OS and its Three Pieces

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What is an OS?

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- A bunch of software and data residing somewhere in memory.
  - But its not just *any* software.
- OS is the *most privileged* software in a computer.
  - *Privileged* means that OS can do special things, like write to disk, talk over the network, control memory and CPU usage, etc.
- OS manages all system resources
  - CPU, Memory, and I/O devices

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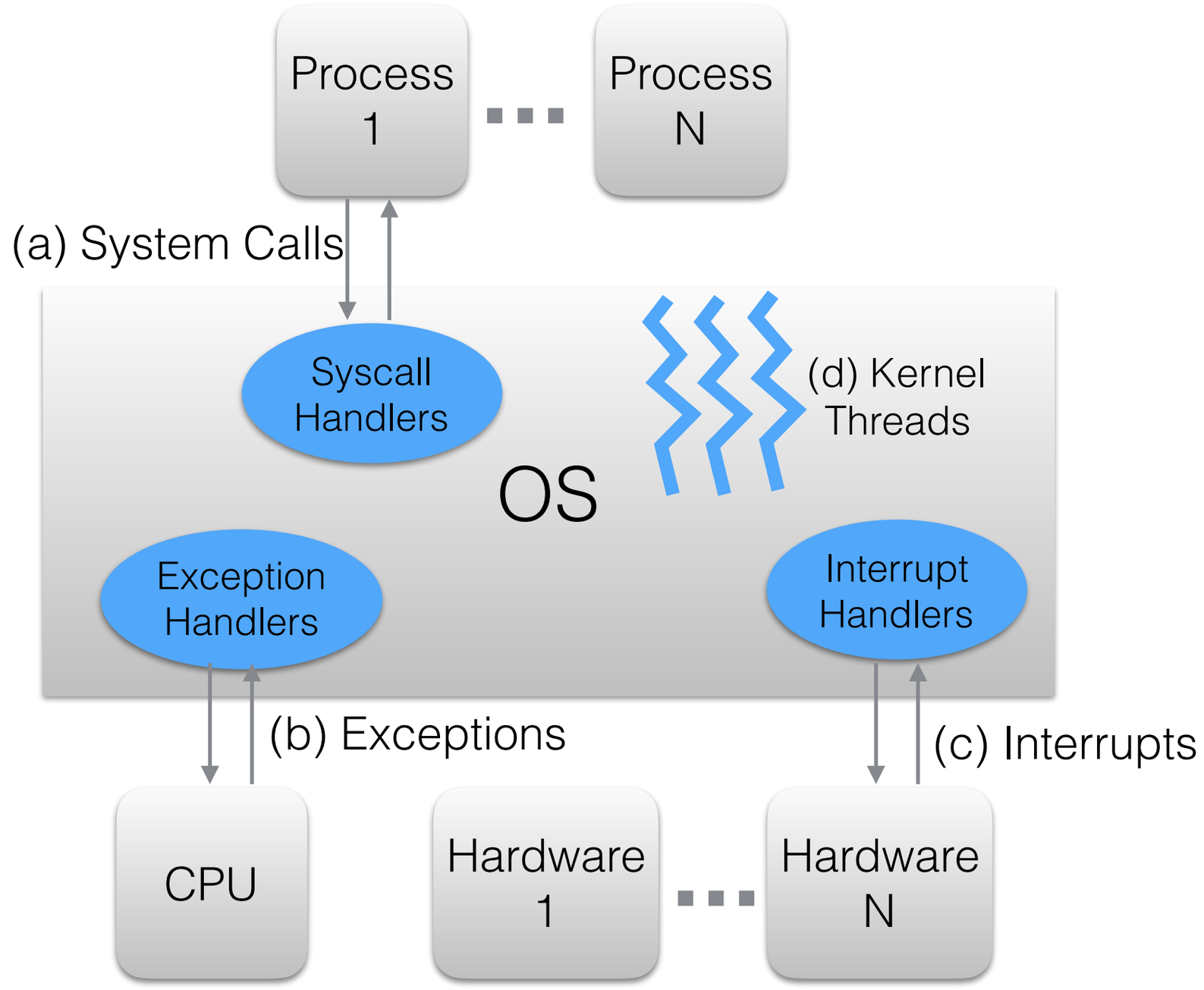
Four ways to invoke OS code



Three major tasks of OS

1. Virtualization
2. Concurrency
3. Persistence

Virtualization

- Making a physical resource look like something else (virtual).
- Why virtualize?
  - To make the computer easier to use and program.
- Examples
  - Make one physical CPU look like multiple virtual CPUs
    - One or more virtual CPUs per process
  - Make physical memory (RAM) and look like multiple virtual memory spaces
    - One or more virtual memory spaces per process
  - Make physical disk look like a file system
    - Physical disk = raw bytes.
    - File system = user's view of data on disk.

Concurrency

- Juggling many tasks together
- Examples
  - One physical CPU runs many processes
  - One process runs many threads
  - One OS juggles process execution, system calls, interrupts, exceptions, CPU scheduling, memory management, etc.
- There's a LOT of concurrency in modern computer systems.
- And its the source of most of the system complexity.

Persistence

- Storing data “forever”
  - On hard disks, SSDs, CDs, floppy disks, tapes, phono discs, paper!
- But its not enough to just store raw bytes
- Users want to
  - Organize data (via file systems)
  - Share data (via network or cloud)
  - Access data easily
    - …and recover data when lost.
  - Protect data from being stolen.

History of OS

- 1950s and 1960s: Early operating systems were simple batch processing systems
  - Users provided their own “OS” as libraries.
- 1960s and1970s: Multi-programming on mainframes
  - Concurrency, memory protection, Kernel mode, system calls, hardware privilege levels, trap handling
  - Earliest Multics hardware and OS on IBM mainframes
  - Which led to the first UNIX OS which pioneered file systems, shell, pipes, and the C language.
- 1980s: Personal computing era
  - MacOS, IBM PC and its DOS, Windows, and so forth.
  - Unfortunately, many lessons from earlier multi-programming era were forgotten and had to be re-learned (painfully).
- 1980s also saw the fragmentation of UNIX
  - Each big company had its own version (IBM, Apple, HP, SUN, SGI, NCR, AT&T….)
  - LOT of legal wrangling over IP and copyrights
- 1990s: Then came BSD and Linux
  - Open source.
  - Led the way to modern OSes and cloud platforms
- 1990s also saw wider adoption of threads and parallelism
- 2000 and beyond: Mobile device OS and hypervisors
  - Android, iOS
  - VMWare ESX, Xen, Linux/KVM etc.