CS 330 - Operating Systems

Introduction

04-08-2025

Course details

Course Overview

- An introductory course to operating systems
  - OS concepts and principles
  - Prepare you for advanced systems courses
- Hands-on experience with OS
  - Create a version of our own operating system

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- An introductory course to operating systems
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- Hands-on experience with OS
  - Programming assignments on a small OS
  - We will learn how an operating system works

Tentative Grading Policy

- Quizzes/Exams : 50 %
- Assignments/Labs : 50 %
- The maximum grade awarded would be A- (will not be shared)

Tentative Grading Policy

- The maximum grade awarded would be A- (will not be shared)
  - To obtain an A (A+), we will have a viva at the end of the semester
  - If you answer 100% of the questions satisfactorily, you will be upgraded twice
  - If you answer 95% of the questions satisfactorily, you will be upgraded
  - If you answer 25% of the questions incorrectly, you will be downgraded
  - Anywhere in between, you will retain your grade
- We may have some surprise elements; announced anytime!

Tentative Grading Policy

- You may skip the examinations/labs/assignments completely if you are building the following
    - An OS in Rust working with Pi5 (in groups of at most 2)
        - Minimal features will be discussed in person
        - If you complete half of the features, you can still take the final examination and complete remaining assignments
        - If you unable to finish half of the features, you can take the examinations and complete remaining assignments
        - The points will be given based on the functionality of the designed OS
        - *Any* code copied will lead to an F for all groups involved

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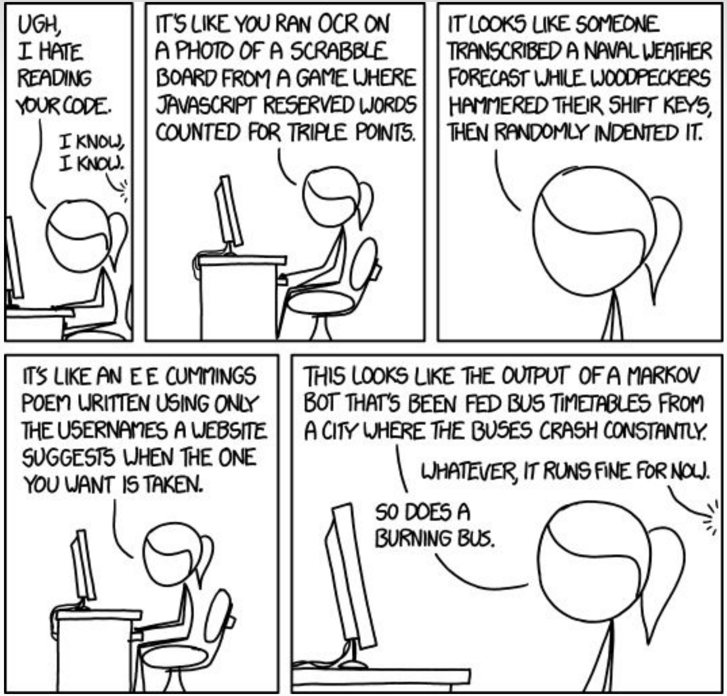
Course Policies

- Lab (assignments/project) may be done in groups of at most 4 (no exceptions!)
- Include reference for code taken from elsewhere
- Everyone in the group must understand the code
- If you feel that someone/group has copied/obtained code from elsewhere and have not cited them, you can pseudo-anonymously report them
  - You receive points, if we are able to verify that (e.g., viva)
  - If it is a spurious request, you lose points for misreporting!
- Assignments will require significant time commitment
  - So start early

Course Policies

- Write your code in a legible manner
  - Points for comments
  - Anything we can’t make sense of does not get points
- Late submissions will incur penalty
  - 1 day late - 25% penalty
  - 2 days late - 50% penalty
  - 3 days late - 75% penalty
  - > 3 days late - 0 points
- Deadline extension requests will incur penalty for the requestor!

