4190.568: Advanced Operating Systems

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Systems Software &
Architecture Lab.

Seoul National University

Fall 2021

Course Information

- Schedule
  - 11:00 – 12:15 (Tuesday & Thursday)
  - Online lecture using zoom
  - 3 credits
 - Official language: Korean

- TA: Kyujin Cho (bori19960)

- Course homepage:
  http://csl.snu.ac.kr/courses/4190.568/2021-2/

- 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, …

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- The best way to contact me is by email
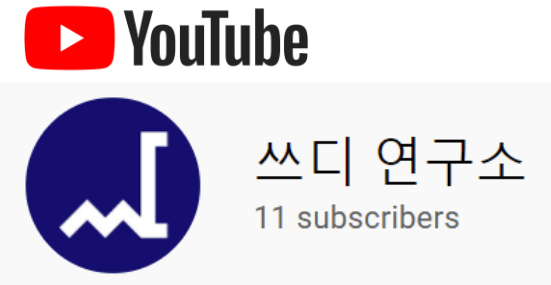
Prerequisites

- **Prerequisites**
  - M1522.000800 Undergraduate Systems Programming or equivalent
  - 4190.307 Undergraduate Operating Systems or equivalent
  - 4190.308 Undergraduate Computer Architecture or equivalent

- **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
- Exams

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
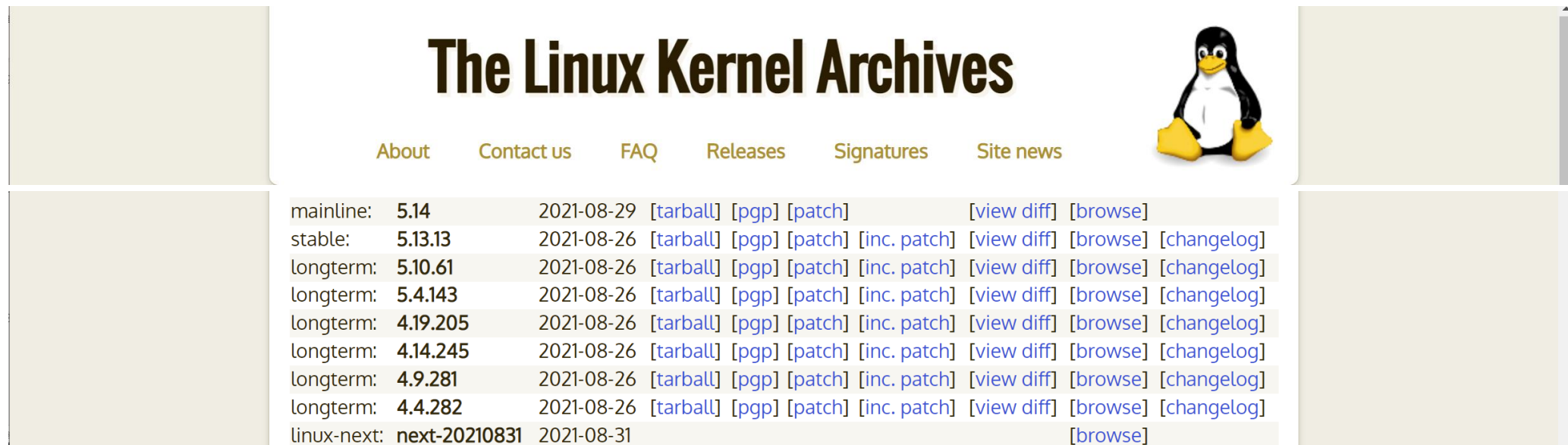 - 4th Edition, Pearson Education, 2015
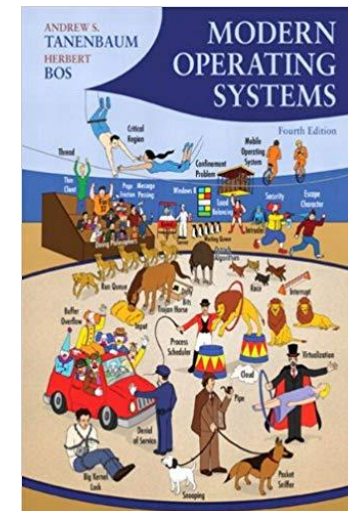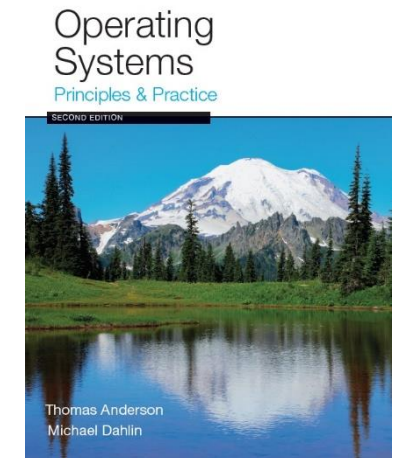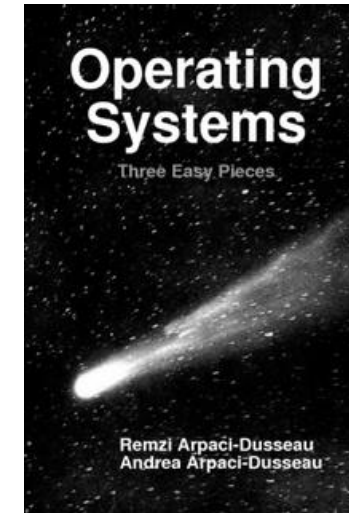
Reading Assignments

- 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

Assignments

- There will be several assignments for your hands-on experience on Linux

- Reference Linux kernel: 5.10.61 (longterm maintenance kernel)
  - Download it from https://kernel.org/pub/linux/kernel/v5.x/linux-5.10.61.tar.gz

The Linux Kernel Archives

About	Contact us	FAQ	Releases	Signatures	Site news

mainline:	5.14	2021-08-29	[tarball] [pgp] [patch]		[view diff]	[browse]	
stable:	5.13.13	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
longterm:	5.10.61	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
longterm:	5.4.143	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
longterm:	4.19.205	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
longterm:	4.14.245	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
longterm:	4.9.281	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
longterm:	4.4.282	2021-08-26	[tarball] [pgp] [patch] [inc. patch]		[view diff]	[browse]	[changelog]
linux-next:	next-20210831	2021-08-31				[browse]	

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 (especially to storage and file 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)

Projects: Possible Topics (cont'd)

- Find bugs in the Linux kernel
  - e.g., Finding crash-consistency bugs with bounded black-box crash testing (OSDI '18)
  - e.g., Can applications recover from fsync failures? (ATC '20)
- 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)
- 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 24th (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 20th (tentative)

- In ACM/IEEE conference proceedings format (two columns)

- 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

- Exams: 70%
- 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. 9th