

Sysbench 분석 및 MySQL 활용

<https://youtu.be/CMB4WsTDW6M>

1. DB에서의 성능 평가

- 美NIST-PQC 공모전 최종 양자내성암호 군을 기존 암호프로토콜 상에 적용 시 연산 성능 테스트

통신

- 美NIST-PQC 공모전 4라운드 후보 양자내성암호 군을 기존 암호프로토콜 상에 적용 시 연산 성능 테스트

- 데이터베이스 재 암호화 성능 테스트 (기존 AES-128로 암호화된 데이터에 대한 AES-256으로 재암호화)

응용프로그램

암호가 많이 사용되는 통신과 데이터베이스에서
암호 알고리즘이 변경됨으로 인한 영향을 조사

2. Sysbench

- Sysbench

- LUA 스크립트를 이용하고, multi-thread 방식을 지원하는 **벤치마크 툴**
 - LUA는 파이썬과 같은 스크립팅 언어로 가볍고 빠른 프로그래밍 언어
- MySQL/MariaDB 데이터베이스에서 주로 사용하는 오픈 소스 벤치마크 툴이며 추가적으로 CPU에서 디스크 I/O, 메모리 성능 등의 시스템 테스트도 가능 (PostgreSQL에서도 가능)
- Sysbench는 읽기 작업, 쓰기 작업, 갱신 작업, 트랜잭션 처리 작업 등 다양한 테스트 시나리오를 지원.

```
bulk_insert.lua      oltp_update_index.lua
oltp_common.lua      oltp_update_non_index.lua
oltp_delete.lua      oltp_write_only.lua
oltp_insert.lua       select_random_points.lua
oltp_point_select.lua select_random_ranges.lua
oltp_read_only.lua    tests
oltp_read_write.lua
```

2. Sysbench

- Homebrew를 통해서 간단하게 설치 가능
 - % brew install sysbench
- 설치 후 설치된 주소를 찾아야함
 - /opt/homebrew/Cellar/sysbench/1.0.20_5/share/sysbench/
 - 위 주소에 .lua 파일이 있음
- 성능 평가할 DBMS 설치
 - MySQL
 - % brew install mysql
 - PostgreSQL
 - % brew install postgresql

3. MySQL

- % mysql.server start

```
siwooeum@SiWooui-13inchi-MacPro ~ % mysql.server start
Starting MySQL
. SUCCESS!
```

- % mysql.server stop

```
siwooeum@SiWooui-13inchi-MacPro ~ % mysql.server stop
Shutting down MySQL
. SUCCESS!
```

- % mysql_secure_installation
 - 서버를 Start 한 후 초기 설정을 진행

3. MySQL

- % mysql -u root -p
 - Mysql로 접속하는 명령어

```
siwooeum@SiWooui-13inchi-MacPro ~ % mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 8
Server version: 8.1.0 Homebrew

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owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
```

- mysql> show databases
 - 현재 생성된 데이터베이스를 확인

3. MySQL

- Sysbench를 사용하기 위한 테스트 데이터베이스 생성
 - 테스트 유저 생성
 - `create user 'sysbench'@'%' IDENTIFIED BY 'sysbench';`
 - sysbench 계정의 외부 접근을 허용하고 sysbench라는 비밀번호는 사용함.
 - `grant all privileges on sysbench.* to sysbench;`
 - 권한 부여
 - 테스트 데이터베이스 생성
 - `create database sysbench;`

```
mysql> select host, user from user;
```

host	user
localhost	mysql.infoschema
localhost	mysql.session
localhost	mysql.sys
localhost	root
localhost	sysbench

```
mysql> show databases;
```

Database
information_schema
mysql
performance_schema
sys
sysbench

3. MySQL

- Sysbench는 Prepare → run → cleanup 순서로 진행
 - Prepare : sysbench 벤치마크를 위해서 테스트 데이터를 생성하는 과정
 - Run : 실제 테스트를 실행 (.lua 에 따라서 다른 테스트를 진행)
 - Cleanup : 테스트 데이터를 삭제하는 과정
- 기본적인 읽고 쓰기, 그리고 삽입 테스트를 진행
 - oltp_read_only.lua 읽고 쓰기 / oltp_insert.lua 삽입

```
bulk_insert.lua
oltp_common.lua
oltp_delete.lua
oltp_insert.lua
oltp_point_select.lua
oltp_read_only.lua
oltp_read_write.lua
```

```
oltp_update_index.lua
oltp_update_non_index.lua
oltp_write_only.lua
select_random_points.lua
select_random_ranges.lua
tests
```


