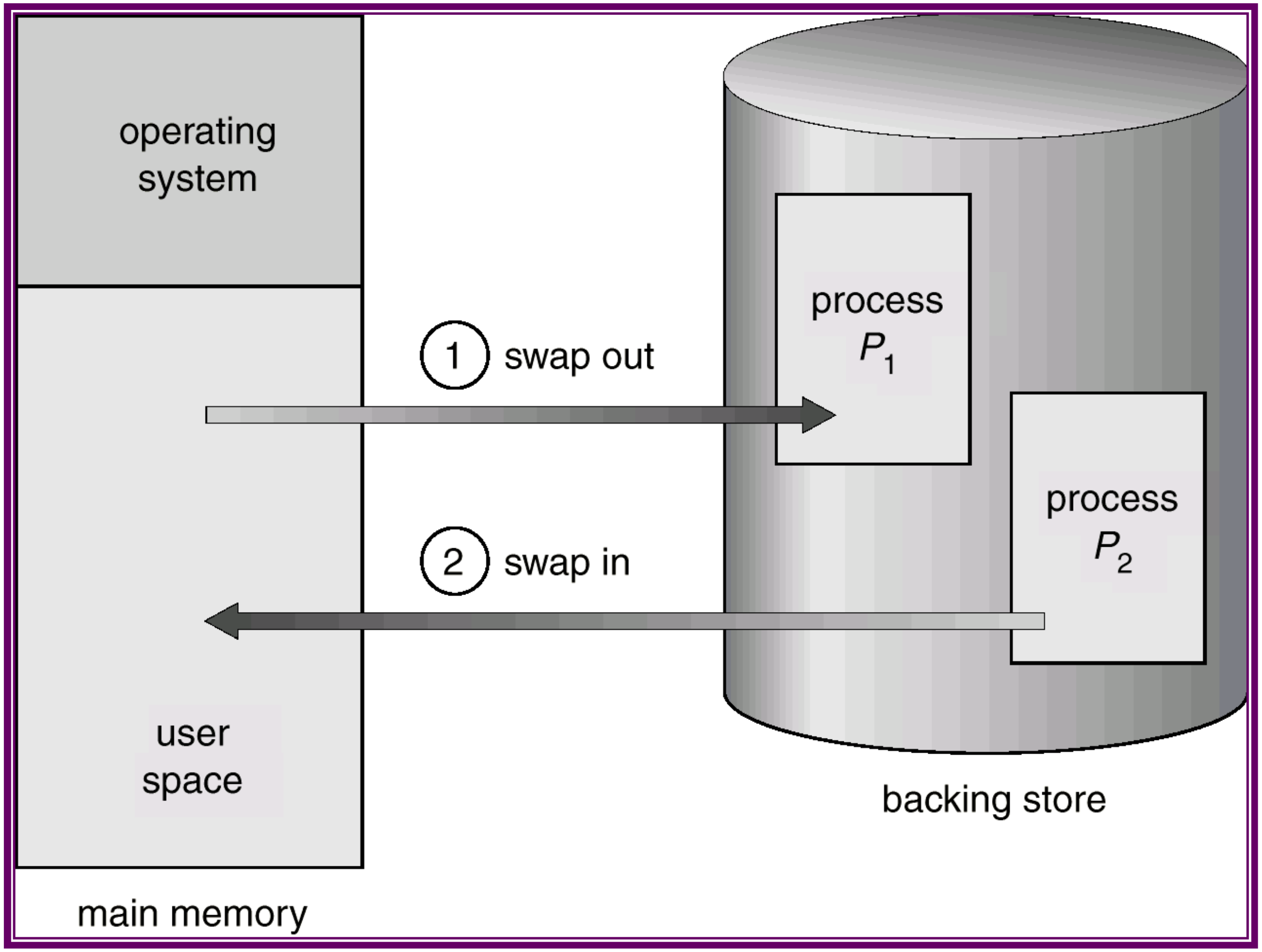
PRINCIPLES OF OPERATING SYSTEMS

LECTURE 12: SWAPPING

Introduction

- A process can be *swapped* temporarily out of memory to a *backing store*, and then brought back into memory for continued execution.
- Backing store – fast disk large enough to accommodate copies of all memory images for all users; must provide direct access to these memory images.
- *Roll out, roll in* – swapping variant used for priority-based scheduling algorithms; lower-priority process is swapped out so higher-priority process can be loaded and executed.
- Major part of swap time is transfer time; total transfer time is directly proportional to the *amount* of memory swapped.
- Modified versions of swapping are found on many systems, i.e., UNIX, Linux, and Windows.

