

LevelDB Study Introduction 1

2022. 07. 05

Presented by Min-guk Choi

koreachoi96@gmail.com

1. Study Introduction

- 2. Why should we understand internal structure?
- 3. What is a key-value store?
- 4. Why open-source?
- 5. Job market
- 6. Lab research subject
- 7. Environment setup
- 8. Homework

■ Study Introduction

- ✓ Members
 - Professor, Assistant, Student
- ✓ Schedule
- ✓ Goals
- ✓ What you can get

Professor



Jongmoo Choi

- Professor (Ph.D.), *Mar. 2003 ~ Present*
- Department of Computer Science and Engineering
at Dankook University
- <https://sslab.dankook.ac.kr/~choijm/>



Seehwan Yoo

- Professor (Ph.D.), *Mar. 2014 ~ Present*
- Department of Mobile Systems Engineering
at Dankook University
- <https://sites.google.com/site/dkumobileos/members/seehwanyoo>

Assistant



Sounghyoun Lee

- Ph.D student
- KV Store, RT-KV Store
- wwbabaww@gmail.com



Hojin Shin

- Ph.D student
- KV Store, RT-KV Store
- ghwls03s@gmail.com



Min-guk Choi

- Undergraduate student
- KV Store, Caching
- koreachoi96@gmail.com

Schedule

- Date: Every Tuesday in July, August
- Time: 14:00 ~ 16:00
- Place: Dankook University Software ICT Hall Room 301

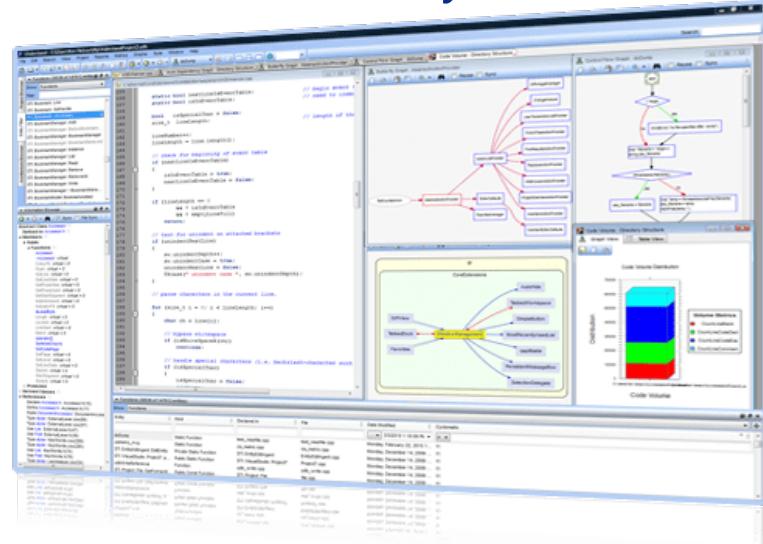
No	Date	Contents	
Week 1	22-07-05	LevelDB Introduction 1	What is key-value store? Why open-source?
Week 2	22-07-12	LevelDB Introduction 2	LevelDB basics Analytics tools
Week 3	22-07-19	LevelDB Analysis 1	
Week 4	22-07-26	LevelDB Analysis 2	
Week 5	22-08-02	LevelDB Analysis 3	
Week 6	22-08-09	LevelDB Analysis 4	
Week 7	22-08-16	Real-World Workload Optimization	YCSB Twitter Trace
Week 8	22-08-23	New Idea Implementation 1	
Week 9	22-08-30	New Idea Implementation 2	Write (undergraduate) research paper

Goals

- Analyze LevelDB.
- Write your LevelDB analysis into a git-book.
- Optimize LevelDB for real-world workload.
- Implement new ideas in LevelDB.
- Write a research (undergraduate) paper based on what you learned.

Goal 1. Analyze LevelDB

- Analyze open-source project.
 - Start with studying documents and lectures
 - Learn and use analytics tools
 - Study code and remarks in small function and classes
 - Try test code
- Analytics tool
 - Debugger: gdb
 - Static analytics tools: Understand by Scitools
 - Dynamic analytics tools: utrace
- Draw figures
 - Code flowchart, Class diagram, Structure



```

TOTAL TIME : FUNCTION
20.914 us : (1) a.out
20.914 us : (1) main
1.997 us :   (1) operator new
              :
4.170 us :   (1) std::shared_ptr::shared_ptr
3.797 us :   (1) std::::shared_ptr::shared_ptr
2.967 us :   (1) std::::shared_count::shared_count
0.630 us :   (1) operator new
              :
0.153 us :   (1) std::::sp_counted_ptr::Sp_counted_ptr
             (1) std::::sp_counted_base::Sp_counted_base
             (1) std::::Mutex_base::Mutex_base
              :
0.153 us :   (1) std::::enable_shared_from_this_helper
              :
10.027 us :   (1) std::shared_ptr::shared_ptr
9.700 us :   (1) std::::shared_count::shared_count
9.374 us :   (1) std::::shared_count::shared_count
9.054 us :   (1) std::::Sp_counted_base::M_release
2.093 us :   (2) __gnu_cxx::__exchange_and_add_dispatch
0.287 us :   (2) __gthread_active_p
              :
0.260 us :   (2) __gnu_cxx::__exchange_and_add_single
              :
3.803 us :   (1) std::::Sp_counted_ptr::M_dispose
2.890 us :   (1) operator delete
              :
2.083 us :   (1) std::::Sp_counted_ptr::M_destroy
1.697 us :   (1) std::::Sp_counted_ptr::~Sp_counted_ptr
0.666 us :   (1) std::::Sp_counted_ptr::~Sp_counted_ptr
0.143 us :   (1) std::::Sp_counted_base::~Sp_counted_base
              :
0.284 us :   (1) operator delete

```

utrace graph: /home/hongyu/shared_ptr.cc [line:3]

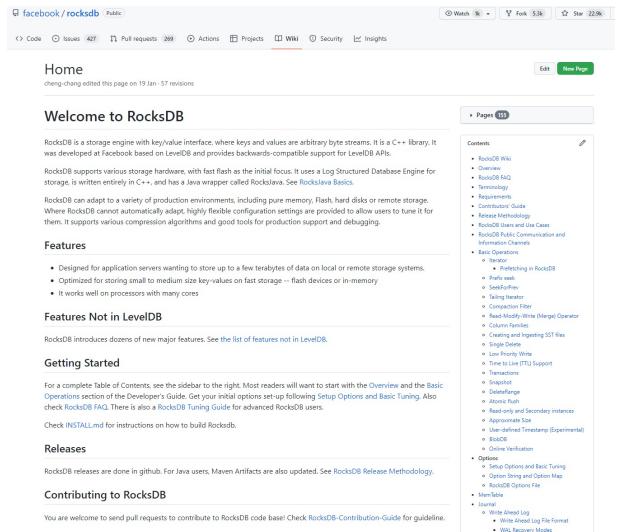
1. Study Introduction (7/11)

Goal 2. Git-book

- Start open-source contribution with writing a document
 - Write your LevelDB analysis into a git-book
 - Use Git-book as a portfolio
- Document what you have studied
 - How to organize and convey your thoughts?
- There are no LevelDB analysis documents written in English yet.
 - write documents in Korean during study.
 - translate documents in English after study.
 - When it finishes, promote git-book on reddit and open-source communities.



<https://leveldb-handbook.readthedocs.io/zh/latest/>



<https://dku-starlab.gitbook.io/leveldb-analysis/>

Goal 3. Tuning

- Tune existing application/system
 - Optimize for your environment, workload

- Before tuning, you should understand
 - Whole structure
 - Relationships between parameters
 - System environment, Workload, Data set

- Tuning Contest
 - Tune LevelDB for real-world workload
 - Twitter Trace/YCSB

kaggle

kakao

MongoDB Engineer 모집

카카오 | 정규직 | 영입종료시 | 판교

◆ 업무내용

- MongoDB 운영
- MongoDB 운영 자동화 시스템 개발
- MongoDB 장애 대응 및 트러블 투팅
- MongoDB 모니터링/분석
- MongoDB 쿼리/서버 설정 투팅
- MongoDB Internal 연구
- Database as a Service(DBaaS) 개발과 운영
- 신기술 리서치 및 서비스 적용

<https://careers.kakao.com/jobs/P-12208>

LINE

Social Platform Backend Engineer

Bundang | LINE Plus | Engineering | Server-side | Full-time

우대사항

- 글로벌 서비스 운영 및 개발 경험이 있으신 분
- k8s 환경에서 서비스를 개발한 경험이 있으신 분
- Kotlin, GO 언어 등의 기타 언어에도 익숙하거나 또는 도입에 거부감이 없으신 분
- 성능 개선을 위해 어플리케이션 혹은 시스템 투팅에 도전해보셨거나 관심이 많으신 분
- 외국어로 업무 진행이 가능하신 분 (영어, 일본어, 중국어)

<https://careers.linecorp.com/ko/jobs/1078>

Goal 4. New Idea Implementation

- Implement on existing project
 - Your own idea, optimization, customization
 - Idea from papers

- How many people do companies need?
 - Many

- How many people have done this?
 - Not many

- Who can do this?
 - Someone just like you.
 - The professors and assistants will support you.



nbase-arc

Distributed memory store based on Redis

[naver / nbase-arc](#) Public

nbase-arc is an open source distributed memory store based on Redis

Apache-2.0 license

162 stars 38 forks

Star Watch

<https://naver.github.io/>

<https://github.com/naver/nbase-arc>

Goal 5. Research Paper

- How can I appeal my research experience?
 - Git-hub and blog are ok.
 - Nevertheless, writing paper is the best.

- Write (an undergraduate) research paper
 - It's is not as hard as you think.
 - Just write it like a homework report.
 - Check how seniors wrote paper before.

