Operating Systems

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Outline

Introduction

Processes and Threads

Synchronization and Locking

Memory Management

Introduction

What is an Operating System?

In simple terms, an interface between the user and the computer hardware.

Basic Computer Architecture

What happens when you turn on a computer?

Processes and Threads

Processes

- What is it?
- Ready queue
- Process scheduling
- Scheduling algorithms
  - FCFS
  - SJF
  - Priority
  - Round Robin
- Context switching

Threads

- What is it?
- Threads vs Processes
- User level threads vs Kernel level threads

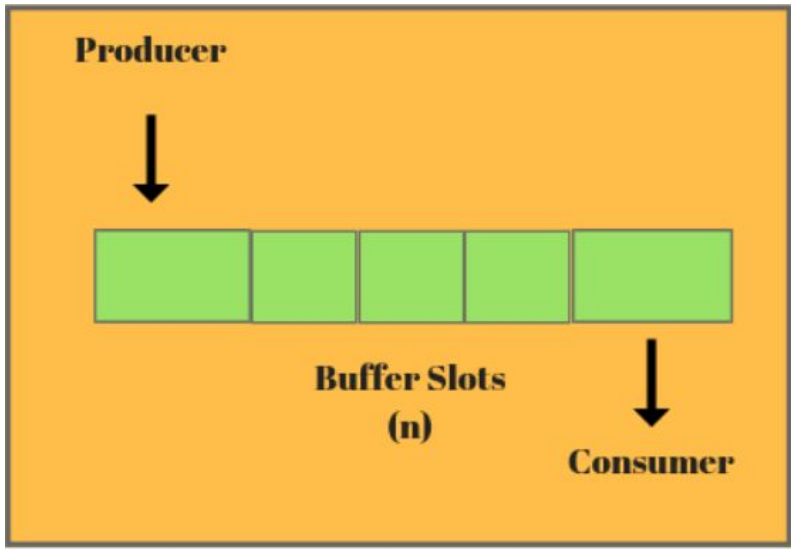
Multiprogramming vs Multithreading vs Multiprocessing

Process Synchronization

Synchronization

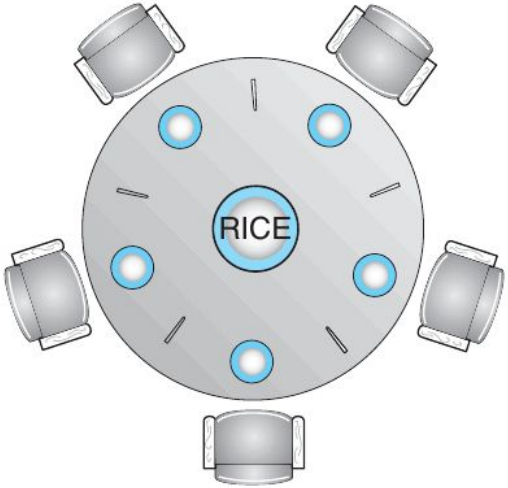
- IPC
  - Shared memory
  - Message Passing
- Critical Section problem, Race condition
- Mutexes - locking mechanism
- Semaphores - signalling mechanism

Producer Consumer Problem



Read up its solution using semaphores

Dining Philosophers Problem



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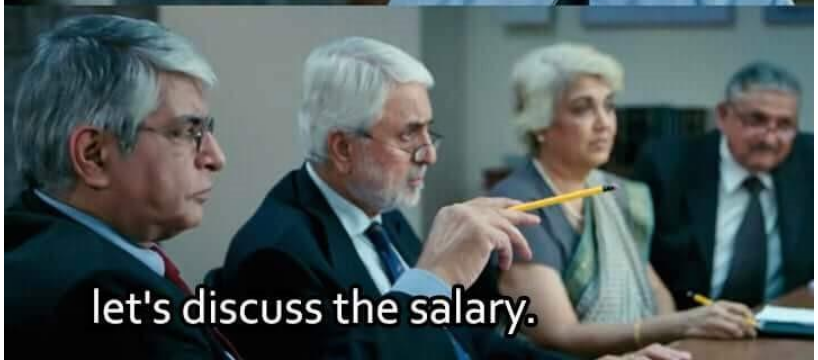
IMPERIAL COLLEGE OF
Explain [redacted] and we'll hire you.


Hire me, and I'll explain it to you.


let's discuss the salary.


