

# CSF2600505 Sistem Operasi CSGE602055 Operating Systems Week 00: Overview 1

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<https://os.vlsm.org/>

Always check for the latest revision!

REV208 03-Sep-2019

# Operating Systems 2019-2

A (Rm 3114) [Tu/Th 08-10] — I (Rm A714) [Tu 13-15/Th 14-16]

Week	Schedule	Topic	OSC10
Week 00	03 Sep - 09 Sep 2019	Overview 1, Virtualization & Scripting	Ch. 1, 2, 18.
Week 01	10 Sep - 16 Sep 2019	Overview 2, Virtualization & Scripting	Ch. 1, 2, 18.
Week 02	17 Sep - 23 Sep 2019	Security, Protection, Privacy, & C-language	Ch. 16, 17
Week 03	24 Sep - 30 Sep 2019	File System & FUSE	Ch. 13, 14, 15
Week 04	01 Oct - 07 Oct 2019	Addressing, Shared Lib, & Pointer	Ch. 9
Week 05	08 Oct - 14 Oct 2019	Virtual Memory	Ch. 10
Reserved	15 Oct - 18 Oct 2019	Q & E	
MidTerm	19 Oct - 25 Oct 2019	TBA — MidTerm (UTS)	
Week 06	29 Oct - 04 Nov 2019	Concurrency: Processes & Threads	Ch. 3, 4
Week 07	05 Nov - 11 Nov 2019	Synchronization & Deadlock	Ch. 6, 7, 8
Week 08	12 Nov - 18 Nov 2019	Scheduling + W06/W07	Ch. 5
Week 09	19 Nov - 25 Nov 2019	Storage, Firmware, Bootldr, & Systemd	Ch. 11
Week 10	26 Nov - 02 Dec 2019	I/O & Programming	Ch. 12
Reserved	03 Dec - 13 Dec 2019	Q & E	
Final	14 Dec - 21 Dec 2019	TBA — Final (UAS)	This schedule is subject to change.
Extra	09 Jan 2020	Extra assignment confirmation	

# STARTING POINT — <https://os.vlsm.org/>

- ❑ **Text Book** — Any recent/decent OS book. Eg. (**OSC10**) Silberschatz et. al.: **Operating System Concepts**, 10<sup>th</sup> Edition, 2018. See also <http://codex.cs.yale.edu/avi/os-book/OS10/>.
- ❑ **Weekly**
  - ❑ Encode your **QRC** with size about 5cm x 5cm (ca. 400x400 pixels):  
**"OS192 CLASS ID SSO-ACCOUNT Your-Full-Name"**  
Write your Memo (with QRC) **every week**.  
See also Assignment#0: Generate your QR Code.
  - ❑ Login to [badak.cs.ui.ac.id](http://badak.cs.ui.ac.id) via [kawung.cs.ui.ac.id](http://kawung.cs.ui.ac.id) for at least **10 minutes** every week. Copy all weekly demo folders into your own badak home directory.  
Eg.: `cp -r /extra/Demos/ .`
- ❑ **Resources**
  - ❑ **All In One** — [BADAK.cs.ui.ac.id:///extra/](http://BADAK.cs.ui.ac.id:///extra/) (**FASILKOM only!**).
  - ❑ **Download Slides and Demos from GitHub.com**  
<https://github.com/UI-FASILKOM-OS/SistemOperasi/>
  - ❑ **Problems** — <https://rms46.vlsm.org/2/>:  
195.pdf (W00), 196.pdf (W01), 197.pdf (W02), 198.pdf (W03),  
199.pdf (W04), 200.pdf (W05), 201.pdf (W06), 202.pdf (W07),  
203.pdf (W08), 204.pdf (W09), 205.pdf (W10).

# Agenda

- 1 Start
- 2 Schedule
- 3 Agenda
- 4 How to contact the Lecturer
- 5 Highlights
- 6 Week 00
- 7 Assessment
- 8 Week 00: Review
- 9 Assignment (W00) #0: Generate your QR Code
- 10 Assignment (W00) #1: MEMO Week00
- 11 Assignment (W00) #2: Try Demo Week00
- 12 TIPS

# Agenda (2)

- 13 Week 00: Summary
- 14 Week 00: Check List
- 15 Week 00
- 16 Week 01
- 17 Week 02
- 18 Week 03
- 19 Week 04
- 20 Week 05
- 21 Week 06
- 22 Week 07
- 23 Week 08
- 24 Week 09
- 25 Week 10
- 26 The End

# How to contact the Lecturer<sup>2</sup>

For Q & A, use WhatsApp Group **OperatingSystems**  
(info +62-881-456-XXXX)

- Email (Subject:[**HELP**]) [operatingsystems@vlsm.org](mailto:operatingsystems@vlsm.org)  
State your "Name", "ID", and "OS class".

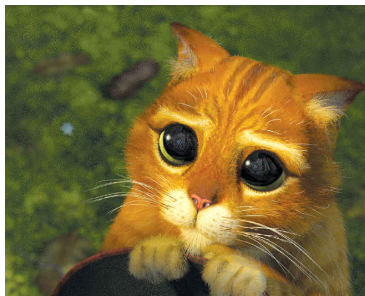


Figure: Never ever whine and pretend like this<sup>1</sup>!

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<sup>1</sup>"Puss in Boots" is a DreamWorks/Paramount Picture character.

<sup>2</sup>FYI: King Goerge II founded the University of Goettingen in 1734.

# Highlights

## Coverage

This is an introduction to a modern operating systems course. It will cover general overview, computer architecture review, operating system overview, GNU/Linux CLI, scripting, C language overview, protection, security, privacy, systemd, I/O, addressing and pointers, memory management, processes and threads, virtual memory, synchronization, mutual exclusion, deadlock, CPU scheduling algorithms, file systems, and I/O programming.

