University of Pittsburgh

Introduction to Operating Systems
CS 1550

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(Some slides are from **Silberschatz, Galvin and Gagne ©2013)**

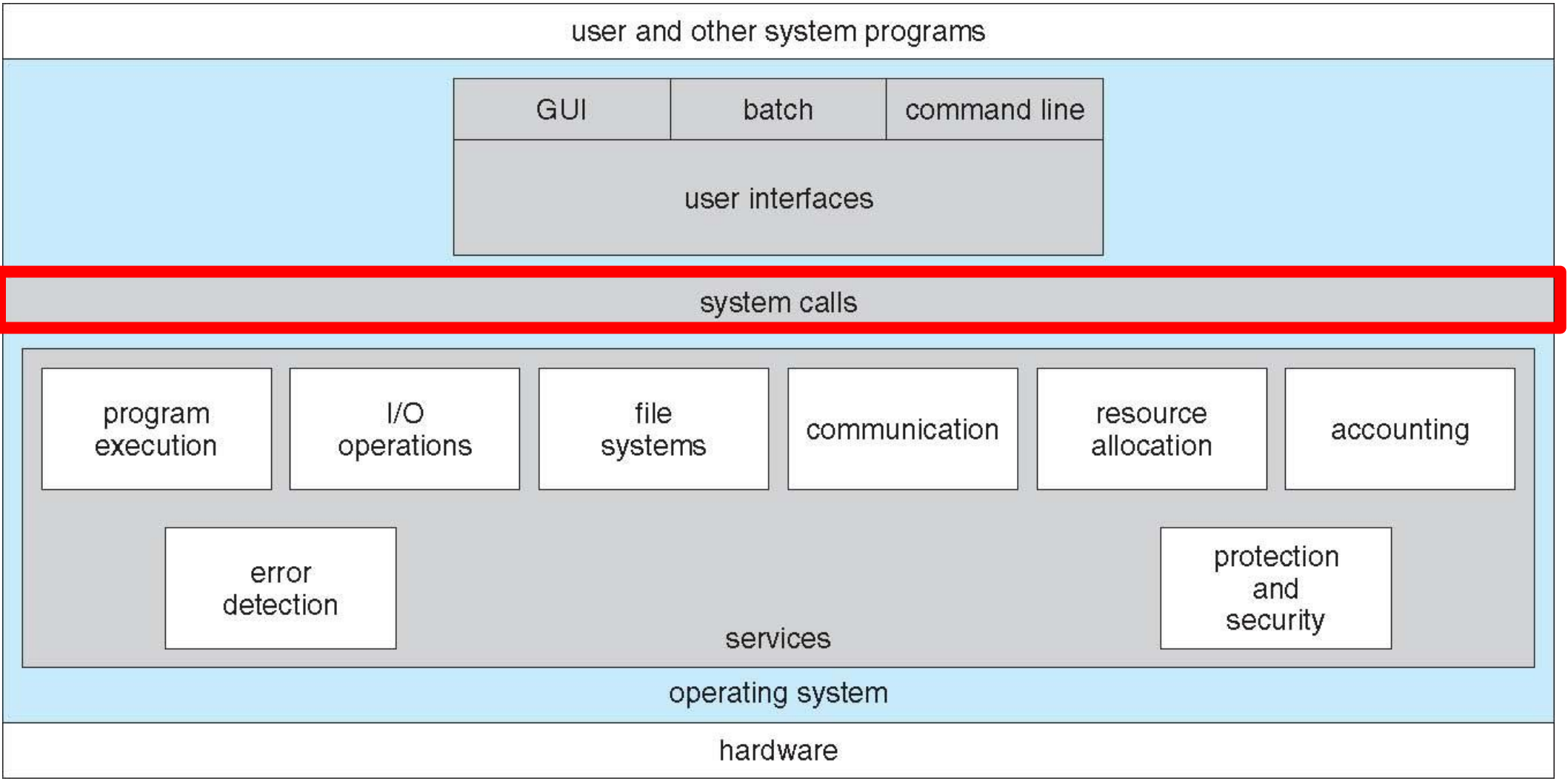
Announcements

- Lab 0 due next Friday
  - soft deadline; not graded; no deliverables
- Homework 1 will be posted on Canvas this Friday
  - 3 attempts
  - A practice homework with unlimited attempts
    - Special for Homework 1
- Recitations start next week
- VS Code setup tutorial on Piazza
  - (also linked from Canvas)
- Draft Slides repo linked from Canvas