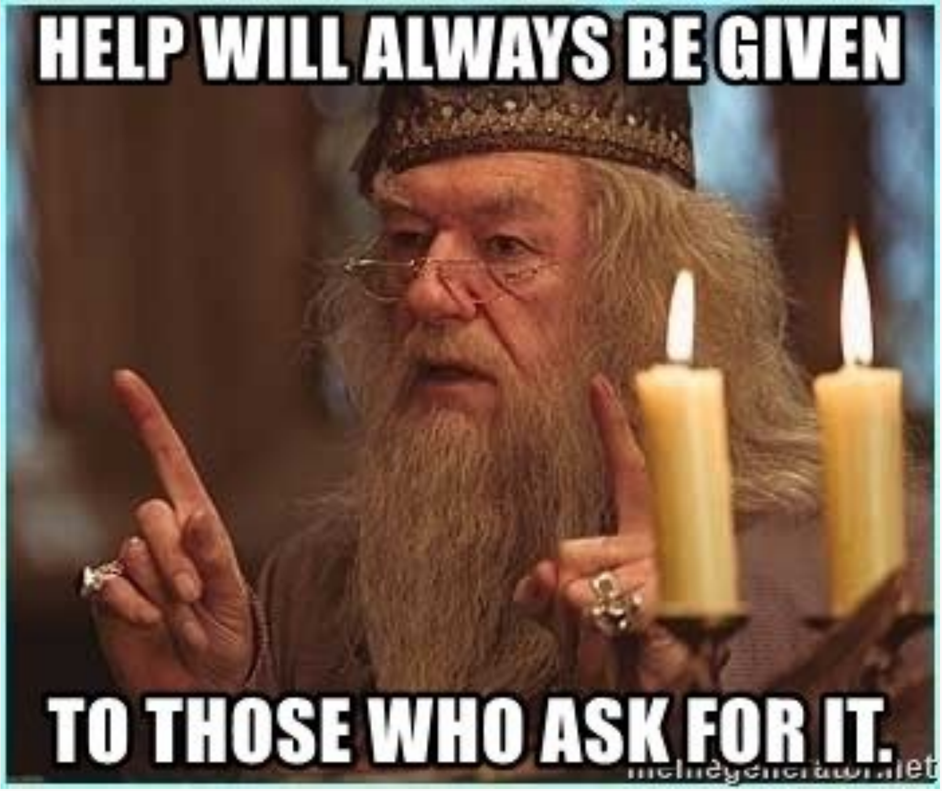

UGH, I HATE READING YOUR CODE.
I KNOW, I KNOW.
IT'S LIKE YOU RAN OCR ON A PHOTO OF A SCRABBLE BOARD FROM A GAME WHERE JAVASCRIPT RESERVED WORDS COUNTED FOR TRIPLE POINTS.
IT LOOKS LIKE SOMEONE TRANSCRIBED A NAVAL WEATHER FORECAST WHILE WOODPECKERS HAMMERED THEIR SHIFT KEYS, THEN RANDOMLY INDENTED IT.
IT'S LIKE AN E E CUMMINGS POEM WRITTEN USING ONLY THE USERNAMES A WEBSITE SUGGESTS WHEN THE ONE YOU WANT IS TAKEN.
THIS LOOKS LIKE THE OUTPUT OF A MARKOV BOT THAT'S BEEN FED BUS TIMETABLES FROM A CITY WHERE THE BUSES CRASH CONSTANTLY.
WHATEVER, IT RUNS FINE FOR NOW.
SO DOES A BURNING BUS.

Textbooks

- Operating System Concepts
  by Silberschatz, Galvin and Gagne
- Operating Systems: Three Easy Pieces (available online)
  by Arpaci-Dusseau^2