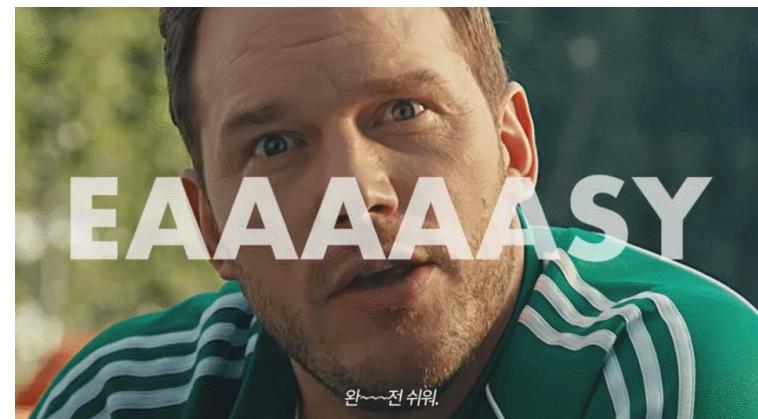
- The professors and assistants will support you.



KSC2021

2021년 12월 20일(월)-22일(수), 휘닉스 평창 호텔&온라인

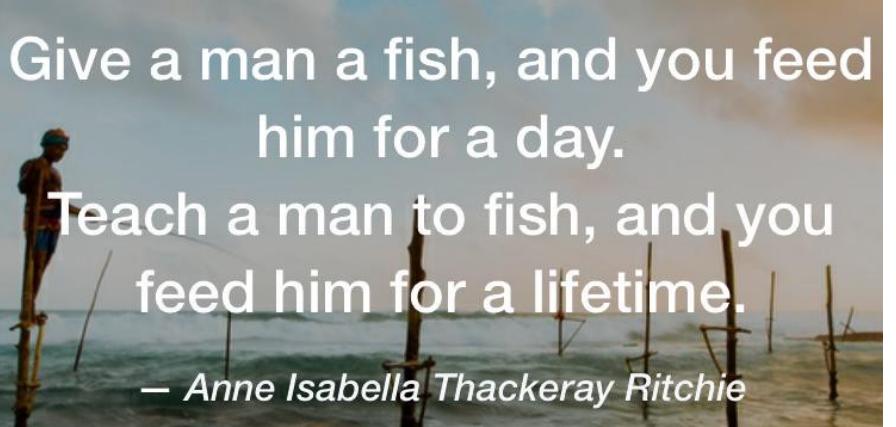
"코로나 이후의 세상: 소프트웨어 중심 사회"



https://www.youtube.com/watch?v=Q39VK9OAbG4&ab_channel=FortniteKR

What you can get

- KV store
 - Knowledge, Tuning, Implementation
- Open-source
 - Learn how to analyze and document the project
 - Start open-source contribution by writing a git-book
- Portfolio
 - Git-book, Tuning Contest, Research paper



Give a man a fish, and you feed
him for a day.
Teach a man to fish, and you
feed him for a lifetime.

— Anne Isabella Thackeray Ritchie

<https://unquote.li/>

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- Why should we understand internal structure?
 - ✓ Indexing in RDB
 - ✓ Coding interview question
 - ✓ B+-tree vs LSM-tree

Indexing in RDB

- Indexing in RDBMS

Mem (B+-tree)

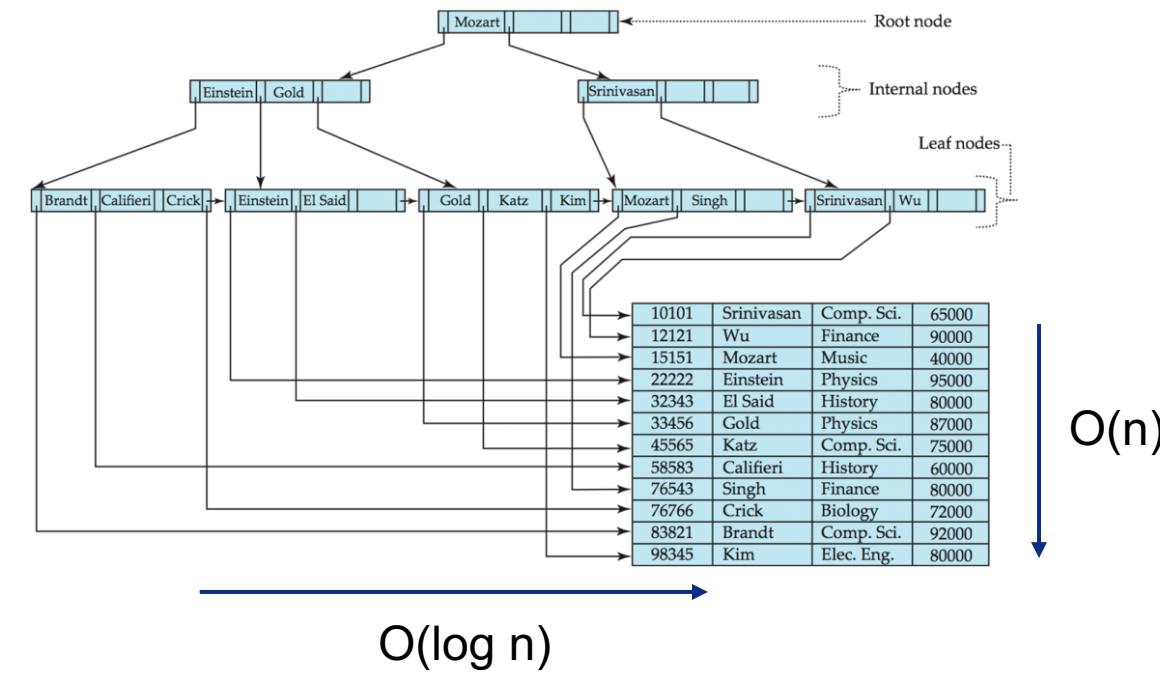
Index Table

Biology
Comp. Sci.
Elec. Eng.
Finance
History
Music
Physics

Pointers

ID	Name	Discipline	Salary
76766	Crick	Biology	72000
10101	Srinivasan	Comp. Sci.	65000
45565	Katz	Comp. Sci.	75000
83821	Brandt	Comp. Sci.	92000
98345	Kim	Elec. Eng.	80000
12121	Wu	Finance	90000
76543	Singh	Finance	80000
32343	El Said	History	60000
58583	Califieri	History	62000
15151	Mozart	Music	40000
22222	Einstein	Physics	95000
33465	Gold	Physics	87000

Disk (File)

Database System Concept 7th Edition, Avi SilberschatzDatabase System Concept 7th Edition, Avi Silberschatz

Coding interview question

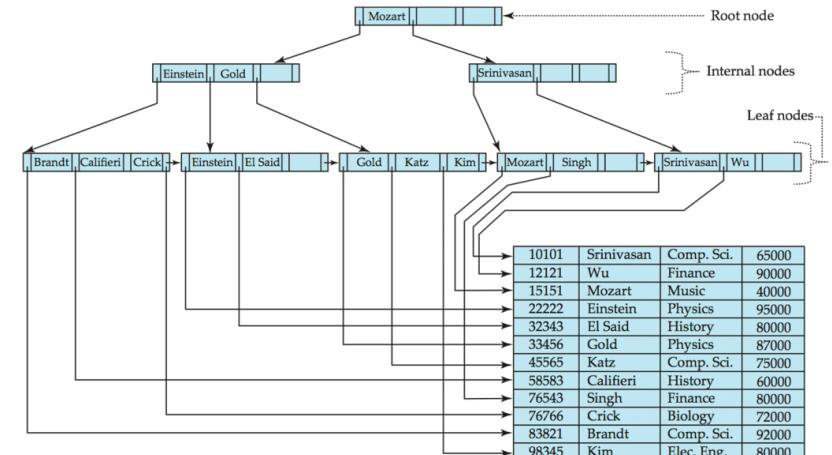
- How should we answer the previous question?
 - Based on structure/architecture (B+-tree)
 - OS/DB kernel knowledge

- Why does the interviewer ask such questions?
 - Performance, efficiency, cost

Index Table

	ID	Name	Discipline	Salary
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	15151	Mozart	Music	40000
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	33465	Gold	Physics	87000

Pointers



B+-tree vs LSM-tree

- Study how LSM-tree based DB works!

DATABASE STORAGE ENGINES

B-TREE



LSM TREE



<https://blog.yugabyte.com/a-busy-developers-guide-to-database-storage-engines-the-basics/>

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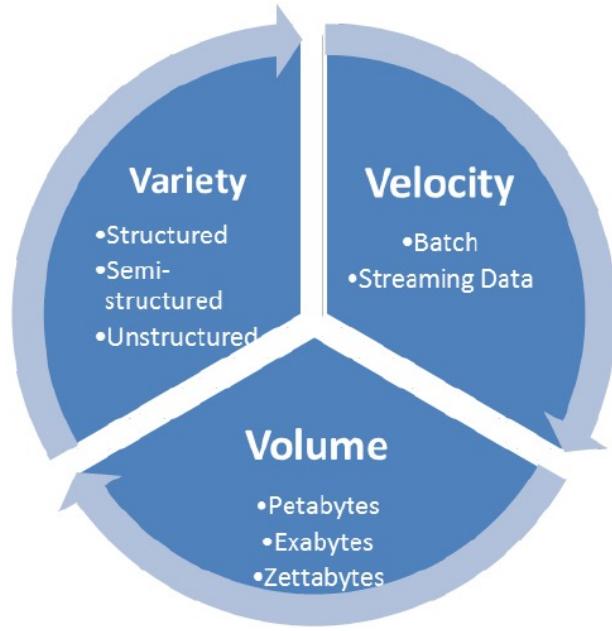
8. Homework

- **What is a key-value store?**

- ✓ What is Big Data?
- ✓ Structured vs Unstructured data
- ✓ Key-Value Store
- ✓ Level DB