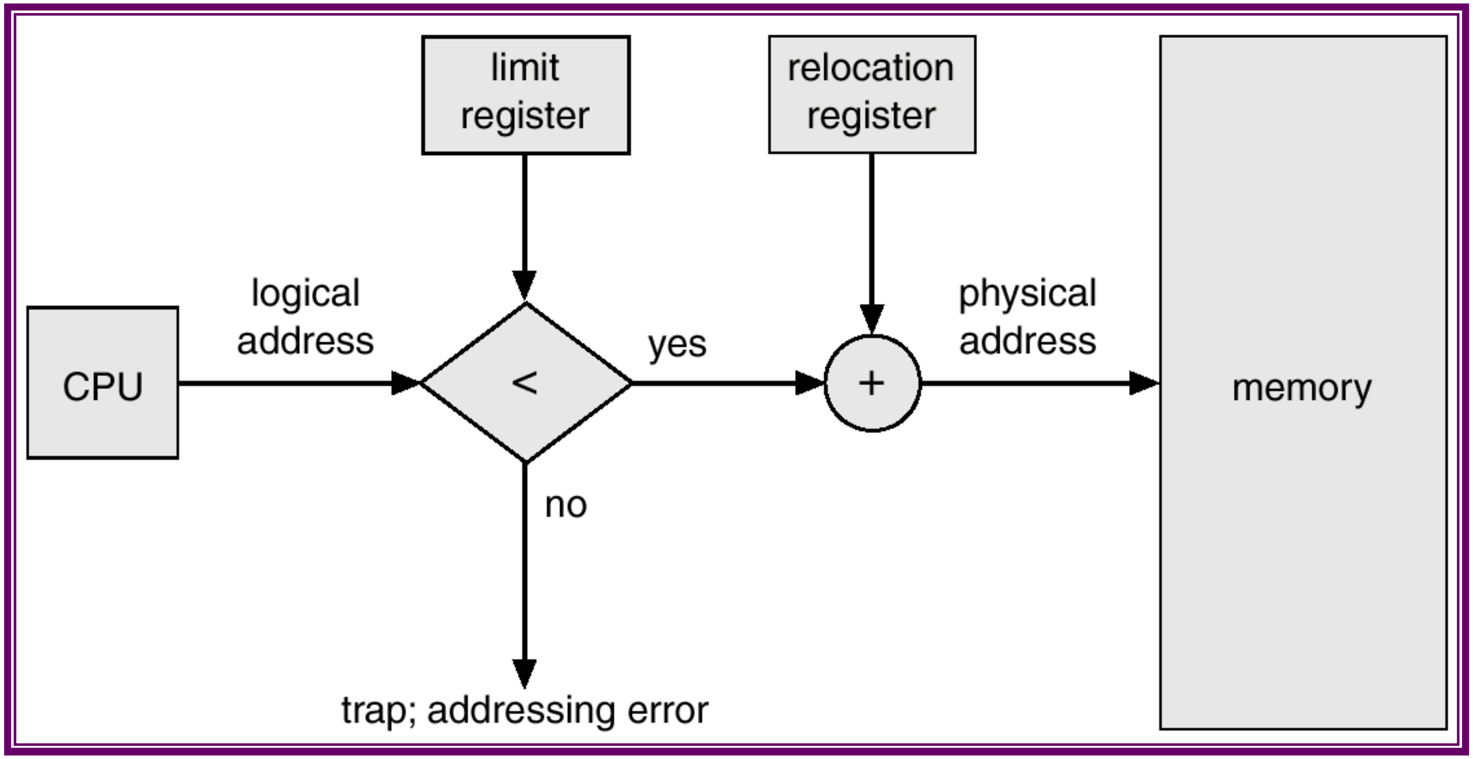
Schematic View of Swapping



Contiguous Allocation

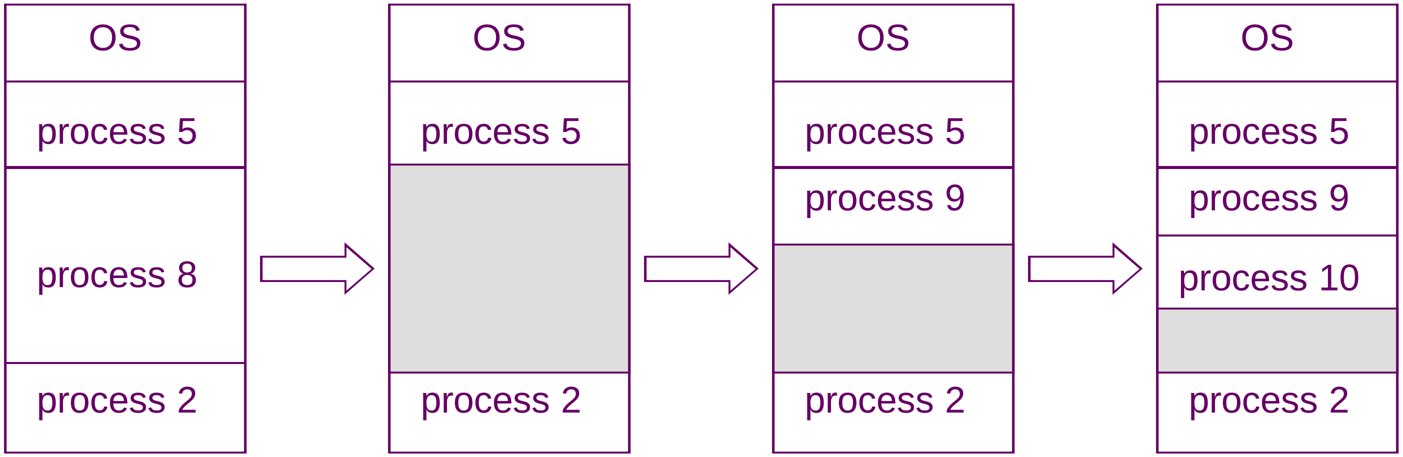
- Main memory usually into two partitions:
  - ☞ Resident operating system, usually held in low memory with interrupt vector.
  - ☞ User processes then held in high memory.
- Single-partition allocation
  - ☞ Relocation-register scheme used to protect user processes from each other, and from changing operating-system code and data.
  - ☞ Relocation register contains value of smallest physical address; limit register contains range of logical addresses – each logical address must be less than the limit register.

Hardware Support for Relocation and Limit Registers



Contiguous Allocation (Cont.)

- Multiple-partition allocation
  - ☞ *Hole* – block of available memory; holes of various size are scattered throughout memory.
  - ☞ When a process arrives, it is allocated memory from a hole large enough to accommodate it.
  - ☞ Operating system maintains information about:
    a) allocated partitions   b) free partitions (hole)



Dynamic Storage-Allocation Problem

How to satisfy a request of size *n* from a list of free holes.

- **First-fit**: Allocate the *first* hole that is big enough.
- **Best-fit**: Allocate the *smallest* hole that is big enough; must search entire list, unless ordered by size. Produces the smallest leftover hole.
- **Worst-fit**: Allocate the *largest* hole; must also search entire list. Produces the largest leftover hole.

First-fit and best-fit better than worst-fit in terms of speed and storage utilization.

Fragmentation

- **External Fragmentation** – total memory space exists to satisfy a request, but it is not contiguous.
- **Internal Fragmentation** – allocated memory may be slightly larger than requested memory; this size difference is memory internal to a partition, but not being used.
- Reduce external fragmentation by compaction
  - Shuffle memory contents to place all free memory together in one large block.
  - Compaction is possible *only* if relocation is dynamic, and is done at execution time.
  - I/O problem
    - Latch job in memory while it is involved in I/O.
    - Do I/O only into OS buffers.