OPERATING SYSTEMS

I/O Management, System Protection and Security

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Kernel I/O Subsystem

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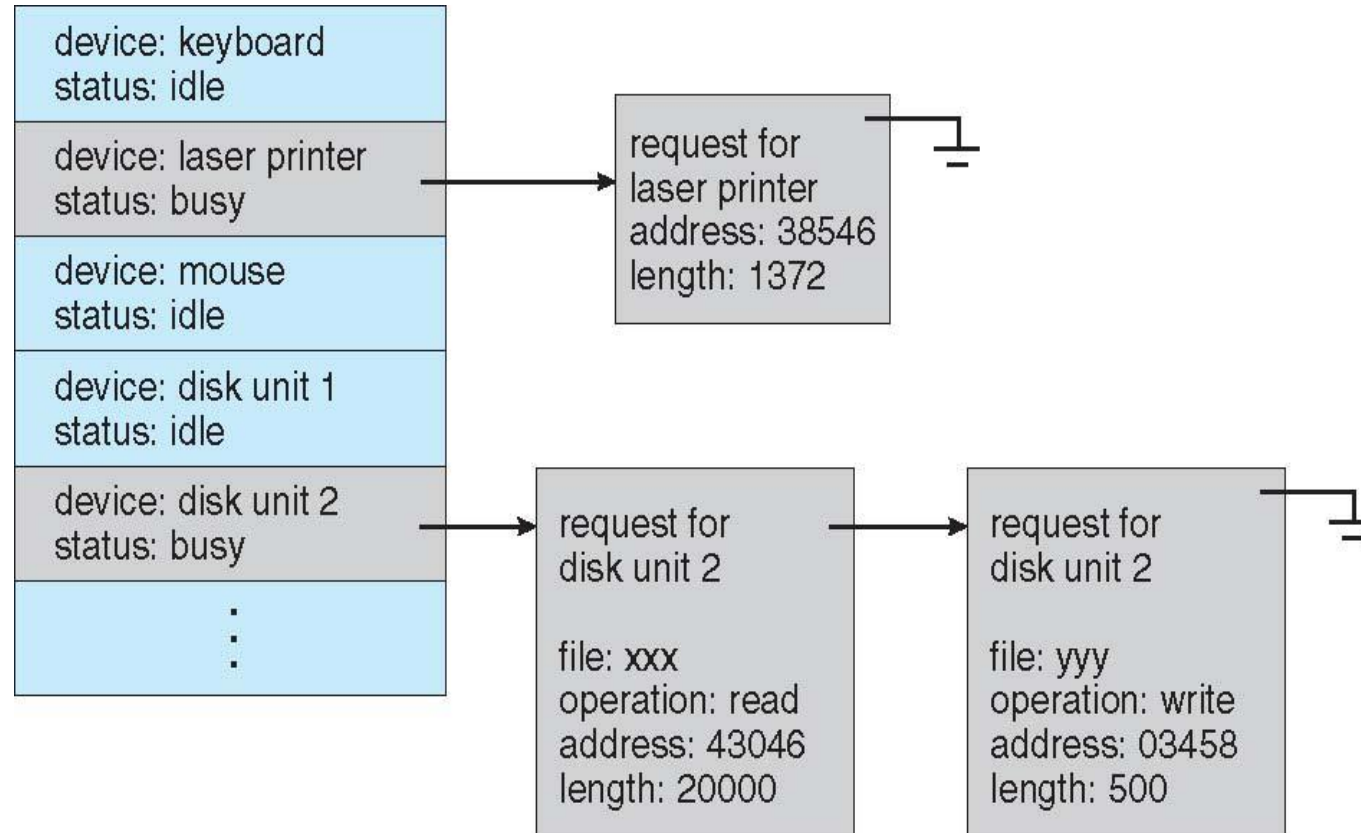
Slides Credits for all PPTs of this course

- The slides/diagrams in this course are an **adaptation**, **combination**, and **enhancement** of material from the following resources and persons:

1. Slides of Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne - 9th edition 2013 and some slides from 10th edition 2018

Overview

- Kernel provide many services related to I/O. Some of them are-

  - scheduling

  - caching

  - spooling

  - Device reservation

  - Error handling

- These are provided by kernel's I/O subsystem and build on the hardware and device driver infrastructure.