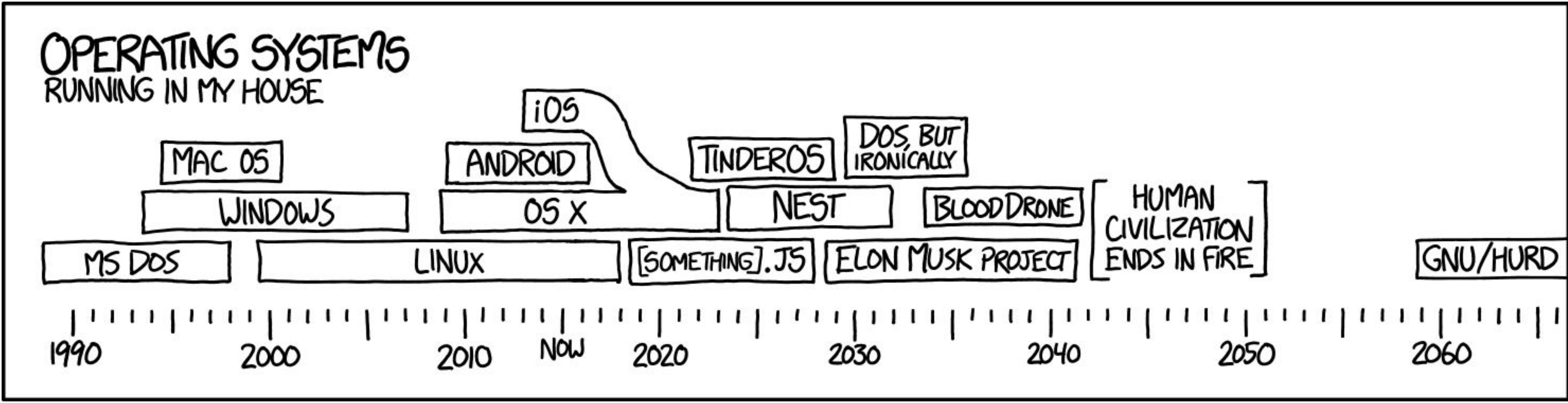
Teaching Assistants

- Gayatri Priyadarsini
- Aniket Asati
- Sreyashi Karmakar
- Krupa Rajani
- Sinngam Khaidem
- Irengbam Singh
- Smrutee Behera
- Utkarsh Agarwal
- Arjun Sekar



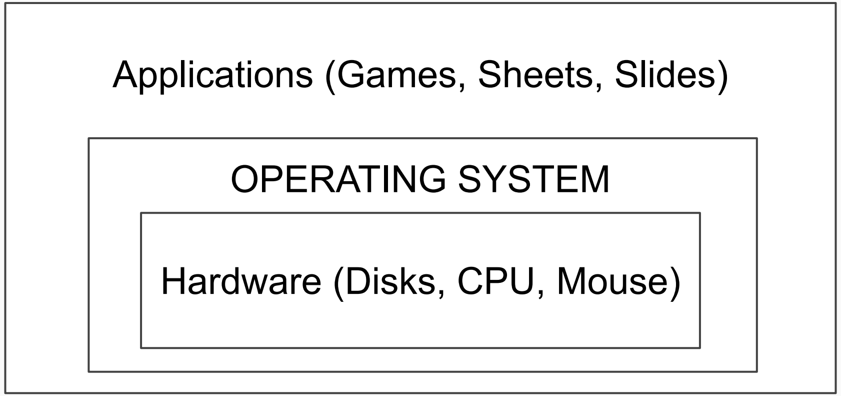
What is an OS?

Operating systems



What is an operating system?

- Layer between applications and hardware
  - Allows applications to “use” hardware
  - Abstracts the details of the hardware from the applications
  - Helps separate applications when using the hardware
- Kernel and system software