## Student-Centered

This course is student-centered where responsibility is in the hands of the students. Students are expected to be prepared for the class meeting.

## GNU/Linux

Students will have a thorough understanding of how GNU/Linux provides services by using a Command Line Interface.

# Week 00 Overview I: Topics<sup>1</sup>

- Role and purpose of the operating system
- Functionality of a typical operating system
- Mechanisms to support client-server models, hand-held devices
- Design issues (efficiency, robustness, flexibility, portability, security, compatibility)
- Influences of security, networking, multimedia, windowing systems
- Structuring methods (monolithic, layered, modular, micro-kernel models)
- Abstractions, processes, and resources
- Concepts of application program interfaces (APIs)
- The evolution of hardware/software techniques and application needs
- Device organization
- Interrupts: methods and implementations
- Concept of user/system state and protection, transition to kernel mode

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013



# Week 00 Overview I: Learning Outcomes (1)<sup>1</sup>

- Explain the objectives and functions of modern operating systems [Familiarity]
- Analyze the tradeoffs inherent in operating system design [Usage]
- Describe the functions of a contemporary operating system with respect to convenience, efficiency, and the ability to evolve. [Familiarity]
- Discuss networked, client-server, distributed operating systems and how they differ from single user operating systems. [Familiarity]
- Identify potential threats to operating systems and the security features design to guard against them. [Familiarity]
- Explain the concept of a logical layer. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 00 Overview I: Learning Outcomes (2)<sup>1</sup>

- Explain the benefits of building abstract layers in hierarchical fashion. [Familiarity]
- Describe the value of APIs and middleware. [Assessment]
- Describe how computing resources are used by application software and managed by system software. [Familiarity]
- Contrast kernel and user mode in an operating system. [Usage]
- Discuss the advantages and disadvantages of using interrupt processing. [Familiarity]
- Explain the use of a device list and driver I/O queue. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Assessment part 1

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85 - ... = A	80 - 85 = A-	75 - 80 = B+	70 - 75 = B
65 - 70 = B-	60 - 65 = C+	55 - 60 = C	50 - 55 = D or C <sup>1</sup>
40 - 50 = D	30 - 40 = E	20 - 30 = E	00 - 20 = E

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- **4 SKS** (Units) = 12 hours per week!
  - Ah Beng said: Work hard!
- **No Lab — No Task — No Pop Quiz – No Teaching Assistant<sup>1</sup>.**
  - No secret hand-shake!
  - But, it may vary from class to class.
- **Active Preparation / Participation / Q&A Only.**
  - Pre-Midterm (UTS): 6 weeks @ 3 points (=18%).
  - Post-Midterm: 5 weeks @ 3 points (=15%).
  - Points for answering questions, trying demos, and writings memos.
  - Deductions for **NOT** answering questions: individually or collectively.

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<sup>1</sup>Terms and Conditions apply. Void where prohibited by law.

- **How to get points?**

- Answer questions, especially not in the middle of a lecture!
- Just prepare and show your "memo" every beginning of the week. Nota Bene: Bad "memos" ain't good for midterm and final!
- Just log into "badak.cs.ui.ac.id" for 10 minutes every week! Nota Bene: Not trying the demos is your own problem.

- **MidTerm+Final:** (6 + 5) set problems @ 6 points ( = 36% + 30%).

- **Extra Rounding:** 1 point<sup>1</sup>

- **C-2C:** upto 5 points<sup>1</sup>.

- Check your points regularly at <https://academic.ui.ac.id/> and **DO NOT COMPLAIN** weeks after!

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<sup>1</sup>Terms and Conditions apply. Void where prohibited by law.

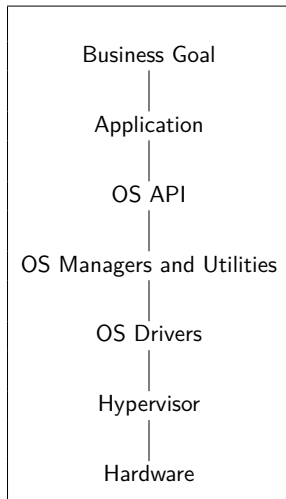
# AIN'T DIFFICULT, lah!



Figure: Even this Goat will get "C" at the end of the semester!

# Week 00: Review

- What is an Operating System?
- Why taking an Operating System class?



# Computer Organization Review

- You should understand:
  - von Neumann Model.
  - Buses, Bridges, Transfer Rate, Clock.
  - Memory: DDR, DDR-2, DDR-3 ...
  - Cache, Buffer, Spool, & Pipelining.
  - Direct Memory Access (DMA).
  - Port & Memory Mapped I/O.
  - CPU: (privilege/kernel/supervisor mode) vs. (user mode).
  - Physical (Hardware) Limitation.
  - Priority: Read vs Write.
  - Interrupts: Polling & Vectored.
  - Multiprocessors: Symmetric vs. Asymmetric.
  - Multicore & Multithreading.
  - Clustered Systems.
  - Numbers: base 2, base 8, base 10, base 16.
    - Base 2:  $110010101010_2$
    - Base 8:  $01234567_8 = 000\ 001\ 010\ 011\ 100\ 101\ 110\ 111_2$
    - Base 10:  $012\ 345\ 679$
    - Base 16:  $9AB\ CDEF_{16} = 1001\ 1010\ 1011\ 1100\ 1101\ 1110\ 1111_2$

# Block Diagram



Figure: Block Diagram



# APIC (Advanced Programmable Interrupt Controller)



Figure: APIC (Advanced Programmable Interrupt Controller)

# Interrupt Handling



(c) 2017 VauLSMorg – This is a free picture

**Figure:** Interrupt Handling with PIC (Programmable Interrupt Controller)

# Managers Set

- Process:
  - Creating/Deleting; Suspending/Resuming; Synchronization; Communication; Scheduling
- Memory:
  - Tracking; Move In/Move Out; Allocating/Deallocating.
- Storage/File System:
  - Create/Delete; Open/Close; Read/Write.
- Mass Storage:
  - Scheduling; Allocating; Free Space.
- I/O:
  - Buffering; Caching; Spooling.
  - Interfacing (driving).
- Protecting & Security:
  - Protecting.
  - Security.