Explain Deadlock, and we'll hire you.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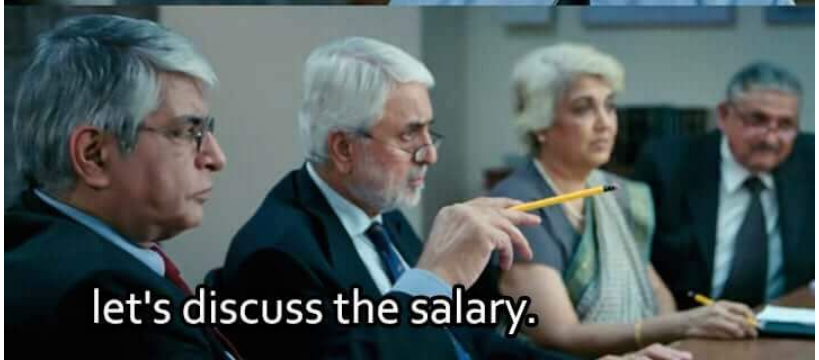
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- What is it?
- Necessary conditions
  - Mutual exclusion
  - Hold and wait
  - No pre-emption
  - Circular wait

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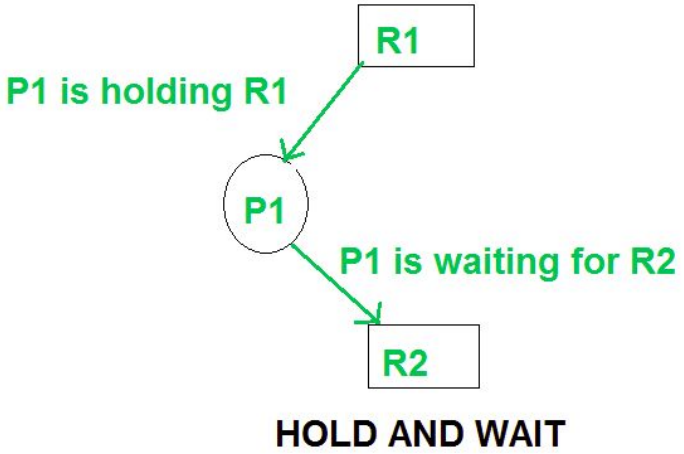

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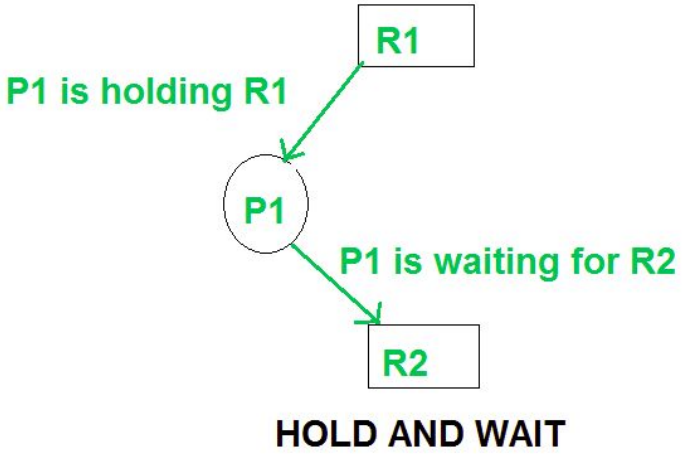

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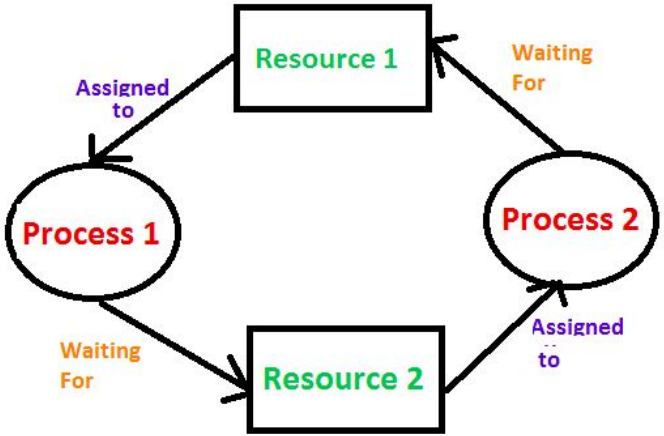

Deadlocks

- Prevention
  - Restructure system to disallow any of the conditions
- Avoidance
  - Allot resources in a way that you stay “safe”
  - Read up on **“Banker’s Algorithm”**
- Recovery
  - Allow deadlocks, but recover when they happen