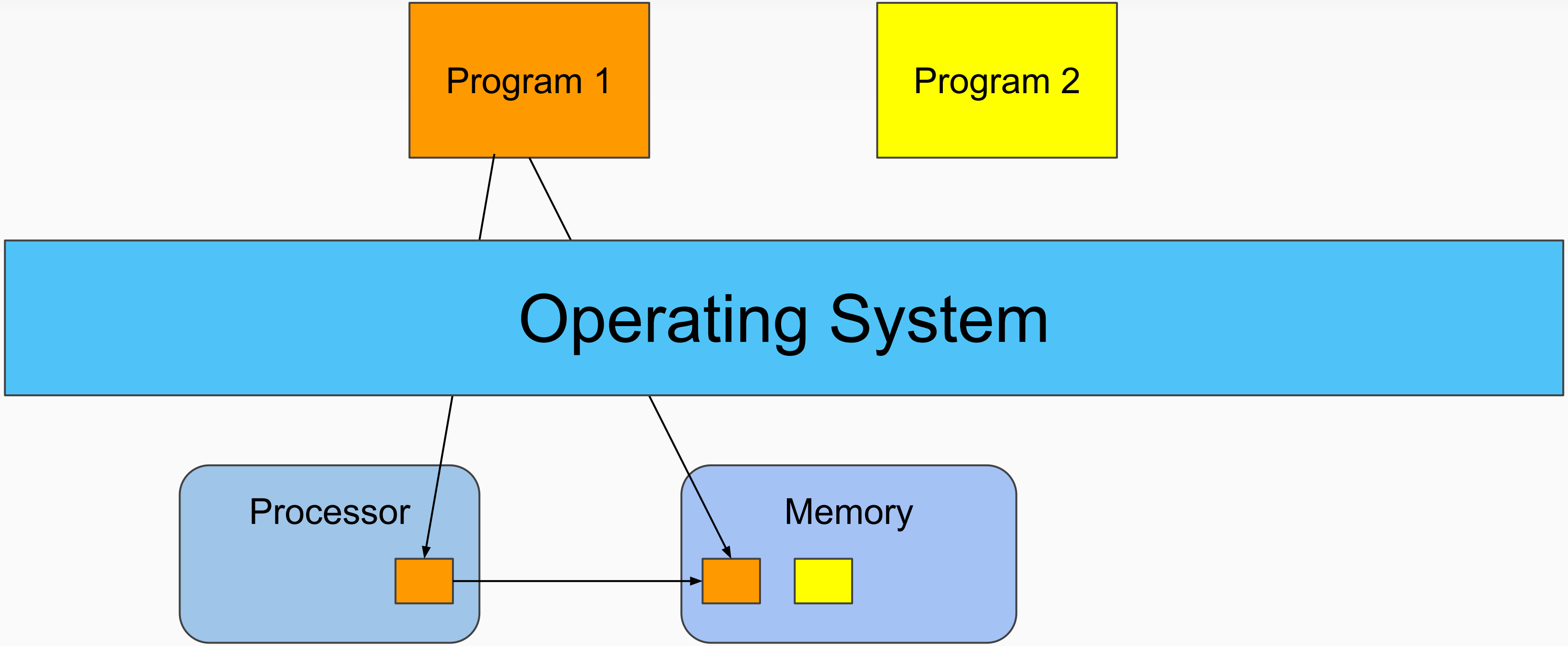

Applications (Games, Sheets, Slides)
OPERATING SYSTEM
Hardware (Disks, CPU, Mouse)

Operating system designs

- Early operating systems
  - Interface above device-drivers
  - Library of services
  - Some systems ran one program at a time or supported one user
  - Advantages and Problems?
- Modern operating systems
  - Multitasking
    - Blocked processes allow other processes to run
    - Advantages and Problems?
  - Multiple users
    - Simultaneously assist many users
    - Advantages and Problems?

What does an OS do?

- Resource Management



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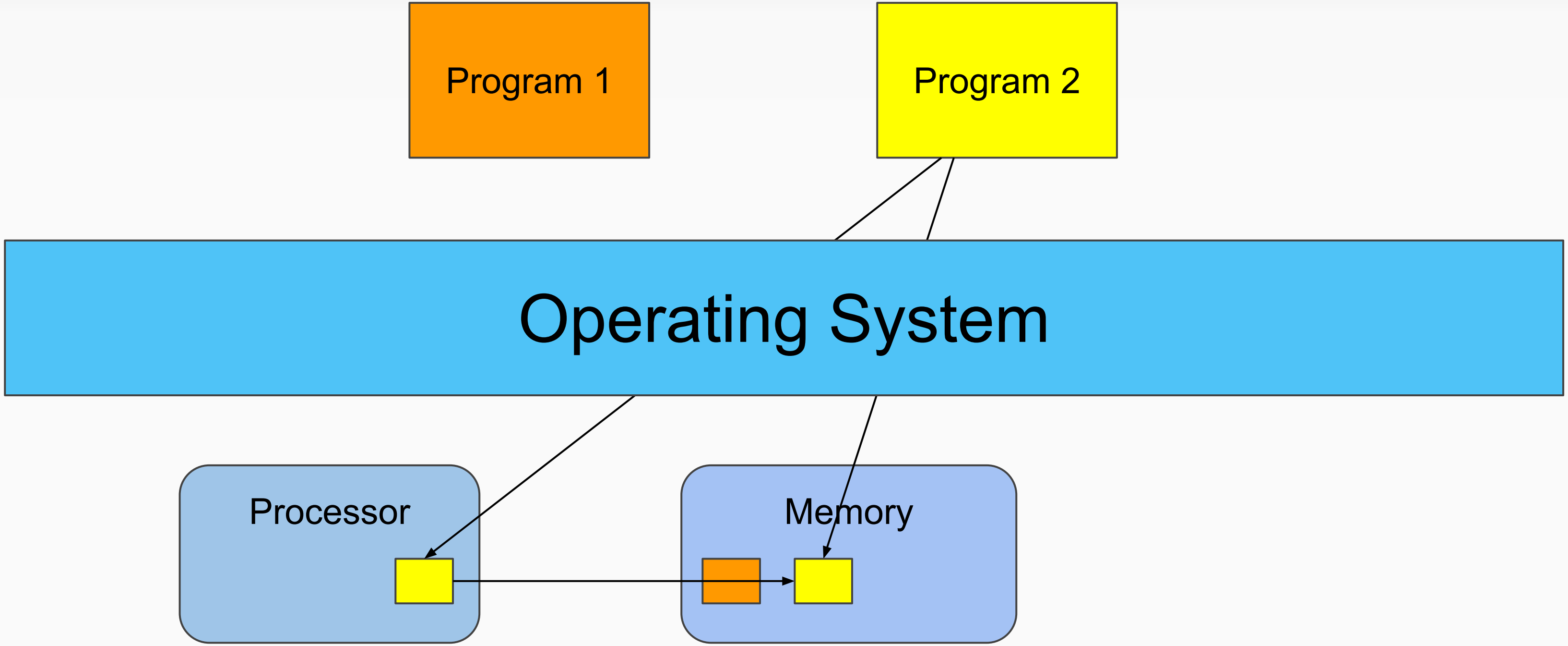