# Make sure, to understand:

- Scripting: bash, regex, sed, awk?
- Security and Protection?
- File System?
- Data Structure in a (logical) Memory?
- Virtual Memory
- Concurrency
- Synchronization
- Mass Storage
- UEFI, GRUB, and systemd
- I/O
- I/O Programming

# Assignment (W00) #0: Generate your QR Code

- Encode your **QRC** with size upto 5cm x 5cm (ca. 400x400 pixels)<sup>1</sup>:  
"**OS192 CLASS ID SSO-ACCOUNT Your-Full-Name**"
  - What year and term? Eg. 2019 – 2 → "OS192"
  - What is your OS class? Regular (A, B, C, D, E)? Or, Extension (X)? Or, International (I)? Or Matrix (M)? Eg. "X".
  - What is your Student ID (NPM)? Eg. "1253755125".
  - What is your SSO Account (for using badak.cs.ui.ac.id)? Eg. "demo".
  - What is your Full Name (at SIAK)? Eg. "Demo Suremo".
- E.g.: **OS192 X 1253755125 demo Demo Suremo**



# Assignment (W00) #1: MEMO Week00

- Write your Memo (with QRC) **every week**.
- Good start: check the previous problems collection.

[OS192][WEEK **00** 01 02 03 04 05 06 07 08 09 10]

[CLASS: A B C D E I N X] [D: 1253755125] [Name: Demo Suremo] [Rev: 09]



$$\begin{aligned} \hat{H}|\psi(t)\rangle &= i\hbar \frac{\partial}{\partial t} |\psi(t)\rangle \\ \frac{1}{i\hbar} \frac{\partial \phi_n}{\partial t} - \nabla^2 \phi_n + \left(\frac{m\omega^2}{2}\right) \phi_n &= 0 \\ n \frac{\partial}{\partial t} \psi &= S / \hbar \frac{\partial}{\partial t} \psi = \rho \circ s, j=1, \dots, k \\ f(\phi_n) &= \sum_{k=1}^n \frac{\partial \phi_n}{\partial t} \phi_n \\ d(x,y) &\leq d(x,y) + d(y,z) \end{aligned}$$

$$\begin{aligned} \hat{H}|\psi(t)\rangle &= i\hbar \frac{\partial}{\partial t} |\psi(t)\rangle \\ \frac{1}{i\hbar} \frac{\partial \phi_n}{\partial t} - \nabla^2 \phi_n + \left(\frac{m\omega^2}{2}\right) \phi_n &= 0 \\ n \frac{\partial}{\partial t} \psi &= S / \hbar \frac{\partial}{\partial t} \psi = \rho \circ s, j=1, \dots, k \\ f(\phi_n) &= \sum_{k=1}^n \frac{\partial \phi_n}{\partial t} \phi_n \\ d(x,y) &\leq d(x,y) + d(y,z) \end{aligned}$$

$$\begin{aligned} |x,y\rangle &\leq \|x\| \|y\| \\ \frac{\partial \psi}{\partial t} &= \frac{\partial}{\partial t} \psi \\ \frac{\partial \psi}{\partial t} &= \frac{\partial}{\partial t} \psi \\ \frac{\partial \psi}{\partial t} &= \frac{\partial}{\partial t} \psi \\ \frac{\partial \psi}{\partial t} &= \frac{\partial}{\partial t} \psi \end{aligned}$$

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# Assignment (W00) #2: Try Demo Week00

- Login to `badak.cs.ui.ac.id` (via `kawung.cs.ui.ac.id`) for at least **10 minutes** every week.

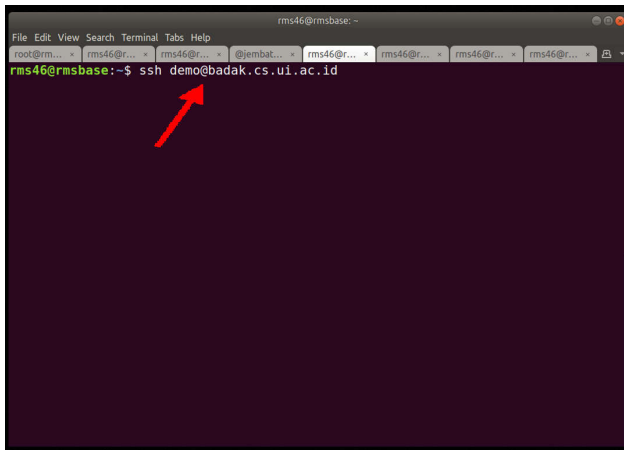
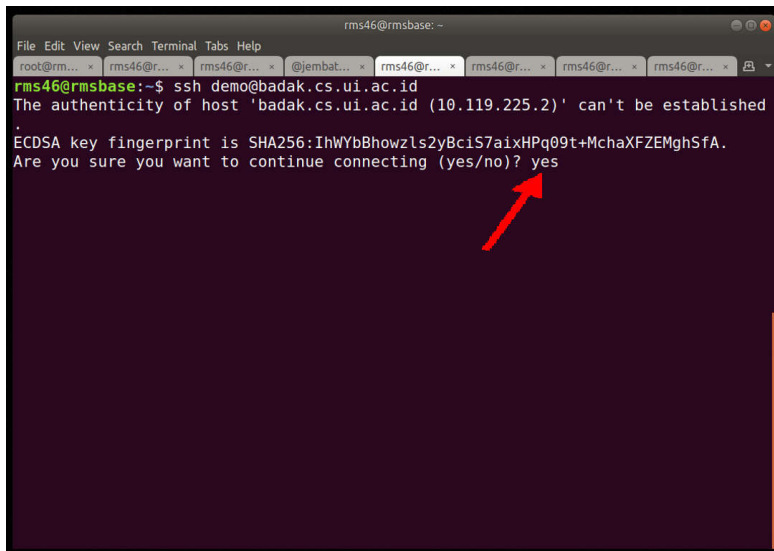


