

CSGE602055 Operating Systems

CSF2600505 Sistem Operasi

Week 00: Overview 1, Virtualization & Scripting

C. BinKadal

Sendirian Berhad

<https://os.vlsm.org/Slides/os00.pdf>

Always check for the latest revision!

REV391 19-Aug-2022

OS222³): Operating Systems Schedule 2022 - 2

Week	Topic ¹⁾	OSC10 ²⁾
Week 00	Overview (1), Assignment of Week 00	Ch. 1, 2
Week 01	Overview (2), Virtualization & Scripting	Ch. 1, 2, 18.
Week 02	Security, Protection, Privacy, & C-language.	Ch. 16, 17.
Week 03	File System & FUSE	Ch. 13, 14, 15.
Week 04	Addressing, Shared Lib, & Pointer	Ch. 9.
Week 05	Virtual Memory	Ch. 10.
Week 06	Concurrency: Processes & Threads	Ch. 3, 4.
Week 07	Synchronization & Deadlock	Ch. 6, 7, 8.
Week 08	Scheduling + W06/W07	Ch. 5.
Week 09	Storage, Firmware, Bootloader, & Systemd	Ch. 11.
Week 10	I/O & Programming	Ch. 12.

¹⁾ For schedule, see <https://os.vlsm.org/#idx02>

²⁾ Silberschatz et. al.: **Operating System Concepts**, 10th Edition, 2018.

³⁾ This information will be on **EVERY** page two (2) of this course material.

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

- ☐ **Text Book** — Any recent/decent OS book. Eg. (**OSC10**) Silberschatz et. al.: **Operating System Concepts**, 10th Edition, 2018. (See <https://www.os-book.com/OS10/>).
- ☐ **Resources** (<https://os.vlsm.org/#idx03>)
 - ☐ **SCELE OS222** — <https://scele.cs.ui.ac.id/course/view.php?id=3398>.
The enrollment key is **XXX**.
 - ☐ **Download Slides and Demos from GitHub.com** — (<https://github.com/os2xx/os/>)
[os00.pdf \(W00\)](#), [os01.pdf \(W01\)](#), [os02.pdf \(W02\)](#), [os03.pdf \(W03\)](#), [os04.pdf \(W04\)](#), [os05.pdf \(W05\)](#),
[os06.pdf \(W06\)](#), [os07.pdf \(W07\)](#), [os08.pdf \(W08\)](#), [os09.pdf \(W09\)](#), [os10.pdf \(W10\)](#).
 - ☐ **Problems**
[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 \(W10\)](#).
 - ☐ **LFS** — <http://www.linuxfromscratch.org/lfs/view/stable/>
 - ☐ **OSP4DISS** — <https://osp4diss.vlsm.org/>
 - ☐ **This is How Me Do It!** — <https://doit.vlsm.org/001.html>
 - ☐ PS: "Me" rhymes better than "I", duh!

Agenda

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- 14 What defines an Operating System? (The Three Layers Model)
- 15 OSC10 (Silberschatz) Chapter 1 and 2

Agenda (2)

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- 28 Week 10
- 29 Week 00: Summary
- 30 TIPS

Week 00 Overview I: Topics¹

- 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

¹Source: ACM IEEE CS Curricula 2013

Week 00 Overview I: Learning Outcomes (1)¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 00 Overview I: Learning Outcomes (2)¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

How to contact the Lecturer

- **Always introduce yourself.**
 - State your "GitHubAccount", "Name", "Student ID", and "OS class".
- Post a question/query on **SCELE OS222** — (The enrollment key is **XXX**):
<https://scele.cs.ui.ac.id/course/view.php?id=3398>.
- For SIAK related questions, use email with Subject: **[OS]** rms46(AT)ui.ac.id.
 - **DO NOT** send an email for assignment-related questions.

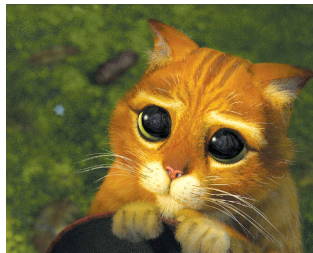


Figure: Never ever whine and pretend like [this](#)¹!

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

An Email from a Millenial to a Babbyboomer

selamat malam pak,

saya cicak salah satu mahasiswa sistem operasi di kelas bapak,
dengan username : cbkadal

1 saya ingin bertanya, kenapa XXXXX YYYYY ZZZZZ ya pak??
XXXXX YYYYY ZZZZZ, kalau boleh tau kesalahan saya dimana ya pak??

