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Basis Data Terdistribusi

1. Implementasi Arsitektur Sistem Basis Data Terdistribusi

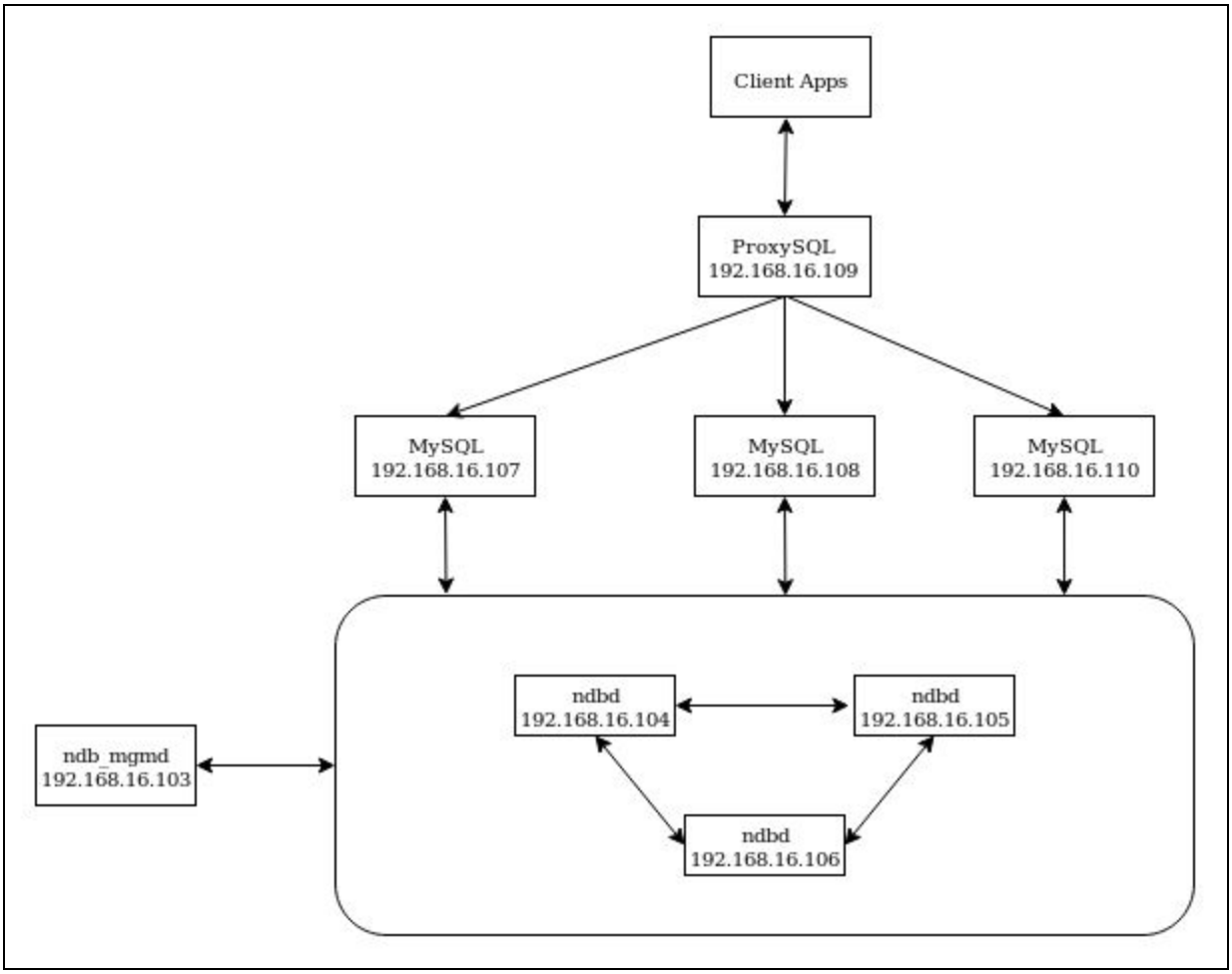
A. Spesifikasi Server

Arsitektur terdiri dari 7 server, masing-masing server memiliki spesifikasi sebagai berikut:

- 512 MB RAM
- Ubuntu 16.04

Pembagian IP server sebagai berikut:

- NDB Management server:
  - 192.168.16.103
- NDB Data server:
  - 192.168.16.104, 192.168.16.105, dan 192.168.16.106
- MySQL Server:
  - 192.168.16.107, 192.168.16.108, dan 192.168.16.110
- ProxySQL:
  - 192.168.16.109



Ilustrasi arsitektur MySQL NDB Cluster

B. Proses Konfigurasi dan Instalasi

1. Instalasi dan konfigurasi cluster manager

- Pada server 192.168.16.103 jalankan command berikut untuk download file .deb cluster manager:

```
wget
https://dev.mysql.com/get/Downloads/MySQL-Cluster-7.6/mysql-cluster-community-management-server_7.6.12-1ubuntu16.04_amd64.deb
```

- Install .deb yang telah didownload:

```
sudo dpkg -i
mysql-cluster-community-management-server_7.6.12-1ubuntu16.04_amd64.deb
```

- Konfigurasi cluster manager:

```
sudo mkdir /var/lib/mysql-cluster
sudo nano /var/lib/mysql-cluster/config.ini
```

- File /var/lib/mysql-cluster/config.ini, pada file ini terdapat pembagian IP NDB Data server, IP NDB Management server, dan MySQL server.

```
[ndbd default]
NoOfReplicas=3

[ndb_mgmd]
hostname=192.168.16.103
datadir=/var/lib/mysql-cluster

[ndbd]
hostname=192.168.16.104
NodeId=2
datadir=/usr/local/mysql/data

[ndbd]
hostname=192.168.16.105
NodeId=3
datadir=/usr/local/mysql/data

[ndbd]
hostname=192.168.16.106
NodeId=4
datadir=/usr/local/mysql/data

[mysqld]
hostname=192.168.16.107

[mysqld]
hostname=192.168.16.108

[mysqld]
hostname=192.168.16.110
```

- Buat systemd service

```
sudo nano /etc/systemd/system/ndb_mgmd.service
```

- File /etc/systemd/system/ndb_mgmd.service

```
[Unit]
Description=MySQL NDB Cluster Management Server
After=network.target auditd.service

[Service]
Type=forking
ExecStart=/usr/sbin/ndb_mgmd -f /var/lib/mysql-cluster/config.ini
ExecReload=/bin/kill -HUP $MAINPID
KillMode=process
Restart=on-failure

[Install]
WantedBy=multi-user.target
```

- Jalankan ndb_mgmd service

```
sudo systemctl daemon-reload
sudo systemctl enable ndb_mgmd
sudo systemctl start ndb_mgmd
sudo systemctl status ndb_mgmd
```

2. Instalasi dan konfigurasi NDB Data server

- Download dan install NDB Data server

```
wget
https://dev.mysql.com/get/Downloads/MySQL-Cluster-7.6/mysql-cluster-community-data-node_7.6.12-1ubuntu16.04_amd64.deb

Sudo apt update
sudo apt install libclass-methodmaker-perl
sudo dpkg -i
MySQL-Cluster-7.6/mysql-cluster-community-data-node_7.6.12-1ubuntu16.04_amd64.deb
```

- File konfigurasi NDB Data:

```
sudo nano /etc/my.cnf
sudo mkdir -p /usr/local/mysql/data
```

- File /etc/my.cnf, berisi connection string NDB Management server

```
[mysql_cluster]
ndb-connectstring=192.168.16.103
```

- Systemd ndb service

```
sudo nano /etc/systemd/system/ndbd.service
```

```
[Unit]
Description=MySQL NDB Data Node Daemon
After=network.target auditd.service

[Service]
Type=forking
ExecStart=/usr/sbin/ndbd
ExecReload=/bin/kill -HUP $MAINPID
KillMode=process
Restart=on-failure

[Install]
WantedBy=multi-user.target
```

```
sudo systemctl daemon-reload
sudo systemctl enable ndbd
sudo systemctl start ndbd
sudo systemctl status ndbd
```

3. Instalasi dan konfigurasi MySQL server dan client

- Download dan install MySQL server

```
wget
https://dev.mysql.com/get/Downloads/MySQL-Cluster-7.6/mysql-cluster_7.6.12
-1ubuntu16.04_amd64.deb-bundle.tar

mkdir install
tar -xvf mysql-cluster_7.6.12-1ubuntu16.04_amd64.deb-bundle.tar -C install/

cd install

sudo apt update
sudo apt install libaio1 libmecab2

sudo dpkg -i mysql-common_7.6.12-1ubuntu16.04_amd64.deb
```

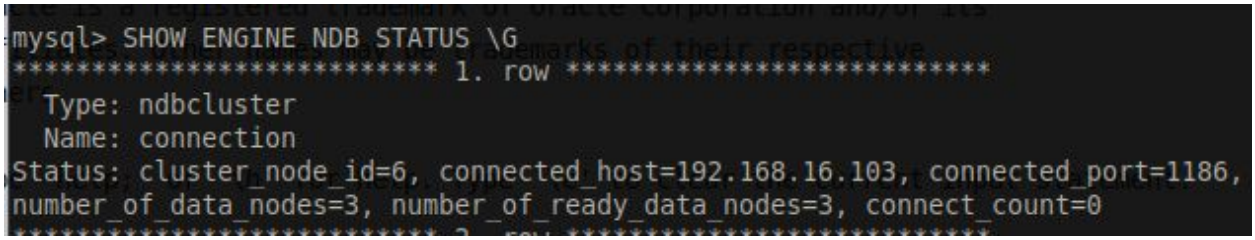
```
sudo dpkg -i mysql-cluster-community-client_7.6.12-1ubuntu16.04_amd64.deb
sudo dpkg -i mysql-client_7.6.12-1ubuntu16.04_amd64.deb
sudo dpkg -i
mysql-cluster-community-server_7.6.12-1ubuntu16.04_amd64.deb

sudo dpkg -i mysql-server_7.6.12-1ubuntu16.04_amd64.deb
```

- Konfigurasi file /etc/mysql/my.cnf

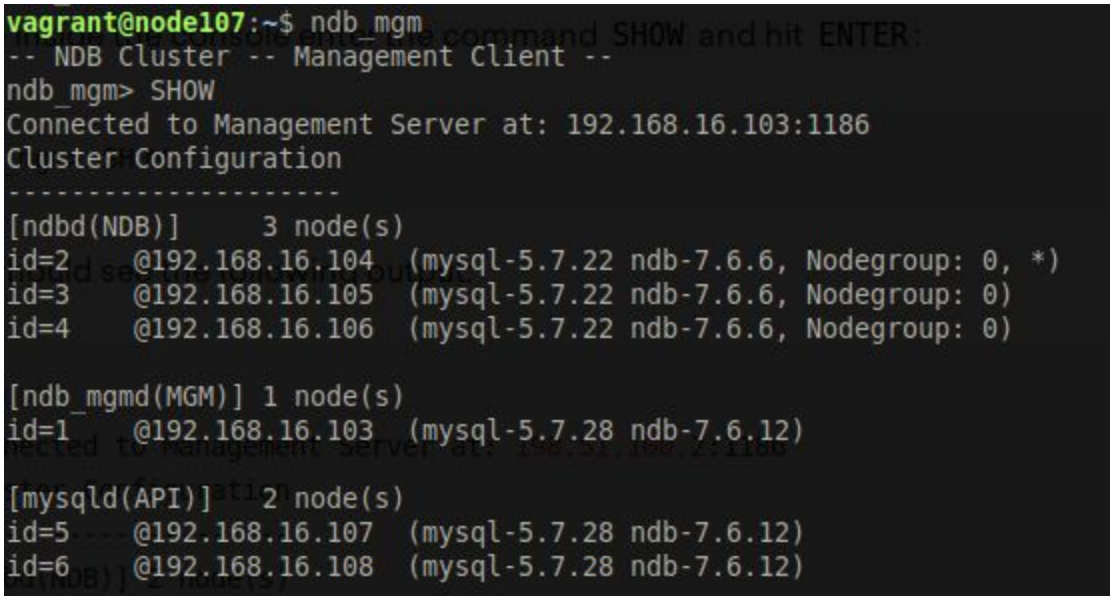
```
!includedir /etc/mysql/conf.d/
!includedir /etc/mysql/mysql.conf.d/

[mysqld]
# Options for mysqld process:
ndbcluster                # run NDB storage engine
default-storage-engine=NDBCLUSTER

[mysql_cluster]
# Options for NDB Cluster processes:
ndb-connectstring=192.168.16.103  # location of management server
```

4. Melihat status cluster

- Terdapat 3 NDB Data server yang terkoneksi



- Melalui client ndb_mgm, terdapat 3 NDB Data server yang terkoneksi, 1 NDB Management server, dan 2 MySQL server.