Figure: Login to `badak.cs.ui.ac.id` using "ssh" Ubuntu GNU/Linux

## SSH to "badak.cs.ui.ac.id" — 2

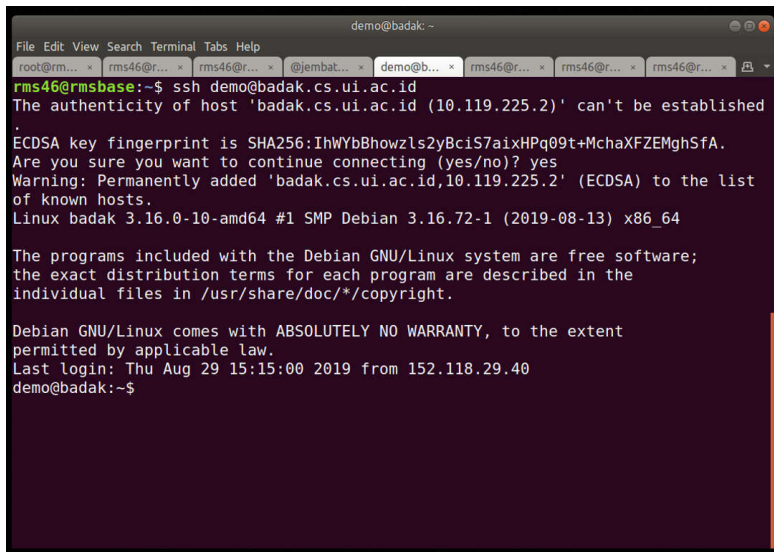


```
rms46@rmsbase: ~  
File Edit View Search Terminal Tabs Help  
root@rm... * rms46@r... * rms46@r... * @jembat... * rms46@r... * rms46@r... * rms46@r... * rms46@r... *  
rms46@rmsbase:~$ ssh demo@badak.cs.ui.ac.id  
The authenticity of host 'badak.cs.ui.ac.id (10.119.225.2)' can't be established  
.  
ECDSA key fingerprint is SHA256:IhWYbBhowzls2yBciS7aixHPq09t+MchaXFZEMghSfA.  
Are you sure you want to continue connecting (yes/no)? yes
```

Figure: SSH to "badak.cs.ui.ac.id" — (For the first time only!)



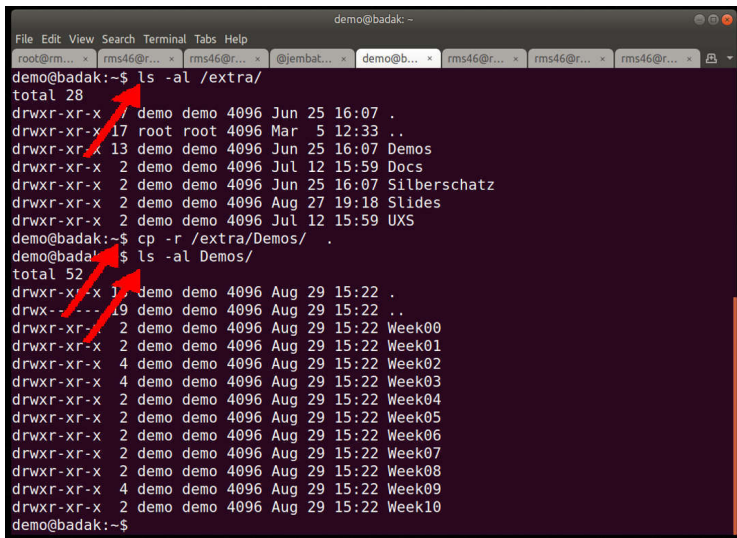
# SSH to "badak.cs.ui.ac.id" — 3

A screenshot of a terminal window titled "demo@badak: ~". The window has a menu bar with "File", "Edit", "View", "Search", "Terminal", "Tabs", and "Help". Below the menu bar is a tab bar with several tabs, including "root@rm...", "rms46@r...", "@jembat...", "demo@b...", "rms46@r...", "rms46@r...", and "rms46@r...". The terminal content shows an SSH session from "rms46@rmsbase" to "demo@badak.cs.ui.ac.id". The output includes a warning about the host's authenticity, a confirmation to continue, a warning about adding the host to the known hosts list, and system information for Linux badak 3.16.0-10-amd64 #1 SMP Debian 3.16.72-1 (2019-08-13) x86\_64. It also mentions the Debian GNU/Linux system's warranty and the last login time. The prompt "demo@badak:~\$" is shown at the end.

```
demo@badak: ~  
File Edit View Search Terminal Tabs Help  
root@rm... x rms46@r... x rms46@r... x @jembat... x demo@b... x rms46@r... x rms46@r... x rms46@r... x  
rms46@rmsbase:~$ ssh demo@badak.cs.ui.ac.id  
The authenticity of host 'badak.cs.ui.ac.id (10.119.225.2)' can't be established  
.  
ECDSA key fingerprint is SHA256:IhWYbBhowzls2yBciS7aixHPq09t+MchaXFZEMghSfA.  
Are you sure you want to continue connecting (yes/no)? yes  
Warning: Permanently added 'badak.cs.ui.ac.id,10.119.225.2' (ECDSA) to the list  
of known hosts.  
Linux badak 3.16.0-10-amd64 #1 SMP Debian 3.16.72-1 (2019-08-13) x86_64  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Thu Aug 29 15:15:00 2019 from 152.118.29.40  
demo@badak:~$
```