- **Scheduling**
  - Some I/O request ordering via per-device queue
  - Some OSs try fairness
  - Some implement Quality Of Service (i.e. IPQOS)
- **Buffering** - store data in memory while transferring between devices
  - To cope with device speed mismatch
  - To cope with device transfer size mismatch
  - To maintain "copy semantics"
  - **Double buffering** – two copies of the data
    - Kernel and user
    - Varying sizes
    - Full / being processed and not-full / being used
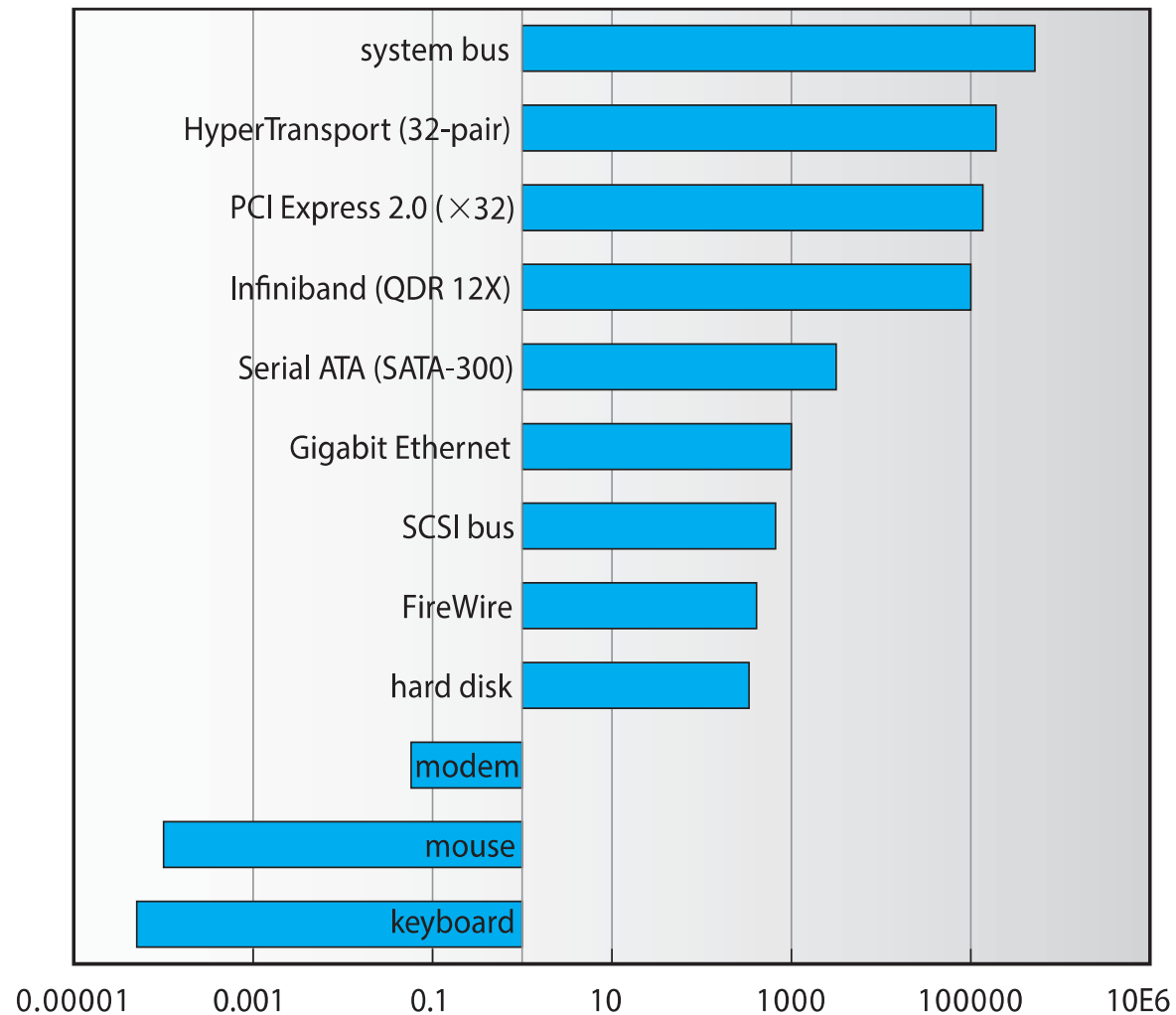   - Copy-on-write can be used for efficiency in some cases

