

1. Introduction

Special Topics in Computer Systems:

Modern Storage Systems

(IC820-01)

Instructor:

Prof. Sungjin Lee (sungjin.lee@dgist.ac.kr)

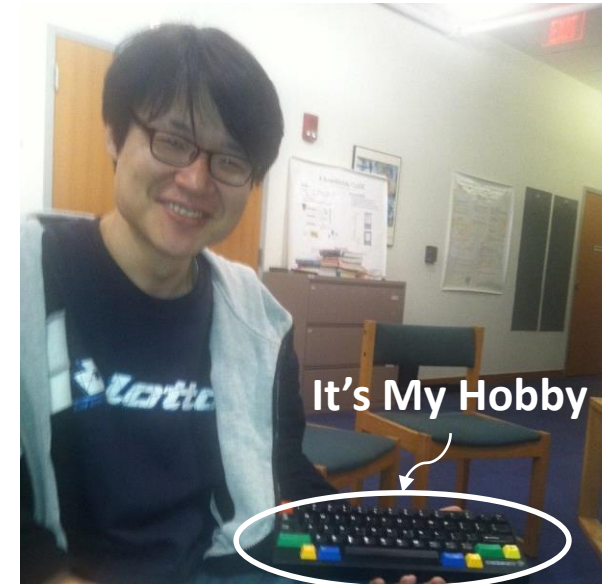
Hello!

■ Instructor

- **Prof. Sungjin Lee** (Room 410, E3, sungjin.lee@dgist.ac.kr)
 - Researcher at CSAIL MIT
 - PhD. SNU
- **DataLab**
 - **Data**-intensive Computing Systems **Laboratory**
 - Location: Room 404, E3

■ Major research area – **Computer Systems**

- Operating systems
- Distributed storage systems
- Non-volatile memory systems (e.g., Flash and 3D-XPoint)
- Embedded Systems
- ...



Research Area

- We are living in a world overflowing with data
 - We are **collecting** and **analyzing** ever-greater amounts of data

Every Minute!



400 hours of new video are uploaded



277,000 of new twittes are sent



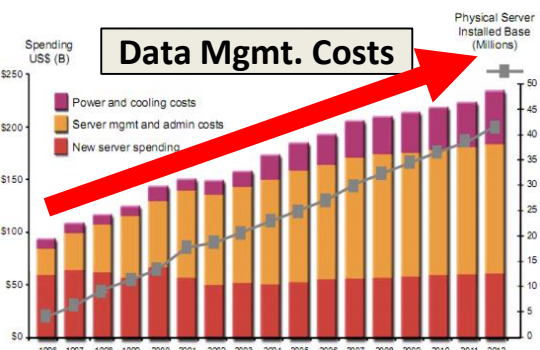
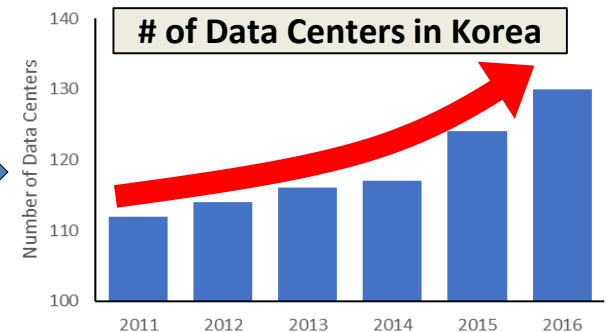
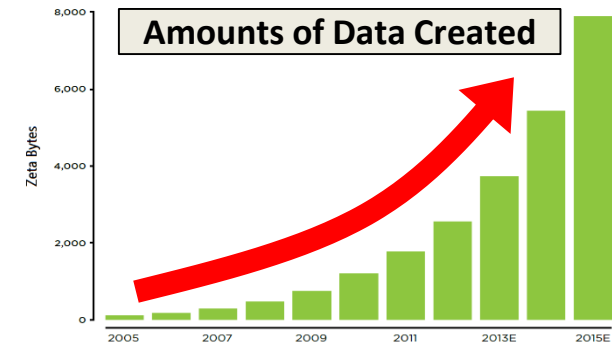
Facebook processes 350 GB of data



Users like 2,430,555 new posts



Users upload 833,333 new files



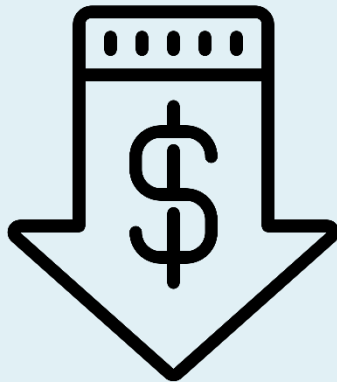
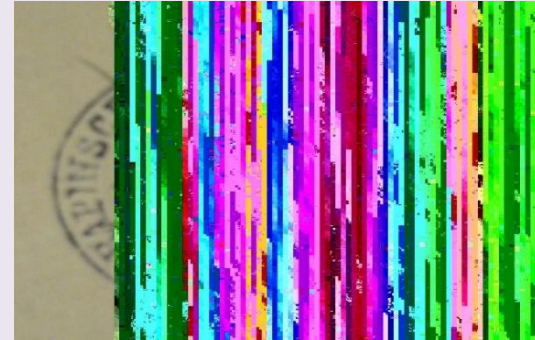
Research Area

- Key requirements the computing systems should meet to handle large amounts of data:

High-performance



High-reliability



Low Cost

Energy Efficiency



Energy Efficiency

Research Area

- Key requirements the computing systems should meet to handle large amounts of data:

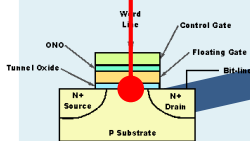
High-performance



Storage Firmware
Storage Architecture

Understand Characteristics
of Memory Cells

Memory Cells

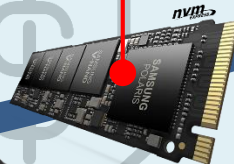


Memory Chips

Low Cost

Controller Logics

Data Storage



Storage System

Operating Systems
File Systems
I/O Stack
...