2 untu | 2 atiannya saya ucapkan terima kasih.

Salam,

Cicak Bin Kadal

3

Hallo Millennials Zaman Now!

1 Kalimat baru seharusnya selalu dimulai dengan huruf besar.

2 Tanda baca seperti ":" (titik dua) seharusnya tanpa spasi. "Ini betul: ", "Ini salah :".

3 Mengapa sampai lebih dari satu tanda-tanya????????????????

Salam,

Babyboomer.

- **11 Weekly Assignments @ 11.11 points.**

- Assignments will vary from week to week.
- The assignment deadline will be by the end of every week. See <https://os.vlsm.org/#idx02>.
- Check your points regularly at <https://academic.ui.ac.id/>
- See also, <https://os.vlsm.org/Log/>.
- **DO NOT COMPLAIN** weeks after!
- You need to log your weekly activities!
 - See <https://osp4diss.vlsm.org/ETC/logCodes.txt>
 - See <https://cbkadal.github.io/os222/TXT/mylog.txt>
 - **4 SKS** (Units) means 12 hours (720 minutes) per week!
 - The average time allocation for each weekly assignment is 425 minutes—only 45% of the four SKS (units) load.
 - Most of the time (44 %) will be spent on the weekly assignment.

Average Time Allocation

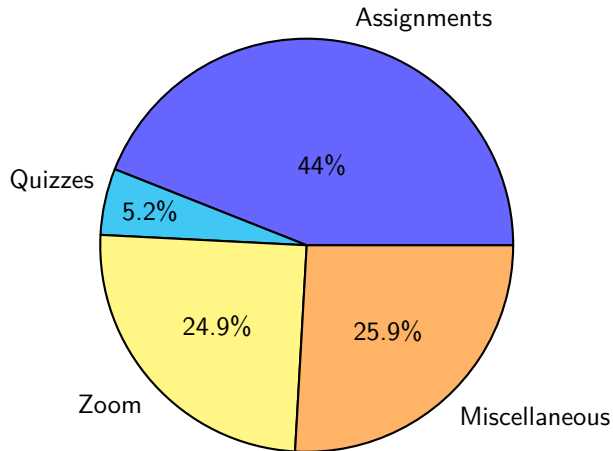


Figure: Operating Systems classes (2021-2022) student time allocation chart

NFT: Non-Fungible Tests

- You have the option to take Midterm (UTS) and Finalterm (UAS).
- You are allowed to read an A4 size MEMO – reciprocal – written in your own handwriting.
- The UTS result will replace the worst grade of Assignment 00-05, even if the result is less.
- The UAS result will replace the worst grade of Assignments 06-10, even if the result is less.
- You need to register if you want to take UTS/UAS.
- Failure to show up on the day of the exam without reason and evidence will get a score of "0".

Final Grade

- The final grade will be the best 9 out of 11 assignments.
 - Do not apply any dispensation of broken computer, circumcision (sunat), cold, competitions, deadline extension, influenza, lame excuses, marriage, mourning, power failure, remedial, return to the village (mudik), slow network (lemot), two-semester evaluation, umrah, weddings, etc.
 - **Two (2) "spare" assignments will be more than enough!**
 - In case of emergency, contact your Academic Advisor!
- Score Range

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 ¹
40 - 50 = D	30 - 40 = E	20 - 30 = E	00 - 20 = E

- **C-2C (C minus to C)**
 - Up to 5 points, only if:
 - your grade is between 50.00 and 55.00, and
 - you have a "good" track record.

¹C-2C: terms and conditions apply — void where prohibited by law.