Device Status Table

device: keyboard
status: idle

device: laser printer
status: busy → request for
laser printer
address: 38546
length: 1372

device: mouse
status: idle

device: disk unit 1
status: idle

device: disk unit 2
status: busy → request for
disk unit 2

file: xxx
operation: read
address: 43046
length: 20000

→ request for
disk unit 2

file: yyy
operation: write
address: 03458
length: 500

Sun Enterprise 6000 device-transfer rates

- **Caching** - faster device holding copy of data
  - Always just a copy
  - Key to performance
  - Sometimes combined with buffering

- **Spooling** - hold output for a device
  - If device can serve only one request at a time
  - i.e., Printing

- **Device reservation** - provides exclusive access to a device
  - System calls for allocation and de-allocation
  - Watch out for deadlock

Error Handling

- OS can recover from disk read, device unavailable, transient write failures
  - Retry a read or write, for example
  - Some systems more advanced – Solaris FMA, AIX
    - Track error frequencies, stop using device with increasing frequency of retry-able errors
- Most return an error number or code when I/O request fails
- System error logs hold problem reports

I/O Protection

- User process may accidentally or purposefully attempt to disrupt normal operation via illegal I/O instructions
  - All I/O instructions defined to be privileged
  - I/O must be performed via system calls
    - Memory-mapped and I/O port memory locations must be protected too

Kernel Data Structures
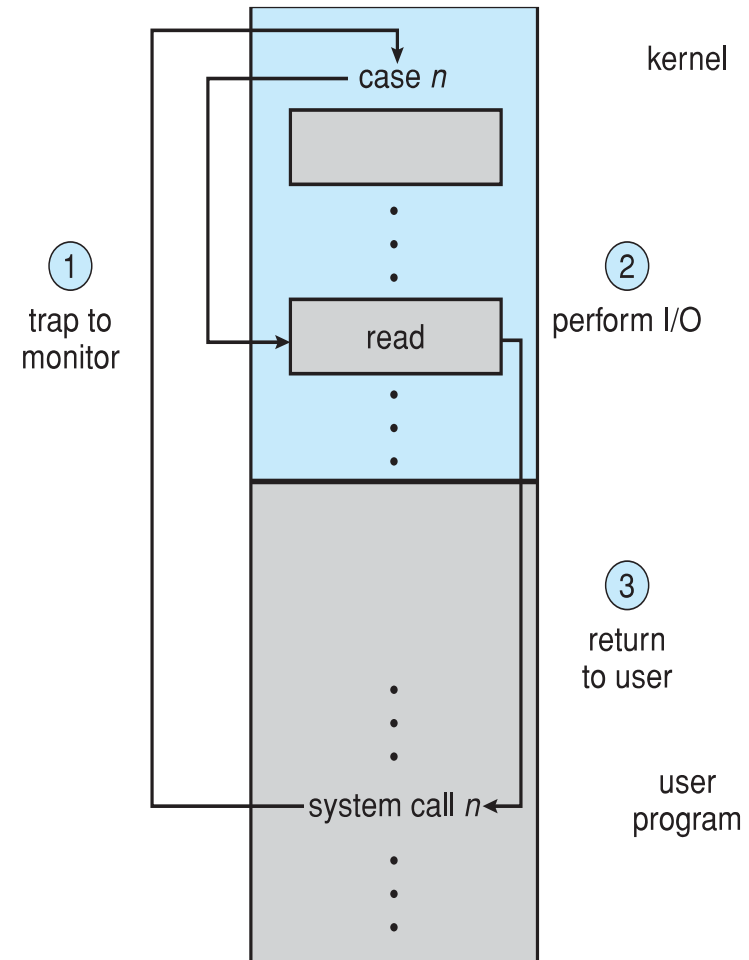
- Kernel keeps state info for I/O components, including open file tables, network connections, character device state