Figure: SSH to "badak.cs.ui.ac.id"

# SSH to "badak.cs.ui.ac.id" — 4



A terminal window titled "demo@badak: ~" with a menu bar (File, Edit, View, Search, Terminal, Tabs, Help) and several open tabs. The terminal shows the following commands and output:

```
demo@badak:~$ ls -al /extra/
total 28
drwxr-xr-x 7 demo demo 4096 Jun 25 16:07 .
drwxr-xr-x 17 root root 4096 Mar  5 12:33 ..
drwxr-xr-x 13 demo demo 4096 Jun 25 16:07 Demos
drwxr-xr-x 2 demo demo 4096 Jul 12 15:59 Docs
drwxr-xr-x 2 demo demo 4096 Jun 25 16:07 Silberschatz
drwxr-xr-x 2 demo demo 4096 Aug 27 19:18 Slides
drwxr-xr-x 2 demo demo 4096 Jul 12 15:59 UXS
demo@badak:~$ cp -r /extra/Demos/ .
demo@badak:~$ ls -al Demos/
total 52
drwxr-xr-x 1 demo demo 4096 Aug 29 15:22 .
drwxr-xr-x 19 demo demo 4096 Aug 29 15:22 ..
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week00
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week01
drwxr-xr-x 4 demo demo 4096 Aug 29 15:22 Week02
drwxr-xr-x 4 demo demo 4096 Aug 29 15:22 Week03
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week04
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week05
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week06
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week07
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week08
drwxr-xr-x 4 demo demo 4096 Aug 29 15:22 Week09
drwxr-xr-x 2 demo demo 4096 Aug 29 15:22 Week10
demo@badak:~$
```

Two red arrows are drawn on the terminal output. The first arrow points from the "Demos" directory entry in the first listing to the "Demos/" directory entry in the second listing. The second arrow points from the "Week00" directory entry in the second listing to the "Week10" directory entry in the same listing.

Figure: SSH to "badak.cs.ui.ac.id"

# SSH using PowerShell (Windows10) — 1

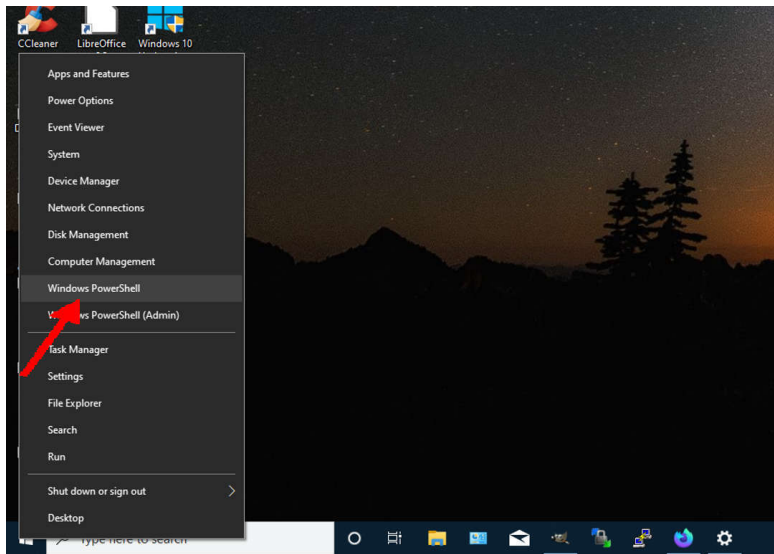
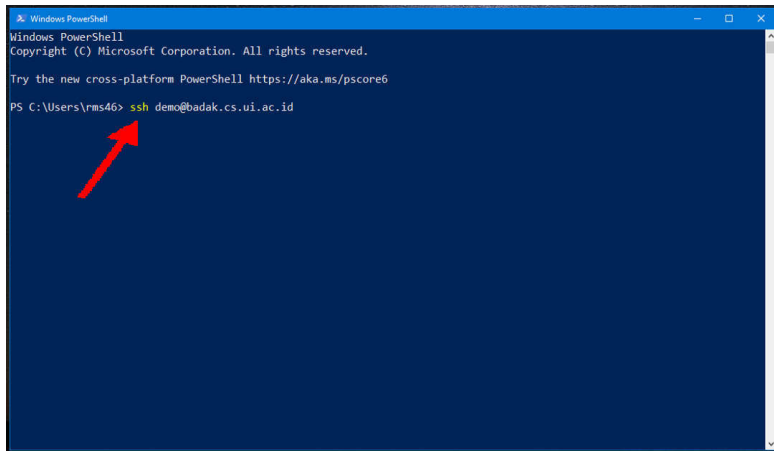


Figure: SSH using PowerShell (Windows 10)

## SSH using PowerShell (Windows10) — 2



A screenshot of a Windows PowerShell terminal window. The window has a blue title bar with the text "Windows PowerShell" and standard window controls. The main area is dark blue with white text. The text displayed is: "Windows PowerShell", "Copyright (C) Microsoft Corporation. All rights reserved.", "Try the new cross-platform PowerShell https://aka.ms/pscore6", and "PS C:\Users\rms46> ssh demo@badak.cs.ui.ac.id". A red arrow points to the "ssh" command in the prompt.