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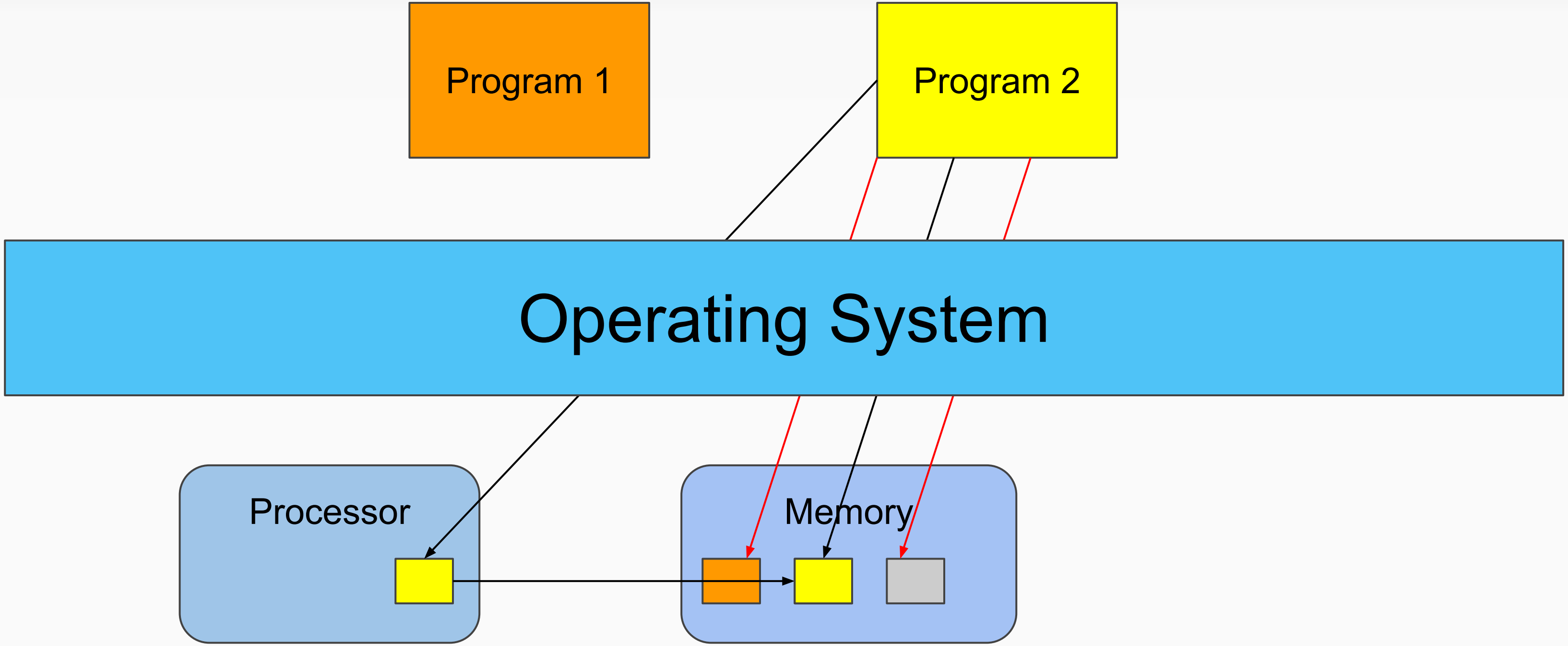

