

Reporte de Instalación y Configuración de Galera 4 Cluster con MariaDB en Ubuntu Server

1. Introducción

El objetivo de esta tarea es la instalación y configuración de un Galera 4 Cluster con MariaDB en Ubuntu Server. El cluster se compone de tres nodos, siendo inicialmente configurado con dos nodos. Se realizó un benchmark para medir el rendimiento de la base de datos y se compararon los tiempos de respuesta entre un cluster de 2 nodos y uno de 3 nodos. La instalación se llevó a cabo en máquinas virtuales usando VirtualBox.

2. Requisitos y Herramientas

- **Sistema operativo:** Ubuntu Server
- **Versión de MariaDB:** [especificar versión]
- **Galera Cluster versión:** 4
- **Virtualización:** VirtualBox
- **Benchmark:** Herramienta de benchmarking de MariaDB (por ejemplo, `mysqlslap`)

3. Proceso de Instalación

3.1 Preparación del entorno en VirtualBox

Se crearon dos máquinas virtuales con Ubuntu Server, asignándoles los siguientes recursos:

- **Nodo 1 (IP 192.168.56.104)**
- **Nodo 2 (IP 192.168.56.105)**
-

3.2 Instalación de MariaDB y Galera Cluster

1. **Instalar herramientas necesarias en ambos nodos:**
 - a. `sudo apt -y install net-tools`
 - b. `sudo apt -y install software-properties-common`
 - c. `sudo apt update`

- d. `sudo apt -y install mariadb-server mariadb-client galera-4`
- e. `sudo apt -y install galera-arbitrator-4`
- f. `sudo apt -y install mariadb-client libmariadb3`
- 2. **Detener el servicio de MySQL en ambos nodos:**
 - a. `systemctl stop mysql`
 - b. `systemctl status mysql`
- 3. **Configurar Galera Cluster en ambos nodos:**
 - a. Editar el archivo `/etc/mysql/mariadb.conf.d/60-galera.cnf` en ambos nodos y configurar los siguientes parámetros:
 - b. `vi /etc/mysql/mariadb.conf.d/60-galera.cnf`
- 4. Reemplazar el contenido del documento por el siguiente:(en mi caso)

```
1 [mysqld]
2 binlog_format=ROW
3 default-storage-engine=innodb
4 innodb_autoinc_lock_mode=2
5 bind-address=0.0.0.0
6
7 # Galera Provider Configuration
8 wsrep_on=ON
9 wsrep_provider=/usr/lib/galera/libgalera_smm.so
10
11 # Galera Cluster Configuration
12 wsrep_cluster_name="test_cluster"
13 wsrep_cluster_address="gcomm://192.168.56.104,192.168.56.105,192.168.56.106" # Aquí añades las IPs de todos los nodos
14
15 # Galera Synchronization Configuration
16 wsrep_sst_method=rsync
17
18 # Galera Node Configuration
19 wsrep_node_address="192.168.56.104"
20 wsrep_node_name="nodo1"
21
```

Nota: Cambiar a modo solo anfitrión

- 5. **Iniciar el primer nodo y crear el cluster:** En el primer nodo, ejecutar:
 - a. `galera_new_cluster`

```
root@nodo1:/home/orbe# galera_new_cluster
root@nodo1:/home/orbe# |
```