Grade Examples

Mata Kuliah:		CSCM602055 - Sistem Operasi															
Kelas:		696070 - Sistem Operasi A, B, C, INT															
																-1 = no exam	
Nama	NPM	W00	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	UTS	UAS	C-2C	TOTAL	
1234567890	1234567890	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	0	99.99	A
1234567891	1234567891	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	-1	-1	0	99.99	A
1234567892	1234567892	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	0	0	0	99.99	A
1234567893	1234567893	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	0	0	-1	-1	0	99.99	A
1234567894	1234567894	0	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	0	-1	-1	0	99.99	A
1234567895	1234567895	6.01	6.01	6.01	6.01	8.31	6.01	5.55	10.55	5.55	5.55	5.55	-1	-1	0	60.01	C+
1234567896	1234567896	6.01	6.01	6.01	6.01	8.31	6.01	5.55	10.55	5.55	5.55	5.55	0	0	0	59.55	C
1234567897	1234567897	6.01	6.01	6.01	6.01	8.31	6.01	5.55	10.55	5.55	5.55	5.55	11.1	11.1	0	70.65	B
1234567898	1234567898	6.21	4.88	6.21	3.11	6.21	6.21	6.21	6.01	6.01	6.01	6.01	-1	-1	0	55.09	C
1234567899	1234567899	6.21	4.88	6.21	3.11	6.21	6.21	6.21	6.01	6.01	6.01	6.01	0	0	1.05	55.01	C
1234567900	1234567900	6.21	4.88	6.21	3.11	6.21	6.21	6.21	6.01	6.01	6.01	6.01	11.1	11.1	0	65.27	B-

The Three-Strikes Rule



- All major academic rules violations will be handled directly by the Faculty of Computer Science, University of Indonesia.
- "Accidents" may happen. There will be warnings for the first two minor violations.
- Your final grade will be reduced for the third warning.
- Your final grade will be reduced to "D" for the fourth warning.
- Five (5) or more warnings will be considered as a significant academic-rules violation.

AIN'T DIFFICULT, lah!



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

Study From Anywhere?

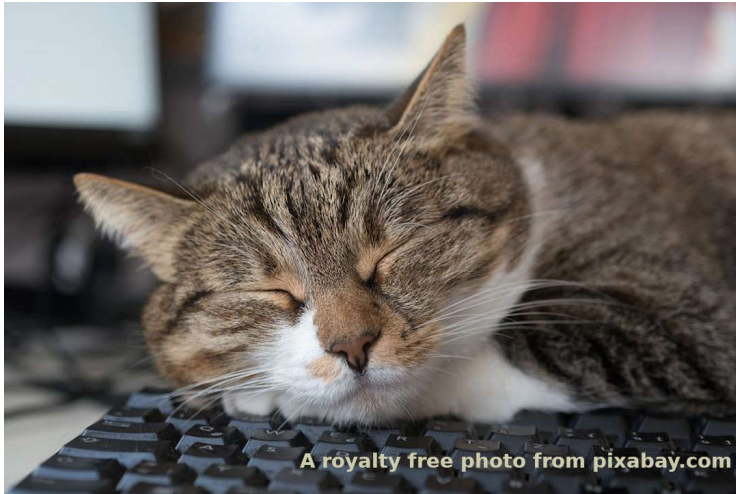


Figure: Who is on Zoom? What? I don't know! Why? Because! Today, I Don't Give a Darn!

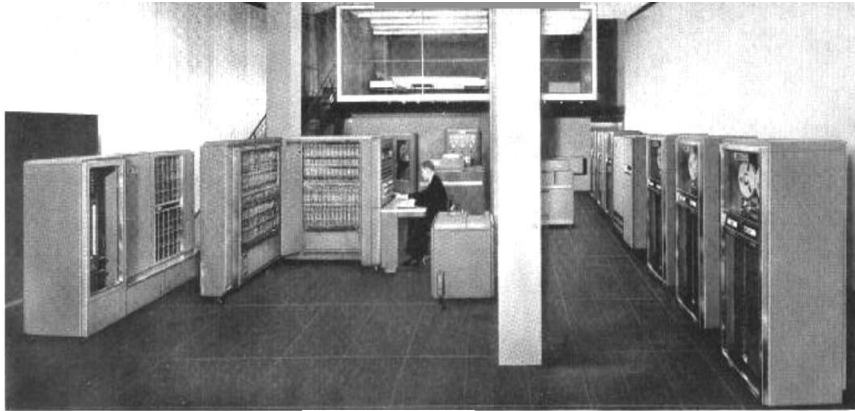
Prelude: Daisy Bell – Bicycle Built for Two



Daisy, Daisy,
Give me your answer, do!
I'm half crazy,
All for the love of you!
It won't be a stylish marriage,
I can't afford a carriage,
But you'll look sweet on the seat
Of a bicycle built for two!

YouTube (https://youtu.be/TXK_cE9AqAI). A choir (emulation) of **VOCODER** (pre WW2), **IBM704** (1950s) and **Vocaloid4** (2014). See also the classical movie **2001: A Space Odyssey**.

IBM 704 at Los Alamos National Laboratory in the 1950s



IBM 704 ELECTRONIC DATA-PROCESSING MACHINES

Estimate price (2020 value): USD 8,000,000.