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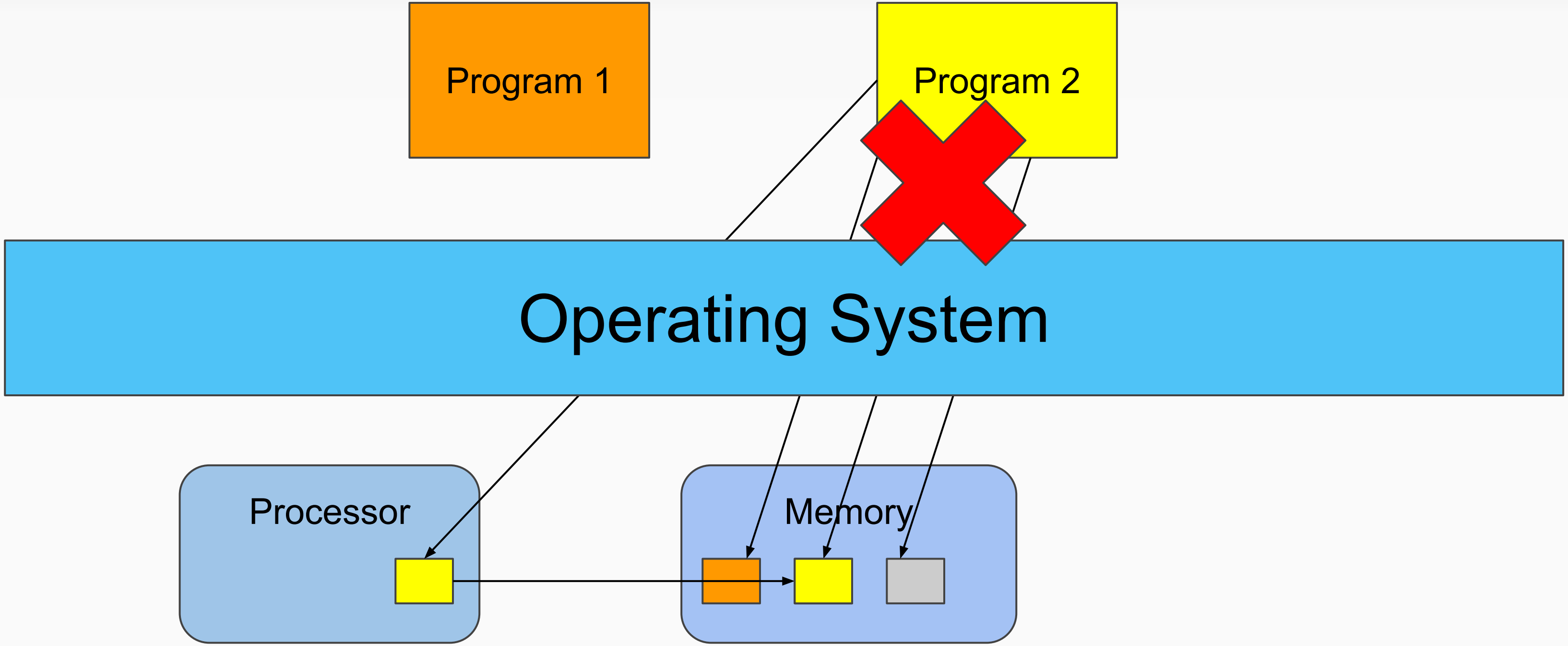
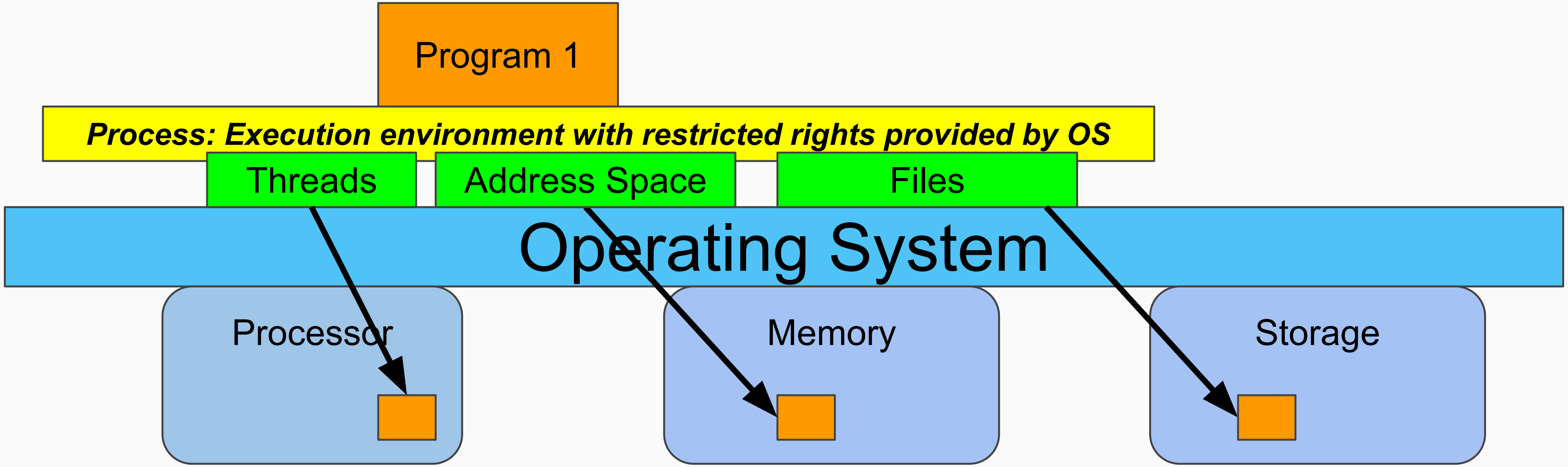