Agenda

- Main tasks of an operating system
- System Calls
  - What an interrupt is
  - What happens when an interrupt occurs
  - What a system call is
  - How system calls implemented
  - Effect of OS structure on system calls

System Calls



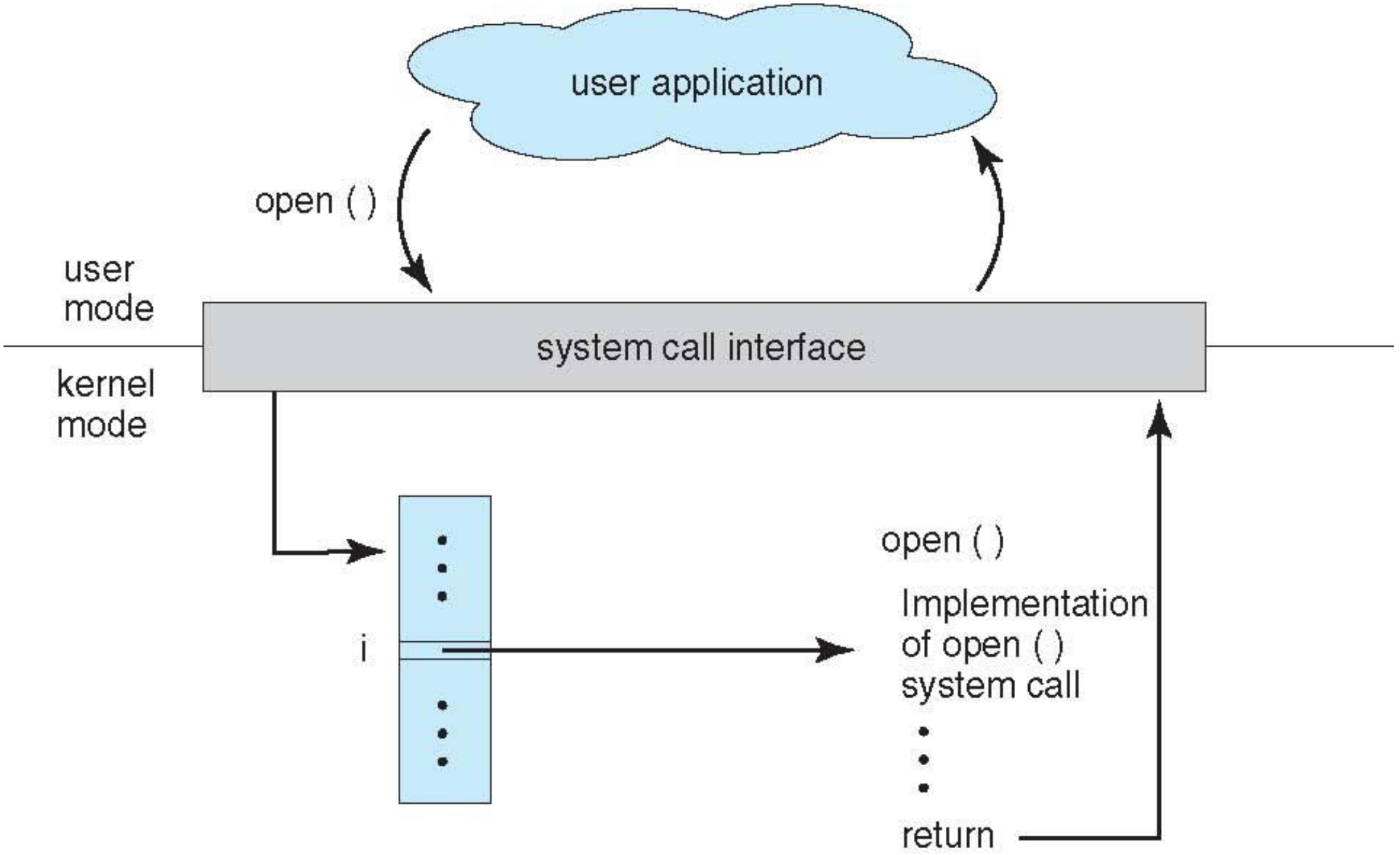
System Calls

- Programming interface to OS services
- Typically written in a high-level language (C or C++)
- Mostly accessed by programs via a high-level **Application Programming Interface (API)** rather than direct system call use
  - Win32 API for Windows
  - POSIX API for POSIX-based systems (including virtually all versions of UNIX, Linux, and Mac OS X), and
  - Java API for the Java virtual machine (JVM)