What is Big Data

- 3 Vs of Big Data: Volume, Velocity, Variety
 - Extended to 5 or 8 Vs



https://www.researchgate.net/figure/BM-Big-Data-characteristics-3V-Adopted-from-Zikopoulos-and-Eaton-2011_fig1_258247680



<https://shreyanshmathur1998.medium.com/big-data-with-8-vs-and-todays-challenges-9938f00363c5>

What is Bigdata

- Volume and Velocity Perspective
 - Data gathered while driving



What is Bigdata

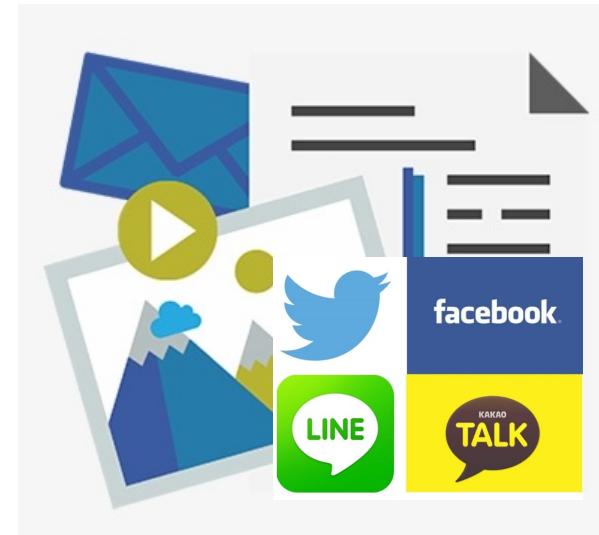
- How about Variety?
 - Conventional data: well-defined format
 - Big data: various and diverse
 - Various fields/frequencies in each record, Diverse format ...

Attributes →

Column ↓

	Roll_No	Name	Age	GPA
1	1	Arya	21	4
2	2	Bran	19	3
3	3	John	24	4.3
4	4	Max	24	1

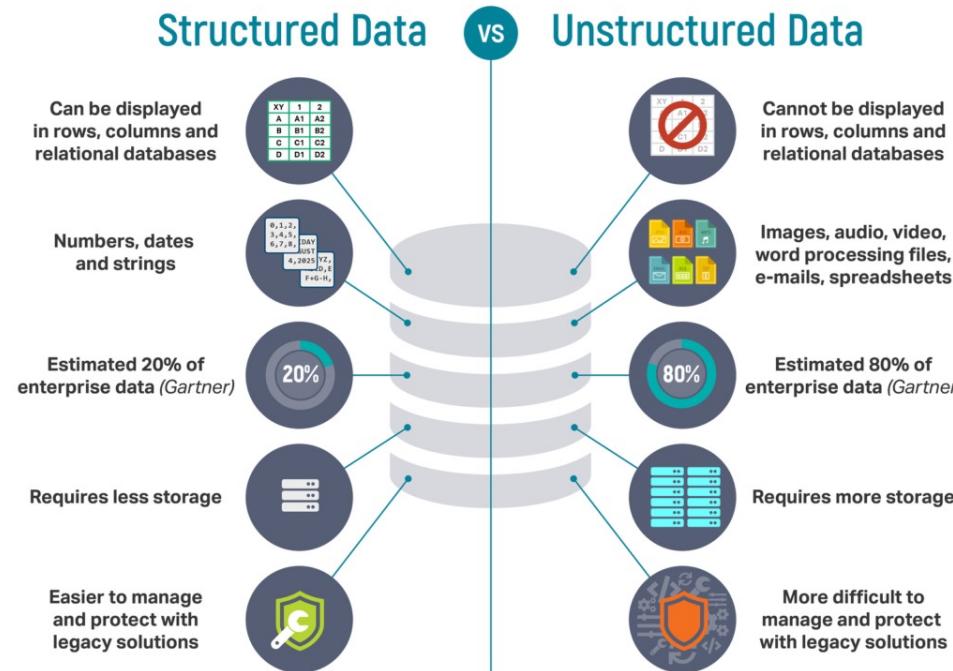
Tuple →



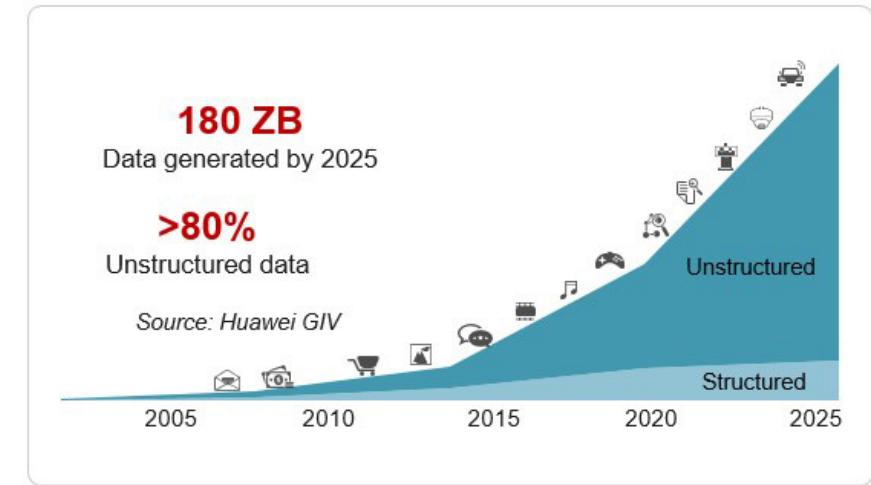
<https://prepinsta.com/dbms/rdbms/>

Structured vs. Unstructured data

- Types of Data



New Connections Drive Explosive Data Growth

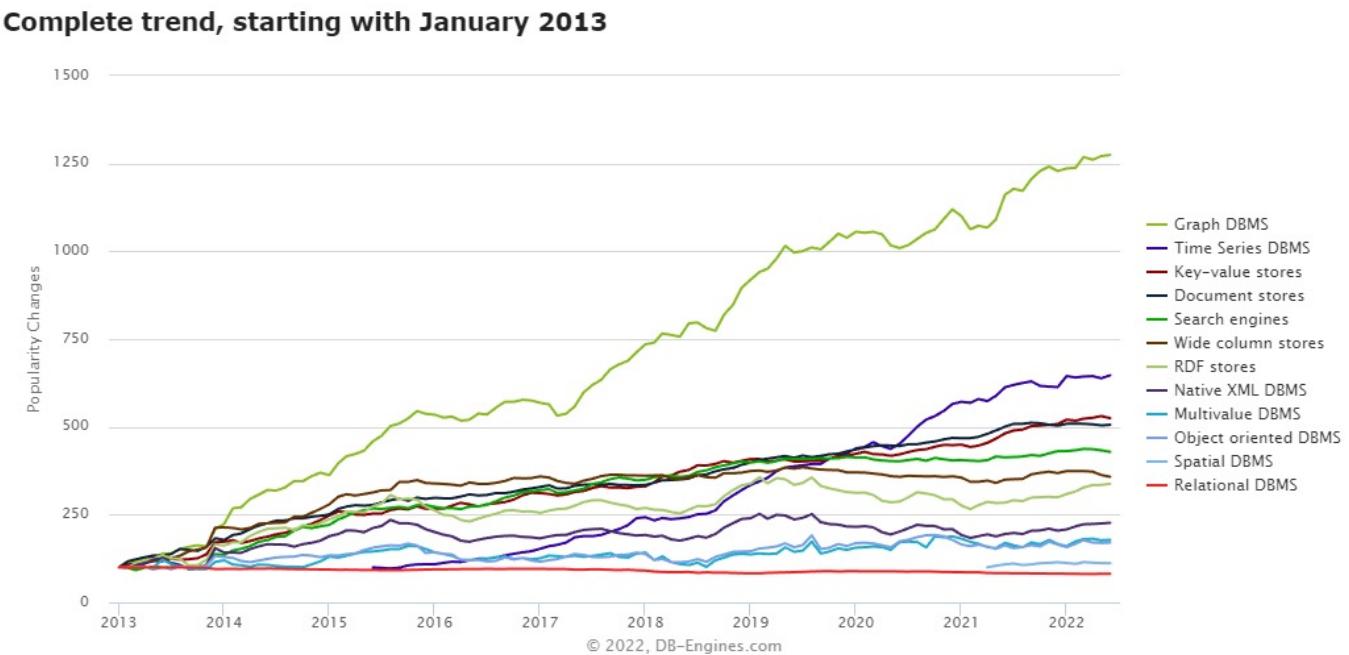


<https://lawtomated.com/structured-data-vs-unstructured-data-what-are-they-and-why-care/>

<https://e.huawei.com/kr/products/storage/topic/2021/all-flash-data-center-green-energy>

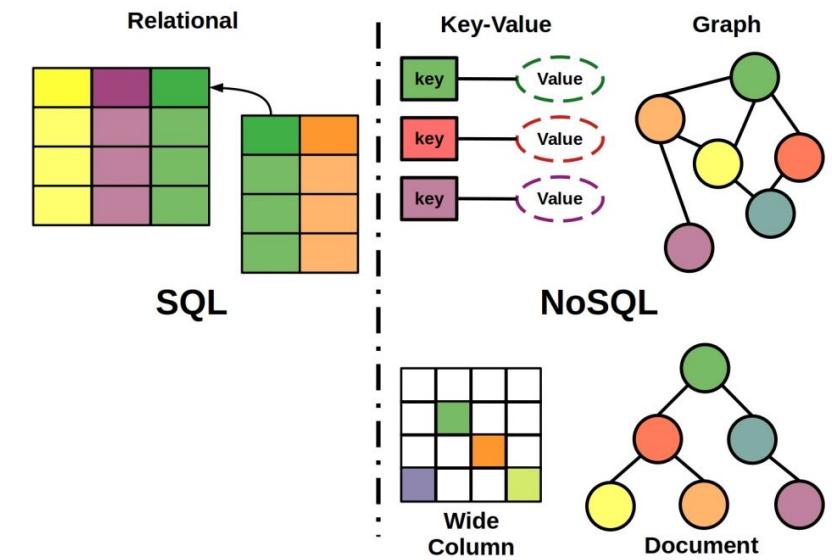
Structured vs. Unstructured data

- Types of Database
 - SQL DB, RDB (Relational DB) for structured data
 - NoSQL(Not-Only SQL) DB, Non RDB for unstructured data



Structured vs. Unstructured data

- Types of NoSQL Database
 - Key-Value DB
 - Manage key and value pair
 - Ex. LevelDB, RocksDB, Redis ...
 - Document DB
 - Extend KV store, KVs are stored in organized format (like XML)
 - Ex. MongoDB, Couchbase
 - Column-family (wide column) DB
 - Column-oriented KV management (sparse)
 - Ex. Bigtable, Hbase, Cassandra
 - Graph DB
 - KV pairs and their relationships
 - Ex. Neo4j, JanusGraph
 - Time Series DB
 - time series through associated pairs of time(s) and value(s)
 - Ex. Influx DB, Apache Druid



<https://starship-knowledge.com/when-to-use-nosql-vs-sql>

Key-Value Store

- Key-Value Stores (a.k.a Key-Value DB)
 - A de-facto standard DB for unstructured data
 - Google, Facebook, Amazon, Microsoft, MongoDB, Yahoo, Hbase, LinkedIn, Oracle, Baidu, Basho, In Memory DB (Memcached), ...



