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Systems Software &  
Architecture Lab.

Seoul National University

Fall 2020

# 4190.568: Advanced Operating Systems



# Course Information

- **Schedule**

- 15:30 – 16:45 (Monday & Wednesday)
- Online lecture using zoom
- 3 credits
- Official language: Korean

- **TA: TBD**

- **Course homepage:**

<http://csl.snu.ac.kr/courses/4190.568/2020-2/>

- **Lecture slides will be uploaded in the course homepage before the class**

# About Me

- Jin-Soo Kim (김진수)
  - Professor @ CSE Dept.
  - Systems Software & Architecture Laboratory
  - Operating systems, storage systems, parallel and distributed computing, embedded systems, ...
- E-mail: [jinsoo.kim@snu.ac.kr](mailto:jinsoo.kim@snu.ac.kr)
- Tel: 02-880-7302
- Office: Engineering Bldg. #301-520 (office hours: Monday & Wednesday)
- The best way to contact me is by email

# Prerequisites

- Prerequisites
  - MI522.000800 Undergraduate Systems Programming or equivalent – **Must!**
  - 4190.307 Undergraduate Operating Systems or equivalent – **Must!**
  - 4190.308 Undergraduate Computer Architecture or equivalent – **Must!**
  
- We will review some of fundamental operating system concepts to awaken the force within you



# Course Plan

- Lectures
  - Advanced topics on operating systems
  - Linux case study
- Invited talks
- Reading assignments
  - You should read them BEFORE the class
  - There will be quizzes
- ~~Paper presentation~~
- Assignments & Term project
- Final exam (no Midterm 😊)

# Topics Planned

- Introduction to computer systems research
- Introduction to operating systems
- Processes and threads
- CPU scheduling
- ~~■ Synchronization~~
- Virtual memory
- Linux memory management
- Storage
- SSDs
- File systems
- Virtual machines
- OS structure and design
- Distributed file systems
- Key-value stores

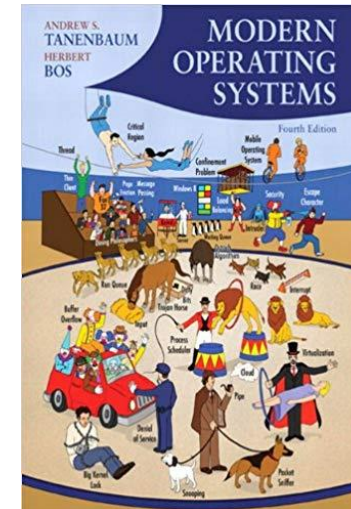
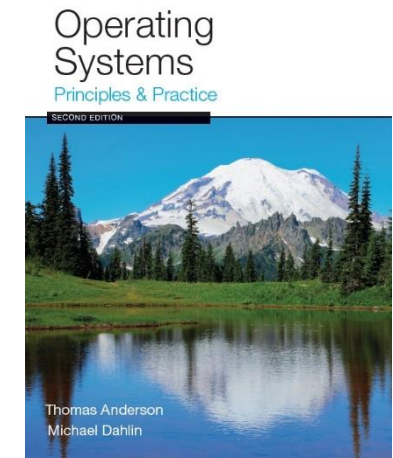
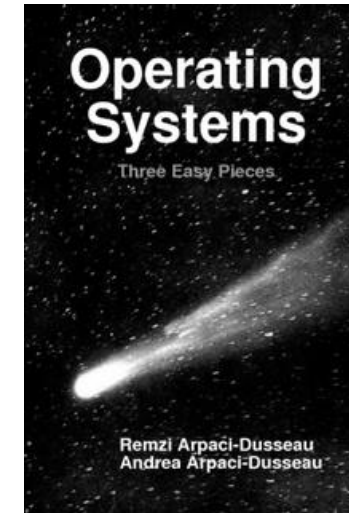
# Class Materials

- Quality research papers from major conferences will be used:
  - **SOSP** (ACM Symposium on Operating Systems Principles)
  - **OSDI** (USENIX Symposium on Operating Systems Design and Implementation)
  - **ASPLOS** (ACM Conference on Architectural Support for Programming Languages and Operating Systems)
  - **USENIX ATC** (USENIX Annual Technical Conference)
  - **FAST** (USENIX Conference on File and Storage Technologies)
  - **EuroSys** (ACM European Systems Conference)
  - **NSDI** (USENIX Symposium on Networked Systems Design and Implementation)
  - ...



