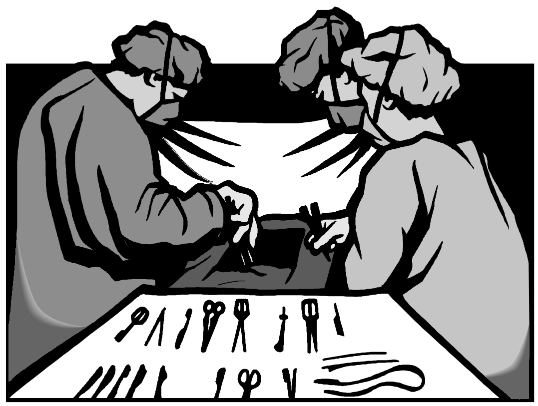
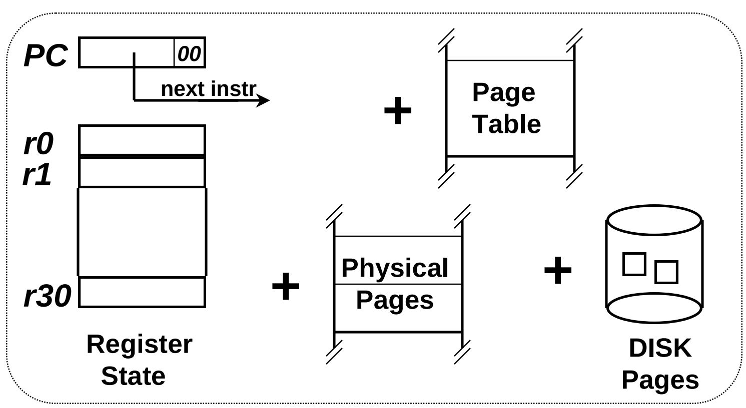
Operating Systems



1

Recap: A Process



Many of these can coexist in memory.
ONE can be executing.

Assign each process a unique number (PID)

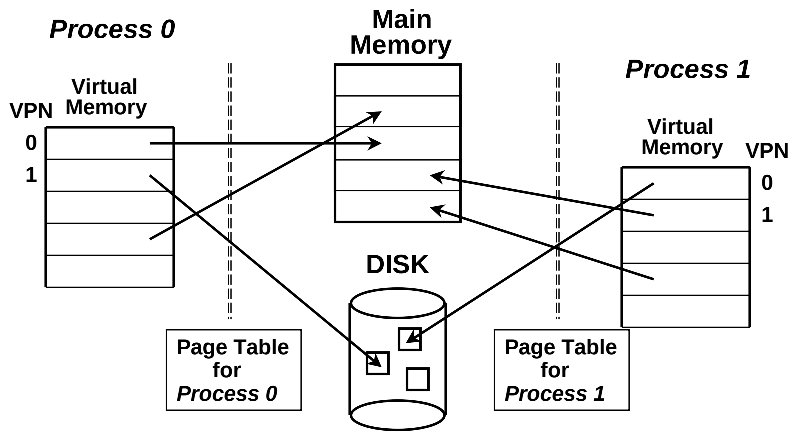
2

Operating System (O/S)

- A distinguished program that supports the process abstraction by managing the physical resources of the machine
  - Allocation and Protection: Assignment of physical memory to processes
  - Scheduling: Assignment of processor to processes
  - Input/Output (I/O): Sharing of devices

3

Process Isolation and Protection

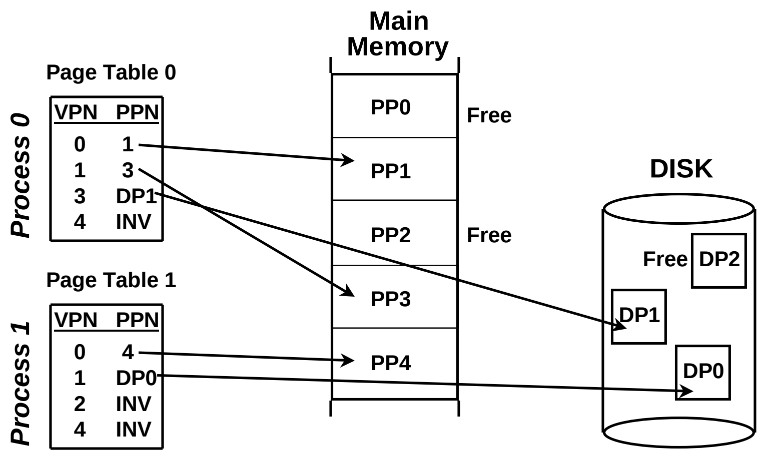


Virtual addresses of each process begin from 0

4

6004 Spring 1998: L43

Virtual-Memory-Based Protection



Protection implies at each instant page tables are <u>disjoint</u>

5

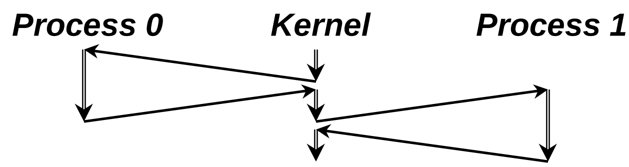
Allocation and Protection

- **Basic mechanism is virtual memory**
- **Operating system ensures that page tables are disjoint**
- **Operating system can:**
  - **Allocate free pages to processes on demand**
  - **Reclaim pages of terminated processes**
- **Can a process manipulate its own page table? ANSWER: _______**