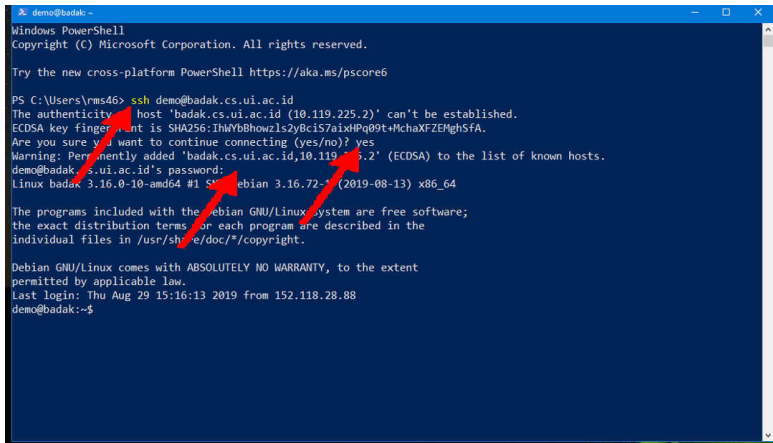
```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\rms46> ssh demo@badak.cs.ui.ac.id
```

Figure: SSH using PowerShell (Windows 10)

# SSH using PowerShell (Windows10) — 3



```
demo@badak: ~  
Windows PowerShell  
Copyright (C) Microsoft Corporation. All rights reserved.  
  
Try the new cross-platform PowerShell https://aka.ms/pscore6  
  
PS C:\Users\rms46> ssh demo@badak.cs.ui.ac.id  
The authenticity of host 'badak.cs.ui.ac.id (10.119.225.2)' can't be established.  
ECDSA key fingerprint is SHA256:IHwYbBhowzls2yBciS7aixHPq09t+MchaXFZEMghSfA.  
Are you sure you want to continue connecting (yes/no)? yes  
Warning: Permanently added 'badak.cs.ui.ac.id,10.119.225.2' (ECDSA) to the list of known hosts.  
demo@badak.cs.ui.ac.id's password:  
Linux badak 3.16.0-10-amd64 #1 SMP Debian 3.16.72-1 (2019-08-13) x86_64  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Thu Aug 29 15:16:13 2019 from 152.118.28.88  
demo@badak:~$
```

Figure: SSH using PowerShell (Windows 10)

# Program Example (Week 00)

```
$ cat c-program-example.c
/* (c) 2016-2019 Rahmat M. Samik-Ibrhaim
 * REV03 Fri Jan 25 18:56:46 WIB 2019
 * REV02 Mon Aug 27 18:17:11 WIB 2018
 * REV01 Sun Aug 20 15:01:12 WIB 2017
 * START Fri Jan 01 00:00:00 WIB 2016
 * This is a free software.
 * To compile:
 * $ gcc -o c-program-example c-program-example.c
 * To execute:
 * $ ./c-program-example
 */
```

```
#include <stdio.h>
```

```
void main() {
    printf("Hello World!\n");
}
```

# Makefile

```
$ cat Makefile
```

```
# (c) 2016-2017 Rahmat M. Samik-Ibrahim  
# REV01 Tue Aug 22 14:45:14 WIB 2017  
# START Fri Jan 01 00:00:00 WIB 2016  
# This is a free Makefile configuration.  
# Just run:  
# % make
```

```
ALL:  c-program-example
```

```
c-program-example: c-program-example.c  
    gcc -o c-program-example c-program-example.c
```

```
clean:  
    rm -f c-program-example
```

# Week 00: Demo Directory

```
demo@badak:~/mydemo/W00-demos$ PS1="$ "
$ ls -al
total 1080
drwxr-xr-x  2 demo demo  4096 Jan 30 17:35 .
drwx----- 14 demo demo  4096 Jan 30 17:35 ..
-rw-r--r--  1 demo demo  1637 Jan 30 17:35 1-READ-THIS-FIRST.txt
-rw-r--r--  1 demo demo   930 Jan 30 17:35 c-program-example.c
-rw-r--r--  1 demo demo   406 Jan 30 17:35 .head
-rw-r--r--  1 demo demo   376 Jan 30 17:35 Makefile
-rw-r--r--  1 demo demo 516465 Jan 30 17:35 QR-Code.docx
-rw-r--r--  1 demo demo 238225 Jan 30 17:35 QR-Code.pdf
-rw-r--r--  1 demo demo 317401 Jan 30 17:35 QR-Code.png
$ make
gcc -o c-program-example c-program-example.c
$ ./c-program-example
Hello World!
$ ls -F
1-READ-THIS-FIRST.txt  c-program-example*  c-program-example.c  Makefile  QR-Code.docx  QR-Code.pdf
QR-Code.png
$ make clean
rm -f c-program-example
$ ls -F
1-READ-THIS-FIRST.txt  c-program-example.c  Makefile  QR-Code.docx  QR-Code.pdf  QR-Code.png
$
```



# Week 00: Problem Example (from OSC2e)

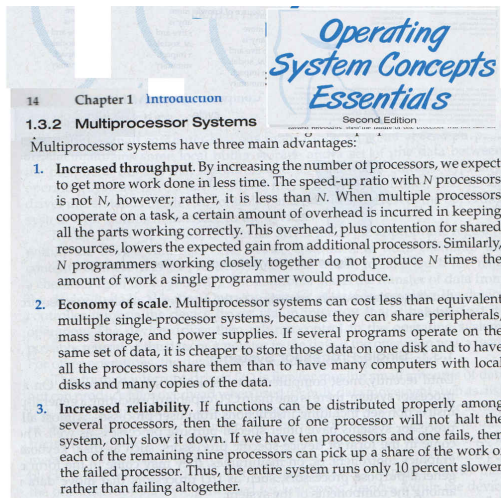


Figure: T / F The advantages of a multiprocessor system include: increased throughput, economy of scale, and increased reliability (Week00 2016-1).