# References

- **Operating Systems: Three Easy Pieces**
  - By Remzi & Andrea Arpaci-Dusseau
  - Freely available at <http://ostep.org>
- **Operating Systems: Principles and Practice**
  - By Tom Anderson & Michael Dahlin
  - 2nd Edition, Recursive Books, 2014
- **Modern Operating Systems**
  - By Andrew Tanenbaum & Herbert Bos
  - 4th Edition, Pearson Education, 2015






# Reading Assignments

- Critical reading of technical papers is a must skill to have for your research
- Papers you have to read will be listed in the course home page
- There will be online quizzes

# Assignments

- There will be several assignments for your hands-on experience on Linux
- Reference Linux kernel: 5.4.59 (longterm maintenance kernel)
  - Download it from <https://kernel.org/pub/linux/kernel/v5.x/linux-5.4.59.tar.gz>

## The Linux Kernel Archives



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mainline:	<b>5.9-rc1</b>	2020-08-16	<a href="#">[tarball]</a>	<a href="#">[patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>			
stable:	<b>5.8.2</b>	2020-08-19	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
stable:	<b>5.7.16</b>	2020-08-19	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
longterm:	<b>5.4.59</b>	2020-08-19	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
longterm:	<b>4.19.140</b>	2020-08-19	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
longterm:	<b>4.14.193</b>	2020-08-07	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
longterm:	<b>4.9.232</b>	2020-07-31	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
longterm:	<b>4.4.232</b>	2020-07-31	<a href="#">[tarball]</a>	<a href="#">[pgp]</a>	<a href="#">[patch]</a>	<a href="#">[inc. patch]</a>	<a href="#">[view diff]</a>	<a href="#">[browse]</a>	<a href="#">[changelog]</a>
linux-next:	<b>next-20200819</b>	2020-08-19						<a href="#">[browse]</a>	

# Projects: Basic Policies

- Term projects should be done in teams of three students
- Each project should be completed within this semester with some tangible results
  - New ideas without any evaluation will not be considered for grading, no matter how novel they are.
- Project topics need to be related to operating systems, and must be explicitly okay'd by the instructor

# Projects: Possible Topics

- Find a problem in Linux and improve it
- Characterize applications' behavior
  - Scheduling behavior, memory access patterns, storage access patterns, etc.
  - What should be changed to accommodate emerging devices/applications/services?
- Verify whether a certain Linux policy works well under synthetic and real-world workloads
  - e.g., The Linux scheduler: a decade of wasted cores (EuroSys '16)
  - Memory/file system anti-fragmentation policy, hugepage support, etc.
- Find scalability issues in the Linux kernel
  - e.g., Understanding manycore scalability of file systems (ATC '16)
- Find bugs in the Linux kernel
  - e.g., Finding crash-consistency bugs with bounded black-box crash testing (OSDI '18)

# Projects: Possible Topics (cont'd)

- Analyze the evolution of a Linux subsystem
  - e.g., A study of Linux file system evolution (FAST '13)
  - e.g., An analysis of performance evolution of Linux's core operations (SOSP '19)
- Write an operating system in high-level language
  - OSes in Rust: <https://github.com/flosse/rust-os-comparison>
  - Biscuit OS: <https://github.com/mit-pdos/biscuit> (OSDI '18)
- Reproduce the results from other papers on your platform and investigate a way to improve it
- Code-level analysis on a particular Linux subsystem
  - e.g., Memory management, File system, Synchronization, NUMA support, ...

# Projects: Proposal

- Due: October 16th (tentative)
- Format: 1 page, free writing
- Project proposal should include the followings:
  - The motivation and the goal of your work
  - The problem you would like to solve (define clearly)
  - Brief summary of related work
  - Your ideas to solve the problem
  - Research plan for the project
- Project proposals will be reviewed by the instructor

# Projects: Term Paper

- You are expected to write up a term paper
- Due: December 18th (tentative)
- In ACM/IEEE conference proceedings format
- Up to 6-page long (either in English or in Korean)

# Projects: Evaluation

- Your term paper will be evaluated using the following criteria:
  1. **Brightness**: on your motivation and idea
  2. **Comprehensiveness**: on the survey of existing work
  3. **Soundness**: on your methodology
  4. **Impressiveness**: on your results
  5. Your **time and efforts** spent on this project



# Grading Policy

- Assignments and Quizzes: 40%
- Final exam: 30%
- Term project: 30%
  
- *Subject to change*

# Reading Assignment #1

- Dennis M. Ritchie and Ken Thompson, “The UNIX Time-Sharing System,” CACM, 1974
- Due: Before the class on Sep. 9
- There will be an online quiz for this paper during the class on Sep. 9