6

The Kernel

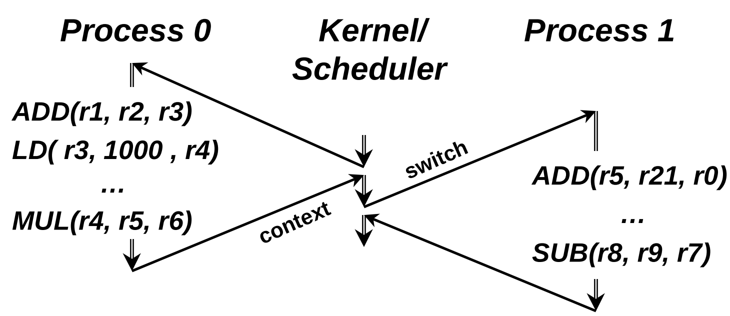
- Assign a process to the operating system, call it the <u>kernel</u> process
- Exceptions and operating system calls cause scheduling of kernel



- Kernel can execute privileged instructions which modify page tables!
  - Most significant bit of PC distinguishes between user and kernel supervisor mode
  - Set bit to disable interrupts in kernel

7

Context Switch

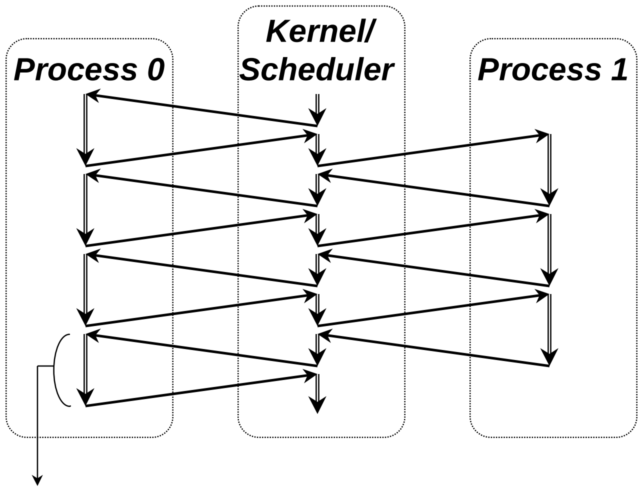


- Kernel saves all state corresponding to the execution of *Process 0* in memory
- Kernel installs state associated with the execution of *Process 1* on processor

8

6004 Spring 1998: L43

Timesharing/Process Scheduling

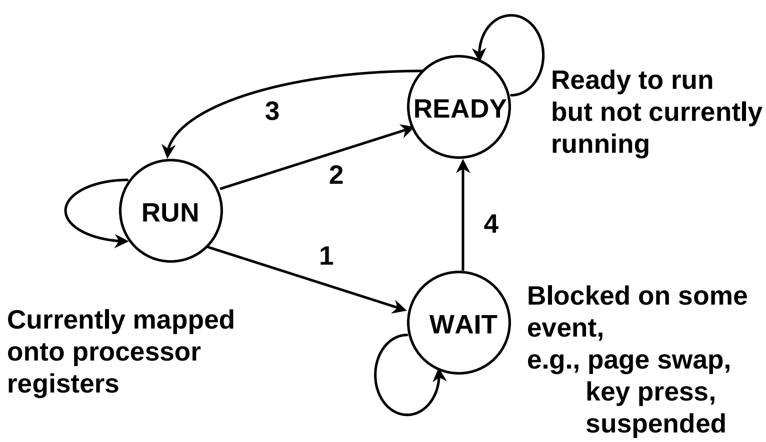


This period is called the <u>time quantum</u>

9

Scheduling

A process can be in one of three states



At most one process is in its RUN state

10

6004 Spring 1998: L43

Scheduling Transitions - I

1 RUN → WAIT : Running process executes a long latency operation.

- Implicit execution: ___________
- Explicit execution: ___________

2 RUN → READY : Two possibilities.

- Process is "a good citizen" and yields explicitly. Called co-operative scheduling.
- Process is forcibly de-scheduled due to timer interrupt when its time quantum expires. Called time-slicing.

11

Scheduling Transitions - II

3 READY → RUN : Prerogative of operating system which selects one process from all processes in the READY state based on <u>priorities</u>.