# TIPS (1)

- For any administrative issues, contact SEKRE at building B, 2<sup>nd</sup> floor – especially for absences, illness, sick letters, follow-up exams, etc. Please do not contact the **Lecturer** (RMS).
- Please complete the follow-up / paper work within 6 working days (RMS).
- Prepare the weekly MEMO as completely as possible. You should have mastered the material at the beginning of the week (RMS).
- Study the Operating System Concept book which deals with the material will be discussed that week (MIM). Make a summary of material in your Memo (IP).
- You should understand every single problem of the past examinations. Write down all hints in your "**MEMO**" (MHP).
- You are allowed to bring up to 6 sheets of MEMOs for the midterm (UTS) and up to 5 sheets of MEMOs for the final term (UAS) (RMS).
- You should understand every single line of the "**DEMOS**" (MHP).

## TIPS (2)

- You should ask **the lecturer** or anyone, anything you do not understand (TA).

# TIPS (3)

- TBA.

# Special Thanks

**Special thanks** for the early version of this writing to:

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See also <https://rms46.vlsm.org/2/221.pdf>.

# Week 00: Summary

- What is an Operating Systems?
  - Definition: Resource Allocator & Control Program.
  - Why taking an Operating System class?
- Computer Organization Review
- The Manager Set
  - Process Manager, Memory Manager, I/O Manager, Storage Manager.
- Security and Protection
- Virtualization
  - Hypervisor type 0, 1, 2
  - Paravirtualization, Emulators, Containers.
  - VCPU: Virtual CPU
  - Virtualization Implementation:
    - Trap-and-Emulate mode
    - Binary Translation mode

# Week 00: Check List

- ☐ Starting **Week 01**: TABULA RASA is not accepted anymore!
- ☐ Find/copy this document from <https://os.vlsm.org/>
- ☐ Find/read a recent/decent OS Book and map it to **OSC10**.
- ☐ Using your **SSO** account, login to `badak.cs.ui.ac.id` via `kawung.cs.ui.ac.id`.
- ☐ Check folder `badak:///extra/Demos/Week00/`
  - ☐ Try to copy and compile `c-program-example.c`.
- ☐ QR Code: (Eg) "OS191 X 1253755125 demo Demo Suremo"
- ☐ Write "Memo Week00" + your QRC.
- ☐ **How to improve this document?**

# Week 00 Overview I: Topics<sup>1</sup>

- Role and purpose of the operating system
- Functionality of a typical operating system
- Mechanisms to support client-server models, hand-held devices
- Design issues (efficiency, robustness, flexibility, portability, security, compatibility)
- Influences of security, networking, multimedia, windowing systems
- Structuring methods (monolithic, layered, modular, micro-kernel models)
- Abstractions, processes, and resources
- Concepts of application program interfaces (APIs)
- The evolution of hardware/software techniques and application needs
- Device organization
- Interrupts: methods and implementations
- Concept of user/system state and protection, transition to kernel mode

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013



# Week 00 Overview I: Learning Outcomes (1)<sup>1</sup>

- Explain the objectives and functions of modern operating systems [Familiarity]
- Analyze the tradeoffs inherent in operating system design [Usage]
- Describe the functions of a contemporary operating system with respect to convenience, efficiency, and the ability to evolve. [Familiarity]
- Discuss networked, client-server, distributed operating systems and how they differ from single user operating systems. [Familiarity]
- Identify potential threats to operating systems and the security features design to guard against them. [Familiarity]
- Explain the concept of a logical layer. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 00 Overview I: Learning Outcomes (2)<sup>1</sup>

- Explain the benefits of building abstract layers in hierarchical fashion. [Familiarity]
- Describe the value of APIs and middleware. [Assessment]
- Describe how computing resources are used by application software and managed by system software. [Familiarity]
- Contrast kernel and user mode in an operating system. [Usage]
- Discuss the advantages and disadvantages of using interrupt processing. [Familiarity]
- Explain the use of a device list and driver I/O queue. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 01 Overview II: Topics<sup>1</sup>

- Types of virtualization (including Hardware/Software, OS, Server, Service, Network)
- Paging and virtual memory
- Virtual file systems
- Hypervisors
- Portable and cost of virtualization; emulation vs. isolation
- Cloud services: IAAS, PAAS and Platform APIs, SAAS
- Introduction to Scripting and REGEX.

---

<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 01 Overview II: Learning Outcomes<sup>1</sup>

- Explain the concept of virtual memory and how it is realized in hardware and software. [Familiarity]
- Discuss hypervisors and the need for them in conjunction with different types of hypervisors. [Usage]
- Differentiate emulation and isolation. [Familiarity]
- Evaluate virtualization trade-offs. [Assessment]
- Discuss the importance of elasticity and resource management in cloud computing. [Familiarity]
- Explain the advantages and disadvantages of using virtualized infrastructure. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 02 Security & Protection: Topics<sup>1</sup>

- Overview of system security
- Policy/mechanism separation
- Security methods and devices
- Protection, access control, and authentication
- Backups

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 02 Security & Protection: Learning Outcomes<sup>1</sup>

- Articulate the need for protection and security in an OS (cross-reference IAS/Security Architecture and Systems Administration/Investigating Operating Systems Security for various systems). [Assessment]
- Summarize the features and limitations of an operating system used to provide protection and security [Familiarity]
- Explain the mechanisms available in an OS to control access to resources [Familiarity]
- Carry out simple system administration tasks according to a security policy, for example creating accounts, setting permissions, applying patches, and arranging for regular backups [Usage]

---

<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 03 File System & FUSE: Topics<sup>1</sup>

- Files: data, metadata, operations, organization, buffering, sequential, nonsequential
- Directories: contents and structure
- File systems: partitioning, mount/unmount, virtual file systems
- Standard implementation techniques
- Memory-mapped files
- Special-purpose file systems
- Naming, searching, access, backups
- Journaling and log-structured file systems

---

<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 03 File System & FUSE: Learning Outcomes<sup>1</sup>

