

Install LevelDB

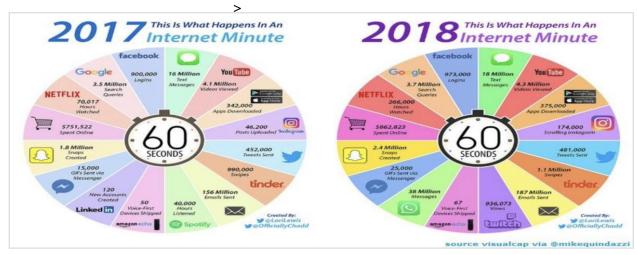
오명훈 snt2426@gmail.com

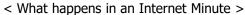


- **Data Growth**
 - Unstructured Data는 미리 정의된 데이터 모델이 없거나, 정의된 방식으로 정리되지 않음



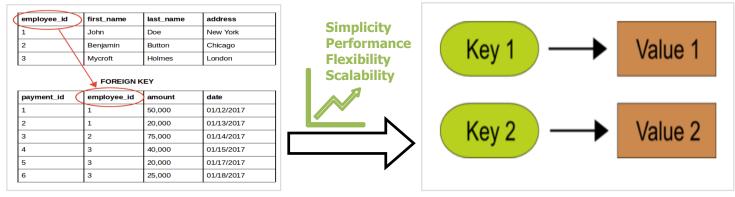
< Unstructured Data의 증가







- Key-Value Stores are Common
 - Unstructured Data의 증가로 RDBMS 모델(SQL DB)의 대안으로 Key-Value Store 모델(NoSQL DB)을 활용



< RDBMS: Employees and Payments Tables >

< Key-Value Store >

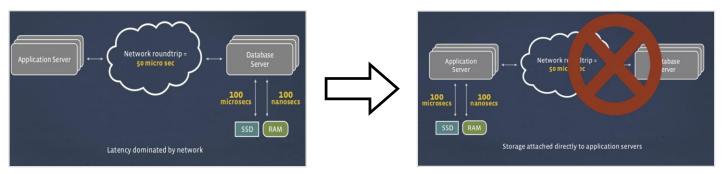
□ 현재 다양한 기업에서 용도에 따라 Key-Value Store를 활용



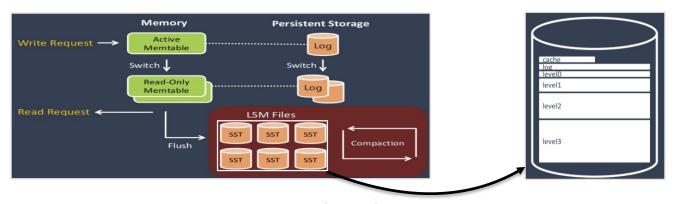


- LevelDB, RocksDB

 - Most popular embedded NoSQL database



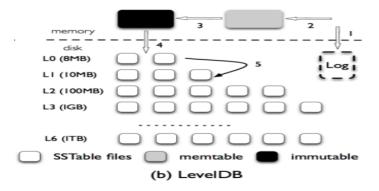
- < Embedded database >
- Persistent Key-Value Store
- Optimized for storage (Disk, SSD)



< Database Architecture >



- DB Implementation
 - Log Structured Merge tree architecture



- Log structured
 - Only append, Only Sequential write
- Overlapped Data



< Sorted String Table file>

Time: t ₁ New sstable in Level 0	Level 0 Level 1	10 210 1 100 200 400
Time: t ₂ After compacting Level 0 into Level 1	Level 0 Level 1	1 10 100 200 210 400
Time: t ₃	Level 0	20 220
New sstable in Level 0	Level 1	1 10 100 200 210 400
Time: t4 After compacting Level 0 into Level 1	Level 0 Level 1	1 10 20 100 200 210 220 400
Time: t ₅ New sstable in Level 0	Level 0	30 330
	Level 1	1 10 20 100 200 210 220 400
Time: t ₆ After compacting Level 0 into Level 1	Level 0 Level 1	1 10 20 30 100 200 210 220 330 400



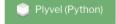
- LevelDB
 - → http://leveldb.org



A light-weight, single-purpose library for persistence with bindings to many platforms.