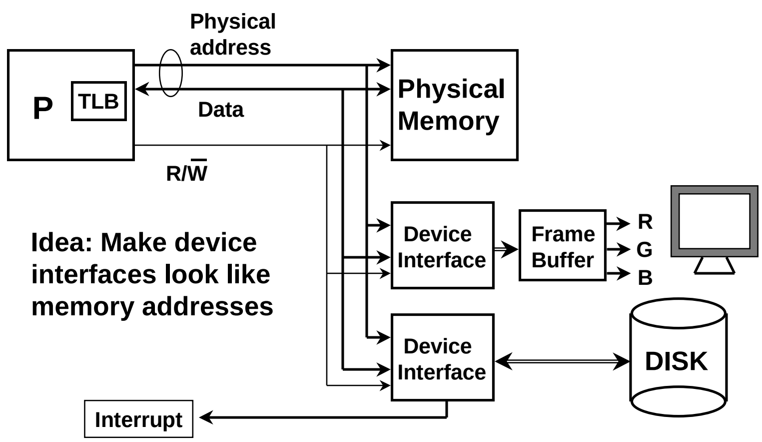
4 WAIT → READY : Completion of long latency operation, indicated by an I/O device (e.g., disk, keyboard) interrupt.

The scheduler (part of the kernel) manages the state transitions of all processes.

12

Input and Output

Attach I/O devices to processors by memory-mapping device and using supervisor calls



Idea: Make device interfaces look like memory addresses

13

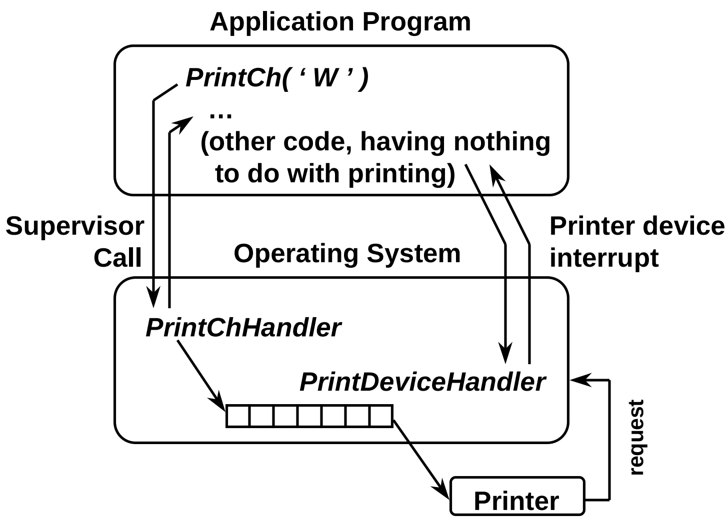
Supervisor Calls

- **Certain instructions are *trapped* or intercepted by the operating system, and interpreted as requests for additional service**
- **Implementation:**
  - **Reserve a block of unused instructions, say *SVC(0)* through *SVC(255)*, for use by programs**
  - **Attach a conventional meaning to each, e.g.,**
    - » ***ReadCh = SVC(0)* : Read a character from console, return its ASCII code in *r0*.**
    - » ***TypeCh = SVC(1)* : Pop an ASCII code from the stack, display the character on console.**
    - » ***PrintCh = SVC(2)* : Pop a character code, print the corresponding character to a printer.**
  - **Use an illegal instruction fault to trap *SVCs***

14

6004 Spring 1998: L43

I/O Device Handling



15

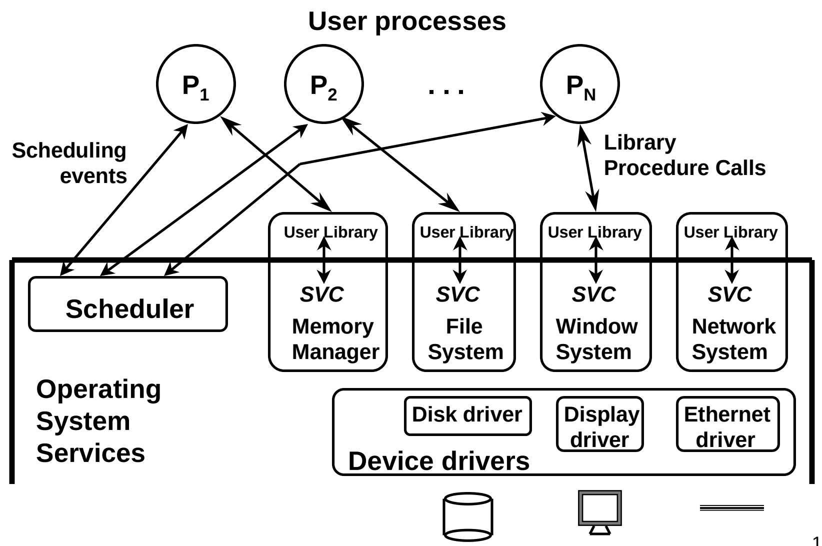
Sharing of I/O Devices

- Two options in sharing devices
- Virtual devices: Multiplex a single hardware device, e.g., display, over different processes
  - Device is emulated by faulting on reads and writes to device
  - Example: IBM OS/370
- Abstraction: Provide device drivers and “Application Programming Interfaces” (APIs)

Device	Abstraction
Frame Buffer	X Windows
Disk	UNIX File System

16

Process and O/S Interactions



17