5. Instalasi dan konfigurasi ProxySQL

- Download dan install file ProxySQL

```
curl -OL
https://github.com/sysown/proxysql/releases/download/v1.4.4/proxysql_1.4.4-ubuntu16_amd64.deb

sudo dpkg -i proxysql_*

sudo apt-get update
sudo apt-get install mysql-client
```

- Jalankan ProxySQL

```
sudo systemctl start proxysql
```

- Pada MySQL server, jalankan command berikut untuk setting MySQL user yang digunakan oleh ProxySQL untuk monitoring server

```
curl -OL
https://gist.github.com/lefred/77ddbde301c72535381ae7af9f968322/raw/5e40b03333a3c148b78aa348fd2cd5b5dbb36e4d/addition_to_sys.sql

mysql -u root -p < addition_to_sys.sql
mysql -u root -p
```

```
mysql> CREATE USER 'monitor'@'%' IDENTIFIED BY 'monitorpassword';
mysql> GRANT SELECT on sys.* to 'monitor'@'%';
mysql> FLUSH PRIVILEGES;
```

- Konfigurasi monitoring ProxySQL

```
ProxySQLAdmin> UPDATE global_variables SET variable_value='monitor'
WHERE variable_name='mysql-monitor_username';
ProxySQLAdmin> UPDATE global_variables SET
variable_value='monitorpassword' WHERE
variable_name='mysql-monitor_password';

ProxySQLAdmin> LOAD MYSQL VARIABLES TO RUNTIME;
ProxySQLAdmin> SAVE MYSQL VARIABLES TO DISK;
```

- Menambahkan MySQL server ke ProxySQL server pool

```
ProxySQLAdmin> INSERT INTO mysql_group_replication_hostgroups
(writer_hostgroup, backup_writer_hostgroup, reader_hostgroup,
offline_hostgroup, active, max_writers, writer_is_also_reader,
max_transactions_behind) VALUES (2, 4, 3, 1, 1, 3, 1, 100);

ProxySQLAdmin> INSERT INTO mysql_servers(hostgroup_id, hostname, port)
VALUES (2, 192.168.16.107', 3306);
ProxySQLAdmin> INSERT INTO mysql_servers(hostgroup_id, hostname, port)
VALUES (2, '192.168.16.108', 3306);
ProxySQLAdmin> INSERT INTO mysql_servers(hostgroup_id, hostname, port)
VALUES (2, '192.168.16.110, 3306);

LOAD MYSQL SERVERS TO RUNTIME;
SAVE MYSQL SERVERS TO DISK;
```

- Membuat MySQL user di MySQL server

```
mysql> CREATE USER 'adis'@'%' IDENTIFIED BY ‘password’;
mysql> GRANT ALL PRIVILEGES on playground.* to ‘adis’@'%';
mysql> FLUSH PRIVILEGES;
```

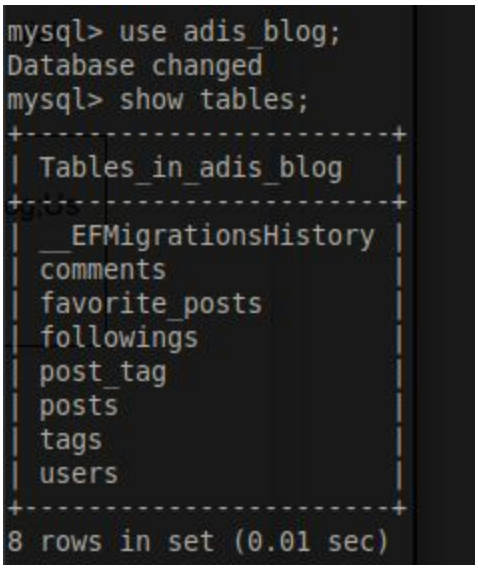
- Menambahkan MySQL user yang baru dibuat ke ProxySQL

```
ProxySQLAdmin> INSERT INTO mysql_users(username, password,
default_hostgroup) VALUES ('playgrounduser', 'playgroundpassword', 2);
```

```
ProxySQLAdmin> LOAD MYSQL USERS TO RUNTIME;
ProxySQLAdmin> SAVE MYSQL USERS TO DISK;
```

2. Pemanfaatan basis data terdistribusi dalam aplikasi
    a. Import struktur database aplikasi CRUD
    - Source code mengarahkan ke IP ProxySQL menggunakan database credentials yang sudah dibuat

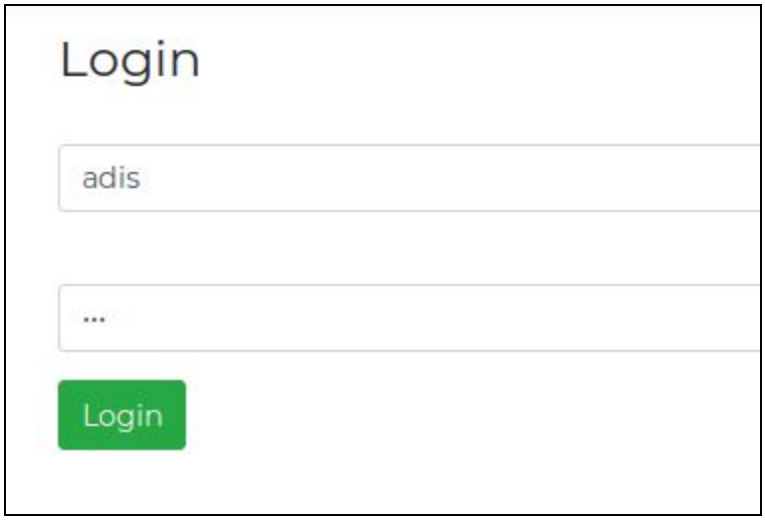
```
services.AddDbContext<BlogsDbContext>(options =>
options.UseMySql("Server=192.168.16.109;Port=6033;Database=adis_blog;User=adis;Password=password;" ));

dotnet ef database update
```