- Many, many complex data structures to track buffers, memory allocation, "dirty" blocks

- Some use object-oriented methods and message passing to implement I/O
  - Windows uses message passing
    - Message with I/O information passed from user mode into kernel
    - Message modified as it flows through to device driver and back to process

OPERATING SYSTEMS
UNIX I/O Kernel Structure
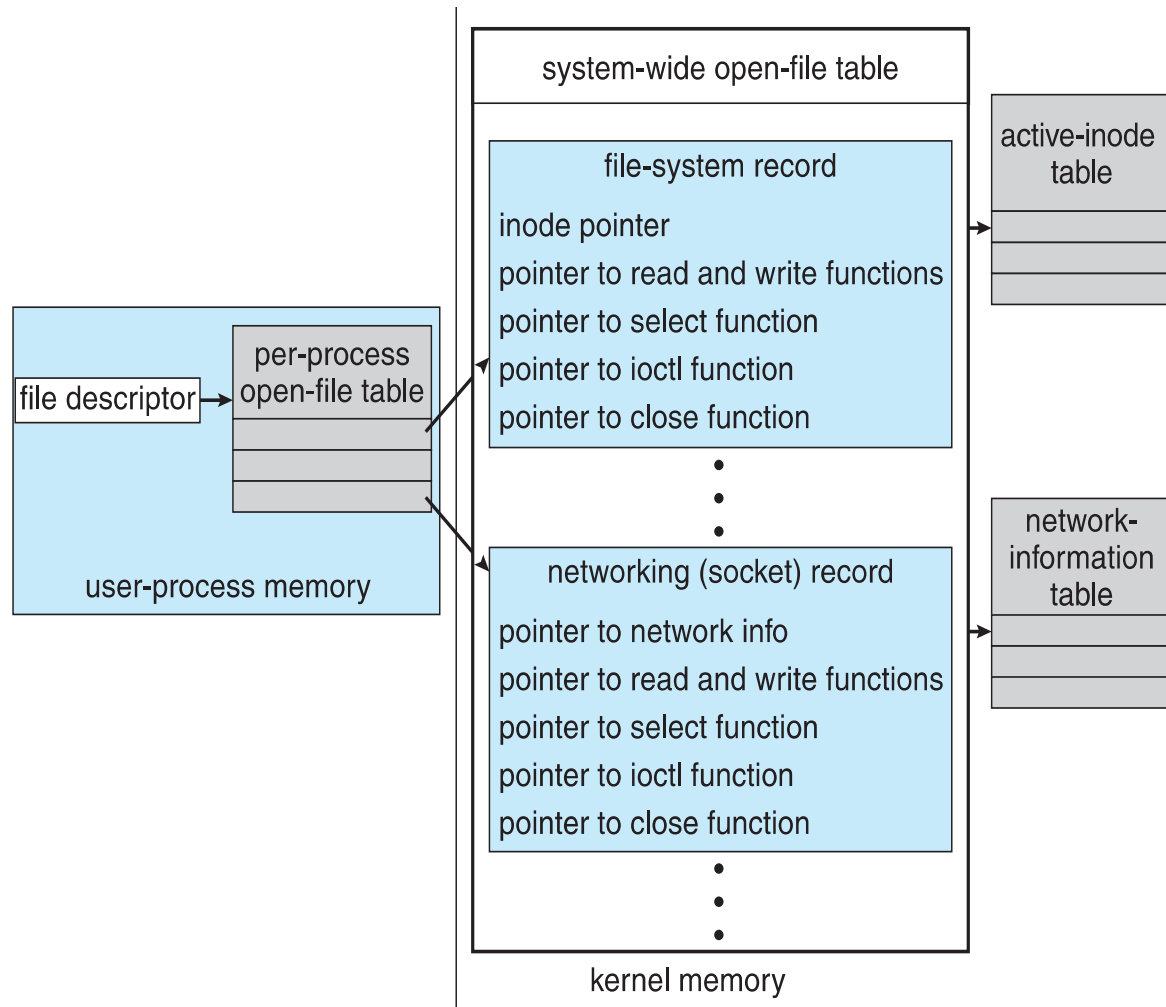
THANK YOU

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