3. MySQL

- % sysbench --mysql-host=localhost \
--mysql-port=3306 --mysql-user=sysbench \
--mysql-password=sysbench --mysql-db=sysbench \
--table-size=544444 --tables=5 \
/opt/homebrew/Cellar/sysbench/1.0.20_5/share/sysbench/oltp_read_write.lua **prepare**
- 5개의 테이블에 544444개의 데이터를 생성

```
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Creating table 'sbtest1'...
Inserting 544444 records into 'sbtest1'
Creating a secondary index on 'sbtest1'...
Creating table 'sbtest2'...
Inserting 544444 records into 'sbtest2'
Creating a secondary index on 'sbtest2'...
Creating table 'sbtest3'...
Inserting 544444 records into 'sbtest3'
Creating a secondary index on 'sbtest3'...
Creating table 'sbtest4'...
Inserting 544444 records into 'sbtest4'
Creating a secondary index on 'sbtest4'...
Creating table 'sbtest5'...
Inserting 544444 records into 'sbtest5'
Creating a secondary index on 'sbtest5'...
```

3. MySQL

- Prepare를 통한 데이터 생성하는 쿼리문

```
query = string.format([[
CREATE TABLE sbtest%d(
  id %s,
  k INTEGER DEFAULT '0' NOT NULL,
  c CHAR(120) DEFAULT '' NOT NULL,
  pad CHAR(60) DEFAULT '' NOT NULL,
  %s (id)
) %s %s]],
    table_num, id_def, id_index_def, engine_def,
    sysbench.opt.create_table_options)
```

```
mysql> desc sbtest1;
```

Field	Type	Null	Key	Default	Extra
id	int	NO	PRI	NULL	auto_increment
k	int	NO	MUL	0	
c	char(120)	NO			
pad	char(60)	NO			

3. MySQL

```
if sysbench.table.auto_inc then
    query = "INSERT INTO sbtest" .. table_num .. "(k, c, pad) VALUES"
else
    query = "INSERT INTO sbtest" .. table_num .. "(id, k, c, pad) VALUES"
end

con:bulk_insert_init(query)
```

```
local c_val
local pad_val
```

```
for i = 1, sysbench.opt.table_size do
```

```
    c_val = get_c_value()
    pad_val = get_pad_value()
```

```
    if (sysbench.opt.auto_inc) then
```

```
        query = string.format("(%d, '%s', '%s')",
```

```
            sysbench.rand.default(1, sysbench.opt.table_size),
            c_val, pad_val)
```

```
    else
```

```
        query = string.format("(%d, %d, '%s', '%s')",
```

```
            i,
            sysbench.rand.default(1, sysbench.opt.table_size),
            c_val, pad_val)
```

```
    end
```

```
    con:bulk_insert_next(query)
```

```
end
```

```
con:bulk_insert_done()
```

```
540801 272480 8990418185-3307449356-763390218-2452107090-5893886247-785885318-4703181767-7202859545-5531139788-3887939324
540802 272130 8980267488-9813894280-58891964421-16748482581-2636556417-84528878581-5718571258-4834624444-47748719745-1383525344
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540804 272284 2916384280-8207868485-8431493266-72961484576-87725987897-22382719128-46857791887-51542129379-6247582537-64993931368
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540873 274596 394933193-5897393162-40388362448-41118844379-2468577884-15548436974-3683933483-4646524738-5889191497-2958315249
540874 273682 2981448807-72848789013-98522485579-71894219384-5726318738-4976162966-2153413984-2671888924-89253341248-75564889419
540875 274532 1189285881-37846887588-4985672344-81951394276-82932885882-38888823853-37619799418-9534473722-99767484274-81422387287
540876 273924 34649646213-14896822573-12644958644-76558134245-32749854651-8534323682-72573285324-99428388871-87379382284-78196185163
540877 274879 9918133852-5645317836-4816484248-87988975992-24522373135-9458989884-5213443866-7578585844-5458898864-8217219799
540878 274596 394933193-5897393162-40388362448-41118844379-2468577884-15548436974-3683933483-4646524738-5889191497-2958315249
540879 273682 2981448807-72848789013-98522485579-71894219384-5726318738-4976162966-2153413984-2671888924-89253341248-75564889419
540880 274532 1189285881-37846887588-4985672344-81951394276-82932885882-38888823853-37619799418-9534473722-99767484274-81422387287
540881 273924 34649646213-14896822573-12644958644-76558134245-32749854651-8534323682-72573285324-99428388871-87379382284-78196185163
540882 274879 9918133852-5645317836-4816484248-87988975992-24522373135-9458989884-5213443866-7578585844-5458898864-8217219799
540883 274596 394933193-5897393162-40388362448-41118844379-2468577884-15548436974-3683933483-4646524738-5889191497-2958315249
540884 273682 2981448807-72848789013-98522485579-71894219384-5726318738-4976162966-2153413984-2671888924-89253341248-75564889419
540885 274532 1189285881-37846887588-4985672344-81951394276-82932885882-38888823853-37619799418-9534473722-99767484274-81422387287
540886 273924 34649646213-14896822573-12644958644-76558134245-32749854651-8534323682-72573285324-99428388871-87379382284-78196185163
540887 274879 9918133852-5645317836-4816484248-87988975992-24522373135-9458989884-5213443866-7578585844-5458898864-8217219799
540888 274596 394933193-5897393162-40388362448-41118844379-2468577884-15548436974-3683933483-4646524738-5889191497-2958315249
540889 273682 2981448807-72848789013-98522485579-71894219384-5726318738-4976162966-2153413984-2671888924-89253341248-75564889419
540890 274532 1189285881-37846887588-4985672344-81951394276-82932885882-3888882385
```