System Call Implementation

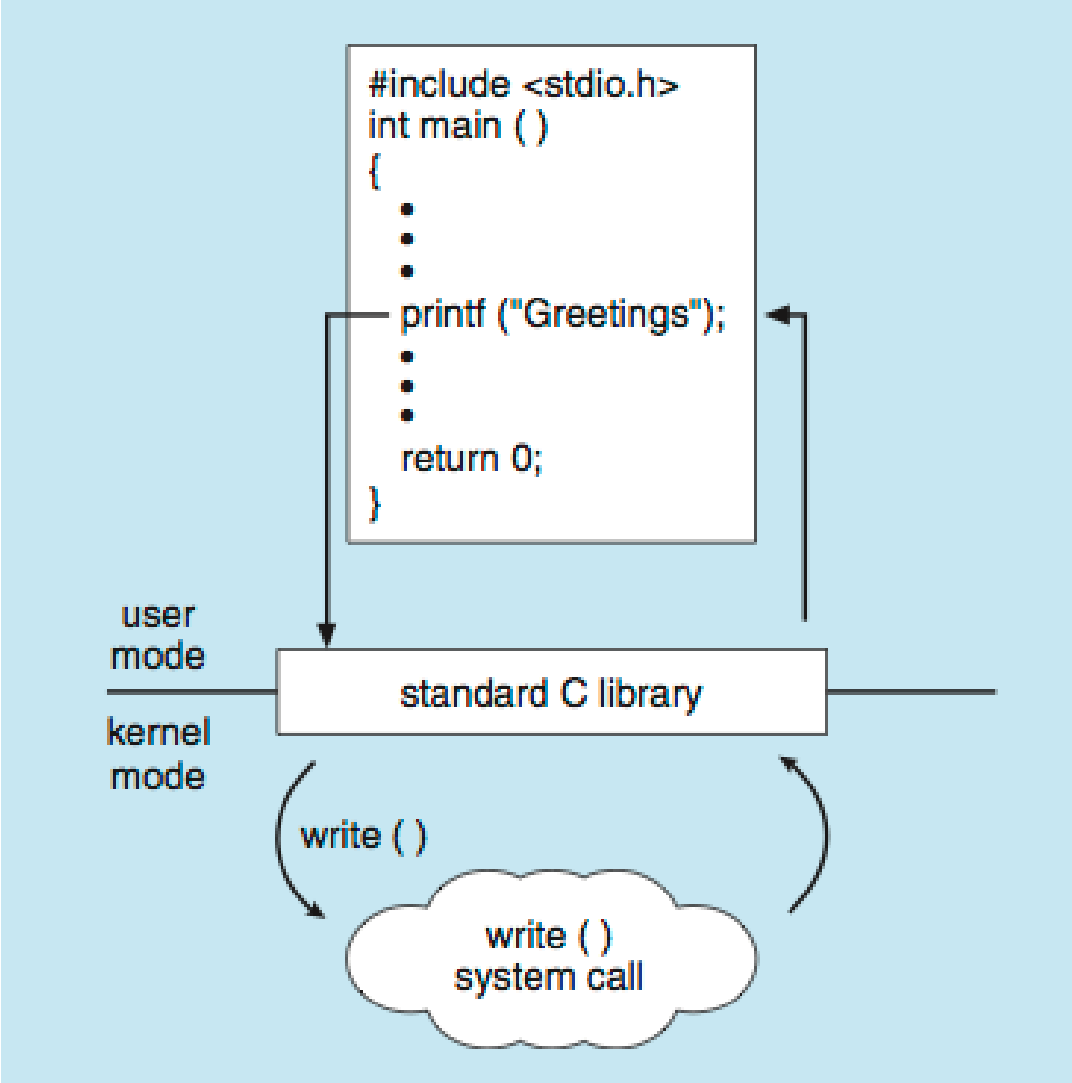
- Typically, there is a number associated with each system call
- Each system call has a corresponding system call implementation function (part of the OS kernel)
- **System-call table** indexed according to these numbers
  - Each entry in the table contains the address of the corresponding system call implementation function
- The system call interface is the ISR corresponding to the syscall software interrupt
  - invokes the intended system call in OS kernel,
  - passes arguments if needed, and
  - returns status of the system call and any return values
- The caller need know nothing about how the system call is implemented