What does an OS do?

- Resource Management
  - Allocation and sharing of resources
    - Finite memory and disk space
    - What happens in infinite loop? Concurrency?
  - Isolation
    - One application should not disturb other
    - What happens if a program uses other’s memory?
    - In particular, we need fault isolation to prevent crashing our systems
  - Communication
    - Between different applications and users
    - What happens in a web server?
    - Crossing the isolated boundaries in a controlled fashion

What does an OS do?

- Abstraction and virtualization
    - Mask restrictions of the hardware
    - What happens when apps ask more resources than available?
    - Higher level objects - files, folders, etc.



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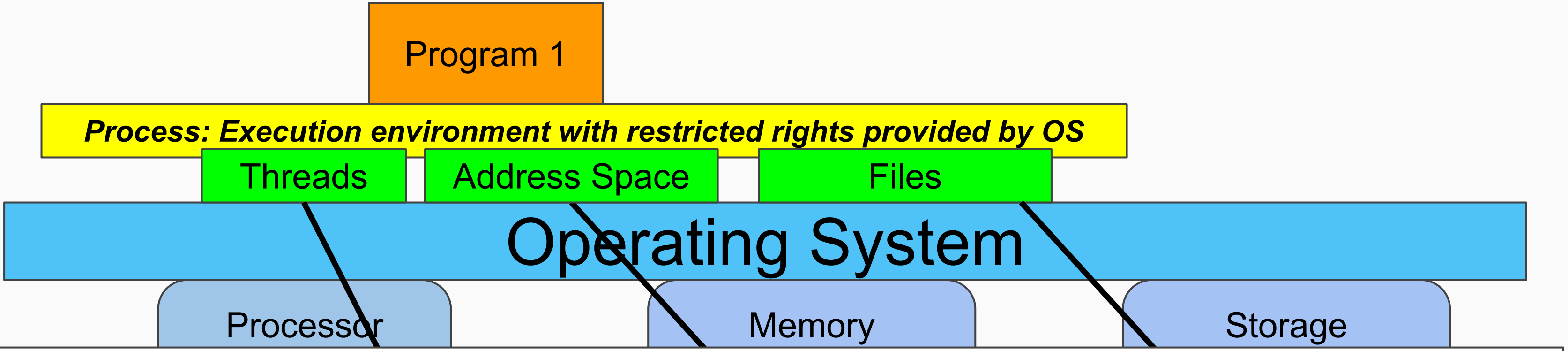