Weight: 8800 kg — Electricity: ca. 200 kWatt — 42000 flops — 128 kbytes (eq.) core memory — 64 kbytes (eq.) drum memory — 3 Mbytes (eq.) Tape Unit.

Xiaomi 12 Pro

Master Every Scene

12GB / 256GB

Rp 12.999.000



Pro-grade triple 50MP camera array



Leading 4nm Snapdragon 8 Gen 1 5G processor



Smart 120W Xiaomi HyperCharge



WQHD+ dynamic 120Hz AMOLED display

Figure: Source: Mi Indonesia (2022)

Out of Topic/Intermezzo/Segue

- Semiconductor Scalling:
 - Process Shrink: $10\mu m$ (1971), $250nm$ (1996), $10nm$ (2016), $5nm$ (2020), $3nm$ (2022).
 - Smaller Devices means:
 - Less space.
 - Less power consumption.
 - More density.
- Indonesia:
 - Fairchild Semiconductor Indonesia.
 - National Semiconductor Indonesia.
 - Minister of Manpower (Menteri Tenaga Kerja) 1983–1988.
- Technology:
 - SoC: System on a Chip.
 - SiP: System in a Package.
 - Fab/Foundry: Taiwan Semiconductor Manufacturing Company (TSMC), Ltd.
 - Have No Fab? It is OK! E.g., Marvell Technology, Inc (1995).
 - Lithography: ASML Holding, N.V: Advanced Semiconductor Materials Lithography.
 - Optics: Carl Zeiss SMT GmbH (This is NOT Optik Seis, Duh :).

TSMC Logic Nodes

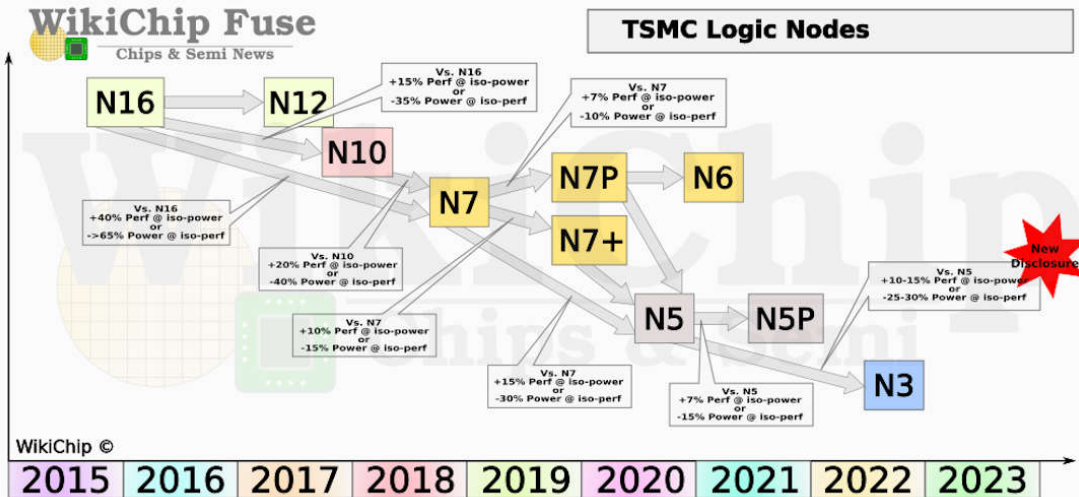


Figure: Source: [WikiChip](#)

The Computing Disciplines

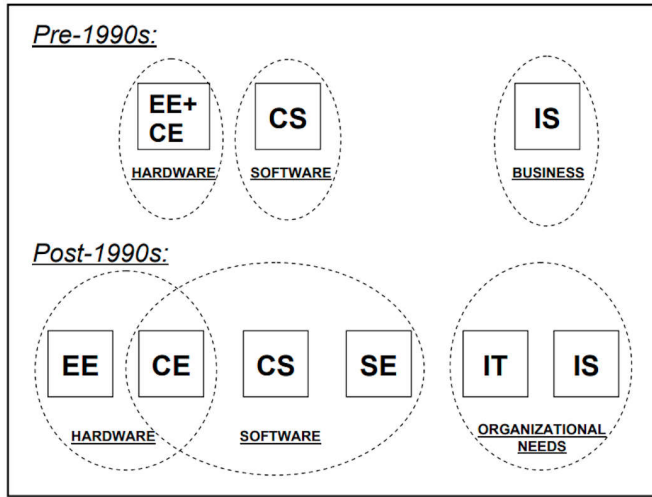


Figure 2.1. Harder Choices: How the Disciplines Might Appear to Prospective Students
Computing Curricula 2005