API – System Call – OS Relationship

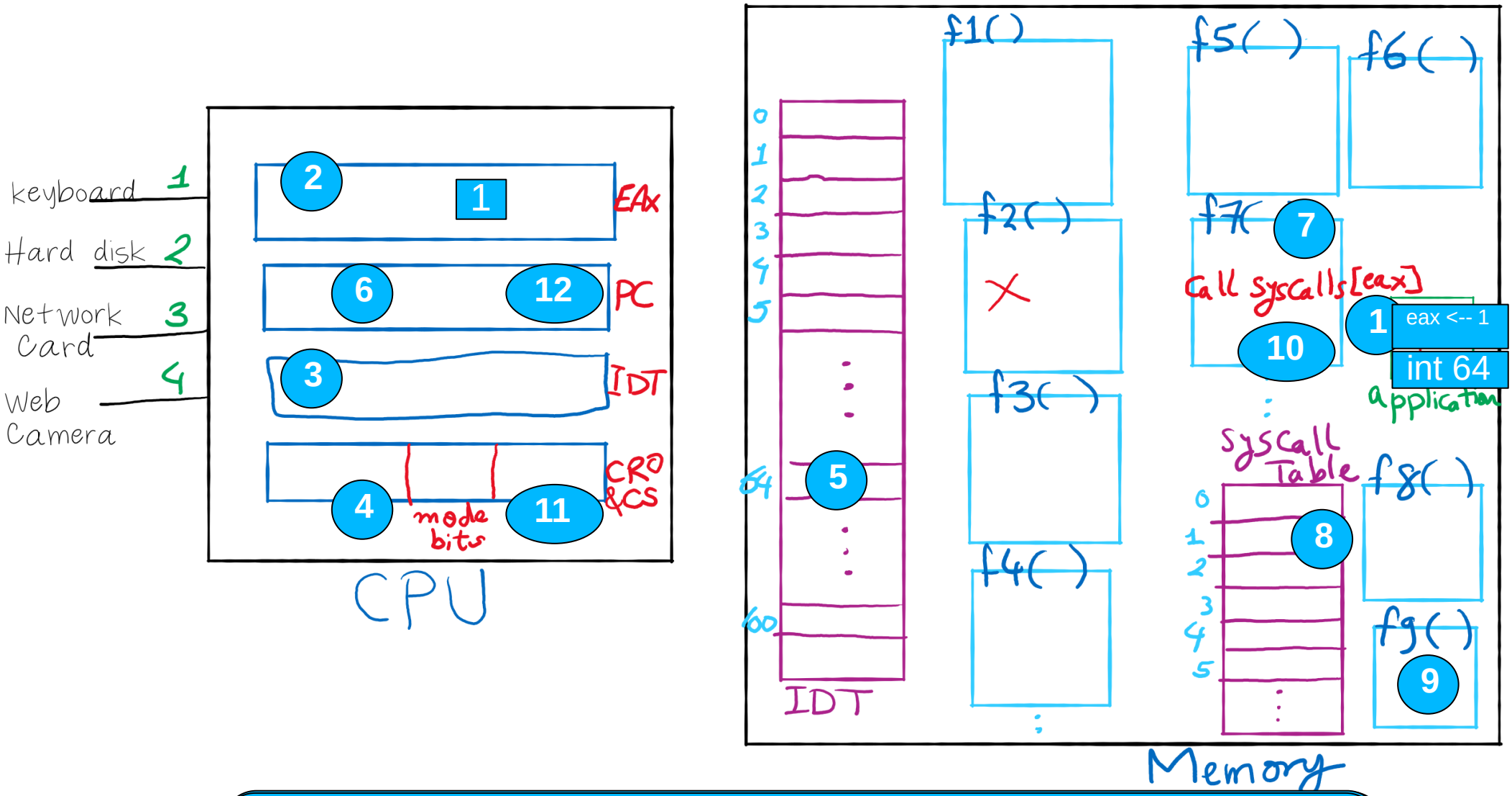


Standard C Library Example

- C program invoking printf() library call, which calls write() system call



What happens on a syscall?