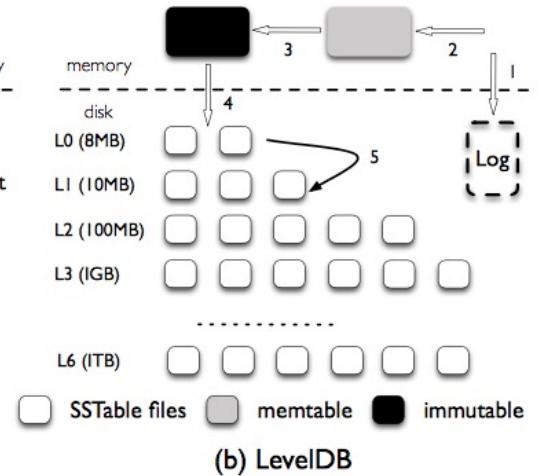
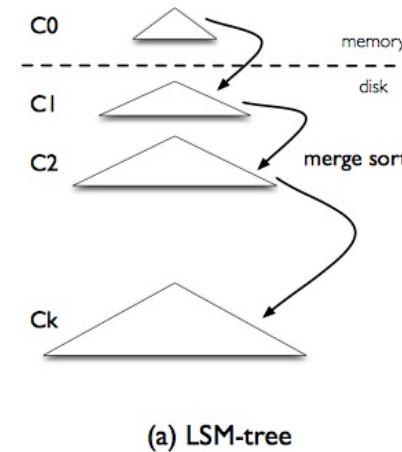
Key-Value Store

- Key-Value Stores: some examples
 - LevelDB
 - By Google, 2011, a subset of Bigtable (Column-oriented DB, OSDI, 2006)
 - Level compaction, Open-source
 - RocksDB
 - By Facebook, 2012, a fork of LevelDB
 - Various algorithms (e.g. Tier compaction), High performance, Diverse applications
 - Hbase
 - By Apache, 2008, motivated by Google's Bigtable
 - A distributed data storage system for the Hadoop ecosystem
 - Cassandra
 - By Apache (Facebook), 2008, motivated by Amazon's Dynamo
 - A decentralized architecture, each node is powered by LST-tree based DB



Key-Value Store

- LevelDB
 - an open source on-disk key-value store
 - written by Google fellows
Jeffrey Dean and Sanjay Ghemawat
 - By Google, 2011, a subset of Bigtable
 - minimal dependencies, suitable for open sourcing
 - a light-weight, single-purpose library
for persistence with bindings to many platforms. – leveldb.org



"WiscKey: Separating keys from values in ssd-conscious storage." TOS '17

Key-Value Store

- Projects using LevelDB

Google Cloud Bigtable



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■ Why Open-Source?

- ✓ Trend of open-source
- ✓ Company
- ✓ Developer
- ✓ How to start open-source
- ✓ Most important language for open-source

Trend of open-source

- 2016
 - Alpha Go vs Lee Sedol
- 2015
 - Many Company have released open-source machine learning framework
 - Google, Facebook, Samsung, IBM, MS ...
- Machine learning framework which is not open-source?
 - No one uses it



<http://m.baduk.or.kr/>

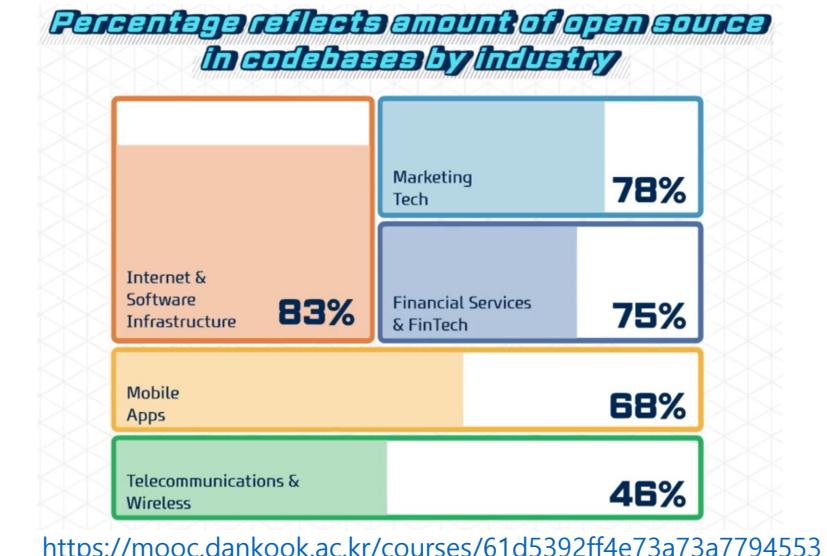
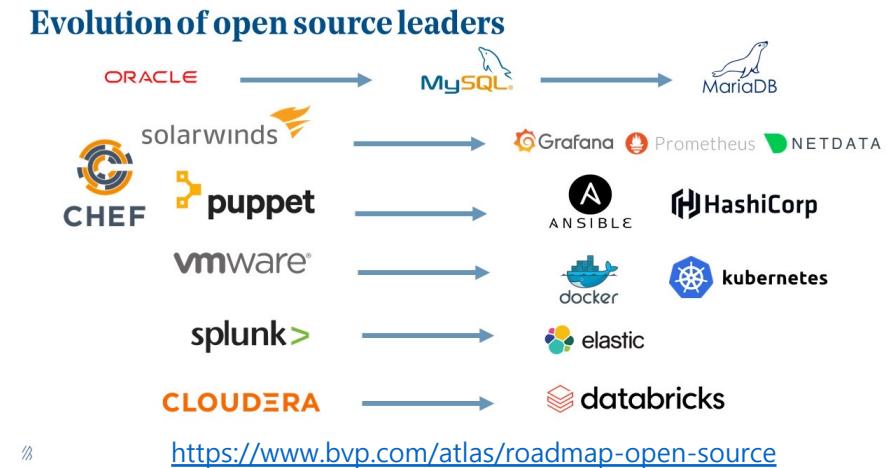


Trend of open-source

- Past
 - Cheaper version of closed source software

- Present
 - Superior alternative offering higher quality
 - Better support, and more flexibility.
 - Started in infra structure, data analytics and AI

- In emerging industries,
 - Companies open-source their projects
 - Companies use and contribute to open-source



Company

- Big Tech
 - Software/cloud platform

- Service Startup
 - Fast development
 - Cloud service

- Manufacturer
 - Linux kernel

RANK	ORGANIZATION	ACTIVE CONTRIBUTORS	TOTAL COMMUNITY	
1	Google	4643 +414	9706 +689	>
2	Microsoft	4394 +486	9515 +903	>
3	Red Hat	3298 +198	4956 +226	>
4	Intel	1837 +172	4027 +339	>
5	IBM	1720 +188	4129 +414	>
6	Amazon	1512 +187	3869 +420	>
7	Facebook	1140 +103	4288 +567	>
8	GitHub	975 +120	2460 +270	>
9	VMware	874 +72	1587 +112	>
10	SAP	739 +76	1519 +148	>
37	Samsung	217 +23	610 +60	>
89	LG Electronics	62 +9	199 +29	>
103	LINE Corporation	53 +9	171 +14	>

Open-Source Contributor Index
[\(https://opensourceindex.io/\)](https://opensourceindex.io/)

Company

- Multiplying the company's investment
- Benefiting from the most recent advancement
- Spreading knowledge of the software
- Increasing the developer base
- Upgrading internal developer skills
- Building reputation
- Recruiting and retaining developer



Ref. Open Source in the enterprise,
Andy Oram & Zaheda Bhorat

Developer

- Fun and happy
- Learn to code
- Gain early experience
- Experiencing critical mass
- There are good eyes on who is contributing what
- Positions of public trust
- Learn to communicate positively
- It's idealistic and the way of the future

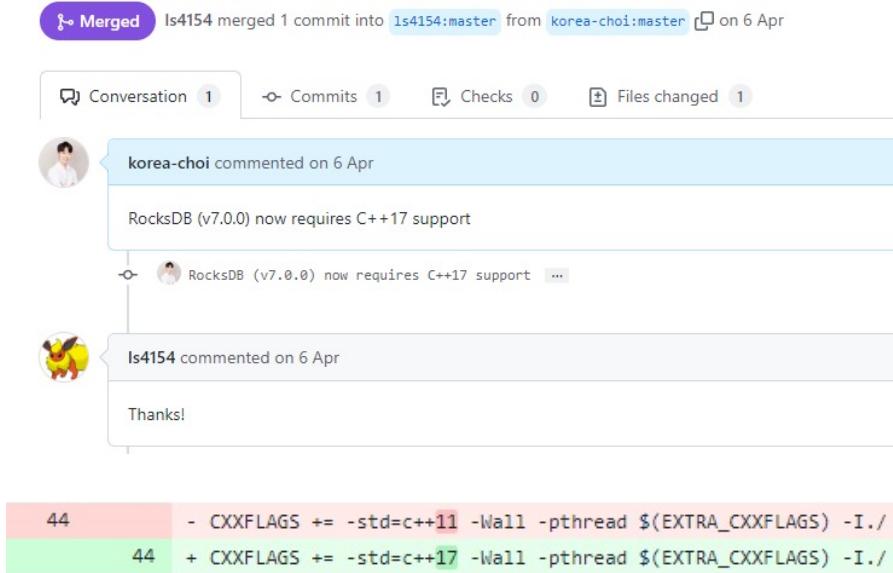


Ref. Open Source in the enterprise,
Andy Oram & Zaheda Bhorat

How to start open-source?