3. MySQL

- `sysbench --mysql-host=localhost --mysql-port=3306 \`
`--mysql-user=sysbench --report-interval=2 \`
`--mysql-password=sysbench --mysql-db=sysbench \`
`--table-size=544444 --threads=4 \`
`/opt/homebrew/Cellar/sysbench/1.0.20_5/share/sysbench/oltp_read`
`_write.lua` **run**

```
[ 2s ] thds: 4 tps: 3457.74 qps: 69178.69 (r/w/o: 48430.28/13830.94/6917.47) lat (ms,95%): 0.00 err/s: 0.00 reconn/s: 0.00
[ 4s ] thds: 4 tps: 4326.54 qps: 86535.34 (r/w/o: 60575.59/17306.67/8653.08) lat (ms,95%): 0.00 err/s: 0.00 reconn/s: 0.00
[ 6s ] thds: 4 tps: 4557.81 qps: 91160.13 (r/w/o: 63809.29/18235.23/9115.61) lat (ms,95%): 0.00 err/s: 0.00 reconn/s: 0.00
[ 8s ] thds: 4 tps: 4687.99 qps: 93746.78 (r/w/o: 65623.35/18747.46/9375.98) lat (ms,95%): 0.00 err/s: 0.00 reconn/s: 0.00
[ 10s ] thds: 4 tps: 4656.97 qps: 93137.85 (r/w/o: 65194.04/18630.87/9312.93) lat (ms,95%): 0.00 err/s: 0.00 reconn/s: 0.00
SQL statistics:
  queries performed:
    read:                607292
    write:               173512
    other:                86756
    total:               867560
  transactions:         43378 (4337.34 per sec.)
  queries:              867560 (86746.79 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)
General statistics:
  total time:            10.0008s
  total number of events: 43378
Latency (ms):
  min:                   0.64
  avg:                   0.92
  max:                   6.83
  95th percentile:      0.00
  sum:                   39987.52
Threads fairness:
  events (avg/stddev):   10844.5000/6.87
  execution time (avg/stddev): 9.9969/0.00
```

