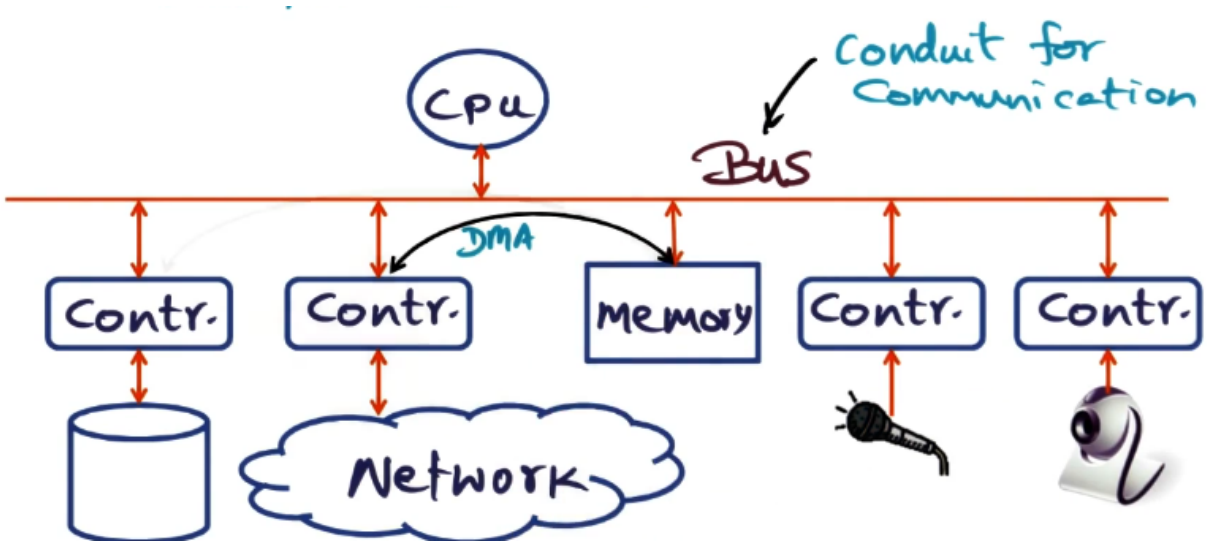
Introduction to AOS

Principle of Abstraction

* Abstraction: Well-understood interface that hides all the details within a subsystem
    - Examples of abstractions:
        1. Door knob
        2. Instruction set architecture
        3. AND logic gate
        4. Transistor
        5. INT data type
    - Abstractions between Google Earth and the electrons on the silicon
        + Transistors
        + Logic gates
        + ALU, Memory
        + Processor
        + Instruction set architecture
        + Operating system
        + Applications