- 6. **Verificar estado de mariadb**
 - a. `systemctl status mysql`

```

root@nod01:/home/orbe# systemctl status mysql
● mariadb.service - MariaDB 10.11.8 database server
   Loaded: loaded (/usr/lib/systemd/system/mariadb.service; enabled; preset: enabled)
   Active: active (running) since Sun 2025-02-16 01:22:51 UTC; 1min 26s ago
     Docs: man:mariadb(8)
           https://mariadb.com/kb/en/library/systemd/
   Process: 4876 ExecStartPre=/usr/bin/install -m 755 -o mysql -g root -d /var/run/mysqld (code=exited, status=0/SUCCESS)
   Process: 4878 ExecStartPre=/bin/sh -c systemctl unset-environment _WSREP_START_POSITION (code=exited, status=0/SUCCESS)
   Process: 4880 ExecStartPre=/bin/sh -c [ ! -e /usr/bin/galera_recovery ] && VAR=|| VAR=`cd /usr/bin/..; /usr/bin/galera_recovery`; [ $?
   Process: 5008 ExecStartPost=/bin/sh -c systemctl unset-environment _WSREP_START_POSITION (code=exited, status=0/SUCCESS)
   Process: 5010 ExecStartPost=/etc/mysql/debian-start (code=exited, status=0/SUCCESS)
  Main PID: 4989 (mariadb)
    Status: "Taking your SQL requests now..."
     Tasks: 15 (limit: 29680)
    Memory: 107.2M (peak: 110.2M)
       CPU: 1.720s
    CGroup: /system.slice/mariadb.service
            └─4989 /usr/sbin/mariadb --wsrep-new-cluster --wsrep_start_position=e6740c4b-eb4b-11ef-85c7-f64b3b3462ef:16

Feb 16 01:22:51 nod01 mariadb[4989]: Version: '10.11.8-MariaDB-0ubuntu0.24.04.1' socket: '/run/mysqld/mysqld.sock' port: 3306 Ubuntu 24.04
Feb 16 01:22:51 nod01 mariadb[4989]: 2025-02-16 1:22:51 2 [Note] WSREP: Lowest cert index boundary for CC from group: 17
Feb 16 01:22:51 nod01 mariadb[4989]: 2025-02-16 1:22:51 2 [Note] WSREP: Min available from gcache for CC from group: 1
Feb 16 01:22:51 nod01 mariadb[4989]: 2025-02-16 1:22:51 2 [Note] WSREP: Server nod01 synced with group
Feb 16 01:22:51 nod01 mariadb[4989]: 2025-02-16 1:22:51 2 [Note] WSREP: Server status change joined -> synced
Feb 16 01:22:51 nod01 mariadb[4989]: 2025-02-16 1:22:51 2 [Note] WSREP: Synchronized with group, ready for connections
Feb 16 01:22:51 nod01 mariadb[4989]: 2025-02-16 1:22:51 2 [Note] WSREP: wsrep_notify_cmd is not defined, skipping notification.
Feb 16 01:22:51 nod01 systemd[1]: Started mariadb.service - MariaDB 10.11.8 database server.
Feb 16 01:22:51 nod01 /etc/mysql/debian-start[5013]: Upgrading MariaDB tables if necessary.
Feb 16 01:22:51 nod01 /etc/mysql/debian-start[5029]: Triggering myisam-recover for all MyISAM tables and aria-recover for all Aria tables
root@nod01:/home/orbe#

```

7. Verificar el tamaño del cluster: En el primer nodo

a. `mysql -u root -p -e "SHOW STATUS LIKE 'wsrep_cluster_size'"`

```

root@nod01:/home/orbe# mysql -u root -p -e "SHOW STATUS LIKE 'wsrep_cluster_size'"
Enter password:
+-----+-----+
| Variable_name | Value |
+-----+-----+
| wsrep_cluster_size | 1 |
+-----+-----+

```

8. Es hora de realizar las pruebas de sysbench con un nodo

a. Set de pruebas de sysbench:

- `oltp_delete`

`sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_delete run`

1 nucleo

```

root@nod01:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_delete run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:               3967
    other:               84862
    total:               88829
  transactions:         88829 (1480.39 per sec.)
  queries:              88829 (1480.39 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0011s
  total number of events: 88829

Latency (ms):
  min:                   0.07
  avg:                   0.67
  max:                   141.26
  95th percentile:      1.16
  sum:                   59855.37

Threads fairness:
  events (avg/stddev):   88829.0000/0.00
  execution time (avg/stddev): 59.8554/0.00

```

`sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_delete run`

2 nucleos

```
root@nodol:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_delete run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:               1306
    other:               912968
    total:              914274
  transactions:        914274 (15235.71 per sec.)
  queries:             914274 (15235.71 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:          0 (0.00 per sec.)

General statistics:
  total time:           60.0060s
  total number of events: 914274

Latency (ms):
  min:                 0.06
  avg:                 0.13
  max:                 179.70
  95th percentile:    0.18
  sum:                 119174.99

Threads fairness:
  events (avg/stddev): 457137.0000/1503.00
  execution time (avg/stddev): 59.5875/0.01
```

- oltp_insert

1 nucleos

sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_insert run

```
root@nodol:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_insert run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:              15438
    other:                0
    total:              15438
  transactions:        15438 (257.28 per sec.)
  queries:             15438 (257.28 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:          0 (0.00 per sec.)

General statistics:
  total time:           60.0023s
  total number of events: 15438

Latency (ms):
  min:                 1.87
  avg:                 3.88
  max:                 26.35
  95th percentile:    7.30
  sum:                 59938.99

Threads fairness:
  events (avg/stddev): 15438.0000/0.00
  execution time (avg/stddev): 59.9390/0.00
```