□ LevelDB build

```
embedded@embedded11:~\$ git clone https://github.com/google/leveldb.git
'leveldb'에 복제합니다...
remote: Enumerating objects: 7, done.
remote: Counting objects: 100% (7/7), done.
remote: Compressing objects: 100% (6/6), done.
remote: Total 2099 (delta 1), reused 3 (delta 1), pack-reused 2092
오브젝트를 받는 중: 100% (2099/2099), 1.16 MiB | 1.90 MiB/s, 완료.
델타를 알아내는 중: 100% (1415/1415), 완료.
연결을 확인하는 중입니다... 완료.
embedded@embedded11:~\ county count
```

LevelDB

embedded@embedded11:~/leveldb/build\$ ls CMakeCache.txt bloom_test cmake_install.cmake crc32c_test dbformat_test fault_injection_test hash_test issue200 test libleveldb.a memeny test skiplist test version edit test **CMakeFiles** env posix test filename test arena_test c_test codina test db_bench include leveldbConfigVersion.cmake log test no destructor test status test version set test CTestTestfile.cmake autocompact test cache test corruption test env test filter block test issue178 test leveldbutil logging test recovery test table test

LevelDB install

```
bedded@embedded11:~/leveldb/build$ ./db bench
LevelDB:
            version 1.20
Date:
            Tue Jan 8 23:08:07 2019
            64 * Intel(R) Xeon(R) CPU E7-4809 v4 @ 2.10GHz
CPUCache:
Keys:
            16 bytes each
Values:
            100 bytes each (50 bytes after compression)
Entries:
RawSize:
            110.6 MB (estimated)
FileSize: 62.9 MB (estimated)
WARNING: Snappy compression is not enabled
                     2.727 micros/op;
                                       40.6 MB/s
fillsync
                 8352.154 micros/op;
                                        0.0 MB/s (1000 ops)
fillrandom
                    3.988 micros/op;
                                       27.7 MB/s
overwrite
                    4.875 micros/op;
                                       22.7 MB/s
readrandom
                    4.537 micros/op; (1000000 of 1000000 found)
readrandom
                    3.946 micros/op; (1000000 of 1000000 found)
                    0.282 micros/op; 391.8 MB/s
readreverse :
                     0.575 micros/op; 192.4 MB/s
compact
               588581.000 micros/op;
                     3.016 micros/op; (1000000 of 1000000 found)
readrandom
readseq
                    0.306 micros/op; 361.1 MB/s
                    0.502 micros/op; 220.5 MB/s
readreverse :
fill100K
                  950.573 micros/op; 100.3 MB/s (1000 ops)
                     2.090 micros/op; 1869.4 MB/s (4K per op)
snappycomp :
                 9166.000 micros/op; (snappy failure)
snappyuncomp:
                 8542.000 micros/op; (snappy failure)
acquireload :
                    0.665 micros/op; (each op is 1000 loads)
```

```
embedded@embedded11:~/leveldb/build$ sudo make install
[sudo] password for embedded:
 24%] Built target leveldb
 27%] Built target db_bench
 30%] Built target env_posix_test
 32%] Built target logging_test
 34%] Built target hash test
 36%] Built target coding test
 39%] Built target bloom_test
 41%] Built target arena test
 43%] Built target autocompact_test
 45%] Built target issue200_test
 48%] Built target db test
 50%] Built target no destructor test
 53%] Built target status_test
 55%] Built target env test
 57%] Built target c_test
 60%] Built target issue178_test
 61%] Built target leveldbutil
 64%] Built target write batch test
```

LevelDB install2

embedded@embedded11:~/leveldb/build\$ ls /usr/local/include/leveldb/
c.h cache.h comparator.h db.h dumpfile.h env.h export.h filter_policy.h iterator.h memenv.h options.h slice.h status.h table.h table_builder.h write_batch.h



LevelDB Library

→ DB Open

```
#include <cassert>
#include "leveldb/db.h"

leveldb::DB* db;
leveldb::Options options;
options.create_if_missing = true;
leveldb::Status status = leveldb::DB::Open(options, "/tmp/testdb", &db);
assert(status.ok());
...

#include "leveldb/cache.h"

leveldb::Options options;
options.block_cache = leveldb::NewLRUCache(100 * 1048576); // 100MB cache
leveldb::DB* db;
leveldb::DB::Open(options, name, &db);
... use the db ...
delete db
delete options.block_cache;
```

□ Data Put

```
// Add 256 values to the database
leveldb::WriteOptions writeOptions;
for (unsigned int i = 0; i < 256; ++i)
{
    ostringstream keyStream;
    keyStream << "Key" << i;
    ostringstream valueStream;
    valueStream << "Test data value: " << i;

    db->Put(writeOptions, keyStream.str(), valueStream.str());
}
```



