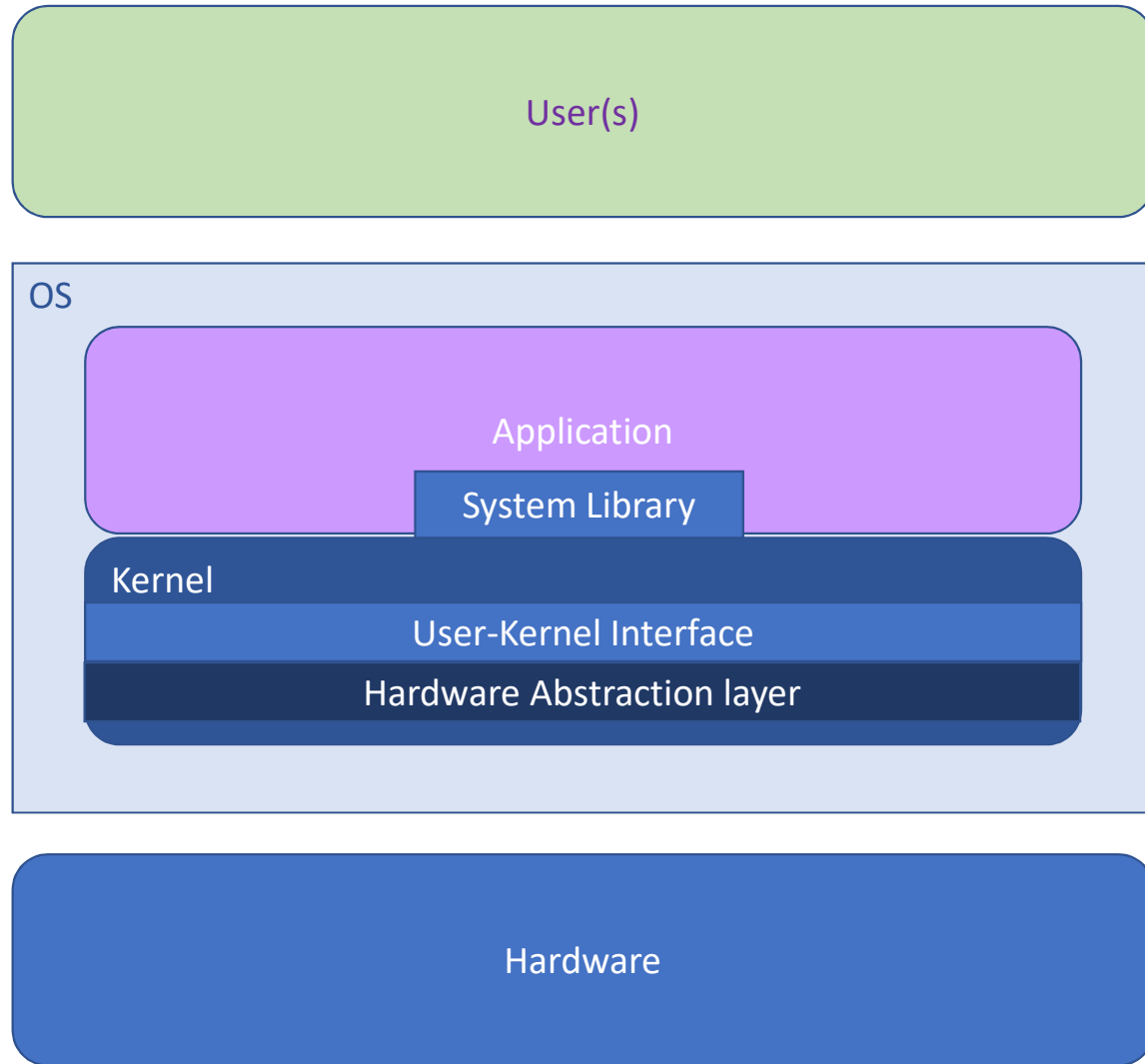


Introduction

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What is an Operating System?



Roles of the Operating System

- Referee:
 - **Resource allocation** among users, applications
 - **Isolation** of different users, applications from each other
 - **Communication** between users, applications
- Illusionist
 - Each application appears to have the entire machine to itself
 - Infinite number of processors, (near) infinite amount of memory, reliable storage, reliable network transport
- Glue
 - Libraries, user interface widgets, ...

Operating System Evaluation

- Reliability and Availability
- Security
- Portability
 - AVM, API, HAL
- Performance
 - Overhead, efficiency
 - Fairness, response time, throughput
 - Performance predictability
- Adoption

Design Tradeoffs

- Must balance between the 5s
- Examples
 - Preserves legacy API → Portability ↑, reliable ↓, secure ↓
 - Breaking an abstraction → Performance ↑, Portability ↓, Reliability ↓

Computer Performance Over Time

	1981	1997	2014	Factor (2014/1981)
Uniprocessor speed (MIPS)	1	200	2500	2.5K
CPUs per computer	1	1	10+	10+
Processor MIPS/\$	\$100K	\$25	\$0.20	500K
DRAM Capacity (MiB)/\$	0.002	2	1K	500K
Disk Capacity (GiB)/\$	0.003	7	25K	10M
Home Internet	300 bps	256 Kbps	20 Mbps	100K
Machine room network	10 Mbps (shared)	100 Mbps (switched)	10 Gbps (switched)	1000
Ratio of users to computers	100:1	1:1	1:several	100+

From Thomas Anderson and Michael Dahlin, Operating Systems Principles & Practice Volume I, 2nd edition, Recursive Books, 2015

Early Operating Systems: Computers Very Expensive

- One application at a time
 - Had complete control of hardware
 - OS was runtime library
 - Users would stand in line to use the computer
- Batch systems
 - Keep CPU busy by having a queue of jobs
 - OS would load next job while current one runs
 - Users would submit jobs, and wait, and wait, and

Time-Sharing Operating Systems: Computers and People Expensive

- Multiple users on computer at same time
 - Multiprogramming: run multiple programs at same time
 - Interactive performance: try to complete everyone's tasks quickly
 - As computers became cheaper, more important to optimize for user time, not computer time

Today's Operating Systems: Computers Cheap

- Smartphones
- Embedded systems
- Laptops
- Tablets
- Virtual machines
- Data center servers

Tomorrow's Operating Systems

- Giant-scale data centers
- Increasing numbers of processors per computer
- Increasing numbers of computers per user
- Very large scale storage