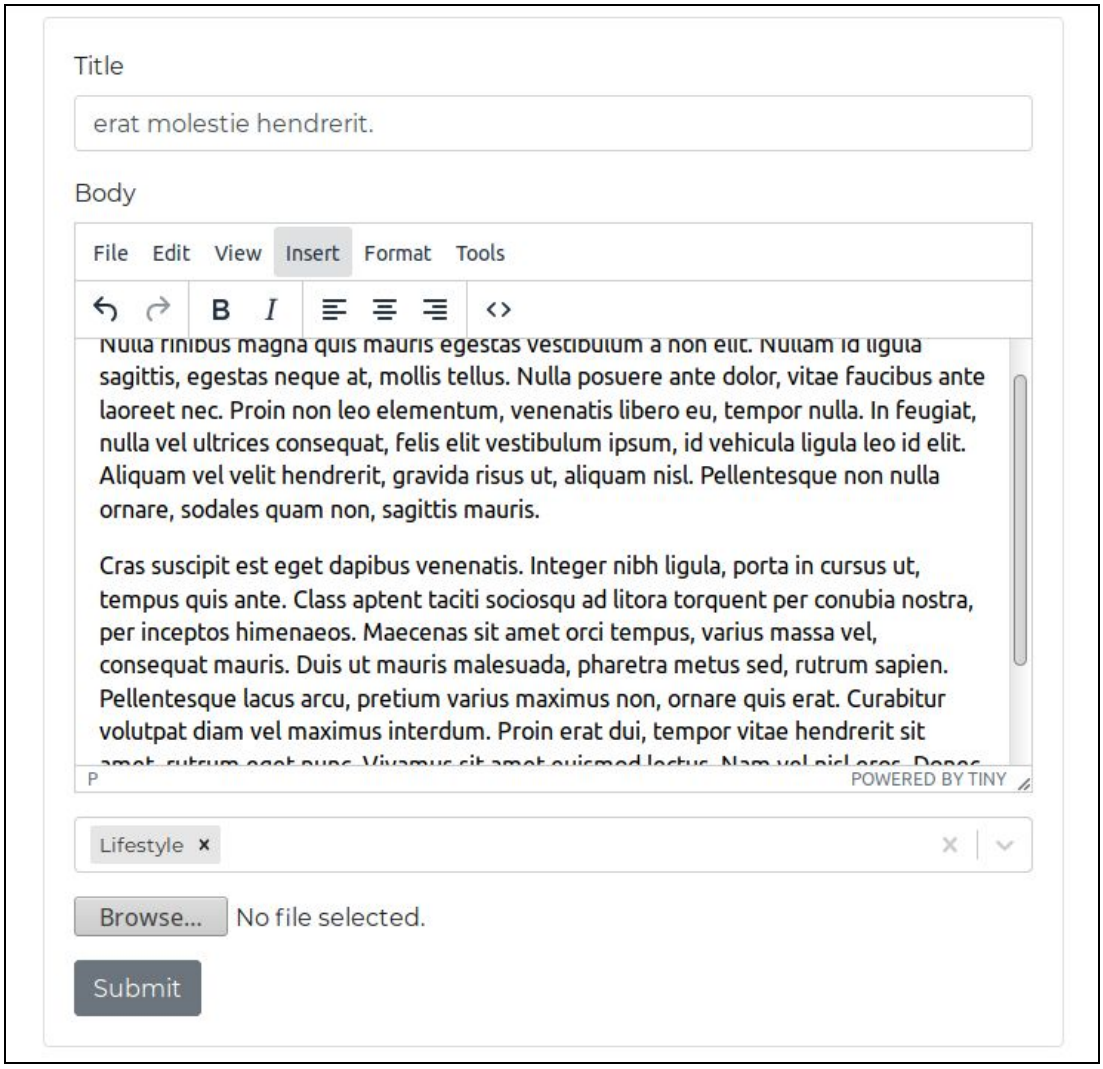
Hasil import struktur database

    b. Cara menggunakan aplikasi
    - Register

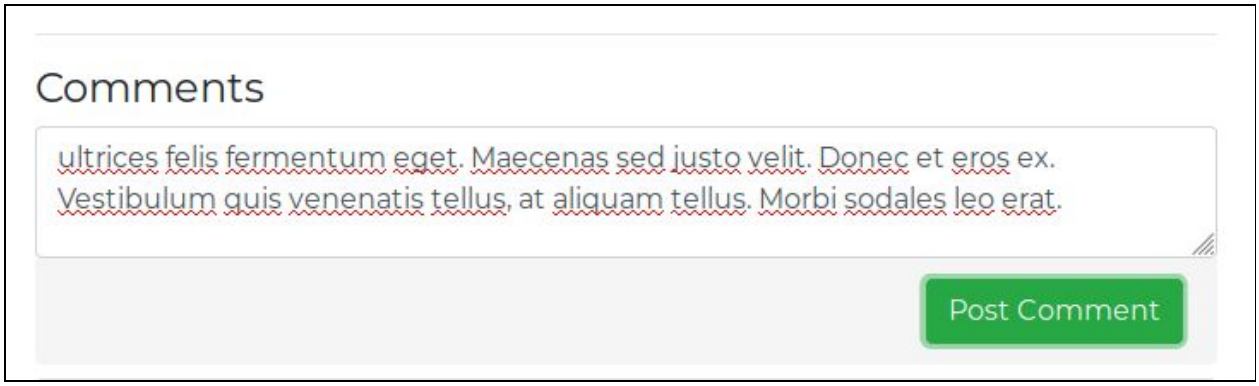
- Login



- Create post

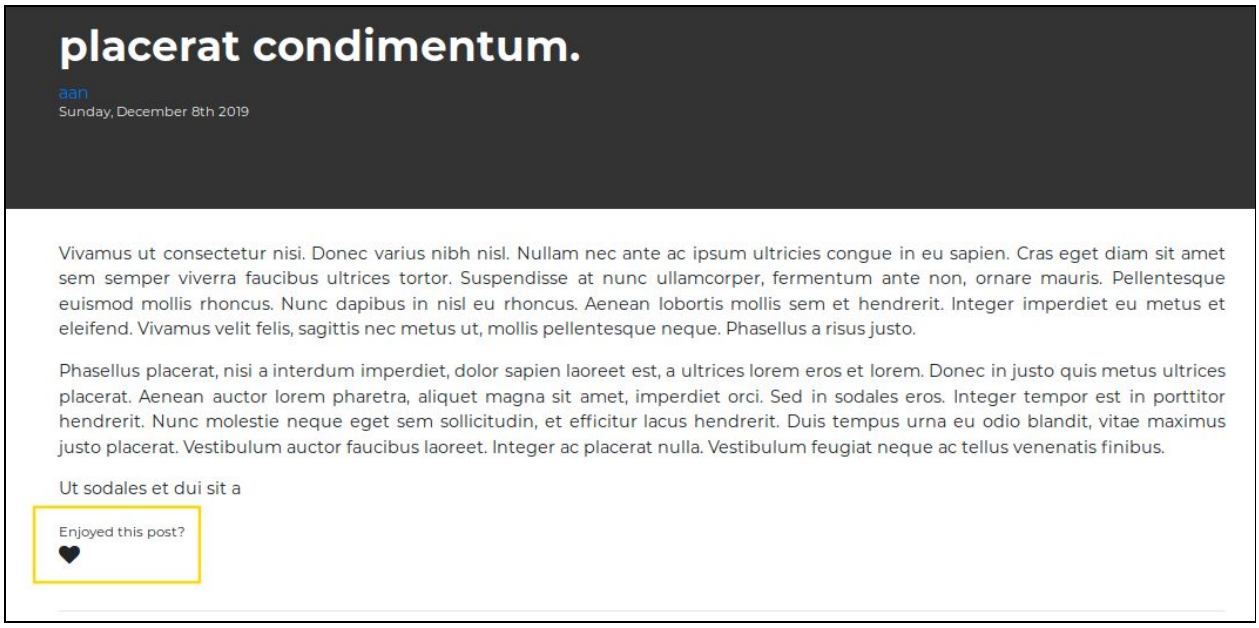


- Comment post

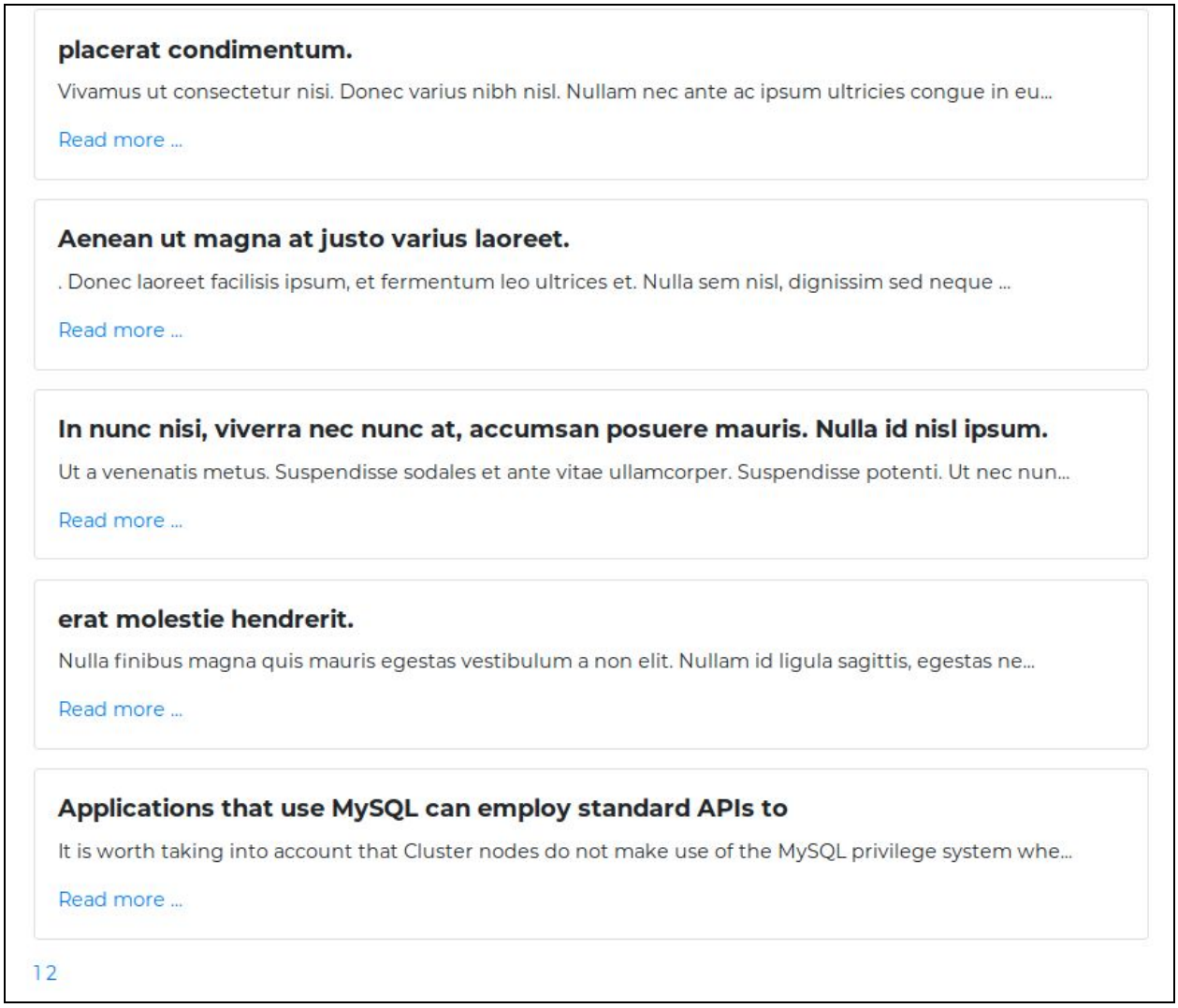


- Follow/ unfollow user

- Like post



- All posts



- View comments

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Sunday, December 8th 2019

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Sunday, December 8th 2019

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Sunday, December 8th 2019

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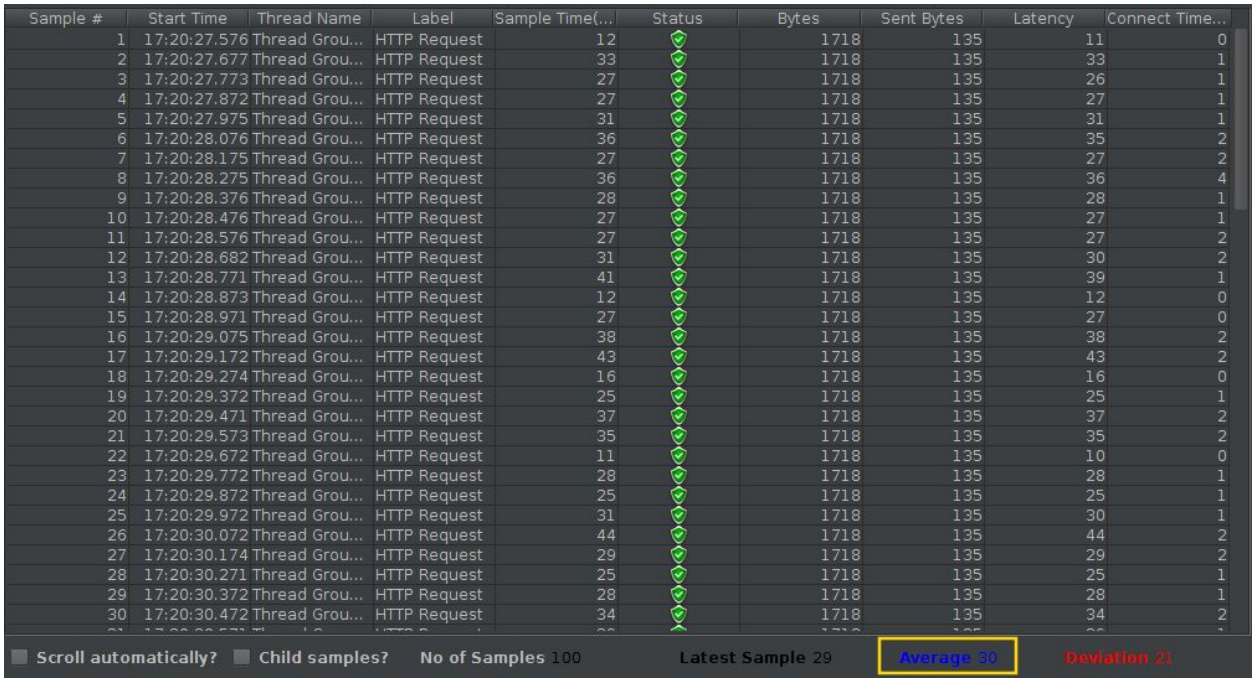
3. Uji performa aplikasi dan basis data
    a. Aplikasi JMeter
        i. 100 users selama 10 detik
        Ketika hit endpoint /api/posts menghasilkan rata-rata sample time 30 ms.
        Seluruh request mendapatkan status 200 OK.