Lessons from the Development of the Boeing 787 Dreamliner

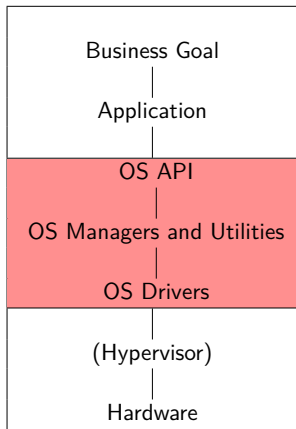
- 1997: Boeing acquired the nearly bankrupt McDonnell Douglas.
 - Result: "Boeing honorable name" with "McDonnell Douglas Greedy Culture."
- 2003: Boeing announced the Boeing 787 Dreamliner project.
- 2007: An "empty skeleton" prototype was rolled out on schedule. Many fuselage parts were temporarily attached.
 - Result: as expected, its stock price rose sharply.
- 2009: maiden flight after multiple delays.
 - Problem: Boeing and its partners have had no experience with many new technologies.
- 2011: Enter into service, but the problems did not go away.
 - Result: The budget increased from US\$5b to more than US\$30bil.
- 2018: Problems did not go away but were overshadowed by the Boeing 737 MAX problems.
- Lesson learned?
 - <https://rahmatm.samik-ibrahim.vlsm.org/2022/08/pelajaran-dari-pengembangan-boeing-787.html>

LFS: Linux From Scratch (Week 00 — Week 10)

- THIS IS HOW WE DOIT!
- <http://www.linuxfromscratch.org/lfs/view/stable/>
- To build a GNU/Linux system from scratch (source code).
- To learn a GNU/Linux system inside out.
- To use a Virtual Machine.
- A Chicken and Egg dependency problem:
 - It would be best if you had the tools to build an Operating System.
 - You need an Operating System to build tools.
 - To build a cross-toolchain (compiler and its libraries).
 - To build cross utilities using the cross-toolchain.
 - To build an Operating System in a chroot environment.
 - To do iterations (if necessary).
- How deep would you like to know of a "real" Operating System?
- Whatever, however, from Week 00 to Week 10!
- **YOU** decide!

What defines an Operating System? (The Three Layers Model)

URL: <https://rahmatm.samik-ibrahim.vlsm.org/2021/07/what-defines-operating-system.html>



- The Three Layers Model

- An Operating System is between your Application and your Hardware (or Hypervisor).
 - OS API: Application Programming Interface
 - OS Resources Managers and Utilities: Process, Scheduler, Dispatcher, (Virtual) Memory, Disk, I/O, Network, Security, Protection, etc.
 - OS Device Drivers: controls devices
- Remember that your future "**Business Goal**" may not directly relate to an Operating System at all!

OSC10 (Silberschatz) Chapter 1 and 2

• OSC10 Chapter 1

- What Operating Systems Do
- Computer-System Organization
- Computer-System Architecture
- Operating-System Operations
- Resource Management
- Security and Protection
- Virtualization
- Distributed Systems
- Kernel Data Structures
- Computing Environments
- Free/Libre and Open-Source Operating Systems

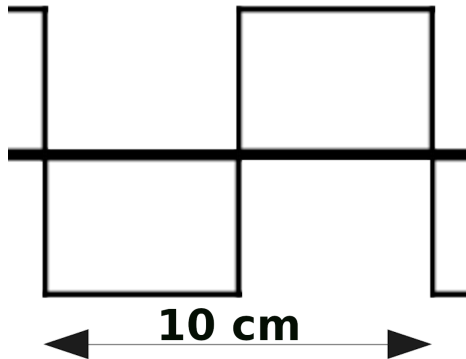
• OSC10 Chapter 2

- Operating System Services
- User and Operating System-Interface
- System Calls
- System Services
- Linkers and Loaders
- Why Applications are Operating System Specific
- Operating-System Design and Implementation
- Operating System Structure
- Building and Booting an Operating System
- Operating System Debugging

Remember Computer Organization (POK/DDAK)?