YCSB (Yahoo! Cloud Serving Benchmark)

https://drive.google.com/drive/folders/1_SovTvkTkofWqpz7jC05Rrr3wHRNIAEX?usp=sharing

```
8 embedded embedded
                                4096
                                      1월
                                           9 09:09 ./
drwxrwxr-x
drwxr-xr-x 31 embedded embedded
                                4096
                                      1월
                                           9 04:04
drwxrwxr-x 10 embedded embedded
                                4096
                                      1월
                                           9 08:31 boost_1_66_0/
drwxrwxr-x 13 embedded embedded
                                4096
                                     1월
                                           8 22:43 leveldb/
                                     1월
                                          9 00:58 libevent/
drwxrwxr-x 13 embedded embedded 12288
                                     1월
                                          9 05:55 mapkeeper/
drwxrwxr-x 15 embedded embedded
                                4096
drwxrwxr-x 14 embedded embedded
                                     1월
                                          9 06:17 thrift/
                                4096
                                           9 04:05 ycsb-0.1.4/
drwxrwxr-x 15 embedded embedded
                                4096
                                      1월
embedded@embedded11:~/ycsb-levedb$
```

YCSB (Yahoo! Cloud Serving Benchmark)

```
8 embedded embedded
                                4096
                                     1월
                                          9 09:09 ./
drwxr-xr-x 31 embedded embedded
                                4096 1월
                                          9 04:04
drwxrwxr-x 10 embedded embedded
                                4096
                                          9 08:31 boost_1_66_0/
drwxrwxr-x 13 embedded embedded
                                4096 1월
                                          8 22:43 leveldb/
drwxrwxr-x 13 embedded embedded 12288 1월
                                          9 00:58 libevent/
drwxrwxr-x 15 embedded embedded
                                4096 1월 9 05:55 mapkeeper/
drwxrwxr-x 14 embedded embedded
                                4096 1월 9 06:17 thrift/
drwxrwxr-x 15 embedded embedded
                                4096
                                    1월
                                          9 04:05 ycsb-0.1.4/
embedded@embedded11:~/ycsb-levedb$ _
```

- ¬ cd libevent
- mkdir build && cd build && cmake ...
- □ cd boost_1_66_0
- ./bootstrap.sh —prefix=/usr/local && sudo ./b2 install
- □ cd thrift
- ./configure --prefix=/usr/local --with-cpp --with-boost-libdir=/usr/local/lib
- Make && sudo make install



YCSB (Yahoo! Cloud Serving Benchmark)

```
drwxrwxr-x 15 embedded embedded 4096
                                          9 05:55 ./
drwxrwxr-x 8 embedded embedded 4096
                                         9 09:09 ../
drwxrwxr-x 8 embedded embedded 4096
                                         9 05:55 .git/
                                         9 05:55 Makefile.config
-rw-rw-r-- 1 embedded embedded 372
                                         9 05:55 README
drwxrwxr-x 3 embedded embedded 4096
                                         9 05:55 bdb/
drwxrwxr-x 3 embedded embedded 4096
                                         9 05:55 bdbi/
drwxrwxr-x 2 embedded embedded 4096
                                         9 05:55 client/
drwxrwxr-x 2 embedded embedded 4096
                                         9 05:55 handlersocket/
drwxrwxr-x 3 embedded embedded 4096
                                     1월
                                         9 09:07 leveldb/
                                         9 05:55 lib/
drwxrwxr-x 2 embedded embedded 4096
                                         9 05:55 mysql/
drwxrwxr-x 2 embedded embedded 4096
                                    1월
                                         9 05:55 stlmap/
drwxrwxr-x 2 embedded embedded 4096
                                         9 05:55 stubcpp/
                                         9 05:55 stubjava/
drwxrwxr-x 2 embedded embedded 4096
drwxrwxr-x 4 embedded embedded 4096
                                    1월
                                         9 06:26 thrift/
drwxrwxr-x 4 embedded embedded 4096 1월
                                        9 05:55 ycsb/
embedded@embedded11:~/ycsb-levedb/mapkeeper$
```

- cd mapkeeper
- □ cd thrift && make
- ☐ cd .. && cd leveldb

```
LevelDbServer.cpp
Makefile
README
data/
mapkeeper_leveldb*
embedded@embedded11:~/ycsb-levedb/mapkeeper/leveldb$
```

mbedded@embedded11:~/ycsb-levedb/mapkeeper/leveldb\$./mapkeeper_leveldb

¬ ./mapkeeper_leveldb 0 0 0

Usage: ./mapkeeper_leveldb <sync:0 or 1> <blindinsert:0 or 1> <blindupdate:0 or 1>