Memory Management

Physical and Logical Addresses

Physical Addresses

- Variables, instructions stored in RAM
- Actual address in the memory

Logical Addresses

- Abstracted view of main memory
- Symbolic Addresses

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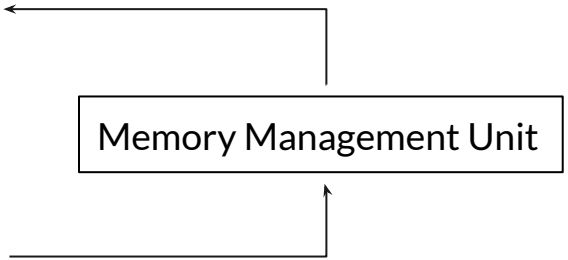


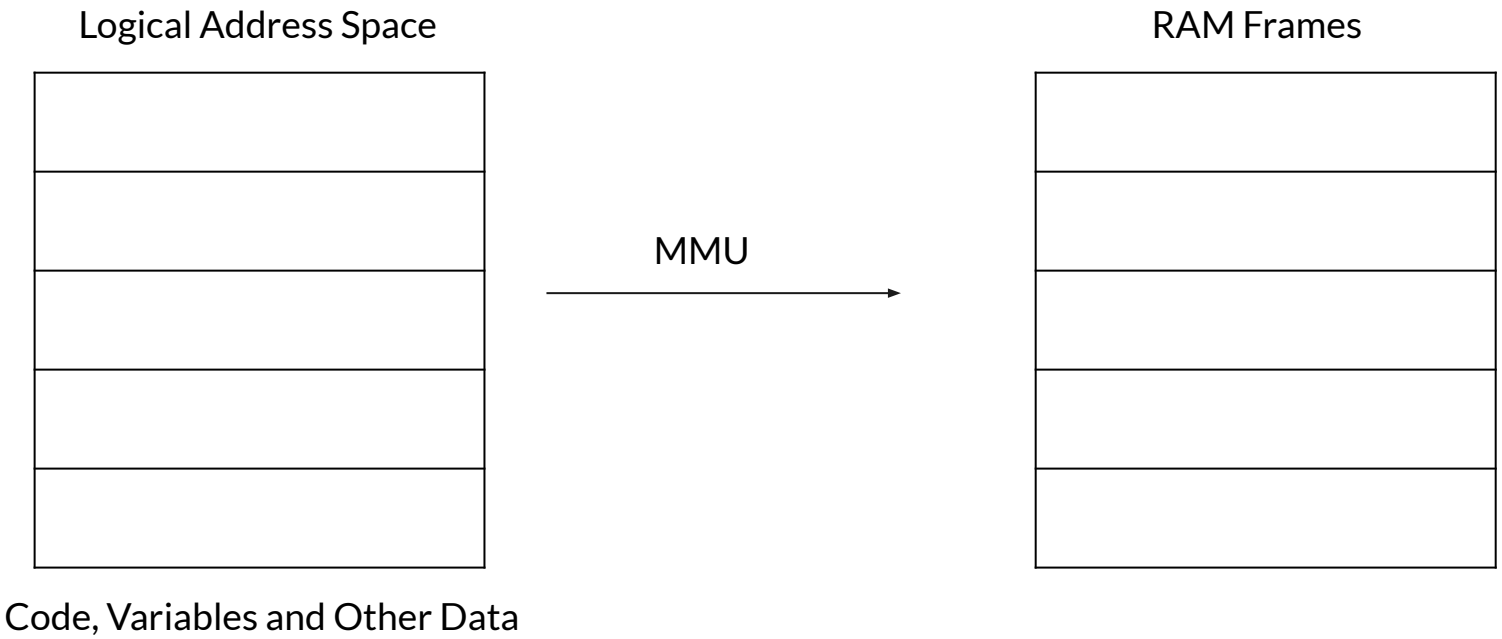
Physical and logical address space - everything addressable

Pages and Frames

How does this mapping happen?