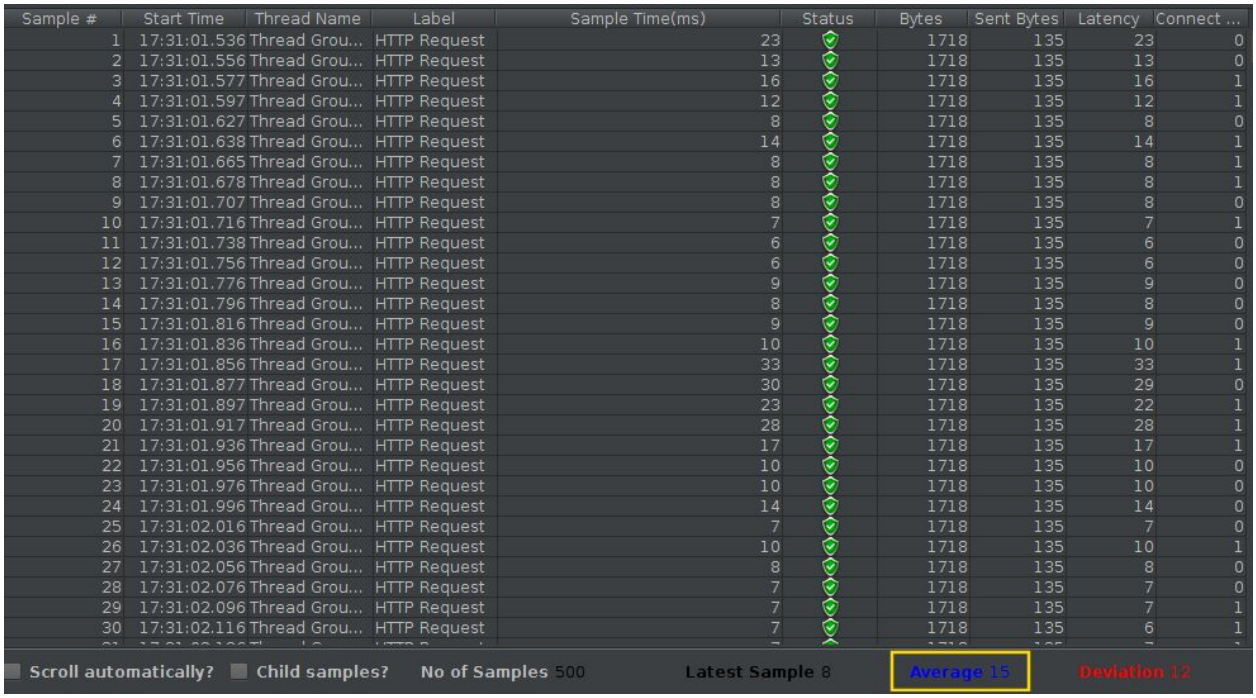


Sample #	Start Time	Thread Name	Label	Sample Time(...	Status	Bytes	Sent Bytes	Latency	Connect Time...
1	17:20:27.576	Thread Grou...	HTTP Request	12		1718	135	11	0
2	17:20:27.677	Thread Grou...	HTTP Request	33		1718	135	33	1
3	17:20:27.773	Thread Grou...	HTTP Request	27		1718	135	26	1
4	17:20:27.872	Thread Grou...	HTTP Request	27		1718	135	27	1
5	17:20:27.975	Thread Grou...	HTTP Request	31		1718	135	31	1
6	17:20:28.076	Thread Grou...	HTTP Request	36		1718	135	35	2
7	17:20:28.175	Thread Grou...	HTTP Request	27		1718	135	27	2
8	17:20:28.275	Thread Grou...	HTTP Request	36		1718	135	36	4
9	17:20:28.376	Thread Grou...	HTTP Request	28		1718	135	28	1
10	17:20:28.476	Thread Grou...	HTTP Request	27		1718	135	27	1
11	17:20:28.576	Thread Grou...	HTTP Request	27		1718	135	27	2
12	17:20:28.682	Thread Grou...	HTTP Request	31		1718	135	30	2
13	17:20:28.771	Thread Grou...	HTTP Request	41		1718	135	39	1
14	17:20:28.873	Thread Grou...	HTTP Request	12		1718	135	12	0
15	17:20:28.971	Thread Grou...	HTTP Request	27		1718	135	27	0
16	17:20:29.075	Thread Grou...	HTTP Request	38		1718	135	38	2
17	17:20:29.172	Thread Grou...	HTTP Request	43		1718	135	43	2
18	17:20:29.274	Thread Grou...	HTTP Request	16		1718	135	16	0
19	17:20:29.372	Thread Grou...	HTTP Request	25		1718	135	25	1
20	17:20:29.471	Thread Grou...	HTTP Request	37		1718	135	37	2
21	17:20:29.573	Thread Grou...	HTTP Request	35		1718	135	35	2
22	17:20:29.672	Thread Grou...	HTTP Request	11		1718	135	10	0
23	17:20:29.772	Thread Grou...	HTTP Request	28		1718	135	28	1
24	17:20:29.872	Thread Grou...	HTTP Request	25		1718	135	25	1
25	17:20:29.972	Thread Grou...	HTTP Request	31		1718	135	30	1
26	17:20:30.072	Thread Grou...	HTTP Request	44		1718	135	44	2
27	17:20:30.174	Thread Grou...	HTTP Request	29		1718	135	29	2
28	17:20:30.271	Thread Grou...	HTTP Request	25		1718	135	25	1
29	17:20:30.372	Thread Grou...	HTTP Request	28		1718	135	28	1
30	17:20:30.472	Thread Grou...	HTTP Request	34		1718	135	34	2

Scroll automatically? Child samples? No of Samples 100 Latest Sample 29 Average 30 Deviation 21

ii. 500 users selama 10 detik

Ketika hit endpoint /api/posts menghasilkan rata-rata sample time 15 ms.
Seluruh request mendapatkan status 200 OK.

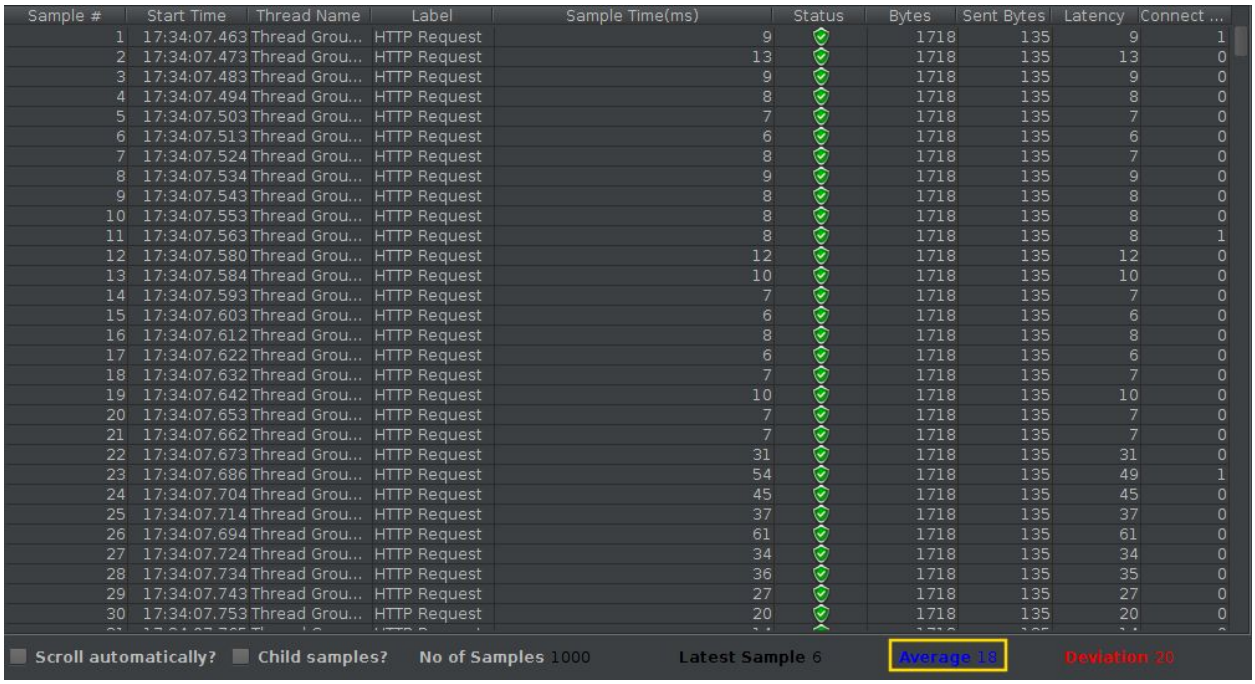


Sample #	Start Time	Thread Name	Label	Sample Time(ms)	Status	Bytes	Sent Bytes	Latency	Connect ...
1	17:31:01.536	Thread Grou...	HTTP Request	23		1718	135	23	0
2	17:31:01.556	Thread Grou...	HTTP Request	13		1718	135	13	0
3	17:31:01.577	Thread Grou...	HTTP Request	16		1718	135	16	1
4	17:31:01.597	Thread Grou...	HTTP Request	12		1718	135	12	1
5	17:31:01.627	Thread Grou...	HTTP Request	8		1718	135	8	0
6	17:31:01.638	Thread Grou...	HTTP Request	14		1718	135	14	1
7	17:31:01.665	Thread Grou...	HTTP Request	8		1718	135	8	1
8	17:31:01.678	Thread Grou...	HTTP Request	8		1718	135	8	1
9	17:31:01.707	Thread Grou...	HTTP Request	8		1718	135	8	0
10	17:31:01.716	Thread Grou...	HTTP Request	7		1718	135	7	1
11	17:31:01.738	Thread Grou...	HTTP Request	6		1718	135	6	0
12	17:31:01.756	Thread Grou...	HTTP Request	6		1718	135	6	0
13	17:31:01.776	Thread Grou...	HTTP Request	9		1718	135	9	0
14	17:31:01.796	Thread Grou...	HTTP Request	8		1718	135	8	0
15	17:31:01.816	Thread Grou...	HTTP Request	9		1718	135	9	0
16	17:31:01.836	Thread Grou...	HTTP Request	10		1718	135	10	1
17	17:31:01.856	Thread Grou...	HTTP Request	33		1718	135	33	1
18	17:31:01.877	Thread Grou...	HTTP Request	30		1718	135	29	0
19	17:31:01.897	Thread Grou...	HTTP Request	23		1718	135	22	1
20	17:31:01.917	Thread Grou...	HTTP Request	28		1718	135	28	1
21	17:31:01.936	Thread Grou...	HTTP Request	17		1718	135	17	1
22	17:31:01.956	Thread Grou...	HTTP Request	10		1718	135	10	0
23	17:31:01.976	Thread Grou...	HTTP Request	10		1718	135	10	0
24	17:31:01.996	Thread Grou...	HTTP Request	14		1718	135	14	0
25	17:31:02.016	Thread Grou...	HTTP Request	7		1718	135	7	0
26	17:31:02.036	Thread Grou...	HTTP Request	10		1718	135	10	1
27	17:31:02.056	Thread Grou...	HTTP Request	8		1718	135	8	0
28	17:31:02.076	Thread Grou...	HTTP Request	7		1718	135	7	0
29	17:31:02.096	Thread Grou...	HTTP Request	7		1718	135	7	1
30	17:31:02.116	Thread Grou...	HTTP Request	7		1718	135	6	1

Scroll automatically? Child samples? No of Samples 500 Latest Sample 8 Average 15 Deviation 12

iii. 1000 users selama 10 detik

Ketika hit endpoint /api/posts menghasilkan rata-rata sample time 18 ms.
Seluruh request mendapatkan status 200 OK.