2 nucleos

sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_insert run

```

root@node1:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_insert run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:               20877
    other:                0
    total:               20877
  transactions:         20877 (347.92 per sec.)
  queries:              20877 (347.92 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0049s
  total number of events: 20877

Latency (ms):
  min:                   2.06
  avg:                   5.74
  max:                   122.27
  95th percentile:      9.39
  sum:                   119907.38

Threads fairness:
  events (avg/stddev):    10438.5000/5.50
  execution time (avg/stddev): 59.9537/0.00

```

- **oltp_point_select**

**sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
oltp_point_select run**

```

root@node1:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql
--mysql-user=root --events=0 oltp_point_select run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                117539
    write:                0
    other:                0
    total:               117539
  transactions:         117539 (1958.92 per sec.)
  queries:              117539 (1958.92 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0008s
  total number of events: 117539

Latency (ms):
  min:                   0.06
  avg:                   0.51
  max:                   5.38
  95th percentile:      0.81
  sum:                   59824.35

Threads fairness:
  events (avg/stddev):    117539.0000/0.00
  execution time (avg/stddev): 59.8244/0.00
root@node1:/home/orbe#

```

sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_point_select run

```
root@nodol1:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_point_select run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                1191106
    write:                0
    other:                0
    total:               1191106
  transactions:         1191106 (19850.46 per sec.)
  queries:              1191106 (19850.46 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:           0 (0.00 per sec.)

General statistics:
  total time:            60.0020s
  total number of events: 1191106

Latency (ms):
  min:                   0.07
  avg:                   0.10
  max:                   70.71
  95th percentile:      0.15
  sum:                   119229.80

Threads fairness:
  events (avg/stddev):   595553.0000/850.00
  execution time (avg/stddev): 59.6149/0.01
```

- **oltp_read_only**

1 nucleos

sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only run

```
root@nodol1:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                82824
    write:                0
    other:               11832
    total:               94656
  transactions:         5916 (98.58 per sec.)
  queries:              94656 (1577.33 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:           0 (0.00 per sec.)

General statistics:
  total time:            60.0096s
  total number of events: 5916

Latency (ms):
  min:                   1.90
  avg:                   10.14
  max:                   80.48
  95th percentile:      12.08
  sum:                   59987.79

Threads fairness:
  events (avg/stddev):   5916.0000/0.00
  execution time (avg/stddev): 59.9878/0.00
```

2 nucleos

```
sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only run
```

```
root@node1:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_only run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                715694
    write:                0
    other:               102242
    total:              817936
  transactions:        51121 (851.97 per sec.)
  queries:             817936 (13631.54 per sec.)
  ignored errors:      0 (0.00 per sec.)
  reconnects:          0 (0.00 per sec.)

General statistics:
  total time:          60.0020s
  total number of events: 51121

Latency (ms):
  min:                 1.56
  avg:                 2.35
  max:                 59.60
  95th percentile:    3.02
  sum:                119886.70

Threads fairness:
  events (avg/stddev): 25560.5000/43.50
  execution time (avg/stddev): 59.9434/0.00
```

- **oltp_update_index**

1 nucleos

```
sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_update_index run
```

```
root@nodol1:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql
--mysql-user=root --events=0 oltp_update_index run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)
```

Running the test with following options:

Number of threads: 1

Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:

queries performed:	
read:	0
write:	56
other:	125633
total:	125689
transactions:	125689 (2094.76 per sec.)
queries:	125689 (2094.76 per sec.)
ignored errors:	0 (0.00 per sec.)
reconnects:	0 (0.00 per sec.)

General statistics:

total time:	60.0008s
total number of events:	125689

Latency (ms):

min:	0.04
avg:	0.48
max:	113.30
95th percentile:	0.77
sum:	59818.41

Threads fairness:

events (avg/stddev):	125689.0000/0.00
execution time (avg/stddev):	59.8184/0.00

2 nucleos

**sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
oltp_update_index run**

```
root@nodol1:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_update_index run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)
```

Running the test with following options:

Number of threads: 2

Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:

queries performed:	
read:	0
write:	526
other:	1111832
total:	1112358
transactions:	1112358 (18536.60 per sec.)
queries:	1112358 (18536.60 per sec.)
ignored errors:	0 (0.00 per sec.)
reconnects:	0 (0.00 per sec.)