Hardware Resources

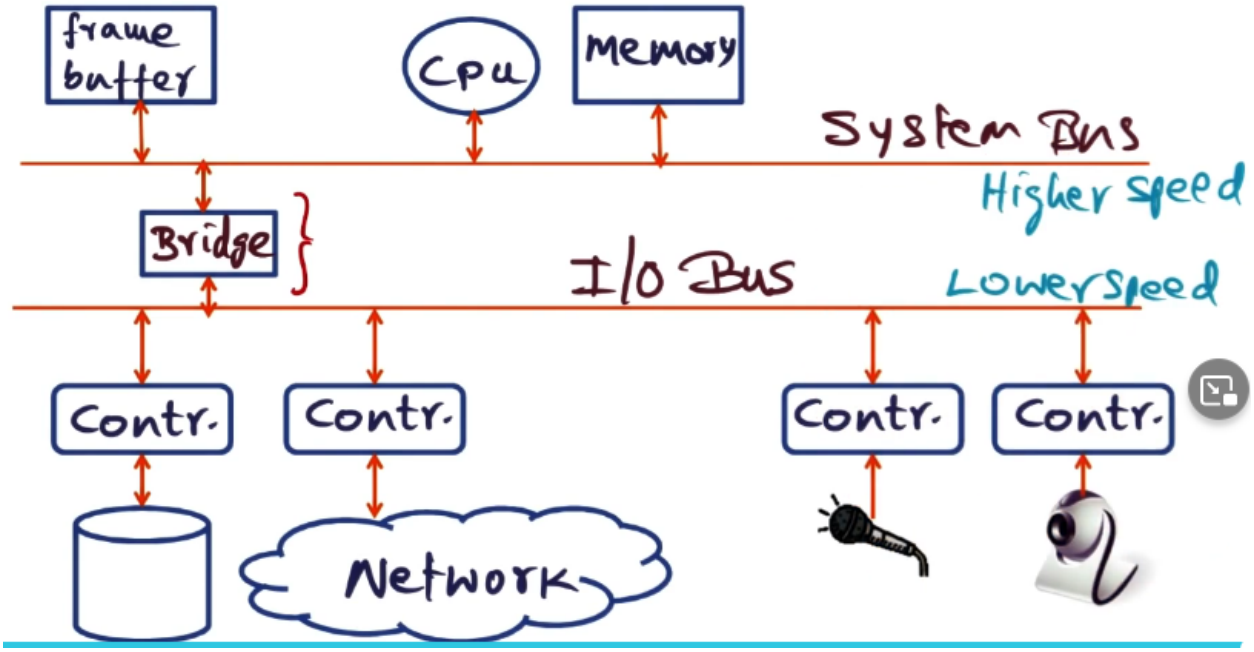
* Hardware consists of processor, memory, and IO devices
    - Organization of these components is fairly constant across devices
* Internal organization
    - CPU connected to a bus
    - Memory connected to same bus
    - Storage and other peripheral devices accessible through bus
    - Network interface through a controller
    - DMA can allow controllers to interface with memory directly instead of through the shared bus



Hardware Organization

* Organization with I/O Bus
    - Separate bus for I/O from system with bridge connecting them

- Intent is that cumulative need for bandwidth of individual devices is less than the bandwidth needed by the memory/CPU
- System bus is higher speed, I/O bus is lower speed
- Bridge arbitrates DMA or communication with CPU



Hardware Organization with I/O Bus

* Specifics of computational power, memory capacity, and number/types of I/O devices may vary from one computer system to the next, but the underlying organization is similar

OS Functionality

* Functionality required of operating systems
    1. OS is a resource manager
    2. OS provides a consistent interface to the hardware resources
    3. OS schedules applications on the CPU
* Definition of OS
    - Protected acccess to hardware resources
    - Arbitrate among competing requests
    - Well-defined APIs for OS services
* What happens when a mouse is clicked?
    1. Hardware controller interfacing with mouse raises an interrupt on the interrupt line (dedicated line on bus)
        + Interrupt is a hardware mechanism that alerts the OS that some piece of hardware needs attention
    2. OS fields the interrupt
        + OS schedules itself to run on the CPU in addition to applications
    3. OS passes it to the program for appropriate action for this particular interrupt

Managing the CPU and Memory

* Different programs all need access to hardware without hogging the CPU or overwriting code/data of other programs
    - OS needs to manage this process by scheduling itself on the CPU, but needs to minimize its time spent consuming cycles
* How can one CPU run several programs in parallel with only one CPU?
    - Applications share the CPU through the operating system, but only one is running at a time. OS multiplexes the CPU
* Resource needs of applications include CPU, memory, peripheral devices
    - At the time of launch, OS knows enough about the application to create a memory footprint (stack, heap, global data, code)
    - Application asks for additional resources at runtime
    - OS only interferes only to arbitrate resources needed by application and gets out of the way as quickly as possible
* Processor-related OS abstractions
    - Program: Static image loaded into memory of an application
    - Process: A program in execution (process = program + state)
        + State is continuously evolving as the process executes
* Process vs Thread
    - A process is a program plus the state of all the threads executing in the program
* Memory-Related OS Abstraction
    - Address space for each process is distinct from one another
    - Implement the abstraction using hardware capabilities