Sample #	Start Time	Thread Name	Label	Sample Time(ms)	Status	Bytes	Sent Bytes	Latency	Connect ...
1	17:34:07.463	Thread Grou...	HTTP Request	9		1718	135	9	1
2	17:34:07.473	Thread Grou...	HTTP Request	13		1718	135	13	0
3	17:34:07.483	Thread Grou...	HTTP Request	9		1718	135	9	0
4	17:34:07.494	Thread Grou...	HTTP Request	8		1718	135	8	0
5	17:34:07.503	Thread Grou...	HTTP Request	7		1718	135	7	0
6	17:34:07.513	Thread Grou...	HTTP Request	6		1718	135	6	0
7	17:34:07.524	Thread Grou...	HTTP Request	8		1718	135	7	0
8	17:34:07.534	Thread Grou...	HTTP Request	9		1718	135	9	0
9	17:34:07.543	Thread Grou...	HTTP Request	8		1718	135	8	0
10	17:34:07.553	Thread Grou...	HTTP Request	8		1718	135	8	0
11	17:34:07.563	Thread Grou...	HTTP Request	8		1718	135	8	1
12	17:34:07.580	Thread Grou...	HTTP Request	12		1718	135	12	0
13	17:34:07.584	Thread Grou...	HTTP Request	10		1718	135	10	0
14	17:34:07.593	Thread Grou...	HTTP Request	7		1718	135	7	0
15	17:34:07.603	Thread Grou...	HTTP Request	6		1718	135	6	0
16	17:34:07.612	Thread Grou...	HTTP Request	8		1718	135	8	0
17	17:34:07.622	Thread Grou...	HTTP Request	6		1718	135	6	0
18	17:34:07.632	Thread Grou...	HTTP Request	7		1718	135	7	0
19	17:34:07.642	Thread Grou...	HTTP Request	10		1718	135	10	0
20	17:34:07.653	Thread Grou...	HTTP Request	7		1718	135	7	0
21	17:34:07.662	Thread Grou...	HTTP Request	7		1718	135	7	0
22	17:34:07.673	Thread Grou...	HTTP Request	31		1718	135	31	0
23	17:34:07.686	Thread Grou...	HTTP Request	54		1718	135	49	1
24	17:34:07.704	Thread Grou...	HTTP Request	45		1718	135	45	0
25	17:34:07.714	Thread Grou...	HTTP Request	37		1718	135	37	0
26	17:34:07.694	Thread Grou...	HTTP Request	61		1718	135	61	0
27	17:34:07.724	Thread Grou...	HTTP Request	34		1718	135	34	0
28	17:34:07.734	Thread Grou...	HTTP Request	36		1718	135	35	0
29	17:34:07.743	Thread Grou...	HTTP Request	27		1718	135	27	0
30	17:34:07.753	Thread Grou...	HTTP Request	20		1718	135	20	0

Scroll automatically? Child samples? No of Samples 1000 Latest Sample 6 Average 18 Deviation 20

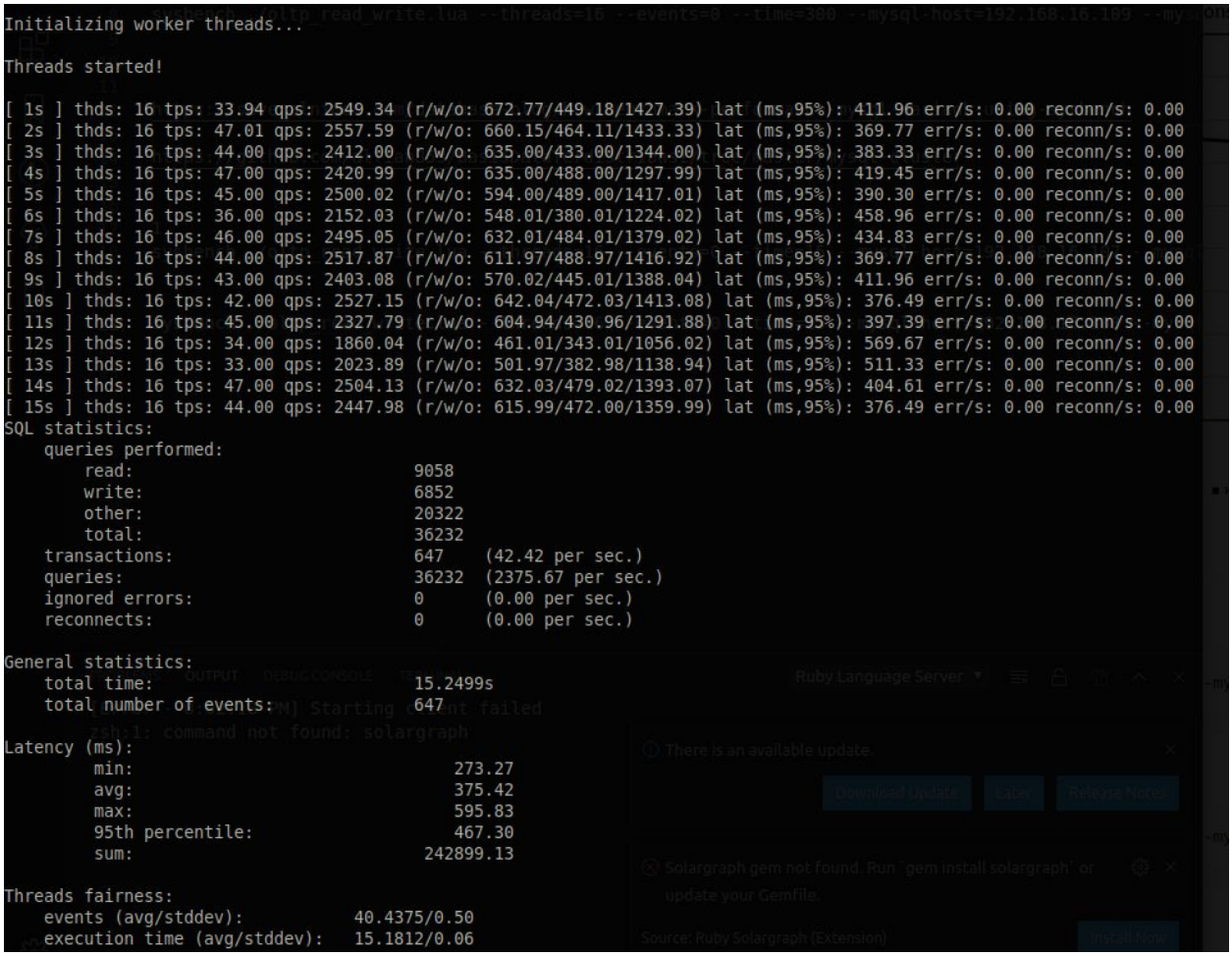
b. Basis Data Sysbench

i. Prepare data

```
sysbench ./oltp_read_write.lua --threads=5
--mysql-host=192.168.16.109 --mysql-user=adis
--mysql-password=password --mysql-port=6033 --tables=20
--table-size=10000000 --db-driver=mysql
--mysql_storage_engine=ndbcluster prepare
```

ii. Uji coba server 192.168.16.107

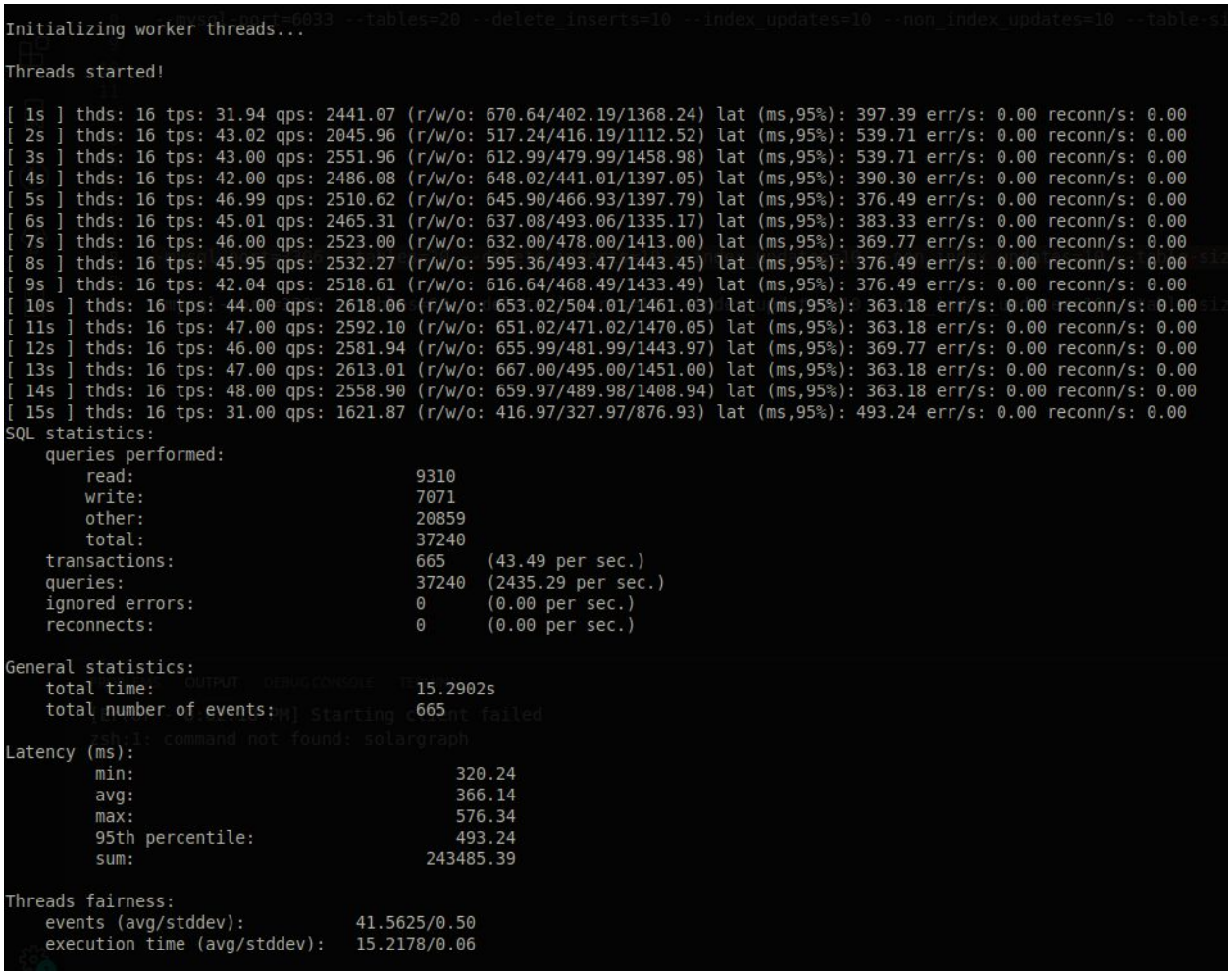
```
sysbench ./oltp_read_write.lua --threads=16 --events=0 --time=15
--mysql-host=192.168.16.107 --mysql-user=adis
--mysql-password=password --mysql-port=3306 --tables=20
--delete_inserts=10 --index_updates=10 --non_index_updates=10
--table-size=10000000 --db-ps-mode=disable --report-interval=1
--db-driver=mysql --mysql_storage_engine=ndbcluster run
```



```
Initializing worker threads...

Threads started!

[ 1s ] thds: 16 tps: 33.94 qps: 2549.34 (r/w/o: 672.77/449.18/1427.39) lat (ms,95%): 411.96 err/s: 0.00 reconn/s: 0.00
[ 2s ] thds: 16 tps: 47.01 qps: 2557.59 (r/w/o: 660.15/464.11/1433.33) lat (ms,95%): 369.77 err/s: 0.00 reconn/s: 0.00
[ 3s ] thds: 16 tps: 44.00 qps: 2412.00 (r/w/o: 635.00/433.00/1344.00) lat (ms,95%): 383.33 err/s: 0.00 reconn/s: 0.00
[ 4s ] thds: 16 tps: 47.00 qps: 2420.99 (r/w/o: 635.00/488.00/1297.99) lat (ms,95%): 419.45 err/s: 0.00 reconn/s: 0.00
[ 5s ] thds: 16 tps: 45.00 qps: 2500.02 (r/w/o: 594.00/489.00/1417.01) lat (ms,95%): 390.30 err/s: 0.00 reconn/s: 0.00
[ 6s ] thds: 16 tps: 36.00 qps: 2152.03 (r/w/o: 548.01/380.01/1224.02) lat (ms,95%): 458.96 err/s: 0.00 reconn/s: 0.00
[ 7s ] thds: 16 tps: 46.00 qps: 2495.05 (r/w/o: 632.01/484.01/1379.02) lat (ms,95%): 434.83 err/s: 0.00 reconn/s: 0.00
[ 8s ] thds: 16 tps: 44.00 qps: 2517.87 (r/w/o: 611.97/488.97/1416.92) lat (ms,95%): 369.77 err/s: 0.00 reconn/s: 0.00
[ 9s ] thds: 16 tps: 43.00 qps: 2403.08 (r/w/o: 570.02/445.01/1388.04) lat (ms,95%): 411.96 err/s: 0.00 reconn/s: 0.00
[ 10s ] thds: 16 tps: 42.00 qps: 2527.15 (r/w/o: 642.04/472.03/1413.08) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 11s ] thds: 16 tps: 45.00 qps: 2327.79 (r/w/o: 604.94/430.96/1291.88) lat (ms,95%): 397.39 err/s: 0.00 reconn/s: 0.00
[ 12s ] thds: 16 tps: 34.00 qps: 1860.04 (r/w/o: 461.01/343.01/1056.02) lat (ms,95%): 569.67 err/s: 0.00 reconn/s: 0.00
[ 13s ] thds: 16 tps: 33.00 qps: 2023.89 (r/w/o: 501.97/382.98/1138.94) lat (ms,95%): 511.33 err/s: 0.00 reconn/s: 0.00
[ 14s ] thds: 16 tps: 47.00 qps: 2504.13 (r/w/o: 632.03/479.02/1393.07) lat (ms,95%): 404.61 err/s: 0.00 reconn/s: 0.00
[ 15s ] thds: 16 tps: 44.00 qps: 2447.98 (r/w/o: 615.99/472.00/1359.99) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
SQL statistics:
    queries performed:
        read:                            9058
        write:                           6852
        other:                           20322
        total:                           36232
    transactions:                        647    (42.42 per sec.)
    queries:                             36232  (2375.67 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          15.2499s
    total number of events:              647

Latency (ms):
         min:                                  273.27
         avg:                                  375.42
         max:                                  595.83
         95th percentile:                      467.30
         sum:                                242899.13

Threads fairness:
    events (avg/stddev):           40.4375/0.50
    execution time (avg/stddev):   15.1812/0.06
```