3. MySQL

```
function prepare_statements()
    if not sysbench.opt.skip_trx then
        prepare_begin()
        prepare_commit()
    end

    prepare_point_selects()

    if sysbench.opt.range_selects then
        prepare_simple_ranges()
        prepare_sum_ranges()
        prepare_order_ranges()
        prepare_distinct_ranges()
    end

    prepare_index_updates()
    prepare_non_index_updates()
    prepare_delete_inserts()
end
```

Prepare

```
function event()
    if not sysbench.opt.skip_trx then
        begin()

        execute_point_selects()

        if sysbench.opt.range_selects then
            execute_simple_ranges()
            execute_sum_ranges()
            execute_order_ranges()
            execute_distinct_ranges()
        end

        execute_index_updates()
        execute_non_index_updates()
        execute_delete_inserts()

        if not sysbench.opt.skip_trx then
            commit()
        end

        check_reconnect()
    end
end
```

Execute

```
point_selects = {
    "SELECT c FROM sbtest%u WHERE id=?",
    t.INT},
simple_ranges = {
    "SELECT c FROM sbtest%u WHERE id BETWEEN ? AND ?",
    t.INT, t.INT},
sum_ranges = {
    "SELECT SUM(k) FROM sbtest%u WHERE id BETWEEN ? AND ?",
    t.INT, t.INT},
order_ranges = {
    "SELECT c FROM sbtest%u WHERE id BETWEEN ? AND ? ORDER BY c",
    t.INT, t.INT},
distinct_ranges = {
    "SELECT DISTINCT c FROM sbtest%u WHERE id BETWEEN ? AND ? ORDER BY c",
    t.INT, t.INT},
```

```
con:query(string.format("INSERT INTO %s (id, k, c, pad) VALUES " ..
   ("(%d, %d, '%s', '%s')",
    table_name, i, k_val, c_val, pad_val))
```

3. MySQL

- `sysbench --mysql-host=localhost --mysql-port=3306 \`
`--mysql-user=sysbench --mysql-password=sysbench \`
`--mysql-db=sysbench --threads=4 --table-size=544444 \`
`--tables=5 \`
`/opt/homebrew/Cellar/sysbench/1.0.20_5/share/sysbench/oltp_read_write.lua cleanup`

- 테스트를 위해 생성된 데이터를 삭제

```
Dropping table 'sbtest1'...  
Dropping table 'sbtest2'...  
Dropping table 'sbtest3'...  
Dropping table 'sbtest4'...  
Dropping table 'sbtest5'...
```

3. MySQL

- MySQL 암호 기능 확인

```
[mysql> SELECT @@block_encryption_mode;
+-----+
| @@block_encryption_mode |
+-----+
| aes-128-ecb              |
+-----+
1 row in set (0.00 sec)
```

```
[mysql> SET block_encryption_mode = 'aes-256-ecb';
Query OK, 0 rows affected (0.00 sec)

[mysql> SELECT @@block_encryption_mode;
+-----+
| @@block_encryption_mode |
+-----+
| aes-256-ecb             |
+-----+
1 row in set (0.00 sec)
```

```
[mysql> SET block_encryption_mode = 'aes-128-ctr';
ERROR 1231 (42000): Variable 'block_encryption_mode' can't be set to the value of 'aes-128-ctr'
[mysql> SET block_encryption_mode = 'aes-128-ecb';
```

MODE : CBC / CFB1 / CFB8 / CFB128 / OFB / ECB

Key Length : 128 / 192 / 256 bit

3. MySQL

- SET @변수명 = ...;
- AES_ENCRYPT(plain text, key, iv);
- AES_ENCRYPT(cipher text, key, iv);
- SELECT @변수명;

```
[mysql> SET @key = '0000000000000000';
Query OK, 0 rows affected (0.00 sec)

[mysql> SET @cipher = AES_ENCRYPT('TEST PLAINTEXT', @key);
Query OK, 0 rows affected (0.00 sec)

[mysql> SELECT @key;
+-----+
| @key  |
+-----+
| 0000000000000000 |
+-----+
1 row in set (0.00 sec)

[mysql> SELECT @cipher;
+-----+
| @cipher |
+-----+
| 0xDA1DFAFF387CCD121625A78310D06951 |
+-----+
1 row in set (0.00 sec)
```


감 사 합 니 다