YCSB (Yahoo! Cloud Serving Benchmark)

```
embedded@embedded11:~/ycsb-levedb$ ls -1
boost_1_66_0
leveldb
libevent
mapkeeper
thrift
ycsb-0.1.4
```

- ./bin/ycsb load mapkeeper -s -P workloads/workloada
- ☐ ./bin/ycsb run mapkeeper -s -P workloads/workloada

```
[INSERT], 974, 0
[INSERT], 975, 0
[INSERT], 976, 0
[INSERT], 977, 0
[INSERT], 978, 0
[INSERT], 979, 0
[INSERT], 998, 0
[INSERT], 991, 0
[INSERT], 981, 0
[INSERT], 982, 0
[INSERT], 983, 0
[INSERT], 984, 0
[INSERT], 984, 0
[INSERT], 986, 0
[INSERT], 996, 0
[INSERT], 997, 0
[INSERT], 999, 0
[INSERT], 991, 0
[INSERT], 995, 0
[INSERT], 996, 0
[INSERT], 997, 0
[INSERT], 996, 0
[INSERT], 996, 0
[INSERT], 997, 0
[INSERT], 996, 0
[INSERT], 997, 0
[INSERT], 999, 0
```

```
TKIOada

[UPDATE], 966, 0
[UPDATE], 961, 0
[UPDATE], 961, 0
[UPDATE], 962, 0
[UPDATE], 962, 0
[UPDATE], 963, 0
[UPDATE], 966, 0
[UPDATE], 966, 0
[UPDATE], 966, 0
[UPDATE], 969, 0
[UPDATE], 970, 0
[UPDATE], 971, 0
[UPDATE], 972, 0
[UPDATE], 973, 0
[UPDATE], 973, 0
[UPDATE], 974, 0
[UPDATE], 975, 0
[UPDATE], 976, 0
[UPDATE], 980, 0
[UPDATE], 981, 0
[UPDATE], 982, 0
[UPDATE], 983, 0
[UPDATE], 984, 0
[UPDATE], 986, 0
[UPDATE], 989, 0
[UPDATE], 999, 0
[UPDATE], 999,
```

embedded@embedded11:~/ycsb-levedb\$ cd ycsb-0.1.4/ embedded@embedded11:~/ycsb-levedb/ycsb-0.1.4\$ ls -1

CHANGELOG

README

LICENSE.txt NOTICE.txt

cassandra-binding

gemfire-binding

hbase-binding infinispan-binding

jdbc-binding mapkeeper-binding

workloads

mongodb-binding nosqldb-binding redis-binding voldemort-binding



YCSB (Yahoo! Cloud Serving Benchmark)

```
# Yahoo! Cloud System Benchmark
# Workload A: Update heavy workload
# Application example: Session store recording recent actions
#
# Read/update ratio: 50/50
# Default data size: 1 KB records (10 fields, 100 bytes each, plus key)
# Request distribution: zipfian

recordcount=1000
operationcount=1000
workload=com.yahoo.ycsb.workloads.CoreWorkload

readallfields=true

readproportion=0.5
updateproportion=0.5
scanproportion=0
insertproportion=0
requestdistribution=zipfian
```

- → vi workload/workloada
 - Workload A: Update heavy workload
 - Workload B: Read mostly workload
 - Workload C: Read only
 - Workload D: Read latest workload
 - Workload E: Short ranges
 - Workload F: Read-modify-write
- Implementing New Workloads
 - https://github.com/brianfrankcooper/YCSB/wiki

- fieldcount: the number of fields in a record (default: 10)
- fieldlength: the size of each field (default: 100)
- readallfields: should reads read all fields (true) or just one (false) (default: true)
- readproportion: what proportion of operations should be reads (default: 0.95)
- updateproportion: what proportion of operations should be updates (default: 0.05)
- insertproportion: what proportion of operations should be inserts (default: 0)
- scanproportion: what proportion of operations should be scans (default: 0)
- readmodifywriteproportion: what proportion of operations should be read a record, modify it, write it back (default: 0)
- requestdistribution: what distribution should be used to select the records to operate on –
 uniform, zipfian or latest (default: uniform)
- maxscanlength: for scans, what is the maximum number of records to scan (default: 1000)