iii. Uji coba server 192.168.16.108

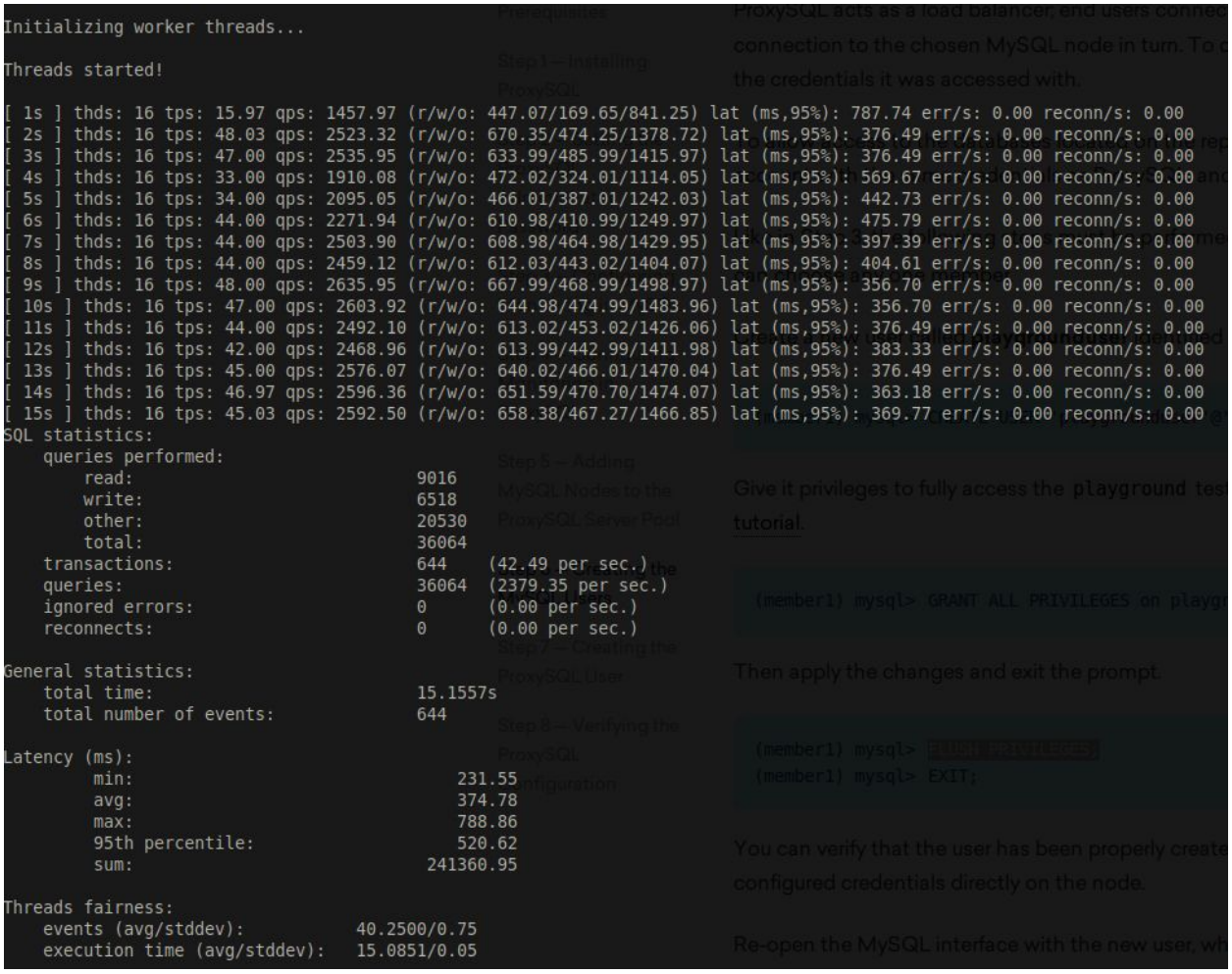
```
sysbench ./oltp_read_write.lua --threads=16 --events=0 --time=15
--mysql-host=192.168.16.108 --mysql-user=adis
--mysql-password=password --mysql-port=3306 --tables=20
--delete_inserts=10 --index_updates=10 --non_index_updates=10
--table-size=10000000 --db-ps-mode=disable --report-interval=1
--db-driver=mysql --mysql_storage_engine=ndbcluster run
```



```
Initializing worker threads...

Threads started!

[ 1s ] thds: 16 tps: 31.94 qps: 2441.07 (r/w/o: 670.64/402.19/1368.24) lat (ms,95%): 397.39 err/s: 0.00 reconn/s: 0.00
[ 2s ] thds: 16 tps: 43.02 qps: 2045.96 (r/w/o: 517.24/416.19/1112.52) lat (ms,95%): 539.71 err/s: 0.00 reconn/s: 0.00
[ 3s ] thds: 16 tps: 43.00 qps: 2551.96 (r/w/o: 612.99/479.99/1458.98) lat (ms,95%): 539.71 err/s: 0.00 reconn/s: 0.00
[ 4s ] thds: 16 tps: 42.00 qps: 2486.08 (r/w/o: 648.02/441.01/1397.05) lat (ms,95%): 390.30 err/s: 0.00 reconn/s: 0.00
[ 5s ] thds: 16 tps: 46.99 qps: 2510.62 (r/w/o: 645.90/466.93/1397.79) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 6s ] thds: 16 tps: 45.01 qps: 2465.31 (r/w/o: 637.08/493.06/1335.17) lat (ms,95%): 383.33 err/s: 0.00 reconn/s: 0.00
[ 7s ] thds: 16 tps: 46.00 qps: 2523.00 (r/w/o: 632.00/478.00/1413.00) lat (ms,95%): 369.77 err/s: 0.00 reconn/s: 0.00
[ 8s ] thds: 16 tps: 45.95 qps: 2532.27 (r/w/o: 595.36/493.47/1443.45) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 9s ] thds: 16 tps: 42.04 qps: 2518.61 (r/w/o: 616.64/468.49/1433.49) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 10s ] thds: 16 tps: 44.00 qps: 2618.06 (r/w/o: 653.02/504.01/1461.03) lat (ms,95%): 363.18 err/s: 0.00 reconn/s: 0.00
[ 11s ] thds: 16 tps: 47.00 qps: 2592.10 (r/w/o: 651.02/471.02/1470.05) lat (ms,95%): 363.18 err/s: 0.00 reconn/s: 0.00
[ 12s ] thds: 16 tps: 46.00 qps: 2581.94 (r/w/o: 655.99/481.99/1443.97) lat (ms,95%): 369.77 err/s: 0.00 reconn/s: 0.00
[ 13s ] thds: 16 tps: 47.00 qps: 2613.01 (r/w/o: 667.00/495.00/1451.00) lat (ms,95%): 363.18 err/s: 0.00 reconn/s: 0.00
[ 14s ] thds: 16 tps: 48.00 qps: 2558.90 (r/w/o: 659.97/489.98/1408.94) lat (ms,95%): 363.18 err/s: 0.00 reconn/s: 0.00
[ 15s ] thds: 16 tps: 31.00 qps: 1621.87 (r/w/o: 416.97/327.97/876.93) lat (ms,95%): 493.24 err/s: 0.00 reconn/s: 0.00
SQL statistics:
    queries performed:
        read:                            9310
        write:                           7071
        other:                           20859
        total:                           37240
    transactions:                        665    (43.49 per sec.)
    queries:                             37240  (2435.29 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          15.2902s
    total number of events:              665

Latency (ms):
         min:                                    320.24
         avg:                                    366.14
         max:                                    576.34
         95th percentile:                        493.24
         sum:                                 243485.39

Threads fairness:
    events (avg/stddev):           41.5625/0.50
    execution time (avg/stddev):   15.2178/0.06
```

iv. Uji coba server 192.168.16.110

```
sysbench ./oltp_read_write.lua --threads=16 --events=0 --time=15
--mysql-host=192.168.16.110 --mysql-user=adis
--mysql-password=password --mysql-port=3306 --tables=20
--delete_inserts=10 --index_updates=10 --non_index_updates=10
--table-size=10000000 --db-ps-mode=disable --report-interval=1
--db-driver=mysql --mysql_storage_engine=ndbcluster run
```