- Describe the choices to be made in designing file systems. [Familiarity]
- Compare and contrast different approaches to file organization, recognizing the strengths and weaknesses of each. [Usage]
- Summarize how hardware developments have led to changes in the priorities for the design and the management of file systems. [Familiarity]
- Summarize the use of journaling and how log-structured file systems enhance fault tolerance. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013



# Week 04 Addressing: Topics<sup>1</sup>

- Bits, bytes, and words
- Numeric data representation and number bases
- Representation of records and arrays

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 04 Addressing: Learning Outcomes<sup>1</sup>

- Explain why everything is data, including instructions, in computers. [Familiarity]
- Explain the reasons for using alternative formats to represent numerical data. [Familiarity]
- Describe the internal representation of non-numeric data, such as characters, strings, records, and arrays. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 05 Virtual Memory: Topics<sup>1</sup>

- Review of physical memory and memory management hardware
- Virtual Memory
- Caching
- Memory Allocation
- Memory Performance
- Working sets and thrashing

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 05 Virtual Memory: Learning Outcomes<sup>1</sup>

- Explain memory hierarchy and cost-performance trade-offs. [Familiarity]
- Summarize the principles of virtual memory as applied to caching and paging. [Familiarity]
- Describe the reason for and use of cache memory (performance and proximity, different dimension of how caches complicate isolation and VM abstraction). [Familiarity]
- Defend the different ways of allocating memory to tasks, citing the relative merits of each. [Assessment]
- Evaluate the trade-offs in terms of memory size (main memory, cache memory, auxiliary memory) and processor speed. [Assessment]
- Discuss the concept of thrashing, both in terms of the reasons it occurs and the techniques used to recognize and manage the problem. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 06 Concurrency: Topics<sup>1</sup>

- States and state diagrams
- Structures (ready list, process control blocks, and so forth)
- Dispatching and context switching
- The role of interrupts
- Managing atomic access to OS objects
- Implementing synchronization primitives
- Multiprocessor issues (spin-locks, reentrancy)

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 06 Concurrency: Learning Outcomes (1)<sup>1</sup>

- Describe the need for concurrency within the framework of an operating system. [Familiarity]
- Demonstrate the potential run-time problems arising from the concurrent operation of many separate tasks. [Usage]
- Summarize the range of mechanisms that can be employed at the operating system level to realize concurrent systems and describe the benefits of each. [Familiarity]
- Explain the different states that a task may pass through and the data structures needed to support the management of many tasks. [Familiarity]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

## Week 06 Concurrency: Learning Outcomes (2)<sup>1</sup>

- Summarize techniques for achieving synchronization in an operating system (e.g., describe how to implement a semaphore using OS primitives). [Familiarity]
- Describe reasons for using interrupts, dispatching, and context switching to support concurrency in an operating system. [Familiarity]
- Create state and transition diagrams for simple problem domains. [Usage]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 07 Synchronization & Deadlock: Topics<sup>1</sup>

- Shared Memory and Critical Section
- Consistency, and its role in programming language guarantees for data-race-free programs
- Message passing: PtPo vs Multicast, Blocking vs non-blocking, buffering.

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013



# Week 07 Synchronization & Deadlock: Learning Outcomes<sup>1</sup>

- Use mutual exclusion to avoid a given race condition. [Usage]
- Give an example of an ordering of accesses among concurrent activities (e.g., program with a data race) that is not sequentially consistent. [Familiarity]
- Use semaphores to block threads [Usage]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 08 Scheduling: Topics<sup>1</sup>

- Preemptive and non-preemptive scheduling
- Schedulers and policies
- Processes and threads
- Deadlines and real-time issues

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 08 Scheduling: Learning Outcomes<sup>1</sup>

- Compare and contrast the common algorithms used for both preemptive and non-preemptive scheduling of tasks in operating systems, such as priority, performance comparison, and fair-share schemes. [Usage]
- Describe relationships between scheduling algorithms and application domains. [Familiarity]
- Discuss the types of processor scheduling such as short-term, medium-term, long-term, and I/O. [Familiarity]
- Describe the difference between processes and threads. [Usage]
- Compare and contrast static and dynamic approaches to real-time scheduling. [Usage]
- Discuss the need for preemption and deadline scheduling. [Familiarity]
- Identify ways that the logic embodied in scheduling algorithms are applicable to other domains, such as disk I/O, network scheduling, project scheduling, and problems beyond computing. [Usage]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 09 Storage, Firmware, Bootloader, & Systemd: Topics<sup>1</sup>

- Storage
- Storage Arrays
- BIOS
- Loader
- Systemd

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 09 Storage, Firmware, Bootloader, & Systemd: Learning Outcomes<sup>1</sup>

- Storage [Usage]
- Storage Arrays [Usage]
- BIOS [Usage]
- Loader [Usage]
- Systemd [Usage]

---

<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 10 I/O & Programming: Topics<sup>1</sup>

- Characteristics of serial and parallel devices
- Abstracting device differences
- Buffering strategies
- Direct memory access
- Recovery from failures
- I/O Programming
- Network Programming

---

<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 10 I/O & Programming: Learning Outcomes<sup>1</sup>

- Explain the key difference between serial and parallel devices and identify the conditions in which each is appropriate. [Familiarity]
- Identify the relationship between the physical hardware and the virtual devices maintained by the operating system. [Usage]
- Explain buffering and describe strategies for implementing it. [Familiarity]
- Differentiate the mechanisms used in interfacing a range of devices (including hand-held devices, networks, multimedia) to a computer and explain the implications of these for the design of an operating system. [Usage]
- Describe the advantages and disadvantages of direct memory access and discuss the circumstances in which its use is warranted. [Usage]
- Identify the requirements for failure recovery. [Familiarity]
- Implement a simple device driver for a range of possible devices. [Usage]
- I/O Programming [Usage]
- Network Programming [Usage]

# The End

- ☐ This is the end of the presentation.
- ☒ This is the end of the presentation.
  - This is the end of the presentation.