High-reliability

Clustered System



Distributed Storage

Scalability
Networking
Distributed Data Management
...

Energy Efficiency

What Will You Learn from This Course?

■ Modern storage systems:

- **How modern storage devices are built and operate?**
 - Understand the physical characteristics of storage media (e.g., HDD, Flash, ...)
 - Understand the internals of storage devices (e.g., firmware and HW controller)
- **How a host computer interacts with storage devices**
 - Local, networked storage, storage array, storage protocols, ...
- **Learn key technologies for storage management**
 - Local/distributed file system, compression/deduplication, near-storage computing, ...

■ Getting knowledge about the latest storage research:

- Reading and understanding technical papers presented at prestigious system conferences (e.g., USENIX ATC, FAST, ASPLOS, OSDI/SOSP, EuroSys, ...)

Lecture Organization

■ Lecture and paper reading

- **Lecture:** One and a half hour a week (10:30-12:00, Tuesday)
- **Paper reading:** Present few of selected papers (10:30-12:00, Thursday)
- **Final project**

■ Prerequisites (strongly required)

- C/C++ programming
- Data structures
- Operating System
- Computer Architecture

Lectures

■ Topics

- Storage Hardware
 - Storage Controller
 - Storage Firmware
- } **Storage Device**
-
- Storage Interface and protocols
 - Storage Architecture
- } **I/O Interface**
-
- Advanced File Systems
 - RAID & Replication & Erasure Code
 - Compression & Deduplication
 - In-storage Computing
 - Nonvolatile Memory
- } **Storage management**

Evaluation

■ Final Examination: 30%

- Comprehensive evaluation based on what you learn from the lecture

■ Presentation: 30%

- 40 minutes paper presentation, including Q&A
- Two presentations per class

■ Project: 30%

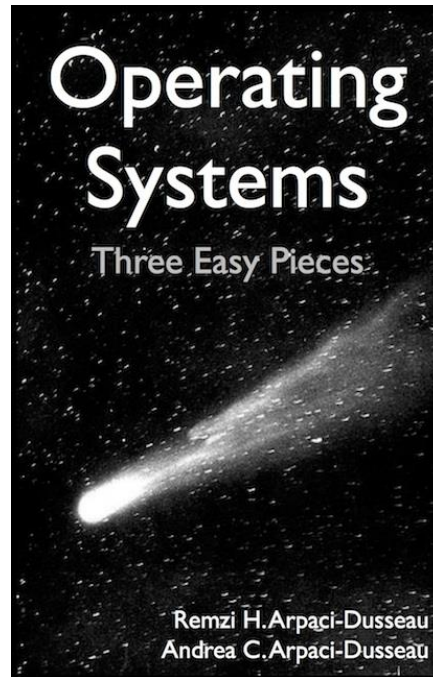
- Implementation of storage management algorithms
- Project report

■ Participation: 10%

Textbooks

- **No official textbook is available**

- But, Remzi's OSTEP would be helpful to get background



- **Lecture slides & papers**

- To fully understand the contents of the lectures, read lecture slides & papers

Cheating

■ What is cheating?

- Sharing code: by copying, retyping, looking at, or supplying a file
- Coaching: helping your friend to write a lab, line by line
- Copying code from previous course or from elsewhere on WWW

■ What is NOT cheating?

- Explaining how to use systems or tools
- Helping others with high-level design issues

■ Penalty for cheating

- Removal from course with failing grade

Getting Help

■ Mail to us:

- Sungjin Lee (instructor): sungjin.lee@dgist.ac.kr
- Youngdon Jung (TA): yeavov@dgist.ac.kr

■ Office hours:

- Tue/Thur, 13:00-15:00pm, E3-410

■ Note:

- This class is somewhat *experimental* – the grading policy and course schedules *could be changed* according to feedback and progress of students

Paper Presentation Schedules

■ Sept 19: Storage Hardware

- SMaRT: An Approach to Shingled Magnetic Recording Translation, USENIX FAST '17
- GearDB: A GC-free Key-Value Store on HM-SMR Drives with Gear Compaction, USENIX FAST '19

■ Sept 26: SSD Controller

- Exploiting Process Similarity of 3D Flash Memory for High Performance SSDs, MICRO '19
- 2B-SSD: The Case for Dual, Byte- and Block-Addressable Solid-State Drives, ISCA '18

■ Oct 10: SSD Firmware

- DFTL: A Flash Translation Layer Employing Demand-based. Selective Caching of Page-level Address Mappings, ASPLOS '09
- Fully Automatic Stream Management for Multi-Streamed SSDs Using Program Contexts, USENIX FAST '19

■ Oct 17: File Systems

- F2FS: A New File System for Flash Storage, USENIX FAST '15
- Strata: A Cross Media File System, SOSP '17

Register your self on Doodle: <https://doodle.com/poll/vrhv6emfbi9x6g4g>

Welcome and Enjoy!