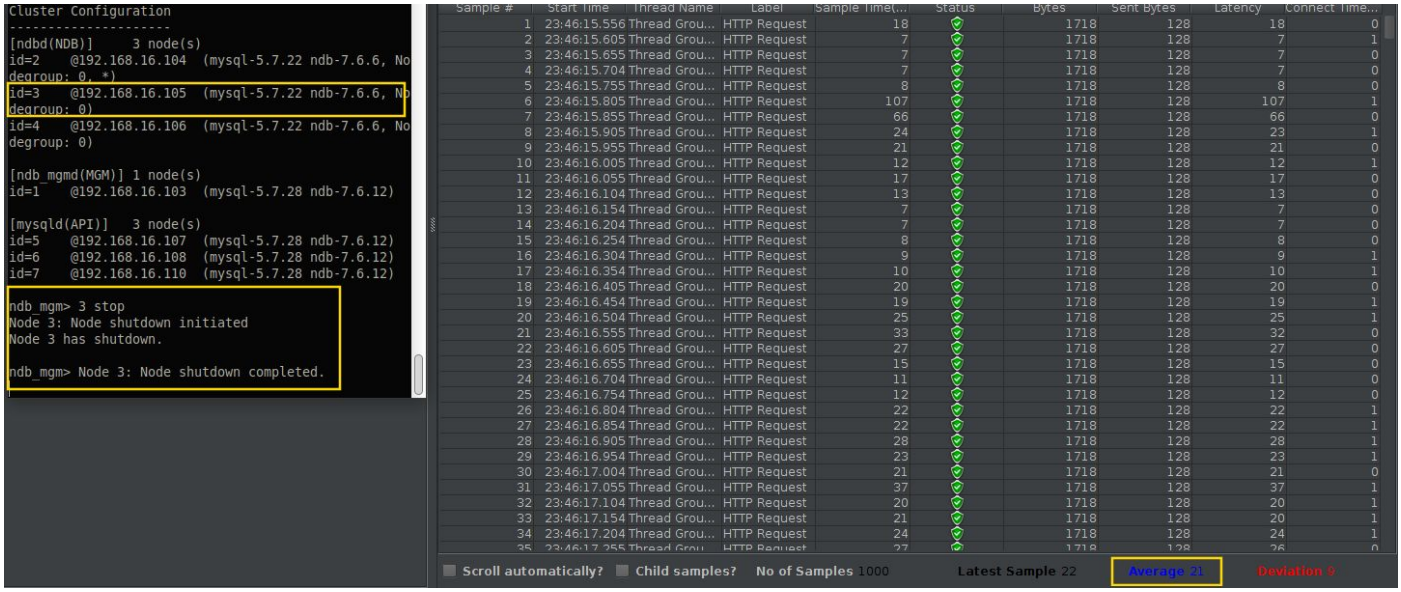


```
Initializing worker threads...

Threads started!

[ 1s ] thds: 16 tps: 15.97 qps: 1457.97 (r/w/o: 447.07/169.65/841.25) lat (ms,95%): 787.74 err/s: 0.00 reconn/s: 0.00
[ 2s ] thds: 16 tps: 48.03 qps: 2523.32 (r/w/o: 670.35/474.25/1378.72) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 3s ] thds: 16 tps: 47.00 qps: 2535.95 (r/w/o: 633.99/485.99/1415.97) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 4s ] thds: 16 tps: 33.00 qps: 1910.08 (r/w/o: 472.02/324.01/1114.05) lat (ms,95%): 569.67 err/s: 0.00 reconn/s: 0.00
[ 5s ] thds: 16 tps: 34.00 qps: 2095.05 (r/w/o: 466.01/387.01/1242.03) lat (ms,95%): 442.73 err/s: 0.00 reconn/s: 0.00
[ 6s ] thds: 16 tps: 44.00 qps: 2271.94 (r/w/o: 610.98/410.99/1249.97) lat (ms,95%): 475.79 err/s: 0.00 reconn/s: 0.00
[ 7s ] thds: 16 tps: 44.00 qps: 2503.90 (r/w/o: 608.98/464.98/1429.95) lat (ms,95%): 397.39 err/s: 0.00 reconn/s: 0.00
[ 8s ] thds: 16 tps: 44.00 qps: 2459.12 (r/w/o: 612.03/443.02/1404.07) lat (ms,95%): 404.61 err/s: 0.00 reconn/s: 0.00
[ 9s ] thds: 16 tps: 48.00 qps: 2635.95 (r/w/o: 667.99/468.99/1498.97) lat (ms,95%): 356.70 err/s: 0.00 reconn/s: 0.00
[ 10s ] thds: 16 tps: 47.00 qps: 2603.92 (r/w/o: 644.98/474.99/1483.96) lat (ms,95%): 356.70 err/s: 0.00 reconn/s: 0.00
[ 11s ] thds: 16 tps: 44.00 qps: 2492.10 (r/w/o: 613.02/453.02/1426.06) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 12s ] thds: 16 tps: 42.00 qps: 2468.96 (r/w/o: 613.99/442.99/1411.98) lat (ms,95%): 383.33 err/s: 0.00 reconn/s: 0.00
[ 13s ] thds: 16 tps: 45.00 qps: 2576.07 (r/w/o: 640.02/466.01/1470.04) lat (ms,95%): 376.49 err/s: 0.00 reconn/s: 0.00
[ 14s ] thds: 16 tps: 46.97 qps: 2596.36 (r/w/o: 651.59/470.70/1474.07) lat (ms,95%): 363.18 err/s: 0.00 reconn/s: 0.00
[ 15s ] thds: 16 tps: 45.03 qps: 2592.50 (r/w/o: 658.38/467.27/1466.85) lat (ms,95%): 369.77 err/s: 0.00 reconn/s: 0.00
SQL statistics:
    queries performed:
        read:                            9016
        write:                           6518
        other:                           20530
        total:                           36064
    transactions:                        644    (42.49 per sec.)
    queries:                             36064  (2379.35 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          15.1557s
    total number of events:              644

Latency (ms):
         min:                                  231.55
         avg:                                  374.78
         max:                                  788.86
         95th percentile:                      520.62
         sum:                               241360.95

Threads fairness:
    events (avg/stddev):           40.2500/0.75
    execution time (avg/stddev):   15.0851/0.05
```

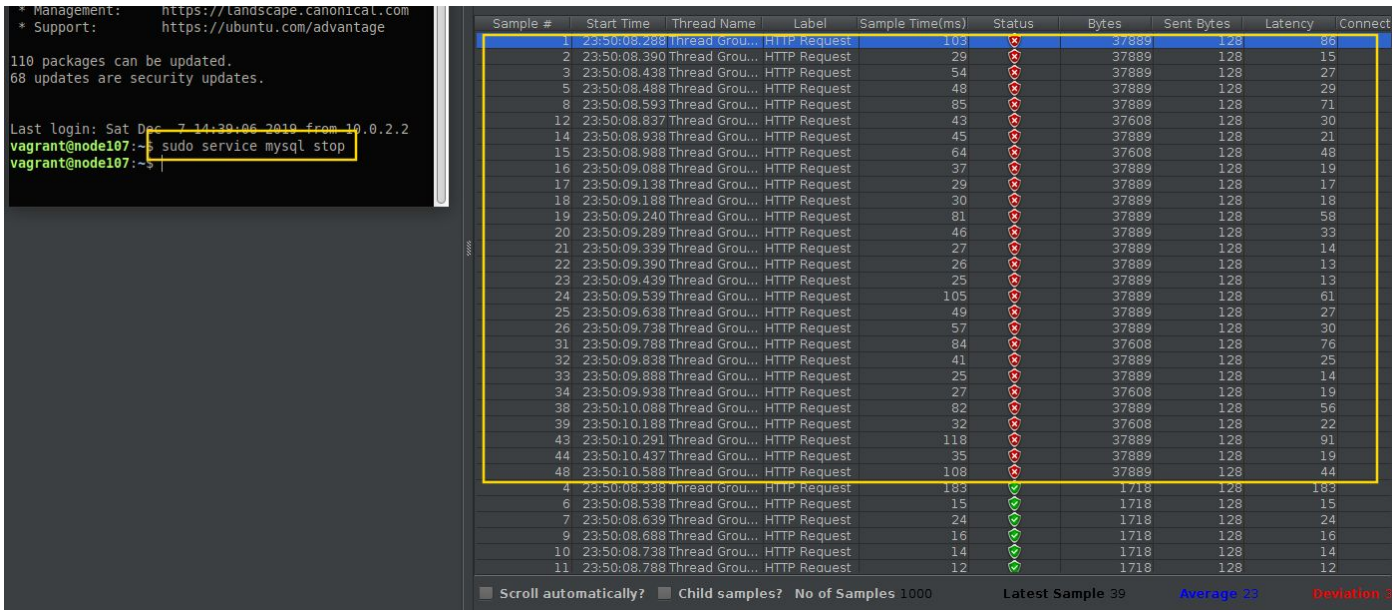
c. Uji fail-over

   i. Menghentikan salah satu NDB server ditengah-tengah load test endpoint /api/posts menggunakan JMeter

   Meskipun salah satu NDB server dimatikan, pengambilan data melalui endpoint /api/posts tetap dapat dilakukan dengan jumlah 1000 user tanpa error.



ii. Menghentikan salah satu MySQL server ditengah-tengah load test endpoint /api/posts menggunakan JMeter
Ketika salah satu MySQL server dimatikan, ada 28 dari 1000 request yang menghasilkan error. Ini disebabkan karena ProxySQL masih menggunakan host MySQL yang telah dimatikan. Setelah ProxySQL mengetahui host tersebut tidak bisa dikontak, maka ProxySQL menggunakan host lain yang ada di pool.



2. Tambahkan monitoring dashboard menggunakan Grafana
    a. Install dan konfigurasi MySQL exporter
    - Pada masing-masing MySQL server, jalankan command berikut

```
wget https://github.com/prometheus/mysqld_exporter/releases/download/v0.11.0/mysqld_exporter-0.11.0.linux-amd64.tar.gz

tar xvzf /vagrant/mysqld_exporter-0.11.0.linux-amd64.tar.gz
cd mysqld_exporter-0.11.0.linux-amd64/


sudo mv mysqld_exporter /usr/local/bin/
```

- Buat file konfigurasi

```
sudo nano /etc/.exporter.cnf
```

- Isi file /etc/.exporter.cnf sebagai berikut, nilai host mengikuti IP address masing-masing server

```
[client]
host=192.168.16.107
user=adis
password=password
```

- Buat MySQL exporter menjadi service, pada masing-masing server

```
sudo nano /lib/systemd/system/mysql_exporter.service
```

- File /lib/systemd/system/mysql_exporter.service

```
[Unit]
Description=MySQL Exporter

[Service]
Type=simple
Restart=always
ExecStart=/usr/local/bin/mysqld_exporter \
--config.my-cnf /etc/.exporter.cnf \
--collect.auto_increment.columns \
--collect.binlog_size \
--collect.engine_innodb_status \
```

```
--collect.global_status \
--web.listen-address=192.168.16.107:9104

[Install]
WantedBy=multi-user.target
```

- Jalankan service MySQL exporter

```
sudo systemctl daemon-reload
sudo systemctl start mysql_exporter.service
sudo systemctl status mysql_exporter.service
```

b. Install dan konfigurasi Prometheus

- Buat direktori Prometheus dan user Prometheus

```
sudo useradd --no-create-home --shell /bin/false prometheus
sudo mkdir /etc/prometheus
sudo mkdir /var/lib/prometheus
sudo chown prometheus:prometheus /etc/prometheus
sudo chown prometheus:prometheus /var/lib/prometheus
```

- Download dan extract file Prometheus

```
curl -LO
https://github.com/prometheus/prometheus/releases/download/v2.3.2/prometh
eus-2.3.2.linux-amd64.tar.gz
tar -xvf prometheus-2.3.2.linux-amd64.tar.gz
mv prometheus-2.3.2.linux-amd64 prometheus-files
```