- You don't have to contribute code

RocksDB (v7.0.0) now requires C++17 support #1



Fix typos in remarks or documentation

<https://github.com/ls4154/YCSB-cpp/pull/1>

namhyung / uftrace Public Watch 88 Fork 317 Starred 2.1k

Code Issues 253 Pull requests 36 Discussions Actions Wiki Security Insights

uftrace for LevelDB RocksDB with YCSB Min-guk Choi edited this page 18 days ago · 6 revisions Edit New Page

This document is written by Min-guk Choi.

LevelDB

- Download LevelDB

```
git clone --recurse-submodules https://github.com/google/leveldb.git
```

- Add -pg option on leveldb/CMakeList.txt for uftrace

```
+ # Add -pg option for uftrace
+ set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -pg")
if(CMAKE_CXX_COMPILER_ID STREQUAL "MSVC")
# Disable C++ exceptions.
```

Pages 37

- Home
- Tutorial
 - Arguments
 - Filters
- Development
 - Data Format
 - TODO Items
 - Testing
 - Code Coverage
 - Korean man page
- Practical Use Cases
 - GCC
 - Clang/LLVM
 - Node.js
 - Chromium
 - MySQL/InnoDB

Giving guidance on a specific project and how to use it

<https://github.com/namhyung/uftrace/wiki/uftrace-for-LevelDB-RocksDB-with-YCSB>

How to start open-source?

- You don't have to contribute code

leveldb properties option bug fix #2

Merged ls4154 merged 1 commit into ls4154:master from korea-choi:develop on 20 May

Conversation 1 Commits 1 Checks 0 Files changed 2

korea-choi commented on 19 May

Existing Leveldb properties options had a "Integer underflow" bug on default values.

```
size_t cache_size = std::stol(props.GetProperty(PROP_CACHE_SIZE, PROP_CACHE_SIZE_DEFAULT))
```

When we use default option of cache, r-value is long(-1).
But type size_t doesn't support negative value, therefore "Integer underflow" occurs.

Thanks.

leveldb properties option code fix

ls4154 merged commit 93bfa0a into ls4154:master on 20 May

ls4154 commented on 20 May • edited

Thanks for your PR! :)
I've deleted `leveldb.properties` from the commit since it is unrelated to this patch.

Bug Fix

<https://github.com/ls4154/YCSB-cpp/pull/2>

LevelDB WiKi

LevelDB Analysis

- Overview
- Basic Operations
- Memtable
- WAL
- Compaction
- SSTable
- Bloom Filter
- Cache

LevelDB Analysis

Next
Overview

Last modified 3d ago

Write Document

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- **Job market**

- ✓ KCC X KAKAO
- ✓ Samsung DS
- ✓ SK Hynix
- ✓ Naver
- ✓ LINE

KCC 2022 X KAKAO

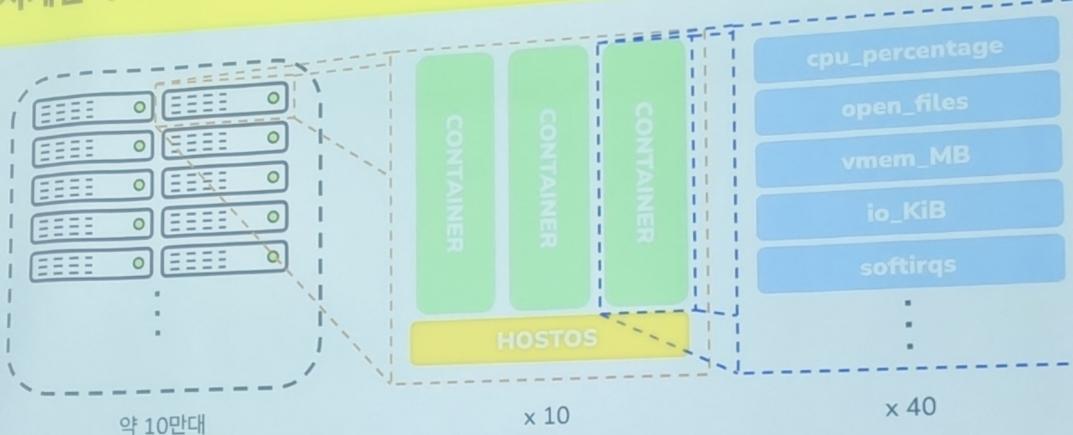
15:00 ~ 15:30	SPDK를 사용한 클라우드 볼륨 스토리지 가속화	손성국
15:30 ~ 16:00	클라우드 지표 저장을 위한 대용량 TSDB 만들기	김연우
16:00 ~ 16:30	카카오 대용량 로그 파이프라인을 위한 시스템	윤상민



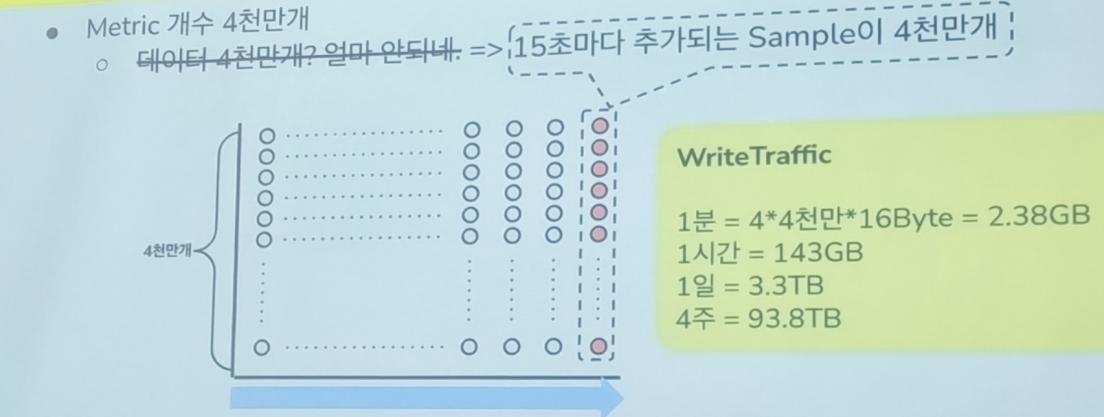
https://www.kiise.or.kr/conference/main/getContent.do?CC=KCC&CS=2022&PARENT_ID=011600&content_no=1595