- You should understand:
 - von Neumann Model.
 - Buses, Bridges, Transfer Rate, Clock.
 - Memory: DDR, DDR-2, DDR-3, 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: 110010101010₂
 - Base 8: 01234567₈ = 000 001 010 011 100 101 110 111₂
 - Base 10: 012 345 679

Physics 101: Signal Length (E.g. 3 GHz)



1 second = 300 000 km

1 second = 3 000 000 000 cycles

1 cycle = 10 cm (lambda)

Figure: What is the length of a 3 GHz signal?

Physics 101: Safe Distance for 3 GHz



Figure: Safe Distance

Physics 101: Serial vs. Parallel Transmission

- Serial Transmission

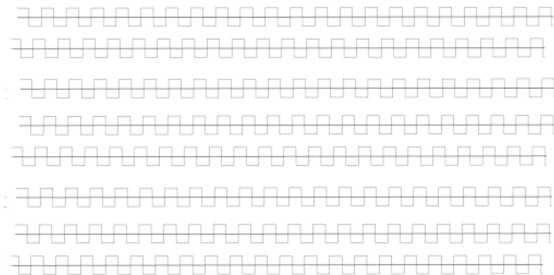
- Longer Distance
- Easy to implement



(serial)

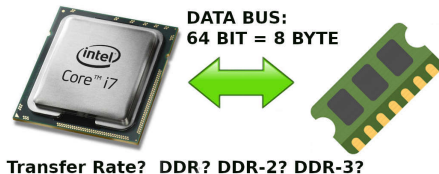
- Parallel Transmission

- Faster
- Not easy to implement



(parallel)

Transmission Rate (E.g. **BUS**: 64 bit/133 MHz)



- E.g. **BUS**: 64 bit, **Clock**: 133 MHz
 - SDRAM (Synchronous Dynamic RAM): 1 transmission/cycle.
Transfer Rate = $64/8 \text{ byte} \times 133\text{M} \times 1 = 1064 \text{ Mbyte/s}$.
 - DDR (Double Date Rate): 2 transmission/cycle.
Transfer Rate = $64/8 \text{ byte} \times 133\text{M} \times 2 = 2128 \text{ Mbyte/s}$.
 - DDR-2 (Double Date Rate 2): 4 transmission/cycle.
Transfer Rate = $64/8 \text{ byte} \times 133\text{M} \times 4 = 4256 \text{ Mbyte/s}$.
 - DDR-3 (Double Date Rate 3): 8 transmission per cycle.
Transfer Rate = $64/8 \text{ byte} \times 133\text{M} \times 8 = 8512 \text{ Mbyte/s}$.
 - DDR-3+ = DDR-3 with a better clock rate, lower voltage, and greater capacity.

CPU: SuperVisor Mode

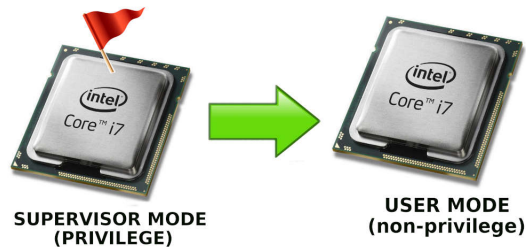


Figure: SuperVisor (Privilege) Mode to User Mode

- SuperVisor Mode

- A.k.a. Kernel Mode, Privilege Mode.
- Initial STATE (Mode) of a CPU (Power On).
- STATE (Mode) after Interrupt.
- All operations are allowed, including to switch to User Mode!

CPU: User Mode

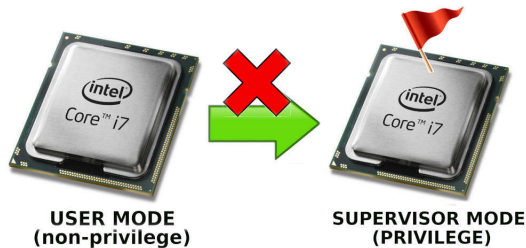


Figure: User Mode to SuperVisor (Privilege)

- User Mode

- It is not allowed to switch back to SuperVisor Mode.
- It is not allowed to access I/O directly.
- It is not allowed to modify the Interrupt Vector.
- It is allowed to request Interrupt.

Can you read a Block Diagram?