- Copy file Prometheus dan ubah ownership

```
sudo cp prometheus-files/prometheus /usr/local/bin/
sudo cp prometheus-files/promtool /usr/local/bin/
sudo chown prometheus:prometheus /usr/local/bin/prometheus
sudo chown prometheus:prometheus /usr/local/bin/promtool

sudo cp -r prometheus-files/consoles /etc/prometheus
sudo cp -r prometheus-files/console_libraries /etc/prometheus
sudo chown -R prometheus:prometheus /etc/prometheus/consoles
sudo chown -R prometheus:prometheus /etc/prometheus/console_libraries
```

- Konfigurasi Prometheus

```
sudo nano /etc/prometheus/prometheus.yml
```

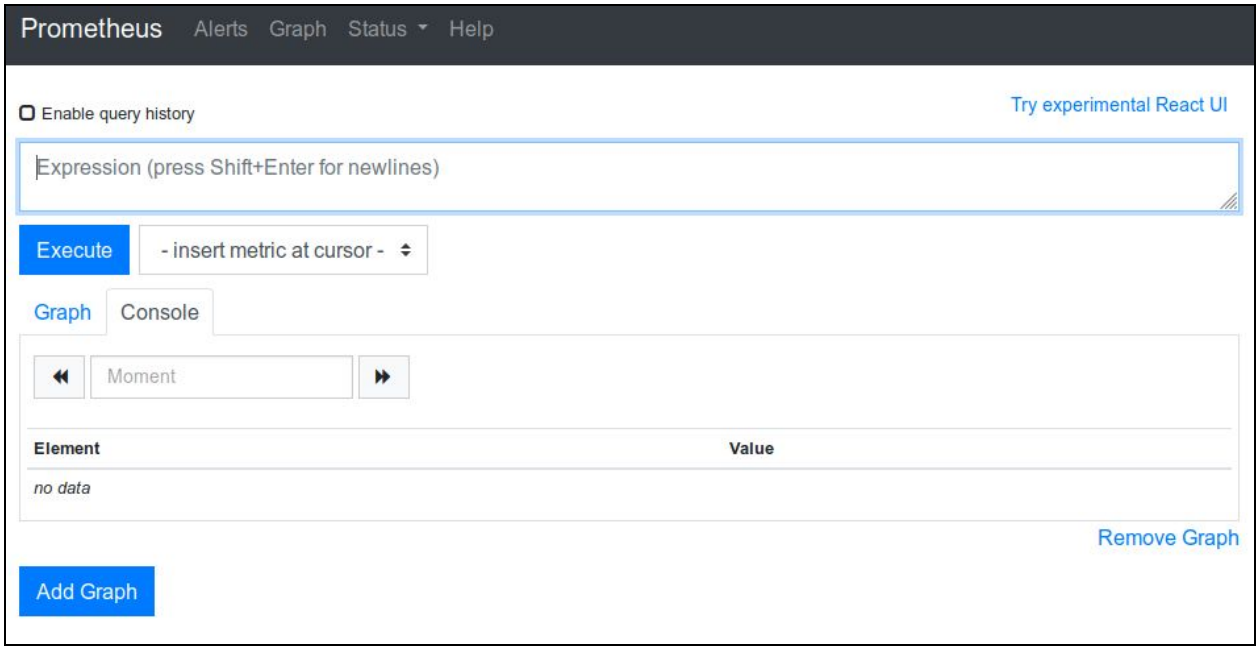
- File /etc/prometheus/prometheus.yml

```
global:
  scrape_interval: 10s

scrape_configs:
  - job_name: 'prometheus'
          scrape_interval: 5s
          static_configs:
          - targets: ['localhost:9090']

  - job_name: 'mysql'
          scrape_interval: 5s
          static_configs:
          - targets:
['192.168.16.107:9104','192.168.16.108:9104','192.168.16.110:9104']
```

- Ubah ownership dan jalankan service promotheus

```
sudo chown prometheus:prometheus /etc/prometheus/prometheus.yml

sudo systemctl start prometheus
```

- Akses localhost:9090 melalui web browser untuk melihat dashboard Prometheus

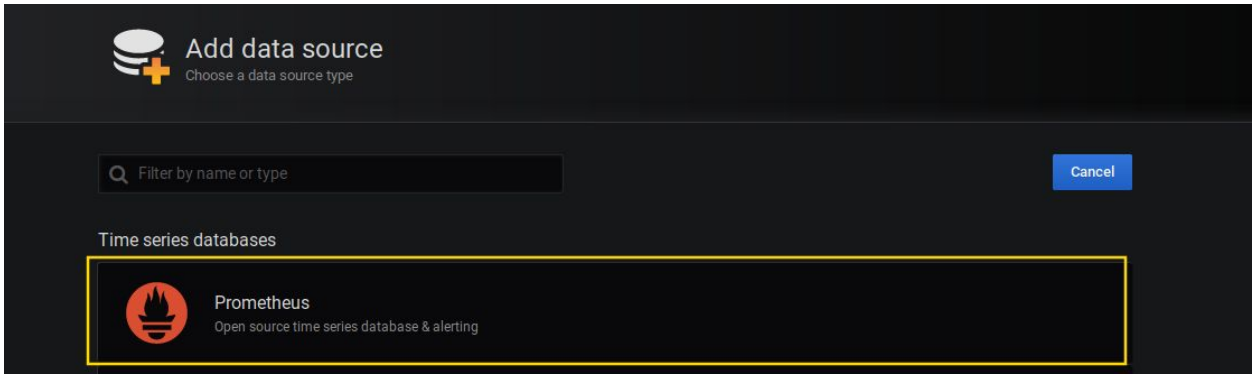


c. Install dan konfigurasi Grafana

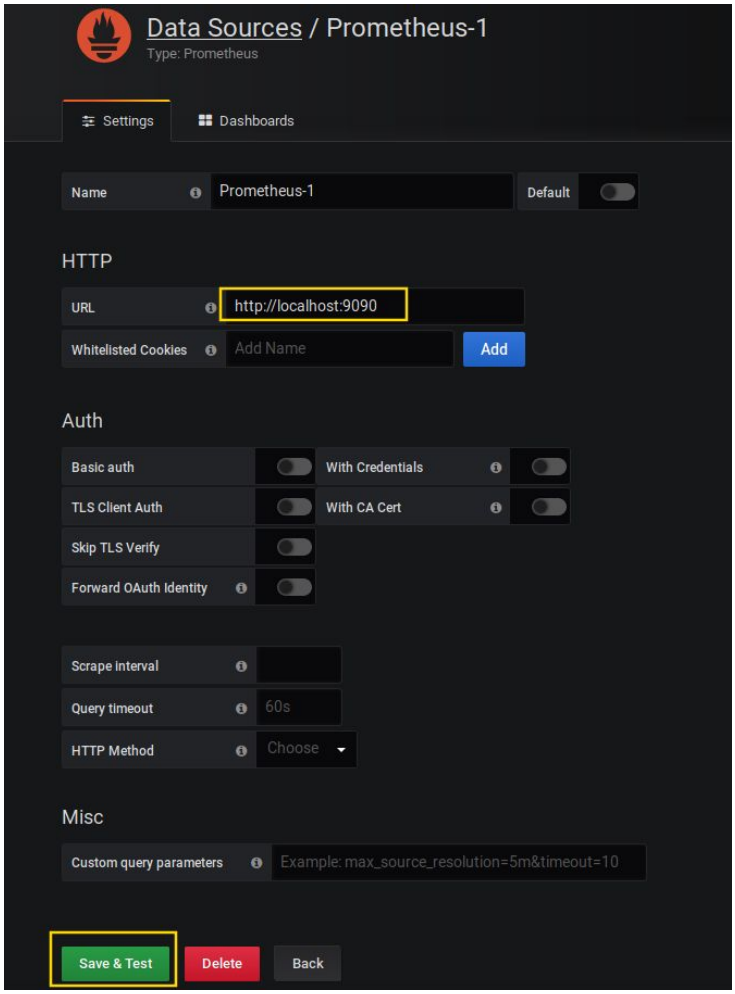
- Download Grafana

```
sudo apt-get install -y apt-transport-https
sudo apt-get install -y software-properties-common wget
sudo add-apt-repository "deb https://packages.grafana.com/oss/deb stable main"
sudo apt-get update
sudo apt-get install grafana
```

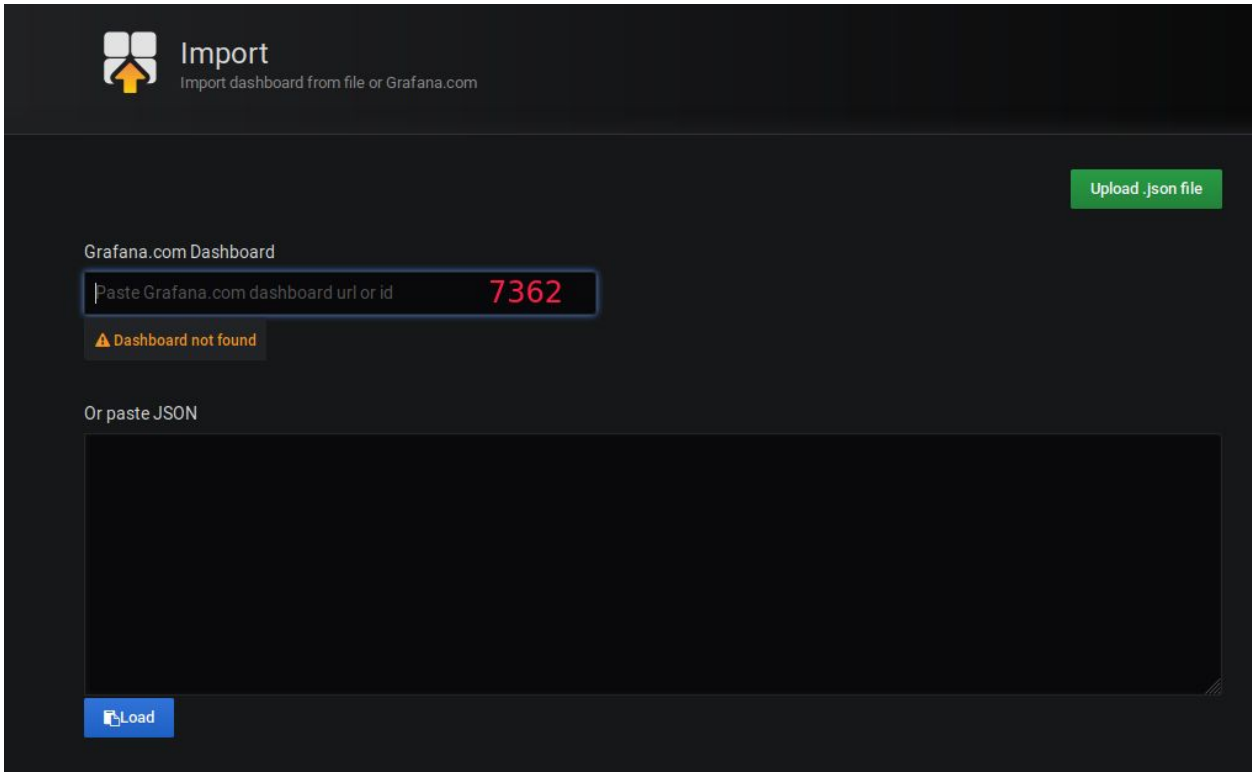
- Akses localhost:9090 untuk membuka dashboard Grafana. Tambahkan datasource baru, pilih Prometheus.



- Isi http://localhost:9090 pada field URL



- Isi kode 7362 untuk MySQL dashboard



- Tunggu beberapa saat agar statistik pada dashboard muncul