General statistics:

total time:	60.0072s
total number of events:	1112358

Latency (ms):

min:	0.04
avg:	0.11
max:	215.73
95th percentile:	0.15
sum:	119317.52

Threads fairness:

events (avg/stddev):	556179.0000/6946.00
execution time (avg/stddev):	59.6588/0.01

- **oltp_read_write**

1 Nucleo

sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_write run

```
root@nodo1:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_write run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                45668
    write:               10712
    other:               8860
    total:              65240
  transactions:         3262 (54.36 per sec.)
  queries:              65240 (1087.27 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:           0 (0.00 per sec.)

General statistics:
  total time:           60.0026s
  total number of events: 3262

Latency (ms):
  min:                  7.00
  avg:                  18.39
  max:                  31.28
  95th percentile:     22.69
  sum:                  59979.99

Threads fairness:
  events (avg/stddev):  3262.0000/0.00
  execution time (avg/stddev): 59.9800/0.00
```

2 Nucleos

sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_write run

```

root@nodol:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_read_write run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                88046
    write:               22393
    other:               15341
    total:              125780
  transactions:         6289 (104.79 per sec.)
  queries:              125780 (2095.72 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0168s
  total number of events: 6289

Latency (ms):
  min:                   5.67
  avg:                   19.08
  max:                   51.80
  95th percentile:      25.74
  sum:                   119978.42

Threads fairness:
  events (avg/stddev):    3144.5000/10.50
  execution time (avg/stddev): 59.9892/0.01

```

- **oltp_update_index**

1 Nucleo

**sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
oltp_update_index run**

```

root@nodol:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_update_index run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:              10567
    other:               1400
    total:              11967
  transactions:         11967 (199.44 per sec.)
  queries:              11967 (199.44 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0018s
  total number of events: 11967

Latency (ms):
  min:                   0.08
  avg:                   5.01
  max:                   15.36
  95th percentile:      9.22
  sum:                   59956.08

Threads fairness:
  events (avg/stddev):    11967.0000/0.00

```

2 Nucleos

**sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
oltp_update_index ru**

```

root@nodol:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_update_index run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:               15766
    other:               2126
    total:              17892
  transactions:        17892 (298.16 per sec.)
  queries:             17892 (298.16 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:           0 (0.00 per sec.)

General statistics:
  total time:           60.0082s
  total number of events: 17892

Latency (ms):
  min:                  0.05
  avg:                   6.70
  max:                   25.24
  95th percentile:     11.87
  sum:                  119927.39

Threads fairness:
  events (avg/stddev):  8946.0000/41.00
  execution time (avg/stddev): 59.9637/0.00

```

- **oltp_update_non_index**

1 Nucleo

**sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
oltp_update_non_index run**

```

root@nodol:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_update_non_index run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:              10522
    other:               1446
    total:              11968
  transactions:        11968 (199.45 per sec.)
  queries:             11968 (199.45 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:           0 (0.00 per sec.)

General statistics:
  total time:           60.0033s
  total number of events: 11968

Latency (ms):
  min:                  0.11
  avg:                   5.01
  max:                   16.42
  95th percentile:     9.39
  sum:                  59969.38

Threads fairness:
  events (avg/stddev):  11968.0000/0.00
  execution time (avg/stddev): 59.9694/0.00

```

2 Nucleos

**sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
oltp_update_non_index run**

```

root@nodol:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_update_non_index run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:               15914
    other:               2049
    total:              17963
  transactions:        17963 (299.34 per sec.)
  queries:             17963 (299.34 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:          0 (0.00 per sec.)

General statistics:
  total time:          60.0085s
  total number of events: 17963

Latency (ms):
  min:                 0.06
  avg:                 6.68
  max:                184.92
  95th percentile:    11.87
  sum:                119954.18

Threads fairness:
  events (avg/stddev): 8981.5000/23.50
  execution time (avg/stddev): 59.9771/0.00

```

- **oltp_write_only**

1 Nucleo

sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_write_only run

```

root@nodol:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_write_only run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:              23901
    other:              14631
    total:             38532
  transactions:        6422 (107.03 per sec.)
  queries:             38532 (642.17 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:          0 (0.00 per sec.)

General statistics:
  total time:          60.0021s
  total number of events: 6422

Latency (ms):
  min:                 3.58
  avg:                 9.34
  max:                34.83
  95th percentile:    13.46
  sum:                59955.38

Threads fairness:
  events (avg/stddev): 6422.0000/0.00
  execution time (avg/stddev): 59.9554/0.00