KCC 2022 X KAKAO

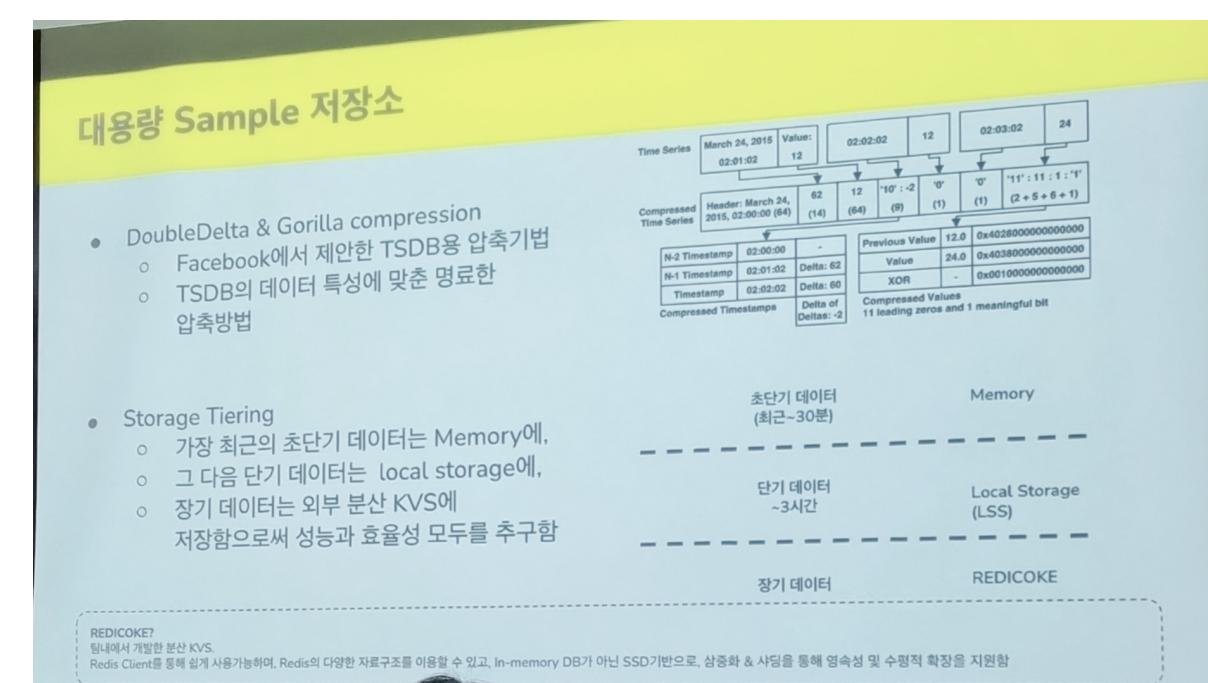
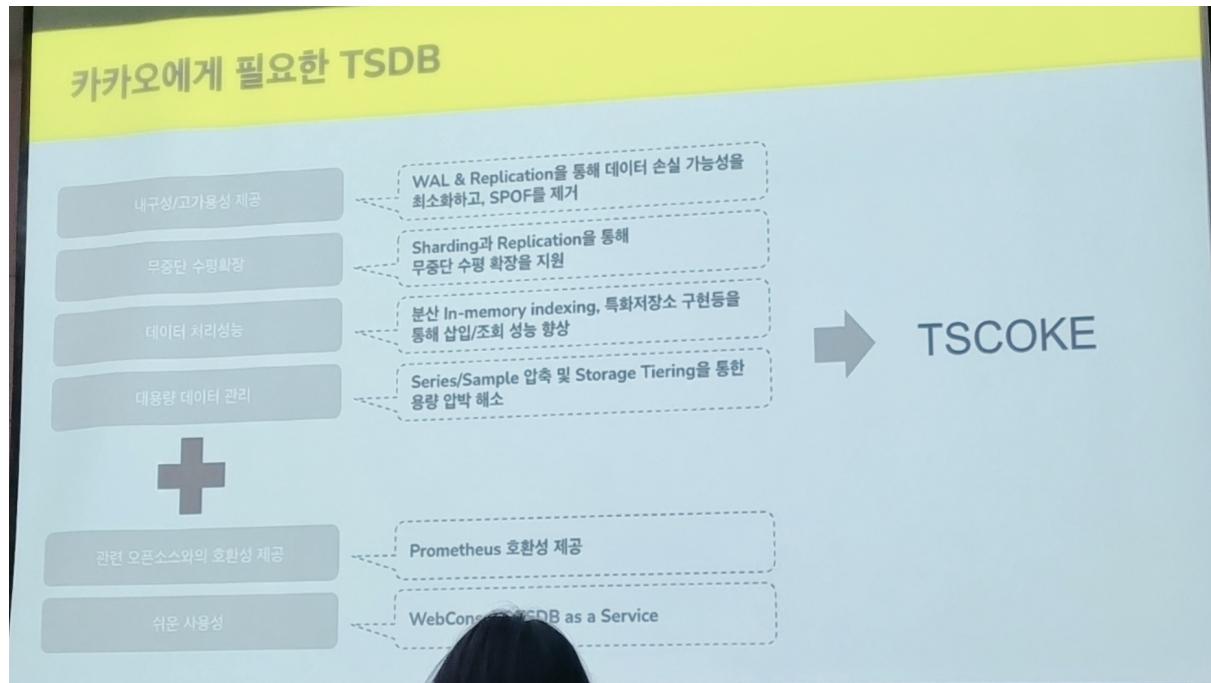
시계열의 규모



시계열의 규모



KCC 2022 X KAKAO



KCC 2022 X KAKAO

분산 In-memory Series 인덱스

Dictionary Coding
Series Name의 중복된 Symbol들을 Dictionary Coding
-> 공간 절약 및 성능 향상

ART(Adaptive Radix Tree)도입
ART(Adaptive Radix Tree)도입
-> Dictionary Coding을 통해, Unbalance Tree인 Radix Tree의 단점이 최소화됨

Dictionary Coding

```

mem{method=free,instance=10.0.20.3}
mem{method=pgfault,instance=10.0.20.3}
disk{method=free,instance=10.0.20.3}
mem{method=pgfault,instance=10.0.20.4}
mem{method=pgfault,instance=10.0.20.4}
disk{method=free,instance=10.0.20.4}
disk{method=used,instance=10.0.20.4}
    
```

ART(Adaptive Radix Tree)도입

```

graph TD
    A(( )) --> N(( ))
    A --> R(( ))
    N --> D[AND]
    N --> T1[ANT]
    N --> Y[ANY]
    R --> E[ARE]
    R --> T2[ART]
    D --- digit1[digit 1]
    T1 --- digit2[digit 2]
    Y --- digit3[digit 3]
    E --- leafnodes[leaf nodes]
    T2 --- leafnodes
    
```

Fig. 1. Adaptively sized nodes in our radix tree.

대용량 Sample 저장소

- LSS(Log-structured Segment Storage)
 - SSD에 최적화된 Append only storage
 - 비슷한 생존시간을 가진 Segment들을 Block에 묶어 저장하고 이를 Rollout시킴으로써, 안정적이고 빠른 성능을 제공함

Segment - Sample을 압축해 저장하는 고정크기[512Byte] ByteArray

Samsung DS

■ Jobs

- Software architecture
- System software
- System development

■ '22 Open Recruitment

- https://www.samsung-dsrecruit.com/tnc_2022_6_jd

Storage System SW

담당 업무	필요 역량	우대 역량
<ul style="list-style-type: none"> ■ <u>PCIe, NVMe 등 Storage Protocol Spec 연구/개발</u> ■ Data Center 표준 Spec 연구/개발 ■ <u>Storage 시스템, 분산시스템, 네트워크, 클라우드, 서버 연구/개발</u> ■ <u>SSD 성능 분석 (host-to-device) 연구/개발</u> ■ Data-Intensive 기술 ■ <u>Linux Kernel / Device Driver 연구/개발</u> ■ <u>Server / Client Application 연구/개발</u> 	<ul style="list-style-type: none"> ■ 전공 관련 <ul style="list-style-type: none"> - 컴퓨터공학 전공, 스토리지 시스템/분산 시스템 분야 Lab - OS/컴퓨터구조/알고리즘 교과목 이수 ■ Knowledge 관련 <ul style="list-style-type: none"> - <u>스토리지 시스템/분산 시스템 개발</u> 경력 보유 - 클라우드 서비스 개발 경력 보유 ■ Skill 관련 <ul style="list-style-type: none"> - C/C++/Rust 프로그래밍 활용 - 영어회화 중급자 - Linux 개발 환경 	<ul style="list-style-type: none"> ■ Knowledge 관련 <ul style="list-style-type: none"> - <u>오픈소스 Contribution 경험자</u>

SK Hynix

- Jobs
 - System software
 - Solution software
 - Application Engineering

- Job Introduction
 - https://recruit.skhynix.com/servlet/reab_jobIntroduce1.view



System-level Architecture Analysis

주요수행업무

- 주요 수행 업무
 - 데이터센터/클라우드 컴퓨팅 환경 상에서의 벤치마크 기반 메모리 성능 분석
 - 차세대 응용 기반 워크로드/벤치마크 발굴 및 특성 분석
 - 차세대 메모리 솔루션 아키텍처 개발
 - 아키텍처 분석/검증을 위한 차세대 메모리 모델링 및 성능 분석

- 요구 역량
 - 오픈 소스 기반의 데이터센터 SW 프레임워크 구축 및 평가 경험 (e.g. In-memory DB, Storage DB, Multi-tenancy, Spark, Hadoop, KVM 관련)
 - 컴퓨터 구조, 운영체제, 메모리 시스템에 대한 깊이 있는 이해
 - 시뮬레이터 기반 성능/파워 분석 경험
 - 프로그래밍/스크립팅 경험

https://recruit.skhynix.com/servlet/reap_rcrtSearchForm.view



■ Jobs

- Database Engineer
- Cloud Platform Engineer
- Object Storage Engineer

[NAVER Cloud] Object Storage 서비스 개발 D-71

[역할]

- 네이버 클라우드 플랫폼 Object Storage 서비스 개발 및 운영

[필요역량]

- 관련 경력 3년 이상
- 분산환경에서 개발 & 디버깅
- 분산시스템 성능 테스트
- 운영체제 및 Network에 대한 이해
- Java, C/C++ 등 중급 이상
- Test Code 작성, Test 자동화
- 클라우드 서비스에 대한 기본적인 이해 및 활용 경험
- RDBMS, NoSQL 등 데이터베이스 활용 경험 및 성능 튜닝 경험
- 웹 서비스의 일반적인 아키텍처에 대한 이해 및 RESTful API 설계 역량

[지원자격/우대사항]

- 리눅스 커널, 파일시스템 관련 개발 경험이 있으신 분
- 스토리지 관련 오픈 소스 운영 및 비교 경험 / 연구 경험 보유하신 분
- Distributed Lock, Consistency, Replication 등 분산 시스템이나 파일시스템 관련 실무 또는 연구 경험 보유하신 분
- 대규모 요청에 대한 아키텍처 설계 및 성능 튜닝 경험을 보유하신 분
- 리눅스 환경에서 개발 및 운영 경험을 보유하신 분
- Zookeeper, Redis, Kafka 등 분산 플랫폼 사용 경험을 보유하신 분

<https://career.navercorp.com/naver/job/detail/1000122/?annold=20005410&classId=&jobId=>



■ Jobs

- Database Engineer
- Cloud Platform Engineer
- DevOps Software Engineer

■ '21 Open Recruitment

- <https://www.careers-2021-liner.com>

■ '22 Open Recruitment

- <https://careers.linecorp.com/ko/jobs/1165>

DevOps Software Engineering

LINE의 다양한 서비스들의 문제점들을 인지하고 해결하는 과정에서 안정적인 운영 기반이 되는 Observability Platform 개발을 담당하고 있습니다. 필연적으로 대용량 데이터를 처리해야 하는 모니터링 기능 개발을 위한 다양한 도전과 경험을 할 수 있습니다.