Step 11-12: PC value restored from kernel stack

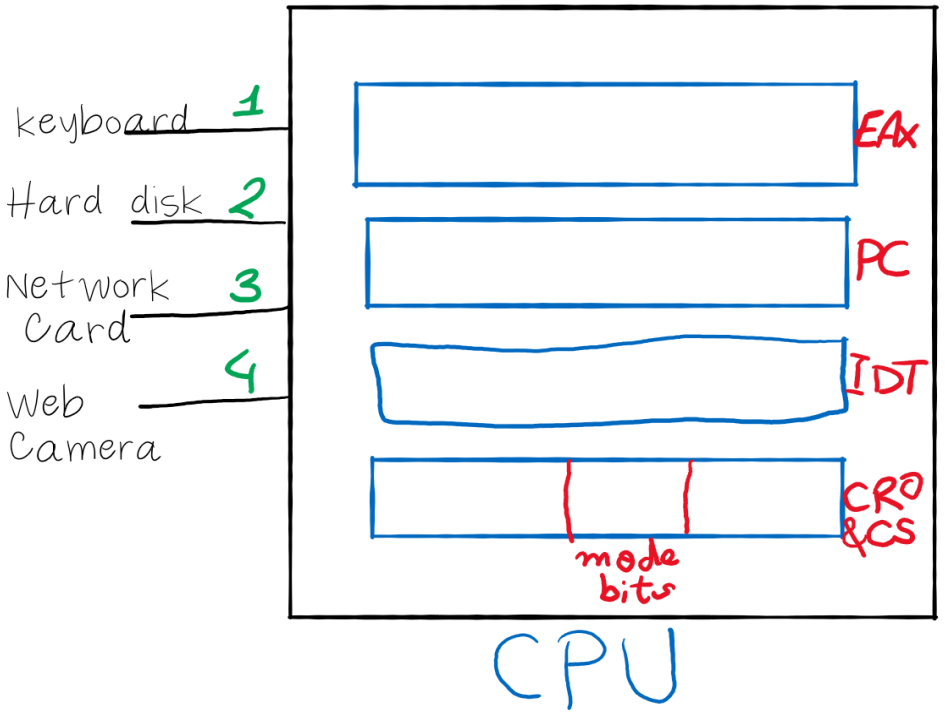
CPU switches back to user mode

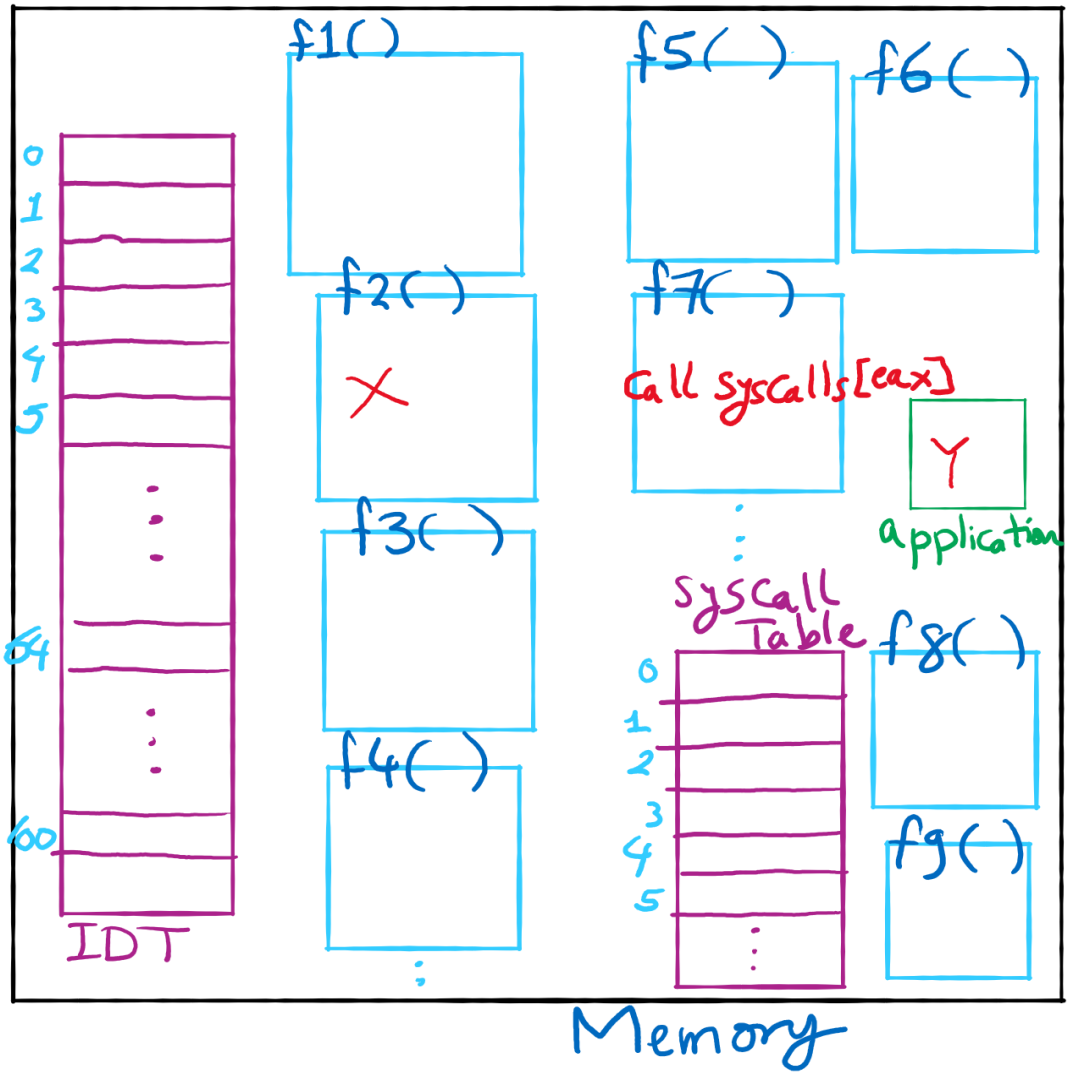
Execution of the application resumes in user mode

System Call Parameter Passing

- Three general methods used to pass parameters to the OS
  - Simplest: pass the parameters in registers
    - In some cases, may be more parameters than registers
  - Parameters stored in a block, or table, in memory, and address of block passed as a parameter in a register
    - This approach taken by Linux and Solaris
  - Parameters placed, or **pushed**, onto the **stack** by the program and **popped** off the stack by the operating system
    - XV6
- Block and stack methods do not limit the number or length of parameters being passed