```

2 Nucleos

sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_write_only run

```
root@nodol1:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 oltp_write_only run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                0
    write:               41661
    other:               23613
    total:               65274
  transactions:         10879 (181.29 per sec.)
  queries:               65274 (1087.74 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0080s
  total number of events: 10879

Latency (ms):
  min:                   4.39
  avg:                   11.02
  max:                   45.15
  95th percentile:      15.27
  sum:                   119940.56

Threads fairness:
  events (avg/stddev):   5439.5000/11.50
  execution time (avg/stddev): 59.9703/0.00
```

- **select_random_points**

1 Nucleo

sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 select_random_points run

```
root@nodol1:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 select_random_points run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                3627
    write:                0
    other:                0
    total:               3627
  transactions:         3627 (60.43 per sec.)
  queries:               3627 (60.43 per sec.)
  ignored errors:        0 (0.00 per sec.)
  reconnects:            0 (0.00 per sec.)

General statistics:
  total time:            60.0155s
  total number of events: 3627

Latency (ms):
  min:                   3.78
  avg:                   16.54
  max:                   271.22
  95th percentile:      23.95
  sum:                   59986.31

Threads fairness:
  events (avg/stddev):   3627.0000/0.00
  execution time (avg/stddev): 59.9863/0.00
```

2 Nucleos

**sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
select_random_points run**

```
root@nod1:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 select_random_points run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                666384
    write:                0
    other:                0
    total:               666384
  transactions:         666384 (11105.73 per sec.)
  queries:              666384 (11105.73 per sec.)
  ignored errors:        0      (0.00 per sec.)
  reconnects:            0      (0.00 per sec.)

General statistics:
  total time:            60.0024s
  total number of events: 666384

Latency (ms):
  min:                   0.07
  avg:                   0.18
  max:                   13.21
  95th percentile:      0.27
  sum:                   119057.49

Threads fairness:
  events (avg/stddev):   333192.0000/21880.00
  execution time (avg/stddev): 59.5287/0.02
```

- **select_random_ranges**

1 Nucleo

**sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0
select_random_ranges run**

```
root@nod1:/home/orbe# sysbench --threads=1 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 select_random_ranges run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                8662
    write:                0
    other:                0
    total:               8662
  transactions:         8662 (144.35 per sec.)
  queries:              8662 (144.35 per sec.)
  ignored errors:        0      (0.00 per sec.)
  reconnects:            0      (0.00 per sec.)

General statistics:
  total time:            60.0049s
  total number of events: 8662

Latency (ms):
  min:                   1.83
  avg:                   6.92
  max:                   18.80
  95th percentile:      9.56
  sum:                   59971.83

Threads fairness:
  events (avg/stddev):   8662.0000/0.00
  execution time (avg/stddev): 59.9718/0.00
```

2 Nucleos

```
sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0  
select_random_ranges run
```

```
root@nodol:/home/orbe# sysbench --threads=2 --time=60 --rate=0 --db-driver=mysql --mysql-user=root --events=0 select_random_ranges run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 2
Initializing random number generator from current time

Initializing worker threads...

Threads started!

SQL statistics:
  queries performed:
    read:                651714
    write:                0
    other:                0
    total:               651714
  transactions:         651714 (10860.85 per sec.)
  queries:              651714 (10860.85 per sec.)
  ignored errors:       0 (0.00 per sec.)
  reconnects:          0 (0.00 per sec.)

General statistics:
  total time:            60.0031s
  total number of events: 651714

Latency (ms):
  min:                   0.07
  avg:                   0.18
  max:                   11.64
  95th percentile:     0.26
  sum:                   119070.40

Threads fairness:
  events (avg/stddev):   325857.0000/7309.00
  execution time (avg/stddev): 59.5352/0.01
```

La práctica mostró que aumentar el número de hilos mejora el rendimiento de la base de datos en la mayoría de los escenarios de carga concurrente, especialmente en operaciones de lectura, escritura, actualización y eliminación. Sin embargo, la magnitud de la mejora depende de la naturaleza de la prueba y de la capacidad de la base de datos para manejar múltiples hilos de manera eficiente. Para cargas de trabajo con un solo hilo, las bases de datos pueden tener un rendimiento más limitado, pero para cargas de trabajo concurrentes, como las que involucran múltiples usuarios o procesos simultáneos, el uso de 2 hilos demostró ser una mejora significativa.

Esto resalta la importancia de ajustar la cantidad de hilos en función de la carga de trabajo real de la base de datos, para obtener el mejor rendimiento en un entorno de producción.