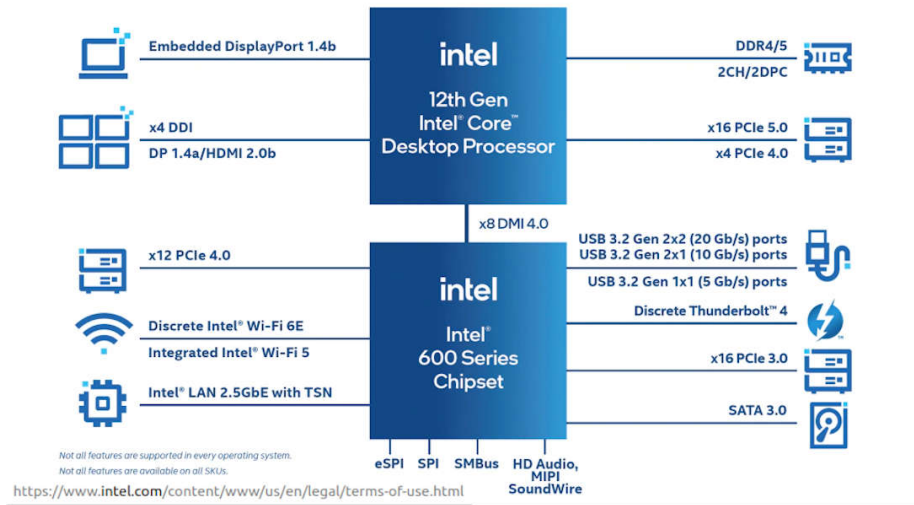


Figure: Block Diagram

Block Diagram

- eDP: Embedded DisplayPort, for internal displays.
- DDI: Digital Display Interface
- PCIe: Peripheral Component Interconnect express
- eSPI: Enhanced Serial Peripheral Interface
- SPI: Serial Peripheral Interface
- SMBus: System Management Bus
- HD Audio: High Definition Audio

What is an APIC?!

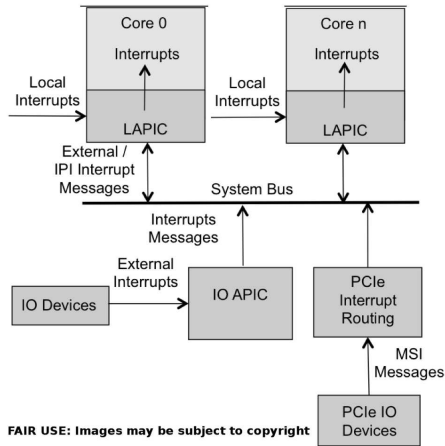
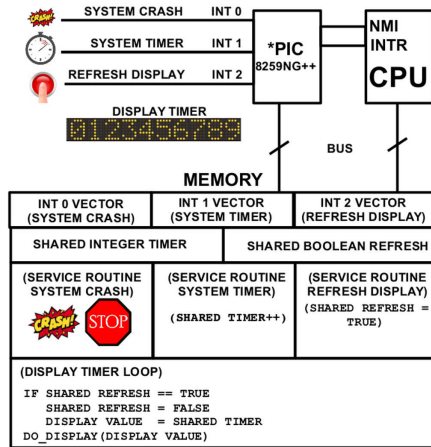


Figure: APIC (Advanced Programmable Interrupt Controller)

And, what is "Interrupt Handling"?



(c) 2017 VauLSMorg – This is a free picture

Figure: Interrupt Handling with PIC (Programmable Interrupt Controller)

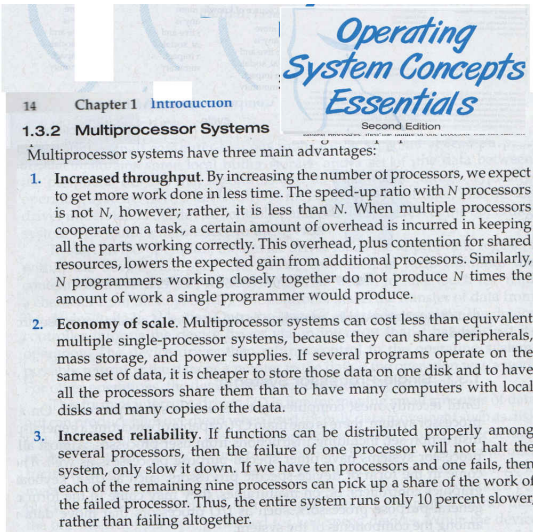
The Operating System Managers

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

Any idea what these following terms mean?!

- 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

Week 00: QUIZ Example #1 (from OSC2e)



True or False?

The advantages of a multiprocessor system include: increased throughput, economy of scale, and increased reliability.