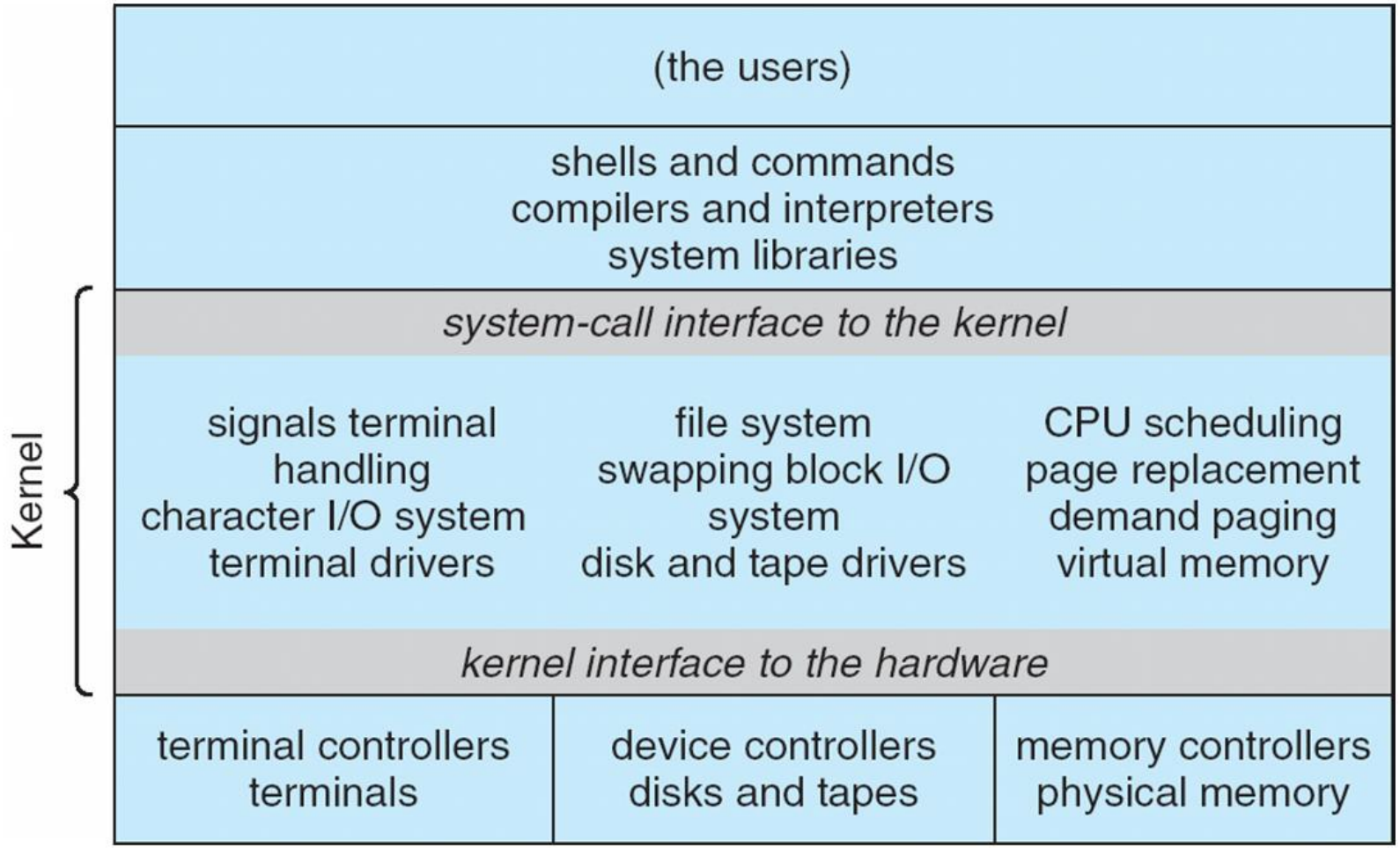
How to add a system call to an OS?





Traditional UNIX System Structure

Beyond simple but not fully layered



Microkernel System Structure