[신입 LINER가 되시면 이런 업무를 담당할 수 있습니다]

- Metric, Log, Tracing 등의 대용량 데이터 전달을 위한 클라이언트 라이브러리 개발
- 대용량 데이터 수집을 위한 API 서버/파이프라인 개발
- 사내 인프라/서비스에 특화된 모니터링 시스템 개발
- 자체 개발되는 대규모 수준의 Time Series DB 개발

[신입 LINER에게 바랍니다]

- 컴퓨터 과학의 기초 지식(자료 구조/알고리즘/데이터베이스/네트워크/운영 체제 등)을 이해하고 있는 분이면 좋습니다.
- Java, Go 등의 프로그래밍 언어를 활용한 서버 개발 경험이나 관심이 많은 분이면 좋습니다.
- 대용량의 데이터를 다루는 것을 즐길 줄 아는 분이면 좋습니다.
- 발생한 이슈들에 대해 분석하고 해결하는 것에 관심이 있는 분이면 좋습니다.

[필수는 아니지만 아래의 경험이 있으시면 좋습니다]

- 대용량 Storage 오픈소스/기술에 관심이 있는 분이면 좋습니다.
- 성능 개선을 위한 어플리케이션/시스템 튜닝 경험이나 관심이 많은 분이면 좋습니다.

<https://www.careers-2021-liner.com>

1. Study Introduction

2. Why should we understand internal structure?

3. What is a key-value store?

4. Why open-source?

5. Job market

6. Lab research subject

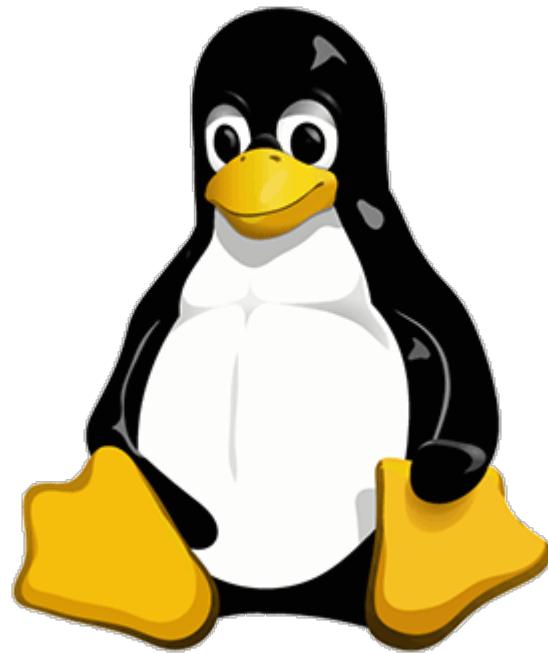
7. Environment setup

8. Homework

- **Lab research subject**

- ✓ Summary
- ✓ StarLab
- ✓ NRF
- ✓ SK Hynix

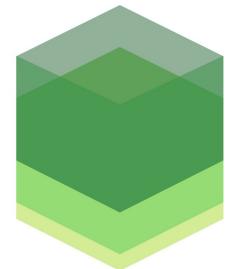
Lab research subject



Linux Kernel



redis



LEVELDB



RocksDB

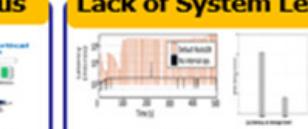
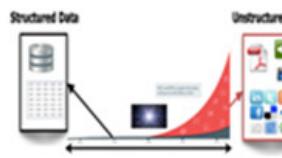
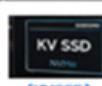
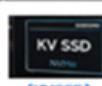
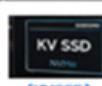


Next Generation SSD

<https://www.aspsys.com/solutions/storage-solutions/flash-storage-nvme/>

StarLab



Objective	 키-밸류 DB와 차세대 SSD, 오픈 소스에 정통한 빅데이터 전문가 양성 									
Approach	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Key-Value DB Optimization <ul style="list-style-type: none"> • User-level Direct Access • Hot-cold separation • New compaction algorithm </div> <div style="text-align: center;"> HW-SW Codesign <ul style="list-style-type: none"> • Predictable I/O on ZNS • Host-SW for KVSSD • SW-enabled WAF reduction </div> <div style="text-align: center;"> Integrating New Domain <ul style="list-style-type: none"> • Learned index (ML) • BlueStore (Ceph) • HW-assisted Transaction </div> </div>									
Necessity	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Software Semantic Gap  <ul style="list-style-type: none"> • Compaction/Lookup issue • Duplication/Unawareness </div> <div style="text-align: center;"> HW features Oblivious  <ul style="list-style-type: none"> • Storage-aware DB mgmt. • Make use of ISP </div> <div style="text-align: center;"> Lack of System Level View  <ul style="list-style-type: none"> • Unpredictable latency spike • Storage level vs. Client level </div> </div>									
Background	Growth of unstructured data  Diverse Key-Value DB  Next Generation SSDs <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>Zone IF</th> <th>KV IF</th> <th>FTL (Flash Translation Layer)</th> </tr> </thead> <tbody> <tr> <td>NAND (channel, way, ...)</td> <td>NAND (channel, way, ...)</td> <td>PCM (NVM)</td> </tr> <tr> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Zone IF	KV IF	FTL (Flash Translation Layer)	NAND (channel, way, ...)	NAND (channel, way, ...)	PCM (NVM)			
Zone IF	KV IF	FTL (Flash Translation Layer)								
NAND (channel, way, ...)	NAND (channel, way, ...)	PCM (NVM)								
										

http://www.swstarlab.kr/page/page02_02.php?c=lab37

NRF 중견연구

과제명(국문)

응답 시간 예측성을 보장하는 새로운 키-밸류 스토어 개발

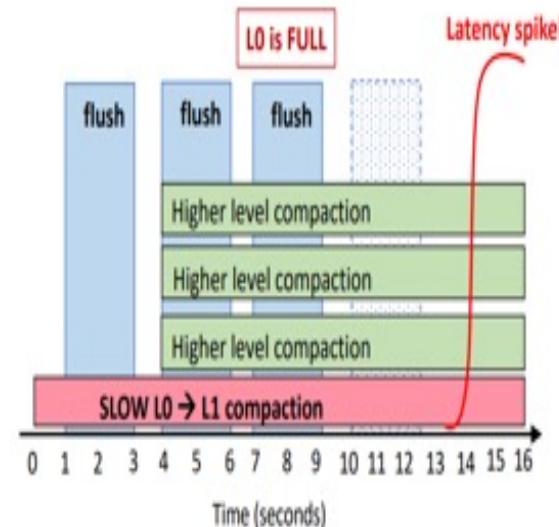
과제명(영문)

Development of a Novel Key-Value Store that Supports Predictable Latency

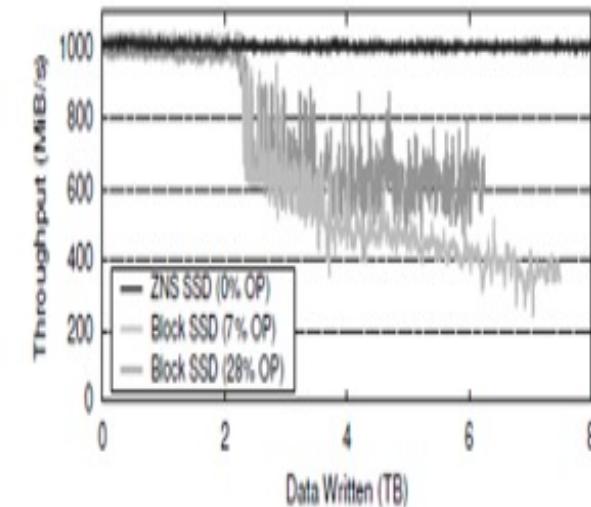
Tail Latency



(a) Latency spike (from LISA talk)



(b) Latency spike (from Silk paper)



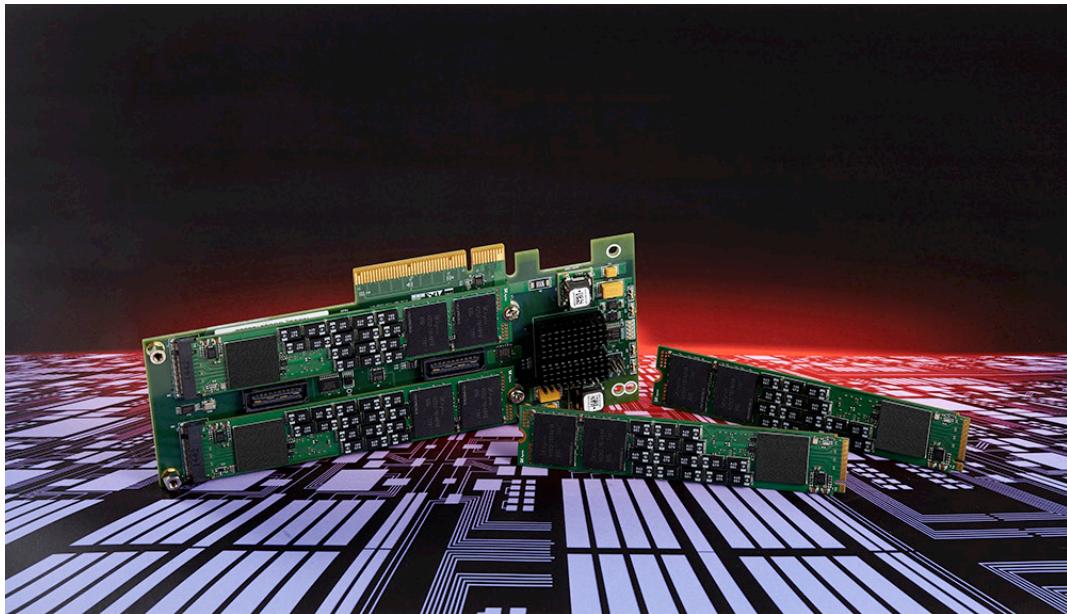
(c) SSD GC effect (from ZNS paper)

