Introduction

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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

- Had complete control of hardware
- OS was runtime library
- Users would stand in line to use the computer

- 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

- 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

กิจกรรม #1

- ในความคิดเห็นของนักศึกษา ระบบปฏิบัติการมีบทบาทหน้าที่หลักอะไรบ้าง

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, ...

กิจกรรม #2

- ระบบปฏิบัติการคืออะไร?

What is an Operating System?

- A set of software that manage computer's resources for its users and their applications
  - May visible or invisible to the user
  - 2 major kinds
    - General purpose OS
    - Specific purpose OS

กิจกรรม #3

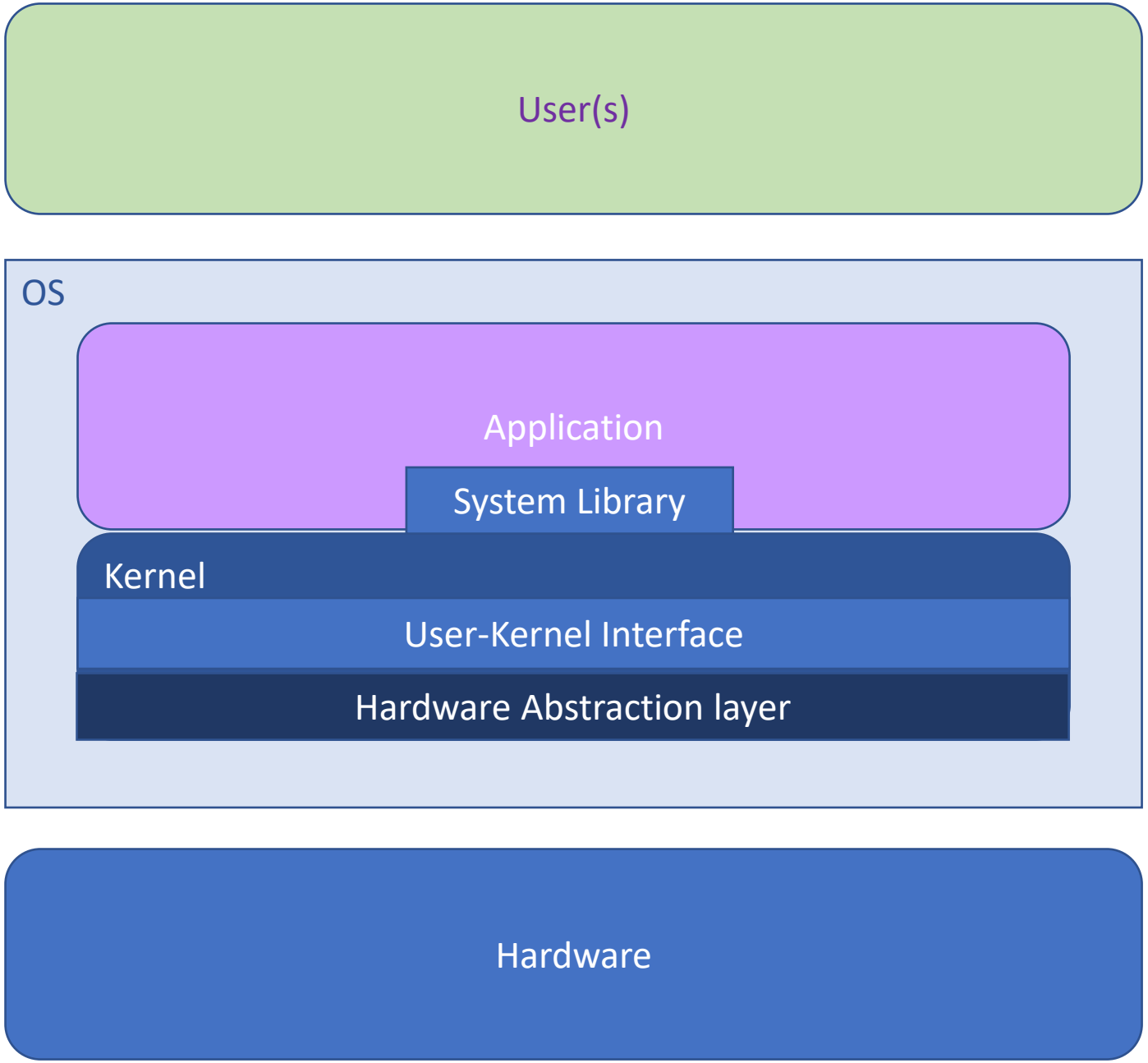
- หากนักศึกษาต้องประเมินระบบปฏิบัติการหนึ่ง นักศึกษาจะประเมินด้านใดบ้าง และแต่ละด้านจะวัดอย่างไร

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 ↓


User(s)
OS
Application
System Library
Kernel
User-Kernel Interface
Hardware Abstraction layer
Hardware