Program 1

Process: Execution environment with restricted rights provided by OS

Threads

Address Space

Files

Operating System

Processor

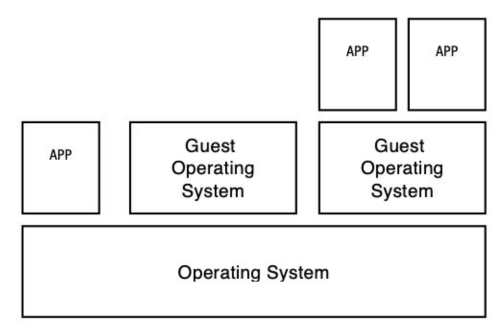
Memory

Storage

Each running program runs in its own process
Processes provide better APIs than directly interacting with the hardware

What does an OS do?

- Abstraction and virtualization
  - Mask restrictions of the hardware
  - What happens when apps ask more resources than available?
  - Higher level objects - files, folders, etc.
  - Virtualization
    - Infinite memory with no “other” application running
  - Virtual machines - OS on an OS
    - Portability
    - Debug OS
    - Security

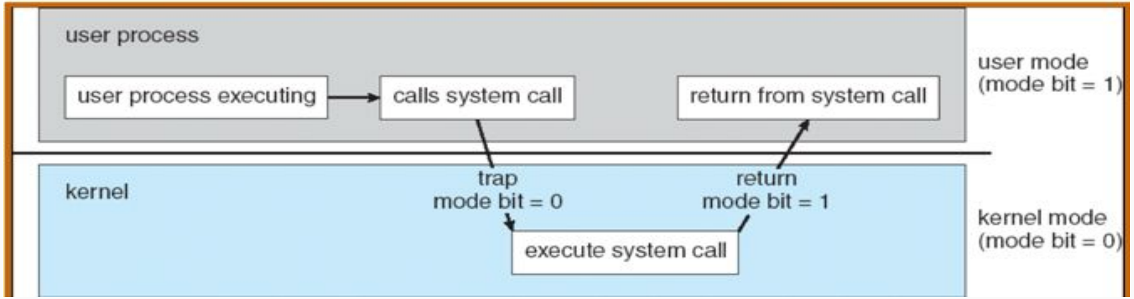


What does an OS do?

- Also, providing common services to applications
  - What happens when you copy some text from browser?
  - Simplify task of the application
    - Does not need to worry about how to do it
  - Provide different interfaces
    - Networking
    - Storage
    - Sensors
    - GUI Library

Dual-mode operation

- Kernel-mode
  - OS has full access to hardware
  - Initiate I/O request, network sends and receives, memory access
- User-mode
  - User applications
  - System calls to transfer control to kernel mode (*traps*)
    - Comes back to user mode (return-from-trap)



Operating systems are …

- Abstractions to handle hardware, coordinate between resources, contain faults and simplify applications

- Building blocks
  - Processes
  - Threads, concurrency, scheduling, coordination
  - Address spaces
  - Protection, isolation, sharing and security
  - Communication and protocols
  - Storage, transactions, consistency and resilience
  - Interfaces

Example

Complex OS!

Example: Mars Rover

- Pathfinder hardware limitations/complexity:
    - 20Mhz processor, 128MB of DRAM, VxWorks OS
    - cameras, scientific instruments, batteries, solar panels, etc.
    - Many independent processes work together
    - Must reboot itself if necessary
    - Must always be able to receive commands from Earth
    - Do not crash antenna positioning software!
    - Need to stop before hitting something
    - Must track orbit of Earth for communication

What *really* is an Operating System?

An operating system is …

I dream of Lebanon asked: What operating system you use the most on your computer?

- □ Google Chrome ...
- □ Firefox ...
- □ Facebook ...

8 More...

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An operating system is …

- System that most likely performs
  - Memory management
  - CPU scheduling
  - I/O management
  - Communications
  - Multitasking

- Some examples?