SK Hynix



SK hynix Demonstrates Industry's First ZNS-based SSD Solution for Data Centers

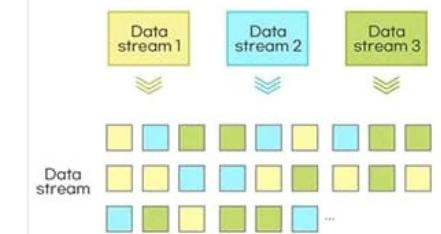
March 25, 2019



<https://news.skhynix.com/sk-hynix-demonstrates-industrys-first-zns-based-ssd-solution-for-data-centers-2/>

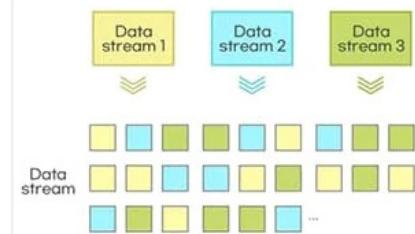
일반 SSD와 ZNS SSD의 데이터 저장 방식 비교

I 일반 SSD

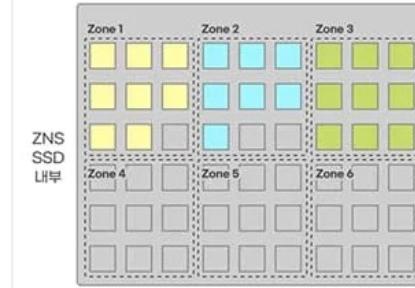
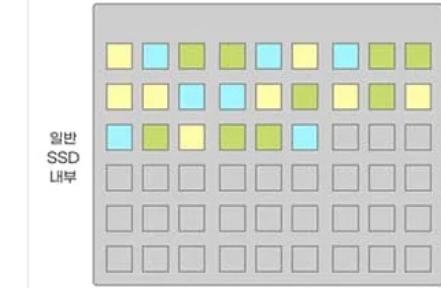


일반
SSD
내부

I ZNS SSD



ZNS
SSD
내부



<https://semiconductor.samsung.com/kr/newsroom/news/samsung-introduces-its-first-zns-ssd-with-maximized-user-capacity-and-enhanced-lifespan/>

1. Study Introduction

2. Why should we understand internal structure?

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6. Lab research subject

7. *Environment setup*

8. Homework

■ Environment setup

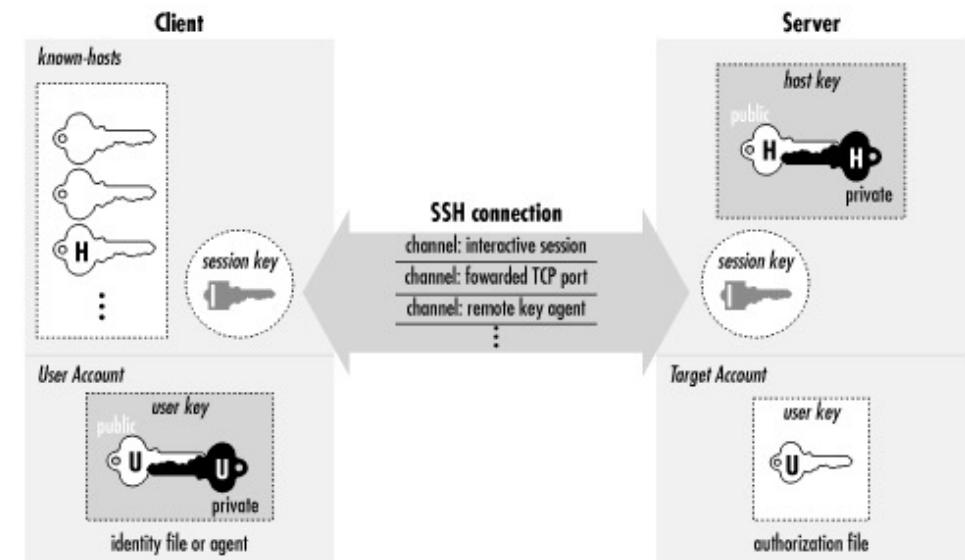
- ✓ SSH
- ✓ Linux
 - SSH Server
- ✓ VS code
 - SSH Client App

SSH

- SSH (Secure Shell)
 - Network protocol
 - Client-Server architecture

- Why?
 - Linux env. for LevelDB
 - It's inconvenient to use Linux alone

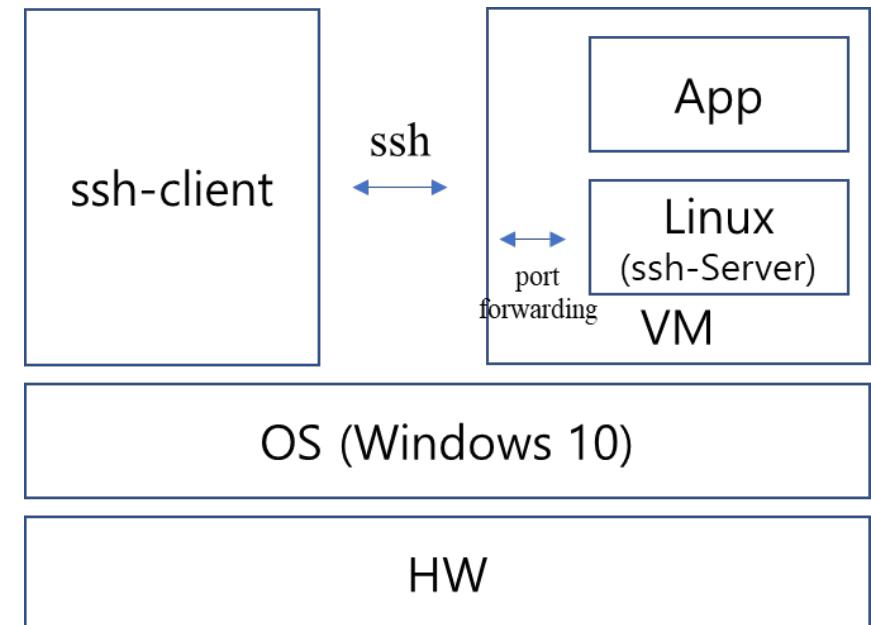
- Linux Server <-> Windows Client



https://docstore.mik.ua/orelly/networking_2ndEd/ssh/ch03_03.htm

Linux

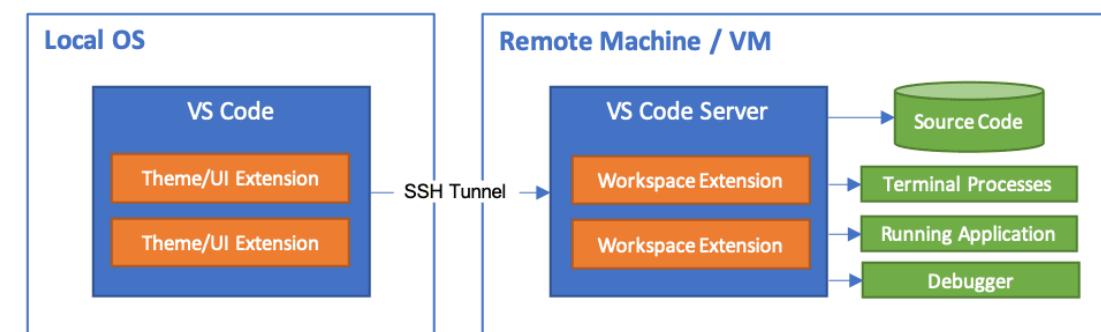
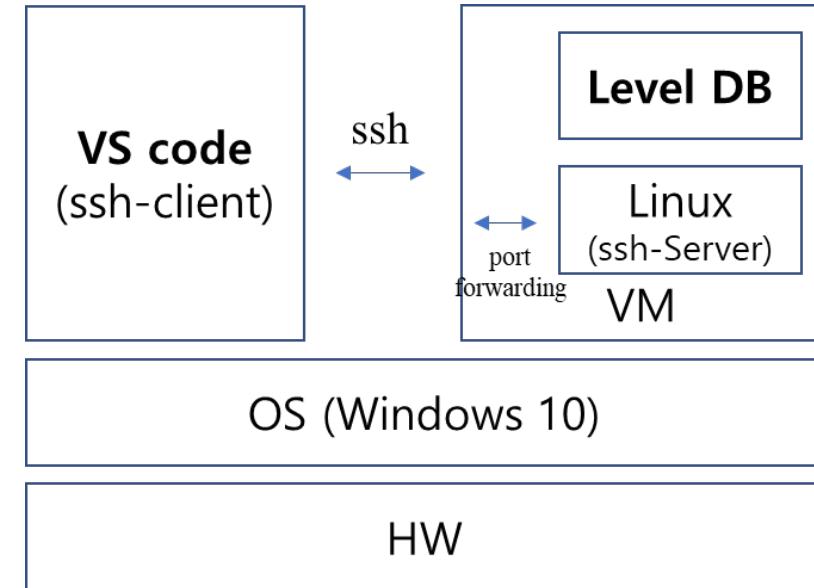
- Ubuntu
 - 20.04 <https://releases.ubuntu.com/20.04/>
- Machine
 - Remote Machine
 - VM (Virtual Box) : <https://www.virtualbox.org/wiki/Downloads>
 - WSL (not recommended)
- SSH Server setup
 - <https://ubuntu.com/server/docs/service-openssh>
- Virtual Box port forwarding
 - <https://medium.com/platform-engineer/port-forwarding-for-ssh-http-on-virtualbox-459277a888be>



VS code

- SSH Client App (+ IDE)
 - Putty + Vim
 - Xshell + Vim
 - VS code (+ Remote Development Extension)

- VS code
 - Download (<https://code.visualstudio.com/>)
 - Remote Development Extension-SSH
 - <https://code.visualstudio.com/docs/remote/ssh>



<https://code.visualstudio.com/docs/remote/ssh>

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8. Homework

■ Homework

- ✓ Jongmoo Choi, 『Key-Value DB for Unstructured data』, 2021
 - <https://mooc.dankook.ac.kr/courses/61d537a3b6b71841651153b3>
- ✓ Environment setup

■ Photo time

Thank you