(from MidTerm 2016)

Week 00: More QUIZ Examples

- **TRUE/FALSE**

The best way to get any help is to send an email to rms46 AT ui.ac.id.

- **TRUE/FALSE**

Questions regarding assignments should be posted at SCELE.

- **TRUE/FALSE**

Making a **PUSS IN BOOT** face is increasing the chance to get a better deal.

- **TRUE/FALSE**

Anyone can appeal any time, even after the (official) final grade is announced on SIAK.

- **TRUE/FALSE**

There are bonus points for early assignment submission.

Assignments

- You need to run "VirtualBox" on a computer with more than 4GB RAM and at least 64 GB disk space.
- Each assignment deadline will be by the end of that "week". The weekly schedule will be at <https://os.vlsm.org/#idx02>.
- Use the "**GitHub web interface**" for the Week 00 assignment. However, starting Week 01, you need to understand "**pull, add, commit, push, and ssh-keys**".
- Submit (push) the assignments to <https://github.com/>. If you still don't have one, you need to sign up for a [GitHub](#) account. More information will follow.
- See the assignment list at <https://osp4diss.vlsm.org/AOS.html>.

Course Highlights and Syllabus

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: Topics¹

- 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

¹Source: ACM IEEE CS Curricula 2013

Week 00 Overview I: Learning Outcomes (1)¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 00 Overview I: Learning Outcomes (2)¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 01 Overview II: Topics¹

- Intellectual Property Rights (IPR)
- Software Licenses and Free Software
- Operating System Services and Interfaces
- System Calls and System Programming
- Types of virtualization (including Hardware/Software, OS, Server, Service, Network)
- Hypervisors
- Portable and cost of virtualization; emulation vs. isolation
- Cloud services: IAAS, PAAS and Platform APIs, SAAS
- Introduction to Scripting and REGEX.

¹Source: ACM IEEE CS Curricula 2013

Week 01 Overview II: Learning Outcomes¹

- 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 the virtualized infrastructure. [Familiarity]

¹Source: ACM IEEE CS Curricula 2013

Week 02 Security & Protection: Topics¹

- Overview of system security
- Cyber Security Introduction
- Policy/mechanism separation
- Security methods and devices
- Protection, access control, and authentication
- Backups
- Safety and Privacy
- Threads
- Cryptography: (Symmetric and Asymmetric) Encryption,
- C Language

¹Source: ACM IEEE CS Curricula 2013

Week 02 Security & Protection: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 03 File System & FUSE: Topics¹

- 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

¹Source: ACM IEEE CS Curricula 2013

Week 03 File System & FUSE: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 04 Addressing: Topics¹

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

¹Source: ACM IEEE CS Curricula 2013

Week 04 Addressing: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 05 Virtual Memory: Topics¹

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

¹Source: ACM IEEE CS Curricula 2013

Week 05 Virtual Memory: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 06 Concurrency: Topics¹

- 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)

¹Source: ACM IEEE CS Curricula 2013

Week 06 Concurrency: Learning Outcomes (1)¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 06 Concurrency: Learning Outcomes (2)¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 07 Synchronization & Deadlock: Topics¹

- 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.

¹Source: ACM IEEE CS Curricula 2013

Week 07 Synchronization & Deadlock: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 08 Scheduling: Topics¹

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

¹Source: ACM IEEE CS Curricula 2013

Week 08 Scheduling: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 09 Storage, Firmware, Bootloader, & Systemd: Topics¹

- Storage
- Storage Arrays
- BIOS
- Loader
- Systemd

¹Source: ACM IEEE CS Curricula 2013

Week 09 Storage, Firmware, Bootloader, & Systemd: Learning Outcomes¹

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

¹Source: ACM IEEE CS Curricula 2013

Week 10 I/O & Programming: Topics¹

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

¹Source: ACM IEEE CS Curricula 2013

Week 10 I/O & Programming: Learning Outcomes¹

- 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]

¹Source: ACM IEEE CS Curricula 2013

Week 00: Summary

- What is an Operating System?
 - 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

TIPS (1)

- See also <https://rms46.vlsm.org/2/221.pdf>.
- For any administrative issues, contact SEKRE at building B, 2nd 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 six (6) working days (RMS).
- Study the Operating System Concept book, which deals with the material that will be discussed that week (MIM). Make a summary of the 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 a sheet of MEMO for the midterm (UTS) and a sheet for the finalterm (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).
- The **ASDOS** are the lectures's helper, not your personal tutors (RMS).

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The End

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