- Physical Address Space (RAM) divided into frames
- Logical Address Space divided into equal sized pages
- Load one page in one frame - **Paging**

Paging

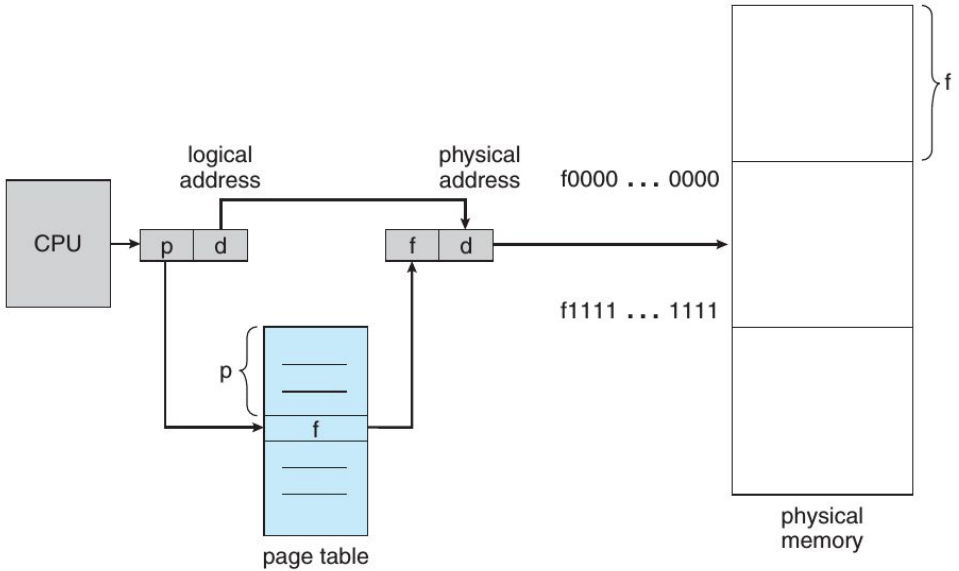

Logical Address Space
RAM Frames
MMU
Code, Variables and Other Data

Memory Mapping (MMU)

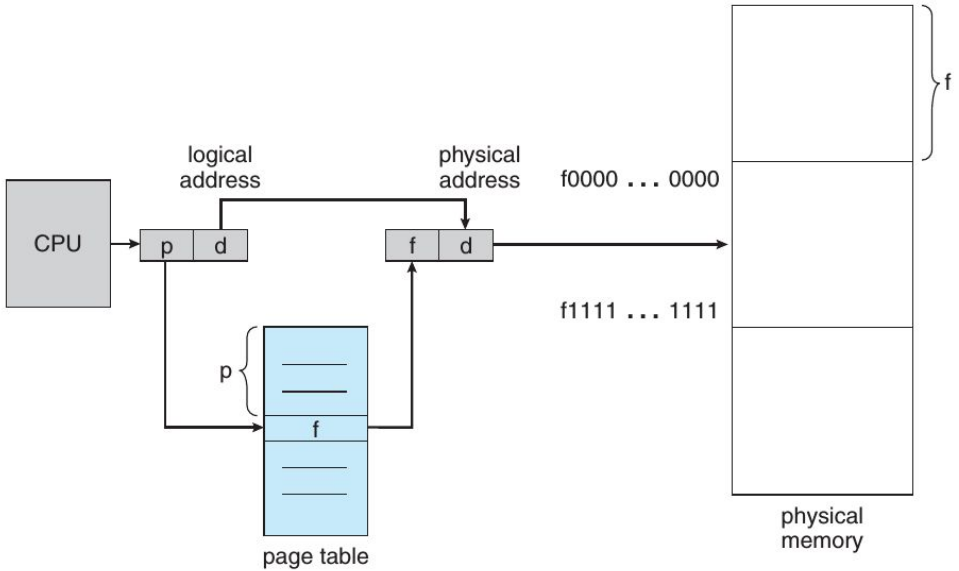
Page Table

- Logical Address -> Page number + Offset
- Physical Address -> Frame Number + Offset
- Basically have to obtain page number from frame number

Page Table


CPU
logical address
p
d
physical address
f
d
f0000 . . . 0000
f1111 . . . 1111
f
p
f
page table
physical memory

Page Table



Read up “valid-invalid bit” in page table

Page Fault

Ways to load process into RAM

- Load the entire process - can waste memory
- Load only required pages - what if more pages are required
- Required page not available - **Page Fault**
- Solution?
- Bring in more pages - **Demand Paging**

Page Replacement

Assume: We need to bring in one page

1. Find page on disk
2. Find a free frame
    a. If free frame present, use it
    b. If not, select a **victim frame**
    c. Write victim frame to disk
3. Copy required page into frame

Page Replacement Algorithms

- FIFO
- LRU
- LFU
- MFU
- Read up on “Second chance algorithm” - LRU approximation

Questions?

Thank You

Acknowledgements

Images taken from *Operating System Concepts (Galvin and Gagne) 9th Edition*